Appendix K
Walla Walla District TDG Report

US Army Corps
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Walla Walla District

Quality Assurance and Quality Control for Total Dissolved Gas Monitoring - Lower Snake River, Washington; Clearwater River, Idaho; and Columbia River, Oregon and Washington Water Year 2001

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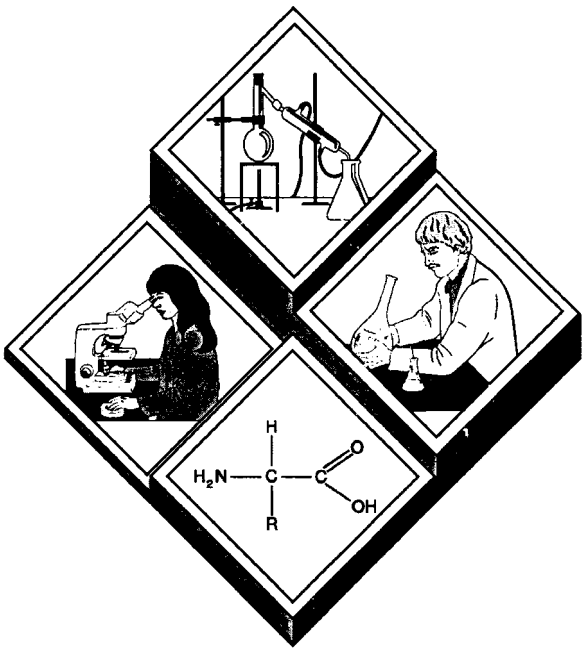

March 2002

QUALITY ASSURANCE AND QUALITY CONTROL FOR TOTAL DISSOLVED GAS MONITORING - LOWER SNAKE RIVER, WASHINGTON; CLEARWATER RIVER, IDAHO; AND COLUMBIA RIVER, OREGON AND WASHINGTON WATER YEAR 2001

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ABSTRACT

The U.S. Army Corps of Engineers Walla Walla District (CENWW) operates 16 water quality stations to monitor total dissolved gas (TDG) in the Columbia, Snake, and Clearwater Rivers. Each station collects and transmits hourly data via the Geo-stationary Operational Environmental Satellite (GOES) system every 4 hours to the Corps of Engineers Northwestern Division (CENWD) in Portland, Oregon. The data is stored in the Columbia River Operational Hydromet Management System (CROHMS) database. Collectively, this system is called the Total Dissolved Gas Monitoring System (TDGMS). The acronym DQO generally means data quality objective but a more limited definition is intended for TDGMS and that is the level of acceptable deviation of a sensor's measurements from 1) its standard in the laboratory, or 2) a portable standard in the field. The CENWW directed the use of the following DQOs for the TDGMS: 1) for comparison to a laboratory standard (minisonde calibration data) the TDG sensor Delta values may be $\leq \pm 2$ mmHg from a mercury barometer and temperature sensor Delta values may be $\leq \pm 0.10$ °C from a mercury thermometer, and; 2) for comparison to a portable field standard (station comparison data) the TDG sensor Delta values may be $\leq \pm 4$ mmHg, temperature sensor Delta values may be $\leq \pm 0.20$ °C, and dissolved oxygen sensor Delta values may be $\leq \pm 0.50$ mg/L from the field standard (newly calibrated minisonde). The following cumulative means and single standard deviations (SDV) were calculated for fiscal year 001 (FY01) minisonde calibration data: 0.00 ± 0.70 mmHg for the base TDG calibration point; -0.01 ± 0.70 mmHg for offset TDG calibration point; and -0.07 ± 0.04 °C for water temperature. The following cumulative means and single standard deviations (SDV) were calculated for FY01 station comparison data: -0.10 ± 1.79 mmHg for TDG; -0.01 ± 0.06 °C for water temperature; and -0.28 ± 0.59 mg/L for dissolved oxygen. Station barometer performance is also monitored using a portable barometer as a standard although a DQO is not currently maintained for this parameter. The cumulative mean and SDV for station barometer Delta values was $+0.50 \pm 2.22$ mmHg. In FY01, CENWW's focus was on maximizing barometer reliability and precision. The success of this effort was exemplified by the fact that measurement accuracy increased for all of the parameters in FY01 from the levels measured in fiscal year 2000 (FY00). Improved calibration procedures and new calibration standards accounted for the increases in data quality.

SECTION 1.0 - INTRODUCTION

1.01. BACKGROUND.

The CENWW operates six multi-purpose dams in the Columbia River, Lower Snake River, and Clearwater River Basins. The drainage area above these dams is approximately 214,000 square miles. These facilities provide flood control, navigation, irrigation, recreation, hydropower, fish and wildlife habitat, and municipal and industrial water supply. During spring runoff, air is entrained with plunging flows over the spillways and is carried deep into the stilling basin where water pressure causes the air to dissolve. Beyond the stilling basin, the river becomes shallow and the water becomes supersaturated. The U.S. Environmental Protection Agency (USEPA) has established an upper limit of 110 percent saturation for protection of freshwater aquatic life. Concentrations above this level can cause gas bubble trauma in fish and adversely affect other aquatic organisms (USEPA, 1986). Spillway deflectors have been installed on all dams in the area served by CENWW to reduce the plunging depths of spillway flows during normal water years. The CENWW collects real-time TDG data (available within about 4 hours of current time) upstream and downstream from its dams in a network of fixed station monitors known as the Total Dissolved Gas Monitoring System (TDGMS).

Real-time TDG data are vital for dam operation and for monitoring compliance within state and Federal guidelines and regulations. Water management personnel at the CENWD maintain favorable water quality conditions, facilitate fish passage, and improve survival in the Federal Hydropower System. HDR Engineering (HDR), under contract DACW-00-D-001 with CENWW, operated and maintained instruments from the 16 TDGMS sites. The CENWW was responsible for maintaining the data collection system while increasing levels of quality assurance/quality control (QA/QC). Data collection methods and QA plans have changed significantly since 1996. In water year 2001, the purchase of new standards and development of new laboratory calibration procedures improved the quality assurance of TDG and temperature data. In addition, hourly data for water year 2001 was deleted to reflect measurements made during instrument calibration that were within the data quality objectives. Water Year 2001 also included the design and construction of an improved deployment station facility for two sites located in the Ice Harbor and Lower Monumental tailwaters. The new system used a series of stainless steel cables and a pedestal as an alternative to the poly-vinyl chloride (PVC) protective pipes. Further evaluation will determine the merits of that design.

Measurement of water quality parameters (oxygen, temperature, dissolved gas, and, recently, depth of station) has evolved over the last 20 plus years. In the early 1980s, the TDG equipment used in monitoring consisted primarily of analog scaled voltage readings. The equipment averaged true accuracies of $\pm$ 5 mmHg for TDG, $\pm$ 0.7°C, and dissolved oxygen was accurate to $\pm$ 2mg/L most of the time. Maintenance was at times troublesome and costly. In many cases the maintenance was done at 1-

to 2-month cycles. A significant increase in reliability and accuracy required new instrumentation and a better quality assurance program. In 1996, the CENWD headquarters relinquished the task of data collection to the districts. This reorganization proved successful, and a very close partnership has developed between CENWD Water Management, the districts, and their prospective contractors such as the USGS and HDR Engineering.

1.02. PURPOSE AND SCOPE.

The purpose of gas monitoring is to provide managers, agencies, and interested parties with near real-time data for managing stream flows and TDG levels downstream from Federal dams. As with any data collection activity, an important component that cannot be overlooked is the quality of the data. Measurement of data quality allows determination of the usefulness and relevance of data for current and future decision processes.

This report described the data collection methods and evaluates QA/QC data for the TDGMS that includes the McNary, Ice harbor, Lower Monumental, Little Goose, and Lower Granite reservoirs. Additionally, this system provided water quality data for the Clearwater River downstream of Dworshak Dam, the Columbia River near Pasco, and the Snake River near Anatone, Washington (see table 3-1 and figures 3-1, 3-2, and 3-3). This report was designed to document data quality of the TDGMS for water year 2001. Measurements include TDG pressure, dissolved oxygen, barometric pressure, and water temperature at 16 sites. The QA/QC data are divided into two categories:

(1) Instrument data are used to evaluate how an instrument performs based on the magnitude and direction that the individual sensors deviate over time from their respective laboratory standards. These relationships are measured for each sensor during the calibration procedures, which usually occur every 2 weeks.

(2) Station data present the comparison between an in-place instrument that has been deployed at a given station for a 2-week cycle and a newly calibrated QA/QC instrument (field standard). The Honeywell barometers at each station were also evaluated using the Surveyor 4 that serves as a portable field standard for barometric pressure. In the summer (1 April to 15 Sept), 16 stations were visited for maintenance two times per month. In the winter (16 Sept to 30 Mar), 9 stations were maintained on the same bi-weekly schedule.

Field data are entered into a Microsoft Access® database utilizing an automated data entry form with validation rules in place to minimize errors associated with data transfer from the field collection sheets. Microsoft Access® was used to store and sort the data in preparation for statistical analyses that were preformed in Microsoft Excel®.

1.03. ACKNOWLEDGMENTS.

The authors also acknowledge Mr. Greg Rupert, Mr. Andy Records, Mr. Joe Bunt, and Mr. Dwight Tanner, our co-operators from the USGS, for assistance in operation of the data collection platforms (DCPs). Thanks go to Ms. Ruth Abney for her help from the division office. And our very special thanks go to Mrs. Julie Dockery and Mrs. Charlene Duncan from the Walla Walla District, Contracting Division.

SECTION 2.0 - METHODS

2.01. DATA QUALITY OBJECTIVES.

The acronym DQO generally means data quality objective but a more limited definition is intended for TDGMS and that is the level of acceptable deviation of a sensor's measurements from (1) its standard in the laboratory, or (2) a portable standard in the field. Thus, the DOQs are actually Delta values, which were used as a guide to define conditions under which sensor measurements were considered to be normal (reflect only error inherent in the sensor) or conditions under which sensor measurements reflected additional error induced by the user. When sensor measurements differed from the standard by an amount greater than the corresponding DQO for that parameter, the Delta value was designated as an *outlying data point*, which was an indication that attention should be given to the occurrence of such data points in order to identify and eliminate the additional error before it became systemic. In either case, whether the Delta value exceeded or did not exceed the DQO, the values were included in the QA/QC summary statistics. Only when sensor measurements were deemed *invalid* were they not included in summary statistics.

The CENWW directed the use of the following data quality objectives to maintain the TDGMS during fiscal year 2001 (FY01):

(1) For comparison to a laboratory standard (minisonde calibration data) the TDG sensor Delta values may be $\leq \pm 2$ mmHg from a mercury barometer and temperature sensor Delta values may be $\leq \pm 0.10$ °C from a mercury thermometer.

(2) For comparison to a portable field standard (station comparison data) the TDG sensor Delta values may be $\leq \pm 4$ mmHg, temperature sensor Delta values may be $\leq \pm 0.20$ °C, and dissolved oxygen sensor Delta values may be $\leq \pm 0.50$ mg/L from the field standard (newly calibrated minisonde).

(3) The CENWW did not establish DQOs for Delta Bar station values or Delta dissolved oxygen (DO) sonde calibration values in FY01 (see discussion).

These levels are minimum requirements as much as they are thresholds. As improvements are made to the system, these levels would be improved to encourage continued progress towards meeting long-term water quality objective goals for CENWW projects.

2.02. INSTRUMENTATION.

Instrumentation at the 16 fixed stations consisted of a multi-parameter water quality sonde, an electronic barometer, a DCP, and either a 120-volt alternating current (VAC) or 12-volt direct current (VDC) power supply. The same type of instrumentation was used at each of the 16 stations but installations, locations, and river conditions near

the instruments were unique to each site, and stations were subject to daily fluctuations in river flow as turbines and spillway gates were periodically opened and closed.

The DCP has three basic functions: sensor interfacing, data storage, and data transmission to the GOES system. Most of the stations used a crossed Yagi antenna connected to the DCP using a coaxial cable with the antenna mounted on a mast to provide transmission to the GOES system. Due to continuous vandalism problems at the Pasco levee and McNary tailwater stations a "Top-hat" antenna was used. At all 16 stations, the DCP controlled the supply of power to the barometer and the water quality sonde. All DCPs were powered directly by an 86 ampere-hour, 12-volt gelled-electrolyte battery manufactured by Deka®. The battery was charged with a voltage-regulated circuit from a 12 VDC, 30-watt solar panel regulated by a Sun saver® model (6 or 10) LVD power controller or a 120 VAC trickle charge system manufactured by Coastal Environmental Systems®. The DCP was programmed to record and transmit five parameters: barometric pressure (in mmHg), TDG pressure (in mmHg), DO [in milligrams per liter (mg/L) and percent saturation], water temperature (in ° C), and battery voltage (in volts). Battery voltage was monitored to ensure that the instrumentation received adequate power. The data for each parameter was logged electronically every hour, on the hour, and stored in the DCP memory. Every 4 hours, the DCP transmitted the most recent 8 hours of logged data to the GOES satellite. Consequently, each piece of data was transmitted two times to protect against data loss. The GOES satellite re-transmitted the data to a direct readout ground station at Wallops Island where it was automatically decoded and re-transmitted to the DOMSAT system. A satellite downlink automatically transferred the data to the CROHMS database located in Portland, Oregon. During the fixed station calibration visits, the DCP stored data was downloaded to a Rocky 2000® computer. When necessary to fill in any real-time data lost during satellite transmission, the data was sent via e-mail to Corps Division Office in Portland, Oregon.

The water quality sonde currently in use is the Hydrolab Corporation MiniSonde® 4 or MiniSonde® 4a. The Hydrolab minisondes used in the TDGMS were programmed to report TDG, DO, and temperature (Temp). In addition, a Surveyor 4 instrument was used as a field standard to evaluate station barometer performance. The TDG sensor measured the sum of the partial pressures of gaseous compounds dissolved in the water and reported the results in millimeters of mercury (mmHg). The TDG sensor membrane consisted of a cylindrical framework wound with a length of Silastic (dimethyl silicon) tubing. The tubing was tied off at one end and the other end was connected to a mechanical pressure transducer. After the TDG pressure in the river equilibrates with the gas pressure inside the tubing (about 15 to 20 minutes), the pressure transducer measured a potentiometer voltage that was converted to mmHg electronically. Thus, a point measurement of the TDG pressure in the river was then transmitted digitally to the DCP. The water temperature sensor was a thermocouple. Honeywell manufactured the barometer and is a Precision Pressure Transducer (PPT) model [14 pounds per square inch (psi)] precision pressure transducer connected to analog channel 4 on the DCP. A heavy-duty, weatherproof cable connected the sonde to the number one SDI-12 channel of a Sutron® Model 8210 DCP.

Each instrument package was installed in a 4-inch-diameter PVC pipe mounted in a convenient but unobtrusive location. Forebay stations were attached to the face of the dam by clamps. Tailwater and river stations were laid on the bank and anchored to large blocks of concrete a few feet below water. The instrument was inserted and withdrawn by use of a small rope looped over a bolt at the submerged end of the pipe. This usually worked well but, occasionally, river debris, mechanical damage, or fluctuating water levels interfered with normal operation.

The Dworshak tailwater station had a dual communications package and was configured to send 15-minute data to the power plant operator to assist in operation of the Francis turbine air injection system. The data was then sent through the GOES systems on the 4-hour time hack with hourly data like the rest of the DCPs. The special 15-minute data was sent directly to the power plant operator controls and was not available for outside use beyond the project control room.

2.03. INSTRUMENT CALIBRATION.

The TDGMS maintenance schedule was based on a two-week instrument deployment cycle. This means that a newly calibrated instrument was deployed at each active station every two weeks. Instrument re-calibration occurred upon retrieval of the instrument from the field following the two-week deployment except when instruments failed in the field and required early extraction or testing. On the sondes, only the TDG and DO sensors required re-calibration. The temp sensors were factory calibrated and only required performance checks. The Surveyor 4 was also re-calibrated on a regular basis. Station barometers were only calibrated by CENWW personnel.

Barometric pressure readings were used for calibrating the TDG sensors, DO sensors, and the Surveyor 4 instruments. Barometric pressure was also an important value used in calculating the percent of TDG saturation. A wall mounted mercury barometer was the primary standard for barometric pressure in the TDGMS. The Surveyor 4 was calibrated to the mercury barometer and served as a portable secondary standard during fieldwork, which included DO sensor calibrations, periodic TDG sensor calibrations, and performance checks for the Honeywell barometers at each station.

The TDG sensors required a two-step calibration procedure. This meant that adjustments were made at two points on the calibration curve in order to calibrate the sensor. In this report, the atmospheric pressure calibration point was referred to as Base TDG and the pressurized calibration point corresponds to Pressurized TDG (Pres TDG). The base point was equal to the atmospheric pressure at the time of calibration as measured utilizing a wall mounted mercury barometer or recently calibrated Surveyor 4 instrument. The Pres TDG point was equal to the barometric pressure plus a standard value that was chosen to include the full range of TDG values expected to be measured in the field by the sensor. In most cases, a standard of 200 mmHg added to barometric pressure created a slope capable of establishing the calibration curve

over the full range of expected measurement values. Heise™ instrumentation was used to apply pressure to the TDG sensor.

Each sonde contained a temperature sensor for reporting the water temperature. The results were reported in degrees Celsius. Sonde thermometers were factory calibrated. The user could not make adjustments to the temperature sensor calibration. Users could only assess the performance of the temperature sensors by comparing their readings to an NIST traceable mercury thermometer standard.

A dissolved oxygen probe measured the concentration of oxygen present in water. The sonde reported the DO results in percent of saturation (percent sat) and milligrams per liter (mg/L). The DO sensors were refurbished with fresh electrolyte and a new membrane prior to each deployment. The membranes were soaked for a period of 24 hours before field use. DO sensors were field calibrated using the ambient air method with a barometric pressure reading from the portable barometer standard (Surveyor 4). An appropriate evaluation method for DO sensor calibration data has not been fully developed. This report contains an evaluation of only the station comparison dissolved oxygen data.

Station barometers were factory calibrated and have a service life of about 5 years. Users could only assess the performance of the station barometers by comparing the station barometer readings to the Surveyor 4 as a standard during each station visit.

Calibration curves can change over time, hence the need for calibration checks and adjustments. However, when the magnitude of the change is greater than the manufacturer specified precision limit for a sensor, this may indicate a previous calibration error or a faulty sensor. Instruments with damaged or failing sensors were sent to the manufacturer for repair or refurbishment. Some instruments that were older than 4 or 5 years received a Service Life Extension Program (SLEP) refit. This entailed complete overhaul of the sensors and extensive diagnostic checks to the electronics by the manufacturer. At the close of FY01 most of the equipment in use had required some level of maintenance.

2.04. PERFORMANCE DATA.

It is important to recognize the difference between calibration data and performance data. Performance data was collected each time a sensor was compared to its standard or when two instruments were compared at a given station. These values represent the measured difference between two readings and were keyed with the term Delta. Delta values reflected the +/- variation of sensor readings from their respective standard (*e.g.,* a negative value indicates that the sensor or instrument was reading below its respective standard).

2.05. CALIBRATION DATA.

Calibration procedures only took place after recording of the *performance* data described above. Calibration Data reflected the actual adjustments that took place when a sensor was calibrated to correct for drift. These values were keyed with the term Adjustment because they represented the actual adjustment made to the calibration curve. A positive adjustment value indicates that the sensor was reading below the standard (equivalent to a negative performance value) and required pressure be added to the sensor during calibration in order to match the standard. Adjustment and Delta values should always have opposite signs but should be equal in magnitude, unless no adjustment was required (*i.e.,* the Delta was zero, which does not have a sign).

2.06. MONTHLY CHARTING AND CALCULATIONS.

The volume of data collected for any specific instrument or station on a monthly basis was not sufficient to perform meaningful calculations or produce observable variance. To increase the number of (*n*) values for each statistical analysis, all of the station data entered into the QA/QC database in a particular month were combined to evaluate "System-Wide Station Performance." The instrument data points were entered into the QA/QC database during their respective month and were combined to evaluate the "Inventory-Wide Sonde Performance."

Inventory-wide sonde performance charts evaluated the performance data for the entire population of TDG sensors and thermometers. Delta values were calculated for each parameter by subtracting the appropriate standard from the observed pre-calibrated sensor reading collected during instrument calibration. Once the Delta values were calculated they were averaged on a monthly basis to calculate a monthly mean Delta for each parameter. The standard deviation was also calculated for each parameter on a monthly basis. The following equations summarize the previous written description.

Delta Base TDG = [Pre-Calibrated Base TDG] - [Atmospheric Pressure]

Delta Pres TDG = [Pre-Calibrated Pres TDG] - [Pressurized Standard]

Delta Temperature = [Sonde Temperature] - [NBS Standard Temperature]

Monthly mean Delta = [Sum of Deltas for X] / (n) where n = number of Delta for parameter X values for parameter X from entire sonde inventory

Standard Deviation (SDV) = $\sqrt{\frac{n\sum x^2 - \left(\sum x\right)^2}{n(n-1)}}$ where *x* = Delta for any parameter

The monthly sonde performance charts displayed the monthly mean Delta values plotted for each parameter versus time (calibration date). Each chart represented one parameter and contained one data point per month. The y-error bars presented on the charts represent +/- 1 standard deviation for the corresponding mean. The monthly inventory-wide sonde performance data, charts, and tables are contained in section 3.01 and appendix A.

The performance of a station was measured by comparing two instruments at a given station at the same time, then subtracting the QA/QC Sonde (standard) readings from the In-place instrument readings to calculate the Delta values for TDG, DO and Temperature. The QA/QC Sonde was considered the secondary standard of the two instruments being compared since it was the one most recently calibrated in the lab and the best available option. The Honeywell barometers at each station were also evaluated by subtracting the Surveyor 4 readings from the station barometer readings. Once the Delta values were calculated, the averaged monthly data was used to calculate a monthly mean Delta for each parameter. The standard deviation was also calculated for each parameter on a monthly basis. The following equations summarize the previous written description.

Delta TDG: = [In-place Sonde TDG] - [QA/QC Sonde TDG]

Delta DO mg/L = [In-place DO mg/L] - [QA/QC DO mg/L]

Delta Temp = [In-place Temperature] - [QA/QC Temperature]

Delta Bar = [Station Honeywell Bar] - [Surveyor 4 Bar]

Monthly mean Delta = [Sum of Deltas for X] / (n) where n = number of Delta for parameter X values for parameter X from entire system of stations

Standard Deviation (SDV) = $\sqrt{\frac{n\sum x^2 - \left(\sum x\right)^2}{n(n-1)}}$ where *x* = Delta for any parameter

The System-wide station performance charts displayed the monthly mean Deltas plotted for each parameter versus time (deployment date). Each graph represented one parameter and contained one data point per month. The y-error bars presented on the charts represented +/- 1 standard deviation for the corresponding mean. The monthly system-wide station performance data, charts, and tables are contained in section 3.02 and appendix B.

2.07. QUARTERLY CHARTING AND CALCULATIONS.

The contractor provided the CENWW contract officer representative with quarterly QA/QC progress reports for internal system review and to determine the need

for audits if necessary. The quarterly reports contained a sufficient quantity of data to evaluate the performance of an individual instrument or station. The TDG sensor calibration data and thermometer performance data for each instrument was plotted versus time (calibration date) in order to evaluate "Sonde-Specific Performance." Station performance data collected at individual stations were plotted to evaluate "Station-Specific Performance."

A sonde-specific performance chart was plotted for each instrument that had accumulated three or more completed data sheets between the beginning of the monitoring year and the end of the reporting quarter. Each sonde performance chart contained thermometer performance data and TDG sensor calibration data. The Base and Pres TDG Net Cumulative Adjustment (Net Cum Adj) data were also represented on the graph as individual lines. The Net Cum Adj calculation reflects the cumulative adjustments made over time to the base and pressurized points of a particular TDG sensor's calibration curve. Plotting this trend provided insight about the bias of a sensor (tendency to drift over time in a particular direction in relation to the standard).

The Delta calculation was performed on the temperature data because the user cannot calibrate the thermometers (no adjustments are made). An Adjustment calculation was performed on the TDG calibration data. The Adjustment values represented the magnitude and direction that the base and pressurized points of a TDG calibration curve were adjusted to match their respective standards. The Adjustment value was calculated by subtracting the pre-calibrated TDG readings from the calibrated TDG readings. The Net Cum Adj value was calculated by adding each new Base or Pressurized TDG Adjustment value to the sum of the values above them in their respective columns. The following equations and an illustration summarize the above descriptions.

Delta Temp	= [In-place Temperature] - [QA/QC Temperature]
Base TDG Adjustment	= [Calibrated Base TDG] – [Pre-Calibrated Base TDG]
Pres. TDG Adjustment	= [Calibrated Pres. TDG] – [Pre-Calibrated Pres. TDG]
Net Cum Adjustment	= (Net Cum Base calculation is shown below. The same calculation is made for the Pres TDG Adjustments).

Calibration TDG	Base TDG Adj.	Calculation Description	Net Cum Base TDG Adj.
A	+1	= A	+1
B	+3	= Sum of A + B	+4
C	-1	= Sum of (A+B) + C	+3
D	-4	= Previous sum + D	-1

Section 3.03 contains the sonde-specific performance charts. Each chart represented one instrument and displayed the actual Delta Temp and TDG adjustment values plotted over time (calibration date). Net Cum Adj calculations were represented as individual lines on the chart.

Station performance charts plotted the Delta values calculated for each parameter compared between the In-place and QA/QC instruments during site visits at individual stations. Again, the QA/QC Sonde was a secondary standard to compare TDG, dissolved oxygen, and temperature with the In-place instrument, while the Surveyor 4 was a check for barometric pressure to evaluate the precision of the barometers at each station. A station-specific performance chart is plotted for each station that had accumulated three or more completed data sheets between the beginning of the monitoring year and the end of the current quarter. The following equations summarize the above description.

Delta TDG = [In-place Sonde TDG] - [QA/QC Sonde TDG]

Delta DO mg/L = [In-place DO mg/L] - [QA/QC DO mg/L]

Delta Temp = [In-place Temperature] - [QA/QC Temperature]

Delta Bar = [Station Honeywell Bar] - [Surveyor 4 Bar]

Section 3.04 and appendix D contains the station-specific performance charts and data. Each chart represented one station and displayed the actual Delta values for each parameter plotted versus time (deployment date).

2.08. DEFINING AND USING OUTLYING, INVALID, AND MISSING DATA VALUES.

An outlying data point was any parameter value that exceeded the data quality objective (DQO) for that parameter. These values reflected correctible or inherent sources of error in the maintenance procedures, instruments, standards, or stations. All of the outlying data values were included in the QA/QC summary statistics.

The CENWW directed the use of the following data quality objectives (DQOs). For sonde calibration Delta values the DQOs were: Delta TDG $\leq \pm 2$ mmHg and Delta

Temp ≤ ±0.10 degrees Celsius. The DQOs for station comparison data were: ≤ ±4 mmHg for Delta TDG, ≤ ±0.20 °C for Delta Temp, and ≤ ±0.50 mg/L for Delta DO.

Not all data reported by the instruments were included in the QA/QC summary statistics. A second type of data that was designated as invalid data included data values associated with malfunctioning sensors or other inoperative conditions. The technician was responsible for identifying those occurrences. Although not included in QA/QC summary statistic calculations, the invalid data values were plotted on sonde-specific and station-specific charts and were listed in tables 3-19 and 3-20 for reference. A description of each invalid data point is listed in table 3-22.

In some cases, particular data points would not be collected during instrument calibration or site visits. For example, stations that go off-line in the winter did not contain an instrument at the beginning of the summer season maintenance. A comparison cannot be performed during the initial site visit. Another instance occurs when a sensor failed prior to site visitation preventing a value for that parameter from being recorded because it did not make it out of the calibration lab. Blanks created in the record were not included in QA/QC summary statistics. A description of each missing data value is listed in table 3-21.

It was important to have the ability to view trends that may occur between outlying data points or any particular instrument or station. Being able to identify these trends was what turns this entire data management system into a dynamic management tool. To accomplish this, it was necessary to view a column of Delta values, sorted by magnitude, adjacent to the appropriate reference information. For example, it was useful to see if all of the outlying Delta TDG values could be correlated to a particular instrument or group of instruments. A table such as this was constructed for both the instrument data (appendix C) and the station data (appendix D). All of the data from the current reporting month was listed. Outlying data points were highlighted, invalid data points were highlighted in red, and missing values were designated as (*nd*).

2.09. SYSTEM AUDITS.

When a decreasing data quality trend or bias was recognized, a system audit would be initiated to determine the root cause. The system audit would begin with a ground up evaluation for the entire TDGMS for any detectable error or source of error. That error could be in instrumentation, procedure, transmission, or calculation. The purpose of the audit would be to bring the system back into compliance with the data quality objectives or to correct mechanical failure.

SECTION 3.0 – RESULTS

3.01. INVENTORY-WIDE SONDE PERFORMANCE.

A total of 274 site visit records were included in this report's inventory-wide summary statistics. The inventory-wide sonde data are shown in table 3.1 and performance charts are given as figures 3-1, 3-2, and 3-3. Invalid data values were not used in the overall performance evaluation.

The results of the statistical analyses performed on the TDG sensor performance data indicated that the population of TDG sensors regularly met the DQO of $\leq \pm 2$ mmHg. The cumulative mean and standard deviation for Delta Base TDG was calculated to be +0.00 mmHg and 0.70 mmHg, respectively. The cumulative mean and standard deviation for Delta Pres TDG was calculated to be +0.01 mmHg and 0.70 mmHg, respectively. This means that, on average, the difference between a Base TDG sensor reading and the standard (barometric pressure) during calibration was +0.00 mmHg for all of the TDG sensor calibrations performed this year. A total of 274 TDG base and pressurized Delta values were calculated from the FY01 sonde calibration data. One of these values was invalid for each parameter (see table 3-22). Of the remaining 273 Delta values, 4 were above the DQO of $\leq \pm 2$ mmHg, representing 1.5 percent of the total number of valid Delta TDG values.

The results of the statistical analyses performed on the temperature sensor data indicate that the cumulative mean Delta Temp value was –0.07 ºC with an SDV of 0.04 ºC. A total of 260 Temp Delta values were calculated from the FY01 sonde calibration data. Of these 260 values, 10 were above the DQO of $\leq \pm 0.10$ °C, representing 3.8 percent of the total number of valid Delta Temp values. Instrument #28 accounted for 9 of the 10 outlying Temp values. The population of temperature sensors consistently read below the standard temperature by approximately 0.05 °C. These sensors are factory calibrated and, therefore, this was likely an artifact of production.

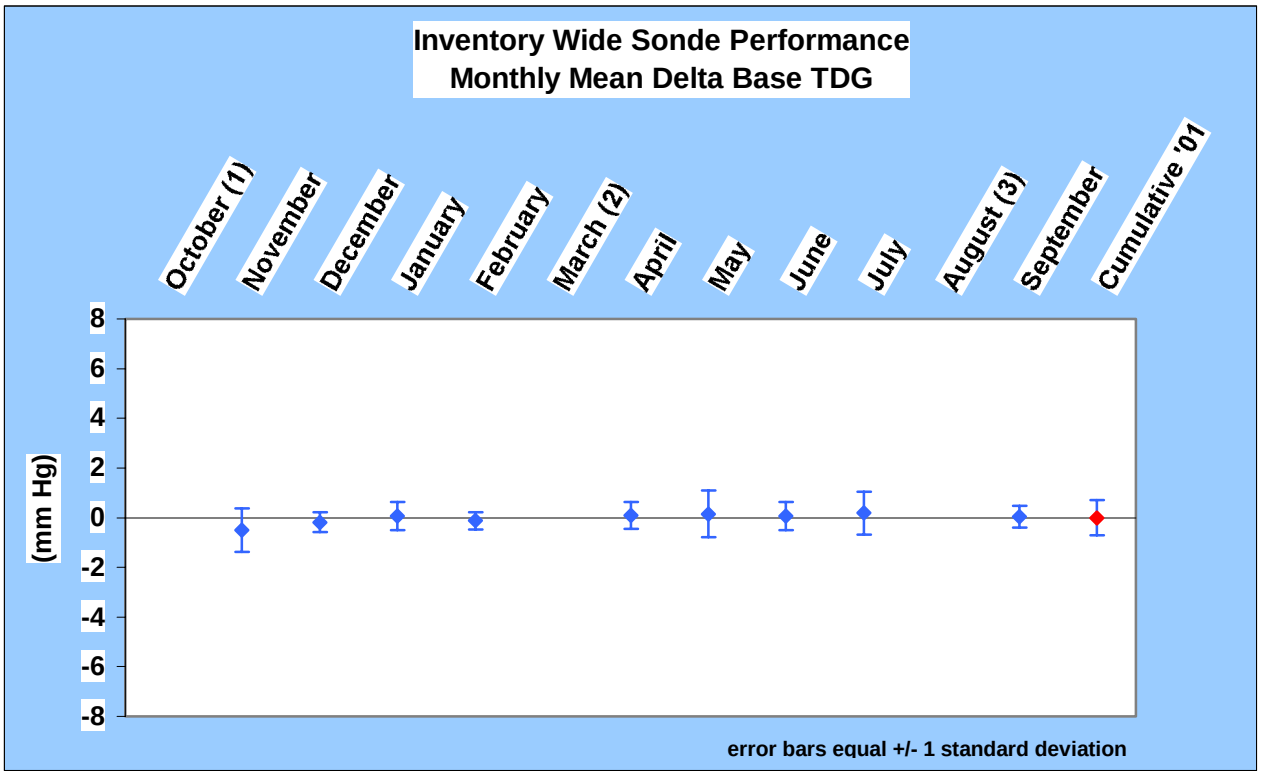
The FY01 data estimates there was a 95 percent chance that any instrument in the inventory could be deployed at a station for 2 weeks. When checked it would vary from the standard by $+0.00 \pm 1.40$ (2SDV) mmHg for Base TDG, $+0.01 \pm 1.40$ (2SDV) mmHg for Pres TDG, and -0.07 ± 0.08 (2SDV) °C for Temp. Both the population of TDG and temperature sensors performed within the DQOs for this year. The average recorded precision levels for the TDG sensors and temperature sensors were also within the accuracy specifications set by the manufacturers.

Table 3-1
2001 Inventory-Wide Sonde Performance Data
(Year 2000 Data shown for comparison)

Reporting Month	(n)*	Mean Delta Base TDG**	Stdev Base TDG**	Mean Delta Pres TDG**	Stdev Pres TDG**	Mean Delta Temp***	Stdev Temp***
October [1]				No Monthly Statistics			
November	32	-0.50	0.88	-0.47	0.92	-0.05	0.06
December	16	-0.19	0.40	-0.13	0.34	-0.08	0.07
January	18	0.06	0.56	0.06	0.56	-0.10	0.06
February	16	-0.13	0.34	-0.13	0.34	-0.04	0.06
March [2]				No Monthly Statistics			
April	48	0.08	0.54	0.08	0.54	-0.05	0.06
May	39	0.15	0.93	0.15	0.93	-0.07	0.05
June	31	0.06	0.57	0.06	0.57	-0.09	0.04
July	32	0.19	0.86	0.19	0.86	-0.08	0.04
August [3]				No Monthly Statistics			
September	42	0.05	0.44	0.05	0.44	-0.09	0.05
Cumulative '01	274	0.00	0.70	0.01	0.70	-0.07	0.04
Cumulative '00	204	0.13	1.07	0.25	1.11	-0.04	0.07

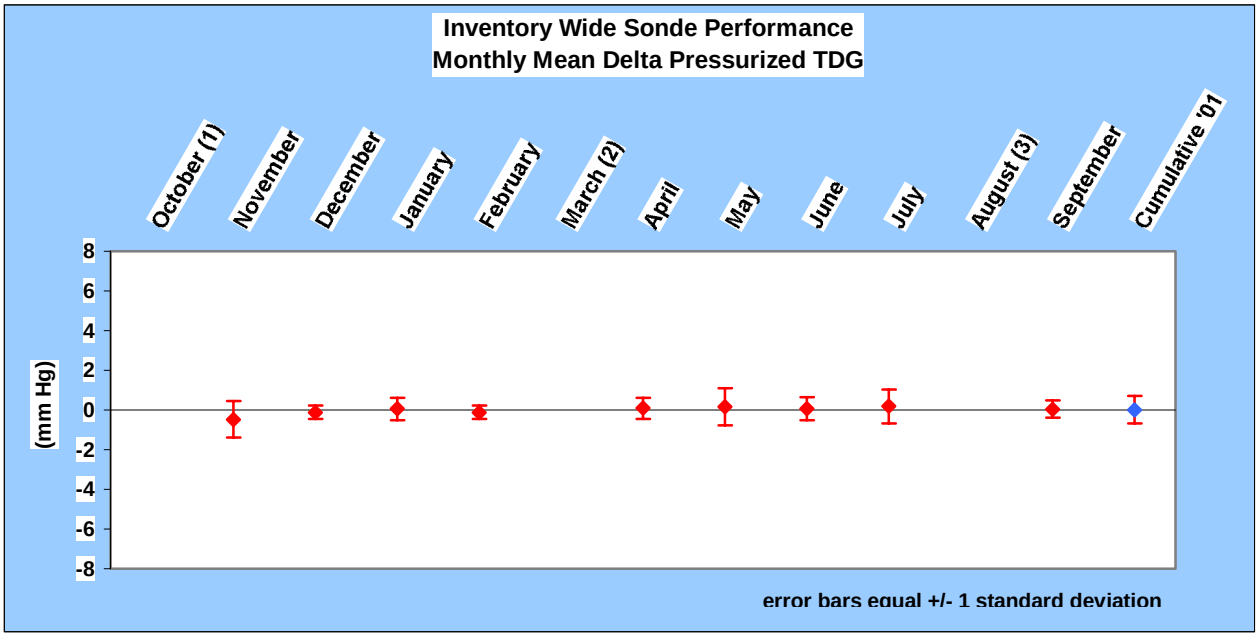
(1) October data (15 records) were included in November statistics and reporting
(2) March data (9 records) were included in April statistics and reporting.
(3) August data (34 records) were included in September statistics and reporting.
* (n) = total number of records entered in a month; not all records are complete for all parameters
** Results reported in (mm Hg)
*** Results reported in (Degrees Celsius)

Figure 3-1



(1) October Data (15 records) included in November statistics and reporting
(2) March Data (9 records) included in April statistics and reporting
(3) August data (34 records) were included in September statistics and reporting.

