AVISTA CORPORATION

2015
LONG LAKE HED TAILRACE
DISSOLVED OXYGEN
MONITORING REPORT

WASHINGTON 401 CERTIFICATION, SECTION 5.6(B)

Spokane River Hydroelectric Project
FERC Project No. 2545

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List of Acronyms and Abbreviations

%	percent
% saturation	percent of saturation
°C	degrees Celsius
7Q10	7-day average flow with a 10-year return period
AC	alternating current
Avista	Avista Corporation
BAR	barometric pressure
cfs	cubic feet per second
DNR	Washington Department of Natural Resources
DO	dissolved oxygen
DO%	dissolved oxygen percent of saturation
DO TMDL	Dissolved Oxygen Total Maximum Daily Load
DO WQAP	Dissolved Oxygen Water Quality Attainment Plan
DQO	data quality objective(s)
Ecology	Washington State Department of Ecology
FERC	Federal Energy Regulatory Commission
ft amsl	feet above mean sea level
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®
LLFB	monitoring station at Long Lake forebay
LLTR	monitoring station at Long Lake tailrace
PDT	Pacific Daylight Time
Project	Spokane River Project
REMI	Reservoir Environmental Management, Inc.
RMSE	root mean squared error
SCCD	Stevens County Conservation District
Spokane Tribe	Spokane Tribe of Indians
TDG	total dissolved gas, as pressure
TDG%	total dissolved gas, as percent of saturation
WDFW	Washington Department of Fish and Wildlife

1.0 INTRODUCTION

1.1 Background

Water quality monitoring results during the Spokane River Project (Project) relicensing process (HDR 2005) indicate that the Long Lake Hydroelectric Development (HED) discharged water that did not meet the applicable dissolved oxygen (DO) water quality standards at certain times of the year. To address this issue, Avista Corporation (Avista) proposed to conduct a feasibility study to identify potential mechanisms to improve DO levels at the Long Lake HED discharge, evaluate which alternatives are reasonable and feasible, and implement selected alternative(s) to improve DO in the Long Lake HED discharge. Avista initiated this process while relicensing the Project with the Long Lake HED Phase I Aeration Study (HDR 2006).

Avista and the Spokane Tribe of Indians (Spokane Tribe) entered into a non-License Agreement, which addresses DO (and other water quality issues) on the Spokane Tribe's reservation. This Agreement commits Avista to "work collaboratively [with the Spokane Tribe] to develop and carry out feasibility studies and implementation actions pertaining to the goal of meeting the DO, TDG (total dissolved gas), and Temperature requirements at the Reservation boundary."

License Article 401, Appendix B, Condition 5.6(B) of the Washington Section 401 water quality certification (Ecology 2010a) required that Avista "*submit to Ecology a Detailed Phase II Feasibility and Implementation Plan based on the Long Lake HED DO Aeration Study within one year of license issuance (by June 17, 2010), choosing one or several options to implement. The plan shall contain:*

- *Anticipated compliance schedule for conducting preliminary and final implementation plans.*
- *A monitoring plan to evaluate compliance (including avoidance of super-saturation) and coordinate results with the DO TMDL efforts."*

Avista submitted the Detailed Dissolved Oxygen Phase II Feasibility and Implementation Plan to Washington State Department of Ecology (Ecology) as directed, and Ecology approved it on June 11, 2010 (Avista 2010). Shortly thereafter DO enhancement testing and monitoring was conducted (HDR and REMI 2010). On December 9, 2010, the Federal Energy Regulatory Commission (FERC; 2010) modified and approved the Feasibility and Implementation Plan. Avista's implementation of the FERC-approved Feasibility and Implementation Plan is documented in the 2011, 2012, and 2013 annual reports (Golder 2012, 2013, and 2014, respectively) along with the Five-Year report (Golder 2015) required under the FERC approved Feasibility and Implementation Plan, which were submitted to Ecology, the Spokane Tribe, and FERC.

This report presents the results of the 2015 DO monitoring immediately downstream of Long Lake Dam for the year's low-flow period and summarizes the use of draft tube aeration to boost DO levels in the river below the dam's tailrace. This report also provides a summary of the monitoring results from the past six years (2010 through 2015); analyzes the effectiveness of the measures implemented to improve DO; and evaluates whether there is a need for additional DO measures and additional monitoring in the Long Lake Dam tailrace.

1.2 Objectives

The objectives of the DO monitoring plan (Avista 2010) are:

1. Improve the understanding of the seasonal timing and magnitude of DO levels in the Long Lake HED tailrace, particularly as they relate to the applicable water quality standards.
2. Obtain data for aeration feasibility studies for the Long Lake Dam, powerhouse, and tailrace.
3. Document the effectiveness of meeting the DO water quality standards through measure(s) implemented to increase DO levels of Long Lake HED discharges.
4. Document super-saturation caused by measure(s) implemented to increase DO levels of Long Lake HED discharges.
5. Coordinate results with DO Total Maximum Daily Load (TMDL) efforts.

1.3 Six-Year Monitoring Period

DO, TDG, and temperature were monitored at both fixed stations and from a roving boat in the Spokane River below the Long Lake HED on September 1 and 2, 2010 to test the feasibility of turbine aeration (HDR and REMI 2010; Section 7.0 and Appendix C). The monitoring period for this study was from July 1 through October 31 during 2011 through 2015.

2.0 2015 METHODS

Water quality parameters that were recorded include DO concentration (milligrams per Liter [mg/L]), TDG (millimeters mercury [mm Hg]), and water temperature (°C). Water depth (meters [m]) was also recorded and used in conjunction with water temperature to evaluate the timing of water quality monitoring instruments being out of water and above the minimum TDG compensation depth.

2.1 Equipment and Calibration

Solinst® baraloggers were used to determine local barometric pressure. A primary barologger was deployed at the Long Lake pump house for the entire monitoring season. A back-up barologger was also deployed at the Long Lake pump house for the entire monitoring season to provide local barometric pressure (BAR) data if the primary barologger failed. As an additional quality assurance measure, resulting site-specific barometric pressures were compared to corresponding values for the Spokane International Airport for each site visit. Spokane International Airport station sea-level barometric pressures were downloaded from the Weather Underground[1] and adjusted by subtracting 37.05 mm Hg to account for the altitude of the Long Lake HED tailrace (1,365 feet above mean sea level [ft ams]).

Hydrolab® MS5 Multiprobe® (MS5) instruments with TDG, optical DO, temperature, and depth sensors were used. A MS5 connected to an external alternating current (AC) power source was used upon initial deployment with the goal of minimizing potential issues associated with low or no power supply. In addition, a second MS5 powered solely with internal batteries was deployed for long-term monitoring and was used to obtain spot measurements of DO, TDG, and temperature.

All Hach instruments used had undergone annual servicing by Hach and were factory calibrated before the 2015 monitoring season. Monitoring equipment was calibrated according to the manufacturer's instructions prior to deployment and on periodic site visits. Pre-deployment field verification included synchronizing the clocks, comparing each MS5's TDG pressure value with the silastic membrane removed to the ambient barometric pressure, confirming the patency of each MS5's TDG silastic membrane, and testing the barologgers to confirm that the recorded values were similar and comparable to those at 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 soda water. The manufacturer's instructions were implemented to calibrate depth, DO sensors, and to verify the temperature sensors.

