AVISTA CORPORATION

2022

NINE MILE DAM

TOTAL DISSOLVED GAS

MONITORING REPORT

WASHINGTON 401 CERTIFICATION, SECTION 5.4(C)

Spokane River Hydroelectric Project
FERC Project No. 2545

Prepared By:

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% 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 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
PT	Pacific Time
RMSE	root mean squared error
Spokane Tribe	Spokane Tribe of Indians
TDG	total dissolved gas, as pressure
TDG%	total dissolved gas, as percent of saturation

1.0 INTRODUCTION

1.1 Background

Avista Corporation (Avista) owns and operates the Spokane River Hydroelectric Project (Project), which consists of five Hydroelectric Developments (HEDs) on the Spokane River; four in the state of Washington (Upper Falls, Monroe Street, Nine Mile, and Long Lake HEDs) and the Post Falls HED located in Idaho. Avista received a 50-year license from the Federal Energy Regulatory Commission (FERC) on June 18, 2009 (FERC 2009; Project No. 2545) for the Project. The license incorporates a water quality certification (401 Certification) issued by the Washington Department of Ecology (Ecology) under Section 401 of the Clean Water Act (Ecology 2009). The 401 Certification establishes compliance with Washington State water quality standards for Washington HED operations.

Sections 5.4(B) and 5.4(C) of the 401 Certification define the 7Q10 flood flow for the Spokane River at Long Lake Dam and Nine Mile Dam as 32,000 cubic feet per second (cfs) and the 7Q10 median flow as 25,400 cfs, respectively. During relicensing, Avista monitored TDG at Nine Dam in the forebay and tailrace during 2003 and 2004. Results demonstrated Nine Mile Dam did not contribute to elevated TDG concentrations at some flow conditions and may in fact reduce TDG levels. However, due to the lack of data recorded at higher flows (above 25,400 cfs), the 401 Certification (Section 4.3(E)) indicated more studies and information was needed to identify Nine Mile Dams' influence on TDG levels.

Article 401(a) and Section 5.4 of Appendix B of the License required Avista to develop a Total Dissolved Gas (TDG) Monitoring Plan. In coordination with Ecology and the Spokane Tribe of Indians (Spokane Tribe), Avista developed the Washington TDG Monitoring Plan, which addresses TDG associated with spills from the Long Lake and Nine Mile Dams (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). During 2011, Nine Mile Dam experienced a number of equipment failures before, during, and after the spill season. The lost generation and increased spill resulted in the 2011 data being not representative of normal project operations. 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. Ecology required that TDG monitoring resume the first season following the completion of these two projects (Ecology 2012). Avista provided Ecology and FERC with annual updates on the TDG monitoring status, starting September 1, 2014, per Ecology and FERC's request (dated February 17, 2012 and July

25, 2013, respectively). 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 Dam during 2022. The report also includes a summary of the two years of TDG data collected post-construction of the rubber dam, turbine unit replacement, and sediment bypass system upgrade, when flow met conditions approaching the 7Q10, as required. Additionally, a summary of the 2022 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 turbine unit replacement and sediment bypass system upgrade 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 2022, Avista began monitoring TDG on March 4 and continued through July 13. Discharge at the Spokane River gage at Spokane neared the 7Q10 median flow in 2022 (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® barologger 5s were used to determine local barometric pressure (BAR). A primary barologger was deployed at the Nine Mile Forebay monitoring location (NMFB). 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 2022 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 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 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 Nine Mile forebay (NMFB) station is located within the Nine Mile HED compound. Modifications to the dams forebay following the sediment bypass system upgrade did not allow for the NMFB station to be in the identical location as in pre-2018 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 March. 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.

[1] On each site visit day, Spokane, Washington KGEG barometric pressure data were downloaded from the History section of: Spokane, WA Weather History | Weather Underground (wunderground.com).

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 dam's 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 eight of Avista's MS5s were serviced and calibrated at Hach's Technical Support & Service Department. Before deployment, seven MS5s successfully passed the mass verification test, indicating they were operating correctly and providing reliable values. The one MS5 that failed the mass verification test was due to a communication issue but was later verified following support from Hach Tech Support. MS5 #48765 stationed at NMTR experienced no difficulties in 2022.

Due to technical issues communicating barometric pressure data from the previously used Solinst gold series barologgers, new Solinst barologger 5s were used to collect barometric pressure data at NMFB from 11:00 on April 21 through the end of the monitoring season. To calculate TDG% from March 4 to April 21, barometric pressure from the Spokane International airport was used. The Spokane International Airport station's sea-level daily ranges for barometric pressure were downloaded from the Weather Underground[2] 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]).

MS5 #68481 was calibrated and redeployed at NMFB on May 4. At the next site visit on May 20, the MS5 was no longer attached to the shore and was not able to be retrieved. A new MS5 (#60376) was deployed on May 23, therefore no data was attained from NMFB from May 4 to May 23.

Because of the limited number of properly functioning MS5s needed throughout the 2022 TDG

[2] Spokane, Washington KGEG barometric pressure data were downloaded from the History section of: Spokane, WA Weather History | Weather Underground (wunderground.com).

monitoring season, multiple MS5s were used to conduct spot measurements at NM3. MS5 #48764 was used to take the first spot measurement on March 16. On March 17, MS5 #48764 was needed to replace a faulty MS5 at Long Lake Dam, so MS5 #60376 was then used for spot readings from March 31 through May 20. On May 23, MS5 #60376 was needed for deployment at NMFB, so MS5 #68482 was then used for the next spot measurement on June 2. The TDG value from the spot measurement on June 2 was significantly different from the TDG value at NMTR and NMFB, so MS5 #68482 was no longer used for spot measurements and the spot reading was removed from the final dataset. MS5 #48763 was used to conduct the remaining spot measurements.

3.0 2022 RESULTS

The TDG monitoring season consisted of the period from March 4 at 14:30 PT through July 13 at 11:00 PT at NMTR and included 12,563 15-minute periods (Table 2-2). The MS5 at NMTR was deployed the entire monitoring season and recorded data for 99 - 100% of the sampling season. The TDG monitoring season at NMFB consisted of the period from March 4 at 16:00 PT through July 13 at 12:15 PT and included 12,562 15-minute periods (Table 2-2). The MS5 at NMFB was deployed the entire monitoring season and recorded data for 84 - 85% of the sampling season (Appendix A, Table A-4).

The primary barologger deployed at NMFB provided local barometric pressure for 64% of the monitoring period and airport barometric pressure was used for 35% of the monitoring season, resulting in barometric pressure data being collected for 99% of the monitoring season (Appendix A, Table A-4). Spot measurements were collected at NM3 on March 16 and 28, April 7 and 21, May 4 and 20, June 2, 17, and 29, and July 13 (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 24,600 cfs in mid-June. Combined Nine Mile HED generation and spill discharge for the March 4 to July 13 monitoring period ranged from 3,660 to 27,503 cfs (Figure 2-2). Discharge through the Nine Mile Dam spillway ranged from 0 to 23,593 cfs.

3.2 Water Temperature

Water temperatures at NMFB ranged from 3.1°C in early March to a high of 19.9°C in mid-July (Figure 2-2). Water temperature measured at NMTR reached a maximum of 19.9°C in mid-July and a low of 3.1°C in early March. 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 730 mm Hg (Table 2-3).

3.4 Total Dissolved Gas

In 2022, TDG pressure for NMFB was greater than or equal to corresponding values for NMTR during 88.5% of the spill period. TDG pressure (mmHg) for NMTR was less than or similar to

corresponding values for NMFB for most of the monitoring season until June 14, when the TDG pressure at NMTR was greater than TDG pressure at NMFB until June 25, when the relationship returned to NMTR being less than or similar to NMFB (Figure 2-3). Spot values for NM3 differed from the continuous monitoring data for NMTR, ranging in difference from 0 - 19 mmHg. Spot values were typically lower than values at NMTR (Table 2-3).

TDG% ranged from 102.8 to 122.4 percent of saturation for NMFB and 101.7 to 128.0 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 10% of the monitoring season (Table 2-5).

3.5 Dissolved Oxygen

Measured DO concentrations were 8.3 to 14.9 mg/L for NMFB, and 8.3 to 14.6 mg/L for NMTR (Figure 2-5). The greatest DO concentrations occurred in early Spring and steadily declined throughout the monitoring season, 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 two years 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 neared the 7Q10 median flow of 25,400 cfs during 2022.

As explained in Section 4.0, Avista will monitor TDG in 2023. Currently, the Spokane River drainage snowpack is at 97% of normal, precipitation totals are 80% of normal, and the NRCS Washington Water Supply Outlook Report, February 1, 2023 forecasts streamflow in the Spokane River at Long Lake to be 83% of average for April – July.

Avista will notify Ecology after the high-flow season as to if river flows reached the 7Q10 median flow of 25,400 cfs, triggering the need to submit an annual monitoring report by March 1, 2024.

4.0 2022 DISCUSSION

Nine Mile Dam turbine operations were near full capacity during the 2022 TDG monitoring season, compared to being at about 85% full capacity in 2019 monitoring.

