AVISTA CORPORATION

2019

NINE MILE HED

TOTAL DISSOLVED GAS

MONITORING REPORT

WASHINGTON 401 CERTIFICATION, SECTION 5.4(C)

Spokane River Hydroelectric Project
FERC Project No. 2545

Prepared By:

April 14, 2020

[Page intentionally left blank]

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICIES

LIST OF ACRONYMNS AND ABBREVIATIONS

% saturation	percent of saturation
°C	degrees Celsius
7Q10	7-day average flow with a 10-year return period
ABS	acrylonitrile-butadiene-styrene piping
amsl	above mean sea level
Avista	Avista Corporation
BAR	barometric pressure
cfs	cubic feet per second
DO	dissolved oxygen
DQO	data quality objective(s)
Ecology	Washington State Department of Ecology
FERC	Federal Energy Regulatory Commission
Golder	Golder Associates Inc.
HED	hydroelectric development
m	meter(s)
mg/L	milligrams per liter
mm Hg	millimeters mercury (pressure)
MQO	measurement quality objective
MS5	Hydrolab® MS5 Multiprobe®
NM3	monitoring station at dock on Shoemaker Lane, approximately 1.2 miles downstream of the Nine Mile HED powerhouse
NMFB	monitoring station at Nine Mile forebay
NMTR	monitoring station at Nine Mile tailrace
PDT	Pacific Daylight Time
RMSE	root mean squared error
Spokane Tribe	Spoke Tribe of Indians
TDG	total dissolved gas, as pressure
TDG%	total dissolved gas, as percent of saturation

1.0 INTRODUCTION

1.1 Background

On June 18, 2009, the Federal Energy Regulatory Commission (FERC) issued Avista Corporation (Avista) a License for the Spokane River Project, which includes the Nine Mile Hydroelectric Development (HED) (FERC 2009). Article 401(a) of the License required Avista to develop a Total Dissolved Gas (TDG) Monitoring Plan.

Avista consulted with Washington State Department of Ecology (Ecology) and the Spokane Tribe of Indians (Spokane Tribe) as it developed the Washington TDG Monitoring Plan, which addresses TDG associated with spills from the Long Lake and Nine Mile HEDs (Golder 2010). Ecology approved this plan on March 17, 2010, and Avista filed the Ecology-approved plan with FERC on March 26, 2010. FERC approved the Washington TDG Monitoring Plan for the Nine Mile HED on December 14, 2010 (FERC 2010).

During 2010, Avista replaced an old flashboard system with an Obermeyer spillway gate (rubber dam), which was installed on the crest of Nine Mile Dam. This new spillway gate system consists of a series of metal plates and rubber bladders which stabilizes the Nine Mile Reservoir surface elevation at 1606.6 feet and eliminates the variable elevations that occurred with use of the flashboards.

Avista conducted seasonal TDG monitoring at Nine Mile HED in 2011, following installation of the rubber dam (Golder 2012). However during 2011, Nine Mile Dam was plagued with numerous equipment issues which resulted in lost generation and increased spill. As a result, Avista consulted with Ecology requesting to delay TDG monitoring until operations at the Nine Mile Dam had returned to normal. On February 17, 2012 Ecology approved Avista's request to delay the required TDG monitoring at Nine Mile Dam until the replacement of turbine/generator units 1 and 2 was complete and the sediment bypass system had been upgraded (collectively referred to as "the Projects"). Ecology required that TDG monitoring resume the first season following the completion of the Projects (Ecology 2012). Avista completed the turbine units 1 and 2 replacement project in 2016 and completed the sediment bypass system upgrade and associated intake deck and trashrack cleaning system in 2018. With these projects complete, Avista resumed TDG monitoring in 2019.

This report discusses the results of the TDG monitoring conducted for Nine Mile HED during 2019, the first season following the completion of the Projects. A summary of the 2019 data quality is provided in Appendix A and a record of consultation with Ecology and the Spokane Tribe is provided in Appendix B.

1.2 Objective

Per Section 5.4(C), Avista shall monitor TDG in the forebay and near the end of the aerated zone (the area of bubble entrainment and dissipation) of Nine Mile Dam. TDG monitoring shall be collected for two years following completion of the Projects when flows occur during the 7Q10 median flow of 25,400 cfs or higher at the Spokane gage (USGS 12422500). The flows may or may not be consecutive years.

The objective for TDG monitoring associated with Nine Mile Dam is:

- Collect two years of data during high-flow seasons with at least 25,400 cfs at the Spokane gage (USGS 12422500) to evaluate whether the Nine Mile Dam causes exceedances of the TDG standard.

1.3 Monitoring Period

The License requires Avista to monitor TDG at Nine Mile Dam when flows at the Spokane gage (USGS 12422500) are forecasted to exceed the 7Q10 median flow (25,400 total cfs) (Section 5.4(C), FERC 2009). In 2019, Avista began monitoring TDG on March 21 and continued through June 10. Discharge at the Spokane River gage at Spokane was close to, but did not exceeded the 7Q10 discharge in 2019 (see section 3.1).

2.0 METHODS

Water quality parameters that were recorded include TDG (millimeters mercury [mmHg]), dissolved oxygen (DO) concentration (milligrams per Liter [mg/L]), and water temperature (°C). Water depth (meters [m]) was also recorded and used in conjunction with water temperature to evaluate the timing for any water quality monitoring instruments being out of water and above the minimum TDG compensation depth. In addition, barometric pressure (BAR; mmHg) was recorded.

2.1 Equipment and Calibration

Hydrolab® MS5 Multiprobe® (MS5) instruments with TDG, optical DO, temperature, and depth sensors were used. Solinst® barologgers were used to determine local barometric pressure (BAR). A primary barologger was deployed at the Nine Mile Forebay monitoring location (NMFB) for the entire monitoring season. As an additional quality assurance measure, site-specific barometric pressures were compared to corresponding values for the Spokane International Airport. The Spokane International Airport station's sea-level daily ranges for barometric pressure were downloaded from the Weather Underground[1] and adjusted by subtracting 43.6 mm Hg to account for the altitude of the Nine Mile Dam forebay (1,607 feet above mean sea level [ft amsl]).

Monitoring equipment was calibrated according to the manufacturer's instructions and following the data quality objectives for the project prior to deployment and on periodic site visits. All instruments used were maintained and calibrated by the manufacturer's (Hach Hydromet) factory service department prior to the 2019 monitoring season. Pre-deployment field verification included synchronizing the clocks, comparing the MS5's TDG pressure value with the silastic membrane removed to the ambient barometric pressure, confirming the MS5s' patency of the TDG silastic membrane, and testing the barologgers to confirm that the recorded values were similar and comparable to the Spokane International Airport.