2.2 Station Facilities

For this study, MS5 long-term deployments were done at a water quality monitoring facility located 0.6 mile downstream of the Long Lake Dam, referred to as LLTR (Table 2-1; Figure 2-1). As agreed upon with Ecology, the water quality monitoring facilities in the Long Lake HED forebay, referred to as LLFB, were not used in 2015, since water quality conditions at LLTR, not LLFB, were used to refine aeration operations at the Long Lake HED powerplant.

The permanent station consisted of a 4-inch-diameter pipe stilling-well (standpipe), which was sealed at the pipe's submerged end to prevent the MS5 from falling out of the pipe. The standpipe had ½-inch-

[1]On each site visit day, Spokane, WA KGEG barometric pressure data were downloaded from the History & Almanac section of http://www.wunderground.com/cgi-bin/findweather/getForecast?query=99219&sp=MKGEG.

diameter perforations along its sides and a hole at the bottom to provide water exchange between the interior and exterior of the pipe and limit accumulation of sediment and debris in the bottom of the pipe. The standpipe's top end is protected by an enclosed box containing AC power and data communication equipment. In 2012, Avista installed a real-time data system to transmit MS5 water quality measurements from the LLTR and LLFB long-term monitoring stations to the HED control room in the powerhouse. A coordinated team of Avista staff, including the HED Operators and water resource specialists, used LLTR's real-time DO and TDG values to select aeration valve openings for each Unit with the goal of meeting the 8-mg/L DO criterion at LLTR without exceeding the 110-percent of saturation TDG criterion.

2.3 Spot Measurements

As a quality assurance measure, spot measurements of DO, TDG, and water temperature were made during instrument-servicing site visits, which were done at approximately 2-week intervals. The river is generally well mixed at the designated long-term monitoring station LLTR located 0.6 mile downstream of the Long Lake Dam. This was determined in 2011 based on paired spot measurements of water temperature, DO, and the percent of saturation of total dissolved gas (TDG%) for both sides of the river (Golder 2012). Therefore, no spot measurements were conducted across the river during the 2015 monitoring season.

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, percent of saturation for TDG and DO were computed based on measurements, as:

- TDG% = TDG in mm Hg / Barometric pressure in mm Hg x 100
- DO percent of saturation (DO%) was computed using equations in the National Park Service's DO Calculator (Thoma and Mailick n.d.)

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 omitted from the final data set.

Long Lake HED operational logs were provided by Avista for the period of July 1 through October 31, 2015. These logs provide the HED's hourly discharges as generation and spill along with total discharge. They also identified aeration operations during the monitoring period.

2.5 Monitoring Difficulties

On arrival for the October 5 site visit, an accumulation of algae was observed on the optical DO sensor of the primary MS5 (#48762). Since this condition can cause unrepresentative DO values, data from the secondary MS5 (#48763) were used for the deployment period of September 15 14:00 PDT through October 5 8:15 PDT. The potential data gap was avoided by deployment and maintenance of a second MS5 at LLTR. In the future, Avista will continue the practice of deploying a second MS5 at this critical site, as needed.

3.0 2015 RESULTS

MS5s and barologgers were set to record data for approximately 11,800 15-minute periods (referred to as "continuous" data in this report) from July 1 through October 31 (Table 3-1). The primary barologger deployed at LLTR provided a complete (100 percent of the entire continuous monitoring period) data set for local barometric pressure. Temperature, DO, and TDG data were successfully obtained for at least 99.5 percent of the entire continuous monitoring period (Appendix A, Table A-4). Spot measurements collected when long-term deployment and/or instrument downloads were conducted[2] were used for the quality assurance/quality control program described in Appendix A.

3.1 Discharge

Extremely low flows and wildfires occurred throughout the Spokane River Basin and the Inland Northwest during 2015 (Landers 2015). Spokane River inflows were at the minimum level reported for the 30-year period of 1986 through 2015 on 52 percent of the days in the July 1 through October 31, 2015 monitoring season.

Combined Long Lake HED generation, spill discharge, and seepage for the July 1 to October 31 monitoring period ranged from approximately 150 to 4,810 cubic feet per second (cfs) (Table 3-2). The maximum hourly discharge of 4,810 cfs occurred in July, and maximum hourly discharge ranged from 4,680 cfs to 4,770 cfs for August through October. Average hourly discharge was greatest (1,656 cfs) in October, least (1,234 cfs) in August, and intermediate in July and September (1,407 and 1,282 cfs, respectively).

[2] This occurred on June 29, July 10, July 27, August 10, September 4, September 18, October 5, October 19, and November 2.

3.2 Water Temperature

Tailrace (LLTR) water temperature increased from approximately 18.5°C at the beginning of July to approximately 21°C in early July, cooled to approximately 19°C by mid-July where it remained through mid-August (Figure 3-1). After this, water temperature steadily cooled to approximately 13°C at the end of October.

3.3 Barometric Pressure

Site-specific barometric pressures ranged from 713 to 730 mm Hg based on the Solonist® barologger deployed at LLTR (Table 3-1).

3.4 Dissolved Oxygen

LLTR DO concentrations (recorded during generation and non-generation) were 5.8 to 9.9 mg/L with the greatest DO concentrations near the beginning and end of the monitoring period when the water was coolest and potential solubility for oxygen is greatest (Figure 3-1). The lack of early July high flows resulted in DO decreasing to 8.0 mg/L (Figure 3-2) and aeration beginning on July 1, which is earlier than years that had high flows in early July. Figures 3-2 through 3-5 display DO and TDG% trends along with aeration operations throughout the progression of the low flow season. These figures show that the daily DO cycle at LLTR peaked in the early afternoon and was lowest in the morning, coinciding with the HED generating from near noon to near midnight. Additional information on the HED's operations, use of spillgates, aeration operation, and the corresponding frequency of LLTR DO values less than 8.0 mg/L are presented in Table 3-3.

Long Lake HED discharges monitored at LLTR were less than the 8.0-mg/L DO criterion 34.9 percent of the time during the DO monitoring season (Table 3-3 and 3-4). DO concentrations of less than 8.0 mg/L occurred in HED discharges during all four months of the monitoring season (Table 3-4). These low DO concentrations were within 0.2 mg/L of 8.0 mg/ L (i.e. 7.8 and 7.9 mg/L) 29 percent of the time (Figure 3-6) with the minimum DO of 5.8 mg/L occurring in early September (Table 3-4). The 2015 aeration operations are summarized in Section 3.6.

DO and other water quality data monitored at LLTR when neither generation nor aeration occurred are summarized in Table 3-5. LLTR's minimum DO concentration for non-generation periods was 5.8 mg/L, which is the same as the minimum DO recorded during generation, and also occurred in early September. Non-generation DO values for LLTR were less than the 8.0-mg/L DO criterion for 60.2 percent of the 7,330 15-minute values (Table 3-5). As with generation periods, non-generation DO concentrations of less than 8.0 mg/L occurred in all four months of the monitoring season (Table 3-5). These low DO concentrations were within 0.2 mg/L of 8.0 mg/ L (i.e. 7.8 and 7.9 mg/L) 20 percent of the time.

Table 3-6 includes a summary of DO values for the entire July 1 through October 31 monitoring season. The frequency for DO less than 8.0 mg/L during generation was 34.9 percent compared with 60.2 percent for non-generation, which resulted in an overall frequency of 50.6 percent (generation and non-generation).