Overall, TDG levels at NMFB and NMTR increased as river flows increased and TDG% values at NMFB and NMTR exceeded the 110% criterion at similar timeframes. TDG values were lower at NMTR than NMFB 88.5% of the monitoring season. On June 14, TDG in the tailrace increased, correlated with an increase in river flows, but TDG in the forebay did not increase, resulting in tailrace TDG values being greater than forebay values from 7:15 on June 14 to 14:00 on June 25, with a maximum difference of 9.2% TDG and an average difference of 6.2% during this time. After 14:00 on June 25, TDG in the tailrace dropped below TDG in the forebay and remained below for the remainder of the monitoring season. The increase in TDG downstream seen in late June of 2022 is unlike any monitoring results seen in the previous six years of TDG

monitoring conducted at Nine Mile Dam (2003, 2004, 2011, 2019, 2020, and 2021[3]). Historically, when Nine Mile Dam is operating near full capacity (4 units operating at greater than 85% full capacity), the difference in the TDG between the forebay and tailrace has not typically differed by more than approximately 4% and tailrace values are typically lower than forebay values when flows are above approximately 15,000 cfs.

According to the 2019 monitoring, 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 (Figure 4-1). This was also observed for the majority of 2022, except for data collected from June 14 through June 25, 2023. Avista believes the data collected at NMFB during this timeframe is inconsistent with previous data patterns. On June 14 Hangman Creek flows peaked at 5,430 cfs, the river was noticeably high in turbidity and results from Ecology's Water Quality Monitoring Station, 54A090 (Spokane River at NineMile Bridge) collected on June 15 reported high nutrient inputs (i.e. Fecal Coliform at 260 #/100 ml, total phosphorus at 70.3 µg/L, nitrate-nitrite as N at 230 µg/L, total suspended solids at 31 mg/L, and turbidity at 25-34.5 NTU), which had the potential to hinder the MS5's TDG sensor's silastic membrane from sensing gas content of the water accurately.

5.0 TWO-YEAR SUMMARY

Data was collected for two years at Nine Mile Dam, in 2019 and in 2022. In 2019, the TDG monitoring season consisted of the period from March 21 through June 10 and included 7,792 15-minute periods (Avista 2020). Nine Mile Dam turbine operations were at about 85% of full capacity during the 2019 TDG monitoring season. In 2022, the TDG monitoring season consisted of the period from March 4 through July 13 and included 12,653 15-minute periods. Nine Mile Dam turbine operations were at or near full capacity during the 2022 TDG monitoring season.

5.1 Discharge

In 2019, flow at the Spokane River gage at Spokane (USGS 12422500) reached a maximum of 21,100 cfs in mid-April and combined Nine Mile Dam generation discharge and spill for the March 21 through June 10 monitoring period ranged from 4,252 to 25,489 cfs. Flow through the Nine Mile Dam spillway ranged from 0 to 19,350 cfs (Avista 2020).

In 2022, flow at the Spokane River gage at Spokane reached a maximum of 24,600 cfs in mid-June and combined Nine Mile Dam generation discharge and spill for the March 4 through July 13 monitoring period ranged from 3,660 to 27,503 cfs. Discharge through the Nine Mile Dam spillway ranged from 0 to 23,593 cfs.

Spokane River flows were greater in 2022 than in 2019 with maximum flows occurring in mid-April in 2019 and in mid-June in 2022.

5.2 Water Temperature

Water temperatures at NMFB ranged from 4.7°C to 17.4°C and water temperature at NMTR

[3] TDG was monitored in 2020 and 2021, but not reported due to flows not nearing the 7Q10 (19,400 cfs in 2020 and 13,600 cfs in 2021). Data is available upon request.

ranged from 4.8°C to 17.4°C in 2019. Water temperatures in 2022 ranged from 3.1°C to 19.9°C at both NMFB and NMTR (Avista 2020).

Overall, water temperature data over the two years shows that operations at Nine Mile HED has no influence on water temperature.

5.3 Barometric Pressure

Site-specific barometric pressures ranged from 703 to 726 mm Hg in 2019 (Avista 2020) and ranged from 703 to 730 mm Hg in 2022.

5.4 Total Dissolved Gas

TDG% ranged from 101 to 122 percent of saturation for NMFB and 101 to 120 percent of saturation for NMTR in 2019 (Avista 2020). Comparing NMTR TDG% and NMFB TDG% for the same time interval, TDG% at NMTR was greater than 110 and greater than the incoming TDG% at NMFB for only 2% of the monitoring season in 2019.

TDG% ranged from 103 to 122 percent of saturation for NMFB and 102 to 128 percent of saturation for NMTR in 2022. Comparing NMTR TDG% and NMFB TDG% for the same time interval, TDG% at NMTR was greater than 110 and greater than the incoming TDG% at NMFB for 10% of the monitoring season in 2022.

TDG% data over the two years show two distinct trends. Data from the entire 2019 monitoring and the beginning of the 2022 monitoring season up until June 14 show that TDG% at NMTR was over 110% and greater than TDG at NMFB 1% of the time with an average increase of 0.7% and a maximum increase of 2.5% during that time. Data pairs during this time show that on average Nine Mile Dam decreases TDG% from NMFB to NMTR by 1.6% with a maximum decrease of 5.5%. After June 14 through June 25, 2022, TDG% at NMTR was over 110% and greater than TDG at NMFB with an average increase of 6.2% and a maximum increase of 9.2%. However, Avista believes the data collected during this timeframe is inconsistent with previous data patterns, potentially impacted by high nutrients and sediments in the water column.

5.5 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 in 2019 and remained above the 8.0 mg/L DO criterion throughout the entire monitoring period at both monitoring stations. Measured DO concentrations were 8.3 to 14.9 mg/L for NMFB, and 8.3 to 14.6 mg/L for NMTR in 2022 and remained above the 8.0 mg/L DO criterion throughout the entire monitoring period at both monitoring stations (Avista 2020).

DO concentrations at NMFB and NMTR had similar concentrations and followed the same seasonal patterns through the entire 2019 monitoring season and for 16.5 weeks of the total 18.5 weeks of monitoring in 2022. DO concentrations were higher at NMTR than at NMFB from June 14 to June 25, 2022. However, Avista believes the data collected during this timeframe was inconsistent with previous data patterns, potentially impacted by high nutrients and sediments in the water column.

Overall, Nine Mile Dam operations had little to no influence on DO concentrations over the two years.

5.6 Two-Year Discussion

Results from the 2019 monitoring indicate that Nine Mile HED does not create TDG greater than 110 percent and that at 2019 Spokane River discharge levels (a maximum of 25,489 cfs), spill at Nine Mile HED typically reduces TDG downstream (Avista 2020). These results were consistent with previous TDG monitoring conducted by Avista in 2004 (Golder 2004) that demonstrated that Nine Mile Dam did not contribute to elevated TDG at 2004 discharge levels (a maximum of 14,900 cfs) and typically reduced TDG levels.

Results of the 2022 TDG monitoring at Nine Mile HED showed that throughout most of the monitoring season, TDG in the Nine Mile HED tailrace was consistently below TDG in the forebay, consistent with previous TDG monitoring results. On June 14, TDG in the tailrace increased, correlated with an increase in river flows, but TDG in the forebay did not increase, resulting in tailrace TDG values being greater than forebay values from 7:15 on June 14 to 14:00 on June 25, with a maximum difference of 9.2% TDG and an average difference of 6.2% during this time. After 14:00 on June 25, TDG in the tailrace dropped below TDG in the forebay and remained below for the remainder of the monitoring season.

The increase in TDG downstream seen in late June of 2022 is unlike any monitoring results seen in the previous six years of TDG monitoring conducted at Nine Mile HED (2003, 2004, 2011, 2019, 2020, and 2021), in regards to both that the dam appears to be increasing TDG at high flows and in the magnitude of the increase in TDG seen. Based on TDG data from 2019 and from March 4 to June 13 in 2022, when Nine Mile Dam was operating at full turbine capacity (4 units operating at greater than 85% full capacity), the difference in the TDG in the forebay and tailrace has not typically differed by more than around 4% and tailrace values are typically lower than forebay values when flows are above approximately 15,000 cfs in previous monitoring data.

6.0 NEXT STEPS

Following the installation of the rubber dam (2010), turbine unit 1 and 2 replacement (2016) and sediment bypass system upgrade (2018), Avista monitored TDG for two years (2019 and 2022) to assess Nine Mile Dam's influence when flows approached the 7Q10 median flow of 25,400 cfs or higher, as measured at the Spokane gage. It should be noted, Avista completed TDG monitoring in 2019, 2020, 2021, and 2022 from the beginning of the spring freshet into June. However, the required flow conditions for TDG monitoring were met only in 2019 and 2022.

Based on the inconsistencies seen in the relationship between forebay TDG and tailrace TDG in the two years of monitoring, Avista proposes monitor annually until flows reach or are near the median 7Q10, in order to better assess the influence Nine Mile Dam has on TDG, without the influence/impact from high sediment loading. Avista will submit a three-year summary report following the next year flow conditions have been met.

Monitoring will be conducted in accordance with the methodology outlined in the Washington TDG Monitoring Plan for the Nine Mile Dam (Golder 2010).

