Appendix F

2021 Walla Walla District TDG Report

USACE Walla Walla District QA/QC Evaluation of the 2021 Water-Year FMS TDG Monitoring Data

Includes:

McNary, Ice Harbor, Lower Monumental, Little Goose, Lower Granite, and Dworshak Projects

USACE Walla Walla District QA/QC Evaluation of the 2021 Water-Year FMS TDG Monitoring Data

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ABSTRACT

The U.S. Army Corps of Engineers (USACE), Walla Walla District (CENWW), operated fourteen fixed-monitoring system (FMS) stations (eight seasonal and six year-round) for total dissolved gas (TDG), barometric pressure (BP), and temperature as part of their 2021 water-quality program. These stations are located on the Columbia, Lower Snake and Clearwater Rivers. This report provides a summary of the 2021 water-year quality assurance/ quality control (QA/QC) evaluation. Highlights include:

- The Little Goose and Lower Monumental seasonal forebay stations were activated on 1 April as they have been in the past. The Ice Harbor and McNary forebay stations came on-line 13 April followed by Lower Granite forebay on 17 June.
- Data completeness for the combined BP, TDG, and temperature data received averaged 99.3 percent for the 14 monitoring sites used in 2021.
- The TDG data received from the individual sites ranged from 87.6 percent to 100.0 percent complete. Thirty-seven percent of all invalid data was due to measurements that were considered too low, primarily at the Peck (PEKI) and Pasco (PAQW) stations. The second most frequent cause of missing information was defective TDG membranes at the Peck (PEKI) and McNary tailwater station (MCPW) that accounted for a combined 48 percent of the invalid data attributed to defective membranes and 15 percent of the total amount of unacceptable TDG data.
- The TDG sensors from the 14 FMS stations were removed from the field and calibrated in the laboratory every three weeks from April 2021 through August 2021. From September 2020 through March 2021, the six annual FMS stations were calibrated at four-week intervals.
- The sensor pre-deployment check had calculated mean ambient pressure, ambient pressure plus 300 mmHg, and temperature differences of -0.48 mmHg, -0.45 mmHg, and 0.03 °C, respectively. The sensor post-deployment check revealed mean ambient pressure, ambient pressure plus 100 mmHg, and temperature differences of 0.10 mmHg, -2.04 mmHg, and 0.00 °C, respectively.
- The calculated median values for the 157 *in-situ* field checks with the replacement probes were:
    1. TDG; -0.1 percent with minimum and maximum station medians of 0.00 percent.
    2. BP; 0.00 mmHg with station medians ranging from -0.20 to 0.10 mmHg.
    3. Water temperature; -0.01 ºC with station median values ranging from -0.04 ºC to 0.03 ºC.
- Station repairs and maintenance were also completed during the 2021 water year:
    1. The Pasco station (PAQW) was relocated from the shore to an offshore floating platform.
    2. The data collection and transmission equipment at Ice Harbor tailwater (IDSW) was moved from the Coast Guard navigation marker to a shore-based station.
    3. Rebuild of the Lower Monumental tailwater station (LMNW) that was damaged by fire in 2019 was completed.
    4. Sediment build-up at four of the deployment pipes was removed with compressed air.

1.0 INTRODUCTION

Walla Walla District (CENWW) of the U.S. Army Corps of Engineers (USACE) operates six hydropower projects in the Columbia, Snake, and Clearwater River basins: McNary, Ice Harbor, Lower Monumental, Little Goose, Lower Granite, and Dworshak dams. These six dams are included in the basin-wide fixed-monitoring system (FMS) network. The tailwater stations at the six projects are operated throughout the year (Figure F-1; Table F-1). The remaining eight forebay and riverine stations record hourly data from the beginning of April through 31 August, and typically bracket that period, with some exceptions noted below.

Three water-quality related parameters are monitored at these facilities. One is total dissolved gas (TDG). This parameter is of interest since gas supersaturation results when air is entrained as water flows over the spillways and plunges into the stilling basin where water pressure causes the air to go into solution. The river subsequently becomes shallow beyond the stilling basin and the result is water supersaturated with TDG relative to atmospheric conditions. The U.S. Environmental Protection Agency (USEPA) has established an upper limit of 110 percent TDG for protection of freshwater aquatic life as well. Greater than 110 percent TDG can cause gas bubble trauma in fish and adversely affect other aquatic organisms. The TDG water quality standards in Washington and Oregon have been modified during the fish passage season but remained unchanged in Idaho.

The forebay FMS stations have historically reported data from 1 April through 31 August. However, as Washington and Oregon state TDG water quality standards specify only the tailwater gauges as compliance points, Northwestern Division (NWD) instructed the District to delay activating the forebay stations until June 21. The District's agreement with the U.S. Geological Survey (USGS) for station maintenance was consequently modified to shorten the duration of forebay monitoring. The District subsequently decided that it was important to monitor forebay TDG during the time when upstream tailwater gas saturation was increased to 125 percent per the 2021 Fish Operating Plan (http://pweb.crohms.org/tmt/documents/fpp/2021/final/FPP21_AppE_03-31-21.pdf). As such, the Little Goose and Lower Monumental forebay stations were activated by the District on 1 April, while the Ice Harbor and McNary stations were activated on 13 April. The District completed station maintenance until the USGS fulfilled that role starting mid-June. The Lower Granite forebay station was not activated until 17 June.

Barometric pressure, water temperature, and TDG measurements were completed hourly at the Columbia, Snake, and Clearwater River station, and at 15-minute intervals at the Dworshak station. All data was transmitted via the Geostationary Operational Environmental Satellite Program (GOES) system to USACE and USGS databases. The water quality data stored in the Corps Water Management System (CWMS) database can be accessed at http://www.nwd-wc.usace.army.mil/ftppub/water_quality/tdg/. The link to real-time USGS data for Washington is http://waterdata.usgs.gov/wa/nwis/current/?type =quality.

2.0 PURPOSE AND SCOPE

The purpose of TDG monitoring is to provide managers, agencies, and interested parties with near real-time data for managing stream flows, spill, and percent TDG downstream from power-producing dams. An additional purpose of this report is to show that CENWW complied with the

2019-2023 TDG Monitoring Plan during 2021. Compliance included achieving greater than 95 percent completeness for the entire data set, accomplishing the lab and field calibration using established criteria, and utilizing the primary and secondary standards called for in the plan.

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 the data for current and future decision processes. As such, this report:

- Describes the data collection methods.
- Evaluates quality assurance/ quality control (QA/QC) data for the FMS stations at McNary, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite reservoirs. Additionally, this data-collection system provided water quality information for; (a) the Clearwater River downstream of Dworshak Dam, and at Peck, (b) the Columbia River near Pasco, and (c) the Snake River near Anatone, Washington (Figure F-1; Table F-1).
    - The QA/QC data includes:
        1. Instrument Data: This data was used to evaluate how an instrument performed as a function of the magnitude and direction that individual sensors deviated over time from their respective laboratory standards. These relationships were determined for each sensor before and after each deployment.
        2. Station Data: These data present comparisons between an in-place instrument that was deployed at a given station for a specified cycle and a newly calibrated QA/QC instrument (field standard). The Sutron® barometers at each station were evaluated with a Novalynx® hand-held barometer that served as a portable field standard for barometric pressure. All fourteen stations, with the exception of the three forebay stations previously mentioned, were visited for routine maintenance once every three weeks between 1 April and 31 August. The six year-round stations were maintained once every four weeks for the remainder of the year.
        3. Data Completeness: The information transmitted to the databases were evaluated to determine whether they were within expected ranges.

3.0 METHODS

3.1 DATA COLLECTION

The instrumentation at each FMS station consisted of components provided by CENWW and the USGS Kennewick, Washington, offices. A 12-volt battery charged by a solar panel powered each station. Forty-eight Hydrolab® multi-parameter probes (*i.e.*, MS4A's and MS5's) were utilized. Forty-one of these units were provided by CENWW and the remaining seven belong to the USGS.

3.2 LABORATORY PROCEDURES

The TDG sensor measures the sum of the partial pressures of gaseous compounds dissolved in the water and reports the result in millimeters of mercury (mmHg). The TDG sensor requires a two-step calibration procedure (*i.e.*, adjustments are made at two points on the calibration curve) that is completed prior to and after deployment. The atmospheric pressure calibration point (Lab BP) is equal to the atmospheric pressure at the time of calibration as measured with a ParoScientific® digiquartz barometric pressure standard that is calibrated yearly at the factory.

The differences between Lab BP and the pressure measured by the sonde were recorded before and after deployment as Δ(BP). The slope of each sensor response was also evaluated to ensure that measurements were interpolated correctly over the full range of expected field values. To accomplish this task, a Heise™ PTE-1 hand-held certified pressure calibrator, calibrated yearly at the factory (primary standard) and an Ashcroft 2089 digital test gauge, also calibrated yearly at the factory, were used to apply pressure to the TDG sensor. Three hundred millimeters of mercury were added to Lab BP during the pre-deployment check and the differences between Lab BP+300 and the sensors' response were recorded as Δ(BP+300). Similar tests were completed post-deployment when 100 mmHg was added to Lab BP, and the resulting differences were recorded as Δ(BP+100). Pre-deployment pressure tests were made without a membrane installed. Post-deployment tests were made with a dry membrane in place.