Figure 3-2

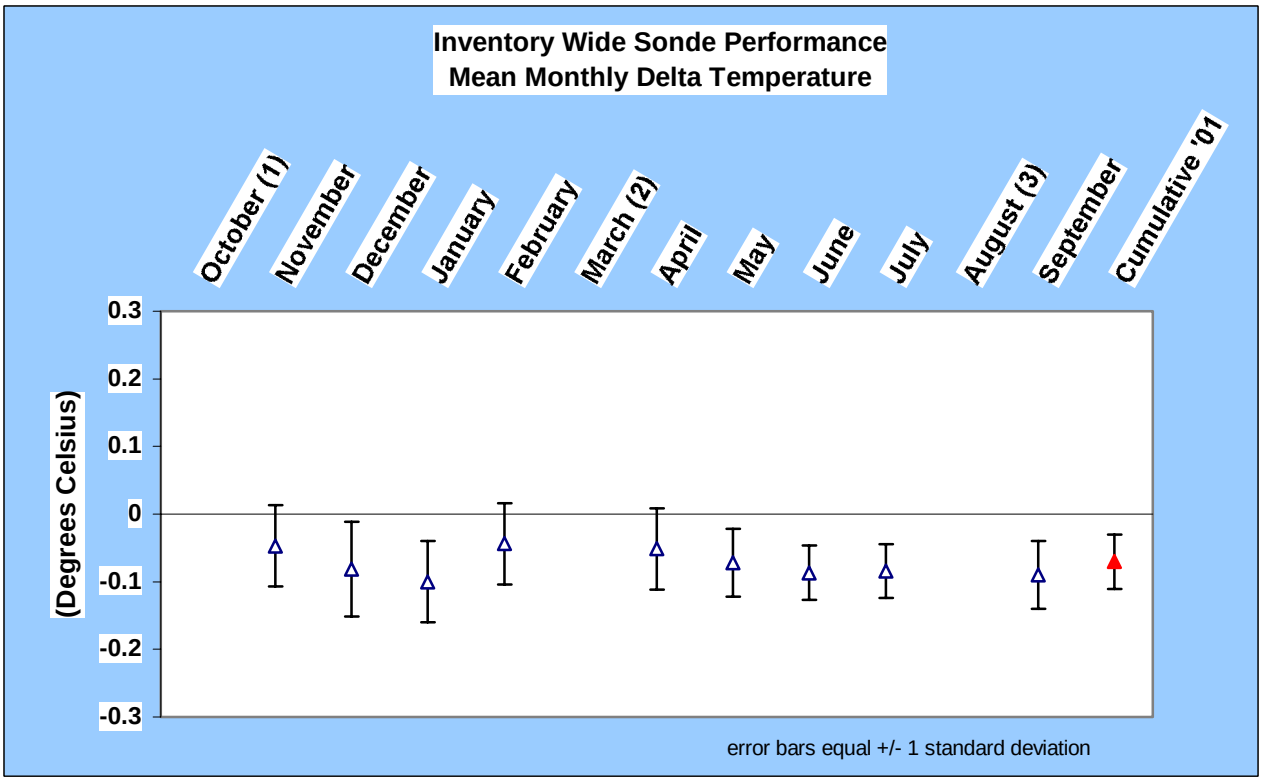


(1) October Data (15 records) included in November statistics and reporting

(2) March Data (9 records) included in April statistics and reporting

(3) August data (34 records) were included in September statistics and reporting.

Figure 3-3



(1) October Data (15 records) included in November statistics and reporting

(2) March Data (9 records) included in April statistics and reporting

(3) August data (34 records) were included in September statistics and reporting.

3.02. SYSTEM-WIDE STATION PERFORMANCE.

A total of 274 site visit records were included in this report's system-wide summary statistics. The system-wide sonde data are shown in table 3-2 and performance charts are given as figures 3-4, 3-5, 3-6, and 3-7. Invalid data values were not used in the overall performance evaluation.

The cumulative mean and standard deviation for TDG comparisons was calculated to be -0.10 mmHg and 1.79 mmHg, respectively. These values met the DQO of $\leq \pm 4$ mmHg TDG for station comparisons. A total of 258 TDG Delta values were calculated from the FY01 station comparison data. Three of these values were invalid (see table 3-22). Of the remaining 255 Delta values, 9 were above the DQO of $\leq \pm 4$ mmHg, representing 3.5 percent of the total number of valid Delta TDG values.

The cumulative mean and standard deviation for DO comparisons was calculated to be –0.28 mg/L and 0.59 mg/L, respectively. This meant that on average, the DQO for dissolved oxygen of $\leq \pm 0.50$ mg/l was generally being met. A total of 260 dissolved oxygen Delta values were calculated from the FY01 station comparison data. Of these 260 values, 77 were above the DQO of $\leq \pm 0.50$ mg/l, representing 29.6 percent of the total number of valid Delta DO values.

The cumulative mean and standard deviation for Temperature comparisons was calculated to be –0.01 ºC and 0.06 ºC, respectively. 100 percent of the station temperature comparison values met the DQO of $\leq \pm$ 0.20 °C.

The cumulative mean and standard deviation for TDG comparisons was calculated to be -0.50 mmHg and 2.22 mmHg, respectively. CENWW did not maintain a DQO for station barometer performance.

The FY01 data estimates there was a 95 percent chance that when a QC instrument is compared to the In-place instrument at any station in the system it would vary by -0.10 $\pm$ 3.58 (2SDV) mmHg for TDG, -0.01 $\pm$ 0.12 (2SDV) °C for Temp, and -0.28 $\pm$ 1.18 (2SDV) mg/L for DO. There was a 95 percent chance that the station barometer would vary from the Surveyor 4 by +0.50 mmHg $\pm$ 4.44 (2SDV) mmHg.

Table 3-2
2001 System-Wide Station Performance Data

Reporting Month	(n)*	Mean Delta TDG**	Stdev TDG**	Mean Delta DO (mg/l)	Stdev DO mg/l	Mean Delta Temp***	Stdev Temp***	Mean Delta Bar **	Stdev Bar**
October [1]					No Monthly Statistics				
November	32	-1.00	2.27	-0.29	0.59	-0.01	0.06	0.72	2.29
December	16	0.38	0.81	-0.13	0.72	-0.02	0.07	0.25	2.08
January	18	0.29	1.16	-0.20	0.55	0.00	0.05	0.56	2.96
February	16	0.31	0.60	-0.03	0.78	0.00	0.08	-0.06	2.49
March [2]					No Monthly Statistics				
April	48	0.53	1.32	-0.40	0.55	-0.02	0.05	0.80	2.83
May	39	0.26	2.30	-0.14	0.65	0.00	0.07	0.33	2.18
June	31	-0.40	1.33	-0.55	0.66	-0.02	0.05	-0.13	2.11
July	32	-0.24	2.12	-0.42	0.45	-0.02	0.07	0.47	1.37
August [3]					No Monthly Statistics				
September	42	-0.49	1.82	-0.17	0.39	-0.01	0.04	0.90	1.54
Cumulative '01	274	-0.10	1.79	-0.28	0.59	-0.01	0.06	0.50	2.22
Cumulative '00	240	0.09	2.39	n/a	n/a	0.00	0.07	n/a	n/a

(1) October data (15 records) were included in November statistics and reporting

(2) March data (9 records) were included in April statistics and reporting.

(3) August data (34 records) were included in September statistics and reporting.

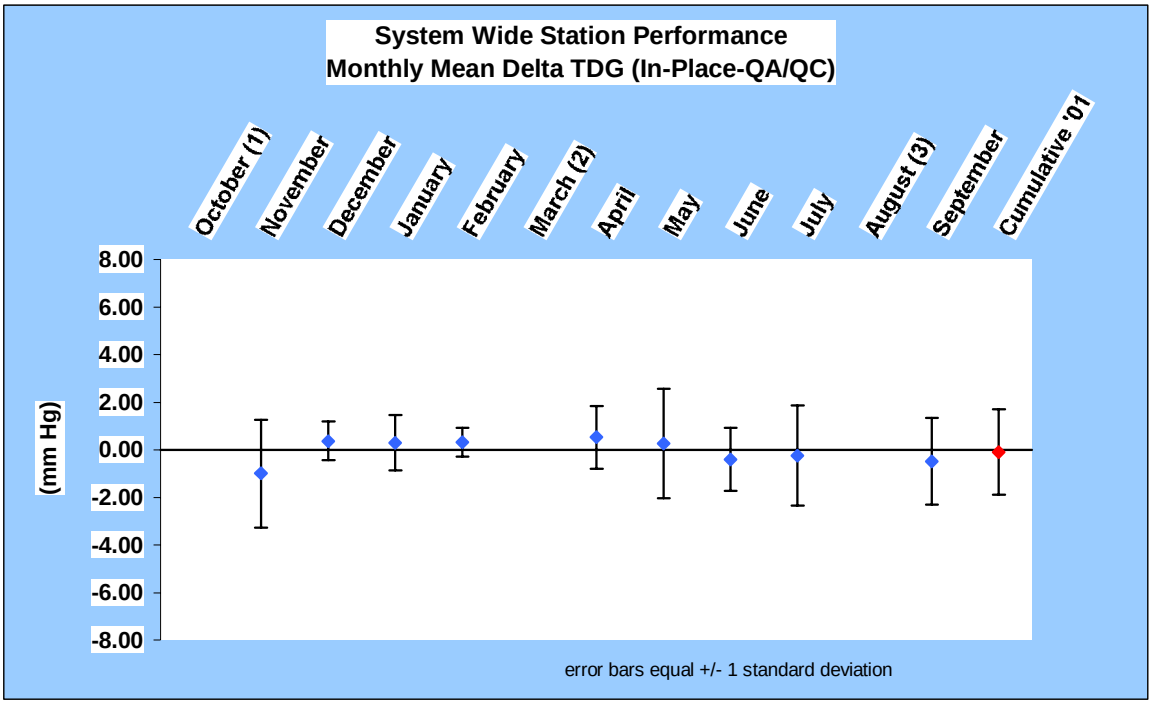
* (n) = total number of records entered in a month; not all records are complete for all parameters

** Results reported in (mm Hg)

*** Results reported in (Degrees Celsius)

n/a - not applicable

Figure 3-4

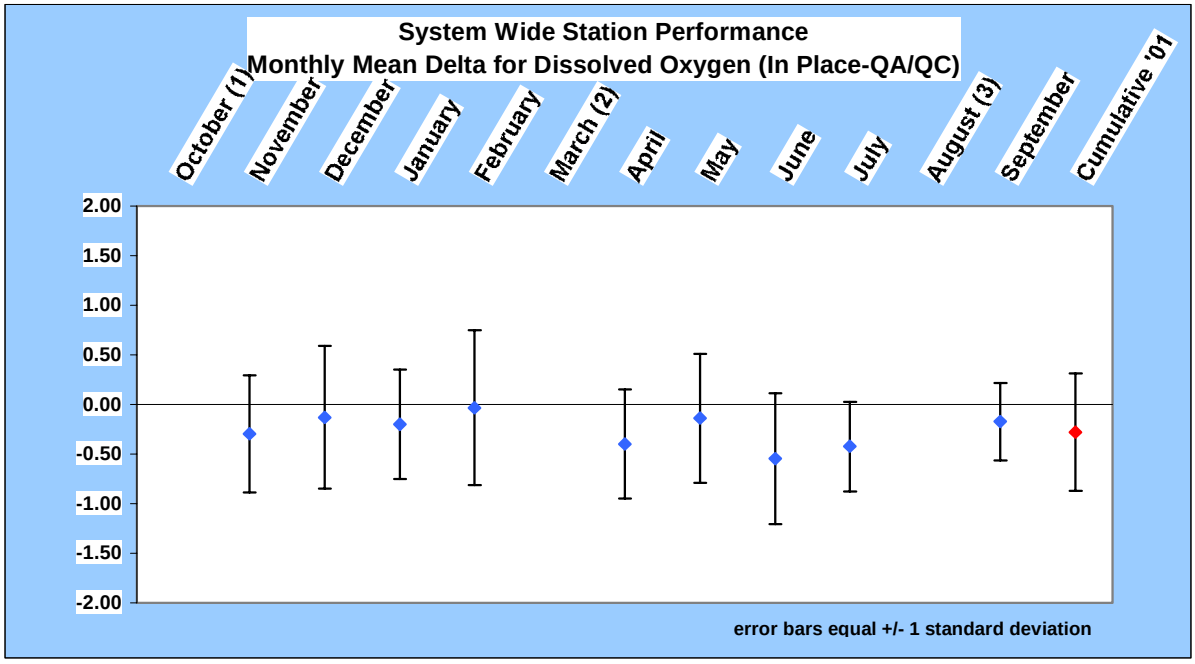


(1) October Data (15 records) included in November statistics and reporting

(2) March Data (9 records) included in April statistics and reporting

(3) August data (34 records) were included in September statistics and reporting.

Figure 3-5

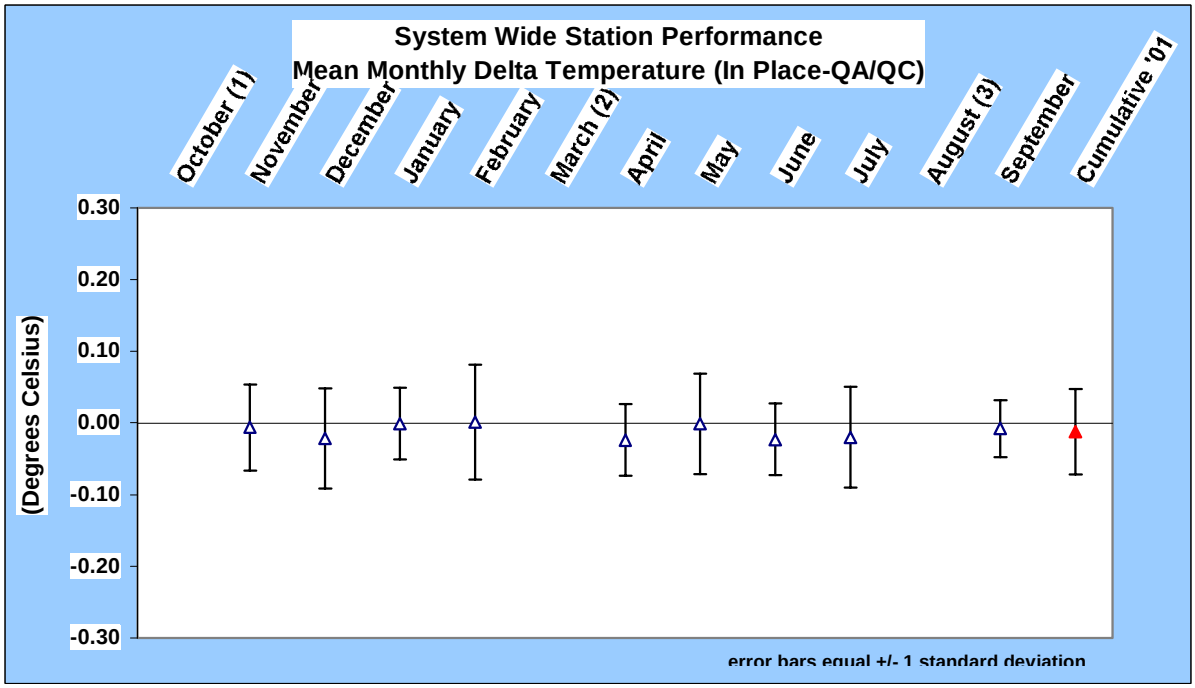


(1) October Data (15 records) included in November statistics and reporting

(2) March Data (9 records) included in April statistics and reporting

(3) August data (34 records) were included in September statistics and reporting.

Figure 3-6



(1) October Data (15 records) included in November statistics and reporting

(2) March Data (9 records) included in April statistics and reporting

(3) August data (34 records) were included in September statistics and reporting.

3.03. SONDE-SPECIFIC PERFORMANCE.

Subsequent paragraphs describe the individual sonde performance and history. This information was used to make in-season determinations of sonde mission capability and fleet management.

a. Sonde #01.

This sonde (barcode 24490) was purchased from Hydrolab Corporation (SN: 32431) on 19 February 1997 and placed into service in April 1997. The unit's service life is 5 years. It went though a SLEP in 2001. This will extend the unit's service life to 2003.

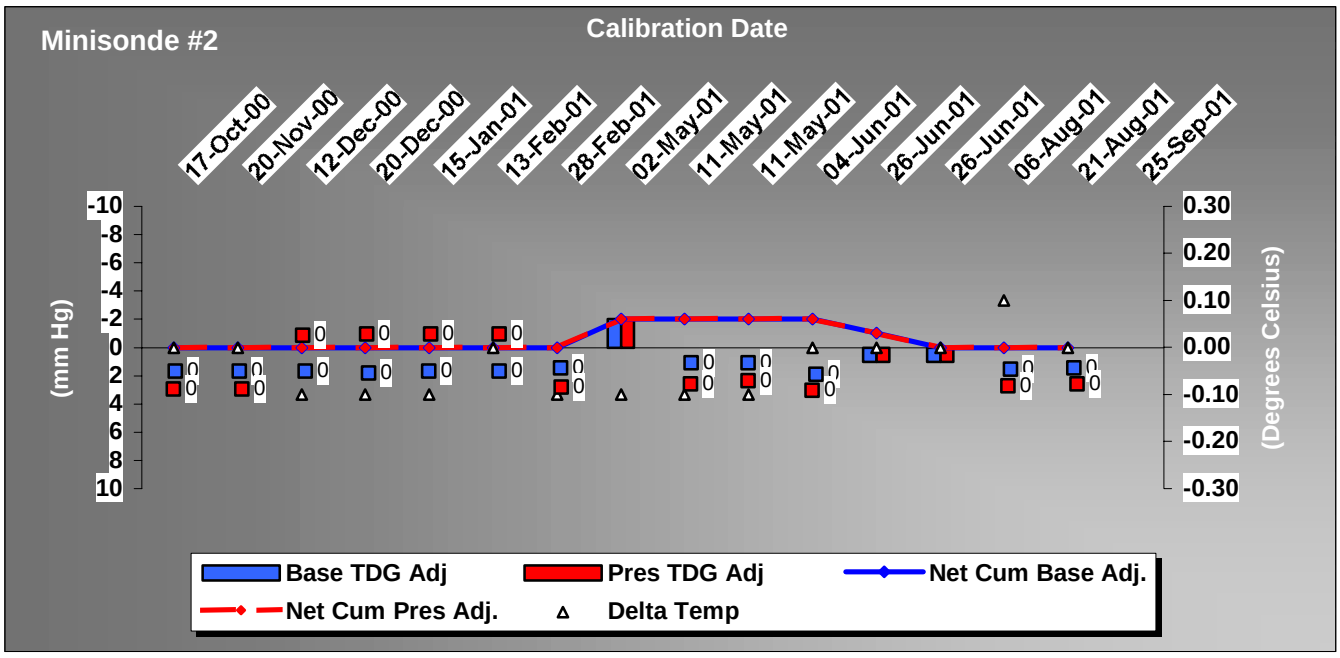
[Fiscal Year 2000 (FY00)] This unit was deployed and actively used from the beginning to the end of last year's field season. It posed no real problems in calibration and was within 2 mmHg of the NBS pressure standard or the QA/QC sonde throughout this season. The temperature was consistently 0.1° C lower than the calibrated QC or NBS standard. This was still within the manufacturer's warranty and specifications. This also met CENWW's control limits.

(FY01) This instrument was inoperative at the beginning of the monitoring year. In April 2001 it received a new TDG, DO, and 25-meter depth sensor. It returned to active duty in August 2001 but was only used two times before the end of the monitoring year. Performance records indicate that the instrument provided high quality data since its repair. Instrument #1 is ready for Fiscal Year 2002 (FY02) operation.

Figure 3-7
Site Location Descriptions

ANQW	Anatone Gaging Station, Snake River	**LMN**	Lower Monumental Forebay, Snake R.
DWQI	Dworshak Tailwater, Clearwater River	**LMNW**	Lower Monumental Tailwater, Snake R.
IDSW	Ice Harbor Tailwater, Snake River	**LWG**	Lower Granite Forebay, Snake River
IHR	Ice Harbor Forebay, Snake River	**MCPW**	McNary Tailwater, Washington side of the Columbia River
LEWI	Lewiston, ID, Clearwater River just upstream of Confluence with Snake River	**MCQO**	McNary Forebay, Oregon side of the Columbia River
LGNW	Lower Granite Tailwater, Snake River	**MCQW**	McNary Forebay, Washington side of the Columbia River
LGS	Little Goose Forebay, Snake River	**PAQW**	Pasco Levee, Columbia River upstream of confluence with the Snake River
LGSW	Little Goose Tailwater, Snake River	**PEKI**	Peck Gaging Station Clearwater River

Figure 3-8



Calibration Date	Base TDG Adj	Pres TDG Adj	Net Cum Base Adj.	Net Cum Pres Adj.	Delta Temp
17-Oct-00	0	0	0	0	0.00
20-Nov-00	0	0	0	0	0.00
12-Dec-00	0	0	0	0	-0.10
20-Dec-00	0	0	0	0	-0.10
15-Jan-01	0	0	0	0	-0.10
13-Feb-01	0	0	0	0	0.00
28-Feb-01	0	0	0	0	-0.10
02-May-01	-2	-2	-2	-2	-0.10
11-May-01	0	0	-2	-2	-0.10
11-May-01	0	0	-2	-2	-0.10
04-Jun-01	0	0	-2	-2	0.00
26-Jun-01	1	1	-1	-1	0.00
26-Jun-01	1	1	0	0	0.00
06-Aug-01	0	0	0	0	0.10
21-Aug-01	0	0	0	0	0.00
25-Sep-01	**Sent to Hydrolab for routine checks**				

Status: Instrument #2 is reliable and provided high quality data throughout the year. It did not require TDG or DO sensor repair this year. It was sent to Hydrolab at the end of the year for general checks and service and to have a 25-meter depth sensor installed. #2 is ready for YR'02 operation.

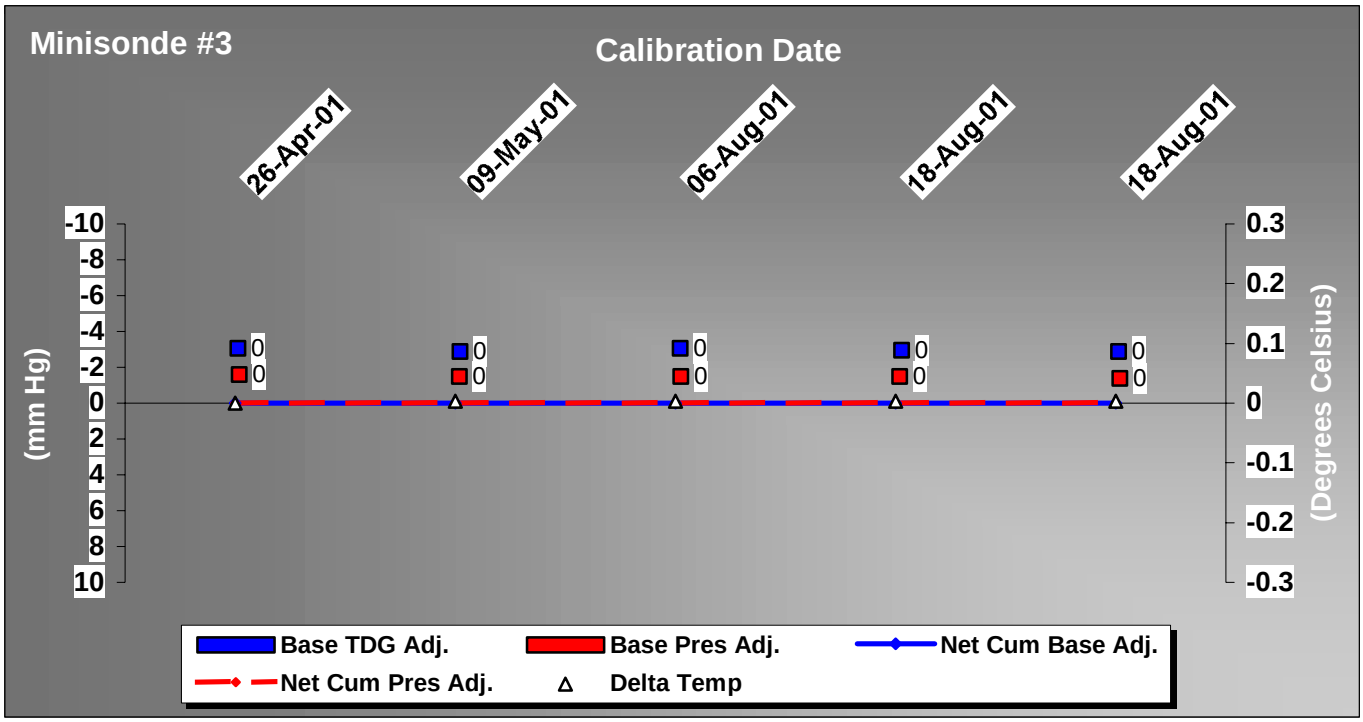
b. Sonde #02 (figure 3-8).

This sonde (barcode 24502) was purchased from Hydrolab Corporation (SN: 32466) on 19 February 1997 and placed into service in April 1997. The unit's service life is 5 years. It went though a SLEP in 2001. This will extend the unit's service life to 2003.

(FY00) This unit was into the manufacturer for repairs and was not placed into general service until May. It posed no real problems in calibration and was within 2 mmHg of the NBS pressure standard or the QA/QC sonde throughout this season. The temperature was consistently 0.1° C lower than the calibrated QC or NBS standard. This was still within the manufacturer's warranty and specifications. This also met CENWW's control limits.

(FY01) Instrument #2 was reliable and provided high quality data all throughout the monitoring year. It did not require TDG or DO sensor repair. It was sent to the manufacturer for a SLEP in September2001 Additional work included a mid-life preventative maintenance and retrofitting of a 25-meter depth sensor. Instrument #2 is ready for FY02 operation.

Figure 3-9



Calibration Date	Base TDG Adj.	Base Pres Adj.	Net Cum Base Adj.	Net Cum Pres Adj.	Delta Temp
26-Apr-01	0	0	0	0	0.00
09-May-01	0	0	0	0	-0.10
06-Aug-01	0	0	0	0	-0.10
18-Aug-01	0	0	0	0	-0.10
18-Aug-01	0	0	0	0	-0.10

The performance chart for instrument #3 indicates that this Minisonde has been reliable and provides high quality data for the system. #3 is ready for YR'02 operation.

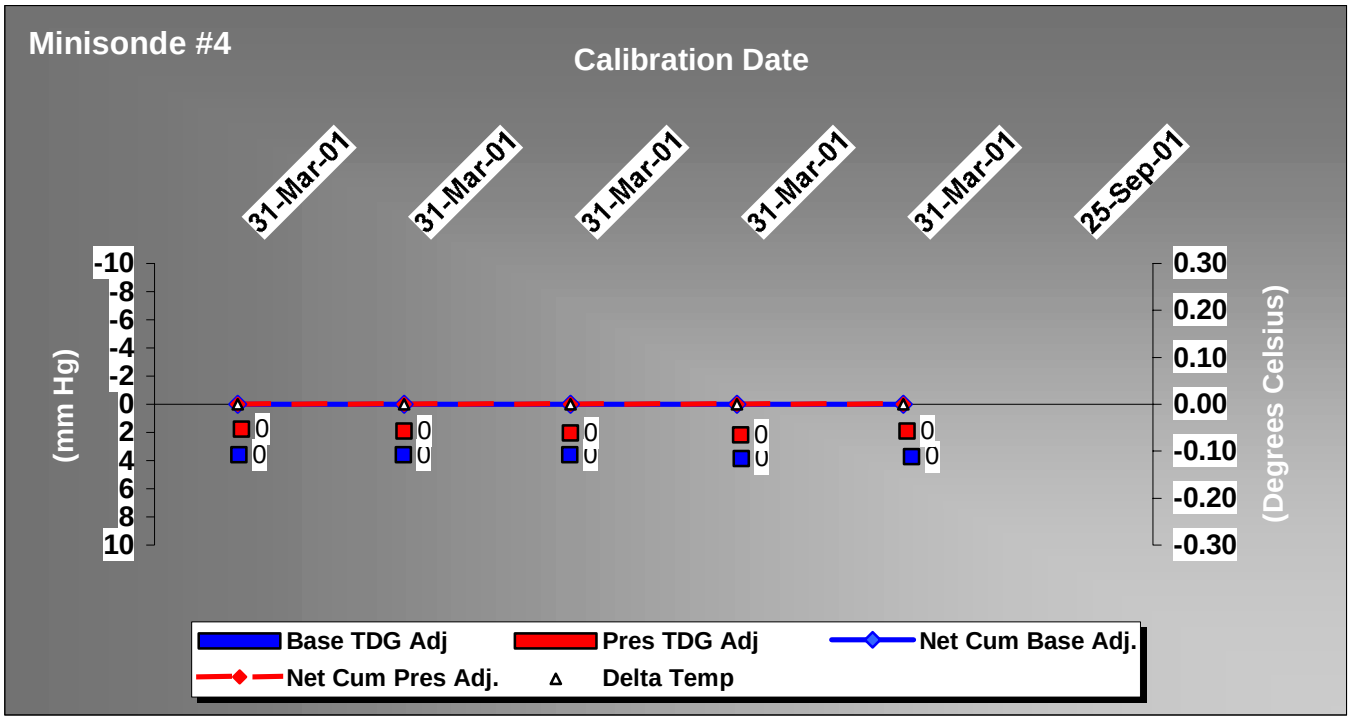
c. Sonde #03 (figure 3-9).

This sonde (barcode 24497) was purchased from Hydrolab Corporation (SN: 32441) on 19 February 1997 and placed into service in April 1997. The unit's service life is 5 years. It went though a SLEP in 2001. This will extend the unit's service life to 2003.

(FY00) This unit was in service for most of the season. In late June and early July, there were some pressure calibration problems. After a factory calibration and service of the pressure transducer, it gave near perfect performance in August. It was on the average within 2 mmHg of the NBS pressure standard or the QA/QC sonde throughout this season. The temperature was consistently 0.1 C° lower than the calibrated QC or NBS standard. This was still within the manufacturer's warranty and specifications. This also met CENWW's control limits.

(FY01) This instrument was inoperative at the beginning of the monitoring year. In April 2001 the instrument went through its SLEP. Additionally, the dissolved oxygen sensor was repaired and a 25-meter depth sensor was installed. Performance records indicate that the instrument provided high quality data since its repair. Instrument #3 is ready for FY02 operation.

Figure 3-10



Calibration Date	Base TDG Adj	Pres TDG Adj	Net Cum Base Adj.	Net Cum Pres Adj.	Delta Temp
31-Mar-01	0	0	0	0	0.00
31-Mar-01	0	0	0	0	0.00
31-Mar-01	0	0	0	0	0.00
31-Mar-01	0	0	0	0	0.00
31-Mar-01	0	0	0	0	0.00
25-Sep-01	**Sent to Hydrolab for maintenance**				

Status: This instrument was inoperative the entire quarter because of power circuit problems. It was sent to Hydrolab for repair at the end of the year. A 25-meter depth was also installed at this time. Following testing of the instrument it will be ready for YR'02 operation.

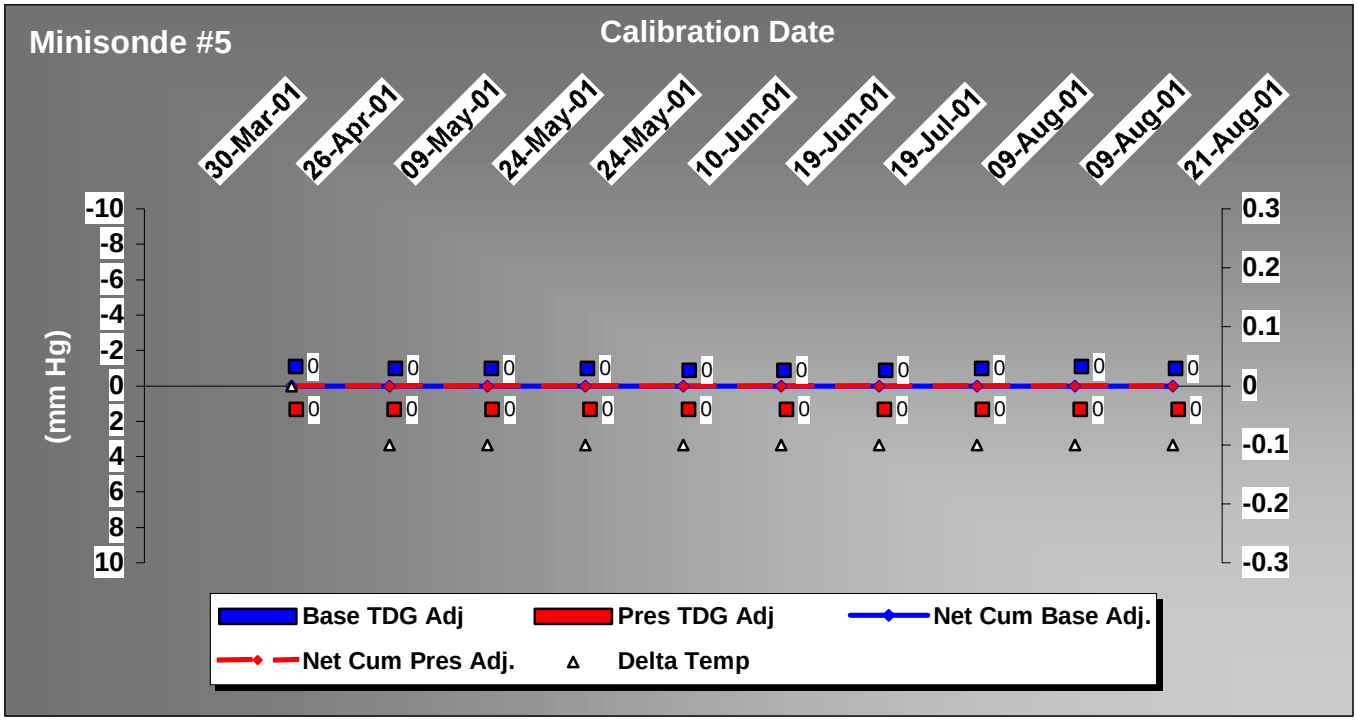
d. Sonde #04 (figure 3-10).

This sonde (barcode 30030) was purchased from Hydrolab Corporation (SN: 32444) on 19 February 1997 and placed into service in April 1997. The unit's service life is 5 years. It went though a SLEP in 2001. This will extend the unit's service life to 2003.

(FY00) This unit was operational but was retained at the CENWW lab for tests and evaluations or as an emergency backup in case a repair was needed on weekends. This unit was used as a static test unit in the hyperbaric chamber experiments. No comparable QA/QC station performance data was collected for this unit in water year 2001.

(FY01) Instrument #4 provided high quality data for three quarters of the year before it was disabled due to an internal power circuit problem. In September 2001 it went through a SLEP and received a new circuit board, circulator, and a 25-meter depth sensor. Instrument #4 is ready for FY02 operation.

Figure 3-11



Calibration Date	Base TDG Adj	Pres TDG Adj	Net Cum Base Adj.	Net Cum Pres Adj.	Delta Temp
30-Mar-01		**Sent to Hydrolab for Maintenance**			
26-Apr-01	0	0	0	0	0.00
09-May-01	0	0	0	0	-0.10
24-May-01	0	0	0	0	-0.10
24-May-01	0	0	0	0	-0.10
10-Jun-01	0	0	0	0	-0.10
19-Jun-01	0	0	0	0	-0.10
19-Jul-01	0	0	0	0	-0.10
09-Aug-01	0	0	0	0	-0.10
09-Aug-01	0	0	0	0	-0.10
21-Aug-01	0	0	0	0	-0.10

Status: The performance chart for instrument #5 indicates that, since its repair in late March, this Minisonde has been reliable and provides high quality data. #5 is ready for YR'02 operation.