7.0 REFERENCES

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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)	3/4/22 16:00	7/13/22 12:15	12,562	3/4/22 14:30	7/13/22 11:00	12,563
Water Temperature (°C)	3.1	19.9	10,705	3.1	19.9	12,507
Dissolved Oxygen (mg/L)	8.3	14.9	10,700	8.3	14.6	12,507
BAR (mm Hg)	703.1	730.3	12,561	Used NMFB BAR		
TDG (mm Hg)	734	881	10,679	730	920	12,469
TDG (% saturation)[1]	102.8	122.4	10,598	101.7	128.0	12,388

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)	NMFB BAR (mm Hg)	TDG (% of saturation)1
NM3	3/16/22 11:15	5.1	13.2	803	723	111.1
NM3	3/28/22 12:15	5.9	12.8	810	711	113.9
NM3	4/7/22 11:00	5.6	13.1	825	728	113.3
NM3	4/21/22 12:15	8.1	11.4	751	712	105.5
NM3	5/4/22 10:30	8.7	11.7	794	720	110.4
NM3	5/20/22 13:00	9.4	12.3	832	721	115.4
NM3	6/2/22 12:00	14.0	11.0		715	
NM3	6/17/22 11:45	14.8	11.3	895	708	126.4
NM3	6/29/22 10:45	16.3	9.5	766	720	106.5
NM3	7/13/22 11:45	19.5	8.6	742	714	103.9

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	9,786			8,582		
Total # of records	12,388			10,598		
Periods when TDG exceeded 110% saturation (PDT)[1,2]	3/4/2022 15:30	to	4/14/2022 0:15	3/4/2022 16:30	to	4/14/2022 8:00
	4/27/2022 12:00	to	4/27/2022 20:30	4/14/2022 9:00		
	4/28/2022 9:15	to	4/29/2022 2:00	4/14/2022 10:00	to	4/14/2022 15:00
	4/29/2022 7:45	to	6/28/2022 19:15	4/18/2022 17:00	to	4/18/2022 19:15
				4/27/2022 10:00	to	6/28/2022 22:45

Notes:

1. Flows did not exceeded the 7Q10 in 2022.
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	2,767	2,767	100%	2,015	1,064	53%
5-11 kcfs spill	6,003	5,999	100%	5,022	0	0%
<5 kcfs spill	2,712	854	31%	2,626	0	0%
No spill	888	0	0%	888	0	0%
All spill and non-spill	12,370	9,620	78%	10,551	1,064	10%

FIGURES

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

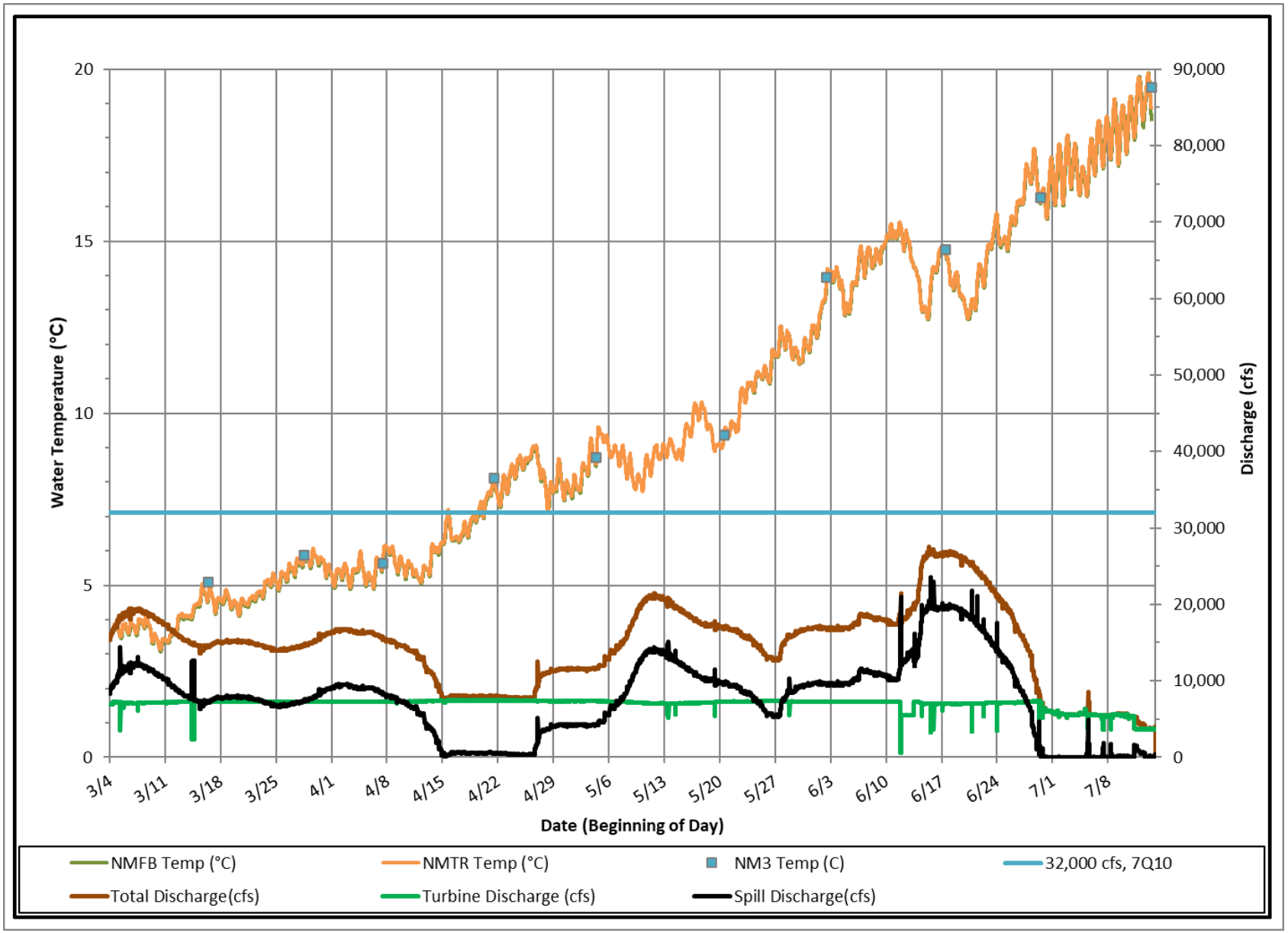


Figure 2-2: Nine Mile HED 2022 water temperature (°C) and operations.

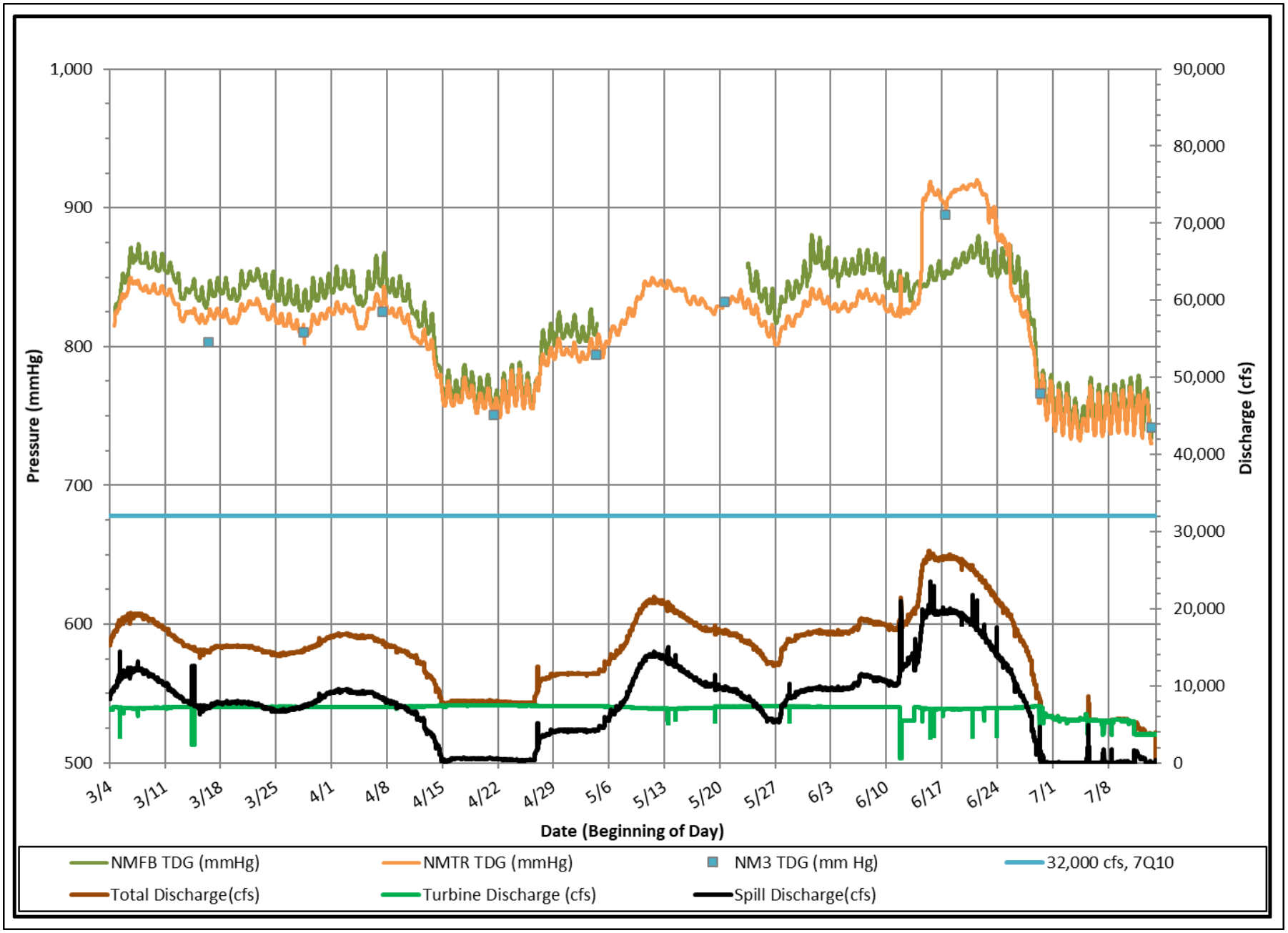


Figure 2-3: Nine Mile HED 2022 barometric pressure (mmHg) and operations.