Each sonde also includes a sensor for reporting water temperature in degrees Celsius (°C). Sensor thermometers are factory calibrated and cannot be adjusted. However, temperature sensor performance was evaluated pre- and post-deployment by comparing instrument readings to two Digi-Sense Traceable Scientific Thermistor Thermometers. Both of these instruments were checked quarterly against a National Institute of Standards and Technology (NIST) traceable Oakton Digital Temp-360 W lab thermistor.

3.3 FIELD PROCEDURES

The differences in barometric pressure, water temperature, and TDG between a secondary standard instrument (*i.e.,* replacement sensor) and the fixed station monitors after three or four weeks of field deployment were measured and recorded as part of the field inspection and calibration procedure. These differences, defined as the secondary standard value minus the field instrument value, were used to compare and quantify the precision between two independent instruments. The Sutron® barometers were checked using a Novalynx® M2 Series hand-held digital barometer that is calibrated yearly at the factory. The water temperature and TDG comparisons were made *in situ* with the secondary standard (*i.e.*, a recently calibrated Hydrolab®) positioned alongside the field Hydrolab®.

3.4 DEFINING INVALID AND MISSING DATA VALUES

The provisional real-time data were examined daily during the workweek by CENWW and/or USGS employees. Missing values and those that appeared to be outside the expected range were flagged. If a reasonable explanation (*e.g.*, routine maintenance, data collection platform [DCP] failure, or defective membrane) could be attributed to the incident, then the data point, or points, was not included in the final data set used for this analysis. Outlying data points that could not be attributed to a specific cause were retained.

4.0 RESULTS AND DISCUSSION

4.1 INVENTORY-WIDE SENSOR QA/QC PERFORMANCE

4.1.1 Pre-deployment (completed without membrane)

The pre-deployment evaluation of the sensors consisted of 160 individual checks for barometric pressure (Table F-2). The evaluation of the pressure sensors to the standard revealed a calculated mean of -0.48 mmHg, and a range of -7.69 to 1.90 mmHg (Table F-2; Figure F-3). TDG sensors outside of the expectable range of 2 mmHg were recalibrated. Three hundred millimeters of

mercury was added to the TDG sensor in the laboratory using the laboratory barometer as the baseline standard. The difference between the TDG pressure sensor with 300 mmHg of added pressure and the instrument was compared against the expected value. The sensor pressure differences ranged from -1.16 percent to 0.44 percent with a calculated mean and median of -0.05 percent (Figure F-4; Tables F-2 and F-3).

The dissimilarities between the NIST-traceable thermometer and the sensor thermistors were also quite small. The calculated mean and median values for all the instruments were 0.03 ºC and 0.05 °C, respectively. These calculated values were based on 160 measurements where the minimum and maximum differences for individual sensors ranged from -0.66 °C to 0.17 °C (Tables F-2 and F-3; Figure F-5). The instrument manufacturer's specification is ±0.20 °C for all instruments within a sample pool.

4.1.2 Post-deployment (completed with membrane in place)

The evaluation of the post-deployment QA/QC data also displayed mostly favorable results. A total of 158 data points were used for the evaluation. The differences between the laboratory barometric pressure and that recorded by the TDG sensors ranged from -2.31 mmHg to 33.68 mmHg, with a mean of 0.10 mmHg (Tables F-2 and F-4; Figure F-3). The extreme range of values noted this year was attributed to defective TDG sondes. The results of the post calibration checks using barometric pressure +100 mmHg showed a calculated mean of -0.11 percent, and a range of -5.62 to 0.70 percent (Table F-2; Figure F-4). The low outliers were attributed to defective TDG membranes.

There were 158 post deployment checks available for the temperature evaluation. Temperature post calibration checks resulted in a calculated mean of 0.00 °C and a median of 0.03 °C, with a range of -1.50 °C to 0.35 °C (Tables F-2 and F-4; Figure F-5).

4.2 System-wide Station QA/QC Performance

The analysis of the differences between in-place barometric air pressure, TDG pressure, and temperature instruments with secondary standards was generally favorable, albeit with a few outliers (Figures F-6 through F-8).

A total of 157 readings were used to calculate the mean and median values for barometric pressure (Table F-5). The median of all the differences between the station barometers and the secondary standards was 0.00 mmHg (Table F-5; Figure F-6). Median values for individual stations ranged from -0.20 to 0.10 mmHg (Table F-6; Figure F-6). Barometers that did not meet manufacturer's accuracy of ±0.7 mmHg they were either reset or replaced.

A total of 157 readings were used to calculate the mean and median values for TDG instrument pressure (Table F-5). The overall median for the percent TDG differences between the in-place and replacement sensors was -0.1 percent saturation (Table F-5; Figure F-7). Individual station median values ranged from -0.3 percent saturation to 0.0 percent saturation (Table F-6). High values of 313 mmHg (41.4 percent), 339 mmHg (45.0 percent), and 282 mmHg (37.7 percent) at Ice Harbor tailwater (IDSW), Lower Monumental tailwater (LMNW), and Lower Granite tailwater (LGNW) were the result of blown TDG membranes (Table F-6; Figure F-7). The very low measurement of -115 mmHg (-15.5 percent) at Lower Granite tailwater was due to a defective sonde.

A total of 157 readings were used to calculate the temperature differences between the in-place and replacement sondes (Table F-5). The calculated mean and median temperature differentials for the field data were both -0.01 °C (Table F-5). The median values for individual stations ranged from -0.04 ºC to 0.03 ºC (Table F-6; Figure F-8). The manufacturer's specification for the temperature sensor is ±0.20 °C.

4.3 FMS DATA COMPLETENESS AND STATION STATISTICS

Percent completeness for the real-time TDG, barometric pressure, and temperature data were 98.1, 99.8, and 99.9 percent, respectively (Table F-7; Figure F-9). The most frequent reason attributed to missing or anomalous information in the real-time data set were values that were considered too low (0.28 percent of the combined station performance, which is equivalent to 37.5 percent of all missing and invalid data shown in the last column of Table F-8). The second and third leading causes of missing/anomalous data were defective TDG membranes (0.19 percent of the combined station performance or 26.0 percent of the 1,750 hours of affected data) followed by sonde/sensor malfunctions (0.18 percent of the combined station performance or 24.2 percent of the total affected data). All stations met or exceeded the required 95 percent criterion for data completeness for all parameters combined. However, the TDG percent completeness at Peck (PEKI) was 87.6 percent (Table F-7). The reason for this was primarily due to values that were considered too low and attributed to sediment build-up in the deployment pipe.

4.3.1 Barometric Pressure

Barometric pressure data from the fourteen stations averaged 99.8 percent complete. Barometric pressure data was 100 percent complete at twelve of the fourteen FMS stations including McNary tailwater (MCPW), McNary forebay (MCNA), Pasco (PAQW), Ice Harbor tailwater (IDSW), Ice Harbor forebay (IHRA), Lower Monumental forebay (LMNA), Little Goose Tailwater (LGSW), Little Goose forebay (LGSA), Lower Granite forebay (LWG), Anatone (ANQW), Peck (PEKI), and Dworshak (DWQI) (Table F-7). The two remaining stations were greater than 98 percent complete (Tables F-8 and F-9). One hundred sixty-four of the 172 hours of invalid data at Lower Monumental tailwater (LMNW) was due to a defective barometer that was replaced on 10 April.

4.3.2 Total Dissolved Gas

The TDG data from the fourteen stations averaged 98.1 percent complete (Table F-7). The three stations that experienced the greatest amount of data loss were Peck (PEKI), Pasco (PAQW), and Lower Monumental forebay (LMNA) where the final data set statistics ranged from 87.6 percent to 97.4 percent complete (Table F-7). Sediment accumulation in the deployment pipes were the primary cause of anomalous data at PEKI and PAQW, while a defective TDG membrane and cable caused data to be removed from the database for LMNA (Table F-8 and F-10).

4.3.3 Temperature

The temperature data from the fourteen FMS stations averaged 99.9 percent complete. Four stations (McNary forebay [MCNA], Little Goose tailwater [LGSW], and Lower Granite forebay [LWG], and Peck [PEKI]) attained 100 percent completeness (Table F-7). The remaining ten stations were all greater than 99 percent complete (Tables F-8 and F-11).

4.4 Deployment Pipe Clean-Out

Sediment build-up occurred in four deployment pipes during the 2021 water year that resulted in measurements that were considered too low. The Dworshak pipe was the first one that required maintenance and was purged on 14 April. Three additional deployment pipes were cleaned-out during the summer: Ice Harbor tailwater (IDSW) on 15 June, Peck (PEKI) on 10 July, and Lower Granite tailwater (LGNW) on 5 August.

4.5 Notable Station Maintenance

The Pasco station (PAQW) was relocated to a floating platform in the Columbia River last April 2021. Prior to the move it was discovered that the deployment pipe was damaged and would need to be rebuilt. Since the pipe was previously prone to sediment build-up and dense aquatic macrophytes impeding water circulation it was decided that a better location would be offshore. A temporary float was deployed directly out from the pipe (Figures F-10 and F-11) for the season and will be replaced by a larger float similar to those used for the forebay temperature strings before the station is reactivated next April.

The Ice Harbor tailwater station (IDSW) was modified in late September. The National Electrical Manufacturers Association (NEMA) box that houses the DCP, satellite transmitter, antenna, and other electronic components was located on the Coast Guard navigation marker tower. A new mast was installed on-shore and all the equipment previously located on the tower were moved to that location to facilitate easier access (Figure F-12).