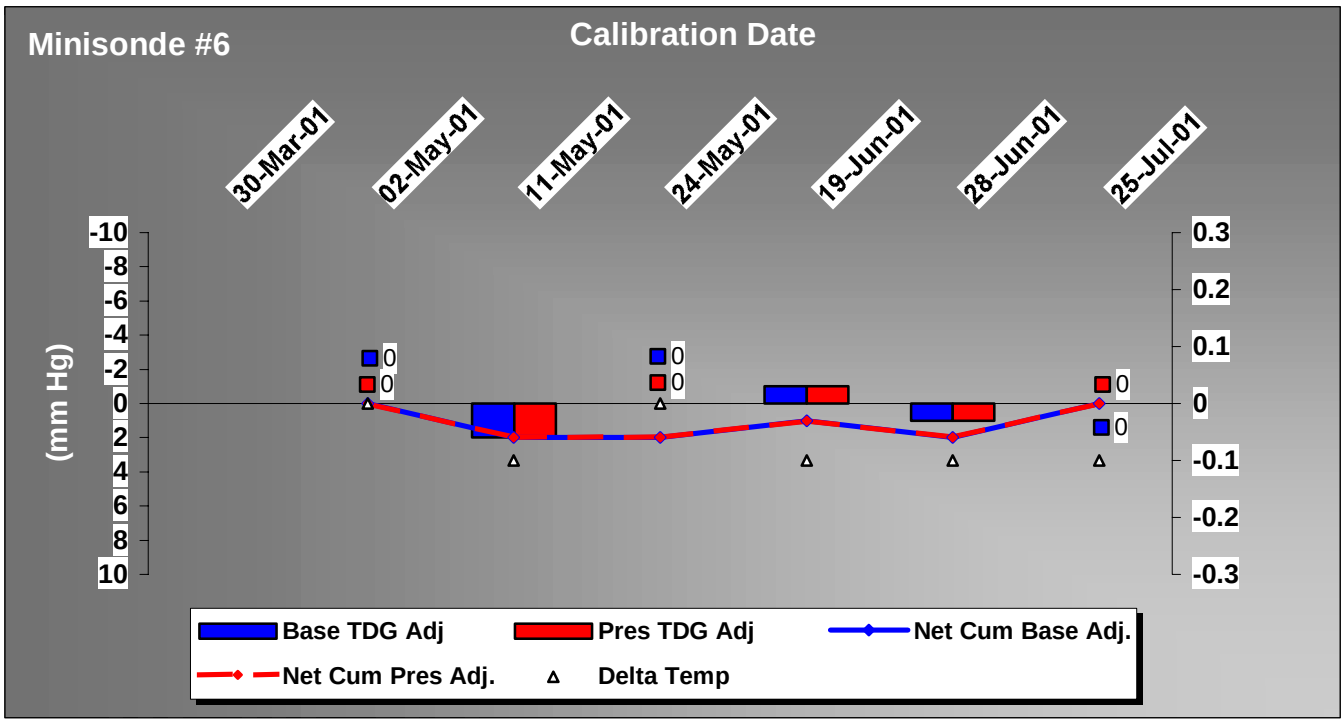
e. Sonde #05 (figure 3-11).

This sonde was purchased from Hydrolab Corporation on 19 February 1997 and placed into service in April 1997. The unit's service life is 5 years. It went though a SLEP in 2001. This will extend the unit's service life to 2003.

(FY00) Unit #05 was utilized regularly during the season and provided excellent results. The unit did prove a little cantankerous to calibrate (it is part of the first batch of units procured) but once calibrated it exceeded manufacturer's specifications and our QA expectations. The temperature was almost always exactly the same as the NBS standard and the TDG averaged approximately within 1 mmHg of accuracy. For all practical purposes this met all significant numbers and further QC would be a magnitude of order greater requiring new equipment and increased QA/QC. This unit is considered to be one of the best since further precision and accuracy beyond what this unit produces is not possible. This unit exceeds manufacturer's specifications and current QA/QC standards.

(FY01) This instrument was inoperative at the beginning of the monitoring year. In April 2001 it received its SLEP and received upgraded TDG software and a 25-meter depth sensor. Performance records indicate that the instrument provided high quality data since its repair. Instrument #5 is ready for FY02 operation.

Figure 3-12



Calibration Date	Base TDG Adj	Pres TDG Adj	Net Cum Base Adj.	Net Cum Pres Adj.	Delta Temp
30-Mar-01		**Sent to hydrolab for Maintenance**			
02-May-01	0	0	0	0	0.00
11-May-01	2	2	2	2	-0.10
24-May-01	0	0	2	2	0.00
19-Jun-01	-1	-1	1	1	-0.10
28-Jun-01	1	1	2	2	-0.10
25-Jul-01	0	0	0	0	-0.10

Status: The performance chart for instrument #6 indicates that, since its repair in late March, this Minisonde has been reliable and provides high quality data. #6 is ready for YR'02 operation.

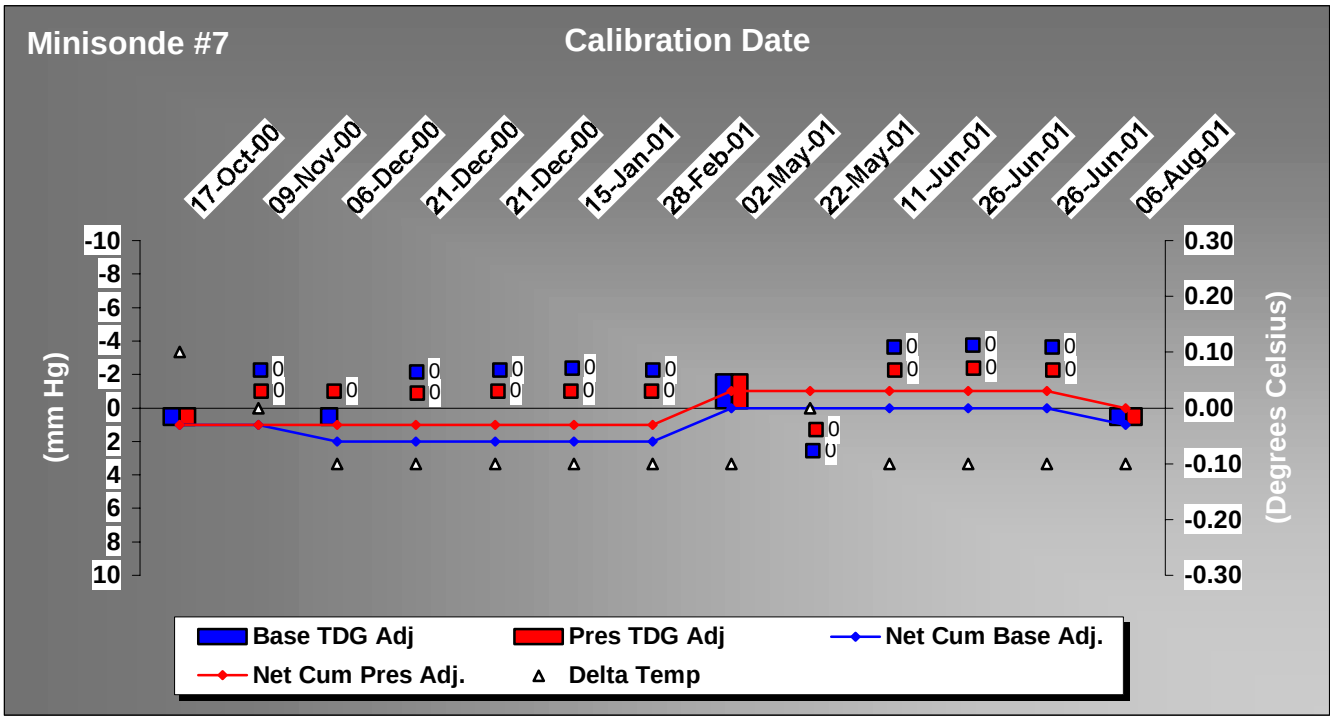
f. Sonde #06 (figure 3-12).

This sonde (barcode 30033) was purchased from Hydrolab Corporation (SN: 32419) on 19 February 1997 and placed into service in April 1997. The unit's service life is 5 years. It went though a SLEP in 2001. This will extend the unit's service life to 2003.

(FY00) Unit #06 was utilized regularly during the season and provided excellent results. The unit did prove a little cantankerous to calibrate (it is part of the first batch of units procured) but once calibrated it exceeded manufacturer's specifications and our QA expectations. The temperature was almost always exactly the same as the NBS standard and the TDG averaged approximately within 1 mmHg of accuracy. For all practical purposes this met all significant numbers and further QC would be a magnitude of order greater requiring new equipment and increased QA/QC. This unit is considered to be one of the best since further precision and accuracy beyond what this unit produces is not possible. This unit exceeds manufacturer's specifications and current QA/QC standards.

(FY01) This instrument was inoperative at the beginning of the monitoring year. In April 2001 it received a SLEP, upgraded TDG software, a new RS232 card, and a 25-meter depth sensor. Performance records indicate that the instrument provided high quality data since its repair. Instrument #6 is ready for FY02 operation.

Figure 3-13



Calibration Date	Base TDG Adj	Pres TDG Adj	Net Cum Base Adj.	Net Cum Pres Adj.	Delta Temp
17-Oct-00	1	1	1	1	0.10
09-Nov-00	0	0	1	1	0.00
06-Dec-00	1	0	2	1	-0.10
21-Dec-00	0	0	2	1	-0.10
21-Dec-00	0	0	2	1	-0.10
15-Jan-01	0	0	2	1	-0.10
28-Feb-01	0	0	2	1	-0.10
02-May-01	-2	-2	0	-1	-0.10
22-May-01	0	0	0	-1	0.00
11-Jun-01	0	0	0	-1	-0.10
26-Jun-01	0	0	0	-1	-0.10
26-Jun-01	0	0	0	-1	-0.10
06-Aug-01	1	1	1	0	-0.10

Status: The performance chart for instrument #7 indicates strong performances throughout the year. This instrument will remain active in the system until it can be sent in for routine maintenance. #7 is ready for YR'02 operation.

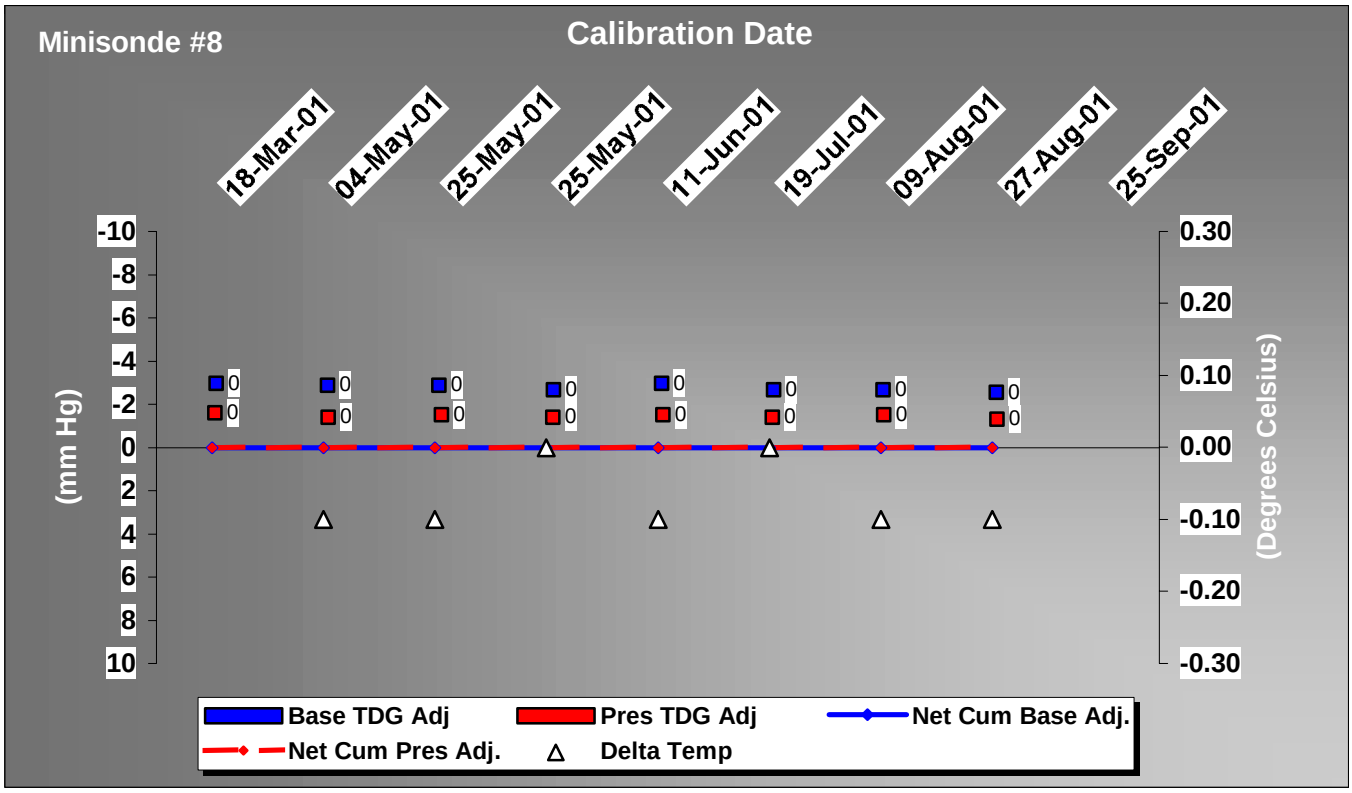
g. Sonde #07 (figure 3-13).

This sonde was purchased from Hydrolab Corporation on 19 February 1997 and placed into service in April, 1997. The unit's service life is 5 years. It received its SLEP in 2000. This will extend its service life to 2002.

(FY00) This unit started service in early March and was providing quality service until May. After two deployments, it was determined this unit was not meeting QC. The unit calibrated correctly but did not provide quality field service. The instrument had its software and drivers erased and updated with the latest Hydrolab firmware. From then on, it became one of the best performing units and maintained accuracy for months on end.

(FY01) Instrument #7 was solid throughout the monitoring year. It did not require any sensor maintenance and it provided high quality data. This instrument is ready for FY02 operation.

Figure 3-14



Calibration Date	Base TDG Adj	Pres TDG Adj	Net Cum Base Adj.	Net Cum Pres Adj.	Delta Temp
18-Mar-01	0	0	0	0	
04-May-01	0	0	0	0	-0.10
25-May-01	0	0	0	0	-0.10
25-May-01	0	0	0	0	0.00
11-Jun-01	0	0	0	0	-0.10
19-Jul-01	0	0	0	0	0.00
09-Aug-01	0	0	0	0	-0.10
27-Aug-01	0	0	0	0	-0.10
25-Sep-01	**Sent to hydrolab for routine checks**				

18-Mar Temp check of Sonde temp sensor was not performed

Status: Instrument #8 is reliable and provided high quality data throughout the year. It did not require TDG or DO sensor repair this year. It was sent to Hydrolab at the end of the year for general checks and service and to have a 25-meter depth sensor installed. #8 is ready for YR'02 operation.

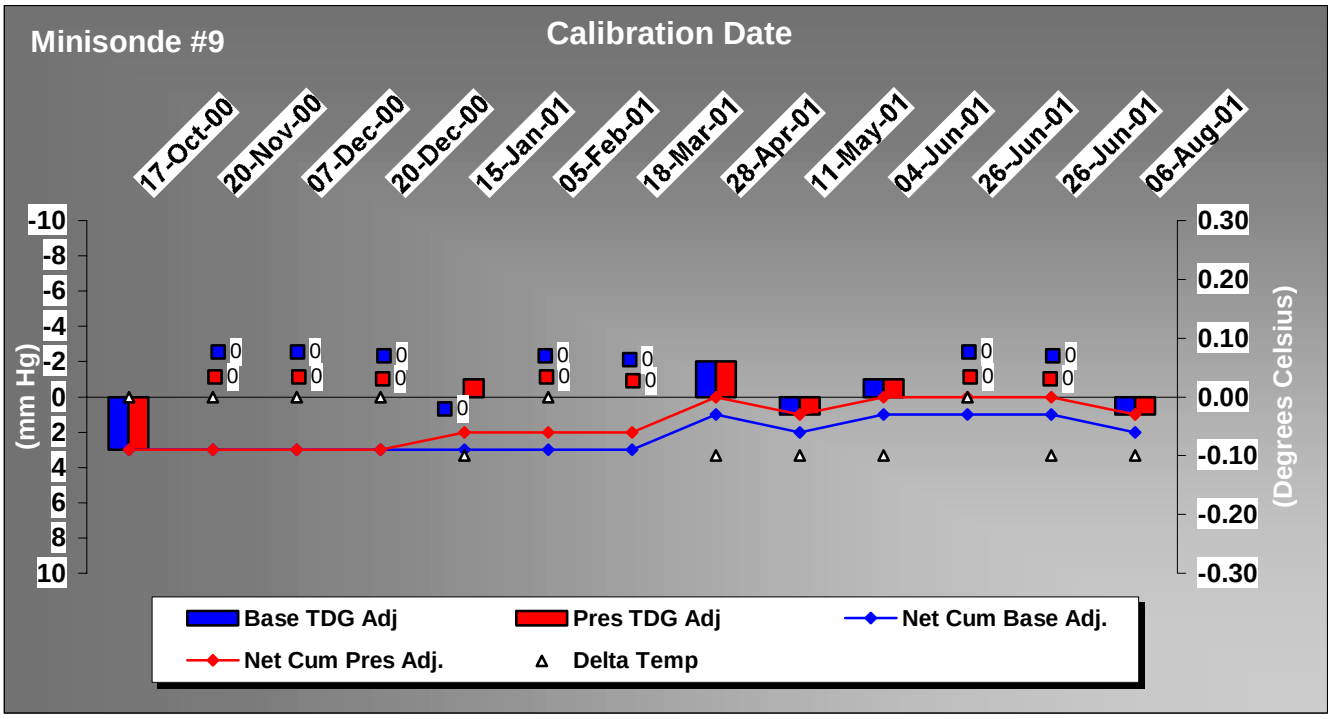
h. Sonde #08 (figure 3-14).

This sonde (barcode 24491) was purchased from Hydrolab Corporation (SN: 32432) on 19 February 1997 and placed into service in April 1997. The unit's service life is 5 years. It received its SLEP in 2001. This will extend its service life to 2003.

(FY00) This unit was deployed continuously during the field season and was utilized frequently as a QA/QC sonde. With the exception of two data points, this unit matched the standards. For all practical purposes this met all significant numbers and further QC would be a magnitude of order greater requiring new equipment and increased QA/QC. This unit is considered to be one of the best since further precision and accuracy beyond what this unit produces is not possible. This unit exceeds manufacturer's specifications and current QA/QC standards.

(FY01) Instrument #8 was reliable and provided high quality data all throughout the monitoring year. It did not require TDG or DO sensor repair. It was sent to the manufacturer in September 2001 for SLEP, preventative maintenance, a new circulator, and retrofitting with a 25-meter depth sensor. Instrument #8 is ready for FY02 operation.

Figure 3-15



Calibration Date	Base TDG Adj	Pres TDG Adj	Net Cum Base Adj.	Net Cum Pres Adj.	Delta Temp
17-Oct-00	3	3	3	3	0.00
20-Nov-00	0	0	3	3	0.00
07-Dec-00	0	0	3	3	0.00
20-Dec-00	0	0	3	3	0.00
15-Jan-01	0	-1	3	2	-0.10
05-Feb-01	0	0	3	2	0.00
18-Mar-01	0	0	3	2	
28-Apr-01	-2	-2	1	0	-0.10
11-May-01	1	1	2	1	-0.10
04-Jun-01	-1	-1	1	0	-0.10
26-Jun-01	0	0	1	0	0.00
26-Jun-01	0	0	1	0	-0.10
06-Aug-01	1	1	2	1	-0.10

18-Mar Temp check of Sonde temp sensor was not performed

Status: Instrument #9 is currently inoperative and awaiting repair of its TDG sensor, which failed in late August. The data produced prior to sensor failure is valid and does meet the DQO requirements for TDGMS. #9 is not ready for YR'02 operation.

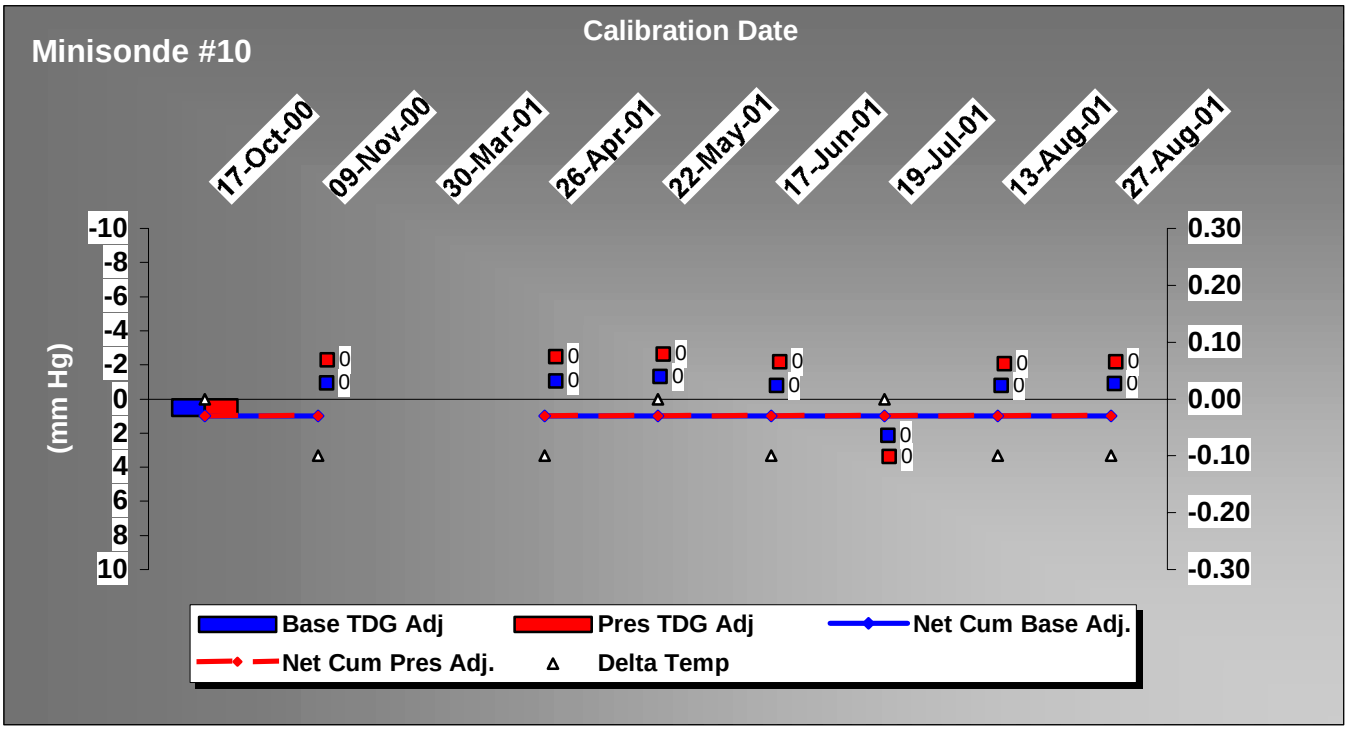
i. Sonde #09 (figure 3-15).

This sonde (barcode 30034) was purchased from Hydrolab Corporation (SN: 32420) on 19 February 1997 and placed into service in April 1997. The unit's service life is 5 years. It did not receive a SLEP in 2001. In FY02 it will have reached its service life and a decision to replace or repair will be made at a later date.

(FY00) This unit was utilized for the first 2 months of this season. In May, the instrument received physical damage and was not repaired until August. The unit was utilized in early water year 2001 with success.

(FY01) This instrument provided high quality data for three quarters of the year before it was disabled in late August due to a malfunctioning TDG sensor. Instrument #9 is awaiting repair and is not ready for FY02 operation.

Figure 3-16



Calibration Date	Base TDG Adj	Pres TDG Adj	Net Cum Base Adj.	Net Cum Pres Adj.	Delta Temp
17-Oct-00	1	1	1	1	0.00
09-Nov-00	0	0	1	1	-0.10
30-Mar-01		**Sent to Hydrolab for Maintenance**			
26-Apr-01	0	0	1	1	-0.10
22-May-01	0	0	1	1	0.00
17-Jun-01	0	0	1	1	-0.10
19-Jul-01	0	0	1	1	0.00
13-Aug-01	0	0	1	1	-0.10
27-Aug-01	0	0	1	1	-0.10

Status: The performance chart for instrument #10 indicates that, since its repair in late March, this Minisonde has been reliable and provides high quality data. #10 is ready for YR'02 operation.

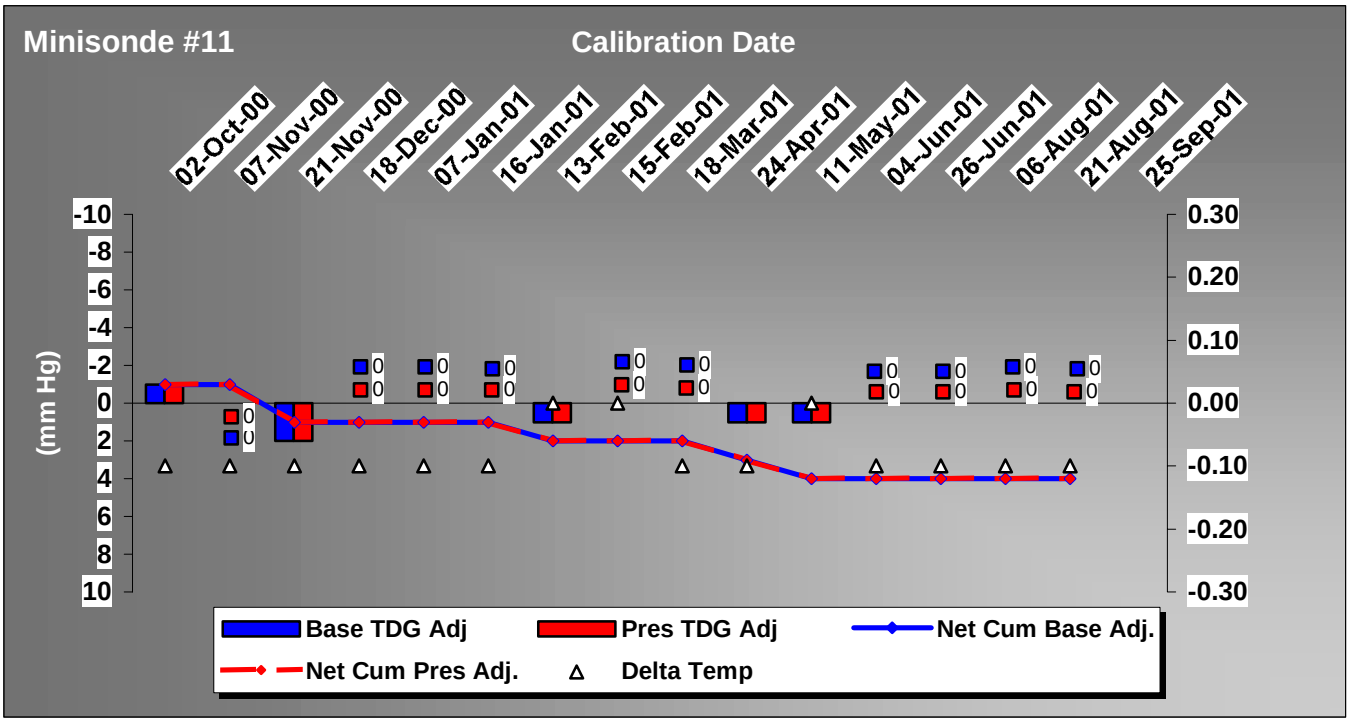
j. Sonde #10 (figure 3-16).

This sonde (barcode 24487) was purchased from Hydrolab Corporation (SN: 32428) on 19 February 1997 and placed into service in April 1997. The unit's service life is 5 years. It received its SLEP in 2001. This will extend the unit's service life to 2003.

(FY00) This unit was in service a majority of the time during this year's season. The temperature was nearly identical to the NBS standard. The TDG sensor did fluctuate throughout the period of service but was within the QA/QC and the manufacturer's specifications. In July and August, the instrument tolerances were at the loosest. However, after thorough lab tests and evaluation no problems were detected and it performed perfectly in September.

(FY01) Instrument #10 was operative until April 2001 at which time the DO sensor failed. It was sent to the manufacturer for SLEP, DO sensor repair and TDG software upgrade. The performance chart indicated that, since its repair, this sonde provided high quality data until the end of the monitoring year. Instrument #10 is ready for FY02 operation.

Figure 3-17



Calibration Date	Base TDG Adj	Pres TDG Adj	Net Cum Base Adj.	Net Cum Pres Adj.	Delta Temp
02-Oct-00	-1	-1	-1	-1	-0.10
07-Nov-00	0	0	-1	-1	-0.10
21-Nov-00	2	2	1	1	-0.10
18-Dec-00	0	0	1	1	-0.10
07-Jan-01	0	0	1	1	-0.10
16-Jan-01	0	0	1	1	-0.10
13-Feb-01	1	1	2	2	0.00
15-Feb-01	0	0	2	2	0.00
18-Mar-01	0	0	2	2	-0.10
24-Apr-01	1	1	3	3	-0.10
11-May-01	1	1	4	4	0.00
04-Jun-01	0	0	4	4	-0.10
26-Jun-01	0	0	4	4	-0.10
06-Aug-01	0	0	4	4	-0.10
21-Aug-01	0	0	4	4	-0.10
25-Sep-01	**Sent to Hydrolab for routine checks**				

Status: Instrument #11 is reliable and provided high quality data throughout the year. It did not require TDG or DO sensor repair this year. It was sent to Hydrolab at the end of the year for general checks and service and to have a 25-meter depth sensor installed. The rising Net Cum trend is not cause for immediate concern but this instrument will be carefully observed for deteriorating TDG sensor performance. For now #11 is ready for YR'02 operation.

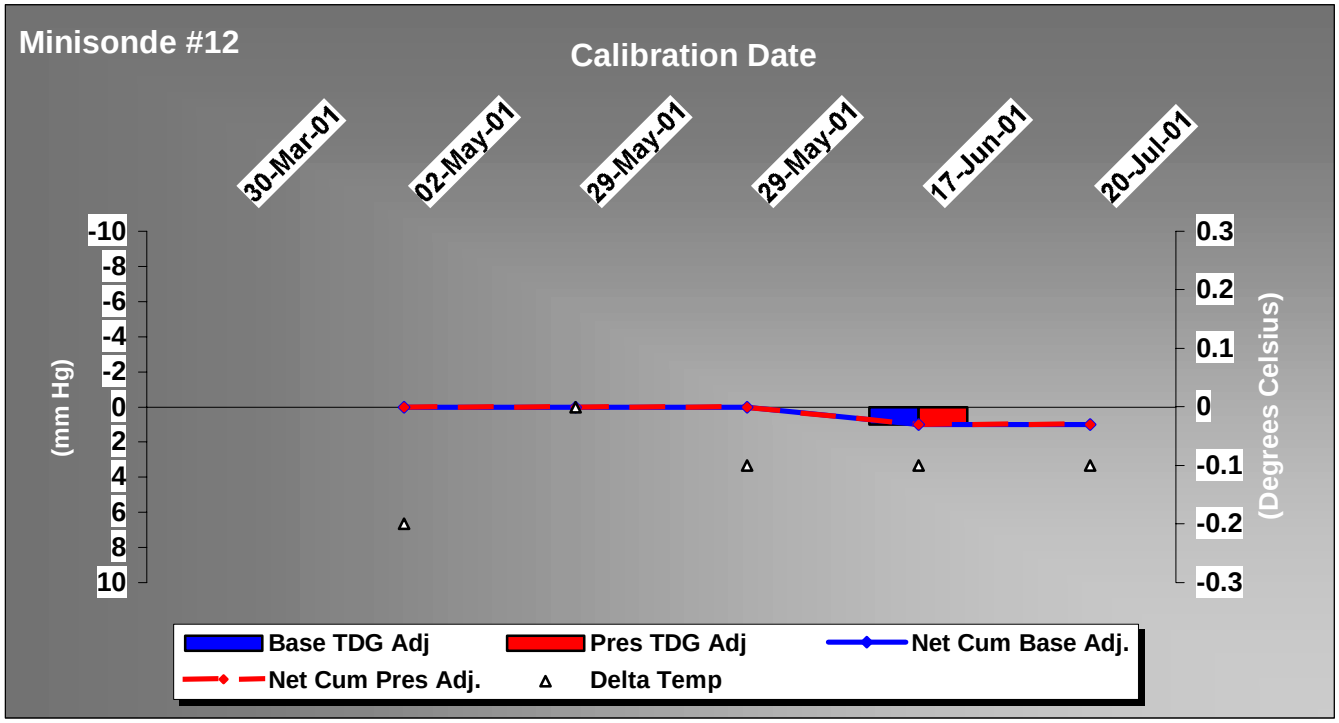
k. Sonde #11 (figure 3-17).

This sonde (barcode 24501) was purchased from Hydrolab Corporation (SN: 32465) on 19 February 1997 and placed into service in April 1997. The unit's service life is 5 years. It received its SLEP in 2001. This will extend the unit's service life to 2003.

(FY00) This instrument was used for most of the season. There was a bit more flux in the temperature sensor as compared to some of the better instruments. This instrument did perform within the manufacturer's specifications and met CENWW's QC.

(FY01) Instrument #11 was reliable and provided high quality data for the entire monitoring year. The rising Net Cum trend was not cause for the immediate concern but the TDG sensor will be monitored for indications of deteriorating performance. This instrument was sent to the manufacturer in September 2001 for SLEP, preventative maintenance, and retrofitting with a 25-meter depth sensor. Instrument #11 is ready for FY02 operation.

Figure 3-18



Calibration Date	Base TDG Adj	Pres TDG Adj	Net Cum Base Adj.	Net Cum Pres Adj.	Delta Temp
30-Mar-01		**Sent to Hydrolab for Maintenance**			
02-May-01	0	0	0	0	-0.20
29-May-01	0	0	0	0	0.00
29-May-01	0	0	0	0	-0.10
17-Jun-01	1	1	1	1	-0.10
20-Jul-01	0	0	1	1	-0.10

The performance chart for instrument #12 indicates that, since its repair in late March, this Minisonde has been reliable and provides high quality data. #12 is ready for YR'02 operation.

l. Sonde #12 (figure 3-18).

This sonde (barcode 24495) was purchased from Hydrolab Corporation (SN: 32465) on 19 February 1997 and placed into service in April 1997. The unit's service life is 5 years. It received its SLEP in 2001. This will extend the unit's service life to 2003.

(FY00) This unit was utilized during the winter monitoring portion for temperature monitoring only. This instrument failed pre-deployment trials in the spring. It remained non-mission capable for the entire season. This unit is currently non-operational and its gas probe port is now capped and plugged. The oxygen sensor was substituted to keep another instrument running.

(FY01) This instrument was inoperative at the beginning of the monitoring year. In April 2001 it received a SLEP, new TDG sensor, a new RS232 card, and a 25-meter depth sensor. Performance records indicate that the instrument provided high quality data since its repair. Instrument #12 is ready for FY02 operation.

m. Sonde #13.

This sonde (barcode 24492) was purchased from Hydrolab Corporation (SN: 32443) on 19 February 1997 and placed into service in April 1997. The unit's service life is 5 years. It did not receive SLEP in 2001. In FY02 it will have reached its service life and a decision to replace or repair will be made at a later date.

(FY00) This instrument was used from May to August. With a single point of data outside of control (30 May) the instrument performed exceptionally. After August, it became non-mission capable when it was apparently damaged at Peck when this station was damaged.

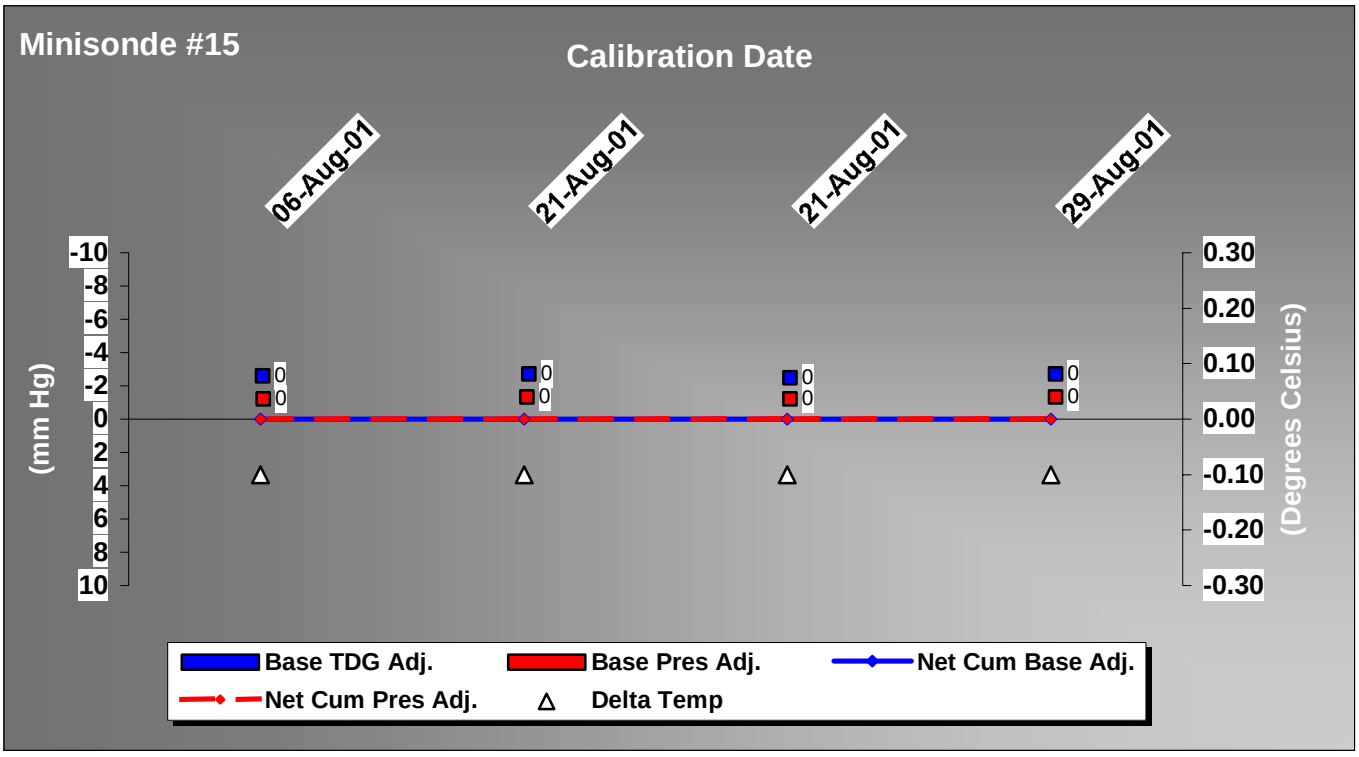
(FY01) Because of poor quality TDG and DO the instrument was not used in FY'01 Instrument #13 is not ready for FY02 operation.

n. Sonde #14.