During service periods, each MS5 was retrieved and the pull time recorded. Each service session

[1] On each site visit day, Spokane, Washington KGEG barometric pressure data were downloaded from the History & Almanac section of https://www.wunderground.com/history/airport/KGEG/2017/4/7/DailyHistory.html?req_city=Spokane+International&req_state=WA&req_statename=&reqdb.zip=99224&reqdb.magic=3&reqdb.wmo=99999

included verification of logging status and downloading the data to a portable field computer. The Solinst® barologgers also were downloaded during these service periods. Patency of the original TDG membrane was confirmed by observing a rapid increase in TDG pressure while pressurizing the sensor with carbonated soda water. Depth, temperature, and DO sensors were calibrated according to the manufacturer's instructions.

2.2 Station Facilities

Monitoring was conducted at two long-term (referred to as continuous) deployment stations and one spot measurement station (Table 2-1).

The 2019 Nine Mile tailrace (NMTR) station is at the location previously used for seasonal TDG monitoring of Nine Mile Dam, approximately 0.2 miles downstream of the dam. At this station, TDG monitoring equipment was deployed into a perforated ABS housing which extended from the shoreline out into the water, at a depth that allowed the TDG instrument to remain below compensation depth during the spill season.

The 2019 Nine Mile forebay (NMFB) station is located within the Nine Mile HED compound. Modifications to the dams forebay interface did not allow for the 2019 station to be in the identical location as in previous monitoring, but was located as near to the previous monitoring station as was logistically possible. At this station, TDG monitoring equipment was protected by a perforated ABS housing that deployed to a depth of 14.5 feet below full pool elevation of 1606.6 feet to ensure the TDG probe remained below the compensation depth.

2.3 Spot Measurements

Spot measurements of TDG, water temperature, and DO were made at station NM3 during each site visit, on one to three week intervals, starting in April. Station NM3 is located on the right downstream bank, at a dock on Shoemaker Lane, approximately 1.2 miles downstream of the Nine Mile Dam powerhouse (Table 2-1). This station is far enough downstream to ensure complete cross-bank mixing during high flows.

2.4 Data Collection and Processing

Parameters monitored at 15-minute log intervals with the instruments described above included:

- Barometric pressure (mm Hg)
- Air Temperature (°C)
- Depth (m)
- TDG (mm Hg)
- Dissolved Oxygen (mg/L)
- Water Temperature (°C)

In addition, TDG percent of saturation (TDG%) was computed based on measurements, as:

- TDG% = TDG in mm Hg / Barometric pressure in mm Hg x 100

Data downloaded to the laptop computer were transferred to an office server and were checked for errors using Microsoft Excel®. Erroneous data were identified, assigned data quality codes, and removed from the final data set (see Appendix A, Table A-5).

Nine Mile Dam's operations are monitored and recorded by Avista's internal plant control software, which was used to output data including: discharge passing over the dam's spillway; discharge passing through the dams units; and total discharge on a fifteen minute basis for the extent of the TDG monitoring period.

2.5 Monitoring Difficulties

Prior to the TDG monitoring season, all six of Avista's MS5s were serviced and calibrated at Hach's Technical Support & Service Department. Before deployment, four MS5s successfully passed the mass verification test, indicating they were operating correctly and providing reliable values. The two MS5s that failed the mass verification test were sent to Hach for repair.

MS5 #48764 stationed at NMTR experienced no difficulties in 2019. MS5 #48763 stationed at NMFB did not experience any difficulties until the final calibration following the end of the monitoring season. During the final calibration, the DO sensor could not communicate with the calibration software, indicating a constant 0.0 value for DO. Because this issue was a communication issue and not a calibration issue, and because the DO values since the previous calibration fit with the NMTR and NM3 spot reading DO values, these data were included in the final analysis.

Because of the limited number of properly functioning MS5s needed throughout the 2019 TDG monitoring season, multiple MS5s were used to conduct spot measurements at NM3. MS5 #48762 was used to take the first spot measurement on March 31. MS5 #48762 or any of the previously mass calibrated MS5s were not available to take a spot reading on April 17, therefore no spot measurement was taken. On April 30, MS5 #65294 was obtained from Hach and was used to take a spot measurement. For the spot measurement taken at the next site visit on May 14, MS5 #65294 was unavailable, therefore MS5 #40905 was used to take the measurement. MS5 #40905 was again used to take the spot reading on May 29 then was returned to Hach. MS5 #60376 was used to take the final spot measurement at the end of the TDG monitoring period on June 10.

3.0 RESULTS

The TDG monitoring season consisted of the period from March 21 at 10:15 PT through June 10 at 14:00 PT, and included 7,792 15-minute periods (Table 2-2). The MS5s at both locations were deployed the entire monitoring season and recorded data for 99-100% of the sampling season (Appendix A, Table A-4).

The primary barologger deployed at NMFB provided local barometric pressure for 100% of the monitoring period (Appendix A, Table A-4). Spot measurements were collected at NM3 on April 2 and 30, May 14 and 29, and June 10 (Table 2-3). All results of continuous and spot measurements are displayed in Figures 2-2 through 2-5.

3.1 Discharge

Discharge at the Spokane River gage at Spokane (USGS 12422500) reached a maximum of 21,100 cfs in mid-April. Combined Nine Mile HED generation and spill discharge for the March 21 through June 10 monitoring period ranged from 4,252 to 25,489 cfs (Figure 2-2). Discharge

through the Nine Mile Dam spillway ranged from 0 to 19,350 cfs.

3.2 Water Temperature

Water temperatures at NMFB ranged from 4.7°C in late March and mid-April to a high of 17.4°C in early June (Figure 2-2). Water temperature measured at NMTR reached a maximum of 17.5°C in early June and a low of 4.8°C in late March and mid-April. Overall, water temperatures stayed low through mid-April, and then steadily increased through the monitoring season as atmospheric temperatures began to increase and precipitation became less frequent.

3.3 Barometric Pressure

Site-specific barometric pressures ranged from 703 to 726 mm Hg based on the Solonist® barologger deployed at NMFB (Figure 2-3).

3.4 Total Dissolved Gas

Overall in 2019, TDG pressure for NMFB was greater than or equal to corresponding values for NMTR during 74% of the spill period. TDG pressure (mmHg) for NMTR was greater than or similar to corresponding values for NMFB when pressure and discharge flows were low, whereas TDG pressure at NMTR was less than pressure at NMFB as pressure and flows increased (Figure 2-3). Spot values for NM3 differed from the continuous monitoring data for NMTR, ranging in difference from 4 - 20 mmHg. Spot values in April and early May were lower than values at NMTR, whereas spot values in late May and early June were slightly higher than NMTR values (Table 2-3).