The Lower Monumental tailwater station (LMNW) rebuild was also completed last year. Work included replacing the NEMA box that was showing signs of rust, the internal electronics, and the omnidirectional antenna. The conduit that connects the NEMA box with the irrigation box that was damaged during the 2019 fire was also replaced to keep the rodents out.

5.0 SUMMARY

Hourly TDG, temperature, and barometric pressure data recorded during the 2021 water year at fourteen FMS stations were evaluated. The six tailwater sites were maintained throughout the year. The seasonal riverine stations at Peck (PEKI), Anatone (ANQW), and Pasco (PAQW) were added at the beginning of April and remained active through 31 August. The forebay stations at Little Goose (LGSA) and Lower Monumental (LMNA) dams also came on-line 1 April. However, the Ice Harbor (IHRA) and McNary (MCNA) dams forebay stations were not activated until 13 April followed by the Lower Granite dam forebay station (LWG) on 17 June. The combined data completeness for all stations exceeded 99 percent.

The USGS Kennewick field office performed routine station maintenance, completed emergency repairs, operated the DCPs, and assisted with station repairs under a cooperative agreement with CENWW. Walla Walla District personnel completed forebay station maintenance from the beginning of April and through mid-June. The preventative maintenance schedule provided for calibration and routine maintenance at three-week intervals during the fish spill season and once every four weeks during the rest of the year. Station performance was hampered primarily by low data values, ruptured or fouled TDG membranes, and defective sondes/sensors.

The pre-deployment QA/QC checks showed a mean difference of -0.48 mmHg when the TDG sensors were compared to barometric pressure and -0.05 percent when 300 mmHg of pressure was added. The calculated means for the post-deployment evaluations were 0.10 mmHg and -0.11 percent when the TDG sensors were compared to barometric pressure and barometric pressure plus 100 mmHg, respectively. The calculated mean temperature difference was 0.03 °C for pre-deployment and 0.00 °C for post-calibration.

The 48 instruments used to perform this year's monitoring met the manufacturers' specifications. Field checks completed during routine maintenance between the in-place sonde and the secondary standard demonstrated that the air barometric pressure, percent TDG, and temperature differences averaged -0.01 mmHg, 1.0 percent, and -0.01 °C, respectively.

FIGURES

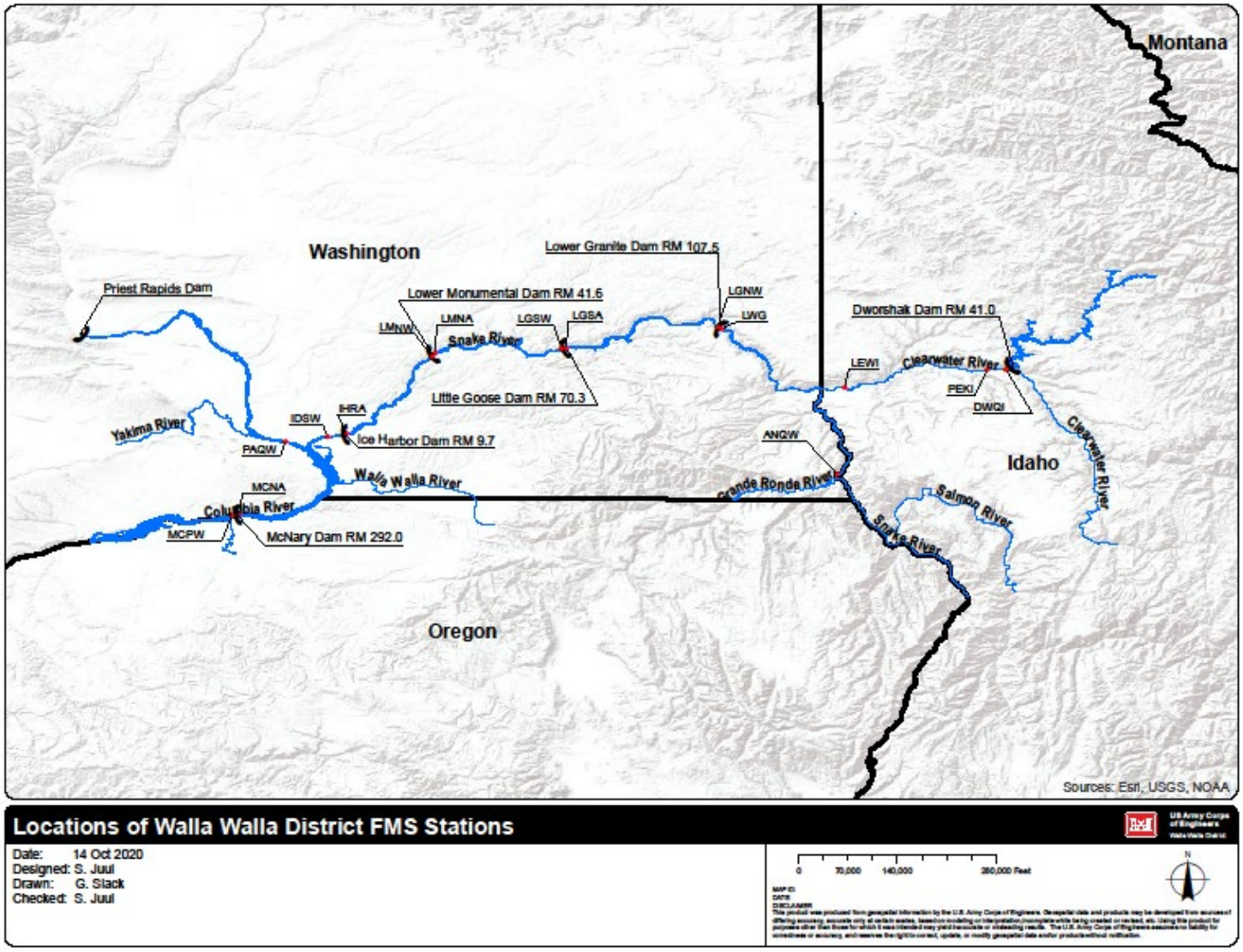


Figure F-1. Locations of Walla Walla District's FMS stations.

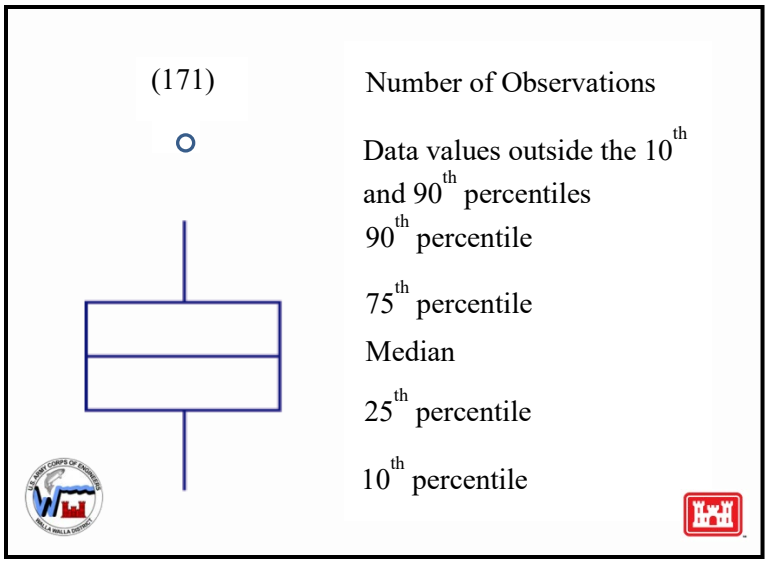
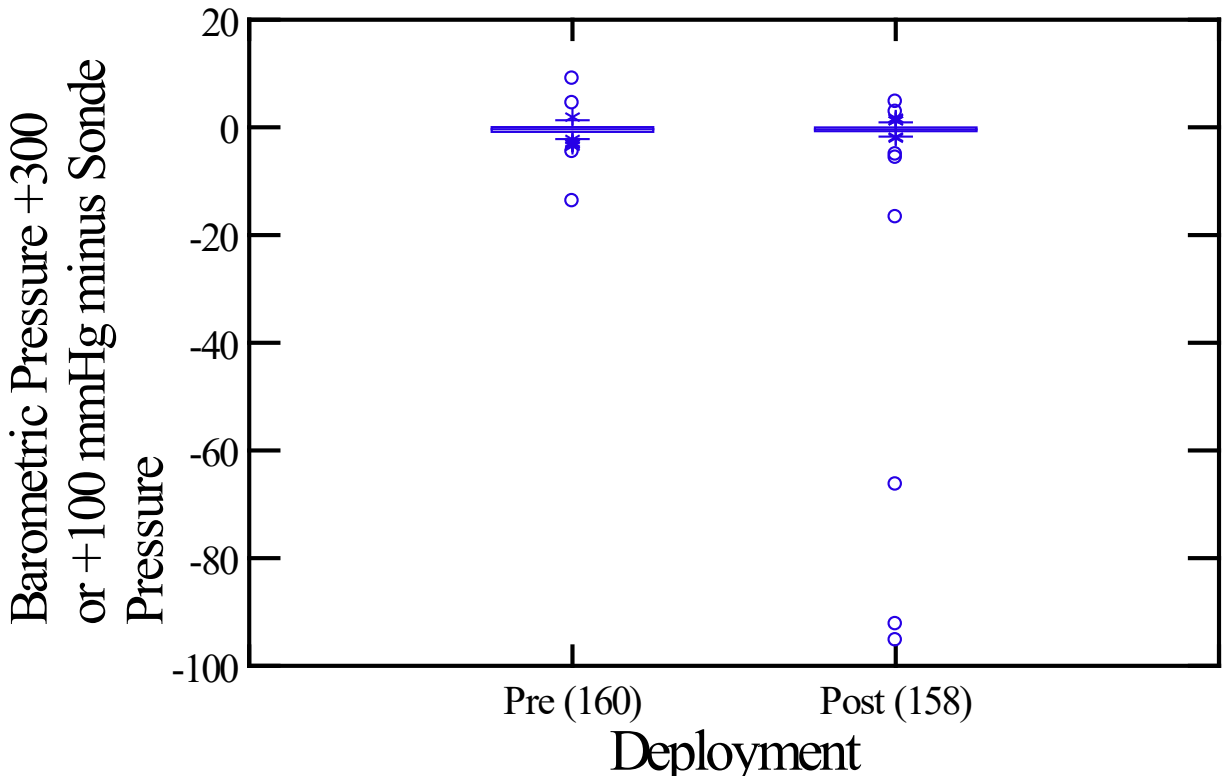


Figure F-2. Explanation key for the box plot information.