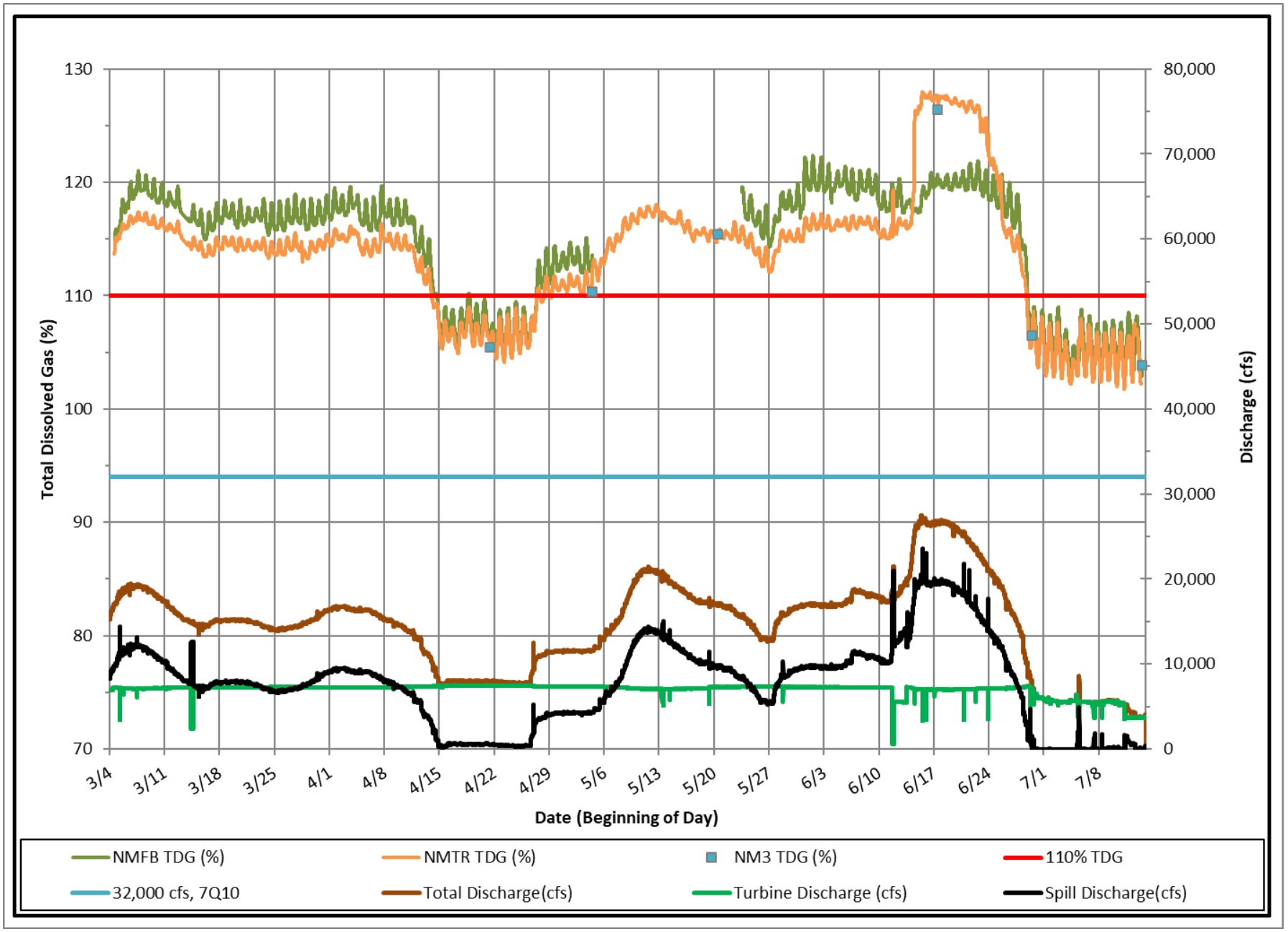


Figure 2-4: Nine Mile HED 2022 total dissolved gas (%) and operations.

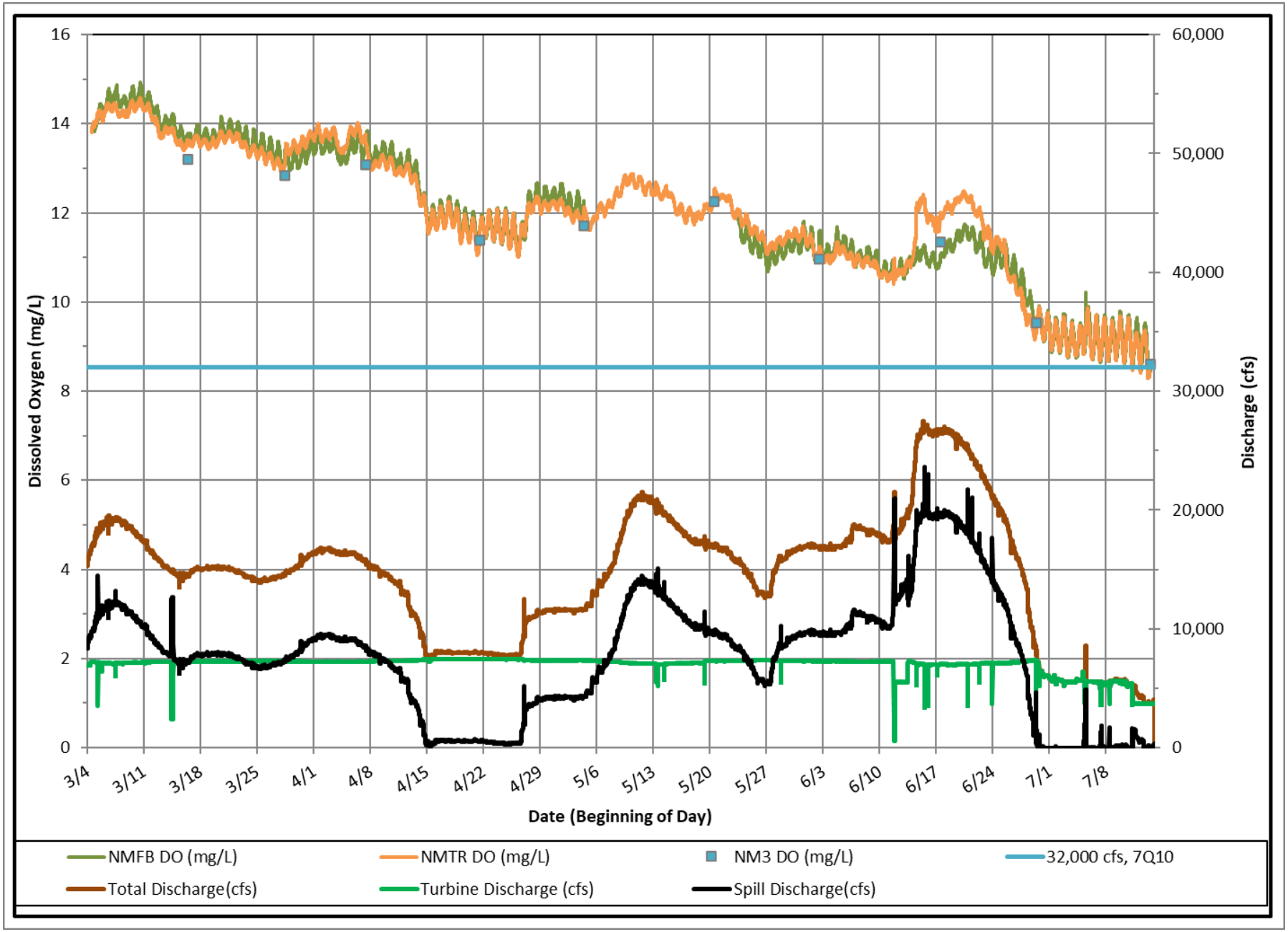


Figure 2-5: Nine Mile HED 2022 dissolved oxygen (mg/l) and operations.