TDG% ranged from 101 to 122 percent of saturation for NMFB and 101 to 120 percent of saturation for NMTR (Figure 2-4). Comparing NMTR TDG% and NMFB TDG% for the same time interval (referred to as data pairs), TDG% at NMTR was greater than 110 and greater than the incoming TDG% at NMFB for only 0.02% of the monitoring season (Table 2-5).

3.5 Dissolved Oxygen

Measured DO concentrations were 8.9 to 14.1 mg/L for NMFB, and 8.8 to 13.8 mg/L for NMTR (Figure 2-5). The greatest DO concentrations occurred during an increase in flows in mid-April, although values remained above the 8.0 mg/L DO criterion throughout the entire monitoring period at all monitoring stations.

3.6 Schedule

Avista has completed one year of TDG monitoring following the completion of the turbine units 1 and 2 replacement project (2016) and sediment bypass system upgrade (2018). Discharge at the Spokane River gage at Spokane was close to, but did not exceed the 7Q10 median flow of 25,400 cfs during 2019, however downstream flows measured at Nine Mile Dam reached 25,489 cfs on April 14 (total discharge and spill).

Avista will monitor TDG in 2020 assuming snowpack and runoff forecasts result in flows reaching the 7Q10.

4.0 DISCUSSION

Nine Mile HED operations were at about 85% of full capacity during the 2019 TDG monitoring season. Units 3 and 4 were run at normal capacity, whereas units 1 and 2 were operated at around 70% of capacity, meaning approximately 600 cfs was spilled instead of going through the units. Having less water passing through the dam changed the proportion of spilled water to non-spilled water downstream of the dam. Having a higher proportion of spilled water at NMTR could potentially inflate the TDG percent values attributed to the dam's spillway operations.

Overall, TDG levels at NMFB and NMTR increased as river flows increased. TDG% values at NMFB and NMTR exceeded the 110% criterion at similar timeframes, however TDG levels at NMTR did not reach the maximum value seen at NMFB. Based on 2019 monitoring, it appears Nine Mile HED does not create TDG greater than 110 percent and that at 2019 Spokane River discharge levels, spill at Nine Mile HED reduces TDG.

5.0 REFERENCES

Federal Energy Regulatory Commission (FERC). 2009. Project Nos. 2545-091, 12606-000, Order issuing new license and approving annual charges for use of reservation lands. Issued June 18.

_____. 2010. Order Modifying and Approving Total Dissolved Gas Monitoring Plan for the Nine Mile Development – Article 401. Issued December 14, 2010.

Golder Associates Inc. (Golder). 2004. Total Dissolved Gas Pressure (TDG) Monitoring on the Spokane River 2004 Final Data Report. Prepared for Avista Corporation.

_____. 2010. Washington Total Dissolved Gas Monitoring Plan. Prepared for Avista Corporation. March 26.

_____. 2012. 2011 Nine Mile HED Total Dissolved Gas Monitoring Report, Washington 401 Certification, Section 5.4(C). Prepared for Avista Corporation. February 16.

Washington State Department of Ecology (Ecology). 2012. Letter approving the request for delay in Total Dissolved Gas (TDG) monitoring at Nine Mile Hydroelectric Development. Issued February 17.

TABLES

Table 2-1: Nine Mile Dam TDG Monitoring Stations

Station Code	Description	Latitude / Longitude (NAD83)	Monitoring Type
NMFB	Below the walkway used to access the Nine Mile HED powerhouse, immediately downstream from trash boom	47°46'29" / 117°32'41"	Continuous
NMTR	On left downstream bank, approximately 0.2 mile downstream from the face of the Nine Mile HED powerhouse	47°46'38" / 117°32'44"	Continuous
NM3	On right downstream bank, at a dock on Shoemaker Lane, approximately 1.2 miles downstream of the Nine Mile HED powerhouse	47°47'19" / 117°31'56"	Spot

Table 2-2: Summary of Continuous Monitoring Results

Parameter	NMFB			NMTR		
	Minimum	Maximum	Count	Minimum	Maximum	Count
Date/Time (m/dd/yyyy PDT)	3/21/19 10:15	6/10/19 14:00	7,792	3/21/19 10:45	6/10/19 13:15	7,787
Water Temperature (°C)	4.7	17.4	7,778	4.8	17.5	7,757
Dissolved Oxygen (mg/L)	8.9	14.1	7,778	8.8	13.8	7,757
BAR (mm Hg)	702.8	725.8	7,761	Used NMFB BAR		
TDG (mm Hg)	722	881	7,759	723	853	7,740
TDG (% saturation)[1]	101	122	7,736	101	120	7,720

Notes:
1. TDG (% saturation) calculated using site-specific barometric pressure (BAR) data collected at NMFB and corrected for altitude.

Table 2-3: NM3 Spot Measurement Results

Station Code	Date Time (PDT)	Water Temperature (°C)	Dissolved Oxygen (mg/L)	TDG (mm Hg)	LLTR BAR (mm Hg)	TDG (% of saturation)[1]
NM3	4/2/19 12:00	5.7	12.8	767	712	107.7
NM3	4/30/19 14:15	8.8	12.1	829	716	115.7
NM3	5/14/19 13:15	13.5	10.7	806	713	113.1
NM3	5/29/19 13:00	14.3	10.5	792	714	111.0
NM3	6/10/19 13:00	16.5	9.9	767	721	106.3

Notes:

1. TDG (% saturation) calculated using site-specific barometric pressure (BAR) data collected at NMFB.

Table 2-4: Summary of TDG Exceedances of 110 Percent of Saturation when Total Discharge was Less Than or Equal to Ecology-Specified 7Q10 of 32,000 cfs

	NMTR			NMFB		
# of records that exceeded 110% saturation	4,895			4,985		
Total # of records	7,720			7,736		
Periods when TDG exceeded 110% saturation (PDT)[1,2]	3/30/2019 15:00	to	3/31/2019 3:30	3/31/2019 15:45	to	3/31/2019 22:45
	4/1/2019 12:45	to	4/2/2019 3:00	4/1/2019 13:30	to	5/3/2019 2:45
	4/2/2019 10:15	to	4/3/2019 8:00	5/8/2019 15:00	to	5/9/2019 5:30
	4/3/2019 8:30	to	5/2/2019 22:00	5/9/2019 10:15	to	5/24/2019 6:15
	5/8/2019 13:15	to	5/8/2019 23:00	5/25/2019 12:15	to	5/30/2019 2:30
	5/9/2019 7:15	to	5/23/2019 23:45			
	5/25/2019 8:45	to	5/29/2019 1:00			
	5/29/2019 12:00	to	5/29/2019 22:45			
	5/30/2019 16:00	to	5/30/2019 18:15			

Notes:

1. Flows did not exceeded the 7Q10 in 2019.
2. Refer to Figure 2-4 and Appendix A for data gaps.

Table 2-5: Summary of NMTR TDG% by spill category and comparison with NMFB TDG%

Spill Category	All NMTR TDG% Values			NMTR TDG% Paired with NMFB TDG%		
	Total Count	Count >110%	% >110%	Total Count	Count >110% and >NMFB	% >110% and >NMFB
>11 kcfs spill	2,281	2,281	100%	2,281	56	2%
5-11 kcfs spill	2,253	2,147	95%	2,253	68	3%
<5 kcfs spill	2,958	350	12%	2,958	32	1%
No spill	216	0	0%	216	0	0%
All spill and non-spill	7,708	4,778	62%	7,708	156	2%

FIGURES

Figure 2-1: Nine Mile HED long-term water quality monitoring locations

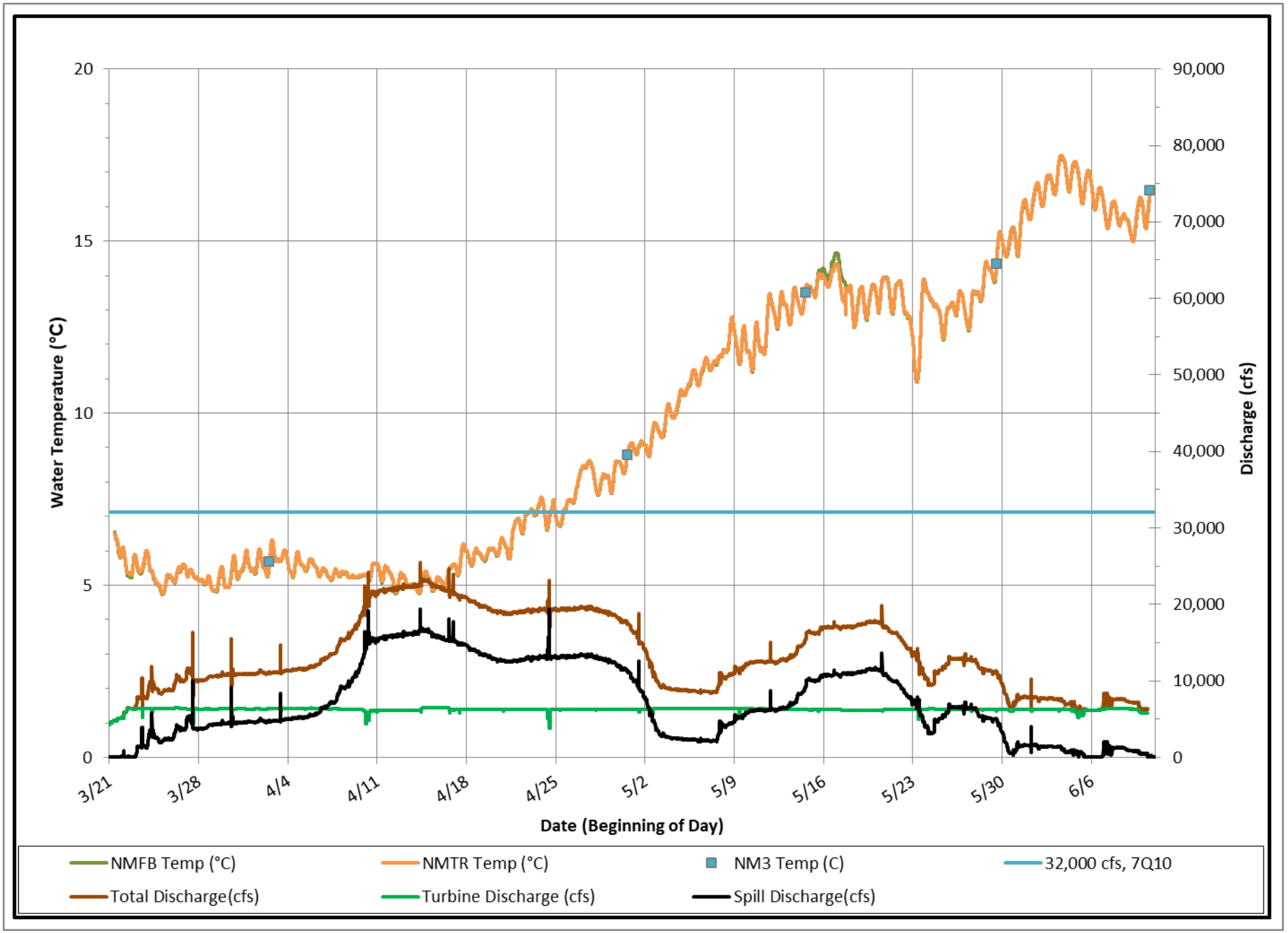

Figure 2-2: Nine Mile HED 2019 water temperature (°C) and operations

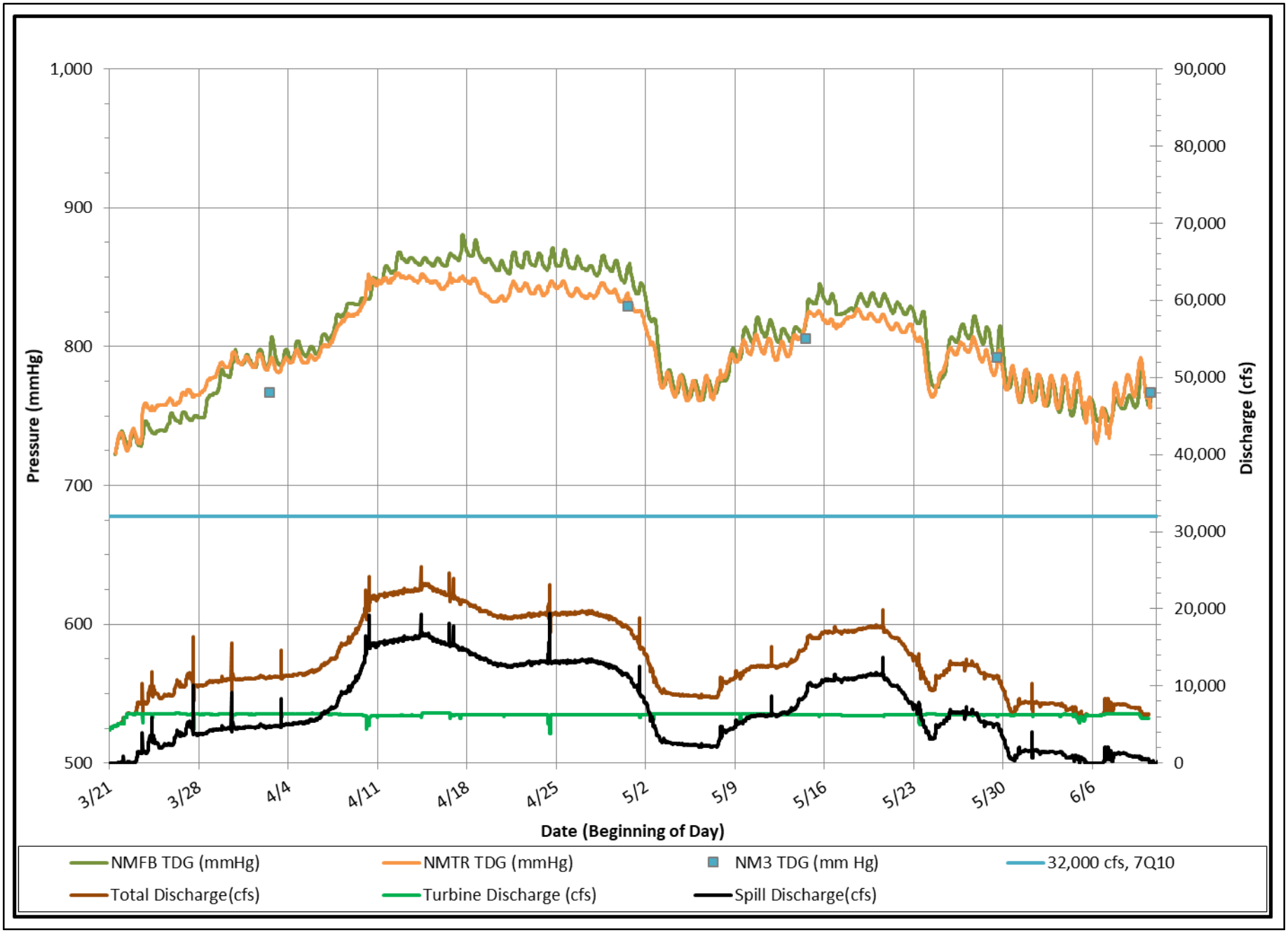

Figure 2-3: Nine Mile HED 2019 barometric pressure (mmHg) and operations

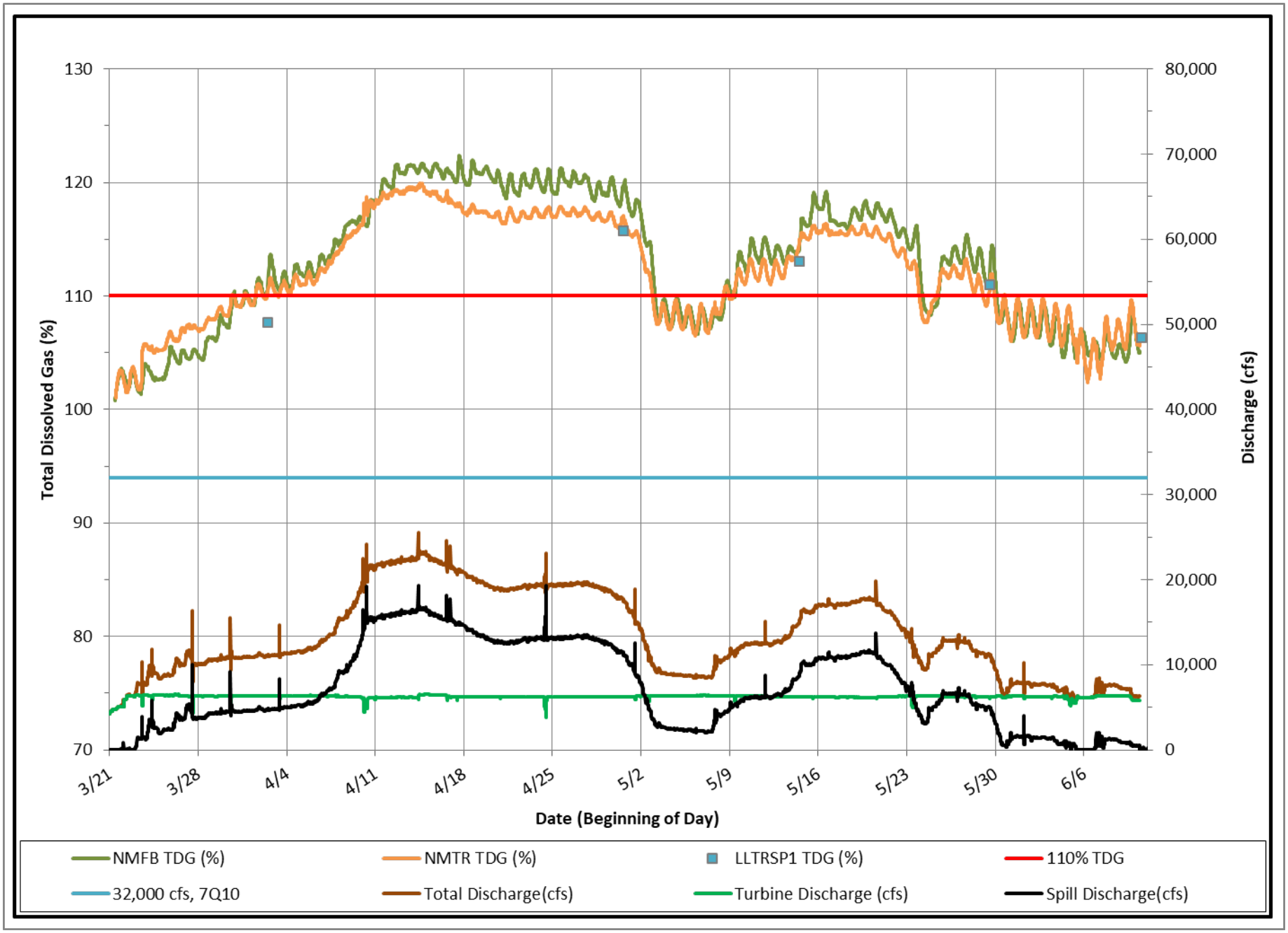

Figure 2-4: Nine Mile HED 2019 total dissolved gas (%) and operations

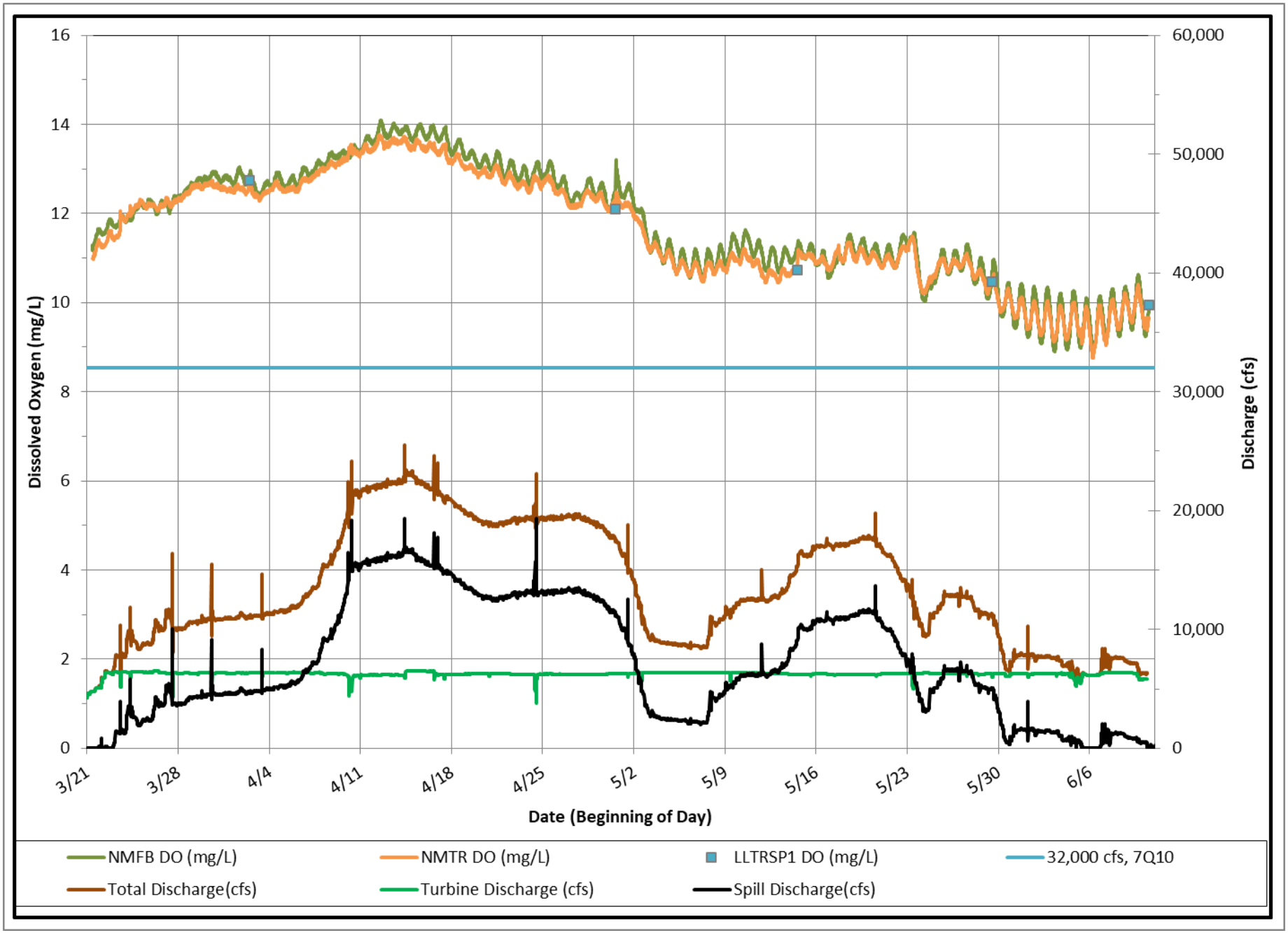

Figure 2-5: Nine Mile HED 2019 dissolved oxygen (mg/l) and operations

APPENDIX A
DATA QUALITY ANALYSIS

DATA QUALITY SUMMARY

Data quality objectives (DQOs) and Measurement Quality Objectives (MQOs) are the quantitative and qualitative terms used to specify how good the data need to be to meet the project's specific monitoring objectives. DQOs for measurement