Calculated DO% saturation values ranged from approximately 63.2 to 112.0 percent for LLTR (Table 3-1, Figure 3-7). DO% saturation for LLTR ranged from 63.3 to 112.0 percent during periods of generation (Table 3-4) and from 63.2 to 107.5 percent during non-generation (Table 3-5).

3.5 Total Dissolved Gas

The range of TDG% computed was 97.4 to 115.0 percent of saturation for LLTR (Table 3-1). TDG% of Long Lake HED discharges monitored at LLTR were greater than the 110.0 percent of saturation criterion for 516 (11.7 percent) of the 4,420 values for generation (Table 3-3, Figure 3-6). Tables 3-3 and 3-4 provide additional insight into the HED operations coinciding with these high TDG% values. These exceedances of the 110.0 percent of saturation criterion occurred on days between July 4 and September 29 with aeration.

3.6 2015 Aeration

Dissolved oxygen levels were monitored from July 1, 2015 through October 31, 2015. Avista operated the HED at varying capacities throughout this period. The spillway released greater than 200 cfs (400 to 470 cfs) for two hours immediately before the season's termination of spill on July 28. Aeration operations were conducted between July 1 and October 31 using different aeration valve openings for Units 1, 2, 3, and 4. Aeration was conducted for a total of 2,204 unit-hours with 20 hours for a single unit, 756 hours for two units simultaneously, and 224 hours for three units simultaneously.[3] The various generating and aeration conditions along with comparisons of DO and TDG% during generation, as measured at LLTR to their applicable criteria, are summarized below and in Tables 3-3 and 3-4.

Key conclusions for the 2015 monitoring period, presented by month, are:

- **July**: Aeration was initiated on July 1 and conducted daily to the end of the month with one to three units. This resulted in 525 unit-hours of aeration. These operations resulted in meeting the 8.0-mg/L DO criterion at a frequency of 98 percent early in the month and 70 percent in the latter part of the month. These operations also resulted in elevating TDG% to greater than the 110 percent criterion at a frequency of 10 percent early in the month and 2 percent in the latter part of the month with a maximum TDG% of 112.8 percent of saturation.

[3] 2,204 unit-hours = (1 unit x 20 hours) + (2 units x 756 hours) + (3 units x 224 hours)

- **August**: Aeration was conducted daily throughout the month with up to three units simultaneously resulting in a total of 472 unit-hours of aeration. These operations resulted in DO meeting the 8.0-mg/L criterion at a frequency of 15 percent early in the month and 48 percent late in the month. These operations also resulted in elevating TDG% to greater than the 110 percent criterion at a frequency of 40 percent early in the month and 28 percent in the latter part of the month with a maximum TDG% of 115.0 percent of saturation.
- **September**: Aeration was conducted daily with up to three units simultaneously, for a total of 521 unit-hours of aeration. These operations resulted in DO meeting the 8.0-mg/L criterion at a frequency of 4 percent early in the month and 66 percent late in the month. These operations also resulted in elevating TDG% to greater than the 110 percent criterion throughout the month at a frequency of 6 percent early in the month and 21 percent in the latter part of the month with a maximum TDG% of 112.4 percent of saturation.
- **October**: Aeration was conducted daily to the end of the month with up to three units simultaneously, for a total of 692-unit-hours of aeration. These operations resulted in meeting the 8.0-mgL DO criterion at a frequency of 90 percent early in the month and 99 percent late in the month. Aeration did not cause TDG% of greater than the 110 percent criterion.

Results of this study demonstrate progress toward meeting the DO criterion through aeration at Units 1, 2, 3, and 4 during the extreme low flow conditions of 2015.[4] From July 1 through October 31 of 2015, daily aeration enabled DO in powerhouse discharges to satisfy the 8.0-mg/L DO criterion approximately 65 percent of the time (Table 3-4) and to be within measurement accuracy (i.e., 7.8 mg/L or greater) 71 percent of the time (Figure 3-6). Aeration operations maintained TDG% that was less than the upper limit of 110 percent of saturation criterion 88 percent of the time (Table 3-4). Avista will continue to refine the use of real-time DO and TDG measurements for selecting aeration valve openings, with the goal of providing additional improvements in DO while limiting adverse TDG% conditions.

4.0 SIX-YEAR EVALUATION

Avista has made substantial progress toward addressing low DO concentrations of Long Lake HED discharges in accordance with the approved schedule (Figure 4-1). Avista initiated the process of determining reasonable and feasible measure(s) to address this issue during FERC relicensing of the Spokane River Project and has since identified turbine aeration as a reasonable and feasible measure, and progressively constructed and implemented aeration systems with a real-time water quality network linked from the compliance station at LLTR to the control room. Specific tasks have included:

- Conducted the Long Lake HED Phase I Aeration Study (HDR 2006).

[4] July through September average outflows for 1985 through 2009 ranged from approximately 4,100 to 1,500 cfs (HDR and REMI 2010, Figure 4-2). In comparison, the 2015 July through September average outflow was 1,308 cfs, which is approximately 200 cfs (13 percent) less than the minimum for any of the 25 years of 1985 through 2009.

- Selected and designed permanent water quality monitoring stations and developed a monitoring plan, then documented them in the Detailed Dissolved Oxygen Phase II Feasibility and Implementation Plan (Avista 2010). Approval of this plan was obtained from the Spokane Tribe on April 20, 2010, from Ecology on June 11, 2010, and from FERC with modifications on December 9, 2010.[5]
- Conducted and documented Phase II study components, which included:
  - Applying modeling tools to determine alternatives most likely to be effective (HDR and REMI 2010, Section 5.0 along with Appendix A and B).
  - Identifying the highest priority alternative to be field tested as turbine aeration with draft tube venting.
  - Preparing a Work Plan to test the effectiveness of highest priority alternative (HDR and REMI 2010, Section 6.0)
  - Implementing the Work Plan by testing turbine aeration on September 1 and 2 of 2010, and prepared a summary report (HDR and REMI 2010, Section 7.0 and Appendix C).
- Determined no additional aeration measures were necessary prior to implementing Phase III.
- Implemented Phase III construction of permanent modifications for the preferred alternative, which included assembly of air-inflow control devices that attach to each of the four draft tube intake ports and include an acoustic silencer, an air flow control valve, a bellmouth, and an "eyelid" type air baffle to enhance vacuum.
  - In 2011, installed air-inflow control devices on the four draft tube intake ports of Units 3 and 4, and conducted aeration operations between August 24 and October 19. Avista and Golder set up and maintained a system to continuously log LLTR water quality measurements onto a laptop computer in the pump house. Aeration valve openings were selected based on the logged DO and TDG values. Aeration was limited to a single unit at a time, even if more than one unit was operating.
  - In 2012, installed the air-inflow control devices on the four draft tube intake ports of Units 1 and 2. Avista also installed a radio-system to relay real-time water quality values from LLTR to the HED's plant, and conducted aeration operations between August 2 and October 14.[6] Avista used real-time DO and TDG values to select aeration valve openings for Units 1 and 2 with the goal of meeting the 8 mg/L DO criterion while maintaining a TDG of no more than 800 mm Hg[7] at LLTR during generation. Aeration included simultaneous use of air-inflow control devices on both Units 1 and 2.
  - In 2013, constructed two additional sets of air-inflow control systems. Avista also installed air-inflow control devices on the four draft tube intake ports of each of the HED's four units, upgraded the real-time water quality data communication to a fiber

[5]The FERC (2010) order modifying and approving this plan also requires Avista to submit the annual and five-year DO Monitoring reports to Ecology and the Spokane Tribe by March 1 of each year following monitoring, allowing the agencies at least 30 days to review and comment prior to submitting the final reports with the FERC by April 15, and documenting consultation with these agencies.