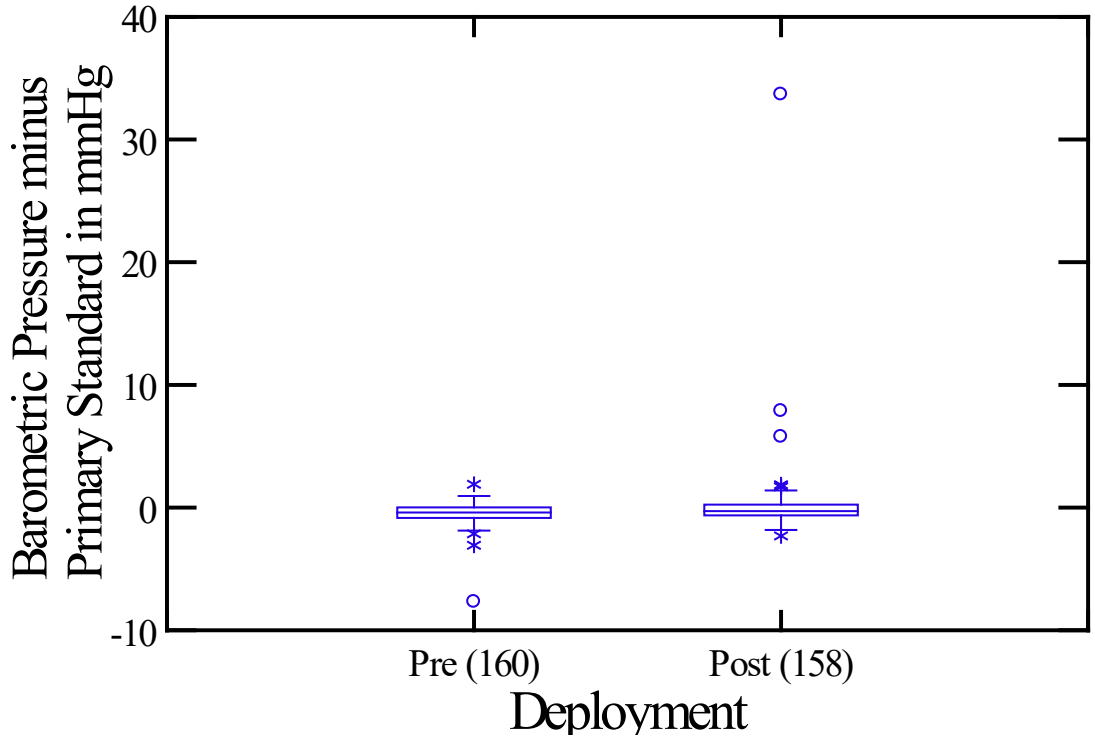


Figure F-4. Summary box plots of the pre-and post-deployment check of the Hydrolab® TDG sensors with the addition of 300 and 100 mmHg, respectively, during the 2021 monitoring season.

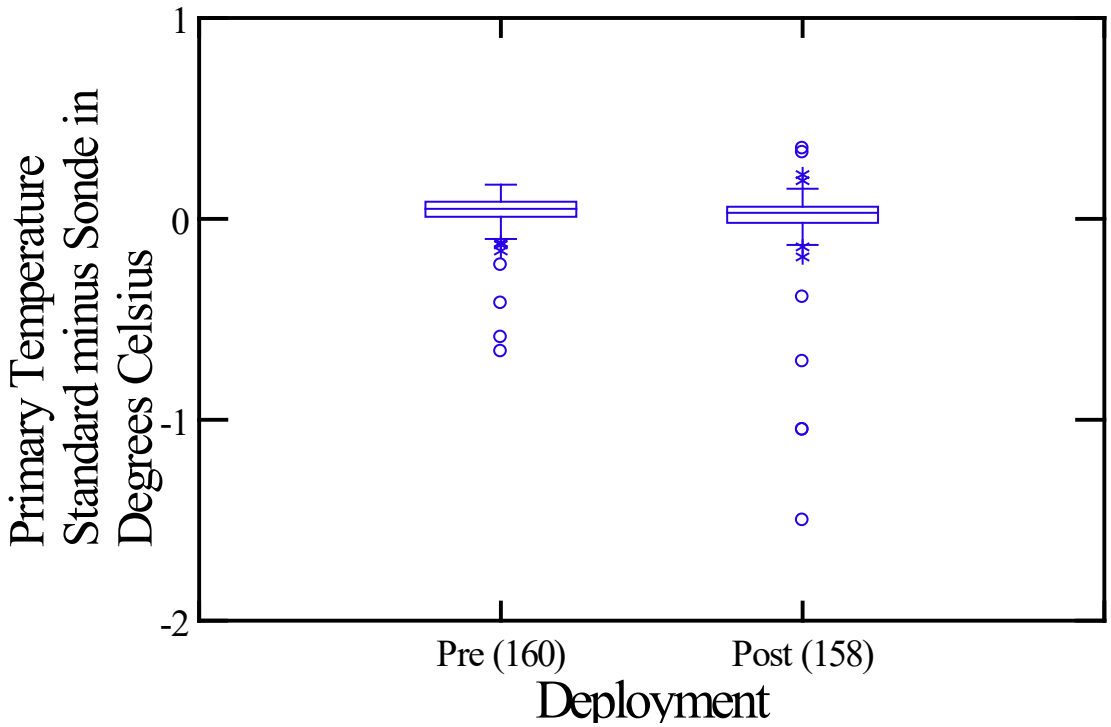


Figure F-5. Summary box plots of the pre- and post-deployment check of the Hydrolab® temperature sensors during the 2021 monitoring season.

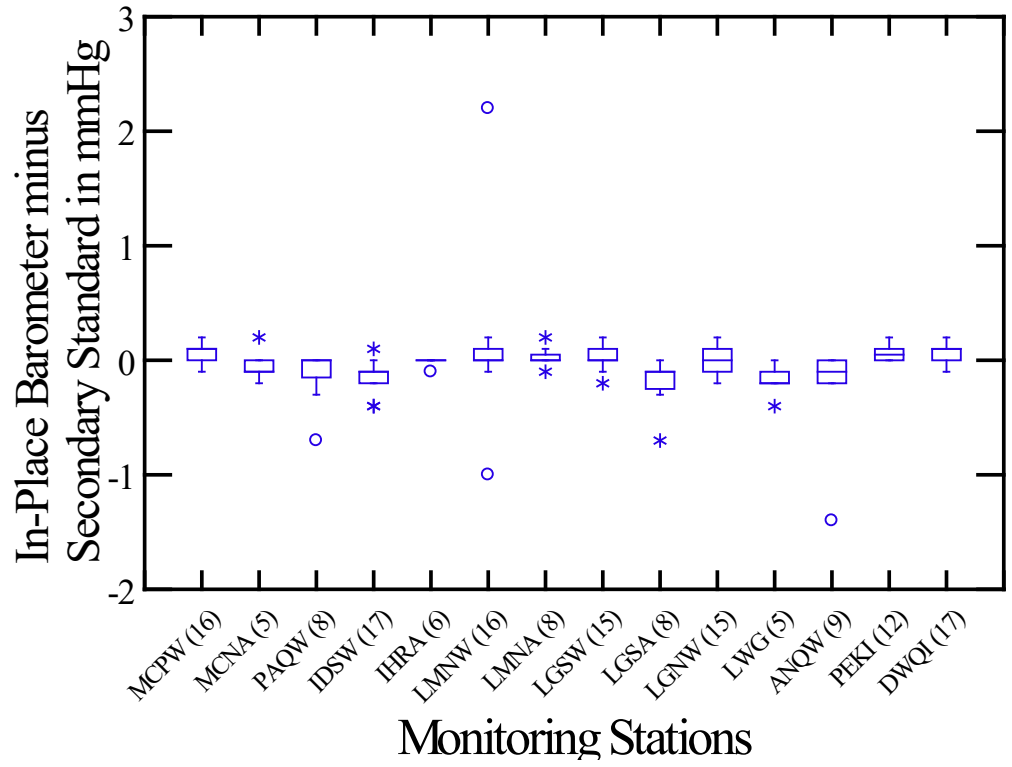


Figure F-6. Box plots of the field barometric pressure sensors check in mmHg by site during the 2021 monitoring season.