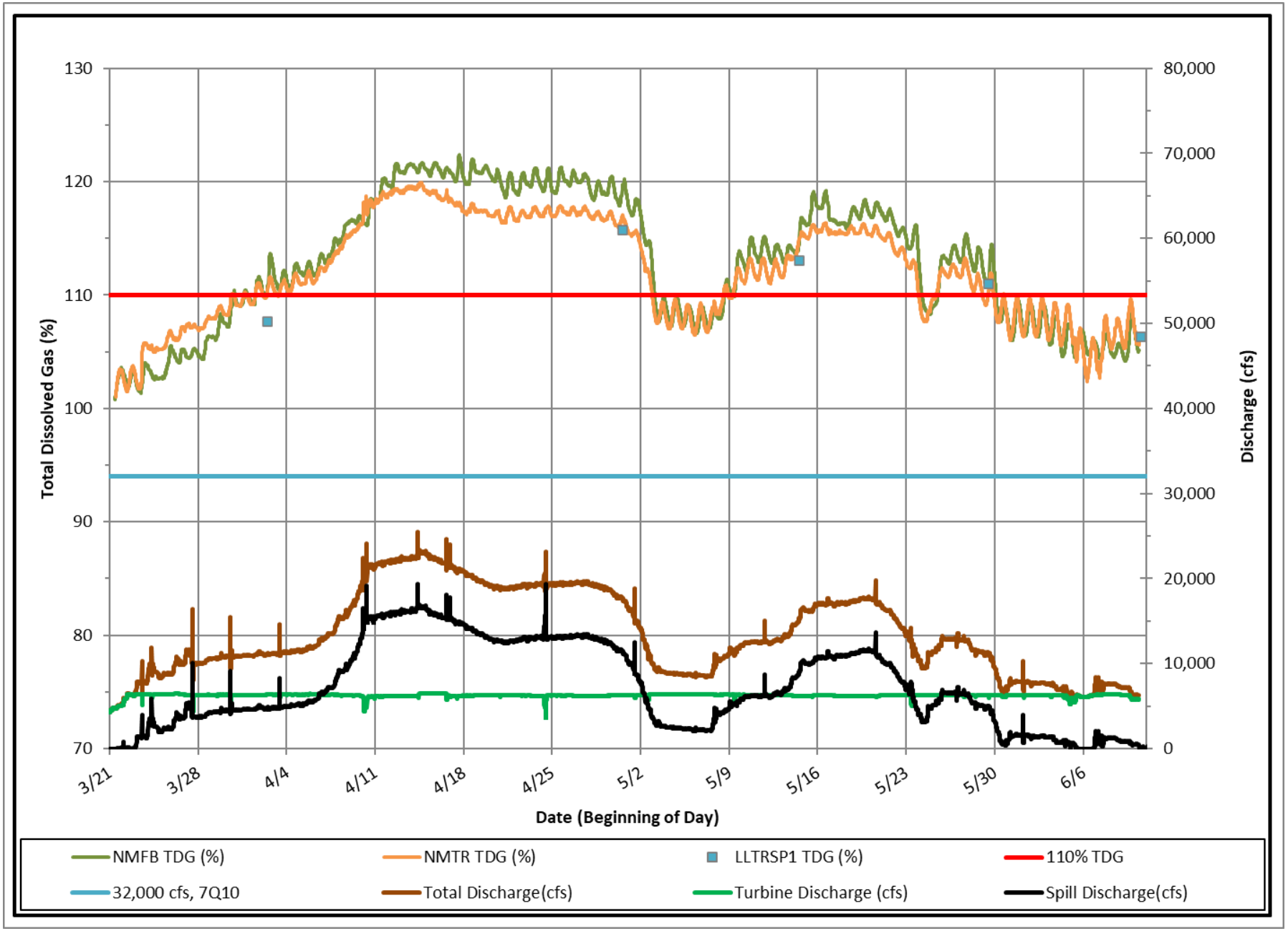


Figure 4-1: Nine Mile HED 2019 total dissolved gas (%) and operations.

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 >8 mg/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 meters	0.01 meters
Barologger Relative Barometric Pressure		±0.05 kPa	0.002% FS
Barologger Temperature	-10 to 50°C	±0.05°C	0.003°C

Notes: Sources: Hach MS5 User Manual and Solinist Levelogger User Guide [4]

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-4 shows which MS5 was deployed at each monitoring location during the sampling period.

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

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

[4] Hach Corporation. 2006. Hydrolab DS5X, DS5, and MS5 Water Quality Multiprobes User Manual. February 2006, Edition 3. Catalog Number 003078HY and Solinist. 2021. Levelogger Series 5 User Guide. September 15, 2021.

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

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

LLHED 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
48764	2.00	0.28	0.28	N/A	2	1	1	5	0.00	-0.72	-0.72	N/A
48763	1.83	0.25	0.25	4.57	2	1	1	5	-0.17	-0.75	-0.75	-0.43
48765	2.10	0.29	0.29	4.43	2	1	1	5	0.10	-0.71	-0.71	-0.57
68481	3.29	0.45	0.46	N/A	2	1	1	5	1.29	-0.55	-0.54	N/A
68482	2.00	0.28	0.28	N/A	2	1	1	5	0.00	-0.72	-0.72	N/A
60376	1.37	0.19	0.19	4.35	2	1	1	5	-0.63	-0.81	-0.81	-0.65
Overall RMSE	2.14	0.30	0.30	4.45	2	1	1	5	0.14	-0.70	-0.70	-0.55

[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).

LLHED 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
48764	0.11	N/A	0.05	N/A	0.5	0.5	-0.39	N/A	-0.45	N/A
48763	0.05	0.16	0.08	0.11	0.5	0.5	-0.45	-0.34	-0.42	-0.39
48765	0.08	0.12	0.11	0.15	0.5	0.5	-0.42	-0.38	-0.39	-0.35
68481	0.04	N/A	0.09	N/A	0.5	0.5	-0.46	N/A	-0.41	N/A
68482	0.06	0.04	0.03	0.04	0.5	0.5	-0.44	-0.47	-0.47	-0.46
60376	0.07	0.10	0.06	0.17	0.5	0.5	-0.43	-0.40	-0.44	-0.33
Overall RMSE	0.07	0.10	0.09	0.12	0.5	0.5	-0.43	-0.40	-0.41	-0.38

[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) = $\sqrt{\frac{\sum_{i=1}^{n}(x_{1,i}-x_{2,i})^2}{n}}$.

Table A-4. ID number, and deployment station and timeframe of MS5s used in 2022.

Deployment Timeframe	NMTR	NMFB	NM3
3/4 - 3/16	48765	68481	48764
3/16 - 3/28	48765	68481	60376
3/28 - 4/7	48765	68481	60376
4/7 - 4/21	48765	68481	60376
4/21 - 5/4	48765	68481	60376
5/4 - 5/20	48765	68481	60376
5/20 - 6/2	48765	60376	68482
6/2 - 6/17	48765	60376	48763
6/17 - 6/29	48765	60376	48763
6/29 - 7/13	48765	60376	48763

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 and spot readings. All MS5s met the MQO for TDG spot readings, but MS5s 48765 and 68481 did not meet the MQO for BAR.

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-5). The TDG data collection period consisted of 12,567 15-minute periods at NMFB, and 12,566 at LLTR. Data completeness was 99 percent or greater for all parameters at NMTR and 84 – 85 percent at NMFB.

Table A-6 summarizes the number of specific DQCodes applied to NMTR, and NMFB data.

Table A-5. Project completeness.

	NMFB		NMTR	
Parameter	**Count**	**Completeness (%)**	**Count**	**Completeness (%)**
Monitoring Period	12,567	--	12,566	--
Water Temperature (°C)	10,705	85%	12,507	100%
Dissolved Oxygen (mg/L)	10,700	85%	12,507	100%
BAR (mm Hg)	12,566	100%	Used NMFB BAR	
TDG (mm Hg)	10,679	85%	12,469	99%
TDG (% saturation)	10,598	84%	12,388	99%

Table A-6: 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	1	1	1	1	1	10	10	10	10	10	0	0
998	Out of water after recovery	3	3	3	3	3	20	20	20	20	20	0	0
997	Equilibrating after deployment	0	26	0	0	0	0	38	0	0	0	0	0
995	No instrument deployed; instrument lost	1,539	1,539	1,539	1,539	1,539	0	0	0	0	0	0	0
993	Out of water for calibration/servicing	15	15	15	15	15	23	23	23	23	23	0	0
888	Power loss	12	12	12	12	12	0	0	0	0	0	0	0
666	Unknown	0	0	0	0	0	0	0	0	0	0	1	2
303	Unrealistic DO value, suspect erratic or low voltage	0	0	0	5	0	0	0	0	0	0	0	0
-1002	Corresponds with spot measurement	0	0	0	0	0	9	9	9	9	9	0	0
0	No data qualifiers	10,992	10,018	10,992	10,987	10,992	12,498	11,517	12,498	12,498	12,498	12,562	12,561
Monitoring Period[1]		12,567	12,567	12,567	12,567	12,567	12,566	12,566	12,566	12,566	12,566	12,566	12,566

Notes:

1. Monitoring periods consisted of 3/4/2022 16:00 PT to 7/13/2022 12:15 PT for NMFB and 3/4/2022 14:30 PT to 7/13/2022 11:00 PT for NMTR.