[6] The air-inflow control devices installed on Units 1 and 2 in 2012 were the same ones that had been installed on Units 3 and 4 in 2011.

[7] A TDG of 800 mm Hg would be 110 percent of saturation at a local barometric pressure of 727 mm Hg (i.e. barometric pressure of 765 mm Hg at sea level).

transmission system, and conducted aeration operations between August 6 and October 6. Avista used real-time water quality values to refine and implement a protocol to meet 8 mg/L DO without exceeding a TDG of 800 mm Hg. Aeration included simultaneous use of air-inflow control devices at as many as three units.

- In 2014, air-inflow control systems on the four draft tube intake ports of each of the HED's four units and the real-time water quality data fiber-transmission communication system were operational, and aeration was conducted between July 24 and October 21. Avista used real-time water quality values to refine and implement a protocol to meet 8 mg/L DO without exceeding a TDG of 800 mm Hg. Aeration was conducted at all four units and included simultaneous use of air-inflow control devices at as many as three units.
- In 2015, air-inflow control systems on the four draft tube intake ports of each of the HED's four units and the real-time water quality data fiber-transmission communication system continued to be operational. The Spokane River Basin's extreme low flows resulted in implementation of aeration each day from July 1 through October 31. Avista continued to use real-time water quality values to refine and implement a protocol to meet 8 mg/L DO without exceeding a TDG of 800 mm Hg. Aeration was conducted at all four units and included simultaneous use of air-inflow control devices at as many as three units, which is the maximum number operated simultaneously.

- Monitored DO and other relevant water quality conditions at monitoring stations including the LLTR located 0.6 mile downstream of Long Lake Dam from July 1 through October 30 of 2011, 2012, 2013, 2014, and 2015.
- Prepared and distributed annual DO monitoring reports (Golder 2012, 2013, and 2014) and the Five-Year DO Monitoring Report (Golder 2015) to Ecology, the Spokane Tribe, and FERC. This report also will be distributed to Ecology, the Spokane Tribe, and FERC.
- Coordinated results with the DO TMDL efforts. This included preparing the Lake Spokane DO Water Quality Attainment Plan (DO WQAP, Avista and Golder 2012), which discussed nine feasible potential measures to improve DO conditions. Ecology approved the DO WQAP on September 27, 2012 and FERC approved it on December 19, 2012 (FERC 2012). Avista summarized the baseline monitoring, implementation activities, effectiveness of the implementation activities, and proposed actions of the upcoming year in its annual reports (Avista 2014, 2015).

4.1 2010-2015 Monitoring Results

In 2010, the efficacy of conducting draft tube aeration to increase Long Lake HED plant discharge DO while maintaining TDG% less than the 110 percent of saturation criterion was tested and determined to be feasible (HDR and REMI 2010, Section 7.0 and Appendix C). During July through October of 2011 through 2015, Avista constructed and installed aeration equipment in Long Lake HED and used adaptive management with the monitored water quality results to determine the most effective aeration-valve openings. Table 4-1 shows the progression of implementing the DO Improvement Program and summarizes the monitoring results including the entire monitoring period (generation and non-generation).

Spring discharge was high and resulted in using the HED's spillgates to release flow for 15 days in 2011 and 5 days in 2012. In comparison, discharges in 2013, 2014, and 2015 were low and resulted in virtually no use of the spillgates to release flow downstream. These differences in discharge and spillgate use suggest less need for aeration in 2011 and 2012 than in 2013, 2014, and 2015. Nonetheless, DO monitoring results show that the DO 8.0-mg/L criterion was met more frequently in the HED's generation during 2013 and 2014 than in 2011 and 2012, and demonstrate improvements achieved through adaptive management. Even with the improvements from aeration, the extreme low flows of 2015, which averaged approximately 40 percent less than in 2013 and 2014, resulted in meeting the DO 8.0-mg/L criterion less frequently than the other years. This demonstrates the challenges of simultaneously meeting both the 8.0 mg/L DO criterion and 110-percent of saturation TDG criterion in extreme low flow periods.

4.2 Effectiveness for Meeting DO Criterion in Long Lake HED Discharge

The effectiveness of meeting the 8.0 mg/L DO criterion improved each year that the aeration system was expanded and real-time water quality network communication with the HED's control room was linked and improved (i.e., 2011 through 2014). This is documented by aeration operations resulting in the HED's discharge meeting the 8.0 mg/L DO criterion with a frequency of 80.8 percent in 2011, 84.7 percent in 2012, and 91.5 percent in 2013. The HED's discharge met the 8.0 mg/L DO criterion 87.4 percent of the time in 2014, which was also more frequently than in 2011 and 2012. Comparison of these results shows an improvement in meeting the DO criterion down to an average discharge of 2,441 cfs in 2014. However, aeration during each day of the 2015 extremely low flow conditions met the 8.0 mg/L DO criterion less frequently (65.1 percent of the time). This is likely due to the extremely low flows, which during 2015 averaged less than 1,396 cfs and were typically less than 2001 flows on coinciding days.[8]

The frequency of meeting the 110-percent TDG criterion was 99.9 percent in 2011, 96.2 percent in 2012, and 88.8 percent in 2013, and 86.6 in 2014. This reduction in the frequency of meeting the 110-percent TDG criterion was due to turbine aeration entraining all gasses present in the atmosphere, although the maximum TDG% resulting from aeration was 113.4 percent of saturation in 2013 and 113.9 percent of saturation in 2014. In 2015, a more conservative approach to not exceeding a TDG of 800 mm Hg, increased the frequency of meeting the 110-percent TDG criterion to 88.3 percent even though aeration occurred on all days of the monitoring period.

Avista and others have implemented measures to address low DO in Lake Spokane. These measures have the potential to increase the DO concentration of water being withdrawn from Lake Spokane and thereby increase DO concentrations in discharges from the Long Lake HED. These measures include, but are not limited to:

[8] Ecology selected 2001 as the critical river flow year for Spokane River DO TMDL water quality modeling and stated that using a representative critical low flow year [2001] should adequately protect water quality in Lake Spokane and the Spokane River (Ecology 2010b, page 20).

- **Lake Spokane DO WQAP** - Avista prepared the Lake Spokane DO WQAP (Avista and Golder 2012), which discussed nine feasible potential measures to improve DO conditions. Upon receiving FERC approval (December 19, 2012), Avista began implementing the DO WQAP and preparing Annual Reports for 2013, 2014, and 2015 (Avista 2014, 2015, and 2016, respectively), which provide a summary of the baseline monitoring, implementation activities, effectiveness of the implementation activities, and proposed actions of the upcoming year.