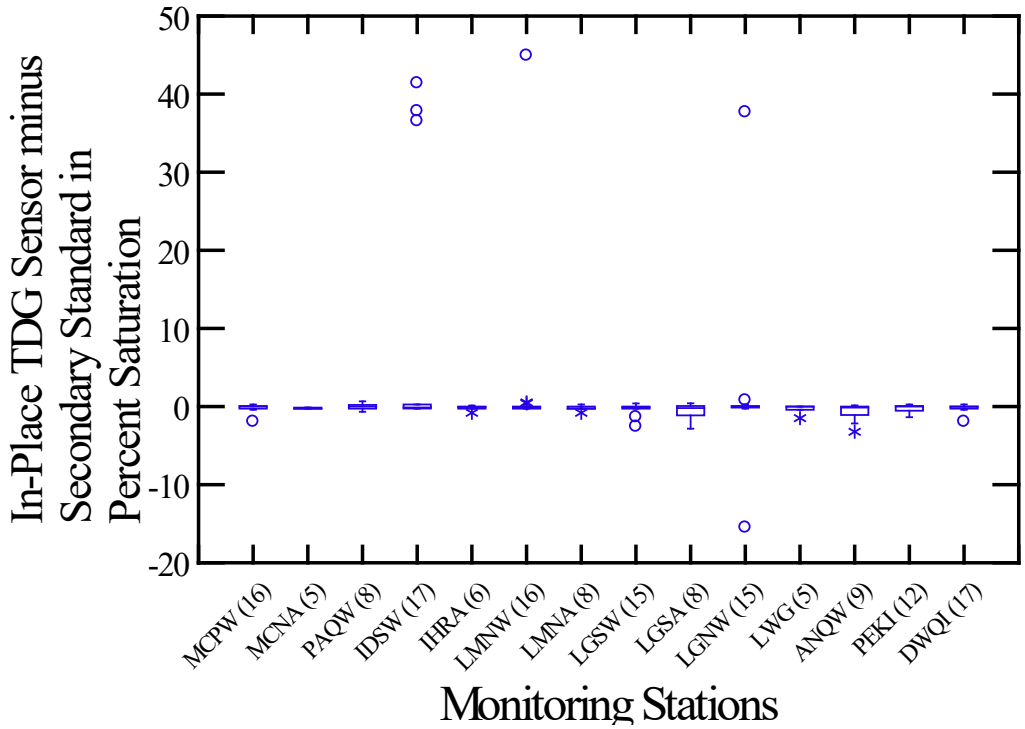


Figure F-7. Box plots of the field total dissolved gas sensor check verses secondary standard in percent saturation by site during the 2021 monitoring season.

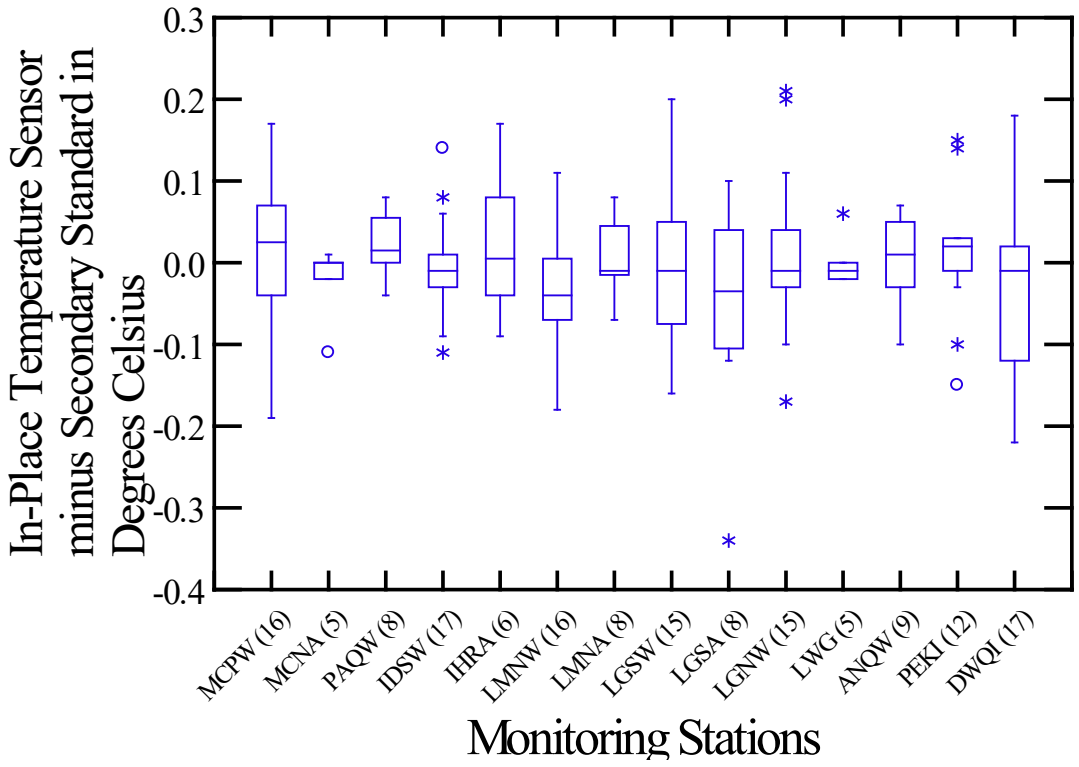


Figure F-8. Box plots of the field temperature sensors check verses secondary standard in degrees Celsius by site during the 2021 monitoring season.

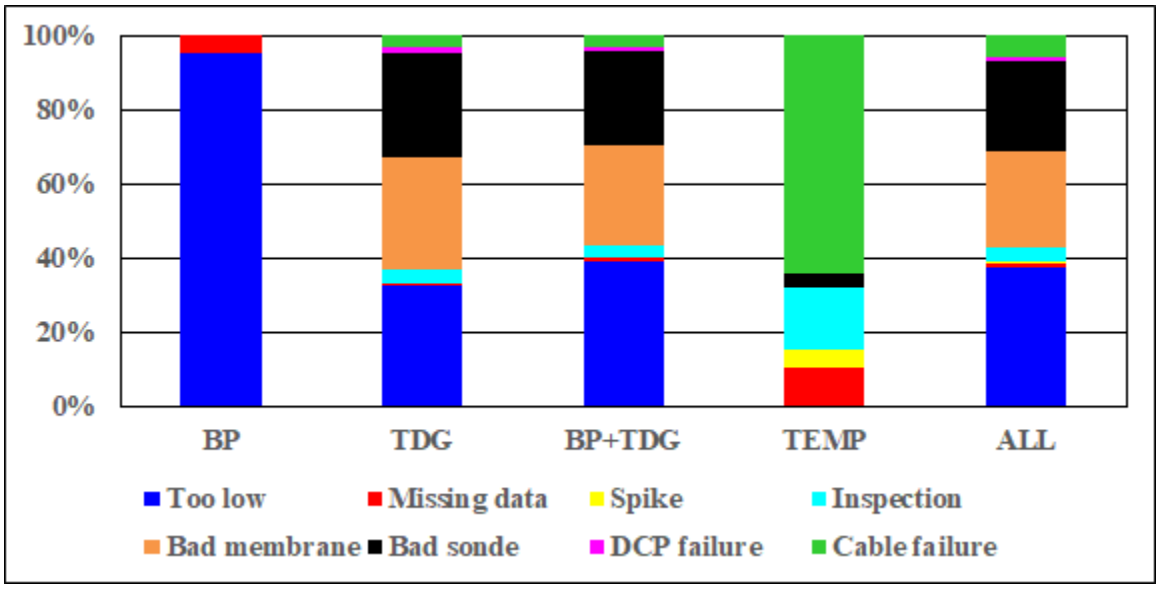


Figure F-9. Percentages for the reasons invalid or anomalous barometric pressure, TDG, and temperature data were removed from the databases during the 2021 monitoring season

Figure F-10. Temporary PAQW TDG floating platform.

Figure F-11. Temporary PAQW TDG floating platform relative to previous onshore station.

Figure F-12. New mast, NEMA box, solar panel, and antenna installed at IDSW.

TABLES

Table F-1. CENWW FMS station identification and location information.