This sonde (barcode 24493) was purchased from Hydrolab Corporation (SN: 32434) on 19 February 1997 and placed into service in April 1997. The unit's service life is 5 years. It did not receive SLEP in 2001. In FY02 it will have reached its service life and a decision to replace or repair will be made at a later date.

(FY00) This unit was used during the main season and performed within standards except in April. The instrument required a 3 mmHg adjustment in April. This is not considered to be within CENWW's control limits but is still within the manufacturer's specifications. The error was discovered in April. During the April audit, it was determined that an error occurred in the barometric pressure reading from the

Figure 3-19



Calibration Date	Base TDG Adj.	Base Pres Adj.	Net Cum Base Adj.	Net Cum Pres Adj.	Delta Temp
06-Aug-01	0	0	0	0	-0.10
21-Aug-01	0	0	0	0	-0.10
21-Aug-01	0	0	0	0	-0.10
29-Aug-01	0	0	0	0	-0.10

The performance chart for instrument #15 indicates that this Minisonde has been reliable and provides high quality data for the system. #15 is ready for YR'02 operation.

mercury standard. This procedural error was corrected and the instrument was in standards the remaining portion of the year.

(FY01) Because of poor quality TDG and DO the instrument was not used in FY'01. Instrument #14 is not ready for FY02 operation.

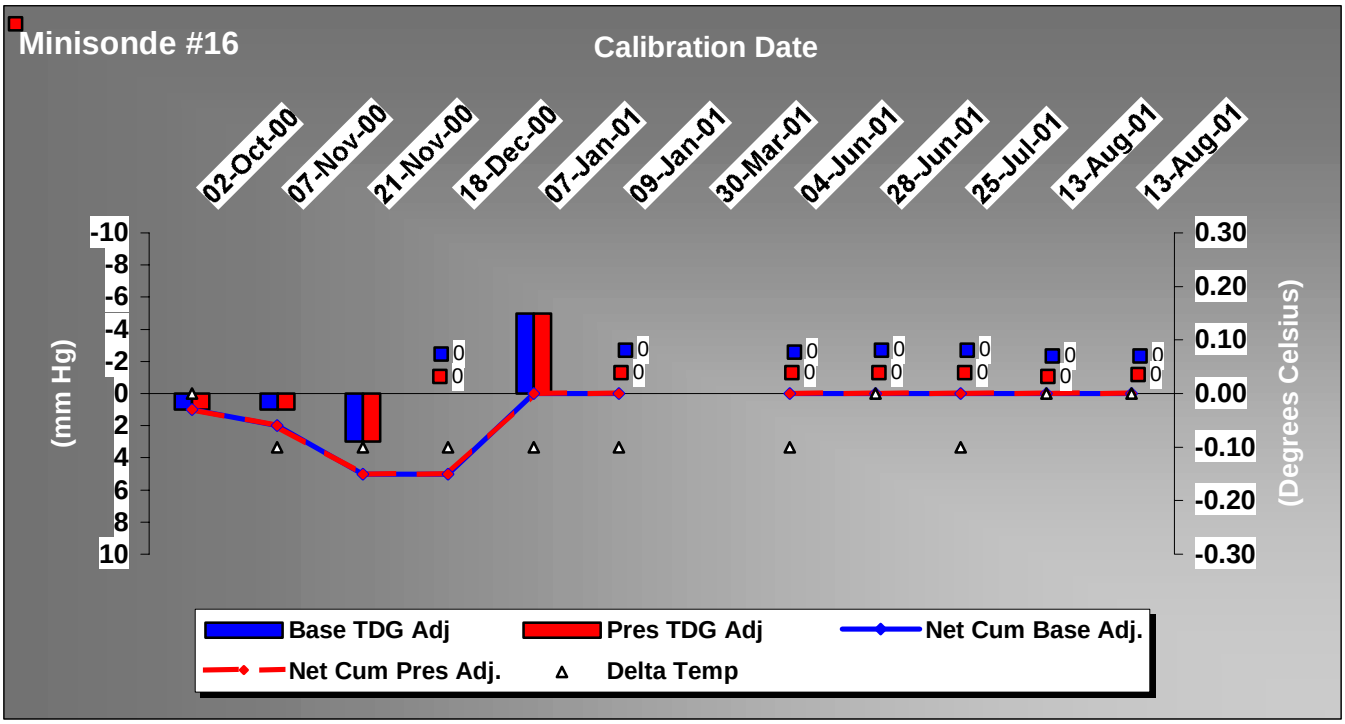
o. Sonde #15 (figure 3-19).

This sonde (barcode 24496) was purchased from Hydrolab Corporation (SN: 32429) on 19 February 1997 and placed into service in April 1997. The unit's service life is 5 years. It received its SLEP in 2001. This will extend the unit's service life to 2003.

(FY00) This instrument was not used in the FY00 monitoring season. It has an unstable pressure transducer (It needed a factory rebuild) and a usable DO sensor. It is still in a non-mission capable status. It will be overhauled in 2001.

(FY01) This instrument was inoperative at the beginning of the monitoring year. In April 2001 it received a SLEP, new DO sensor, a new circulator, and a 25-meter depth sensor. It returned to active duty in August 2001. Performance records indicate that the instrument provided high quality data since its repair. Instrument #15 is ready for FY02 operation.

Figure 3-20



Calibration Date	Base TDG Adj	Pres TDG Adj	Net Cum Base Adj.	Net Cum Pres Adj.	Delta Temp
02-Oct-00	1	1	1	1	0.00
07-Nov-00	1	1	2	2	-0.10
21-Nov-00	3	3	5	5	-0.10
18-Dec-00	0	0	5	5	-0.10
07-Jan-01	**-5**	**-5**	0	0	-0.10
09-Jan-01	0	0	0	0	-0.10
30-Mar-01	**Sent to Hydrolab for maintenance**				
04-Jun-01	0	0	0	0	-0.10
28-Jun-01	0	0	0	0	0.00
25-Jul-01	0	0	0	0	-0.10
13-Aug-01	0	0	0	0	0.00
13-Aug-01	0	0	0	0	0.00

red- invalid data value (see Table 5)

Status: Since its repair in late-March, instrument #16 has been reliable in providing high quality data. This instrument is ready for YR'02 operation.

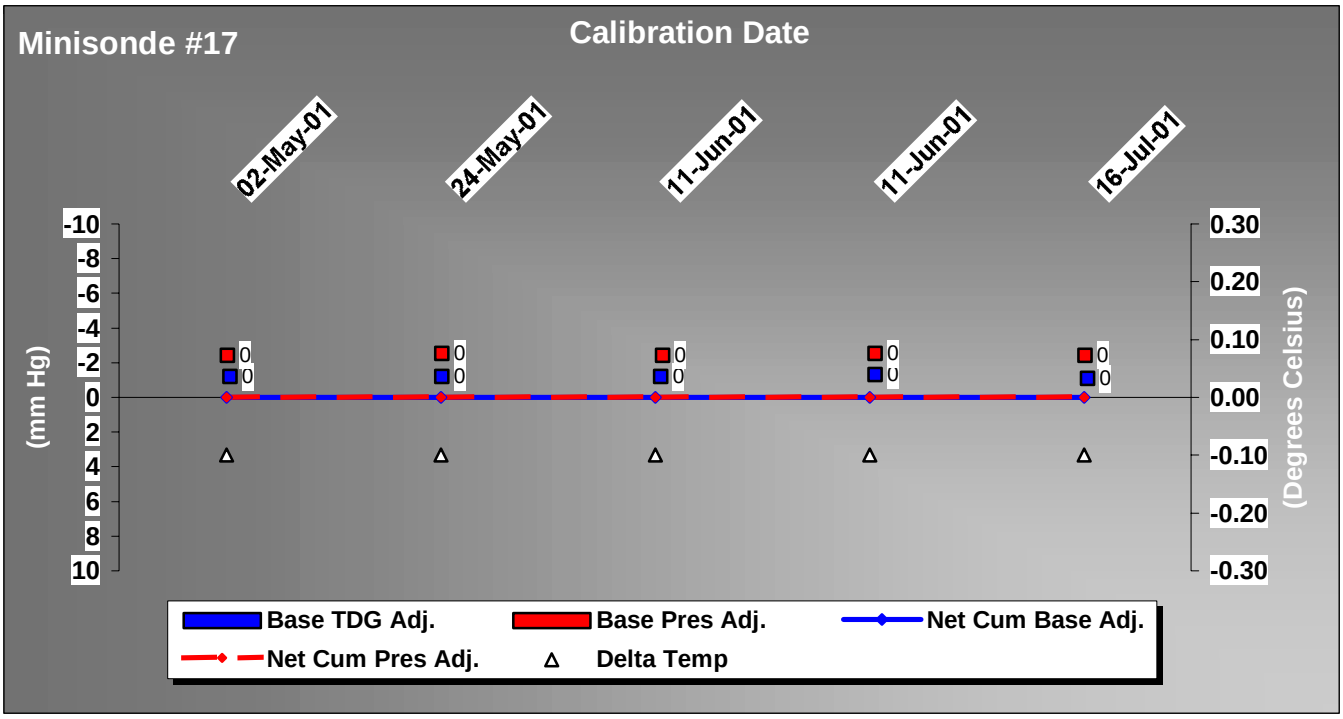
p. Sonde #16 (figure 3-20).

This sonde (barcode 24488) was purchased from Hydrolab Corporation (SN: 32429) on 19 February 1997 and placed into service in April 1997. The unit's service life is 5 years. It received its SLEP in 2001. This will extend the unit's service life to 2003.

(FY00) This instrument performed quite well and achieved the DQOs the entire year.

(FY01) Instrument #16 was operative until January 2001 at which time the DO sensor and TDG sensor failed. It was sent to the manufacturer for repair in April where a SLEP was also completed. The performance chart indicated that, since its repair, this sonde provided high quality data until the end of the monitoring year. Instrument #16 is ready for FY02 operation.

Figure 3-21



Calibration Date	Base TDG Adj.	Base Pres Adj.	Net Cum Base Adj.	Net Cum Pres Adj.	Delta Temp
02-May-01	0	0	0	0	-0.10
24-May-01	0	0	0	0	-0.10
11-Jun-01	0	0	0	0	-0.10
11-Jun-01	0	0	0	0	-0.10
16-Jul-01	0	0	0	0	-0.10

The performance chart for instrument #17 indicates that this Minisonde has been reliable and provides high quality data for the system. #17 is ready for YR'02 operation.

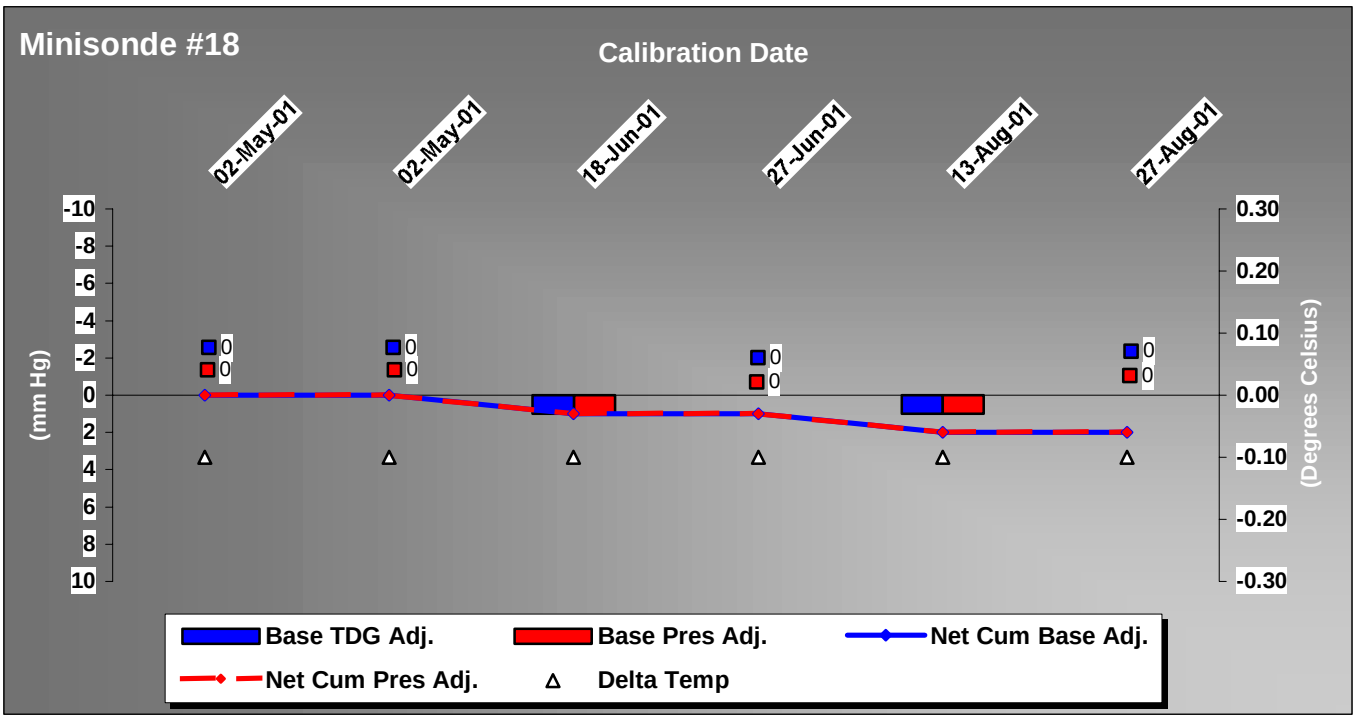
q. Sonde #17 (figure 3-21).

This sonde (barcode 24489) was purchased from Hydrolab Corporation (SN: 32430) on 19 February 1997 and placed into service in April 1997. The unit's service life is 5 years. It received its SLEP in 2001. This will extend the unit's service life to 2003.

(FY00) This unit never passed QA/QC in the winter or the spring and was never deployed. It was sent to the manufacturer and was overhauled. It went through a test and evaluation period after coming back from the factory. It again failed to meet QA and only barely met specifications. It will function but it does meet the QA/QC for deployment. The manufacturer has not made additional repairs. The DO sensor is currently non-operational.

(FY01) This instrument was inoperative at the beginning of the monitoring year. In May 2001 it received SLEP where a new TDG sensor and a 25-meter depth sensor were installed. Performance records indicate that the instrument provided high quality data since its repair. Instrument #17 is ready for FY02 operation.

Figure 3-22



Calibration Date	Base TDG Adj.	Base Pres Adj.	Net Cum Base Adj.	Net Cum Pres Adj.	Delta Temp
02-May-01	0	0	0	0	-0.10
02-May-01	0	0	0	0	-0.10
18-Jun-01	1	1	1	1	-0.10
27-Jun-01	0	0	1	1	-0.10
13-Aug-01	1	1	2	2	-0.10
27-Aug-01	0	0	2	2	-0.10

The performance chart for instrument #18 indicates that this Minisonde has been reliable and provides high quality data for the system. #18 is ready for YR'02 operation.

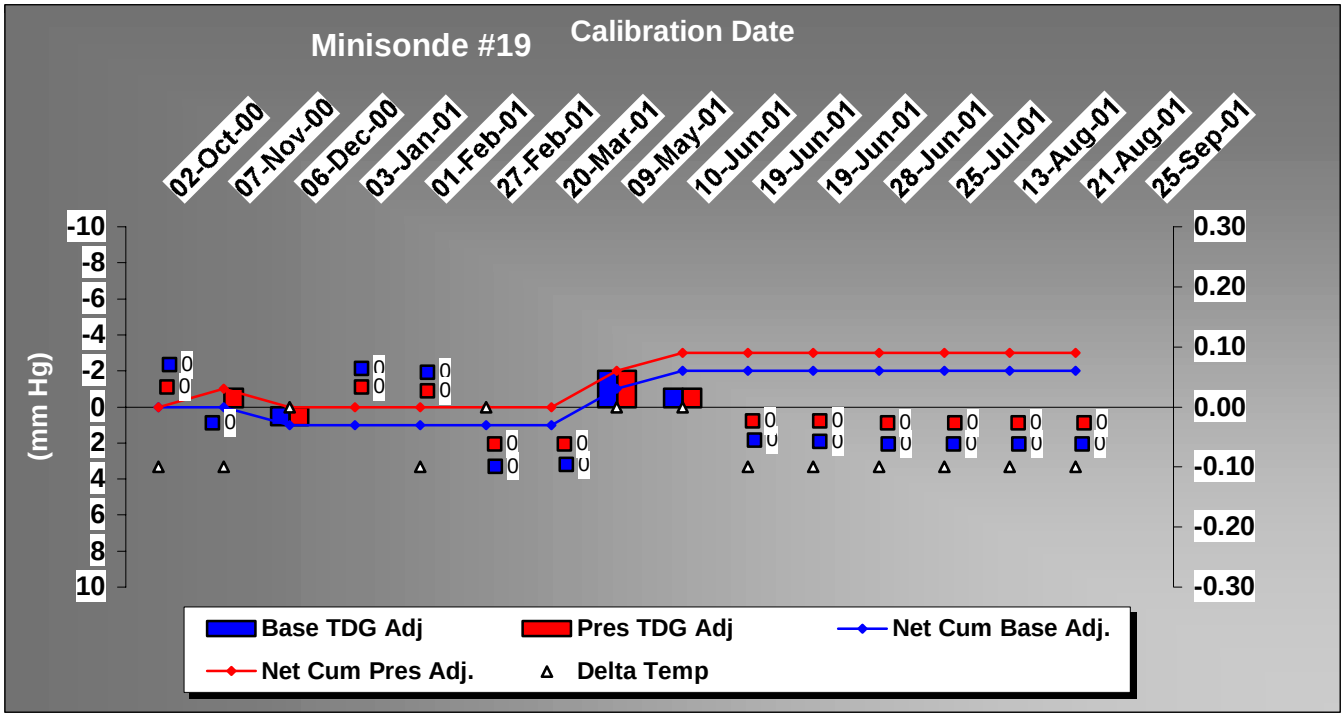
r. Sonde #18 (figure 3-22).

This sonde (barcode 24494) was purchased from Hydrolab Corporation (SN: 32435) on 19 February 1997 and placed into service in April 1997. The unit's service life is 5 years. It received its SLEP in 2001. This will extend the unit's service life to 2003.

(FY00) This unit started service in the month of March and performed consistently very well. In July, it was sent to the manufacturer for maintenance. It was tested in August and failed QC because the pressure transducer (TDG) was still outside the control limits. It is planned to send this unit back to the manufacturer for a complete overhaul. Until the July failure, the unit performed well and it is currently not planned to retire it until some time in 2004.

(FY01) This instrument was inoperative at the beginning of the monitoring year. In April 2001 it received a SLEP, upgraded TDG software, a 25-meter depth sensor, and a new RS232 card. It returned to service in May 2001 but went off-line again in late August 2001 because of power circuit problems. It was sent to the manufacturer in September 2001 for a new circulator, which solved the electrical problems. Instrument #18 is now ready for FY02 operation.

Figure 3-23



Calibration Date	Base TDG Adj	Pres TDG Adj	Net Cum Base Adj.	Net Cum Pres Adj.	Delta Temp
02-Oct-00	0	0	0	0	-0.10
07-Nov-00	0	-1	0	-1	-0.10
06-Dec-00	1	1	1	0	0.00
03-Jan-01	0	0	1	0	
01-Feb-01	0	0	1	0	-0.10
27-Feb-01	0	0	1	0	0.00
20-Mar-01	0	0	1	0	
09-May-01	-2	-2	-1	-2	0.00
10-Jun-01	-1	-1	-2	-3	0.00
19-Jun-01	0	0	-2	-3	-0.10
19-Jun-01	0	0	-2	-3	-0.10
28-Jun-01	0	0	-2	-3	-0.10
25-Jul-01	0	0	-2	-3	-0.10
13-Aug-01	0	0	-2	-3	-0.10
21-Aug-01	0	0	-2	-3	-0.10
25-Sep-01		**Sent to Hydrolab for routine checks**			

03-Jan Temp check of Sonde temp sensor was not performed

20-Mar Temp check of Sonde temp sensor was not performed

Status: Instrument #19 is reliable and provided high quality data throughout the year. It did not require TDG or DO sensor repair this year. It was sent to Hydrolab at the end of the year for general checks and service and to have a 25-meter depth sensor installed. #19 is ready for YR'02 operation.

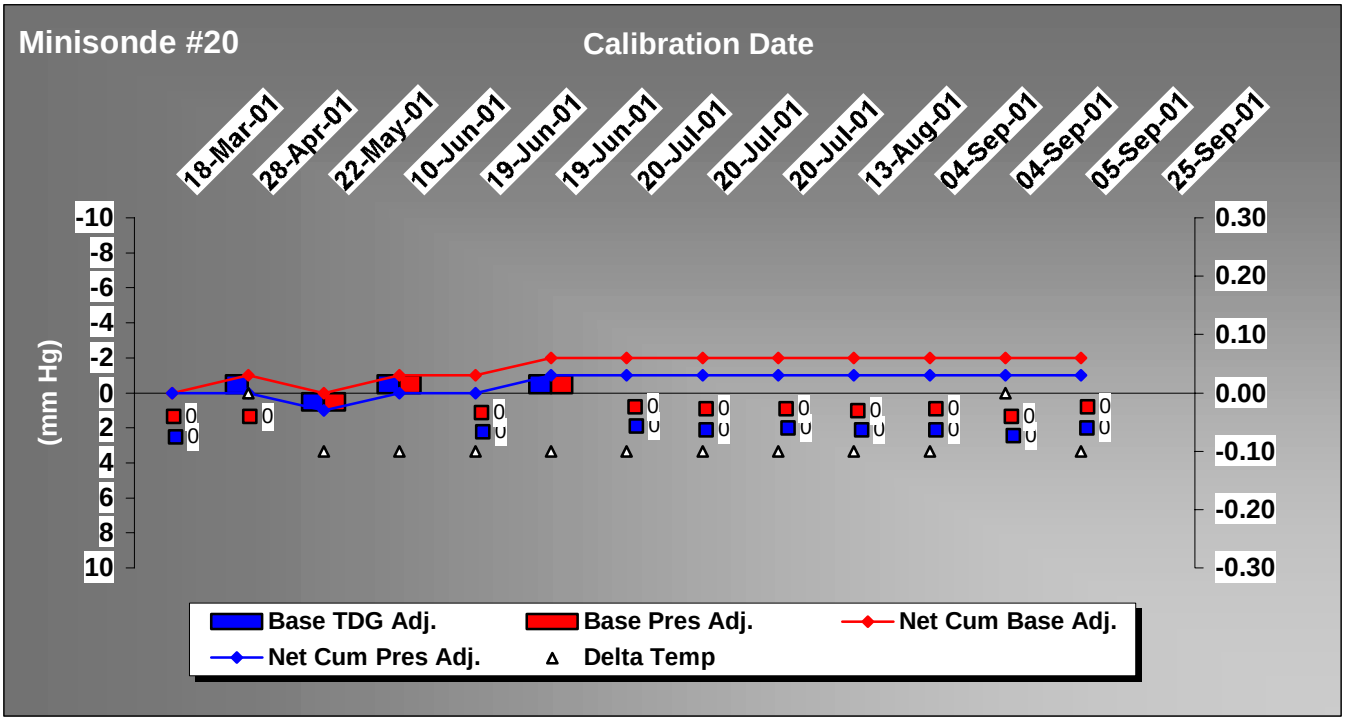
s. Sonde #19 (figure 3-23).

This sonde (barcode 25953?) was purchased from Hydrolab Corporation (SN: 35132) on 2 March 1998 and placed into service in April 1998. The unit's service life is 5 years. It received its SLEP in 2001. This will extend the unit's service life to 2005.

(FY00) This unit was used once in April and once in May. It is fairly new but the unit fails to calibrate properly. It requires repair but has not been repaired yet. We anticipated that it would be sent in for repair rather than replacement since it is only a few years old and has not seen much use.

(FY01) Instrument #19 was reliable and provided high quality data throughout the entire monitoring year. It did not require TDG or DO sensor repair. It was sent to the manufacturer in September 2001 for a SLEP, preventative maintenance, and installation of a 25-meter depth sensor. Instrument #19 is ready for FY02 operation.

Figure 3-24



Calibration Date	Base TDG Adj.	Base Pres Adj.	Net Cum Base Adj.	Net Cum Pres Adj.	Delta Temp
18-Mar-01	0	0	0	0	
28-Apr-01	-1	0	-1	0	0.00
22-May-01	1	1	0	1	-0.10
10-Jun-01	-1	-1	-1	0	-0.10
19-Jun-01	0	0	-1	0	-0.10
19-Jun-01	-1	-1	-2	-1	-0.10
20-Jul-01	0	0	-2	-1	-0.10
20-Jul-01	0	0	-2	-1	-0.10
20-Jul-01	0	0	-2	-1	-0.10
13-Aug-01	0	0	-2	-1	-0.10
04-Sep-01	0	0	-2	-1	-0.10
04-Sep-01	0	0	-2	-1	0.00
05-Sep-01	0	0	-2	-1	-0.10
25-Sep-01			**Sent to hydrolab for routine checks**		

18-Mar Temp check of Sonde temp sensor was not performed

Status: Instrument #20 is reliable and provided high quality data throughout the year. It did not require TDG or DO sensor repair this year. It was sent to Hydrolab at the end of the year for general checks ans service and to have a 25-meter depth sensor installed. #20 is ready for YR'02 operation.

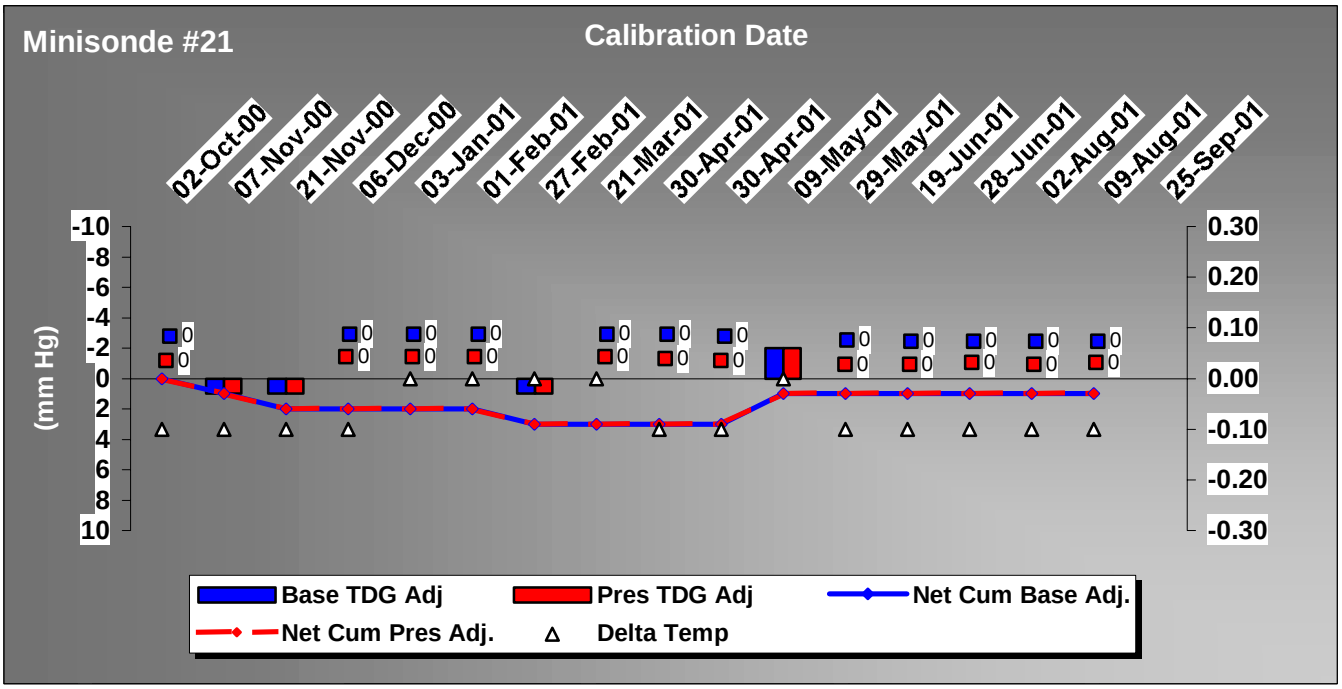
t. Sonde #20 (figure 3-24).

This sonde (barcode 24498) was purchased from Hydrolab Corporation (SN: 32442) on 19 February 1997 and placed into service in April 1997. The unit's service life is 5 years. It received its SLEP in 2001. This will extend the unit's service life to 2003 but based on its performance we do not anticipate retiring it until fiscal year 2005 (FY05) provided it does not receive significant operational damage.

(FY00) This unit is one of the fleet's best sondes. It provided excellent service the entire season and provided better than required precision. The unit exceeded all specifications and QC limits. The unit is currently scheduled for an oxygen sensor rebuild and is expected to return to service in spring of 2001 after a comprehensive SLEP.

(FY01) Instrument #20 was reliable and provided high quality data throughout the entire monitoring year. It did not require TDG or DO sensor repair. It was sent to the manufacturer in September 2001 for SLEP, preventative maintenance, a new circulator, and to be retrofitted with a 25-meter depth sensor. Instrument #20 is ready for FY02 operation.

Figure 3-25



Calibration Date	Base TDG Adj	Pres TDG Adj	Net Cum Base Adj.	Net Cum Pres Adj.	Delta Temp
02-Oct-00	0	0	0	0	-0.10
07-Nov-00	1	1	1	1	-0.10
21-Nov-00	1	1	2	2	-0.10
06-Dec-00	0	0	2	2	-0.10
03-Jan-01	0	0	2	2	
01-Feb-01	0	0	2	2	0.00
27-Feb-01	1	1	3	3	0.00
21-Mar-01	0	0	3	3	
30-Apr-01	0	0	3	3	-0.10
30-Apr-01	0	0	3	3	-0.10
09-May-01	-2	-2	1	1	0.00
29-May-01	0	0	1	1	-0.10
19-Jun-01	0	0	1	1	-0.10
28-Jun-01	0	0	1	1	-0.10
02-Aug-01	0	0	1	1	-0.10
09-Aug-01	0	0	1	1	-0.10
25-Sep-01		**Sent to Hydrolab for routine checks**			

03-Jan Temp check of Sonde temp sensor was not performed

21-Mar Temp check of Sonde temp sensor was not performed

Status: Instrument #21 is reliable and provided high quality data throughout the year. It did not require TDG or DO sensor repair this year. It was sent to Hydrolab at the end of the year for general checks and service and to have a 25-meter depth sensor installed. #21 is ready for YR'02 operation.

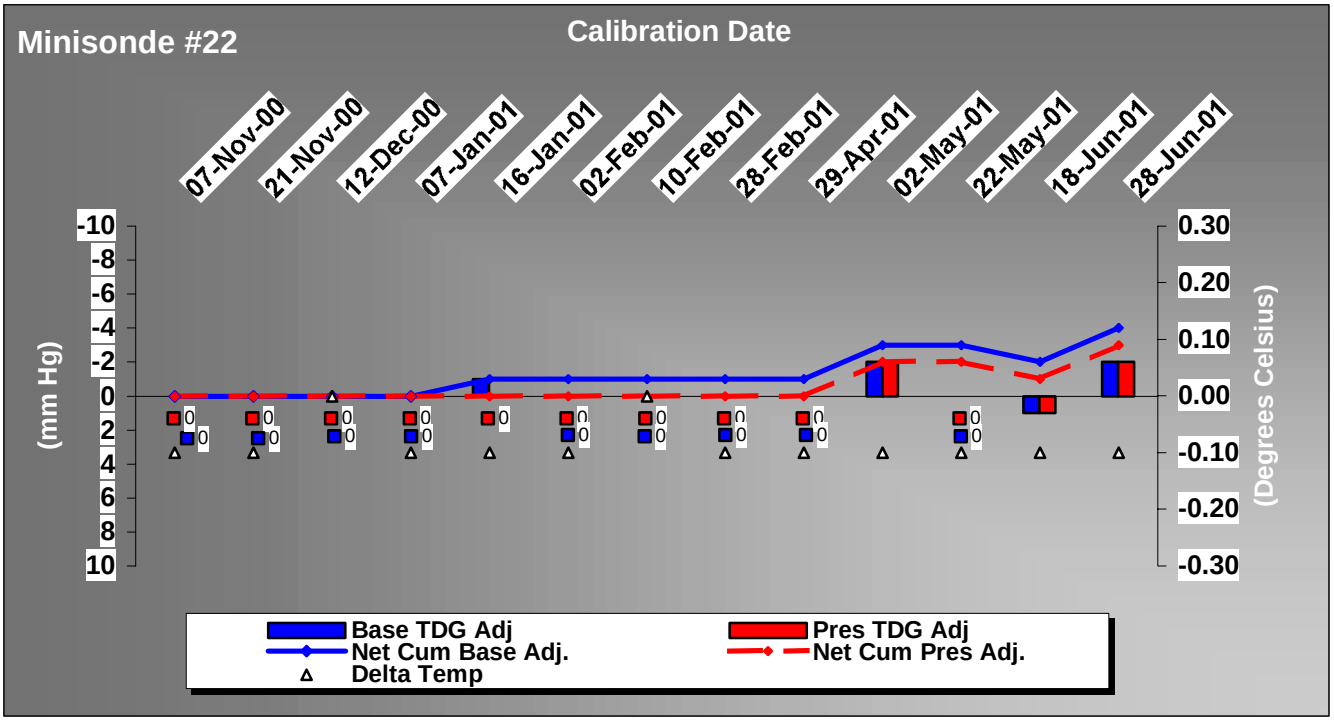
u. Sonde #21 (figure 3-25).

This sonde (barcode 24499) was purchased from Hydrolab Corporation (SN: 32443) on 19 February 1997 and placed into service in April 1997. The unit's service life is 5 years. It received its SLEP in 2001. This will extend the unit's service life to 2003 but based on its performance we do not anticipate retiring it until FY05 provided it does not receive significant operational damage.

(FY00) This instrument performed exceptionally well with its TDG sensor all year. The temperature sensor has performed very well but appears to have drifted slightly downward but still is well within specification. The temperature sensor is still currently within manufacturer's specifications. This unit is one of the best in the fleet and exceeds manufacturer specifications.

(FY01) This instrument was reliable and provided high quality data throughout the entire monitoring year. It did not require TDG or DO sensor repair. It was sent to the manufacturer in September 2001 for SLEP, preventative maintenance and to be retrofitted with a 25-meter depth sensor. Instrument #21 is ready for FY02 operation.

Figure 2-26



Calibration Date	Base TDG Adj	Pres TDG Adj	Net Cum Base Adj.	Net Cum Pres Adj.	Delta Temp
07-Nov-00	0	0	0	0	-0.10
21-Nov-00	0	0	0	0	-0.10
12-Dec-00	0	0	0	0	0.00
07-Jan-01	0	0	0	0	-0.10
16-Jan-01	-1	0	-1	0	-0.10
02-Feb-01	0	0	-1	0	-0.10
10-Feb-01	0	0	-1	0	0.00
28-Feb-01	0	0	-1	0	-0.10
29-Apr-01	0	0	-1	0	-0.10
02-May-01	-2	-2	-3	-2	-0.10
22-May-01	0	0	-3	-2	-0.10
18-Jun-01	1	1	-2	-1	-0.10
28-Jun-01	-2	-2	-4	-3	-0.10

Status: Instrument #22 is currently inoperative and awaiting repair of its TDG sensor, which failed in late June. The data produced prior to sensor failure is valid and does meet the DQO requirements for TDGMS. #22 is not ready for YR'02 operation.

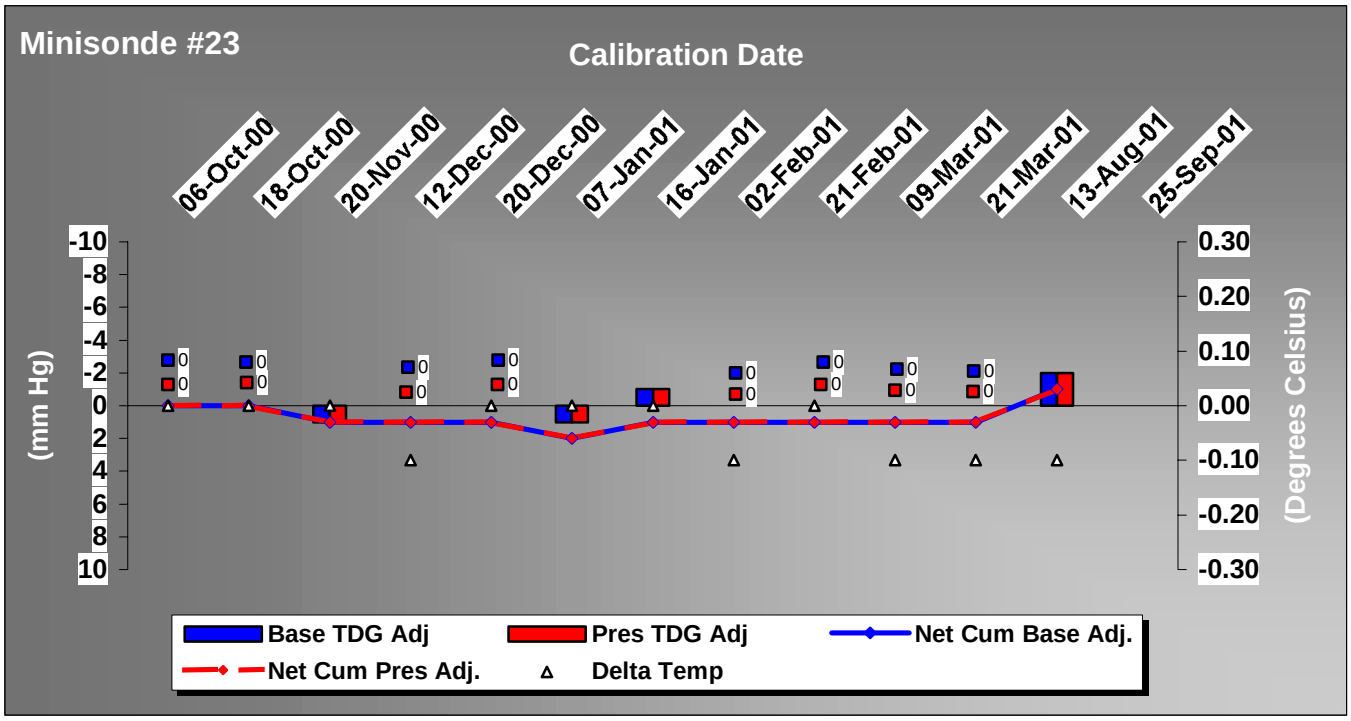
v. Sonde #22 (figure 3-26).