  - **Carp Population Reduction Program** – During 2013 and 2014, a Lake Spokane Carp Population Abundance and Distribution Study consisting of a Phase I and Phase II component was completed. Results of the Phase I and II components are presented in the DO WQAP 2014 Annual Summary Report (Avista 2015) and indicate that carp removal from Lake Spokane may provide meaningful reductions in TP directly through removal of TP in carp biomass (5g of TP/kg of carp) and indirectly through the reduction of re-suspended TP from sediments that carp disturb (bioturbation). The telemetry study in 2014 defined two time periods when carp were concentrated and vulnerable to harvest; during the winter and during the spring spawning period. Based on these findings, Avista recommended implementing a pilot study utilizing a combination of mechanical methods (including spring electrofishing, passive netting and winter seining), to identify an effective way to remove carp from Lake Spokane. Ecology agreed with Avista's plan in an approval letter dated May 28, 2015. Following Ecology's approval, Avista worked with the Washington Department of Fish and Wildlife (WDFW) and Ecology in planning a carp reduction effort for 2016.

    Following several planning discussions with Ecology and WDFW, Avista determined to focus its initial efforts on removing carp during the spring spawning season and will assess the effectiveness of electrofishing and the use of gill nets alone, and in combination, during carp spawning.

    Following the initial carp reduction activities Avista and WDFW will revisit winter seining opportunities, as necessary.

  - **Point Source Nutrient Load Reductions** – Upstream wastewater dischargers are implementing measures to reduce Spokane River point source nutrient loads from discharges in Washington and Idaho to meet the goal of the DO TMDL (Ecology 2010b).

- **Hangman Creek Basin Shoreline Stabilization and Agricultural Practices** - Avista continues to track plans and progress addressing erosion control in the Hangman Creek Basin by participating in meetings, including the Spokane Conservation District's Hangman Creek Bi-State Watershed Project and Ecology's Spokane River and Lake Spokane DO TMDL Advisory Committee meetings.

  In addition, Avista and the Coeur d'Alene Tribe have acquired over 500 acres of farmland with straightened creek beds on upper Hangman Creek through implementation of one of Avista's Spokane River License Wetland Mitigation requirements. Site-specific wetland management plans are updated annually for these properties and include establishing long-term, self-sustaining native emergent, scrub-shrub and/or forested wetlands, riparian habitat and associated uplands, through preservation, restoration and enhancement activities. Since 2013, approximately 8,000 native trees and shrubs have been planted on this approximately 500 acre wetland complex.

- **Native Tree Plantings on Avista Shoreline Property** - Avista and the Stevens County Conservation District planted 300 trees consisting of native cottonwoods and willows along Lake Spokane's northern shoreline on Avista-owned property in April 2013. One of the areas planted consists of a very steep sandy slope. The trees in this location are expected to reduce natural sloughing of sediment, which may contain total phosphorous, into the river and enhance shoreline habitat.
- **Wetland Restoration/Enhancement** - Avista acquired a 109-acre parcel on the Little Spokane River, the Sacheen Springs property, to fulfill its 42.51 acre wetland mitigation requirement identified in Section 5.3.G of the Certification. This property contains over one-half mile of frontage along the West Branch of the Little Spokane River that contains a highly valuable wetland complex with approximately 59 acres of emergent, scrub-shrub and forested wetlands and approximately 50 acres of adjacent upland forested buffer. Several seeps, springs, perennial and annual creeks are also found on the property. The property was purchased "in fee" and Avista will pursue a conservation easement in order to protect the property in perpetuity. Avista completed a detailed site-specific wetland management plan and began implementing it upon its approval by Ecology and FERC in 2014. In 2014 and 2015, a herbicide application was completed to control terrestrial invasive weeds, and should have the added benefit of improving the overall biodiversity and function of the wetland property.
- **Little Spokane Wetland & Shoreline Restoration** - As part of the Nine Mile HED's Rehabilitation Program, Avista partnered with the Washington State Parks and Recreation Commission to complete a wetland and shoreline restoration project on four acres within the Little Spokane Natural Area Preserve. The Natural Area Preserve is a popular location for recreation, however two invasive weed species, yellow flag iris and purple loosestrife, have severely impacted large sections of the river and adjacent shoreline. The mitigation project included herbicide treatments, large woody debris placement, and planting of 400 trees and shrubs (black cottonwoods, quaking aspens, chokecherry and red osier dogwood). Avista will continue to monitor the wetland and shoreline restoration project in 2016 and will implement measures necessary to ensure its continued success.
- **Floating Treatment Wetland** - Avista worked with the Stevens County Conservation District (SCCD) to plan the placement of a floating treatment wetland in Lake Spokane. The purpose of the floating treatment wetland would be for wave attenuation outside a community swim area as well as potential TP removal and surface water temperature reductions.
- **Land Protection** - Avista has identified approximately 215 acres of land that is currently used for grazing under lease from the Washington State Department of Natural Resources (DNR). This land is located within the south half of Section 16 in Township 27 North, Rand 40 E.W. M. in Stevens County. Avista will continue pursuing a lease for the 215 acres of land from DNR with the intent of placing the land in conservation use.

  In addition, Avista owns more than 1,000 acres of land, of which 350 acres are located within 200 feet of the Lake Spokane shoreline at the downstream end of the reservoir. During 2014 Avista continued to protect these lands, which also serve as a buffer adjacent to other undeveloped Avista land.
- **Bulkhead Removal** - During 2012, Avista partnered with Ecology, the Spokane County Conservation District, and the Stevens County Conservation District through an Ecology grant to identify two to five homeowners and encourage them to convert their bulkheads to more naturalized shorelines. Progress to date includes the removal of an approximate

90-foot-long bulkhead located at the Staggs parcel in Spokane County and replacement of the bulkhead with a more naturalized shoreline.[9]

During 2014 and 2015, Avista continued to work with the Stevens County Conservation District to plan and permit a design for an additional bulkhead removal project on an Avista-owned shoreline parcel located in TumTum. The project would consist of replacing an approximate 90-foot-long bulkhead with native rocks and vegetation to provide a more naturalized shoreline. Avista anticipates this project will take place during winter 2016/2017, after all permits have been obtained and when the lake is drawn down.

4.3 Need for Additional DO Enhancement Measures

Avista plans to continue draft tube aeration operations with adaptive management to refine effectiveness using real-time water quality monitoring results. Based on the effectiveness of the draft tube aeration program, combined with other measures being implemented to improve DO in Lake Spokane, no new or additional enhancement measures are necessary to meet the DO Water Quality Standard below Long Lake HED.

4.4 Need for Additional Monitoring

In order to adequately operate the draft tube aeration system for improving DO, but not causing the TDG criterion to be exceeded, there is a continued need for monitoring DO and TDG at LLTR and using the real-time data system to transmit water quality measurements from LLTR to the HED control room in the powerhouse. LLTR monitoring will follow the same procedures used in 2015, as described in the Detailed Dissolved Oxygen Phase II Feasibility and Implementation Plan (Avista 2010). As in 2015, Avista does not plan to monitor at LLFB, since water quality data from LLFB are not used for selecting aeration operations.

In response to the Spokane Tribe's comments on the 2014 Annual Report, Avista cooperated with the Spokane Tribe to compare their water quality monitoring results collected near Chamokane Creek, downstream of Long Lake HED, with those collected at LLTR. The results provided by the Spokane Tribe suggest that the DO levels increase, and are less susceptible to sags caused by power generation at Chamokane Creek than they are immediately downstream of the powerhouse.

Avista will continue to monitor DO and TDG at LLTR and will work with Ecology and the Spokane Tribe to determine the need for providing future annual reports of the aeration, DO and TDG monitoring results following completion of the DO critical season.