data, also referred to as data quality indicators, include measurement range, accuracy, precision, representativeness, completeness, and comparability. The range, accuracy, and resolution for each measured parameter are provided in Table A-1.

Table A-1. Range, accuracy and resolution of parameters recorded.

Instrument and Parameter	Range	Accuracy	Resolution
MS5 Total Dissolved Gas	400 to 1300 mmHg	±0.1% of span	1.0 mmHg
MS5 Dissolved Oxygen	0 to 30 mg/L	± 0.01 mg/L for 0 to 8 mg/L ± 0.02 mg/L for >8mg/L	0.01 mg/L
MS5 Temperature	-5 to 50°C	±0.10°C	0.01°C
MS5 Depth (0-25 meters)	0 to 25 meters	±0.05 meter	0.01 meter
Barologger Relative Barometric Pressure	1.5 meter of water	± 0.1 cm of water	0.002% of full scale
Barologger Temperature	-10 to 40°C	± 0.05°C	0.003°C

Notes: Sources: Hach MS5 User Manual and Solinist Levelogger User Guide [2]

MQOs are the performance or acceptance thresholds or goals for the project's data, based primarily on the data quality indicators precision, bias, and sensitivity. Table A-2 presents MQOs selected during preparation of the Washington TDG Monitoring Plan along with the same MQO for dissolved oxygen as used for the Long Lake HED tailrace DO monitoring plan. The meter-specific root mean squared error (RMSE) of the calibration corrections applied after each calibration, and an overall RMSE for all meters compared to MQOs are shown in Table A-3.