This sonde (barcode 30031) was purchased from Hydrolab Corporation (SN: 32417) on 19 February 1997 and placed into service in April 1997. The unit's service life is 5 years. It did not receive its SLEP in 2001 and unless it is accomplished it will be scheduled for retirement in FY02.

(FY00) The TDG sensor in this unit met specifications and passed QC limits throughout this season. Two outlying data points were observed of the standard but were still within the manufacturer's specifications.

(FY01) This instrument was operative until June 2001 at which time the TDG sensor failed. Instrument #22 has not been repaired and is not ready for FY02 operation. A decision to repair or replace has not been made at the time of this publications printing.

Figure 3-27



Calibration Date	Base TDG Adj	Pres TDG Adj	Net Cum Base Adj.	Net Cum Pres Adj.	Delta Temp
06-Oct-00	0	0	0	0	0.00
18-Oct-00	0	0	0	0	0.00
20-Nov-00	1	1	1	1	0.00
12-Dec-00	0	0	1	1	-0.10
20-Dec-00	0	0	1	1	0.00
07-Jan-01	1	1	2	2	0.00
16-Jan-01	-1	-1	1	1	0.00
02-Feb-01	0	0	1	1	-0.10
21-Feb-01	0	0	1	1	0.00
09-Mar-01	0	0	1	1	-0.10
21-Mar-01	0	0	1	1	-0.10
13-Aug-01	-2	-2	-1	-1	-0.10
25-Sep-01	**Sent to Hydrolab for routine checks**				

Status: Instrument #23 is reliable and provided high quality data throughout the year. It did not require TDG or DO sensor repair this year. It was sent to Hydrolab at the end of the year for general checks and service and to have a 25-meter depth sensor installed. #23 is ready for YR'02 operation.

Sonde #23 (figure 3-27).

This sonde (barcode 30917) was purchased from Hydrolab Corporation (SN: 35131) on 2 May 1999 and placed into service in September 1999. The unit's service life is 5 years. It did not require SLEP in 2001 and its scheduled retirement date it fiscal year 2004 (FY04).

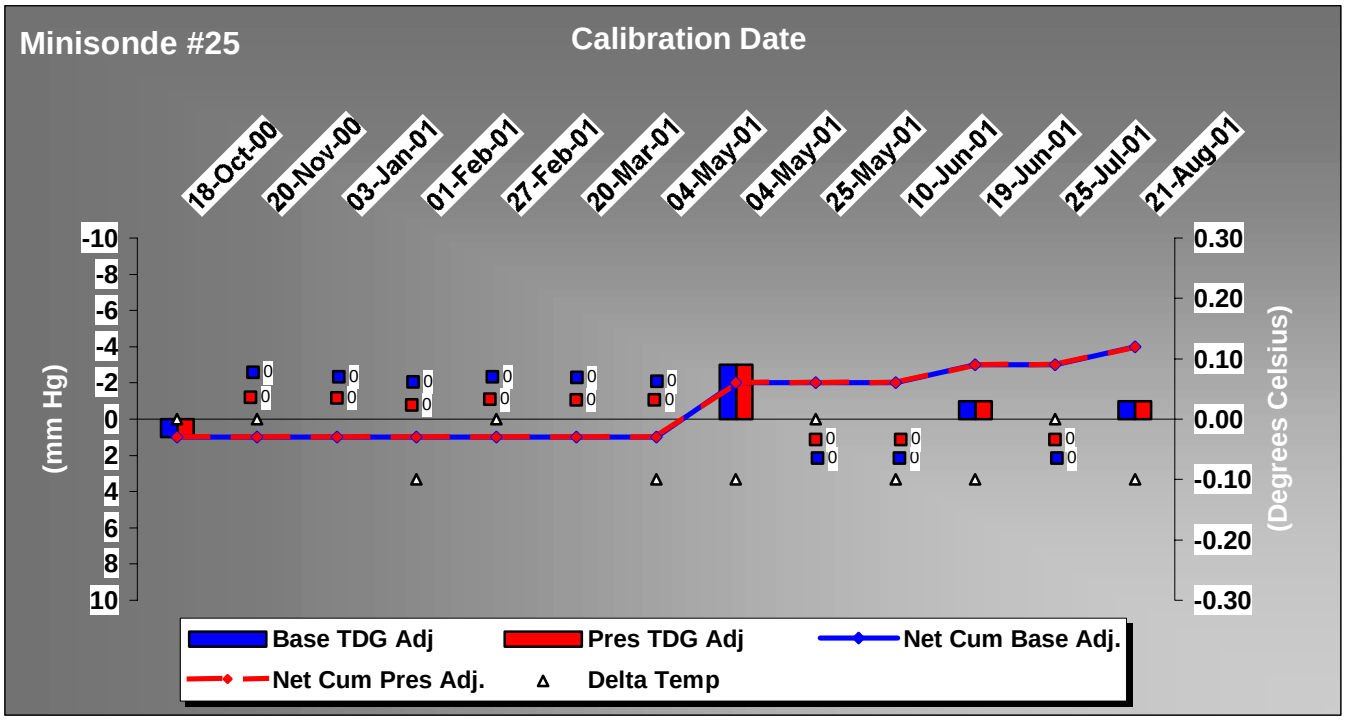
(FY00) This instrument is a new acquisition and was placed into service in September prior to going through trials due to lack of serviceable instruments. The instrument is one of the winter 2001 instruments and has proven to provide flawless data when measured against a standard

(FY01) Instrument #23 was reliable and provided high quality data throughout the entire monitoring year. It did not require TDG or DO sensor repair. It was sent to the manufacturer in September 2001 for preventative maintenance and was retrofitted with a 25-meter depth sensor. Instrument #23 is ready for FY02 operation.

x. Sonde #24.

This instrument's electronic package was flooded on 26 January 2001 due to an o-ring failure and is no longer in the TDGMS inventory.

Figure 3-28



Calibration Date	Base TDG Adj	Pres TDG Adj	Net Cum Base Adj.	Net Cum Pres Adj.	Delta Temp
18-Oct-00	1	1	1	1	0.00
20-Nov-00	0	0	1	1	0.00
03-Jan-01	0	0	1	1	
01-Feb-01	0	0	1	1	-0.10
27-Feb-01	0	0	1	1	0.00
20-Mar-01	0	0	1	1	
04-May-01	0	0	1	1	-0.10
04-May-01	-3	-3	-2	-2	-0.10
25-May-01	0	0	-2	-2	0.00
10-Jun-01	0	0	-2	-2	-0.10
19-Jun-01	-1	-1	-3	-3	-0.10
25-Jul-01	0	0	-3	-3	0.00
21-Aug-01	-1	-1	-4	-4	-0.10

03-Jan Temp check of Sonde temp sensor was not performed

20-Mar temp check of Sonde temp sensor was not performed

Status: Instrument #25 is reliable and provides high quality data. This instrument does not require immediate maintenance and will remain in service until it can be sent in for routine checks and service. The rising Net Cum trend is not cause for immediate concern but this instrument will be carefully observed for deteriorating TDG sensor performance. For now #25 is ready for YR'02 operation.

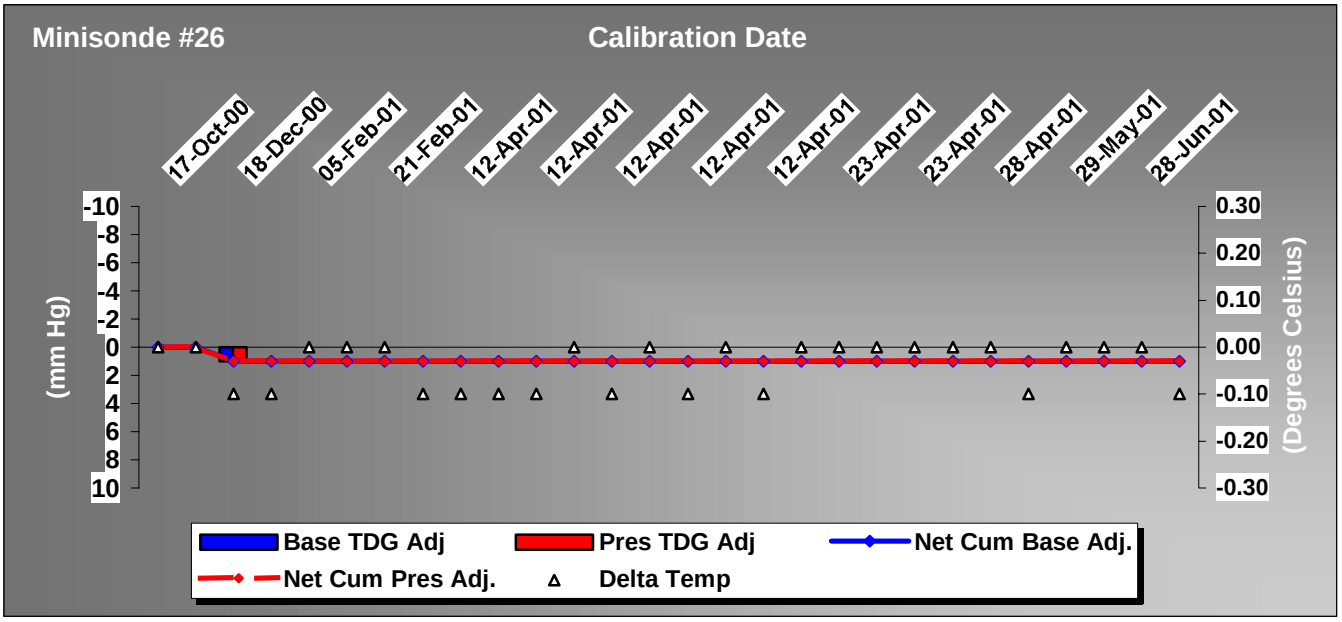
y. Sonde #25 (figure 3-28).

This sonde (barcode 36687) was purchased from Hydrolab Corporation (SN: 36687) on 9 September 1999 and placed into service in October 1999. The unit's service life is 5 years. It did not require SLEP in 2001 and its scheduled retirement date it FY04.

(FY00) This unit is a new acquisition and provided flawless TDG performance. The temperature sensor has been troublesome and failed QC on two occasions. The manufacturer's specification states that this thermister is just inside their specifications and will not warrant repair. This unit was not used in water year 2001 winter cycle and is scheduled for another temperature calibration at the factory.

(FY01.) After a warranty repair, the instrument was reliable and provided high quality data for the entire monitoring year. The continuing rising of the Net Cum trend was not cause for the immediate concern but the TDG sensor will be monitored for indications of deteriorating performance. This instrument continues to be cantankerous during calibration and if it continues to provide problems it could be retired early. Instrument #25 is ready for FY02 operation.

Figure 3-29



Calibration Date	Base TDG Adj	Pres TDG Adj	Net Cum Base Adj.	Net Cum Pres Adj.	Delta Temp
17-Oct-00	0	0	0	0	0.00
20-Nov-00	0	0	0	0	0.00
18-Dec-00	1	1	1	1	-0.10
15-Jan-01	0	0	1	1	-0.10
05-Feb-01	0	0	1	1	0.00
05-Feb-01	0	0	1	1	0.00
21-Feb-01	0	0	1	1	0.00
28-Feb-01	0	0	1	1	-0.10
12-Apr-01	0	0	1	1	-0.10
12-Apr-01	0	0	1	1	-0.10
12-Apr-01	0	0	1	1	-0.10
12-Apr-01	0	0	1	1	0.00
12-Apr-01	0	0	1	1	-0.10
12-Apr-01	0	0	1	1	0.00
12-Apr-01	0	0	1	1	-0.10
12-Apr-01	0	0	1	1	0.00
12-Apr-01	0	0	1	1	-0.10
12-Apr-01	0	0	1	1	0.00
23-Apr-01	0	0	1	1	0.00
23-Apr-01	0	0	1	1	0.00
23-Apr-01	0	0	1	1	0.00
28-Apr-01	0	0	1	1	0.00
28-Apr-01	0	0	1	1	0.00
11-May-01	0	0	1	1	-0.10
29-May-01	0	0	1	1	0.00
18-Jun-01	0	0	1	1	0.00
28-Jun-01	0	0	1	1	0.00
21-Jul-01	0	0	1	1	-0.10

Status: Instrument #26 is currently inoperative and awaiting repair. The instrument flooded and may not be repairable. The data produced prior to failure is valid and does meet the DQO requirements for TDGMS. #26 is not ready for YR'02 operation.

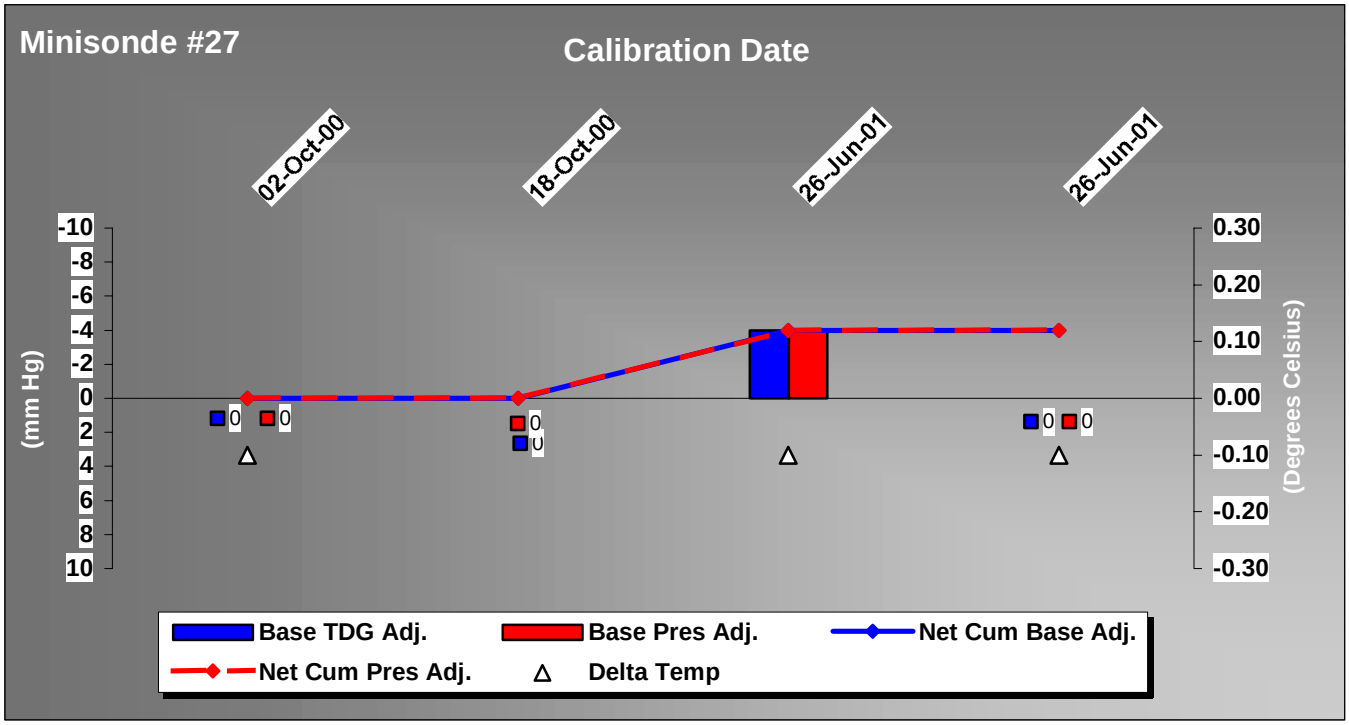
z. Sonde #26 (figure 3-29).

This sonde (barcode 26641) was purchased from Hydrolab Corporation (SN: 36685) on 9 September 1999 and placed into service in October 1999. The unit's service life is 5 years. It did not receive a mid-life service due to its age but was flooded in FY01. No decision was made to repair or replace as of printing.

(FY00) This unit provided data within specifications for the entire water year. It appears that there was one data point outside control limits in early May. This may have been an anomaly since the error could not be repeated in the lab. Additional tests still did not render any reason for the dip in the lower control point. The rest of the year, it continued to provide temperature data within the manufacturer's specifications but was difficult to set up the electronic data transfers with the SDI-12. This unit was a bit cantankerous to calibrate as well.

(FY01) This instrument was operative until July 24, 2001 at which time the instrument flooded due to the failure of an internal O-ring seal. Instrument #26 has not been repaired and is not ready for FY02 operation. This instrument may not be repairable and would be declared an operational loss in FY02.

Figure 3-30



Calibration Date	Base TDG Adj.	Base Pres Adj.	Net Cum Base Adj.	Net Cum Pres Adj.	Delta Temp
02-Oct-00	0	0	0	0	-0.10
18-Oct-00	0	0	0	0	
26-Jun-01	-4	-4	-4	-4	-0.10
26-Jun-01	0	0	-4	-4	-0.10

18-Oct Temp check of Sonde temp sensor not required on old data sheet

This instrument was inoperative the entire quarter. The instrument's DO sensor failed in late-June which must be repaire by Hydrolab. The large TDG delta value on 26-Jun was the result of an initial temperature correction for the TDG sensor. This instrument was not temp corrected at the same time as the other instruments because it was deployed for several months. #27 is not ready for YR'02 operation.

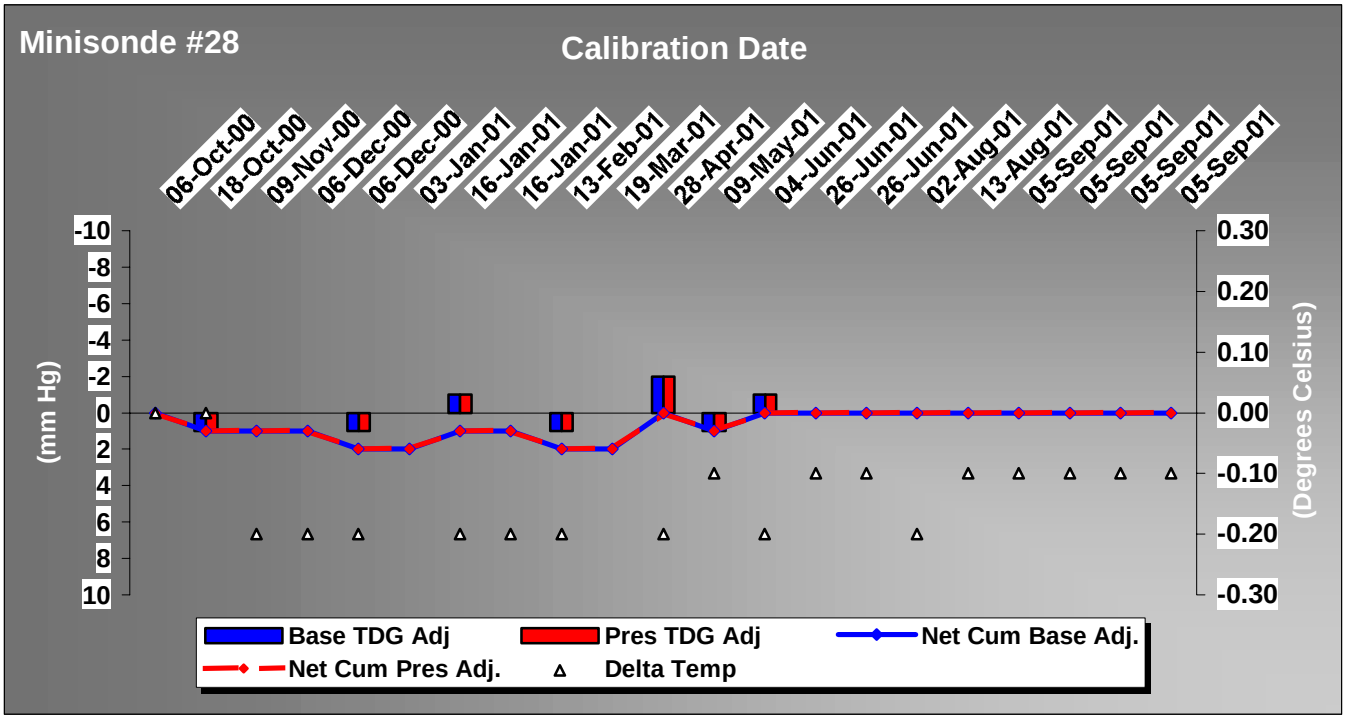
aa. Sonde #27 (figure 3-30).

This sonde (barcode 26644) was purchased from Hydrolab Corporation (SN: 36688) on 9 September 1999 and placed into service in March 2000. The unit's service life is 5 years and it is planned to retire the instrument in FY04 or sooner if possible. It was received from the factory with an inoperable dissolved oxygen sensor but was not repaired by the factory because of a warranty dispute over potential damage in shipping. The CENWW lab repaired the instrument with on hand parts and labor.

(FY00) This unit is also a new acquisition and has performed well in the measurement of TDG pressure. As with other units in this batch (these are Minisonde mode 4a type sondes), the temperature probes appear to be of lesser tolerances than the older (Minisonde 4) units. This unit was kept in service until the end of the season because of the dwindling number of serviceable instruments. The temperature sensor was still within the manufacturer's specifications but marginally.

(FY01) This instrument was operative until July 2001 at which time the DO sensor malfunctioned. After it was sent to the factory for a replacement the instrument was returned with the dissolved oxygen sensor and temperature sensor inoperative. Instrument #27 has not been repaired and is not ready for FY02 operation.

Figure 3-31



Calibration Date	Base TDG Adj	Pres TDG Adj	Net Cum Base Adj.	Net Cum Pres Adj.	Delta Temp
06-Oct-00	0	0	0	0	0.00
18-Oct-00	1	1	1	1	0.00
09-Nov-00	0	0	1	1	-0.20
06-Dec-00	0	0	1	1	-0.20
06-Dec-00	1	1	2	2	-0.20
03-Jan-01	0	0	2	2	
16-Jan-01	-1	-1	1	1	-0.20
16-Jan-01	0	0	1	1	-0.20
13-Feb-01	1	1	2	2	-0.20
19-Mar-01	0	0	2	2	
28-Apr-01	-2	-2	0	0	-0.20
09-May-01	1	1	1	1	-0.10
04-Jun-01	-1	-1	0	0	-0.20
26-Jun-01	0	0	0	0	-0.10
26-Jun-01	0	0	0	0	-0.10
02-Aug-01	0	0	0	0	-0.20
13-Aug-01	0	0	0	0	-0.10
05-Sep-01	0	0	0	0	-0.10
05-Sep-01	0	0	0	0	-0.10
05-Sep-01	0	0	0	0	-0.10
05-Sep-01	0	0	0	0	-0.10

03-Jan Temp check of Sonde temp sensor was not performed

19-Mar Temp check of Sonde temp senor was not performed

Status: Instrument #28 is reliable and provides high quality data. This instrument does not require immediate maintenance and will remain in service until it can be sent in for routine maintenance. The temperarture sensor on this instrument needs to be recalibrated. #28 is ready for YR'02 operation.

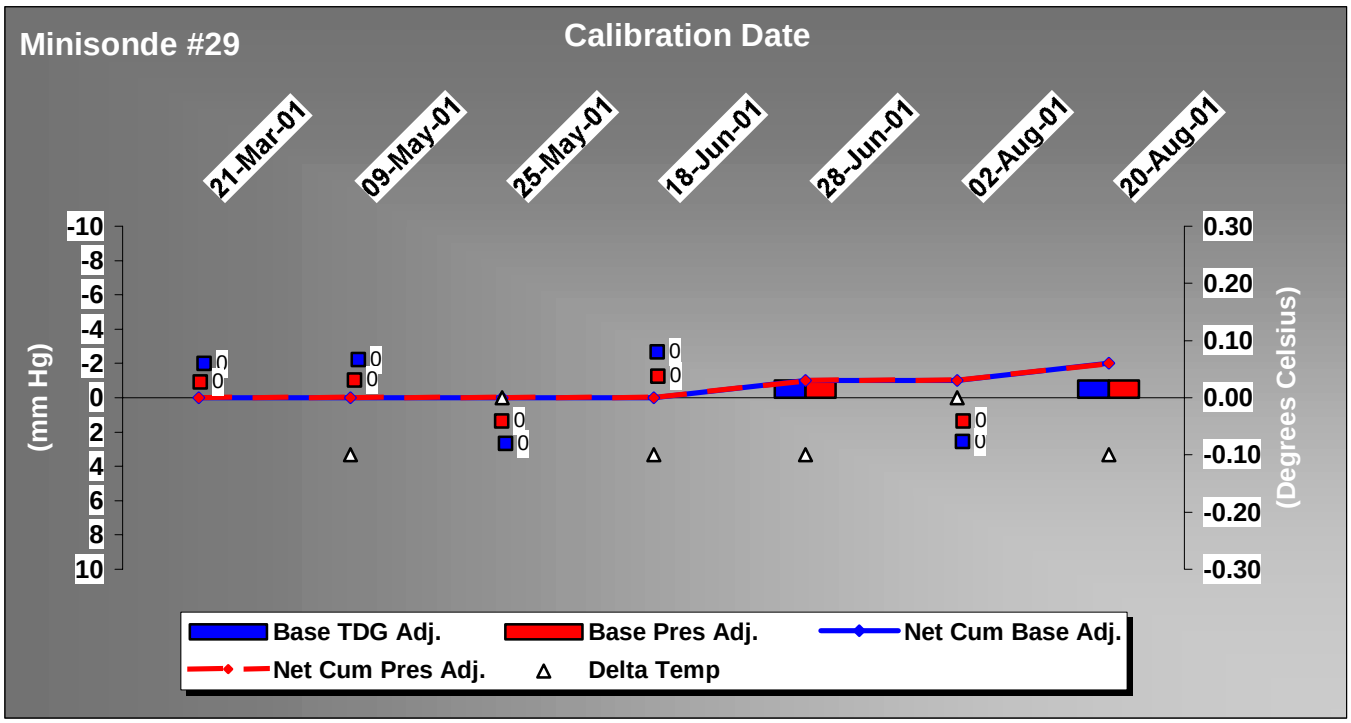
bb. Sonde #28 (figure 3-31).

This sonde (barcode 26642) was purchased from Hydrolab Corporation (SN: 36686) on 9 September 1999 and placed into service in March 2000. The unit's service life is 5 years and it is planned to retire the instrument in FY04 or sooner if possible. It was received from the factory with an inoperable temperature sensor but was not repaired by the factory because of a warranty dispute over acceptable tolerances in the specification. The CENWW used it to provide sensors because of the dwindling number of operational units.

(FY00) This instrument performed in the same manner as the sonde #27 instrument. Again, the thermister barely makes tolerances by manufacturer's specifications but does not meet the CENWW QC limits, which reflect the DQOs. Again, this unit was kept in service due to the dwindling number of serviceable spares. It is currently used as a winter monitoring unit and its thermister is still barely within the manufacturer's specifications.

(FY01) This instrument was reliable and provided high quality TDG and DO data throughout the entire monitoring year. The temperature sensor does not always perform within the CENWW data quality objectives and is difficult to calibrate. The temperature sensor should be replaced when the instrument is sent for routine mid-life maintenance or the instrument should be retired early. Instrument #28 is ready for FY02 operation.

Figure 3-32



Calibration Date	Base TDG Adj.	Base Pres Adj.	Net Cum Base Adj.	Net Cum Pres Adj.	Delta Temp
21-Mar-01	0	0	0	0	
09-May-01	0	0	0	0	-0.10
25-May-01	0	0	0	0	0.00
18-Jun-01	0	0	0	0	-0.10
28-Jun-01	-1	-1	-1	-1	-0.10
02-Aug-01	0	0	-1	-1	0.00
20-Aug-01	-1	-1	-2	-2	-0.10

21-Mar Temp check of Sonde temp sensor was not performed

The performance chart for instrument #29 indicates that this Minisonde has been reliable and provides high quality data for the system. #29 is ready for YR'02 operation.

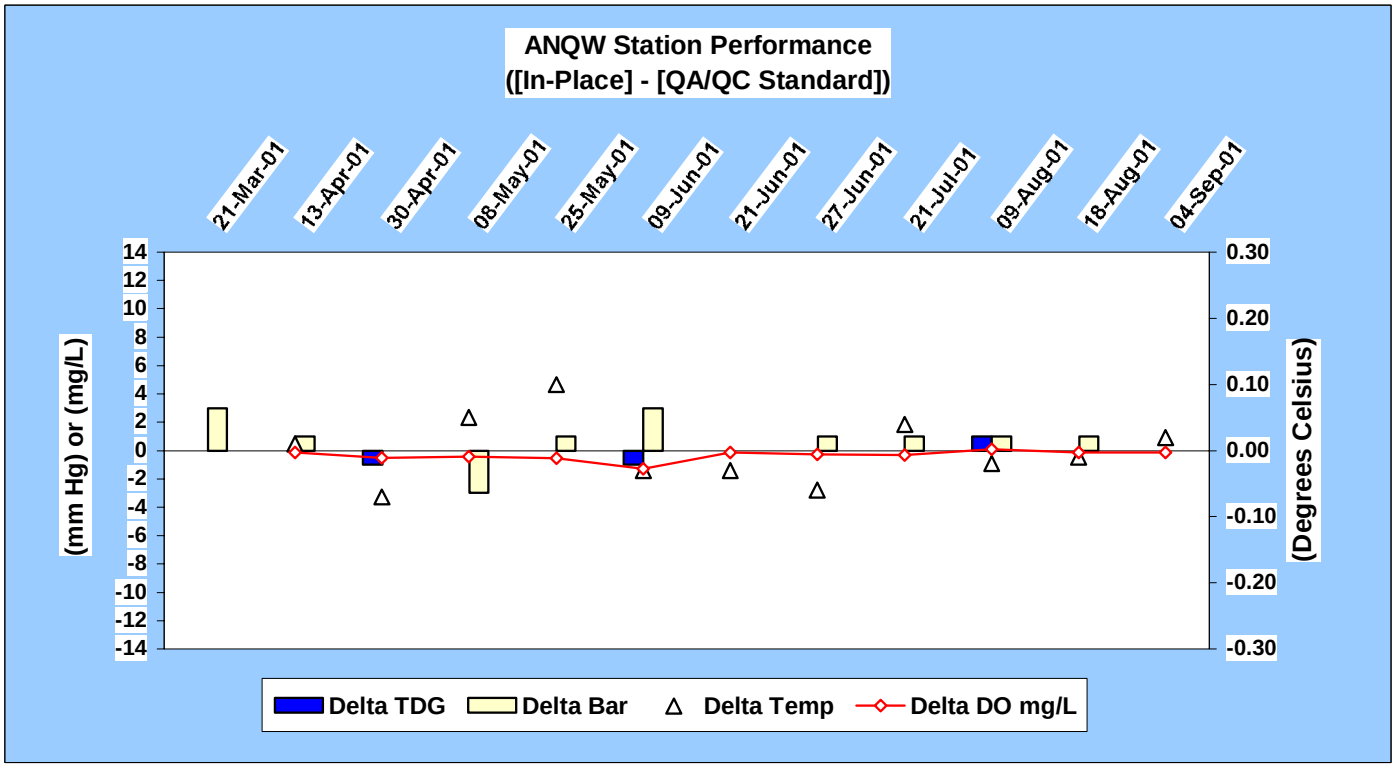
cc. Sonde #29 (figure 3-32).

(FY01) Because of critical shortages of operation instruments the QA/QC officer decided to assemble and instrument from spare parts as an emergency stopgap measure. This sonde (barcode unknown) was assembled from spare parts purchased from Hydrolab Corporation over the last year. The instrument was assigned a factory serial number (SN: 28101) for their administrative purposes. On 21 March 2001, the final assembly was completed and it currently going service trials for the FY02 winter monitoring season. The unit's service life is 5 years and it is planned to retire the instrument in fiscal year 2006 (FY06). At this time the decision to put it into full active service has a suspense date of March 2002 at which time it will receive a permanent barcode number

dd. Sonde #30.

(FY01) Instrument #30 was another attempt to construct a sonde from spare parts as a stopgap measure for the rest of the monitoring year. There were not enough spare parts to complete the sonde for use. The partial assembly will need a TDG sensor and circuit card. Additionally an older spare DO probe was used to build it and could need replacement. This instrument is not ready for FY02 operation.

Figure 3-33



Station ID	QA/QC Sonde	In-Place Sonde	Deployment Date	Delta TDG	Delta Bar	Delta DO mg/L	Delta Temp
ANQW	29		21-Mar-01		3		
ANQW	26	29	13-Apr-01	0	1	-0.16	0.01
ANQW	21	29	30-Apr-01	-1		-0.49	-0.07
ANQW	19	29	08-May-01	0	-3	-0.42	0.05
ANQW	8	19	25-May-01	0	1	-0.54	0.10
ANQW	16	19	09-Jun-01	-1	3	-1.27	-0.03
ANQW	20	16	21-Jun-01	0	0	-0.14	-0.03
ANQW	18	16	27-Jun-01	0	1	-0.28	-0.06
ANQW	26	18	21-Jul-01	0	1	-0.29	0.04
ANQW	8	18	09-Aug-01	1	1	0.09	-0.02
ANQW	1	8	18-Aug-01	0	1	-0.16	-0.01
ANQW	20	1	04-Sep-01	0	0	-0.15	0.02

21-Mar deployment marks start-up of summer monitoring schedule; ANQW did not contain an In-place instrument

30-Apr missing Delta Bar value caused by inaccessible station barometer

3.04. STATION-SPECIFIC PERFORMANCE.

Performance charts were plotted for each of the 16 TDGMS stations. The station deployment data and station performance charts were located in appendix D. Subsequent paragraphs describe the individual station performance and history.

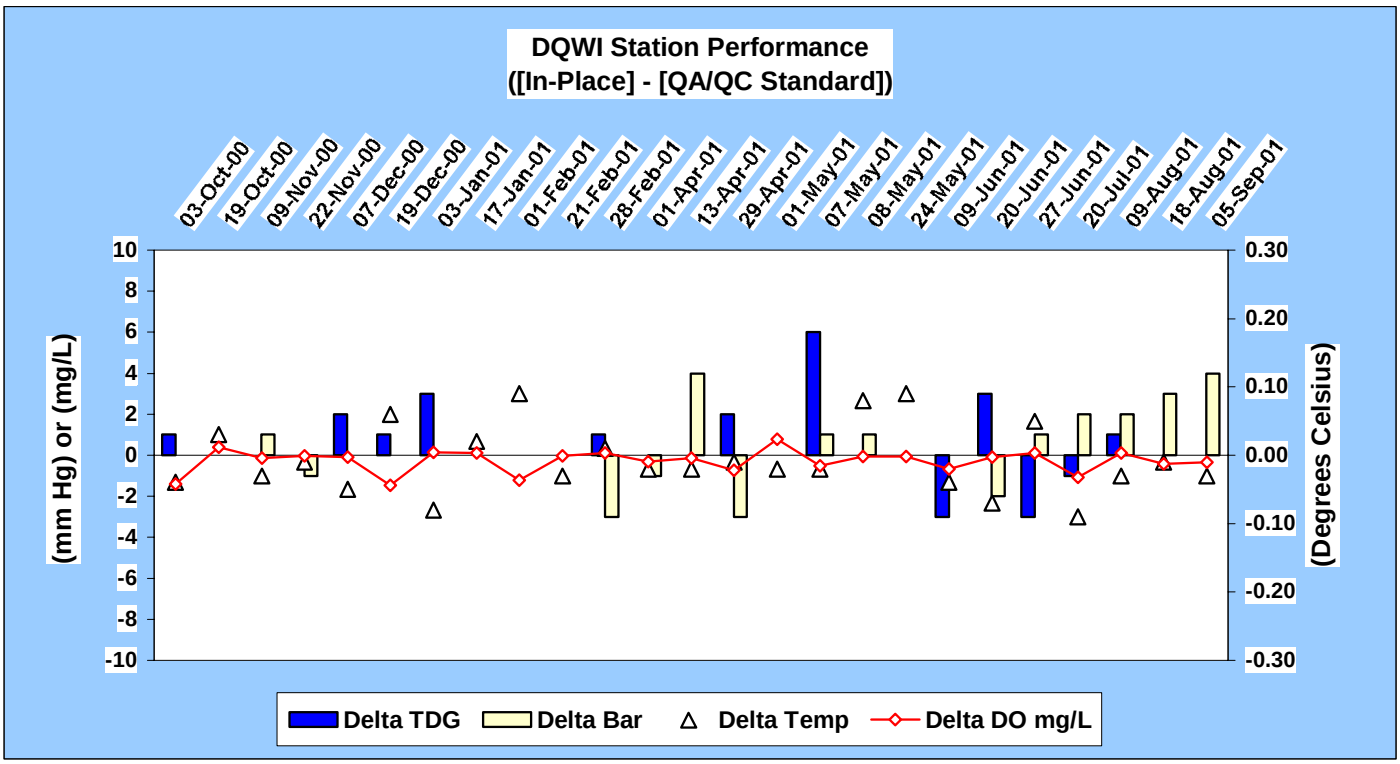
a. Station ANQW - Snake River at Anatone Gaging Station, WA.