[9] A time-lapse video produced by the Staggs features the bulkhead removal project is available for viewing at the following website: http://www.youtube.com/watch?v=luT0RZShJoY.

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TABLES

Table 2-1: Long Lake HED Dissolved Oxygen Monitoring Station

Station Code	Description	Latitude / Longitude (NAD83)	Monitoring Type
LLTR	On left downstream bank, at a water pump house approximately 0.6 mile downstream from Long Lake dam	47°37'48"/ 117°31'47"	Long-term

Table 3-1: Summary of Continuous Water Quality Monitoring Results

Parameter	LLTR		
	Minimum	Maximum	Count
Date/Time (PDT)	7/1/2015 0:00	10/31/2015 23:45	11,808
Water Temperature (°C)	12.7	21.1	11,770
Dissolved Oxygen (mg/L)	5.8	9.9	11,764
BAR (mm Hg)	713	730	11,808
TDG (mm Hg)	710	827	11,750
TDG (% of saturation)	97.4	115.0	11,750
Dissolved Oxygen (% of saturation)	63.2	112.0	11,764

Table 3-2: Monthly Outflow from Long Lake HED

Month - Year	Minimum Hourly Discharge (cfs)	Maximum Hourly Discharge (cfs)	Average Hourly Discharge (cfs)
July 2015	210	4,810	1,407
August 2015	150	4,680	1,234
September 2015	150	4,680	1,282
October 2015	180	4,770	1,656
July through October 2015	150	4,810	1,396

Table 3-3: Summary of Exceedances of DO and TDG% Criteria at LLTR During Generation

Period		Operations, Spill, and Aeration Characteristics			LLTR DO					LLTR TDG			
Start	Stop	Operations	Spill [1]	Aeration	Total Number	Number DO <8.0 mg/L	Frequency DO <8.0 mg/L	Min DO (mg/L)	Min DO (%)	Total Number	Number >110.0%	Frequency >110.0%	Max TDG (%)
7/1/15 0:00	7/9/15 23:45	1 to 3 Units, Capacity varies, generation during portion of the day	110 cfs	3 Units used sometime each day	268	5	1.9%	7.8	90.2	268	46	17.2%	112.8
7/10/15 0:00	7/11/15 23:45	2 Units, Capacity varies, generation during portion of the day	110 cfs	2 Units used sometime each day	73	0	0.0%	8.1	93.9	73	0	0.0%	108.9
7/12/15 0:00	7/15/15 23:45	2 or 3 Units, Capacity varies, generation during portion of the day	110 cfs	3 Units used sometime each day	128	3	2.3%	7.9	90.0	128	0	0.0%	106.7
7/16/15 0:00	7/16/15 23:45	2 Units, Capacity varies, generation during portion of the day	110 cfs	2 Units used sometime each day	33	0	0.0%	8.5	96.8	33	0	0.0%	105.8
7/17/15 0:00	7/19/15 23:45	1 to 3 Units, Capacity varies, generation during portion of the day	110 cfs	3 Units used sometime each day	83	8	9.6%	7.8	89.7	83	0	0.0%	107.4
7/20/15 0:00	7/21/15 23:45	1 to 2 Units, Capacity varies, generation during portion of the day	110 cfs	2 Units used sometime each day	69	6	8.7%	7.9	90.9	69	0	0.0%	108.9
7/22/15 0:00	7/23/15 23:45	1 to 3 Units, Capacity varies, generation during portion of the day	110 cfs	3 Units used sometime each day	59	0	0.0%	8.1	93.1	59	0	0.0%	109.4
7/24/15 0:00	7/27/15 23:45	2 Units, Capacity varies, generation during portion of the day	110 cfs	2 Units used sometime each day	120	15	12.5%	7.6	86.4	120	0	0.0%	108.0
7/28/15 0:00	8/1/15 23:45	2 Units, Capacity varies, generation during portion of the day	No	2 Units used sometime each day	180	158	87.8%	6.8	77.5	180	31	17.2%	112.0
8/2/15 0:00	8/2/15 23:45	2 to 3 Units, Capacity varies, generation during portion of the day	No	3 Units used sometime each day	25	25	100.0%	6.6	74.9	25	12	48.0%	111.5
8/3/15 0:00	8/9/15 23:45	2 Units, Capacity varies, generation during portion of the day	No	2 Units used sometime each day	233	222	95.3%	6.4	72.1	233	71	30.5%	113.1
8/10/15 0:00	8/13/15 23:45	2 to 3 Units, Capacity varies, generation during portion of the day	No	3 Units used sometime each day	103	50	48.5%	6.1	69.2	100	51	51.0%	115.0
8/14/15 0:00	8/16/15 23:45	1 to 2 Units, Capacity varies, generation during portion of the day	No	2 Units used sometime each day	99	66	66.7%	6.1	68.1	99	24	24.2%	110.5
8/17/15 0:00	8/17/15 23:45	2 to 3 Units, Capacity varies, generation during portion of the day	No	3 Units used sometime each day	25	16	64.0%	6.8	77.2	25	4	16.0%	110.2
8/18/15 0:00	8/18/15 23:45	2 Units, Capacity varies, generation during portion of the day	No	2 Units used sometime each day	36	31	86.1%	6.6	74.9	36	6	16.7%	112.1
8/19/15 0:00	8/21/15 23:45	2 to 3 Units, Capacity varies, generation during portion of the day	No	3 Units used sometime each day	76	44	57.9%	7.0	79.6	76	43	56.6%	111.9
8/22/15 0:00	8/22/15 23:45	2 Units, Capacity varies, generation during portion of the day	No	2 Units used sometime each day	29	4	13.8%	6.7	74.9	29	6	20.7%	110.7
8/23/15 0:00	8/26/15 23:45	2 to 3 Units, Capacity varies, generation during portion of the day	No	3 Units used sometime each day	100	41	41.0%	6.6	74.3	100	50	50.0%	111.2
8/27/15 0:00	8/27/15 23:45	2 Units, Capacity varies, generation during portion of the day	No	2 Units used sometime each day	45	5	11.1%	6.6	73.4	45	9	20.0%	110.8
8/28/15 0:00	8/28/15 23:45	2 to 3 Units, Capacity varies, generation during portion of the day	No	3 Units used sometime each day	25	4	16.0%	7.6	85.5	25	10	40.0%	110.5
8/29/15 0:00	8/30/15 23:45	2 Units, Capacity varies, generation during portion of the day	No	2 Units used sometime each day	65	65	100.0%	6.1	67.8	65	0	0.0%	109.9

Golder Associates

Mattax Solutions LLC

Table 3-3: Summary of Exceedances of DO and TDG% Criteria at LLTR During Generation