Table A-2. Measurement quality objectives (MQOs).

Parameter	MQOs
Barometric Pressure	2 mmHg
Temperature	0.5ºC
Total Pressure	1% (5 to 8 mmHg)
TDG%	1%
Dissolved Oxygen	0.5 mg/L

[2] Hach Corporation. 2006. Hydrolab DS5X, DS5, and MS5 Water Quality Multiprobes User Manual. February 2006, Edition 3. Catalog Number 003078HY and Solinist. 2010. Levelogger Series (Levelogger Gold, Barologger Gold, Levelogger Junior, LTC Levelogger Junior and Rainlogger) User Guide - Software Version 3.4.0. August 17, 2010.

Table A-3: Difference between RMSE and MQOs by MS5.

Part 1: Barometric pressure (BAR), total pressure, and total dissolved gas (TDG).

NMHED TDG Monitoring	RMSE [1]				MQO				RMSE - MQO (positive shaded values denote exceedance of MQO)			
Meter and Site IDs	BAR[2]	Total Pressure[3]	TDG-cal[4]	TDG-spot	BAR	Total Pressure	TDG	TDG	BAR	Total Pressure	TDG-cal	TDG-spot
	mm Hg	%	%	mm Hg	mm Hg	%	%	mmHg	mm Hg	%	%	mm Hg
48762	1.00	0.14	0.14	10.00	2	1	1	5	-1.00	-0.86	-0.86	5.00
48763	1.41	0.20	0.20	N/A	2	1	1	5	-0.59	-0.80	-0.80	N/A
48764	1.00	0.14	0.14	6.30	2	1	1	5	-1.00	-0.86	-0.86	1.30
40905	0.00	0.00	0.00	5.15	2	1	1	5	-2.00	-1.00	-1.00	0.15
Overall RMSE	1.11	0.16	0.15	7.15	2	1	1	5	-0.89	-0.84	-0.85	2.15

[1] RMSE calculated for each meter during calibration checks while in use and between spot measurements from multiple meters.