The Anatone station is on the left side of the river at river mile (RM) 167.5 (see plate 1). The station operated continuously from 1 October 1999 until 30 September 2000 although the station was only calibrated from 1 April 2000 until 15 September 2000. Data is good for the period of calibration except for data between about 29 July 2000 and 2 August 2000. River silt accumulated around the end of the probe and reduced the circulation near the sensors. Consequently, dissolved gas readings were lower during this period. By early June, the silting had begun to prevent adequate fresh sample from reaching the instruments. This had a dramatic impact on data quality so, in mid-June the decision was made to deploy the instruments outside the protective deployment pipe on a full-time basis. This event occurred at the same time that the new barometer was being incorporated in the calibration procedures. The large Delta TDG and temperature values can be attributed to both these events. See figure 3-33 and table 3-3.

Table 3-3. Station ANQW - Data Points Failing QA/QC Standard.

Period	Date	Parameter	Reason
0400-0500	01 APR	Bar	Bar malfunction
2200	09 APR	Temp	SDI-12 sonde
0400	10 APR	Temp	SDI-12 sonde
1000	29 APR	Temp, pres	Sonde malfunction
0900	08 MAY	Temp, %sat	Maintenance outage
1000	05 JUN	Temp	SDI-12 sonde
1500	10 JUN	Bar, %sat	Bar malfunction
0200-0400	11 JUN	Temp, %sat, pres	Bar malfunction
1500	13 JUN	Temp	Sonde malfunction
0100-0500	15 JUN	All	Maintenance outage
0700	01 JUL	Press, %sat	SDI-12 sonde
0600	22 AUG	Bar, %sat	Bar Malfunction
0100	26 AUG	Pres, %sat	SDI-12 sonde
2300	29 AUG	Pres, %sat	Bar Malfunction
0300	09 SEP	Bar, %sat	Bar Malfunction

Figure 3-34



Station ID	QA/QC Sonde	In-Place Sonde	Deployment Date	Delta TDG	Delta Bar	Delta DO mg/L	Delta Temp
DWQI	11	7	03-Oct-00	1	0	-1.40	-0.04
DWQI	25	11	19-Oct-00	0	0	0.39	0.03
DWQI	10	25	09-Nov-00	0	1	-0.15	-0.03
DWQI	26	10	22-Nov-00	0	-1	-0.04	-0.01
DWQI	9	26	07-Dec-00	2	0	-0.09	-0.05
DWQI	22	9	19-Dec-00	1	0	-1.47	0.06
DWQI	19	22	03-Jan-01	3	0	0.13	-0.08
DWQI	23	19	17-Jan-01	0	0	0.11	0.02
DWQI	25	23	01-Feb-01	0	0	-1.20	0.09
DWQI	22	25	21-Feb-01	0	0	-0.04	-0.03
DWQI	2	22	28-Feb-01	1	-3	0.10	0.01
DWQI	4	2	01-Apr-01	0	-1	-0.30	-0.02
DWQI	26	2	13-Apr-01	0	4	-0.13	-0.02
DWQI	22	2	29-Apr-01	2	-3	-0.72	-0.01
DWQI	21	22	01-May-01		0	0.78	-0.02
DWQI	18	21	07-May-01	6	1	-0.51	-0.02
DWQI	25	18	08-May-01	0	1	-0.05	0.08
DWQI	17	25	24-May-01	0	0	-0.06	0.09
DWQI	11	17	09-Jun-01	-3	0	-0.67	-0.04
DWQI	6	11	20-Jun-01	3	-2	-0.09	-0.07
DWQI	28	6	27-Jun-01	-3	1	0.10	0.05
DWQI	20	28	20-Jul-01	-1	2	-1.08	-0.09
DWQI	5	20	09-Aug-01	1	2	0.10	-0.03
DWQI	3	5	18-Aug-01	0	3	-0.41	-0.01
DWQI	20	3	05-Sep-01	0	4	-0.34	-0.03

01-May Delta TDG missing due to a malfunctioning TDG sensor on the in-place instrument

b. Station DWQI - N. Fork Clearwater R. Below Dworshak Dam, ID.

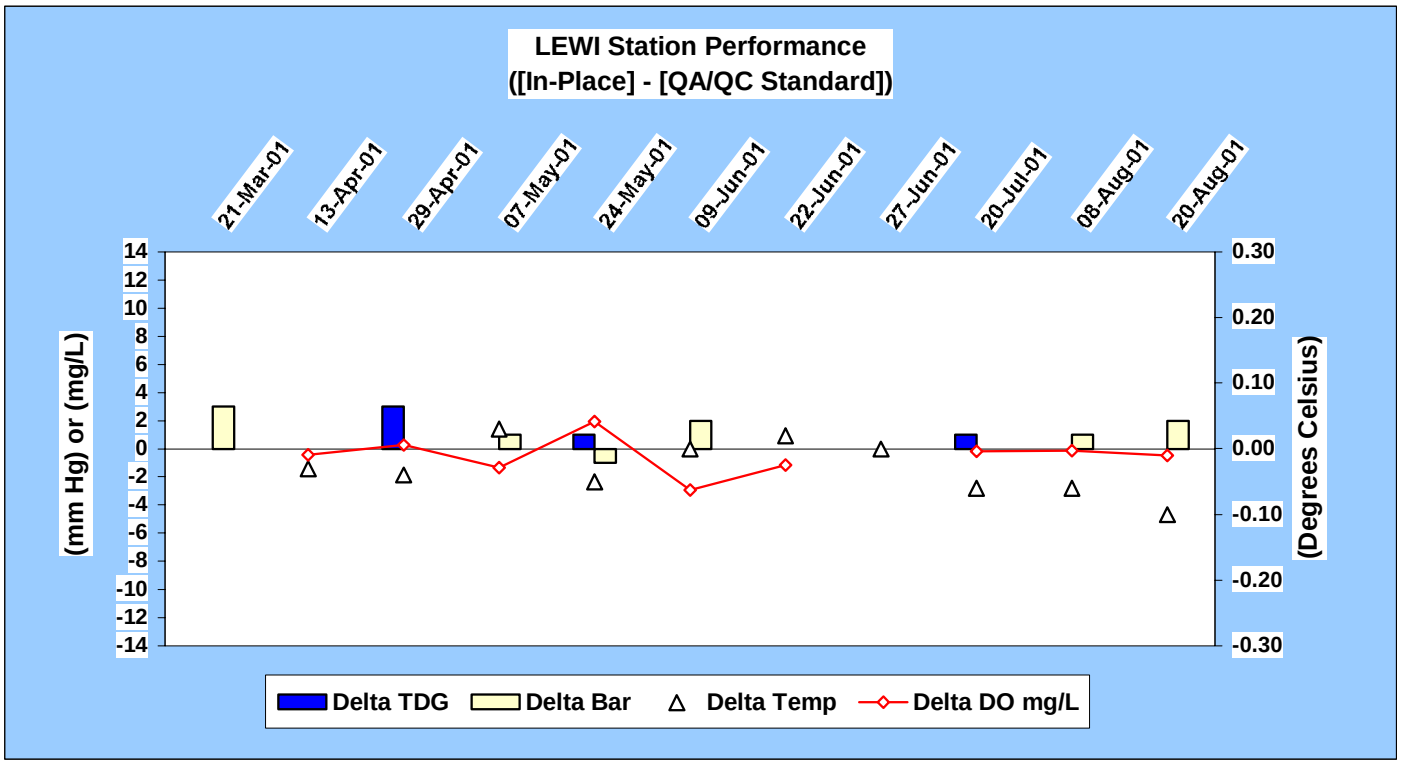
Dworshak Dam's tailwater station is on the left bank at RM 0.5 (see plate 2). It is approximately 7,900 feet downstream of the dam. The station operated continuously from 1 October 1999 until 30 September 2000. Several short outages occurred. On 31 May 2000, the station was down while the modem was serviced. Readings show gaps and abnormally high readings for that period. From 23 June 2000 until 5 July 2000, the station went through a period of sporadic outages lasting 4 to 12 hours. Cables were systematically replaced until the station resumed operation. The readings that were transmitted seem to be in the normal range for this station.

The higher Delta TDG values in June are related to the implementation of a new barometric pressure standard that is used to calibrate the instruments and does not reflect a decrease in the ability of the station to provide fresh sample to the instruments. Notice the increased precision for both TDG and temperature after the implementation of new standards and calibration procedures. See figure 3-34 and table 3-4.

Table 3-4. Station DWQI - Data Points Failing QA/QC Standard.

Period	Date	Parameter	Reason
0300	20 MAR	Pres	SDI-12 sonde
2300-1800	30 APR-2 MAY	Pres	Transducer bad
0100-2300	07 MAY	All	Sonde bad
1200-1700	08 MAY	Temp, pres	Sonde malfunction
1400	09 JUN	Pres, %sat	SDI-12 sonde
1400-1600	14 JUN	All	DCP malfunction
1300	27 JUN	Temp, pres, %sat	Sonde malfunction
2200	24 JUL	Temp	Unknown
2200	09 AUG	Temp	Unknown
2200	04 SEP	Pres, %sat	SDI-12 sonde
0100-0900	05 SEP	No probe data. Internal power problem with probe replaced @ 1000	Sonde Malfunction
	01 NOV-02 NOV	Clocks out of sequence	DCP Malfunction
1500	29 NOV	Temp, pres, %sat	Sonde firmware problem

Figure 3-35



Station ID	QA/QC Sonde	In-Place Sonde	Deployment Date	Delta TDG	Delta Bar	Delta DO mg/L	Delta Temp
LEWI	21		21-Mar-01		3		
LEWI	26	21	13-Apr-01	0	0	-0.41	-0.03
LEWI	28	21	29-Apr-01	3	0	0.26	-0.04
LEWI	8	28	07-May-01	0	1	-1.34	0.03
LEWI	5	8	24-May-01	1	-1	1.95	-0.05
LEWI	2	5	09-Jun-01	0	2	-2.94	0.00
LEWI	19	2	22-Jun-01	0	0	-1.18	0.02
LEWI	27	19	27-Jun-01		0		
LEWI	20	27	20-Jul-01	1	0	-0.20	-0.06
LEWI	5	27	08-Aug-01	0	1	-0.16	-0.06
LEWI	29	27	20-Aug-01		2	-0.49	-0.10

21-Mar deployment marks start-up of summer monitoring schedule; LEWI did not contain an In-place instrument

27-Jun Delta values missing because In-place instrument was inoperative

20-Aug Delta TDG missing due to a failed TDG membrane on In-place instrument

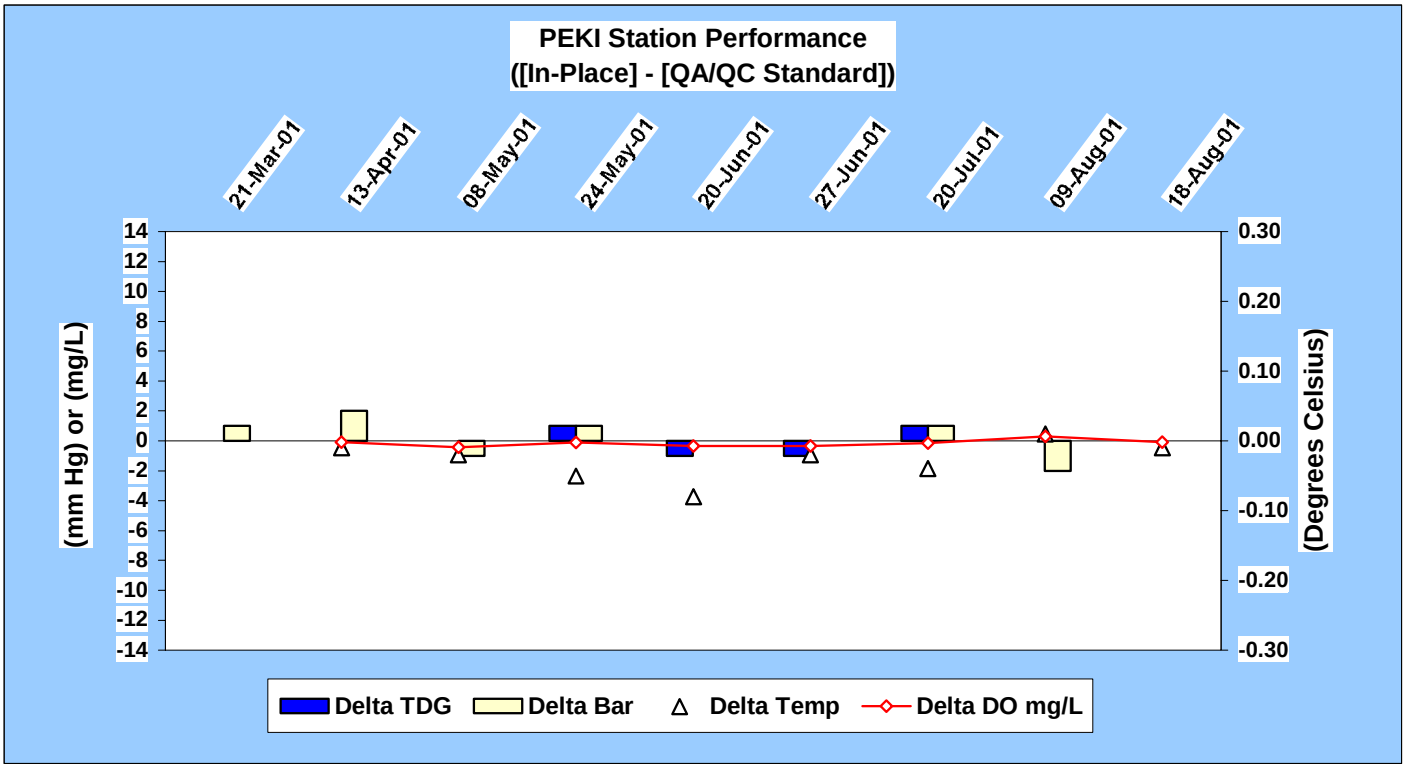
c. Station LEWI - Clearwater River at Lewiston, ID.

The Lewiston station is on the right side of the river near the city's water intake at RM 5.1 (see plate 3). The station operated continuously from 1 April 2000 until 30 August 2000. The station would normally be active until 15 September 2000 but low flows made monitoring impossible. In addition, the station experienced several short outages of 1 to 3 hours. See figure 3-35 and table 3-5.

Table 3-5. Station LEWI - Data Points Failing QA/QC Standard.

Period	Date	Parameter	Reason
0300	29 APR	Temp, press	Sonde malfunction
2200	02 MAY	Temp, bar	Bar malfunction
2300	08 MAY	Temp, %sat	Bar malfunction
2200	14 MAY	Bar	Bar malfunction
2300	09 JUN	Bar, pres	Bar malfunction
1000-1100	25 JUN	Temp, bar, gas, pres, %sat all	Sonde malfunction
1700	27 JUN	Temp, gas, pres, %sat all	Sonde malfunction
1400 / 1800	16 AUG –20 AUG	Bad gas data	TDG sensor malfunction

Figure 3-36



Station ID	QA/QC Sonde	In-Place Sonde	Deployment Date	Delta TDG	Delta Bar	Delta DO mg/L	Delta Temp
PEKI	23		21-Mar-01		1		
PEKI	26	23	13-Apr-01	0	2	-0.08	-0.01
PEKI	25	23	08-May-01	0	-1	-0.43	-0.02
PEKI	5	23	24-May-01	1	1	-0.10	-0.05
PEKI	19	23	20-Jun-01	-1	0	-0.35	-0.08
PEKI	28	23	27-Jun-01	-1	0	-0.36	-0.02
PEKI	20	23	20-Jul-01	1	1	-0.17	-0.04
PEKI	21	23	09-Aug-01	0	-2	0.30	0.01
PEKI	3	21	18-Aug-01	0	0	-0.08	-0.01

21-Mar deployment marks start-up of summer monitoring schedule; PEKI did not contain an In-place instrument

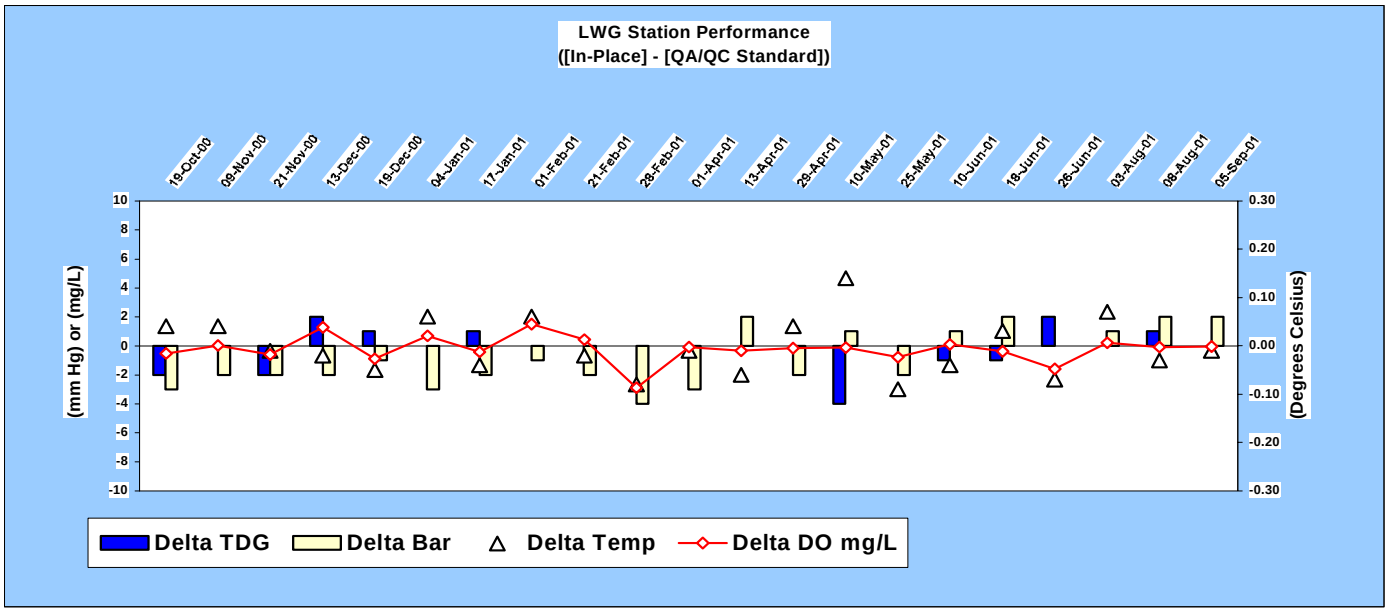
d. Station PEKI - Clearwater River at Peck, ID.

The Peck station is on the left side of the Clearwater River at RM 37.4 (see plate 4). The station operated continuously from 1 April 2000 until 2 September 2000. Like the station at Lewiston, Peck would have been active until 15 September but low flows prevented access to the water. See figure 3-36 and table 3-6.

Table 3-6. Station PEKI - Data Points Failing QA/QC Standard.

Period	Date	Parameter	Reason
2200	29 APR	%sat	Bar malfunction
0100	10 MAY	Temp	SDI-12 sonde
2200	09 AUG	Temp, %sat	Bar Malfunction
2200	25 AUG	Bar, %sat	Bar Malfunction

Figure 3-37



Station ID	QA/QC Sonde	In-Place Sonde	Deployment Date	Delta TDG	Delta Bar	Delta DO mg/L	Delta Temp
LWG	26	22	19-Oct-00	-2	-3	-0.54	0.04
LWG	28	26	09-Nov-00	0	-2	0.03	0.04
LWG	16	28	21-Nov-00	-2	-2	-0.59	-0.01
LWG	2	16	13-Dec-00	2	-2	1.27	-0.02
LWG	11	2	19-Dec-00	1	-1	-0.91	-0.05
LWG	25	11	04-Jan-01	0	-3	0.69	0.06
LWG	11	25	17-Jan-01	1	-2	-0.43	-0.04
LWG	21	11	01-Feb-01	0	-1	1.51	0.06
LWG	26	21	21-Feb-01	0	-2	0.41	-0.02
LWG	7	26	28-Feb-01	0	-4	-2.88	-0.08
LWG	4	7	01-Apr-01	0	-3	-0.09	-0.01
LWG	26	7	13-Apr-01	0	2	-0.36	-0.06
LWG	11	7	29-Apr-01	0	-2	-0.16	0.04
LWG	28	11	10-May-01	-4	1	-0.13	0.14
LWG	25	28	25-May-01	0	-2	-0.81	-0.09
LWG	20	25	10-Jun-01	-1	1	0.10	-0.04
LWG	26	20	18-Jun-01	-1	2	-0.40	0.03
LWG	9	26	26-Jun-01	2	0	-1.60	-0.07
LWG	21	9	03-Aug-01	0	1	0.20	0.07
LWG	2	21	08-Aug-01	1	2	-0.11	-0.03
LWG	28	2	05-Sep-01	0	2	-0.05	-0.01

e. Station LWG - Snake River at forebay of Lower Granite Lock and Dam, WA.

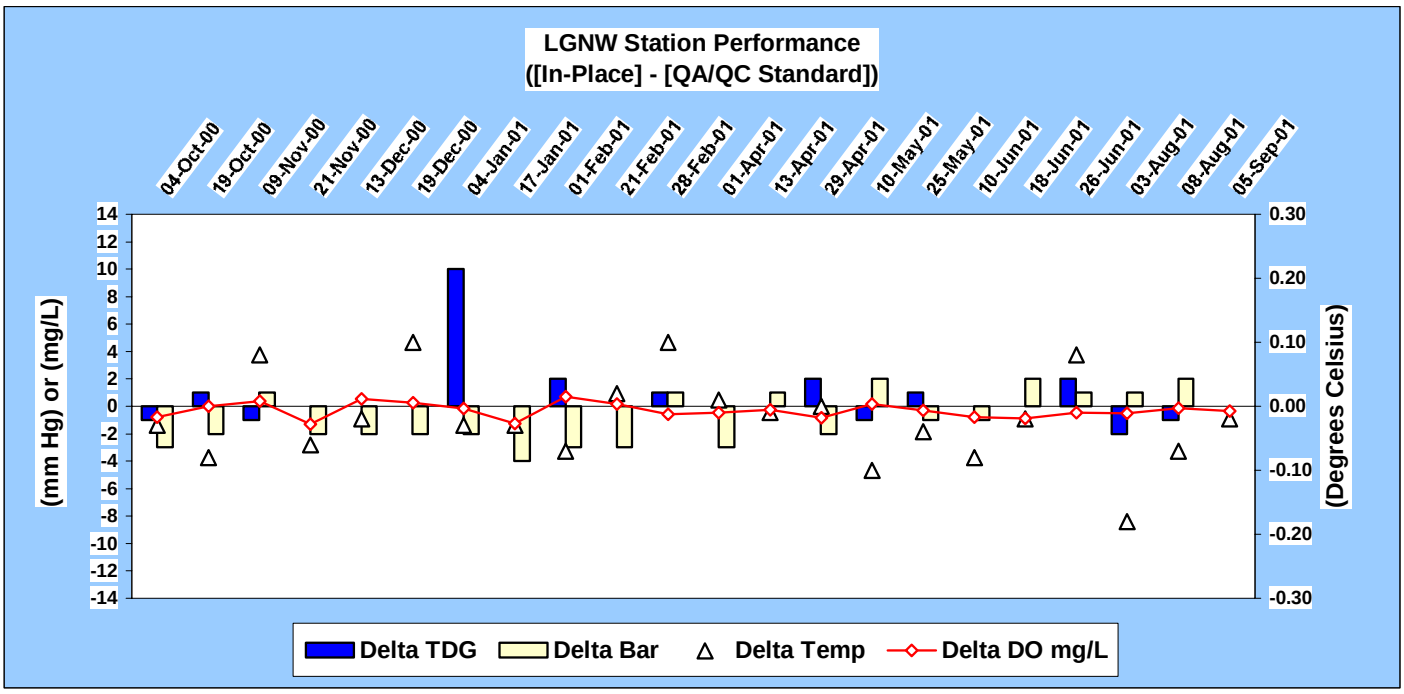
This station is located at the end of the navigation lock guide wall, about 630 feet upstream of the dam and right of the middle of the river (see plate 5). The station operated continuously from 1 October 1999 until 30 September 2000 with no outages.

The data quality at this station reflects changes that were made to the standard operating procedures in May 2000 and the incorporation of the new standards in June to July 2000. After each of these changes, the station performance returned to normal. The larger Delta TDG in late August marks the beginning of an increasing trend that continued on into the next fiscal year. This increase in Delta TDG is likely related to poor circulation in the forebay pool as described in previous sections. See figure 3-37 and table 3-7.,

Table 3-7. Station LWG - Data Points Failing QA/QC Standard.

Period	Date	Parameter	Reason
0900-1200	17 JAN	Pres	SDI-12 sonde
1300	03 MAR	%sat spike	Rapid temp increase
1700	12 MAR	%sat & bar spike	Rapid temp increase
0200-0300	13 MAR	All	Unknown
0300	15 MAR	Temp	SDI-12 sonde
0100	27 APR	Temp, pres	Sonde malfunction
0100-1100	10-15 MAY	All	Bad DCP
0100	19 MAY	Bar	Bar malfunction
1800	26 JUN	Temp, pres, %sat	Sonde malfunction
0600	09 AUG	Pres, %sat	Bar malfunction
2200	25 AUG	Bar, pres, %sat	Bar malfunction
1300	15 SEP	Bar, %sat	Bar malfunction
	01 NOV-06 NOV	Clocks out of sequence	DCP Programming problem
0300	06 DEC	Pres, %sat	SDI-12 sonde

Figure 3-38



Station ID	QA/QC Sonde	In-Place Sonde	Deployment Date	Delta TDG	Delta Bar	Delta DO mg/L	Delta Temp
LGNW	16	26	04-Oct-00	-1	-3	-0.78	-0.03
LGNW	23	16	19-Oct-00	1	-2	0.01	-0.08
LGNW	7	23	09-Nov-00	-1	1	0.38	0.08
LGNW	11	7	21-Nov-00	0	-2	-1.32	-0.06
LGNW	23	11	13-Dec-00	0	-2	0.56	-0.02
LGNW	16	23	19-Dec-00	0	-2	0.24	0.10
LGNW	21	16	04-Jan-01	**10**	-2	-0.16	-0.03
LGNW	22	21	17-Jan-01	0	-4	-1.25	-0.03
LGNW	19	22	01-Feb-01	2	-3	0.72	-0.07
LGNW	23	19	21-Feb-01	0	-3	0.15	0.02
LGNW	22	23	28-Feb-01	1	1	-0.60	0.10
LGNW	4	22	01-Apr-01	0	-3	-0.47	0.01
LGNW	26	22	13-Apr-01	0	1	-0.26	-0.01
LGNW	26	22	29-Apr-01	2	-2	-0.86	0.00
LGNW	29	26	10-May-01	-1	2	0.18	-0.10
LGNW	8	29	25-May-01	1	-1	-0.30	-0.04
LGNW	5	8	10-Jun-01	0	-1	-0.78	-0.08
LGNW	29	5	18-Jun-01	0	2	-0.88	-0.02
LGNW	11	29	26-Jun-01	2	1	-0.46	0.08
LGNW	28	11	03-Aug-01	-2	1	-0.49	-0.18
LGNW	11	28	08-Aug-01	-1	2	-0.11	-0.07
LGNW	28	12	05-Sep-01	0	0	-0.34	-0.02

red - invalid data value (see Table 5)

f. Station LGNW - Snake River below Lower Granite Dam, WA.

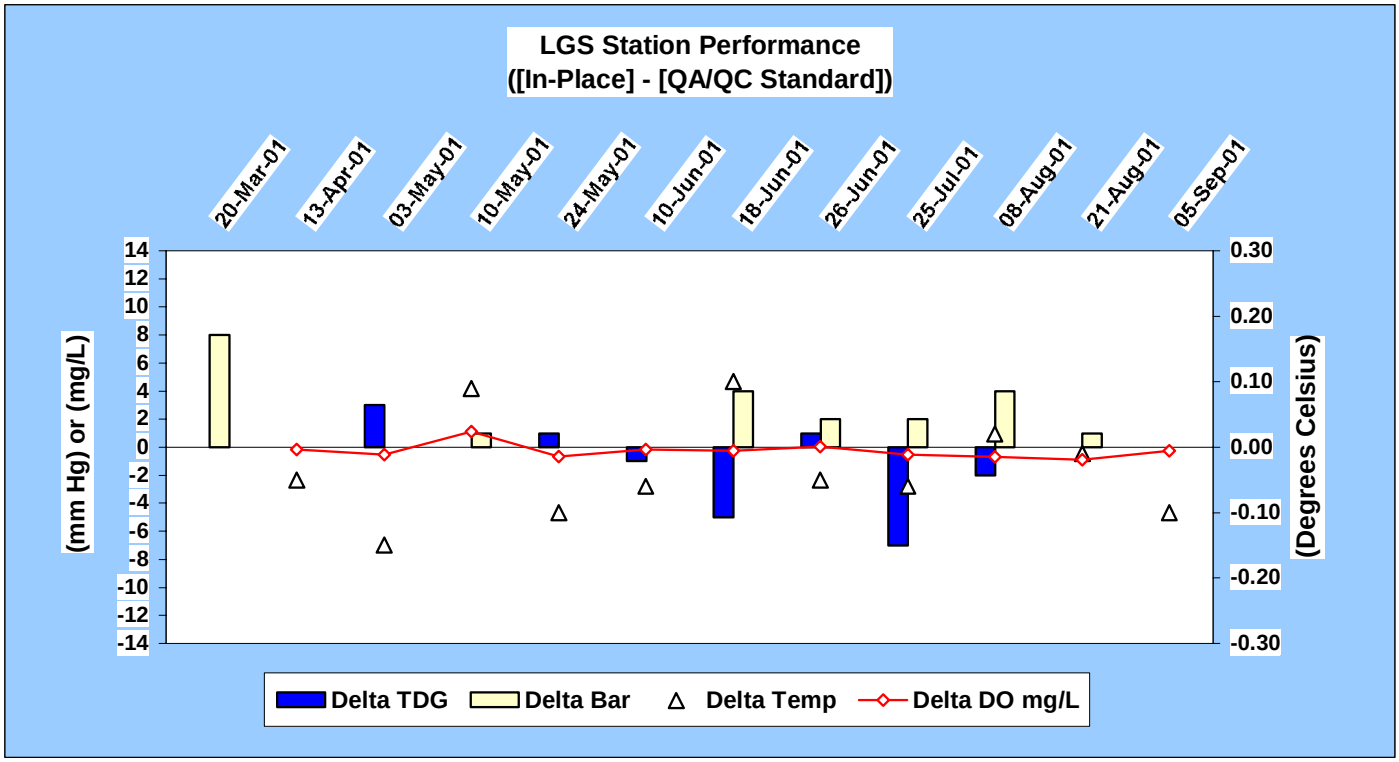
Lower Granite's tailwater station is on the right bank at RM 106.8, approximately 3,500 feet downstream of the dam (see plate 5). The station operated continuously from 1 October 1999 until 30 September 2000 with no unexpected outages.

This station provided high quality data throughout the entire year. The Delta values in June 2000 can be attributed to the new standards used for instrument calibration. They do not reflect station performance. See figure 3-38 and table 3-8.

Table 3-8. Station LGNW - Data Points Failing QA/QC Standard.

Period	Date	Parameter	Reason
1100-1200	04 JAN	Temp, pres	Sonde malfunction
1900	09 JAN	Temp, pres	SDI-12 sonde
2400	10 JAN	Pres	SDI-12 sonde
1100-1900	11 JAN	Temp, pres	Sonde malfunction
1300	17 JAN	Pres	SDI-12 sonde
1300	01 FEB	Pres	SDI-12 sonde
1700	24 FEB	%sat spike	CHROMS
0200	07 MAR	%sat spike	Bar malfunction
1200	12 MAR	Pres, temp, bar spike	Rapid temp increase
2100	09 APR	Bar	Bar malfunction
1100	11 APR	Gas spike	Natural Temp Spike
1100	16 APR	Pres	Sonde malfunction
2200	26 APR	Bar	Bar malfunction
1300	03 MAY	Bar	Bar malfunction
1000	10 MAY	Pres	SDI-12 sonde
0300	17 MAY	All	CHROMES error
0900-2200	26 MAY	Bar, %sat	Bar malfunction
0600-1500	01 JUN	Temp	SDI-12 sonde
0200	19 JUN	Bar, %sat	Bar malfunction
1100	20 JUN	Pres, %sat	SDI-12 sonde
1400-2200	21 JUN	Bar, %sat, pres, temp	Bar failure
1600	22 JUN	%sat	Bar failure
1900	26 JUN	Temp, pres, gas,%sat	Sonde malfunction
1000	30 JUN	Pres, %sat	SDI-12 sonde
1000	02 JUL	Temp	
2300	05 JUL	Pres, %sat	SDI-12 sonde
1000-1200	06 JUL	All data bad, press, %sat	DCP failure
1000	07 JUL	Temp	DCP failure
0900	08 JUL	Temp, bar, %sat	DCP failure
2300	15 JUL	%sat	SDI-12 sonde
1000-1600	23 JUL	Pres, %sat, temp	Sonde failure
0900	01 AUG	Temp	Unknown
1500	03 AUG	Temp, Pres, %sat	SDI-12 sonde
2100	05 AUG	Pres, %sat	SDI-12 sonde
0100-1800	06 AUG	Bar, pres, , %sat	Bar malfunction
1600	08 AUG	Temp, pres, %sat	SDI-12 sonde
1000	14 AUG	Pres, %sat	SDI-12 sonde
1000	29 AUG	Pres, %sat	Bar malfunction
1200	04 OCT	Bar, %sat	Bar Malfunction
0900	13 OCT	Pres, %sat	Sonde SDI-12
	01 NOV-06 NOV	Clocks out of sequence	DCP failure

Figure 3-39



Station ID	QA/QC Sonde	In-Place Sonde	Deployment Date	Delta TDG	Delta Bar	Delta DO mg/L	Delta Temp
LGS	25		20-Mar-01		8		
LGS	26	25	13-Apr-01	0	0	-0.16	-0.05
LGS	6	25	03-May-01	3		-0.54	-0.15
LGS	21	6	10-May-01	0	1	1.10	0.09
LGS	6	21	24-May-01	1	0	-0.65	-0.10
LGS	25	6	10-Jun-01	-1	0	-0.15	-0.06
LGS	18	25	18-Jun-01	-5	4	-0.26	0.10
LGS	7	18	26-Jun-01	1	2	0.05	-0.05
LGS	19	7	25-Jul-01	-7	2	-0.52	-0.06
LGS	9	19	08-Aug-01	-2	4	-0.69	0.02
LGS	19	9	21-Aug-01	0	1	-0.91	-0.01
LGS	28	19	05-Sep-01	0	0	-0.24	-0.10

20-Mar deployment marks start-up of summer monitoring schedule; LGS did not contain an In-place instrument

03-May missing Delta Bar value caused by inaccessible station barometer

g. Station LGS - Snake River at forebay of Little Goose Lock and Dam, WA.

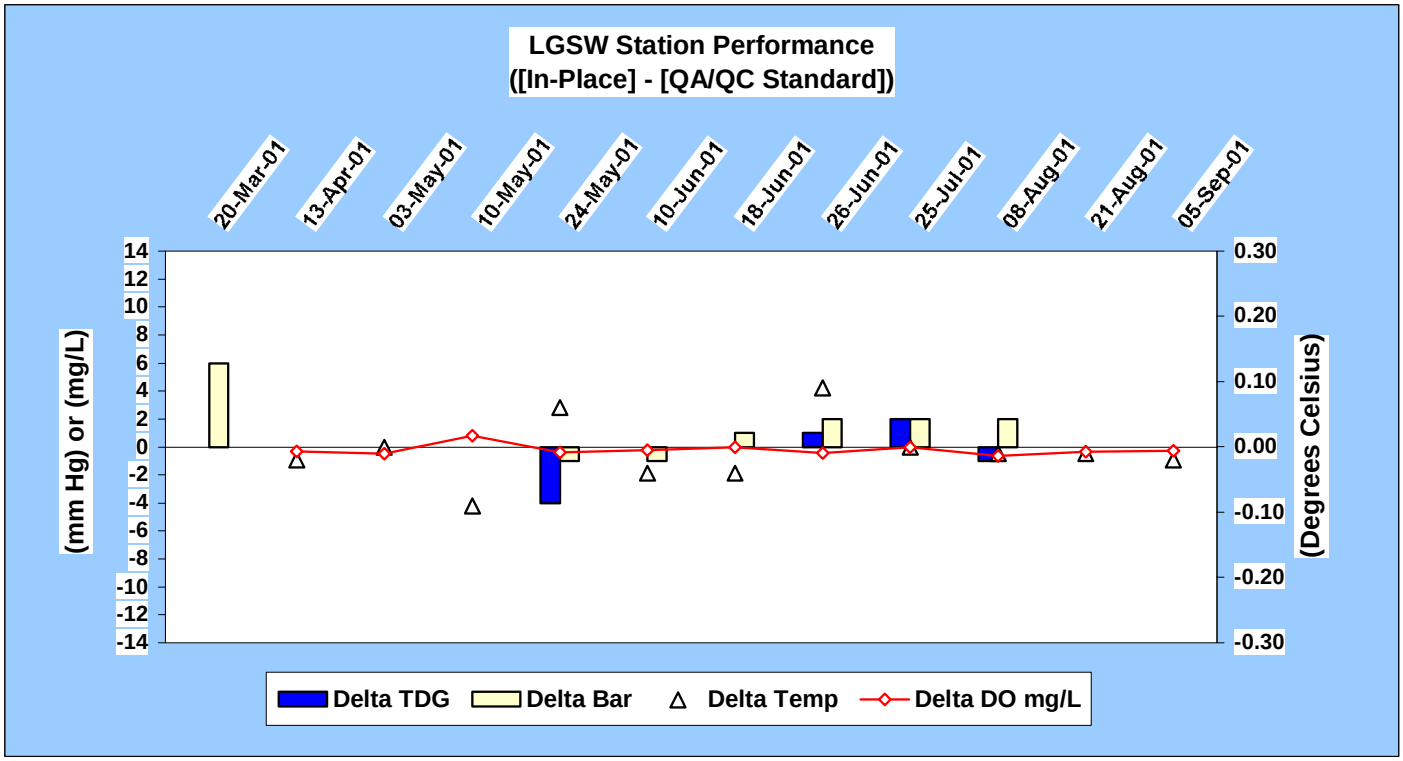
This station is on the face of the dam at about mid-river (see plate 6). The station operated continuously from 1 April 2000 until 15 September 2000 with no extended outages. The primary problem at this station is the marginally functioning barometer. There were no spare available for use in FY01 but it is planned to replace the barometer in FY02.