Period		Operations, Spill, and Aeration Characteristics			LLTR DO					LLTR TDG			
Start	Stop	Operations	Spill [1]	Aeration	Total Number	Number DO <8.0 mg/L	Frequency DO <8.0 mg/L	Min DO (mg/L)	Min DO (%)	Total Number	Number >110.0%	Frequency >110.0%	Max TDG (%)
8/31/15 0:00	9/1/15 23:45	2 to 3 Units, Capacity varies, generation during portion of the day	No	3 Units used sometime each day	73	47	64.4%	6.9	77.5	73	16	21.9%	111.3
9/2/15 0:00	9/8/15 23:45	1 or 2 Units, Capacity varies, generation during portion of the day	No	2 Units used sometime each day	220	219	99.5%	6.8	75.0	217	0	0.0%	109.8
9/9/15 0:00	9/11/15 23:45	2 to 3 Units, Capacity varies, generation during portion of the day	No	3 Units used sometime each day	100	100	100.0%	7.1	77.3	100	20	20.0%	110.7
9/12/15 0:00	9/18/15 23:45	2 to 3 Units, Capacity varies, generation during portion of the day	No	2 Units used sometime each day	257	239	93.0%	5.8	63.3	254	11	4.3%	110.8
9/19/15 0:00	9/19/15 23:45	2 to 3 Units, Capacity varies, generation during portion of the day	No	3 Units used sometime each day	28	13	46.4%	7.6	82.7	28	0	0.0%	109.9
9/20/15 0:00	9/22/15 23:45	1 to 2 Units, Capacity varies, generation during portion of the day	No	2 Units used sometime each day	105	72	68.6%	6.0	64.0	105	29	27.6%	110.8
9/23/15 0:00	9/24/15 23:45	2 to 3 Units, Capacity varies, generation during portion of the day	No	3 Units used sometime each day	83	10	12.0%	7.5	80.7	83	43	51.8%	111.1
9/25/15 0:00	10/3/15 23:45	2 Units, Capacity varies, generation during portion of the day	No	2 Units used sometime each day	355	9	2.5%	7.0	74.1	355	34	9.6%	112.4
10/4/15 0:00	10/4/15 23:45	2 to 3 Units, Capacity varies, generation during portion of the day	No	3 Units used sometime each day	32	0	0.0%	8.7	91.9	32	0	0.0%	109.1
10/5/15 0:00	10/14/15 23:45	2 Units, Capacity varies, generation during portion of the day	No	2 Units used sometime each day	420	61	14.5%	6.7	68.8	418	0	0.0%	109.2
10/15/15 0:00	10/15/15 23:45	2 to 3 Units, Capacity varies, generation during portion of the day	No	3 Units used sometime each day	52	0	0.0%	8.1	82.3	52	0	0.0%	105.2
10/16/15 0:00	10/18/15 0:00	2 Units, Capacity varies, generation during portion of the day	No	2 Units used sometime each day	82	0	0.0%	8.4	85.9	82	0	0.0%	105.7
10/18/15 0:15	10/18/15 23:45	2 to 3 Units, Capacity varies, generation during portion of the day	No	3 Units used sometime each day	55	0	0.0%	8.4	86.5	55	0	0.0%	105.6
10/19/15 0:00	10/20/15 23:45	2 Units, Capacity varies, generation during portion of the day	No	2 Units used sometime each day	132	0	0.0%	8.1	82.6	129	0	0.0%	104.9
10/21/15 0:00	10/25/15 23:45	2 to 3 Units, Capacity varies, generation during portion of the day	No	3 Units used sometime each day	234	8	3.4%	7.9	80.3	234	0	0.0%	105.9
10/26/15 0:00	10/26/15 23:45	1 to 2 Units, Capacity varies, generation during portion of the day	No	2 Units used sometime each day	49	0	0.0%	8.3	84.1	49	0	0.0%	102.5
10/27/15 0:00	10/31/15 23:45	2 to 3 Units, Capacity varies, generation during portion of the day	No	3 Units used sometime each day	283	0	0.0%	8.0	80.2	283	0	0.0%	105.3
7/1/15 0:00	10/31/15 23:45	Cumulative of above operations	≤110 cfs	2 to 3 Units used sometime each day	4,434	1,546	34.9%	5.8	63.3	4,420	516	11.7%	115.0

Notes:

1. During the July 1 - October 31, 2015 monitoring season, spill reached a maximum of 110 cfs during generation and 470 cfs during non-generation immediately before termination of the spill on the morning of July 28.

Table 3-4: Semi-monthly Summary of Water Quality and HED Operations During Generation

Period		HED Operations				LLTR Water Temperature		LLTR DO			LLTR DO%				LLTR TDG%		
Start	Stop	Generation (hours)	Spill >200 cfs (hours)	Average Total Discharge (cfs)	Aeration (unit-hours)	Total Number 15-Min Values	Average Water Temp (°C)	Total Number 15-Min Values	Min DO (mg/L)	Frequency <8.0 mg/L	Total Number 15-Min Values	Min DO%	Max DO%	Frequency <80.0%	Total Number 15-Min Values	Max TDG%	Frequency >110.0% [1]
7/1/2015 0:00	7/15/2015 23:45	117	0	3,730	268	469	19.5	469	7.8	1.7%	469	90.0	112.0	0.0%	469	112.8	9.8%
7/16/2015 0:00	7/31/2015 23:45	127	0	3,253	257	511	19.4	511	6.9	30.1%	511	78.4	103.8	0.4%	511	111.5	1.6%
8/1/2015 0:00	8/15/2015 23:45	116	0	3,178	217	460	19.3	460	6.1	85.0%	460	68.1	99.3	6.1%	457	115.0	39.6%
8/16/2015 0:00	8/31/2015 23:45	118	0	3,435	254	474	18.8	474	6.1	51.9%	474	67.8	98.7	6.8%	474	112.1	28.5%
9/1/2015 0:00	9/15/2015 23:45	128	0	3,230	253	508	17.3	508	5.8	96.5%	508	63.3	92.5	32.3%	505	111.1	5.7%
9/16/2015 0:00	9/30/2015 23:45	140	0	3,028	267	557	16.1	557	6.0	33.8%	557	64.0	97.0	7.2%	554	112.4	21.1%
10/1/2015 0:00	10/15/2015 23:45	156	0	2,996	284	620	15.1	620	6.7	9.8%	620	68.8	103.3	5.8%	618	109.9	0.0%
10/16/2015 0:00	10/31/2015 23:45	210	0	3,396	407	835	13.7	835	7.9	1.0%	835	80.2	94.5	0.0%	832	105.9	0.0%
7/1/2015 0:00	10/31/2015 23:45	1,114	0	3,274	2,204	4,434	17.0	4,434	5.8	34.9%	4,434	63.3	112.0	6.8%	4,420	115.0	11.7%

Notes:

1. 110% TDG criterion is not applicable when discharge exceeds the 7-day average flow with a 10-year return period, which is referred to as the 7Q10.

Table 3-5: Semi-monthly Summary of Water Quality and HED Operations During Non-Generation