[2] RMSE calculated from BAR measured during calibration compared to the TDG in air uncorrected reading.

[3] RMSE calculated as the difference in TDG in air uncorrected measured during calibration minus the BAR, then divided by the TDG and multiplied by 100%.

[4] RMSE calculated as TDG in air uncorrected measured during calibrations divided by the BAR and multiplied by 100%

N/A - No value reported or not applicable.

Table A-3 (Continued): Difference between RMSE and MQOs by MS5.

Part 2: Temperature and dissolved oxygen (DO).

NMHED DO Monitoring	RMSE				MQO		RMSE - MQO (positive shaded values denote exceedance of MQO)			
Meter and Site IDs	Temperature[1]		Dissolved Oxygen[2]		Temp	DO	Temperature[1]		Dissolved Oxygen[2]	
	Calibration	Spot	Calibration	Spot			Calibration	Spot	Calibration	Spot
	ºC	ºC	mg/L	mg/L	ºC	mg/L	ºC	ºC	mg/L	mg/L
48762	0.39	0.12	0.11	0.11	0.5	0.5	-0.11	-0.38	-0.39	-0.40
48763	0.09	N/A	0.09	N/A	0.5	0.5	-0.41	N/A	-0.41	N/A
48764	0.08	0.07	0.06	0.09	0.5	0.5	-0.42	-0.43	-0.44	-0.41
40905	0.00	0.04	0.04	0.04	0.5	0.5	-0.50	-0.46	-0.46	-0.46
Overall RMSE	0.13	0.08	0.08	0.08	0.5	0.5	-0.37	-0.42	-0.42	-0.42

[1] For Calibration, RMSE calculated from the difference between the meter and calibration thermometer at all calibration checks while the meter was in use. Spot differences are average differences between measured values from group average.

[2] Calibration RMSE as difference of the calculated pre-calibration and post-calibration measurement. Spot RMSE calculated as average difference between measured values from group average.

N/A - No value reported or not applicable

Root mean squared error (RMSE) = $\sqrt{\frac{\sum_{i=1}^{n}(x_{1,i}-x_{2,i})^2}{n}}$.

Measurement Range

The measurement range, range of reliable readings of an instrument or measuring device, specified by the manufacturer is displayed in Table A-1 for each measured parameter. Maintenance of field sampling equipment was conducted in a manner consistent with the corresponding manufacturer's recommendations to provide reliable readings within each instrument's reported measurement range.

Bias

TDG meters, like other field monitoring instruments, are subject to bias due to systematic errors introduced by calibration, equipment hardware or software functioning, or field methods. Bias was minimized by following standard protocols for calibration and maintenance, and by following field protocols for stabilization of meter readings.

Precision

Precision refers to the degree of variability in replicate measurements and is typically defined by the instrument's manufacturer. Manufacturer values for the MS5 and barologger (Table A-1) were within MQOs.

Accuracy

Accuracy is a measure of confidence that describes how close the average of a series of replicate measurements is to the "true" value (low bias). Throughout this seasonal TDG monitoring study, the MS5s underwent calibration and verification procedures.

Instrument accuracy was evaluated through the calibration and maintenance activities. MQOs for total pressure and pre-calibration TDG% were met for all meters (Table A-3). All MS5s also met the 0.5°C water temperature MQO and 0.5 mg/L DO MQO both for pre-calibration measurements. MS5s did not meet the MQO for TDG spot readings.

Discharge data were obtained from Avista's internal plant control software and is found to be accurate and reliable.

Representativeness

Representativeness qualitatively reflects the extent to which sample data represent a characteristic of actual environmental conditions. For this project, representativeness was addressed through proper design of the sampling program to ensure that the monitoring locations were properly located and sufficient data were collected to characterize TDG at that location.

Comparability

Comparability is the degree to which data can be compared directly to previously collected data. Comparability was achieved by consistently monitoring the same long-term monitoring stations as in the past, and conducting spot measurements at the same location down river from NMTR as in past years.

Completeness

Completeness is the comparison between the quantity of data planned to be collected and how much usable data was actually collected, expressed as a percentage (Table A-4). The TDG data collection period consisted of 7,792 15-minute periods at NMFB, and 7,787 at LLTR. Data completeness was 99 percent or greater for all parameters at each monitoring station.

Table A-5 summarizes the number of specific DQCodes applied to NMTR, and NMFB data.

Table A-4. Project completeness.

	NMFB		NMTR	
Parameter	**Count**	**Completeness (%)**	**Count**	**Completeness (%)**
Monitoring Period	7,792	--	7,787	--
Water Temperature (°C)	7,778	100%	7,757	100%
Dissolved Oxygen (mg/L)	7,778	100%	7,757	100%
BAR (mm Hg)	7,763	100%	Used NMFB BAR	
TDG (mm Hg)	7,759	100%	7,740	99%
TDG (% saturation)	7,736	99%	7,720	99%

Table A-5: Number of specific DQCodes during monitoring period.

DQ Code	DQ Code Description	NMFB					NMTR						
		Temp (°C)	TDG (mmHg)	Depth (meters)	DO (mg/L)	Batt (volts)	Temp (°C)	TDG (mmHg)	Depth (meters)	DO (mg/L)	Batt (volts)	Level (m H2O)	ATemp (°C)
999	Instrument logging data before deployment at monitoring station	4	4	4	4	4	10	10	10	10	10	0	0
998	Out of water after recovery	2	2	2	2	2	13	13	13	13	13	0	0
997	Equilibrating after deployment	0	19	0	0	0	0	17	0	0	0	0	0
993	Out of water for calibration/servicing	9	9	9	9	9	9	9	9	9	9	0	0
666	Unknown	0	0	0	0	0	0	0	0	0	0	16	16
-102	Between "minimum operating voltage" (<9 volts) and 7 volts, but other data appear reliable	56	56	56	56	56	219	219	219	219	219	0	0
-1002	Corresponds with spot measurement	0	0	0	0	0	4	4	4	4	4	0	0
0	No data qualifiers	7,722	7,703	7,722	7,722	7,722	7,534	7,517	7,534	7,534	7,534	7,747	7,747
	Monitoring Period[1]	7,792	7,792	7,792	7,792	7,792	7,787	7,787	7,787	7,787	7,787	7,763	7,763

Notes:

1. Monitoring periods consisted of 3/21/2019 10:15 PDT to 6/10/2019 14:00 PDT for NMFB and 3/21/2019 10:45 PDT to 6/10/2019 13:15 PDT for NMFB.