This station provided high quality data throughout the entire year. The Delta values in June 2000 can be attributed to the new standards used for instrument calibration. They do not reflect station performance. See figure 3-39 and table 3-9.

Table 3-9. Station LGS - Data Points Failing QA/QC Standard.

Period	Date	Parameter	Reason
1700-2100	28-30 APR	Bar	Barometer failure
1700	26 JUN	Temp, pres, gas, %sat	Sonde malfunction
1300	08 AUG	Temp, pres, %sat	Barometer failure
0400-1000	09 SEP	Bar	Barometer failure
0500-1100	10 SEP	Bar	Barometer failure
0600-1000	11 SEP	Bar	Barometer failure
0300	21 SEP	Bad bar reading causing gas spike	Barometer failure

Figure 3-40



Station ID	QA/QC Sonde	In-Place Sonde	Deployment Date	Delta TDG	Delta Bar	Delta DO mg/L	Delta Temp
LGSW	19		20-Mar-01		6		
LGSW	26	19	13-Apr-01	0	0	-0.29	-0.02
LGSW	2	19	03-May-01	0	0	-0.47	0.00
LGSW	5	2	10-May-01	0	0	0.82	-0.09
LGSW	22	5	24-May-01	-4	-1	-0.41	0.06
LGSW	19	22	10-Jun-01	0	-1	-0.24	-0.04
LGSW	22	19	18-Jun-01	0	1	-0.04	-0.04
LGSW	2	22	26-Jun-01	1	2	-0.42	0.09
LGSW	16	2	25-Jul-01	2	2	-0.03	0.00
LGSW	7	16	08-Aug-01	-1	2	-0.62	-0.01
LGSW	11	7	21-Aug-01	0	0	-0.33	-0.01
LGSW	28	11	05-Sep-01	0	0	-0.28	-0.02

20-Mar deployment marks start-up of summer monitoring schedule; LGSW did not contain an In-place instrument

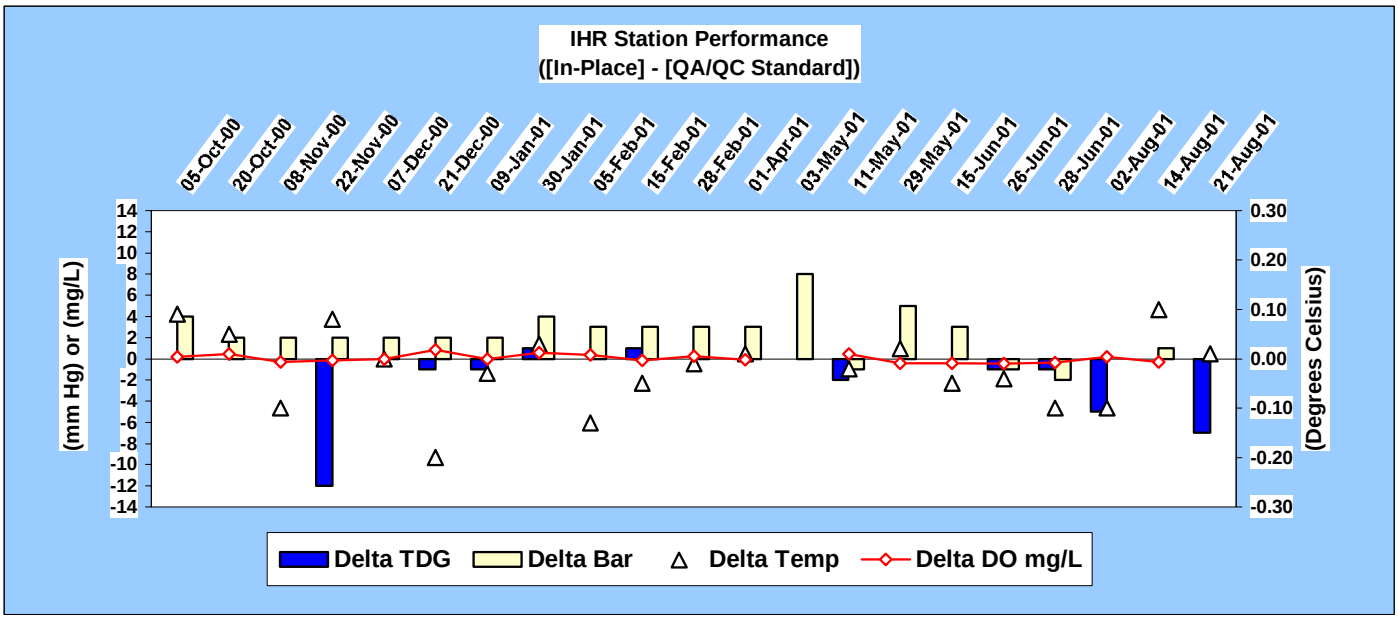
h. Station LGSW - Snake River below Little Goose Lock and Dam, WA.

This tailwater station is on the right bank at RM 69.5, about 3,900 feet downstream of the dam (see plate 6). The station operated continuously from 1 April 2000 until 15 September 2000 with two short outages. Three hours of data were lost on 26 June 2000 due to unknown causes and faulty servicing on 7 September 2000 caused a break in data that lasted until the next day. Again, slow posting of data caused the problem to go unnoticed during the afternoon of 7 September 2000. See figure 3-40 and table 3-10.

Table 3-10. Station LGSW - Data Points Failing QA/QC Standard.

Period	Date	Parameter	Reason
1700	21 AUG	Temp, pres, %sat	Sonde SDI-12
2300	29 AUG	Pres, %sat	Sonde SDI-12

Figure 3-41



Station ID	QA/QC Sonde	In-Place Sonde	Deployment Date	Delta TDG	Delta Bar	Delta DO mg/L	Delta Temp
IHR	21	23	05-Oct-00	0	4	0.20	0.09
IHR	28	21	20-Oct-00	0	2	0.44	0.05
IHR	19	28	08-Nov-00	0	2	-0.29	-0.10
IHR	22	19	22-Nov-00	-12	2	-0.14	0.08
IHR	28	22	07-Dec-00	0	2	0.00	0.00
IHR	7	28	21-Dec-00	-1	2	0.85	-0.20
IHR	16	7	09-Jan-01	-1	2	0.00	-0.03
IHR	28	16	30-Jan-01	1	4	0.58	0.03
IHR	26	28	05-Feb-01	0	3	0.36	-0.13
IHR	11	26	15-Feb-01	1	3	-0.15	-0.05
IHR	26	11	28-Feb-01	0	3	0.22	-0.01
IHR	4	26	01-Apr-01	0	3	-0.08	0.01
IHR	22		03-May-01		8		
IHR	2	22	11-May-01	-2	-1	0.47	-0.02
IHR	12	2	29-May-01		5	-0.41	0.02
IHR	17	12	15-Jun-01	0	3	-0.41	-0.05
IHR	7	17	26-Jun-01	-1	-1	-0.46	-0.04
IHR	21	17	28-Jun-01	-1	-2	-0.34	-0.10
IHR	29	21	02-Aug-01	-5	0	0.21	-0.10
IHR	16	29	14-Aug-01	0	1	-0.30	0.10
IHR	15	16	21-Aug-01	-7	0		0.01

03-May QC comparison not completed because In-place instrument was a DS4

29-May Delta TDG missing due to a malfunctioning TDG sensor on In-place instrument

21-Aug Delta DO missing due to a malfunctioning DO sensor on In-place instrument

i. Station IHR - Snake River at forebay of Ice Harbor Lock and Dam, WA.

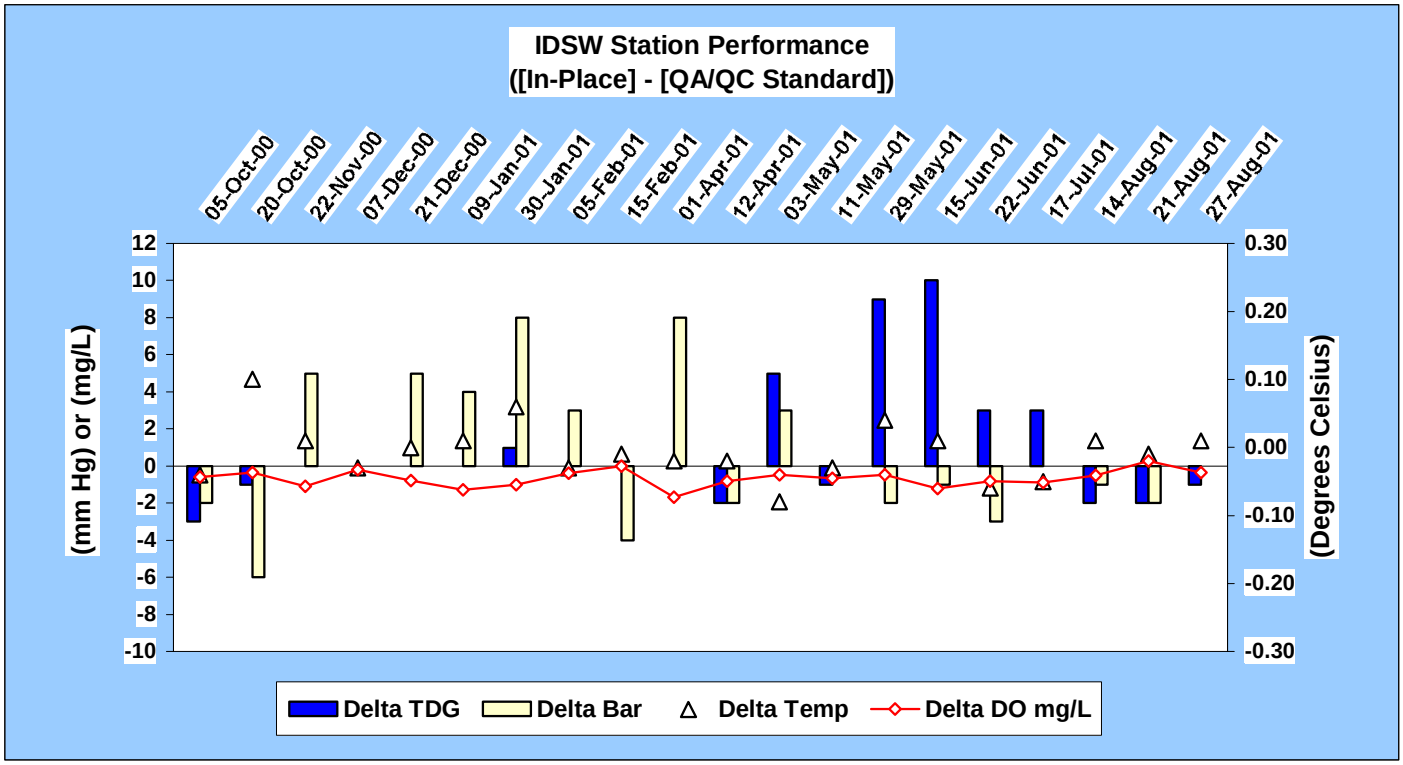
The Ice Harbor station is mounted on the upstream face of the dam approximately at mid-river (see plate 7). The station operated continuously from 1 October 1999 until 30 September 2000 with no extended outages. The primary problem associated with this station was due to the DCP failures. However, the USGS performed diagnostics on two DCPs used at this station and both were shown to function perfectly on the bench.

The station performed very well throughout the spring and summer. As the fish passage season came to an end in early September, the reduction in spill levels caused the circulation in the pool to diminish and likely caused stagnation in and around the deployment pipe that resulted in larger Delta values. The small circulators on the instruments could not adequately mix the stagnant water, causing each instrument to read the water quality in its own microenvironment. This scenario is common among the forebay stations and is consistent with data from other years. There are improvements planned to address this issue. One solution may be to install small circulating pumps inside the pipe to purge the pipe several times an hour to ensure that an adequate volume of fresh sample can reach the instruments. See figure 3-41 and table 3-11.

Table 3-11 Station IHR - Data Points Failing QA/QC Standard.

Period	Date	Parameter	Reason
1600	30 JAN	All	DCP data skip
1500	11 APR	Pres, temp	SDI-12 DCP
1500-2400	26 MAY	%sat	DCP malfunction
0100-0400	27 MAY	%sat	DCP malfunction
0100-2400	28 MAY	%sat	DCP malfunction
0100-1700	29 MAY	%sat	DCP malfunction
0100	08 JUN	Temp	SDI-12 sonde
0400	15 JUN	Pres, %sat	SDI-12 sonde
2200	09 OCT	Bar, %sat	Bar Malfunction
	01 NOV-05 NOV	Clocks out of sequence	DCP Malfunction

Figure 3-42



Station ID	QA/QC Sonde	In-Place Sonde	Deployment Date	Delta TDG	Delta Bar	Delta DO mg/L	Delta Temp
IDSW	19	20	05-Oct-00	-3	-2	-0.59	-0.04
IDSW	27	19	20-Oct-00	-1	-6	-0.35	0.10
IDSW	21	27	22-Nov-00	0	5	-1.09	0.01
IDSW	28	27	07-Dec-00	0	0	-0.20	-0.03
IDSW	7	27	21-Dec-00	0	5	-0.79	0.00
IDSW	16	27	09-Jan-01	0	4	-1.27	0.01
IDSW	28	27	30-Jan-01	1	8	-1.00	0.06
IDSW	26	27	05-Feb-01	0	3	-0.37	-0.03
IDSW	11	27	15-Feb-01	0	-4	-0.02	-0.01
IDSW	4	27	01-Apr-01	0	8	-1.69	-0.02
IDSW	26	27	12-Apr-01	-2	-2	-0.80	-0.02
IDSW	18	27	03-May-01	5	3	-0.47	-0.08
IDSW	2	27	11-May-01	-1	0	-0.67	-0.03
IDSW	12	27	29-May-01	9	-2	-0.46	0.04
IDSW	17	27	15-Jun-01	**10**	-1	-1.22	0.01
IDSW	25	27	22-Jun-01	3	-3	-0.82	-0.06
IDSW	17	25	17-Jul-01	3	0	-0.88	-0.05
IDSW	16	17	14-Aug-01	-2	-1	-0.49	0.01
IDSW	15	17	21-Aug-01	-2	-2	0.28	-0.01
IDSW	10	17	27-Aug-01	-1	0	-0.35	0.01

red - invalid data value (see Table 5)

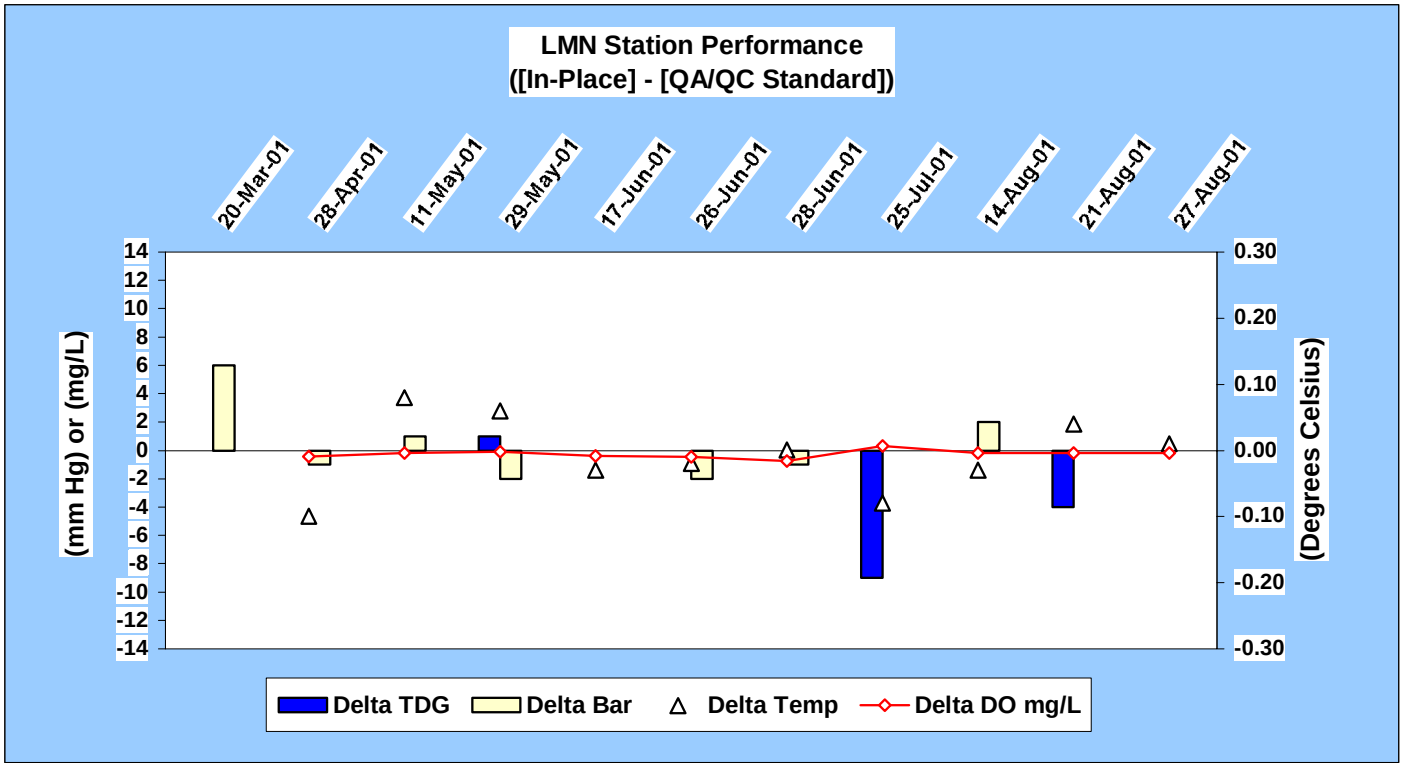
j. Station IDSW - Snake River below Ice Harbor Lock and Dam, WA.

The Ice Harbor tailwater station is on the right bank at RM 6.8 and is 15,400 feet downstream of the dam (see plate 7). The station operated continuously from 1 October 1999 until 30 September 2000 but had a problem on 12 July 2000. The electrical cable was vandalized and the station stopped reporting at 0700 12 July 2000. A technician serviced the unit at 1100 on 13 July 2000. The station completed one 4-hour cycle and failed again due to a fault in the replacement cable. A second servicing brought the station back on-line on 14 July 2000. See figure 3-42 and table 3-12.

Table 3-12 Station IDSW - Data Points Failing QA/QC Standard.

Period	Date	Parameter	Reason
1800	09 APR	Temp	Sonde SDI-12
0500	16 JUL	Bad membrane, cannot get there until tomorrow	TDG membrane
1100	17 JUL	Replaced probe, working fine	TDG membrane
0400-2200	09 AUG	Temp, %sat	SDI-12 sonde
0100	26 AUG	Pres, %sat	SDI-12 sonde
1900	12 SEP	Temp, Pres, %sat	SDI-12 sonde
1800-2200	18 SEP	Pres, %sat Cause unknown, possibly turbine outflow increase	Project operations
1500-2300	19 SEP	Press, %sat Cause unknown	Unknown
0600-0900	23 SEP	Dropped 4-hour cycle	DCP Malfunction
	01 NOV-05 NOV	Clocks out of sequence	DCP Programming problem
2400	01 DEC	No path	Unknown
0100-0400	02 DEC	No path Started working fine	Unknown

Figure 3-43



Station ID	QA/QC Sonde	In-Place Sonde	Deployment Date	Delta TDG	Delta Bar	Delta DO mg/L	Delta Temp
LMN	14		20-Mar-01		6		
LMN	20	14	28-Apr-01		-1	-0.43	-0.10
LMN	9	20	11-May-01	0	1	-0.18	0.08
LMN	26	9	29-May-01	1	-2	-0.09	0.06
LMN	10	26	17-Jun-01	0	0	-0.40	-0.03
LMN	27	10	26-Jun-01	0	-2	-0.45	-0.02
LMN	22	10	28-Jun-01	0	-1	-0.75	0.00
LMN	6	22	25-Jul-01	**-9**	0	0.29	-0.08
LMN	19	6	14-Aug-01	0	2	-0.17	-0.03
LMN	5	19	21-Aug-01	-4	0	-0.20	0.04
LMN	8	5	27-Aug-01	0	0	-0.20	0.01

20-Mar deployment marks start-up of summer monitoring schedule; LMN did not contain an In-place instrument

28-Apr Delta TDG missing due to a malfunctioning TDG sensor on the in-place instrument

red - invalid data value (see Table 5)

k. Station LMN - Snake River, forebay of Lower Monumental Lock and Dam, WA.

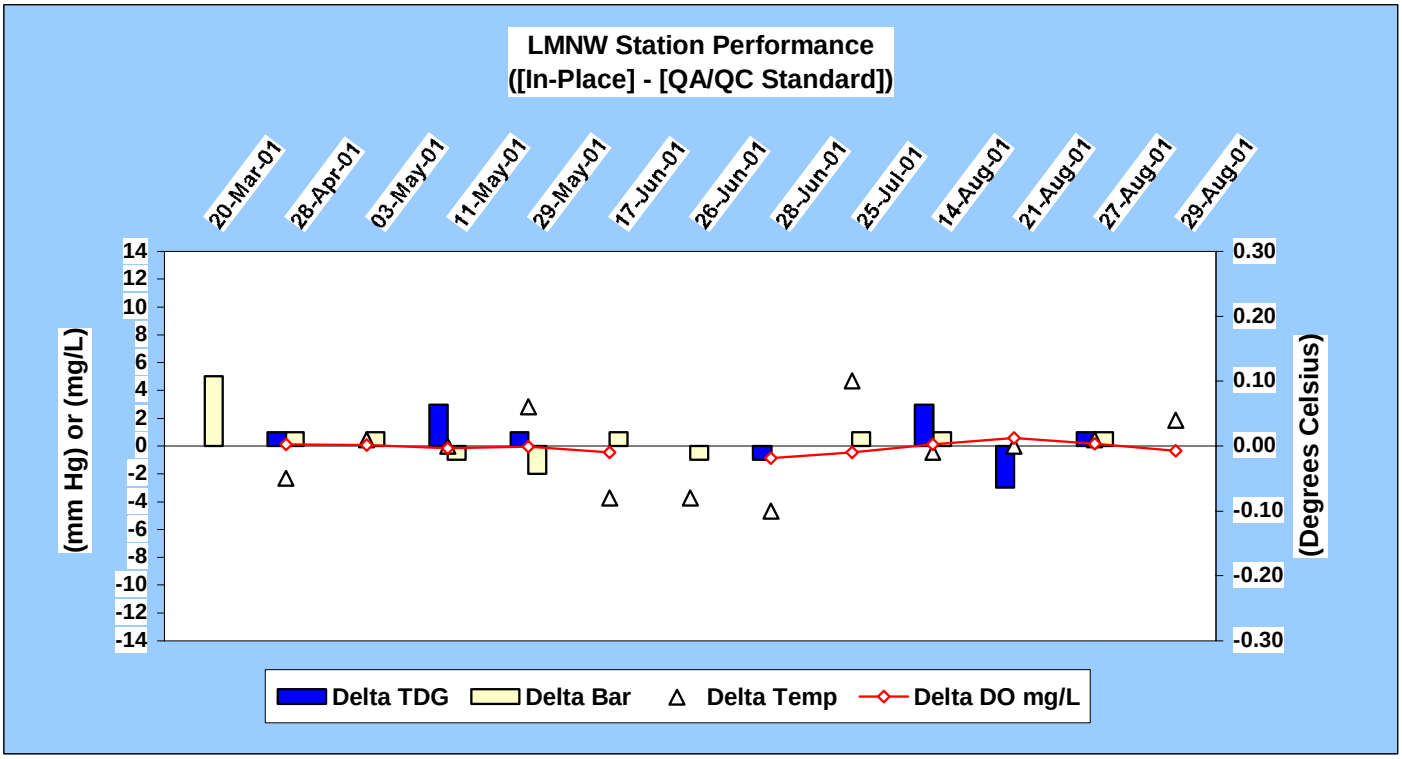
This station is on the face of the dam at about mid-river (see plate 8). The station operated continuously from 1 April 2000 until 15 September 2000 with no extended outages.

The positive impact that the new calibration standards had on station performance is very evident at this station. In late June, after the new barometer and thermometer were incorporated into procedures, the TDG and temperature data improved dramatically. See figure 3-43 and table 3-13.

Table 3-13 Station LMN - Data Points Failing QA/QC Standard.

Period	Date	Parameter	Reason
1000-1200	15 JUN	Temp, Bar, %sat	Maintenance outage

Figure 3-44



Station ID	QA/QC Sonde	In-Place Sonde	Deployment Date	Delta TDG	Delta Bar	Delta DO mg/L	Delta Temp
LMNW	8		20-Mar-01		5		
LMNW	26	8	28-Apr-01	1	1	0.11	-0.05
LMNW	7	8	03-May-01	0	1	0.08	0.01
LMNW	11	7	11-May-01	3	-1	-0.15	0.00
LMNW	21	11	29-May-01	1	-2	-0.05	0.06
LMNW	12	21	17-Jun-01	0	1	-0.44	-0.08
LMNW	9	12	26-Jun-01	0	-1		-0.08
LMNW	29	12	28-Jun-01	-1	0	-0.89	-0.10
LMNW	25	29	25-Jul-01	0	1	-0.44	0.10
LMNW	18	25	14-Aug-01	3	1	0.13	-0.01
LMNW	25	18	21-Aug-01	-3	0	0.58	0.00
LMNW	18	25	27-Aug-01	1	1	0.18	0.01
LMNW	15	18	29-Aug-01	0	0	-0.34	0.04

20-Mar deployment marks start-up of summer monitoring schedule; LMNW did not contain an In-place instrument

26-Jun missing Delta DO value due to a malfunctioning DO sensor on In-Place instrument

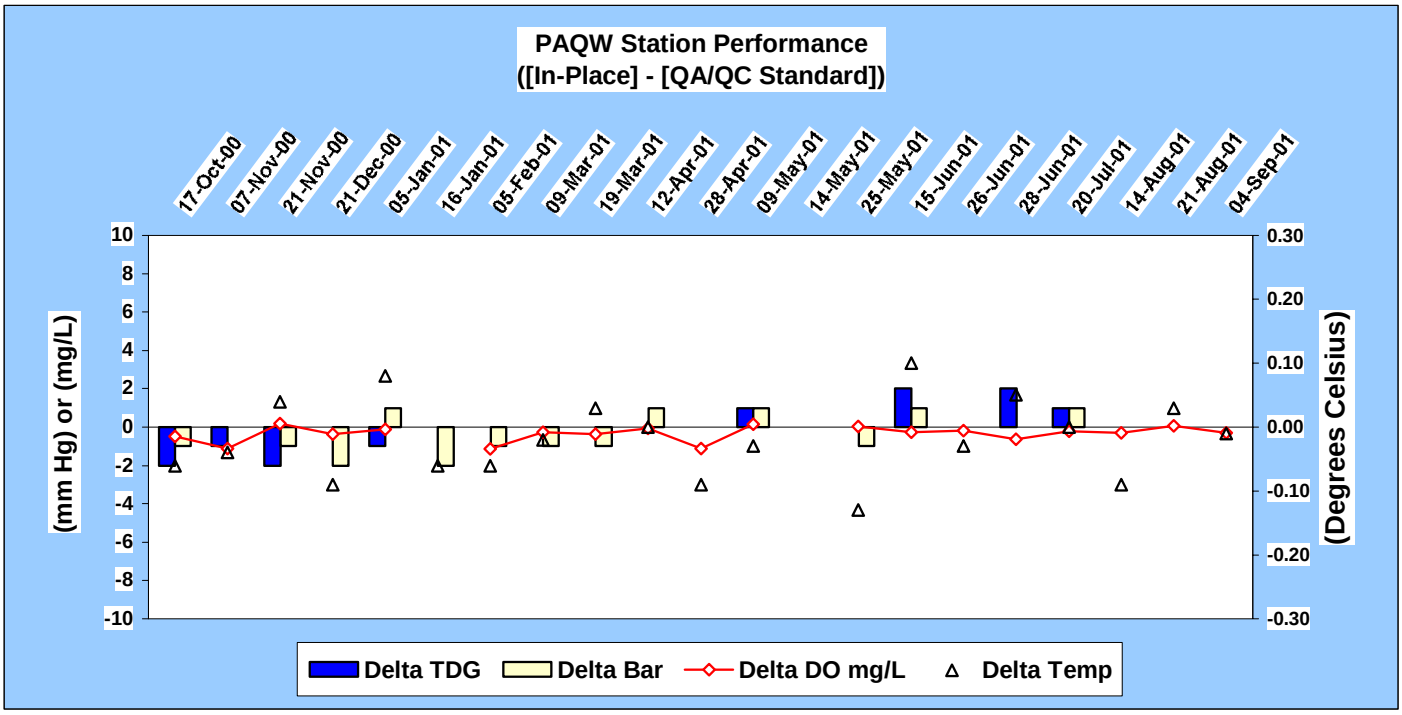
l. Station LMNW - Snake River below Lower Monumental Lock and Dam, WA.

This station is on the left bank at RM 40.8, approximately 4,320 feet downstream of Lower Monumental dam (see plate 8). The station operated continuously from 1 April 2000 until 15 September 2000 with a short outage on 18 May 2000 from 1300 until 19 May 2000 at 1300. Routine service resulted in a bad electrical connection. Slow posting of data prevented the problem from being discovered until the next day. The station went partially down again on 25 August 2000 at 1800 but self-started again at 0400 on 27 August 2000. No service was required. The cause of failure was never determined. See figure 3-44 and table 3-14.

Table 3-14. Station LMNW - Data Points Failing QA/QC Standard.

Period	Date	Parameter	Reason
0600-1200	20-25 APR	All	electric charger open circuit
0900-1400	09 JUN	Pres, %sat	SDI-12 sonde
1600	28 JUN	Temp, gas, %sat	CROMES malfunction
2200-000	22 AUG	Gas spiked over 120 %	Unknown
0100-1000	23 AUG	Gas spiked over 120 %. Came down to normal. Cause unknown.	Unknown possibly project operations and weather

Figure 3-45



Station ID	QA/QC Sonde	In-Place Sonde	Deployment Date	Delta TDG	Delta Bar	Delta DO mg/L	Delta Temp
PAQW	2	25	17-Oct-00	-2	-1	-0.49	-0.06
PAQW	11	2	07-Nov-00	-1	0	-1.10	-0.04
PAQW	25	11	21-Nov-00	-2	-1	0.18	0.04
PAQW	23	25	21-Dec-00	0	-2	-0.37	-0.09
PAQW	28	23	05-Jan-01	-1	1	-0.13	0.08
PAQW	26	28	16-Jan-01	0	-2		-0.06
PAQW	9	26	05-Feb-01	0	-1	-1.13	-0.06
PAQW	23	9	09-Mar-01	0	-1	-0.27	-0.02
PAQW	11	23	19-Mar-01		-1	-0.37	0.03
PAQW	26	11	12-Apr-01	0	1	-0.06	0.00
PAQW	9	11	28-Apr-01	0	0	-1.12	-0.09
PAQW	3	9	09-May-01	1	1	0.16	-0.03
PAQW	26	3	14-May-01		0		
PAQW	29	26	25-May-01	0	-1	0.02	-0.13
PAQW	8	29	15-Jun-01	2	1	-0.28	0.10
PAQW	2	8	26-Jun-01	0	0	-0.17	-0.03
PAQW	26	8	28-Jun-01	2	0	-0.63	0.05
PAQW	12	26	20-Jul-01	1	1	-0.20	0.00
PAQW	10	12	14-Aug-01	0	0	-0.30	-0.09
PAQW	2	16	21-Aug-01	0	0	0.06	0.03
PAQW	20	2	04-Sep-01	0	0	-0.31	-0.01

16-Jan Delta DO missing due to a malfunctioning DO sensor on the in-place instrument

14-May QC comparison not completed because In-place instrument malfunctioned

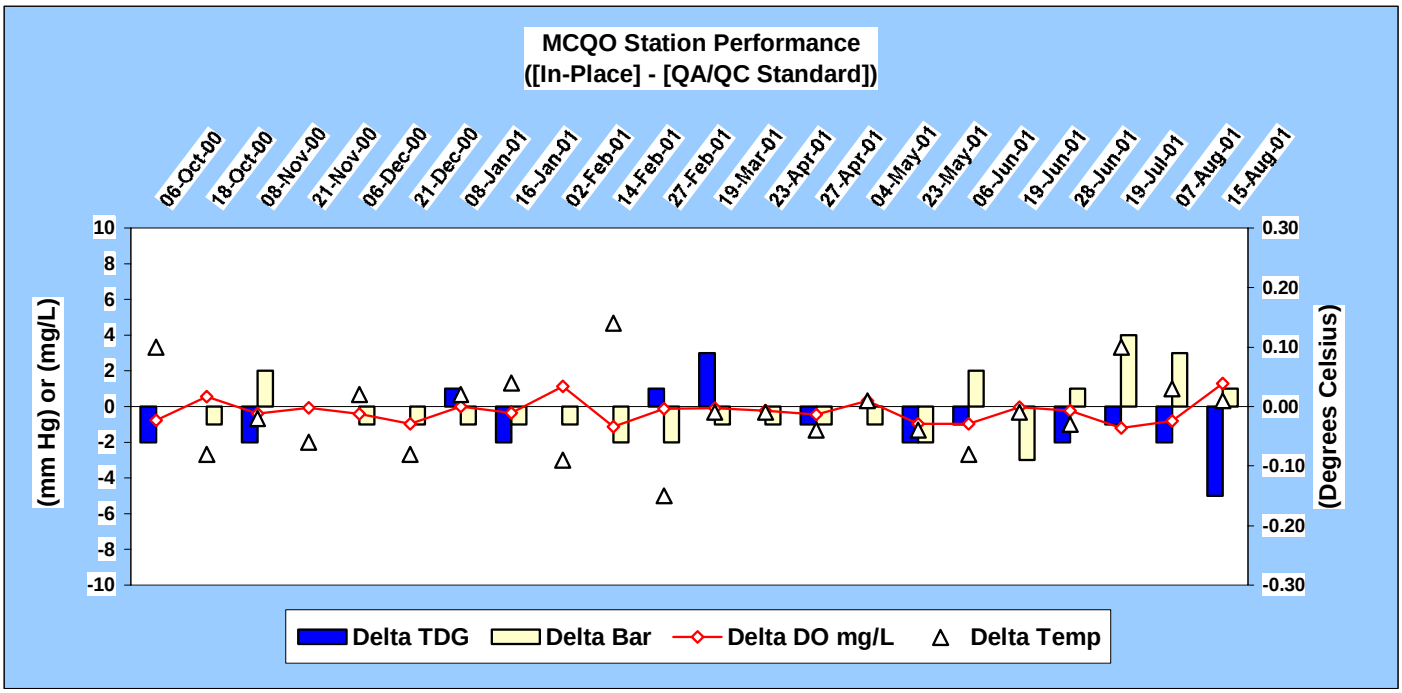
m. Station PAQW - Columbia River at Pasco, WA.

The Pasco station is on the left side of the river at RM 392.0 (see plate 9). The station operated continuously from 1 April 2000 until 15 September 2000. An outage occurred on 22 August 2000 at 0700 following routine station service. Due to slow reporting, the problem wasn't discovered until 23 August 2000 and was quickly fixed. The station was non-reporting from 0700 22 August 2000 until 1100 23 August 2000 but that cause is unknown. The Pasco station because of its location on the system, proximity to CENWW, and proximity the USGS field office, it is the system's experimental test station. Some of the outages are due to experiments and tests. All new instrumentation or prototype testing is conducted at this station year round. The station only officially reports during the summer monitoring season. See figure 3-45 and table 3-15.

Table 3-15 Station PAQW - Data Points Failing QA/QC Standard.