APPENDIX B
CONSULATION RECORD

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

February 28, 2023

Jordan Bauer, Hydropower Compliance Coordinator
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, Long Lake TDG, Nine Mile TDG and Long Lake DO Reporting Requirements

Dear Jordan:

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. Per Sections 5.4 and 5.6.B of the Certification, Avista is submitting the following project status and reports for your review and comment.

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

- *2022 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 spillgate operational protocols. The enclosed 2022 Long Lake TDG Monitoring Report provides the results of the TDG monitoring completed during 2022. It also includes an assessment of TDG monitoring since monitoring was extended for an additional three years in 2020.

  The three-year monitoring extension (2020 – 2022) did not accomplish the goal to obtain additional data at flows near the 7Q10 (32,000 cfs) as river flows fell short of the targeted flows. Therefore, Avista proposes to conduct annual TDG monitoring at Long Lake Dam for an additional three years (2023 through 2025), following the same Long Lake HED TDG Monitoring Plan and reporting structure used in previous annual monitoring

  As this additional monitoring data is collected, Avista will consult and engage with Ecology and the Spokane Tribe to discuss the milestones achieved in the WQAP including the Phase I, II, and III Feasibility Studies, Spillway Modification construction, effectiveness monitoring, spillgate protocols to reduce TDG, identification of data gaps, and impacts or patterns based upon hydrology, water temperature, dissolved oxygen, upstream environmental conditions and incoming TDG levels.

During 2025, Avista, Ecology and the Spokane Tribe will have a pathway and schedule of next steps in accordance with the regulatory tools outlined in WAC 173-201A-510(5).

- *2022 Nine Mile Dam Total Dissolved Gas Monitoring Report*
  Per Section 5.4(C), Avista shall collect TDG data for two years when flows occur during the 7Q10 median flow (25,400 cfs) or higher. In February 2012, Ecology approved Avista's request to delay TDG monitoring at Nine Mile Dam pending the completion of the turbine units 1 and 2 replacement project, the sediment bypass system and associated intake deck and trashrack cleaning system upgrades. These projects were completed by 2018 and TDG monitoring resumed in 2019.

  The enclosed 2022 Nine Mile HED Total Dissolved Gas Monitoring Report provides the results of TDG monitoring conducted for Nine Mile HED during 2022, as well as a summary of the two years of TDG data collected post-construction. Monitoring results from 2019 and 2022 demonstrate that Nine Mile Dam did not contribute TDG compared to upstream levels, except for a time period from June 14 to June 25, 2022 when TDG in the tailrace increased, correlated with an increase in river flows, but TDG in the forebay did not increase, resulting in tailrace TDG values being greater than forebay values.

  Based on the inconsistencies seen in the relationship between forebay TDG and tailrace TDG in the two years of monitoring, Avista proposes monitoring TDG annually until flows reach or are near the median 7Q10, in order to better assess the influence Nine Mile Dam has on TDG, without the influence/impact from high sediment loading. Avista will submit a three-year summary report following the next year flow conditions have been met.

Section 5.6.B: Dissolved Oxygen
The enclosed 2022 Long Lake HED Tailrace Dissolved Oxygen (DO) Monitoring Report provides the results of the 2022 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 2023 and to continue monitoring DO and TDG at the Long Lake Dam Tailrace Station.

Attached, please find the 2022 Long Lake TDG Monitoring Report, 2022 Nine Mile Dam TDG Monitoring Report, and the 2022 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report for the Ecology's review and approval. We would like to receive any comments or recommendations that you may have by **March 31, 2023**, which will allow us time to file these reports with FERC by April 15, 2023.

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: Brian Crossley, Spokane Tribe
Conor Giorgi, Spokane Tribe
Meghan Lunney, Avista

STATE OF WASHINGTON

DEPARTMENT OF ECOLOGY

Eastern Region Office

4601 North Monroe St., Spokane, WA 99205-1295 • 509-329-3400

March 23, 2023

Chris Moan
Avista Corp.
1411 East Mission Avenue
PO Box 3727
Spokane, WA 99220

RE: Request for Ecology Review and Comment – Avista 2022 Long Lake Tailrace HED Dissolved Oxygen, Long Lake Total Dissolved Gas, and Nine Mile Total Dissolved Gas Monitoring Reports – Spokane River FERC Project No. 2545

Dear Chris Moan:

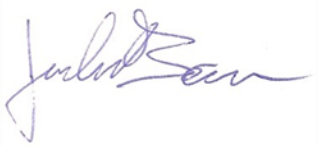
The Department of Ecology (Ecology) has reviewed Avista's submittal of the "2022 Long Lake Total Dissolved Gas Monitoring Report", "2022 Nine Mile Dam Total Dissolved Gas Monitoring Report", and "2022 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report". These reports were received by Ecology on February 28, 2023, via email. The reports were completed in accordance with Sections 5.4(C & D) and 5.6(B) of Ecology's 401 Certification (Certification) and consistent with Spokane River Hydroelectric Project No. 2545 (License) Appendix B.

In summary of the enclosed comments, we have highlighted the following for Avista to pursue:

1. Develop and submit a new Water Quality Attainment Plan (WQAP) for TDG at Long Lake Dam according to WAC 173-201A-510(5) "Compliance schedule for dams". We encourage using the attached guidance document for developing a WQAP with reasonable and feasible TDG abatement measures. A compliance schedule developed with the WQAP must identify the necessary time of up to ten years to evaluate and implement the proposed TDG abatement measures.
2. Using the enclosed guidance document, please prepare a TDG WQAP submittal schedule for Long Lake Dam for Ecology review by April 14, 2023.
3. Continue TDG monitoring at Nine Mile Dam to evaluate TDG dynamics at or higher than the median 7Q10 flows at the Spokane River gage according to Section 5.4(C) of the Certification. Furthermore, continued monitoring is needed to evaluate Hangman Creek's influence on TDG.
4. Continue monitoring DO and TDG at the Long Lake Dam Tailrace Station according to the aeration program's adaptive management measures.

Ecology looks forward to working with Avista during development of the next TDG WQAP at Long Lake Dam. We think it would be beneficial to meet and discuss reasonable and feasible TDG abatement measures for the WQAP given the data collected and past implementation projects. We appreciate the regular conversations and look forward to connecting soon. Please contact me with any questions at (509) 688-9403 or jordan.bauer@ecy.wa.gov.

Sincerely,



Jordan Bauer
Hydropower Compliance Coordinator
Water Quality Program

JB:red
Enclosures
cc: Meghan Lunney, Avista
Chad Atkins, Ecology
Brian Crossley, Spokane Tribe
Conor Giorgi, Spokane Tribe

Avista 2022 TDG Annual Reports and Long Lake HED Tailrace DO/TDG Annual Report
Ecology Review and Comment

2022 Long Lake TDG Monitoring Report ECY review and comment.

Comment No.	Section	Page No.	Comment/Questions
1	2.5	5	Last bulleted item – I think July 14th was meant as the last data recorded at LLGEN and not June 14th? July 14th would match dates further into the document.
2	4.0	7	We suggest including some language explaining how varying flows effect TDG exceedances as in past years' discussion sections and reports. It appears TDG response downstream in the tailrace is dependent on incoming flows and TDG values.
3	5.0	7	Paragraph 2 – Spill gate testing and effectiveness monitoring during the 2017 and 2018 seasons concluded the structural modifications are effective at reducing TDG from pre-construction TDG levels. This analysis included spreading out gate levels more evenly and decreasing TDG further between discharges of approximately 6.5kcfs-13.3kcfs. To supplement these results, we recommend additional gate testing at greater discharges to evaluate opportunities for further maximizing TDG reductions during a higher flow spectrum.
4	5.0	8	Paragraph 3 "Comparing…" – This is a good level of evaluation here, especially the last sentence. Using this further when describing TDG at varying discharge regimes will be beneficial for future abatement investigations and determining the greatest level of TDG reduction (magnitude, duration, frequency).
5	5.0	8	Third bullet – How was this conclusion decided? We did not see discussion on this comparison in the report that would help us understand this conclusion.
6	6.0	9	Though a three-year extension for the TDG compliance schedule was granted in the past for monitoring effectiveness, we typically don't permit extensions but rather request a new compliance schedule be developed. Additionally, we haven't seen a flow year get even to the median 7Q10 value since 2017, therefore there's uncertainty that we see flows near the 7Q10 in the next three years. We believe from instances of continued TDG exceedances, especially during higher flows, there's reason to pursue evaluation and possible implementation of new TDG abatement measures. Actions identified in the final bullet list of the report can be included in determining new TDG abatement actions and pertinent evaluation methods within a new compliance schedule. Therefore, development of a new TDG water quality attainment plan and compliance schedule is the appropriate next step in accordance with WAC 173-201A-510(5) at Long Lake Dam consistent with the 401 Certification Section 5.4(D).