APPENDIX B
CONSULATION RECORD

1411 East Mission Avenue
PO Box 3727
Spokane, WA 99220-3727

February 28, 2020

Chad Atkins, Water Quality Program
Washington Department of Ecology
Eastern Regional Office
4601 N Monroe Street
Spokane, WA 99205-1295

Subject: Federal Energy Regulatory Commission's Spokane River Hydroelectric Project License, Appendix B, Sections 5.4 and 5.6.B, TDG and DO Reporting Requirements

Dear Mr. Atkins:

Ordering Paragraph E of the Federal Energy Regulatory Commission (FERC) Spokane River Hydroelectric Project License incorporated the Washington Department of Ecology (Ecology) Certification Conditions under Section 401 of the Federal Clean Water Act Water Quality Certification (Certification) as Appendix B of the License. In accordance with Section 5.4 and Section 5.6 of the Certification, Avista is submitting the following project status and reports for your review and approval.

Section 5.4: Total Dissolved Gas
There are two components related to Total Dissolved Gas (TDG), which include the following:

- *2019 Long Lake Total Dissolved Gas Monitoring Report*
  Avista completed the Long Lake Dam Spillway Modification Project in December 2016. Following completion of the project, Avista monitored TDG to assess the effectiveness of the modifications and to evaluate spillway gate operational protocols. The enclosed 2019 Long Lake TDG Monitoring Report (LL TDG Report) provides the results of TDG monitoring completed during 2019.

  Additionally, Avista proposes to conduct annual TDG monitoring at Long Lake Dam for another three years (2020 through 2022), following the same Long Lake HED TDG Monitoring Plan and reporting structure used in previous annual monitoring. As the additional monitoring data is collected, Avista will work with Ecology to evaluate Long Lake HED's compliance to the requirements of the License.

- *2019 Nine Mile HED Total Dissolved Gas Monitoring Report*
  In February 2012, Ecology approved Avista's request to delay the required TDG monitoring at Nine Mile Dam until Avista completed the turbine units 1 and 2 replacement project and the sediment bypass system upgrade and associated intake deck and trashrack cleaning system. Ecology required TDG monitoring to resume the first season following the completion of these projects.

  Avista has completed one year of TDG monitoring following the completion of these projects. The enclosed 2019 Nine Mile HED Total Dissolved Gas Monitoring Report (NM TDG Report) provides the results of TDG monitoring completed during 2019. Monitoring results demonstrate that Nine Mile Dam added no TDG compared to upstream levels at flows up to 25,489 cfs (as measured at Nine Mile Dam on April 14).

  Avista will monitor TDG in 2020 assuming snowpack and runoff forecasts result in flows reaching the 7Q10 flow.

Section 5.6.B: Dissolved Oxygen
The enclosed 2019 Long Lake HED Tailrace Dissolved Oxygen (DO) Monitoring Report (LL DO Report) provides the results of the 2019 Dissolved Oxygen (DO) monitoring immediately downstream of Long Lake Dam for the low-flow period of the year and summarizes the use of draft tube aeration to increase DO levels in the river below the dam's tailrace. Avista plans to continue with the aeration program in 2020, and to continue monitoring DO and TDG at the Long Lake Dam Tailrace Station.

With this, Avista is submitting the LL TDG Report, the NM TDG Report, and the LL DO Report for Ecology's review and approval. We would like to receive any comments or recommendations that you may have by **March 31, 2020**, which will allow us time to file the Report with FERC by April 15, 2020.

Please feel free to contact me at (509) 495-4084 or Meghan Lunney at (509) 495-4643 if you have any questions or wish to discuss the report.

Sincerely,

Chris Moan
Fisheries Habitat Biologist

Enclosures (3)

cc: Chad Brown, Ecology
Brian Crossley, Spokane Tribe
Meghan Lunney, Avista

From: Bauer, Jordan (ECY) <jbau461@ECY.WA.GOV>

Sent: Friday, April 3, 2020 4:16 PM

To: Moan, Chris

Cc: Lunney, Meghan; Atkins, Chad (ECY)

Subject: [External] RE: Request for Ecology Review and Approval – Avista 2019 Nine Mile HED Total Dissolved Gas Monitoring Report – Section 5.4(C) Spokane River Hydroelectric Project No. 2545

Dear Chris Moan,

The Department of Ecology (Ecology) has reviewed Avista's submittal of the *2019 Nine Mile HED Total Dissolved Gas Monitoring Report*. This report was received by Ecology on February 28, 2020. The report is required in accordance with Section 5.4 (C) of Ecology's 401 Certification (Certification) and consistent with Spokane River Hydroelectric Project No. 2545 (License).

The purpose of this e-mail is to inform you that Ecology ***approves*** this report as meeting all the requirements of reporting defined in Section 5.4 of the Certification. We acknowledge Avista will continue to monitor TDG at the Nine Mile Hydroelectric Development (HED) in anticipation of reaching the 7Q10 flow.

Ecology looks forward to future discussions as we continue to work together to evaluate TDG at the Nine Mile HED for the License compliance. Please feel free to contact me with any questions.

Sincerely,

Jordan Bauer
Hydropower Compliance Coordinator
Washington Department of Ecology
Water Quality Program
(509) 590-5486

USE CAUTION - EXTERNAL SENDER
Do not click on links or open attachments that are not familiar.
For questions or concerns, please e-mail phishing@avistacorp.com

ECOLOGY COMMENTS AND AVISTA RESPONSES

Ecology Comment
Ecology acknowledged that the information provided in the 2019 Nine Mile HED Total Dissolved Gas Monitoring Report is a requirement of Section 5.4 (C) of Ecology's 401 Certification (Certification) and consistent with Spokane River Hydroelectric Project No. 2545 (License).

Avista Response
Comment noted.

Ecology Comment
Ecology approves the 2019 Nine Mile HED Total Dissolved Gas Monitoring Report as meeting all the requirements of reporting defined in Section 5.4 of the Certification.

Avista Response
Avista appreciates Ecology's approval of the 2019 Nine Mile HED Total Dissolved Gas Monitoring Report.

Ecology Comment
Ecology acknowledged Avista will continue to monitor TDG at the Nine Mile Hydroelectric Development (HED) in anticipation of reaching the 7Q10 flow.

Avista Response
Comment noted.

Ecology Comment
Ecology looks forward to future discussions as we continue to work together to evaluate TDG at the Nine Mile HED for the License compliance.

Avista Response
Avista looks forward to continued collaboration and discussions with Ecology in evaluating TDG at Nine Mile HED.