Period	Date	Parameter	Reason
0100-2400	20-25 MAR	All	Depth sensor trial tests
2200-2400	15 APR	All	DCP malfunction
0100-2400	16 APR	All	DCP failure
0100-1000	17 APR	All	DCP failure
1400	28 APR	Temp	SDI-12 sonde
2100-1000	11-14 MAY	All	Sonde failure
2000	04 JUL	Bar, %sat	Bar Malfunction
2000-2200	05 JUL	%sat	SDI-12 sonde
0200	10 JUL	Pres, %sat	SDI-12 sonde
0200-0500	11 JUL	Dropped 4 hours	DCP failure
1400-1700	22 JUL	Dropped 4 hour cycle	DCP failure
See text	22-23 AUG		
2200-2300	29 AUG	Bar, %sat, Temp	SDI-12 sonde
0100	30 AUG	Temp, Bar, %sat out of water 8/29/01 @0700	Maintenance outage and experiment for increasing temp accuracy
2200-0100	31 AUG	Dropped 4-hour cycle	DCP failure
0200-0500	16 SEP	Dropped 4-hour cycle	DCP failure
0400-0100	18 SEP	All went down. Probably problems @ Div	Transmission problem
1000-1300	26 SEP	Dropped 4-hour cycle	Test of another DCP
2300-2400	09 OCT	%sat, temp	
1400-0000	15 OCT	Dropped data Cause unknown	Experimental test
0100-0500	16 OCT	Dropped data Cause unknown Fixed itself	Experimental test
	31 OCT	Clocks out of sequence	DCP programming error
	01 NOV-02 NOV	Clocks out of sequence	DCP program problem

Figure 3-46



Station ID	QA/QC Sonde	In-Place Sonde	Deployment Date	Delta TDG	Delta Bar	Delta DO mg/L	Delta Temp
MCQO	28	10	06-Oct-00	-2	0	-0.76	0.10
MCQO	10	28	18-Oct-00	0	-1	0.54	-0.08
MCQO	22	10	08-Nov-00	-2	2	-0.38	-0.02
MCQO	9	22	21-Nov-00	0	0	-0.08	-0.06
MCQO	7	9	06-Dec-00	0	-1	-0.43	0.02
MCQO	9	7	21-Dec-00	0	-1	-0.98	-0.08
MCQO	11	9	08-Jan-01	1	-1	-0.01	0.02
MCQO	2	11	16-Jan-01	-2	-1	-0.35	0.04
MCQO	23	2	02-Feb-01	0	-1	1.13	-0.09
MCQO	28	23	14-Feb-01	0	-2	-1.12	0.14
MCQO	19	28	27-Feb-01	1	-2	-0.13	-0.15
MCQO	9	19	19-Mar-01	3	-1	-0.10	-0.01
MCQO	26	9	23-Apr-01	0	-1	-0.21	-0.01
MCQO	5	9	27-Apr-01	-1	-1	-0.46	-0.04
MCQO	12	5	04-May-01	0	-1	0.33	0.01
MCQO	7	12	23-May-01	-2	-2	-0.97	-0.04
MCQO	9	7	06-Jun-01	-1	2	-0.96	-0.08
MCQO	5	9	19-Jun-01	0	-3	-0.04	-0.01
MCQO	6	5	28-Jun-01	-2	1	-0.21	-0.03
MCQO	8	6	19-Jul-01	-1	4	-1.19	0.10
MCQO	3	8	07-Aug-01	-2	3	-0.81	0.03
MCQO	20	3	15-Aug-01	-5	1	1.30	0.01

n. Station MCQO - Columbia River at forebay of McNary Dam, OR.

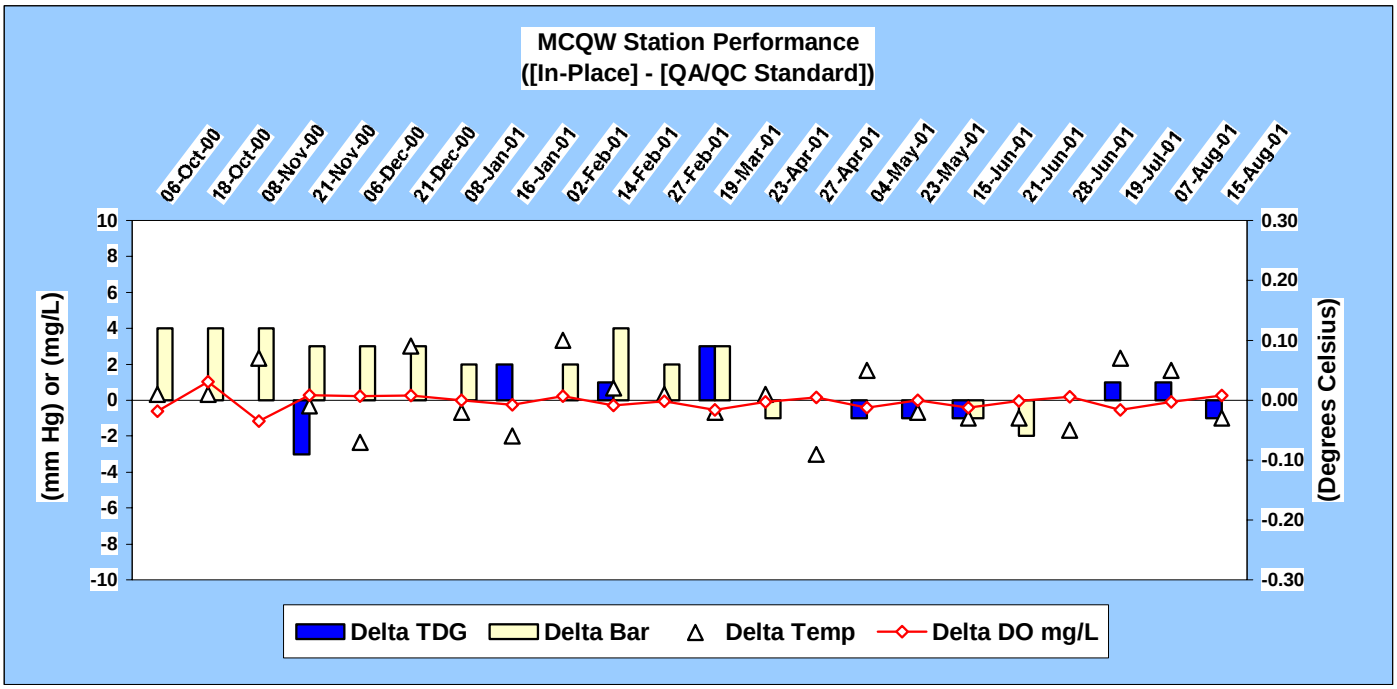
The McNary forebay station on the Oregon side is located on the upstream face of the dam (see plate 10). The station operated continuously from 1 October 1999 until 30 September 2000 with no outages.

New standard operating procedures in May, new standards in June-July, and late-season forebay circulation dynamics all overlap to account for the sporadic Delta values at this station. The underlying station performance is quite good and the station performance data for the following year should improve based on the changes made this season. See figure 3-46 and table 3-16.

Table 3-16 Station MCQO - Data Points Failing QA/QC Standard.

Period	Date	Parameter	Reason
0500	29 JAN	All	DCP data skip
1000-1500	10 FEB	All	Sonde malfunction
1400-1700	19 MAY	All	DCP data skip
1300	07 AUG	Temp, pres, %sat, suspect general maintenance (HDR)	Maintenance outage
0400	27 AUG	Pres, %sat	SDI-12 sonde
2300	09 OCT	Bar, %sat	Bar Malfunction
0000	10 OCT	Temp, pres, %sat	SDI-12 sonde

Figure 3-47



Station ID	QA/QC Sonde	In-Place Sonde	Deployment Date	Delta TDG	Delta Bar	Delta DO mg/L	Delta Temp
MCQW	23	2	06-Oct-00	0	4	-0.60	0.01
MCQW	9	23	18-Oct-00	0	4	1.03	0.01
MCQW	16	9	08-Nov-00	0	4	-1.14	0.07
MCQW	2	16	21-Nov-00	-3	3	0.30	-0.01
MCQW	19	2	06-Dec-00	0	3	0.21	-0.07
MCQW	26	19	21-Dec-00	0	3	0.26	0.09
MCQW	22	26	08-Jan-01	0	2	0.00	-0.02
MCQW	9	22	16-Jan-01	2	0	-0.26	-0.06
MCQW	22	9	02-Feb-01	0	2	0.24	0.10
MCQW	2	22	14-Feb-01	1	4	-0.29	0.02
MCQW	21	2	27-Feb-01	0	2	-0.05	0.01
MCQW	20	21	19-Mar-01	3	3	-0.55	-0.02
MCQW	26	20	23-Apr-01	0	-1	-0.11	0.01
MCQW	3	20	27-Apr-01	0	0	0.15	-0.09
MCQW	17	3	04-May-01	-1	0	-0.43	0.05
MCQW	10	17	23-May-01	-1	0	-0.01	-0.02
MCQW	7	10	15-Jun-01	-1	-1	-0.42	-0.03
MCQW	21	7	21-Jun-01	0	-2	-0.04	-0.03
MCQW	19	21	28-Jun-01	0	0	0.19	-0.05
MCQW	10	19	19-Jul-01	1	0	-0.55	0.07
MCQW	1	10	07-Aug-01	1	0	-0.09	0.05
MCQW	23	1	15-Aug-01	-1	0	0.26	-0.03

o. Station MCQW - Columbia R. at Forebay of McNary Dam, WA.

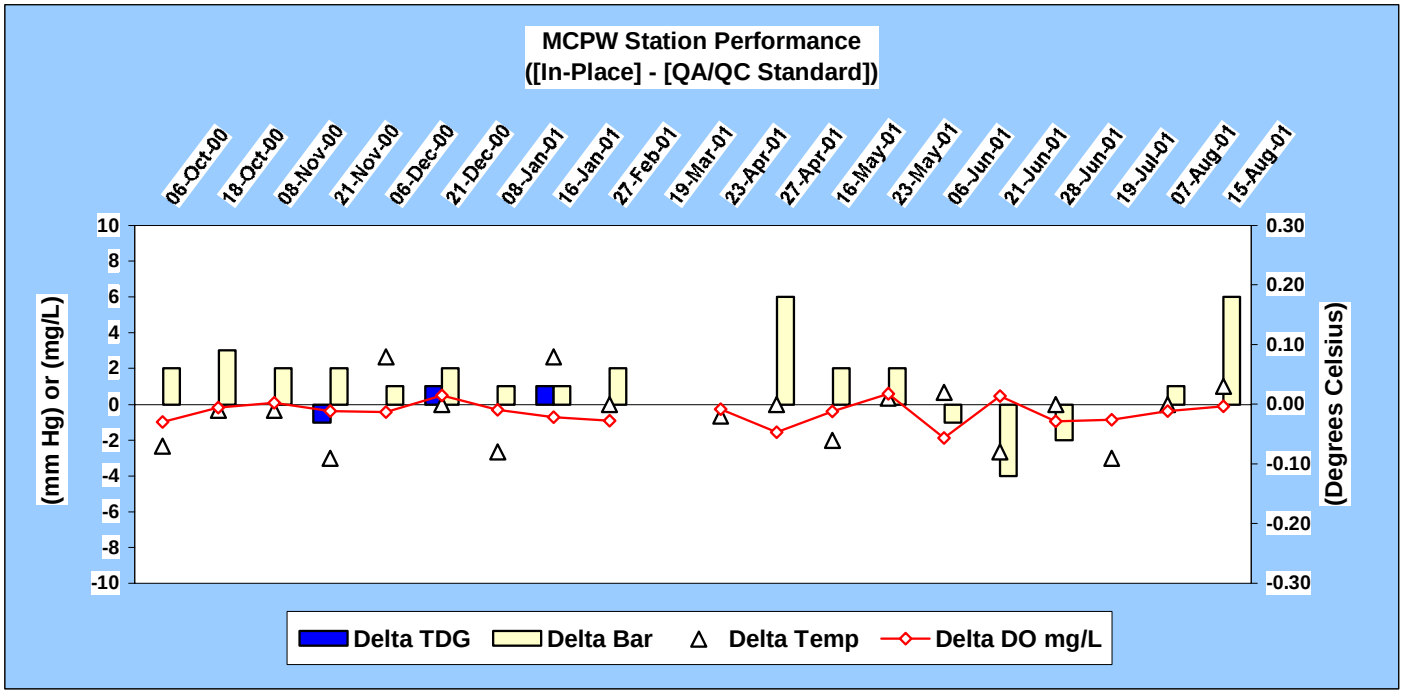
The McNary forebay station on the Washington side is mounted on the upstream end of the Washington shore fish ladder, about 295 feet upstream of the dam (see plate 10). The station operated continuously from 1 October 1999 until 30 September 2000 with no problems.

Station MCQW experienced the same improvements that occurred at MCQO; however, this station did not produce such large Delta values late in the fish passage season. This is likely due to the fact that this station is located on the Washington side of the river and is mostly influenced by the Columbia River discharge, which is much greater than the Snake River discharge that influences the Oregon side of the pool. This station is also located approximately 100 feet from the dam, removing it from the stagnant water trapped between the closed spillway structures. See figure 3-47 and table 3-17.

Table 3-17. Station MCQW - Data Points Failing QA/QC Standard.

Period	Date	Parameter	Reason
2200	21 JAN	Pres	SDI-12 sonde
1500	09 JUN	Pres, %sat	SDI-12 sonde
0200	06 AUG	Pres, %sat	SDI-12 sonde
0000	26 AUG	Pres, %sat	SDI-12 sonde
2200	29 AUG	Pres, %sat	SDI-12 sonde
0000	10 SEP	Bar, Temp, %sat	Bar malfunction

Figure 3-48



Station ID	QA/QC Sonde	In-Place Sonde	Deployment Date	Delta TDG	Delta Bar	Delta DO mg/L	Delta Temp
MCPW	27	28	06-Oct-00	0	2	-0.98	-0.07
MCPW	7	27	18-Oct-00	0	3	-0.19	-0.01
MCPW	21	7	08-Nov-00	0	2	0.09	-0.01
MCPW	23	21	21-Nov-00	-1	2	-0.37	-0.09
MCPW	21	23	06-Dec-00	0	1	-0.43	0.08
MCPW	2	21	21-Dec-00	1	2	0.49	0.00
MCPW	23	2	08-Jan-01	0	1	-0.31	-0.08
MCPW	7	23	16-Jan-01	1	1	-0.71	0.08
MCPW	25	7	27-Feb-01	0	2	-0.92	0.00
MCPW	28	25	19-Mar-01		0		
MCPW	26	28	23-Apr-01	0	0	-0.26	-0.02
MCPW	10	28	27-Apr-01	0	6	-1.55	0.00
MCPW	6	3	16-May-01	0	2	-0.41	-0.06
MCPW	20	6	23-May-01	0	2	0.58	0.01
MCPW	28	20	06-Jun-01	0	-1	-1.89	0.02
MCPW	20	28	21-Jun-01	0	-4	0.46	-0.08
MCPW	16	20	28-Jun-01	0	-2	-0.94	0.00
MCPW	5	16	19-Jul-01	0	0	-0.85	-0.09
MCPW	15	5	07-Aug-01	0	1	-0.36	0.00
MCPW	28	15	15-Aug-01	0	6	-0.11	0.03

19-Mar In-place instrument malfunctioned. Delta values could not be calculated.

p. Station MCPW - Columbia River below McNary Dam, WA.

The McNary tailwater station is located on the right bank at RM 290.6, which is approximately 7,300 feet downstream of the dam (see plate 10). The station operated continuously from 1 October 1999 until 31 September 2000 with two short outages. One was at 0900 on 27 April 2000. Water temperature and dissolved gas sensors recorded high readings for 3 hours followed by 18 hours of low water temperature readings. The second outage was at 1000 on 16 June 2000 following battery replacement. The succeeding four reports failed to transmit. See figure 3-48 and table 3-18.

Table 3-18. Station MCPW - Data Points Failing QA/QC Standard.

Period	Date	Parameter	Reason
1700	13 JAN	Temp	Sonde malfunction
2300	03 MAY	Pres	SDI-12 sonde
1700	31 MAY	Temp	SDI-12 sonde
1200-1300	06 JUN	Temp, %sat	SDI-12 sonde
1400	21 JUN	Temp, pres, %sat	SDI-12 sonde
1400-1700	02 JUL	Dropped one 4-hour cycle	DCP malfunction
1400-1700	26 JUL	Dropped 4-hour cycle	DCP malfunction
1400-1700	02 AUG	Dropped 4-hour cycle	DCP malfunction
1000-1300	04 SEP	Dropped 4-hour cycle	DCP malfunction and DCP replaced
1000	02 OCT	Pres	Pressure sensor malfunction

3.05. OUTLYING, INVALID, AND MISSING SONDE CALIBRATION VALUES.

The YR01 sonde calibration data set contained 8 outlying TDG and 10 outlying DO values, 2 invalid TDG values, and 14 missing temperature data values. Table 3-19 lists the outlying and invalid data values. Outlying values are in black and invalid values are highlighted in red. Descriptions of each invalid and missing data value can be found in tables 3-21 and 3-22 respectively. For a review of the definitions and uses of these data classes refer to the Methods section of this report.

The only clear trend in the data is that the temperature sensor on instrument #28 is responsible for nearly all of the outlying temperature values. This sensor should be replaced.

Table 3-19. YR01 Outlying and Invalid Sonde Calibration Values.

Entry Number	Sonde Admin #	Calibration Date	**Base TDG Adj**
50	16	07-Jan-01	**-5**
215	27	26-Jun-01	-4
153	25	04-May-01	-3
3	9	17-Oct-00	3
30	16	21-Nov-00	3

Entry Number	Sonde Admin #	Calibration Date	**Pres TDG Adj**
50	16	07-Jan-01	**-5**
215	27	26-Jun-01	-4
153	25	04-May-01	-3
3	9	17-Oct-00	3
30	16	21-Nov-00	3

Entry Number	Sonde Admin #	Calibration Date	**Delta Temp**
25	28	09-Nov-00	-0.20
38	28	06-Dec-00	-0.20
37	28	06-Dec-00	-0.20
57	28	16-Jan-01	-0.20
64	28	16-Jan-01	-0.20
76	28	13-Feb-01	-0.20
129	28	28-Apr-01	-0.20
173	28	04-Jun-01	-0.20
229	28	02-Aug-01	-0.20
134	12	02-May-01	-0.20

3.06. OUTLYING, INVALID, AND MISSING STATION COMPARISON VALUES.

The YR01 sonde calibration data set contained 9 outlying TDG and 77 outlying DO values, 3 invalid TDG values, and 43 missing data values. Table 3-20 lists the outlying and invalid data values. Outlying values are in black and invalid values are highlighted in red. Descriptions of each invalid and missing data value can be found in tables 6 and 7 respectively. For a review of the definitions and uses of these data classes refer to the Methods section of this report.

The outlying TDG values were largely attributed to micro-environmental heterogeneity within the deployment pipe caused by inadequate forebay circulation.

The occurrence of 77 outlying Delta DO values can be attributed to an aging population of DO sensors and some temporary problems with the calibration procedures. Drought conditions also contributed to higher Delta DO values because of micro-environmental heterogeneity within the deployment pipes due to low flow.

Most of the missing data points were caused by the start-up of the summer monitoring season at which time there is no In-place instrument thereby preventing an initial QA/QC comparison. The remaining missing data values were due to various malfunctioning sensors.

Table 3-20. YR01 Outlying and Invalid Station Comparison Values.

Station ID	QA/QC Sonde	In-Place Sonde	Deployment Date	**Delta TDG**
IHR	22	19	22-Nov-00	-12
LMN	6	22	25-Jul-01	-9
IHR	15	16	21-Aug-01	-7
LGS	19	7	25-Jul-01	-7
IHR	29	21	02-Aug-01	-5
LGS	18	25	18-Jun-01	-5
MCQO	20	3	15-Aug-01	-5
IDSW	18	27	03-May-01	5
DWQI	18	21	07-May-01	6
IDSW	12	27	29-May-01	**9**
IDSW	17	27	15-Jun-01	**10**
LGNW	21	16	04-Jan-01	**10**

Station ID	QA/QC Sonde	In-Place Sonde	Deployment Date	**Delta DO mg/L**
LEWI	2	5	09-Jun-01	-2.94
LWG	7	26	28-Feb-01	-2.88
MCPW	28	20	06-Jun-01	-1.89
IDSW	4	27	01-Apr-01	-1.69
LWG	9	26	26-Jun-01	-1.60
MCPW	10	28	27-Apr-01	-1.55
DWQI	22	9	19-Dec-00	-1.47
DWQI	11	7	03-Oct-00	-1.40
LEWI	8	28	07-May-01	-1.34
LGNW	11	7	21-Nov-00	-1.32
IDSW	16	27	09-Jan-01	-1.27
ANQW	16	19	09-Jun-01	-1.27
LGNW	22	21	17-Jan-01	-1.25
IDSW	17	27	15-Jun-01	-1.22
DWQI	25	23	01-Feb-01	-1.20
MCQO	8	6	19-Jul-01	-1.19
LEWI	19	2	22-Jun-01	-1.18

Station ID	QA/QC Sonde	In-Place Sonde	Deployment Date	**Delta DO mg/L**
LWG	25	28	25-May-01	-0.81
MCQO	3	8	07-Aug-01	-0.81
IDSW	26	27	12-Apr-01	-0.80
IDSW	7	27	21-Dec-00	-0.79
LGNW	16	26	04-Oct-00	-0.78
LGNW	5	8	10-Jun-01	-0.78
MCQO	28	10	06-Oct-00	-0.76
LMN	22	10	28-Jun-01	-0.75
DWQI	22	2	29-Apr-01	-0.72
MCPW	7	23	16-Jan-01	-0.71
LGS	9	19	08-Aug-01	-0.69
DWQI	11	17	09-Jun-01	-0.67
IDSW	2	27	11-May-01	-0.67
LGS	6	21	24-May-01	-0.65
PAQW	26	8	28-Jun-01	-0.63
LGSW	7	16	08-Aug-01	-0.62
LGNW	22	23	28-Feb-01	-0.60

Table 3-20. YR01 Outlying & Invalid Station Comparison Values (continued).

Station ID	QA/QC Sonde	In-Place Sonde	Deployment Date	**Delta DO mg/L**
MCQW	16	9	08-Nov-00	-1.14
PAQW	9	26	05-Feb-01	-1.13
MCQO	28	23	14-Feb-01	-1.12
PAQW	9	11	28-Apr-01	-1.12
PAQW	11	2	07-Nov-00	-1.10
IDSW	21	27	22-Nov-00	-1.09
DWQI	20	28	20-Jul-01	-1.08
IDSW	28	27	30-Jan-01	-1.00
MCQO	9	7	21-Dec-00	-0.98
MCPW	27	28	06-Oct-00	-0.98
MCQO	7	12	23-May-01	-0.97
MCQO	9	7	06-Jun-01	-0.96
MCPW	16	20	28-Jun-01	-0.94
MCPW	25	7	27-Feb-01	-0.92
LGS	19	9	21-Aug-01	-0.91
LWG	11	2	19-Dec-00	-0.91
LMNW	29	12	28-Jun-01	-0.89
IDSW	17	25	17-Jul-01	-0.88
LGNW	29	5	18-Jun-01	-0.88
LGNW	26	22	29-Apr-01	-0.86
MCPW	5	16	19-Jul-01	-0.85
IDSW	25	27	22-Jun-01	-0.82

Station ID	QA/QC Sonde	In-Place Sonde	Deployment Date	**Delta DO mg/L**
MCQW	23	2	06-Oct-00	-0.60
IDSW	19	20	05-Oct-00	-0.59
LWG	16	28	21-Nov-00	-0.59
MCQW	20	21	19-Mar-01	-0.55
MCQW	10	19	19-Jul-01	-0.55
LGNW	23	11	13-Dec-00	0.56
IHR	28	16	30-Jan-01	0.58
LMNW	25	18	21-Aug-01	0.58
MCPW	20	6	23-May-01	0.58
LWG	25	11	04-Jan-01	0.69
LGNW	19	22	01-Feb-01	0.72
DWQI	21	22	01-May-01	0.78
LGSW	5	2	10-May-01	0.82
IHR	7	28	21-Dec-00	0.85
MCQW	9	23	18-Oct-00	1.03
LGS	21	6	10-May-01	1.10
MCQO	23	2	02-Feb-01	1.13
LWG	2	16	13-Dec-00	1.27
MCQO	20	3	15-Aug-01	1.30
LWG	21	11	01-Feb-01	1.51
LEWI	5	8	24-May-01	1.95

Table 3-21
Description of Missing Data Values.

Sonde Calibration Data

Reporting Month	Calibration Date	Sonde ID	Missing Parameters				Explanation
			TDG	DO	Temp	Bar	
January-01	3-Jan-01	25			*		Unable to perform check of Sonde temp sensor
January-01	3-Jan-01	21			*		Unable to perform check of Sonde temp sensor
January-01	3-Jan-01	19			*		Unable to perform check of Sonde temp sensor
January-01	3-Jan-01	28			*		Unable to perform check of Sonde temp sensor
April-01	18-Mar-01	8			*		Unable to perform check of Sonde temp sensor
April-01	18-Mar-01	20			*		Unable to perform check of Sonde temp sensor
April-01	18-Mar-01	9			*		Unable to perform check of Sonde temp sensor
April-01	19-Mar-01	28			*		Unable to perform check of Sonde temp sensor
April-01	20-Mar-01	14			*		Unable to perform check of Sonde temp sensor
April-01	20-Mar-01	25			*		Unable to perform check of Sonde temp sensor
April-01	20-Mar-01	19			*		Unable to perform check of Sonde temp sensor
April-01	21-Mar-01	21			*		Unable to perform check of Sonde temp sensor
April-01	21-Mar-01	29			*		Unable to perform check of Sonde temp sensor
June-01	18-Oct-00	27			*		Unable to perform check of Sonde temp sensor

Station Comparison Data

Reporting Month	Deploy Date	Station ID	Missing Parameters				Explanation
			TDG	DO	Temp	Bar	
January-01	16-Jan-01	PAQW		*			Malfunctioning DO sensor on In-place instrument
April-01	19-Mar-01	MCPW	*	*	*		In-place instrument was inoperative
April-01	19-Mar-01	PAQW	*				Malfunctioning TDG sensor on In-place instrument
April-01	20-Mar-01	LGSW	*	*	*		Start-up of summer monitoring season; No In-place instrument
April-01	20-Mar-01	LMNW	*	*	*		Start-up of summer monitoring season; No In-place instrument
April-01	20-Mar-01	LMN	*	*	*		Start-up of summer monitoring season; No In-place instrument
April-01	20-Mar-01	LGS	*	*	*		Start-up of summer monitoring season; No In-place instrument
April-01	21-Mar-01	LEWI	*	*	*		Start-up of summer monitoring season; No In-place instrument
April-01	21-Mar-01	ANQW	*	*	*		Start-up of summer monitoring season; No In-place instrument
April-01	30-Apr-01	ANQW				*	Inaccessible station barometer
April-01	3-May-01	LGS				*	Inaccessible station barometer
May-01	28-Apr-01	LMN	*				Malfunctioning TDG sensor on In-place instrument
May-01	1-May-01	DWQI	*				Malfunctioning TDG sensor on In-place instrument
May-01	3-May-01	IHR	*	*	*		In-place instrument was a DS4 unit
May-01	14-May-01	PAQW	*	*	*		In-place instrument was inoperative
May-01	29-May-01	IHR	*				Malfunctioning TDG sensor on In-place instrument
June-01	26-Jun-01	LMNW		*			Malfunctioning DO sensor on In-place instrument
July-01	21-Mar-01	PEKI	*	*	*		Start-up of summer monitoring season; No In-place instrument
July-01	27-Jun-01	LEWI	*	*	*		In-place instrument was inoperative
Sept-01	20-Aug-01	LEWI	*				Failed TDG membrane
Sept-01	21-Aug-01	IHR		*			Malfunctioning DO sensor on In-place instrument

Table 3-22
Description of Invalid Data Values.

Sonde Data

Entry #	Calibration Date	Sonde ID	Parameter	Value	Comment
50	07-Jan-01	16	Delta Base TDG	5	Faulty TDG sensor
50	07-Jan-01	16	Delta Pres TDG	5	Faulty TDG sensor

Station Data

Entry #	Deployment Date	Station ID	Parameter	Value	Comment
59	04-Jan-01	LGNW	Delta TDG	10	Faulty TDG sensor on In-Place (#16)
176	15-Jun-01	IDSW	Delta TDG	10	Faulty TDG sensor on In-Place (#27)
224	25-Jul-01	LMN	Delta TDG	-9	Faulty TDG sensor on In-Place (#22)

SECTION 4.0 - DISCUSSION

4.01. SONDE PERFORMANCE.

At the end of FY01 the deployable inventory of instruments consisted of 28 sondes. The instruments were designated 1 to 29 but instrument #24 was flooded during FY00 and was permanently removed from the inventory leaving only 28 instruments. Performance charts were plotted for instruments that had had three or more completed data sheets from October 2000 to September 2001. There were 25 instruments that met this criterion.

In FY01, a total of 10 instruments were repaired and 8 received routine maintenance checks. 14 of these instruments were outfitted with new 25-meter depth sensors. At the end of FY01 there were 27 sondes capable of reporting depth, however, five of these instruments were not available for use because of maintenance problems. Two additional instruments (#13 and #14) did not have depth sensors and were not operative because they required TDG sensor maintenance. There were four pre-paid 25-meter depth sensors on reserve at Hydrolab. Two of these depth sensors could be used to outfit instruments #13 and #14 if they are sent in for repair. The two remaining sensors could be used to replace the 100-meter depth sensors on instruments #9 and #22.

Many of the instruments are old, well used, and near the end of their service lives. A SLEP was instituted to extend several of the instrumentations service life for another one or two years. A majority of the problems based on records indicate the sonde experience a continuous problems with the SDI-12 protocols. The manufacturer does not believe the problem is with their instrument. However, when attached to an oscilloscope many of the instruments show a momentary voltage and current drop for about a second or two during the exact point in time when a data transmit cycle is started. While this may possibly be a problem only associated with the Sutron® DCP (since we have no other data on DCP performance) and there is no plan to replace DCPs yet new specifications will be issued in FY02. After several tests and experiments at PAQW, coupled with market surveys, it is now possible to procure a third generation version of the TDGMS sondes. It is planned to purchase two prototypes in FY02, with an option buy 8 pre-production of standard models. These instruments would go through trials at PAQW before any implementation at other stations.

4.02. STATION PERFORMANCE.

Station performance was related to both the hydraulic conditions in and around the pipe and the performance of the In-place and QC instruments. During FY01 the following station locations appeared to regularly provide water quality conditions to both the In-place and QC instruments that *were* representative of river water at the time of sampling: MCQW, MCPW, MCQO, PAQW, LMN, LMNW, LGNW, LEWI, PEKI, ANQW.

Figure 4-1. Station Equipment

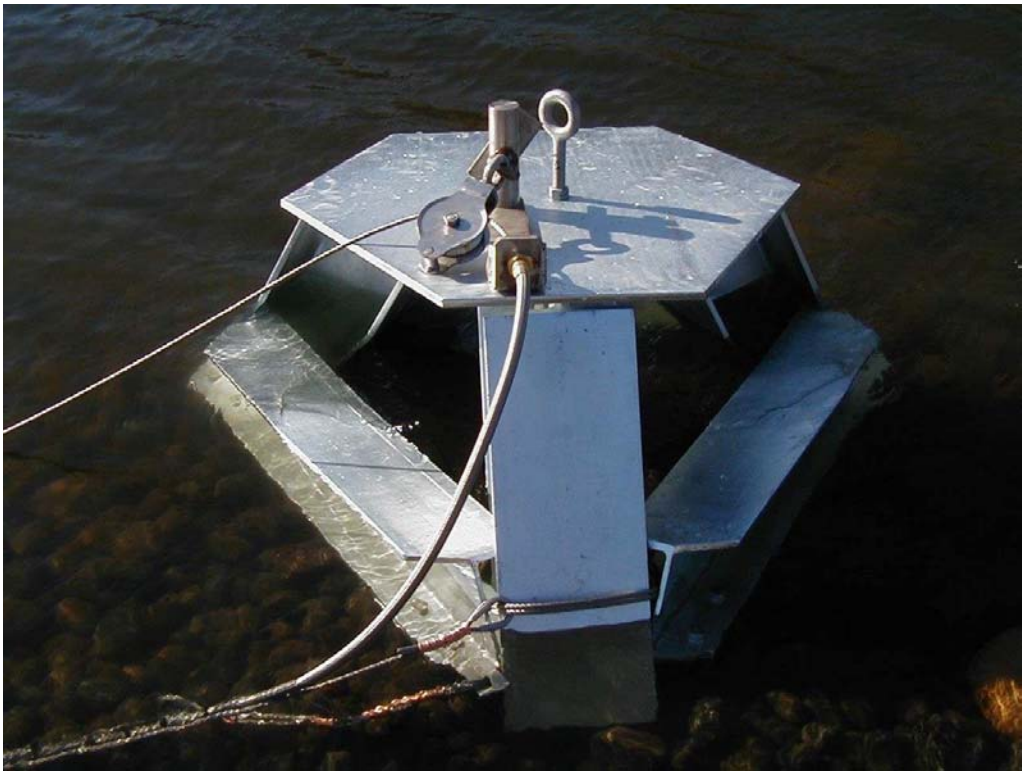


Figure 4-2. Tripod System.

Several stations appeared to regularly provide water quality conditions to the In-place and QC instruments that *were not* representative of river water at the time of sampling: IHR, IDSW, LGS, LGSW, LWG, and DWQI. This statement was based on statistical analyses and field observations. The performance charts for these stations generally depict larger Detla values. Observations in the field generally indicated that more time and technique was required to achieve the same level of data quality at these stations as compared to those stations listed in the previous paragraph.

The location of the deployment pipes at LGS, LGSW, and DWQI stations appears to have affected instrument readings throughout the year. LGSW was located in a small cove that created a pooling affect around the deployment pipe. The water in the cove did not seem to mix well with the river proper causing micro-environmental heterogeneity near the instrument in the deployment pipe. At times, the concentration of dissolved gas measured inside the pipe was 2 to 3 percent higher than the concentration measured outside the pipe. These same conditions were observed at LGS, which was isolated from flow by its location in a corner behind a floating barrier that diverted flow away from the pipe. Similarly, DWQI was located approximately 15-meters off of the river proper near an intake pool from a fish facility that was also blocked by a floating surface barrier and rock debris. The effects of poor station locations were compounded by the impacts of low flow during drought conditions throughout the summer.

Most of the projects in the TDGMS did not spill water through the spill gates during the summer monitoring season because of drought conditions. The low flow conditions reduced the exchange of fresh water in the forebay pools at each project. During the period from late-May to mid-September, the magnitude of the station comparison Detla TDG values generally increased for all of the forebay stations. This meant that it was more difficult to achieve station comparison Detla values at the forebay stations during this period that met the DQO requirements. The acclimation times for these stations were increased substantially during the summer months. This trend was not apparent for tailwater stations during the same period. The CENWW management should consider providing funding to deploy small submersible pumps in the forebay deployment pipes to provide better circulation around instruments during times when forebay circulation is slow. These pumps could be operated automatically via the DCP to run for several minutes prior to each data collection cycle.

During low flow years, the water surface elevation can drop below the deployment pipes at several stations causing the instruments within the pipe to become exposed to atmospheric conditions rather than water quality conditions. In the past CENWW was able to compensate for low flow conditions by deploying instruments outside of the pipes. In the summer of FY01, the water levels dropped so low that the instrument cables at LEWI, PEKI, and ANQW could no longer reach the water. PEKI had to be shut down prior to the scheduled end of the summer monitoring season. Other stations, such as LGNW were at times covered by less than 12 inches of water allowing sunlight to affect water quality conditions. These issues would hopefully be addressed during the repair of selected stations in 2002.

4.03. STATION BAROMETERS.

The calculation of the percent TDG saturation was dependent on accurate measurement of the total dissolved gas pressure in the water and precise measurement of barometric pressure at the point of TDG measurement. Dividing barometric pressure into the TDG measurement would produce the percent saturation value. Considerable error is introduced into the percent saturation value when inaccurate barometric pressure is used in the equation. .

Even though CENWW did not maintain a DQO for station barometer performance in FY01, the station barometers were recalibrated mid-year by CENWW in an attempt to improve the quality of their measurements. The station barometers are at the end of their service lives and were in need of replacement because the manufacturer could no longer service them. Plans to procure improved accuracy units will begin in FY02.

Following the re-calibration of the station barometers there was an apparent shift in station Detla bar values from negative to positive during the last half of the year. This suggested that the calibration standard for the station barometers (S4 instrument) was inadequate. It is recommended that new, more precise and accurate barometric pressure transducers should be procured for use on-site and as a portable standard.

Procurement of station barometers with absolute accuracy of less than 0.5 mmHg and standards capable of measuring half that unit in precision and accuracy are sufficient to provide for all foreseeable requirements of the monitoring system. A direct visual reading display would be required to effectively calibrate instrumentation. In FY02, no less than 6 barometer systems should be replaced at the most critical stations.

4.04. COMPENSATION DEPTH.

Compensation depth measurements were not accomplished in FY01 for several reasons. Increasing repair costs of the older sondes diverted funds available to complete the depth pressure transducer refits. The most crucial monitoring sites (ANQI, PEKI, IDSW, and LEWI) required extensive repairs to the deployment plant and currently, only IDSW is capable of operating with depth. No authorization was given to in FY01 to reprogram the Sutron DCPs to include the depth parameter. A total of 19 sondes were repaired this year in addition to the purchase of a new Surveyor 4 unit. At present, 22 instruments are in full operating condition with 25-meter depth sensors. Five additional sondes with depth-measurement capabilities are inoperative. When authorization is given compensation depth measurements should be programmed to all DCPs as soon as possible.

4.05. DISSOLVED OXYGEN MEASUREMENT AND SENSOR CALIBRATION.

Summary statistics were not calculated for DO sensor calibration data because we employed a one-point ambient air calibration method to 100 percent relative humidity as directed by the sensor manufacturer in place of the Winkler Titration method that calibrates to a known concentration. It is prohibitive to duplicate the original calibration conditions in order to calculate DO sensor drift. Dissolved oxygen sensor performance was inferred from the Detla DO values calculated as part of the station comparison analyses.

SECTION 5.0 – REFERENCES CITED

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13. ABSTRACT (Maximum 200 words)

The U.S. Army Corps of Engineers, Walla Walla District operates 16 water quality stations to monitor total dissolved gas in the Columbia, Snake, and Clearwater Rivers. Stations collect and transmit hourly data via the Geo-stationary Operational Environmental Satellite every 4 hours to the Corps' Northwestern Division. Data is stored in the Columbia River Operational Hydromet Management System database. Collectively, this system is called the Total Dissolved Gas Monitoring System. During spring runoff, air is entrained with plunging flows over the spillways and is carried deep into stilling basins where water pressure causes the air to dissolve. Beyond the stilling basins, rivers become shallow and the water becomes supersaturated. The Environmental Protection Agency established an upper limit of 110 percent saturation for protection of freshwater aquatic life from gas bubble trauma. Spillway deflectors have been installed on all dams in the area served by the District to reduce the plunging depths of spillway flows. In FY01, the District's focus was on maximizing barometer reliability and precision. Measurement accuracy increased for all of the parameters in FY01 from the levels measured in FY00. Improved calibration procedures and new calibration standards accounted for the increases in data quality.

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