Station Number	Station Name	Station ID	Latitude (NAD 83)	Longitude (NAD 83)	Elevation (NGVD 29)	River Mile	DCP ID	XMIT Time
12514400	Columbia River at Pasco, WA	PAQW	46 13 23.9016 N	119 06 59.04 W	345	329.1	17D6E32C	0:27:10
13334300	Snake River Near Anatone, WA	ANQW	46 05 50.7579 N	116 58 41.2382 W	807	167.5	17D63544	0:16:10
13341000	N.F. Clearwater River at Dworshak Hatchery, ID	DWQI	46 30 11.6464 N	116 19 16.4090 W	1,150	0.5	DE90FB26	0:03:05*
13341050	Clearwater River Near Peck, ID	PEKI	46 30 00.9396 N	116 23 32.4163 W	930	37.4	17D613A8	0:14:10
13343590	Lower Granite Dam Forebay, WA	LWG	46 39 34.1727 N	117 25 34.8564 W	738	107.5	17D643D4	0:17:10
13343595	Lower Granite Dam Tailwater, WA	LGNW	46 39 58.0726 N	117 26 19.2595 W	645	106.7	17D650A2	0:18:10
13343855	Little Goose Dam Forebay, WA	LGSA	46 34 58.3188 N	118 01 32.9831 W	638	70.3	17D66538	0:19:10
13343860	Little Goose Dam Tailwater, WA	LGSW	46 35 00.5280 N	118 02 37.4186 W	560	69.6	17D6764E	0:20:10
13352595	Lower Monumental Dam Forebay, WA	LMNA	46 33 44.6559 N	118 32 08.3477 W	540	41.6	17D686CA	0:21:10
13352600	Lower Monumental Dam Tailwater, WA	LMNW	46 33 04.5051 N	118 32 58.9500 W	445	40.4	17D695BC	0:22:10
13352950	Ice Harbor Dam Forebay, WA	IHRA	46 15 05.2792 N	118 52 43.0096 W	440	10.0	17D6A026	0:23:10
13353010	Ice Harbor Dam Tailwater, WA	IDSW	46 14 27.5868 N	118 57 13.7130 W	340	6.1	17D6B350	0:24:10
14019220	McNary Dam Forebay, WA	MCNA	45 56 28.9200 N	119 17 35.4400 W	340	292.0	17D6D6B6	0:26:10
14019240	McNary Dam Tailwater, WA	MCPW	45 56 02.7775 N	119 19 35.4628 W	240	290.7	17D5F754	0:12:10

Note: * Indicates the station transmits at 15-minute intervals as opposed to the standard hourly rate of transmission.

Table F-2. Summary of the laboratory results evaluating the overall differences between laboratory standards and the sensors pre- and post-deployment during the 2021 water year.

Deployment	Observations	Statistic	Delta BP mmHg (%)	Delta (BP+300) mmHg (%)	Delta (BP+100) mmHg (%)	Delta Temp. °C
Pre	160	Minimum	-7.69 (-1.03)	-13.69 (-1.16)	----	-0.66
		25 Percentile	-0.84 (-0.11)	-0.84 (-0.09)	----	0.01
		Median	-0.40 (-0.05)	-0.35 (-0.05)	----	0.05
		75 Percentile	0.00 (0.00)	0.04 (0.00)	----	0.08
		Maximum	1.90 (0.25)	9.06 (0.44)	----	0.17
		Mean	-0.48 (-0.06)	-0.45 (-0.05)	----	0.03
Post	158	Minimum	-2.31 (-0.31)	----	-95.26[(b)] (-5.62[(b)])	-1.50
		25 Percentile	-0.64 (-0.09)	----	-0.72 (-0.08)	-0.02
		Median	-0.29 (-0.04)	----	-0.38 (-0.05)	0.03
		75 Percentile	0.23 (0.03)	----	-0.01 (0.01)	0.06
		Maximum	33.68[(a)] (4.54[(a)])	----	4.77 (0.70)	0.35
		Mean	0.10 (0.01)	----	-2.04 (-0.11)	0.00

Notes: (a) Due to possible defective sensor
(b) Due to membrane failure

Table F-3. Pre-deployment quality assurance data for the individual sensors utilized at the FMS stations during the 2021 water year.

Sensor ID	Δ (PT – BP)			Δ [PT- (BP+300)]			Δ (Water Temperature)		
	Obs. (#)	Range (mmHg)	Median (mmHg)	Obs. (#)	Range (mmHg)	Median (mmHg)	Obs. (#)	Range (º C)	Median (º C)
13b	3	-2.14 to -1.31	-1.88	3	-3.14 to -0.31	--1.88	3	0.08 to 0.08	0.08
26	2	-0.09 to 0.04	-0.03	2	0.04 to 0.91	0.47	2	0.03 to 0.04	0.03
27	3	-0.33 to 0.35	0.17	3	-0.33 to 0.35	0.17	3	-0.12 to 0.14	0.09
29	3	-1.17 to -0.80	-1.02	3	-2.17 to -0.80	-1.02	3	-0.08 to 0.08	-0.06
32	3	-0.34 to 0.03	0.03	3	-0.03 to 1.03	0.66	3	-0.59 to 0.06	0.05
33	3	-0.07 to 0.58	0.02	3	0.02 to 0.93	0.58	3	0.04 to 0.11	0.07
34	3	0.02 to 0.80	0.40	3	-0.98 to -0.20	-0.60	3	-2.12 to 0.07	-0.03
35	4	-0.84 to -0.35	-0.08	4	-0.84 to -0.35	-0.57	4	-0.07 to 0.08	0.02
36	2	-0.16 to 0.06	-0.05	2	-0.16 to 0.06	-0.05	2	-0.01 to -0.01	-0.01
37	3	-1.46 to -0.59	-1.00	3	-1.00 to -0.46	-0.59	3	0.01 to 0.06	0.01
39	4	-0.83 to -0.16	-0.63	4	-4.56 to -0.16	-0.76	4	0.03 to 0.06	0.05
41	5	-0.92 to 0.32	0.11	5	-0.92 to 1.32	0.11	5	0.00 to 0.07	0.00
42	5	-1.21 to -0.69	-0.75	5	-0.21 to 0.31	0.25	5	-0.03 to 0.10	0.09
43	4	-0.80 to -0.07	-0.66	4	-0.80 to 0.03	-0.36	4	-0.08 to 0.03	0.03
44	6	-1.30 to -0.21	0.68	6	-1.21 to -0.28	-0.39	6	0.05 to 0.17	0.07
45	3	-1.49 to -0.88	-1.08	3	-1.08 to 0.12	-0.49	3	0.02 to 0.04	0.02
47	3	-0.14 to 0.32	0.03	3	0.32 to 1.03	0.86	3	-0.03 to 0.11	0.09
49	6	-0.80 to 0.19	-0.19	6	-1.08 to 0.20	-0.13	6	-0.07 to 0.08	0.07
50	5	-1.66 to -0.76	-0.97	5	-1.66 to 0.03	-0.93	5	0.05 to 0.11	0.09
51	2	-0.41 to -0.35	-0.38	2	-0.41 to 0.35	-0.38	2	0.05 to 0.06	0.05
52	5	-1.25 to -0.02	-0.85	5	-2.25 to -0.02	-0.85	5	-0.04 to 0.14	0.10
53	4	-0.53 to 0.07	-0.38	4	-1.53 to -0.93	-1.38	4	0.03 to 0.05	0.05
54	4	0.21 to 0.94	0.45	4	-0.79 to -0.06	-0.55	4	-0.07 to 0.06	0.04
55	3	-0.98 to -0.61	-0.80	3	-0.98 to -0.61	-0.80	3	-0.07 to 0.10	0.04
56	5	-1.22 to 0.21	0.00	5	-3.00 to 9.06	-0.89	5	-0.23 to 0.17	-0.07
57	6	-1.42 to -0.20	-0.77	6	-0.95 to -0.10	-0.37	6	-0.07 to 0.10	0.08
58	3	-0.54 to 0.11	-0.07	3	-2.07 to 0.46	0.11	3	-0.42 to 0.04	0.04
60	5	-0.92 to 0.30	-0.40	5	-1.28 to 0.30	-0.42	5	0.01 to 0.09	0.04
61	4	-1.13 to -0.11	-0.27	4	-2.13 to 0.86	-0.14	4	0.00 to 0.11	0.05
62	5	-0.79 to 0.04	-0.18	5	-0.96 to -0.16	-0.55	5	-0.66 to 0.09	0.00
63	5	-1.04 to -0.19	-0.50	5	-3.50 to -0.19	-1.04	5	-0.10 to 0.09	0.03
64	4	-0.55 to 0.36	0.04	4	-0.87 to 0.36	-0.30	4	-0.16 to 0.04	0.02
65	2	-0.46 to 0.20	-0.13	2	-0.46 to 0.20	-0.13	2	0.05 to 0.05	0.05
66	1	1.90 to 1.90	1.90	1	1.90 to 1.90	1.90	1	0.13 to 0.13	0.13
67	2	0.00 to 0.17	0.08	2	0.00 to 0.17	0.09	2	0.08 to 0.10	0.09
68	2	-0.80 to -0.32	-0.56	2	-0.80 to -0.32	-0.56	2	0.11 to 0.14	0.13
69	2	-7.69 to -0.30	-4.00	2	-13.69[(a)] to -0.30	-7.00	2	0.12 to 0.13	0.13
32432	2	-0.49 to -0.36	-0.43	2	-0.36 to 0.01	-0.18	2	0.01 to 0.10	0.06
35131	1	-0.07 to 0.07	-0.07	1	-0.07 to -0.07	-0.07	1	0.02 to 0.02	0.02
36902	1	0.79 to 0.79	0.79	1	-0.21 to -0.21	-0.21	1	0.03 to 0.03	0.03

Notes: (a) Reason for low reading unknown

Table F-3. Pre-deployment quality assurance data for the individual sensors utilized at the FMS stations during the 2021 water year (continued).