2022 Nine Mile Dam TDG Monitoring Report

Comment No.	Section	Page No.	Comment/Questions
1	3.6	6	Last paragraph – We appreciate Avista adding this notification.
2	4.0	7	Last paragraph, sentence 4 – According to the Hangman Creek USGS monitoring location #12424000 flows peaked at 5,410 cfs on June 14th at 4:45PM (see Hangman Creek #12424000). Consider revising the peak flow value unless the value is referring to a different monitoring location. If that's the case, please include the monitoring site ID.
3	4.0, 5.4, 6.0	7-9	4.0 and 5.4, last paragraphs and Section 6.0 – Ecology agrees more data collection is needed to understand the impacts of Hangman Creek high episodic discharges into the Spokane River during spill events and TDG response at Nine Mile Dam. It is largely unclear how Hangman water quality data effects TDG and how the relationship between NMFB and NMTR respond. Additionally, the median 7Q10 of 25,400 cfs at the Spokane River gage (USGS 12422500) has not been met during annual monitoring periods since the construction projects at Nine Mile Dam were completed. Though flows during 2019 and 2022 came close, we agree continued monitoring is beneficial to further evaluate TDG at Nine Mile Dam. We disagree the data is erroneous during increase flows from Hangman Creek, since QAQC spot checks supported the results and TDG increases were observed at the LLGEN TDG values downstream at Long Lake Dam. There may be more to understand how Hangman Creek discharges influence TDG. Hangman Creek typically reaches high flows earlier in the year than seen in 2022 when TDG levels increase from Spokane River flows over Spokane Falls. There may be some level of interaction explaining the higher TDG at NMTR given how TDG saturation equilibrates from the higher discharges of Hangman Creek with the Spokane River during these periodic events. Additional data collection will hopefully shed some light on these uncertainties. Please provide more information on why nutrients and sediments were assumed to be impacting TDG from Hangman Creek (e.g., cited literature, previous TDG studies). At constant TDG levels, natural environmental conditions impacting TDG typically include barometric pressure, biological activity, and temperature.

2022 Long Lake HED Tailrace DO Monitoring Report ECY review and comment.

Comment No.	Section	Page No.	Comment/Questions
1	General Comment	-	Ecology agrees continued monitoring is needed in the tailrace and during aeration to effectively manage and operate periods of aeration. As mentioned, continued upstream DO, temperature, and TDG water quality attainment plan improvements should only continue to benefit downstream DO conditions.

Ecology Guidance for Preparing a Dam Compliance Schedule Request and Water Quality Attainment Plan

March 2023

This Washington Department of Ecology (Ecology) guidance presents a recommended series of actions for dam owners to pursue to achieve an approvable Water Quality Attainment Plan (WQAP) and compliance schedule in accordance with WAC 173-201A-510(5). Dam owners are encouraged to begin preparations for a WQAP submittal at a minimum one year prior to the due date. As an example, a dam owner may begin working through the guidance actions during the final year(s) of a dam compliance schedule to ensure a new schedule and WQAP is approved by Ecology and begins immediately thereafter. We suggest dam owners consult with Ecology early and often during the recommended guidance process.

The following actions outline a strategy for dam owners to choose reasonable and feasible implementation projects to meet water quality standards, engage key stakeholders, and develop an approvable WQAP:

1. Assemble a WQAP project team with pertinent personnel (e.g., consultants, in-house engineering personnel, etc.) to consider projects for evaluation and implementation as part of the WQAP. The assembled team will review and/or modify past project alternatives and propose new projects in preparation of an extensive list of potential improvement actions. For all potential projects, water quality improvements may include any one or combination of the following factors to achieve compliance:
    - Magnitude
    - Duration
    - Frequency

    Incremental improvement made to any of these factors must be considered to achieve the highest attainable water quality condition if numeric criteria cannot be met.
2. Develop or revise evaluation criteria for ranking and prioritizing projects that are considered reasonable and feasible to achieve the maximum water quality condition. Submit the developed evaluation criteria to Ecology for review and comment.
3. Finalize the criteria and prepare a preliminary list of potential projects from the original extensive list to begin outlining the WQAP. The list of prioritized projects could be informed by the criteria, preliminary modelling, and existing science on water quality improvement strategies, as appropriate.
4. Once the reasonable and feasible list of actions is prepared, the dam owner should hold a series of advisory workshops (see No. 5) to vet actions, decisions, and assumptions made developing the list and evaluation criteria.
5. Form an advisory group including the WQAP project team, regulatory agencies, tribes, and experts in water resources specific to reservoir management, design, and function. Engage the advisory group in a series of workshops facilitated by the dam owner to include the following content:
    - Introduce the general project background and need for water quality attainment of WA water quality standards, past project proposals, evaluation criteria, and the developed reasonable and feasible list of actions and how each measure was evaluated using the criteria.

- Based on the information presented, the dam owner will request from the group any additional implementation projects and alternatives. This may include supplementary water quality studies or data collection needs to support project evaluation and implementation proposals.

2. Following the series of workshops, a final evaluation criteria and vetted project list would be integrated into a draft WQAP for Ecology review and comment. At a minimum, the draft must include all parts of WAC 173-201A-510(5)(b) and the developed evaluation criteria as an attachment.

3. Once having addressed Ecology's comments, we recommend the dam owner present the WQAP to the advisory workgroup and/or broader group of stakeholders for final review. The dam owner should consider recommendations from this review and finalize for Ecology approval and subsequent submittal to the appropriate federal agency.

Ecology Proposed WQAP Submittal Schedule

The following table may be revised based on project scope and conversations between Ecology and the dam owner. Ecology recommends dam owners work with the agency to agree on a schedule incorporating each of the defined tasks to ensure the final WQAP submittal due date is met.

Task No.	Task	Time Required (days)	Notes
1 & 2	Assemble Project team, create comprehensive list of project ideas, and develop evaluation criteria	60	Dam owner schedules advisory meetings ~100 days out
2	Ecology review and comment of evaluation criteria	20	
3	Dam owner addresses Ecology comments and finalizes evaluation criteria	20	
4 & 5	Dam owner prioritizes projects using criteria and presents project proposals to advisory workgroup	10	Approximately three workshops facilitated over 10-day period. Dam owner schedules final advisory group meeting ~100 days out during last workshop.
6a	Dam owner updates project list and develops draft WQAP for Ecology review and comment	45	
6b	Ecology review and comment of draft WQAP	30	
7a	Dam owner addresses Ecology comments and presents to advisory group	30	
7b	Dam owner makes final changes to WQAP based on meeting presentation and submits to Ecology for final approval	10	
7c	Ecology approves WQAP and dam owner submits to the federal agency	10	
	Total	235 or ~8 months	

ECOLOGY COMMENTS AND AVISTA RESPONSES

Ecology Comment

3. Continue TDG monitoring at Nine Mile Dam to evaluate TDG dynamics at or higher than the median 7Q10 flows at the Spokane River gage according to Section 5.4(C) of the Certification. Furthermore, continued monitoring is needed to evaluate Hangman Creek's influence on TDG.

Avista Response

Avista plans to monitor TDG at Nine Mile Dam in 2023.

#	Section	Page No.	Ecology Comment/Questions	Avista Response
1	3.6	6	Last paragraph – We appreciate Avista adding this notification.	Thank you, comment noted.
2	4.0	7	Last paragraph, sentence 4 – According to the Hangman Creek USGS monitoring location #12424000 flows peaked at 5,410 cfs on June 14th at 4:45PM (see Hangman Creek #12424000). Consider revising the peak flow value unless the value is referring to a different monitoring location. If that's the case, please include the monitoring site ID.	The USGS Hangman Creek gage (#12424000) recorded flow at 5,430 cfs on June 14 at 16:30, therefore the text in Section 4.0 was modified to include the peak value of 5,430 cfs.
3	4.0, 5.4, 6.0	7-9	4.0 and 5.4, last paragraphs and Section 6.0 – Ecology agrees more data collection is needed to understand the impacts of Hangman Creek high episodic discharges into the Spokane River during spill events and TDG response at Nine Mile Dam. It is largely unclear how Hangman water quality data effects TDG and how the relationship between NMFB and NMTR respond. Additionally, the median 7Q10 of 25,400 cfs at the Spokane River gage (USGS 12422500) has not been met during annual monitoring periods since the construction projects at Nine Mile Dam were completed. Though flows during 2019 and 2022 came close, we agree continued monitoring is beneficial to further evaluate TDG at Nine Mile Dam.	We appreciate that perspective and Avista plans to monitor TDG at the Ecology approved locations at Nine Mile Dam in 2023 and looks forward to discussing the impacts of Hangman Creek.