Sensor ID	Δ (PT – BP)			Δ [PT- (BP+300)]			Δ (Water Temperature)		
	Obs. (#)	Range (mmHg)	Median (mmHg)	Obs. (#)	Range (mmHg)	Median (mmHg)	Obs. (#)	Range (°C)	Median (°C)
USGS #1	3	-1.35 to -1.00	-1.00	3	0.65 to 1.00	1.00	3	0.02 to 0.13	0.03
USGS #2	4	-0.91 to -0.16	-0.37	4	-1.16 to -0.25	-0.69	4	0.02 to 0.15	0.03
USGS #3	2	-3.08 to -0.50	-1.79	2	-3.08 to 4.50	0.71	2	0.05 to 0.05	0.05
USGS #4	5	-0.50 to 0.55	-0.01	5	-0.50 to 0.55	-0.01	5	0.05 to 0.15	0.07
USGS #5	1	0.17 to 0.17	0.17	1	0.17 to 0.17	0.17	1	0.11 to 0.11	0.11
USGS #6	4	-1.28 to -0.23	-0.71	4	-0.34 to -0.07	-0.25	4	0.02 to 0.08	0.06
USGS #9	3	-0.34 to 0.31	0.02	3	-0.34 to 0.31	0.02	3	-0.04 to 0.00	0.00

Table F-4. Post-deployment quality assurance data for the individual sensors utilized at the FMS stations during the 2021 water year.

	Δ (BP – PT)			Δ [PT - BP+100)]			Δ (Water Temperature)		
Sensor ID	Obs. (#)	Range (mmHg)	Median (mmHg)	Obs. (#)	Range (mmHg)	Median (mmHg)	Obs. (#)	Range (º C)	Median (º C)
13b	2	-1.02 to -0.01	-0.51	2	-2.02 to -0.01	-1.01	2	0.04 to 0.05	0.04
26	1	-0.31 to -0.31	-0.31	1	-0.31 to -0.31	-0.31	1	0.03 to 0.03	0.03
27	3	-0.41 to 0.25	0.02	3	-0.98 to 0.25	-0.41	3	0.06 to 0.10	0.08
29	3	-0.28 to 0.33	-0.01	3	-1.01 to 0.33	-0.28	3	-0.02 to 0.06	0.06
32	3	-0.26 to 0.14	-0.07	3	-0.26 to 0.14	-0.07	3	-0.39 to 0.09	0.05
33	2	-0.38 to 0.52	0.07	2	-0.38 to 0.52	0.07	2	0.04 to 0.05	0.04
34	3	0.25 to 0.40	0.38	3	-0.60 to 0.38	0.25	3	-0.71 to -0.04	-0.05
35	4	-1.83 to 1.71	-1.27	4	-1.71 to 1.71	-0.83	4	-0.11 to 0.03	-0.05
36	1	-0.40 to -0.40	-0.40	1	-0.40 to -0.40	-0.40	1	-0.02 to -0.02	-0.02
37	3	-1.12 to -0.31	-0.78	3	-0.12 to 0.69	0.22	3	-0.05 to 0.04	-0.01
39	4	-0.16 to 0.43	0.19	4	-1.16 to 0.43	-0.31	4	0.01 to 0.06	0.05
41	5	-0.73 to 0.92	0.20	5	-0.73 to 0.92	0.20	5	-0.03 to 0.13	0.06
42	5	-1.51 to 0.39	-0.67	5	-5.61 to 0.49	-0.67	5	-0.03 to 0.10	0.02
43	4	-1.00 to 0.60	-0.17	4	-1.00 to 0.60	-0.17	4	-0.05 to 0.06	-0.01
44	6	-0.53 to 0.19	-0.35	6	-1.40 to 0.19	-0.37	6	-0.06 to 0.07	0.04
45	3	-1.05 to -0.72	-0.76	3	-1.72 to -0.76	-1.05	3	0.01 to 0.03	0.02
47	3	1.03 to 33.68	1.19	3	-66.32[(a)] to 0.19	-0.97	3	0.03 to 0.07	0.07
49	7	-1.53 to 5.77	-0.38	7	-0.74 to 4.77	-0.24	7	0.02 to 0.09	0.06
50	6	-0.92 to -0.26	-0.53	6	-92.26[(b)] to 1.58	-0.59	6	0.02 to 0.11	0.06
51	3	-0.72 to 0.74	-0.41	3	-0.72 to -0.26	-0.41	3	0.04 to 0.07	0.06
52	5	-0.79 to -0.05	-0.42	5	-0.79 to -0.05	-0.42	5	-0.05 to 0.11	0.05
53	5	-0.43 to 0.59	-0.16	5	-1.41 to 0.84	-0.30	5	-1.05 to 0.01	-0.02
54	4	0.74 to 1.86	0.93	4	-0.26 to -0.02	-0.13	4	-0.07 to 0.08	0.00
55	4	-1.14 to 0.00	-0.08	4	-0.16 to 0.00	-0.07	4	0.02 to 0.22	0.04
56	4	-0.70 to 0.13	-0.32	4	-1.29 to 0.30	-0.11	4	-1.05 to 0.14	-0.01
57	7	-0.86 to -0.14	-0.67	7	-1.72 to -0.14	-0.67	7	-0.07 to 0.19	0.04
58	4	-0.54 to 0.69	-0.43	4	-0.54 to -0.31	-0.43	4	0.02 to 0.13	0.04
60	5	-0.92 to 0.06	-0.79	5	-95.26[(b)] – 0.06	-0.83	5	-0.19 to 0.03	-0.01
61	4	0.24 to 1.39	0.66	4	-1.61 to 1.24	0.66	4	-0.06 to 0.09	0.02
62	6	-0.81 to 0.08	-0.33	6	-1.81 to -0.08	-0.33	6	-0.03 to 0.35	0.01
63	5	-0.44 to 0.34	-0.11	5	-16.66[(c)] to -0.11	-1.44	5	-0.11 to 0.09	0.01
64	4	-0.38 to 1.69	-0.04	4	-0.69 to -0.31	-0.38	4	-1.50 to 0.06	-0.03
65	3	-0.80 to -0.14	-0.26	3	-0.80 to -0.14	-0.26	3	-0.02 to 0.06	0.05
67	1	-0.20 to -0.20	-0.20	1	-0.20 to -0.20	-0.20	1	0.09 to 0.09	0.09
68	1	0.21 to 0.21	0.21	1	0.21 to 0.21	0.21	1	0.09 to 0.09	0.09
69	1	0.15 to 0.15	0.15	1	0.15 to 0.15	0.15	1	0.11 to 0.11	0.11
32432	1	-0.94 to -0.94	-0.94	1	0.06 to 0.06	0.06	1	-0.02 to -0.02	-0.02
32435	1	0.47 to 0.47	0.47	1	0.47 to 0.47	0.47	1	-0.14 to -0.14	-0.14
35131	1	0.73 to 0.73	0.73	1	-0.27 to -0.27	-0.27	1	-0.03 to -0.03	-0.03
36902	1	-0.70 to -0.70	-0.70	1	-0.70 to -0.70	-0.70	1	-0.07 to -0.07	-0.07

Notes: (a) Defective TDG sensor
(b) Defective membrane
(c) Fouled membrane

Table F-4. Post-deployment quality assurance data for the individual sensors utilized at the FMS stations during the 2021 water year (continued).

	Δ (BP – PT)			Δ [PT – (BP+100)]			Δ (Water Temperature)		
Sensor ID	**Obs. (#)**	**Range (mmHg)**	**Median (mmHg)**	**Obs. (#)**	**Range (mmHg)**	**Median (mmHg)**	**Obs. (#)**	**Range (ºC)**	**Median (ºC)**
USGS 1	2	-0.75 to -0.38	-0.56	2	-0.38 to 0.25	-0.06	2	-0.03 to 0.05	0.01
USGS 3	2	-2.31 to -0.22	-1.26	2	-0.31 to -0.22	-0.26	2	-0.02 to 0.15	0.06
USGS 4	5	0.03 to 7.88	0.18	5	-1.23 to 2.88	0.08	5	-0.07 to 0.06	0.06
USGS 5	1	0.29 to 0.29	-0.29	1	-0.71 to -0.71	-0.71	1	-0.13 to -0.13	-0.13
USGS 6	4	-1.38 to 0.39	-0.76	4	-1.38 to -0.61	-0.76	4	-0.06 to 0.06	0.03
USGS 9	4	-1.02 to 0.66	-0.39	4	-0.41 to -0.02	-0.36	4	-0.09 to 0.03	-0.05

Table F-5. Summary of the field results for the differences between the in-place and replacement sensors during 2021 water year.

Statistic	Delta BP (mmHg)	Delta TDG (% sat)	Delta Temp. (°C)
Number	157	157	157
Minimum	-1.40	-15.5	-0.34
Maximum	2.20	45.0	0.21
Mean	-0.01	1.0	-0.01
Median	0.00	-0.1	-0.01

Table F-6. Summary of the field results for the differences between the in-place and replacement sensors by station during 2021 water year.

Station ID	Delta Barometric Air Pressure			Delta Total Dissolved Gas					Delta Water Temperature		
	# Obs.	Range (mmHg)	Median (mmHg)	# Obs.	Range (mmHg)	Median (mmHg)	Range (% Sat)	Median (% Sat)	# Obs.	Range (°C)	Median (°C)
MCPW	16	-0.1 to 1.7	0.05	16	-10.0 to 3.0	-1.5	-1.3 to 0.4	-0.2	16	-0.19 to 0.17	0.03
MCNA	5	-0.2 to 0.0	-0.10	5	-2.0 to 2.0	-2.0	-0.3 to 0.3	-0.3	5	-0.11 to 0.01	0.00
PAQW	8	-0.7 to 0.0	0.00	8	-5.0 to 5.0	0.0	-0.7 to 0.7	0.0	8	-0.04 to 0.08	0.02
IDSW	17	-0.4 to 0.1	-0.10	17	-2.0 to 313.0[a]	-1.0	-0.3 to 41.4	-0.1	17	-0.11 to 0.14	-0.01
IHRA	6	-0.1 to 0.0	0.00	6	-6.0 to 1.0	0.5	-0.8 to 0.1	-0.1	6	-0.09 to 0.17	0.01
LMNW	16	-1.0 to 2.2	0.00	16	-2.0 to 339.0[a]	-1.0	-0.3 to 45.0	-0.1	16	-0.18 to 0.11	-0.04
LMNA	8	-0.1 to 0.2	0.00	8	-6.0 to 2.0	-2.0	-0.8 to 0.3	-0.3	8	-0.07 to 0.08	-0.01
LGSW	15	-0.2 to 0.2	-0.00	15	-19.0 to 3.0	-1.0	-2.6 to 0.4	-0.1	15	-0.16 to 0.20	-0.01
LGSA	8	-0.7 to 0.0	-0.10	8	-21.0 to 3.0	-1.5	-2.8 to 0.4	-0.2	8	-0.34 to 0.10	-0.03
LGNW	15	-0.2 to 0.2	0.00	15	-115.0[b] to 282.0[a]	0.0	-15.5 to 37.7	0.0	15	-0.17 to 0.21	-0.01
LWG	5	-0.4 to 0.0	-0.20	5	-11.0 to 0.0	0.0	-1.5 to 0.0	0.0	5	-0.02 to 0.06	-0.01
ANQW	9	-1.4 to 0.0	-0.10	9	-24.0 to 1.0	-1.0	-3.2 to 0.1	-0.1	9	-0.10 to 0.07	0.01
PEKI	12	0.0 to 0.2	0.05	12	-10.0 to 2.0	0.0	-1.4 to 0.3	0.0	12	-0.15 to 0.15	0.02
DWQI	17	-0.1 to 0.2	0.10	17	-14.0 to 2.0	0.0	-1.9 to 0.3	0.0	17	-0.22 to 0.18	-0.01

Notes: (a) Defective membrane
(b) Defective sonde

Table F-7. Database completeness with the number and percent of all missing or invalid barometric pressure, total dissolved gas, and temperature points for each FMS station during the 2021 water year.

Station ID	Monitoring Period	Barometric Pressure		Total Dissolved Gas		Temperature	
		Number Missing/ Anomalous	Percent Complete	Number Missing/ Anomalous	Percent Complete	Number Missing/ Anomalous	Percent Complete
MCPW	1 Oct – 30 Sep	**0**	**100.00**	123	98.60	5	99.94
MCNA	13 Apr – 31 Aug	**0**	**100.00**	**0**	**100.00**	**0**	**100.00**
PAQW	1 Apr – 31 Aug	**0**	**100.00**	164	95.54	1	99.97
IDSW	1 Oct – 30 Sep	**0**	**100.00**	60	99.32	3	99.97
IHRA	13 Apr – 31 Aug	**0**	**100.00**	**0**	**100.00**	1	99.97
LMNW	1 Oct – 30 Sep	172	98.04	71	99.19	8	99.91
LMNA	1 Apr – 31 Aug	**0**	**100.00**	94	97.44	36	99.02
LGSW	1 Oct – 30 Sep	**0**	**100.00**	160	98.17	**0**	**100.00**
LGSA	1 Apr – 31 Aug	**0**	**100.00**	32	99.03	2	99.95
LGNW	1 Oct – 30 Sep	2	99.98	6	99.93	3	99.97
LWG	17 Jun – 31 Aug	**0**	**100.00**	16	99.12	**0**	**100.00**
ANQW	1 Apr – 31 Aug	**0**	**100.00**	20	99.46	14	99.62
PEKI	1 Apr – 31 Aug	**0**	**100.00**	456	87.59	**1**	**100.00**
DWQI	1 Oct – 30 Sep	**0**	**100.00**	16	99.81	4	99.96

Table F-8. Summary of the total hours of barometric pressure, total dissolved gas, and temperature data that were missing or considered invalid in the 2021 water year.

Reason	BP Hours (%)	TDG Hours (%)	BP+TDG Hours (%)	Temp. Hours (%)	All Hours (%)
Too Low	164 (0.21)	492 (0.62)	656 (0.42)		656 (0.28)
Missed transmit					
Missing data	8 (0.01)	8 (0.01)	16 (0.01)	8 (0.01)	24 (0.01)
Spike				4 (0.00)	4 (0.00)
Inspection		57 (0.07)	57 (0.04)	13 (0.02)	70 (0.03)
Defective membrane		455 (0.58)	455 (0.29)		455 (0.19)
Defective sonde		420 (0.53)	420 (0.27)	3 (0.00)	423 (0.18)
DCP failure		20 (0.03)	20 (0.01)		20 (0.01)
Cable failure		50 (0.06)	50 (0.03)	49 (0.06)	99 (0.04)
Totals	**172 (0.22)**	**1,501 (1.90)**	**1,673 (1.06)**	**77 (0.10)**	**1,750 (0.74)**

Table F-9. Number and percent of all missing or invalid barometric pressure data for each FMS station during the 2021 water year, along with the reasons for those designations.

Station ID	Too Low # (%)	Missed Transmit # (%)	Missing DCP Data # (%)	Spike # (%)	Inspection # (%)	Defective Membrane # (%)	Defective Sonde # (%)	DCP Failure # (%)	Cable Failure # (%)
MCPW	-	-	-	-	-	-	-	-	-
MCNA	-	-	-	-	-	-	-	-	-
PAQW	-	-	-	-	-	-	-	-	-
IDSW	-	-	-	-	-	-	-	-	-
IHRA	-	-	-	-	-	-	-	-	-
LMNW	164 (1.87)	-	8 (0.09)	-	-	-	-	-	-
LMNA	-	-	-	-	-	-	-	-	-
LGSW	-	-	-	-	-	-	-	-	-
LGSA	-	-	-	-	-	-	-	-	-
LGNW	-	-	-	-	-	-	-	-	-
LWG	-	-	-	-	-	-	-	-	-
ANQW	-	-	-	-	-	-	-	-	-
PEKI	-	-	-	-	-	-	-	-	-
DWQI	-	-	-	-	-	-	-	-	-

Table F-10. Number and percent of all missing or invalid total dissolved gas data for each FMS station during the 2021 water year, along with the reasons for those designations.

Station ID	Too Low # (%)	Missed Transmit # (%)	Missing DCP Data # (%)	Spike # (%)	Inspection # (%)	Defective Membrane # (%)	Defective Sonde # (%)	DCP Failure # (%)	Cable Failure # (%)
MCPW	-	-	-	-	4 (0.05)	118 (1.35)	1 (0.01)	-	-
MCNA	-	-	-	-	-	-	-	-	-
PAQW	142 (3.86)	-	-	-	2 (0.05)	-	-	20 (0.54)	-
IDSW	-	-	-	-	4 (0.05)	56 (0.64)	-	-	-
IHRA	-	-	-	-	-	-	-	-	-
LMNW	-	8 (0.09)	-	-	-	63 (0.72)	-	-	-
LMNA	-	-	-	-	1 (0.03)	57 (1.55)	-	-	36 (0.98)
LGSW	3 (0.03)	-	-	-	9 (0.10)	-	148 (1.69)	-	-
LGSA	-	-	-	-	-	32 (0.87)	-	-	-
LGNW	-	-	-	-	6 (0.07)	13 (0.15)	271 (3.09)	-	-
LWG	-	-	-	-	-	16 (0.88)	-	-	-
ANQW	1 (0.03)	-	-	-	5 (0.14)	-	-	-	14 (0.38)
PEKI	346 (9.42)	-	-	-	10 (0.27)	100 (2.72)	-	-	-
DWQI	1 (0.57)	-	-	-	16 (0.18)	-	-	-	-

Table F-11. Number and percent of all missing or invalid temperature data for each FMS station during the 2021 water year, along with the reasons for those designations.

Station ID	Too Low # (%)	Missed Transmit # (%)	Missing DCP Data # (%)	Spike # (%)	Inspection # (%)	Defective Membrane # (%)	Defective Sonde # (%)	DCP Failure # (%)	Cable Failure # (%)
MCPW	-	-	-	-	4 (0.05)	-	1 (0.01)	-	-
MCNA	-	-	-	-	-	-	-	-	-
PAQW	-	-	-	-	1 (0.03)	-	-	-	-
IDSW	-	-	-	1 (0.01)	-	-	2 (0.02)	-	-
IHRA	-	-	-	1 (0.03)	-	-	-	-	-
LMNW	-	-	8 (0.09)	-	-	-	-	-	-
LMNA	-	-	-	-	-	-	-	-	36 (0.98)
LGSW	-	-	-	-	-	-	-	-	-
LGSA	-	-	-	-	2 (0.05)	-	-	-	-
LGNW	-	-	-	1 (0.01)	1 (0.01)	-	-	-	-
LWG	-	-	-	-	-	-	-	-	-
ANQW	-	-	-	-	1 (0.03)	-	-	-	13 (0.35)
PEKI	-	-	-	-	1 (0.03)	-	-	-	-
DWQI	-	-	-	1 (0.01)	3 (0.03)	-	-	-	-