			We disagree the data is erroneous during increase flows from Hangman Creek, since QAQC spot checks supported the results and TDG increases were observed at the LLGEN TDG values downstream at Long Lake Dam. There may be more to understand how Hangman Creek discharges influence TDG. Hangman Creek typically reaches high flows earlier in the year than seen in 2022 when TDG levels increase from Spokane River flows over Spokane Falls. There may be some level of interaction explaining the higher TDG at NMTR given how TDG saturation equilibrates from the higher discharges of Hangman Creek with the Spokane River during these periodic events. Additional data collection will hopefully shed some light on these uncertainties.	The report was modified to remove the word "erroneous" from Sections 4.0 and 5.0. The inconsistencies referenced can be observed in Figure 2-4 which shows as river flows increased from 17,400 cfs to over 26,000 cfs from June 10 to 14, TDG at NMTR increased with the substantial increase in flow, but TDG at NMFB did not increase with flow. TDG decreased from 118% to 117.5% from June 10 to June 14. The lack of TDG increase at NMFB during this substantial flow increase is inconsistent with previous data patterns. Avista looks forward to further exploring the interaction of TDG saturation equilibrium with varying flows in the Spokane River and Hangman Creek, per Ecology's suggestion.
			Please provide more information on why nutrients and sediments were assumed to be impacting TDG from Hangman Creek (e.g., cited literature, previous TDG studies). At constant TDG levels, natural environmental conditions impacting TDG typically include barometric pressure, biological activity, and temperature.	The nutrients and sediments in the water during the June 14 through June 25 timeframe may have impacted the MS5 TDG sensor's silastic membrane from accurately sensing gas content of the water. Avista looks forward to discussing the results of TDG data collection efforts along with research observations from cited literature, equipment manufacturer observations, and previous TDG studies regarding these data patterns. Additionally, Avista will continue researching the MS5 TDG sensor's silastic membrane and whether nutrients and sediment can impact its accuracy with sensing gas content of the water.

1411 East Mission Avenue
PO Box 3727
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February 28, 2023

Brian Crossley
Water & Fish Program Manager
Spokane Tribe Natural Resources
P.O. Box 480
Wellpinit, WA 99040

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

Dear Brian:

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. Per Sections 5.4 and 5.6.B of the Certification and the October 2008 Settlement Agreement between Avista and the Spokane Tribe, Avista is submitting the following project status and reports for your review and comment.

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

- *2022 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 spillgate operational protocols. The enclosed 2022 Long Lake TDG Monitoring Report provides the results of the TDG monitoring completed during 2022. It also includes an assessment of TDG monitoring since monitoring was extended for an additional three years in 2020.

  The three-year monitoring extension (2020 – 2022) did not accomplish the goal to obtain additional data at flows near the 7Q10 (32,000 cfs) as river flows fell short of the targeted flows. Therefore, Avista proposes to conduct annual TDG monitoring at Long Lake Dam for an additional three years (2023 through 2025), following the same Long Lake HED TDG Monitoring Plan and reporting structure used in previous annual monitoring

  As this additional monitoring data is collected, Avista will consult and engage with Ecology and the Spokane Tribe to discuss the milestones achieved in the WQAP including the Phase I, II, and III Feasibility Studies, Spillway Modification construction, effectiveness monitoring, spillgate protocols to reduce TDG, identification of data gaps, and impacts or patterns based upon hydrology, water temperature, dissolved oxygen, upstream environmental conditions and incoming TDG levels.

During 2025, Avista, Ecology and the Spokane Tribe will have a pathway and schedule of next steps in accordance with the regulatory tools outlined in WAC 173-201A-510(5).

- *Nine Mile Dam TDG Monitoring Report*
  Per Section 5.4(C), Avista shall collect TDG data for two years when flows occur during the 7Q10 median flow (25,400 cfs) or higher. In February 2012, Ecology approved Avista's request to delay TDG monitoring at Nine Mile Dam pending the completion of the turbine units 1 and 2 replacement project, the sediment bypass system and associated intake deck and trashrack cleaning system upgrades. These projects were completed by 2018 and TDG monitoring resumed in 2019.

  The enclosed 2022 Nine Mile HED Total Dissolved Gas Monitoring Report provides the results of TDG monitoring conducted for Nine Mile HED during 2022, as well as a summary of the two years of TDG data collected post-construction. Monitoring results from 2019 and 2022 demonstrate that Nine Mile Dam did not contribute TDG compared to upstream levels, except for a time period from June 14 to June 25, 2022 when TDG in the tailrace increased, correlated with an increase in river flows, but TDG in the forebay did not increase, resulting in tailrace TDG values being greater than forebay values.

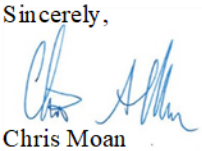
  Based on the inconsistencies seen in the relationship between forebay TDG and tailrace TDG in the two years of monitoring, Avista proposes monitoring TDG annually until flows reach or are near the median 7Q10, in order to better assess the influence Nine Mile Dam has on TDG, without the influence/impact from high sediment loading. Avista will submit a three-year summary report following the next year flow conditions have been met.

Section 5.6.B: Dissolved Oxygen
The enclosed 2022 Long Lake HED Tailrace Dissolved Oxygen (DO) Monitoring Report provides the results of the 2022 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 2023 and to continue monitoring DO and TDG at the Long Lake Dam Tailrace Station.

Attached, please find the 2022 Long Lake TDG Monitoring Report, 2022 Nine Mile Dam TDG Monitoring Report, and the 2022 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report for the Spokane Tribe's review and comment. We would like to receive any comments or recommendations that you may have by **March 31, 2023**, which will allow us time to file these reports with FERC by April 15, 2023.

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: Jordan Bauer, Ecology
Conor Giorgi, Spokane Tribe
Meghan Lunney, Avista

Spokane Tribal Natural Resources
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3/30/2023

Chris Moan
1411 East Mission Avenue
PO Box 3727 MSC-25
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Dear Chris:

I have reviewed the 2022 total dissolved gas reports for Long Lake and Nine Mile Dams and the 2022 dissolved oxygen report for Long Lake Dam with the assistance of Brian Crossley, Water & Fish Program Manager.

In 2016, spill deflectors were installed on Long Lake Dam to help mitigate total dissolved gas impacts. In 2022 Avista recorded TDG levels between 105%-118.7% at LLTR. Although this is an improvement from TDG levels recorded prior to the spill deflector installation, TDG levels are still exceeding the 110% saturation standard below 7Q10 flows. We read in the report the specific dates that LLTR and LLGEN exceeded 110% standard, but it was unclear what percentage of the sampling season the locations exceeded the standard. Please provide percentages (monthly or throughout the entire season) that both locations exceeded 110%. With dam operations being modified over time to better regulate TDG concentrations below Long Lake Dam, we hope that total dissolved gas concentrations continue to be reduced so that native species are not critically impacted. We promote future monitoring and adaptive management to effectively maintain low TDG during spring runoff.

When reviewing the TDG report for Nine Mile Dam we acknowledge that total dissolved gas concentrations both above and below the dam are exceeding the 110% standard. The report does show that for a majority of the season NMTR had a lower TDG than NMFB, and that for 10% of the study period NMTR exceeded levels seen at NMFB. Avista states they believe that data where NMTR exceeded NMFB was erroneous, and was higher because of impacts from high nutrients and sediments in the water column. Please explain how increased levels of nutrients and sediments can result in higher total dissolved gas levels, and how this anomaly is not seen every year when Hangman Creek freshet occurs.

The dissolved oxygen mitigation continues to be modified and improved below Long Lake dam. However, as noted in previous comments of annual reports, dissolved oxygen declines and dips below 8mg/L when the Long Lake Dam is not generating. These declines in dissolved oxygen can negatively impact native species that reside in this reservoir and reduce their already limited available habitat during that time. While reading the document we found the conclusions difficult to interpret when the percent exceedances or compliances were split within a month. We suggest Avista lists the date range for the percentages, as well as add what percent of DO or TDG

readings exceeded or complied over the entire month so there is more clarity and comparability. We encourage Avista to continue their efforts in improving water quality at Nine Mile Dam, in Long Lake (Lake Spokane) and at Long Lake Dam so native species can benefit from those efforts within the reservoirs as well as downstream in Reservation waters.

Sincerely,

C. Flanagan

Casey Flanagan
Water & Fish Project Manager
caseyf@spokanetribe.com

cc: Jordan Bauer, Dept. of Ecology
Chad McCrea, Director Dept. of Natural Resources
Brian Crossley, Water and Fish Program Manager

SPOKANE TRIBE COMMENTS AND AVISTA RESPONSES

Spokane Tribe Comment

When reviewing the TDG report for Nine Mile Dam we acknowledge that total dissolved gas concentrations both above and below the dam are exceeding the 110% standard. The report does show that for a majority of the season NMTR had a lower TDG than NMFB, and that for 10% of the study period NMTR exceeded levels seen at NMFB. Avista states they believe that data where NMTR exceeded NMFB was erroneous, and was higher because of impacts from high nutrients and sediments in the water column. Please explain how increased levels of nutrients and sediments can result in higher total dissolved gas levels, and how this anomaly is not seen every year when Hangman Creek freshet occurs.

Avista Response

The report was modified to remove the word "erroneous" and additional clarification was added into Section 4.0. For additional context, past data observations indicate as river flows increase in the Spokane River, TDG increases, and as flows decrease, TDG decreases. As seen in Figure 2-4, as river flows increased from 17,400 cfs to over 26,000 cfs from June 10 to 14, TDG at NMTR increased with the substantial increase in flow, but TDG at NMFB does not increase with flow, it actually decreased slightly (TDG on June 10 is 118% and on June 14 is 117.5%). It is the lack of TDG increase at NMFB that Avista flagged as not representative of past data patterns. Avista looks forward to further discussing the results of TDG data collection efforts along with research observations from cited literature, equipment manufacturer observations, and previous TDG studies regarding these data patterns. Additionally, Avista will continue researching the MS5 TDG sensor's silastic membrane and whether nutrients and sediment can impact its accuracy with sensing gas content of the water.