Period		HED Operations				LLTR Water Temperature		LLTR DO			LLTR DO%				LLTR TDG%		
Start	Stop	Non-Generation (hours)	Spill >200 cfs (hours)	Average Total Discharge (cfs)	Aeration (unit-hours)	Total Number 15-Min Values	Average Water Temp (°C)	Total Number 15-Min Values	Min DO (mg/L)	Frequency <8.0 mg/L	Total Number 15-Min Values	Min DO%	Max DO%	Frequency <80.0%	Total Number 15-Min Values	Max TDG%	Frequency >110.0% [1]
7/1/2015 0:00	7/15/2015 23:45	242	0	3,730	268	966	19.3	966	7.5	20.0%	966	85.6	103.7	0.0%	964	108.8	0.0%
7/16/2015 0:00	7/31/2015 23:45	256	2	3,253	257	1,021	19.1	1,015	7.0	69.1%	1,015	78.9	97.9	0.5%	1,020	109.3	0.0%
8/1/2015 0:00	8/15/2015 23:45	243	0	3,178	217	975	19.0	975	6.1	95.6%	975	69.3	96.9	33.2%	975	111.5	2.2%
8/16/2015 0:00	8/31/2015 23:45	265	0	3,435	254	1,058	18.6	1,058	6.0	94.9%	1,058	67.5	93.4	38.1%	1,055	110.7	1.5%
9/1/2015 0:00	9/15/2015 23:45	231	0	3,230	253	927	17.2	927	5.8	100.0%	927	63.2	86.8	70.9%	927	109.6	0.0%
9/16/2015 0:00	9/30/2015 23:45	219	0	3,028	267	877	16.1	877	6.8	48.3%	877	72.2	98.7	22.1%	877	112.6	2.7%
10/1/2015 0:00	10/15/2015 23:45	204	0	2,996	284	816	15.1	816	7.0	23.3%	816	72.3	107.5	5.4%	816	109.3	0.0%
10/16/2015 0:00	10/31/2015 23:45	174	0	3,396	407	696	13.8	696	7.8	5.9%	696	78.7	93.3	3.6%	696	104.9	0.0%
7/1/2015 0:00	10/31/2015 23:45	1,837	2	3,274	2,204	7,336	17.5	7,330	5.8	60.2%	7,330	63.2	107.5	22.5%	7,330	112.6	0.8%

Notes:

1. 110% TDG criterion is not applicable when discharge exceeds the 7-day average flow with a 10-year return period, which is referred to as the 7Q10.

Table 3-6: Summary of DO Less than 8.0 mg/L, DO Criterion Lower Limit

Parameter	LLTR		
	Total Number	Number <8.0 mg/L DO[2]	Frequency <8.0 mg/L DO
Generation With Spill > 200 cfs	0	0	#DIV/0!
Generation With Spill ≤ 200 cfs	833	37	4.4%
Generation Without Spill	3,601	1,509	41.9%
All Generation[1]	4,434	1,546	34.9%
Non-Generation[2]	7,330	4,412	60.2%
All	11,764	5,958	50.6%

Notes:

1. Of the 4,434 measurements, 1,101 (24.8%) were less than 7.8 mg/L.
2. Of the 7,330 measurements, 3,544 (48.3%) were less than 7.8 mg/L.

Table 3-7: Summary of TDG% Greater than 110.0%, TDG Criterion Upper Limit

Parameter	LLTR		
	Total Number	Number >110% TDG [2]	Frequency >110% TDG
Generation With Spill > 200 cfs [1]	0	0	#DIV/0!
Generation With Spill <200cfs	833	46	5.5%
Generation Without Spill	3,587	470	13.1%
All Generation [2]	4,420	516	11.7%
Non-Generation [3]	7,330	61	0.8%
All	11,750	577	4.9%

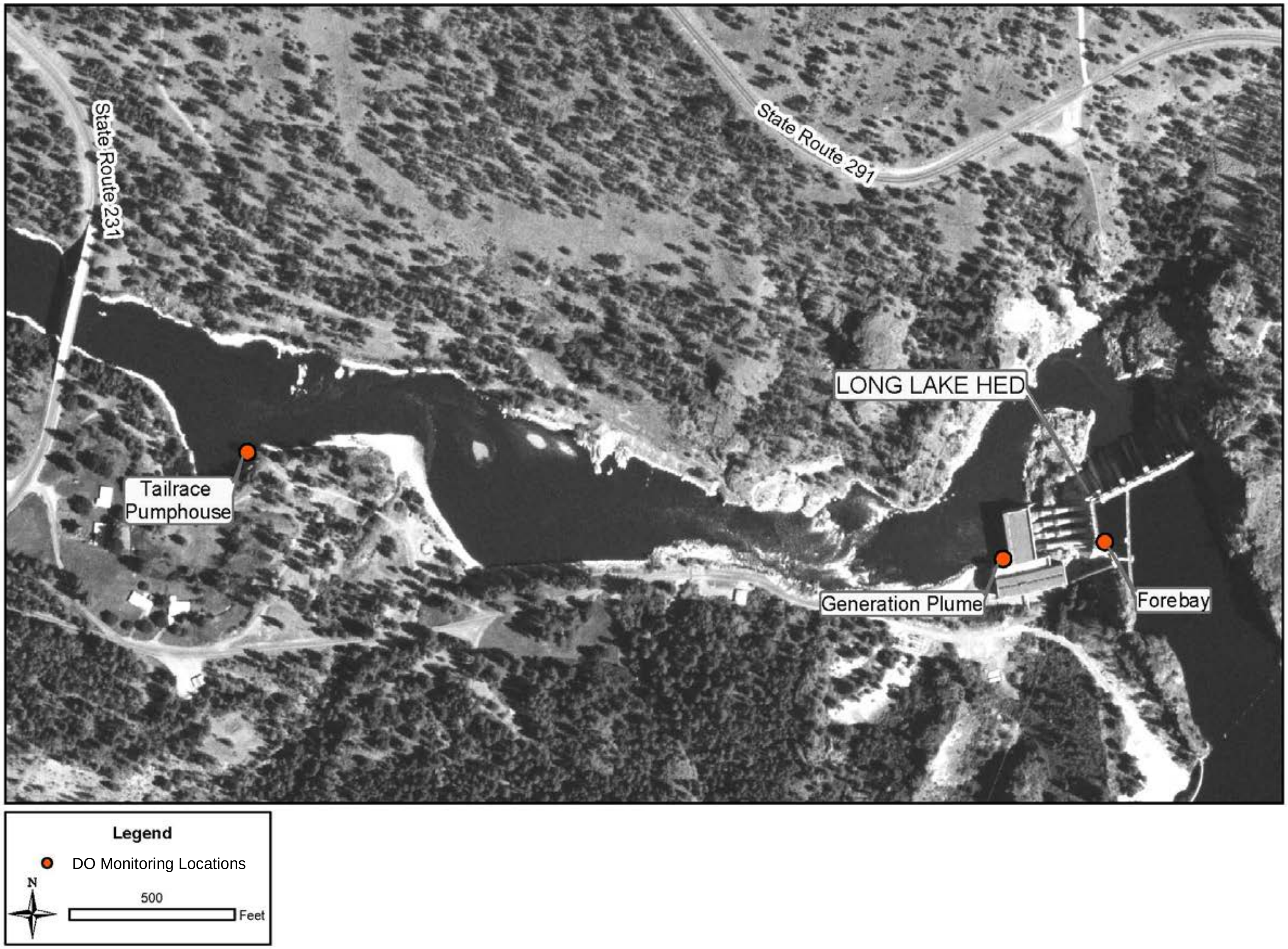
Notes:
1. 110% TDG criterion is not applicable when discharge exceeds the 7-day average flow with a 10-year return period, which is referred to as the 7Q10.
2. Of the 4,420 measurements, 19 (0.4%) were greater than 112% TDG.
3. Of the 7,330 measurements, 1 (0.01%) were greater than 112% TDG.

Table 4-1: Aeration Operations and Frequency of Meeting DO and TDG% Criteria

	2010 [a]	2011 [b]	2012 [c]	2013 [d]	2014 [e]	2015
Long Lake HED Operations						
Average July - October Discharge (cfs)	nr	3,819	2,941	2,298	2,441	1,396
HED Units with Aeration	Tested aeration of Units 3 and 4	Units 3 and 4 with no more than 1 unit aerating at same time	Units 1 and 2 with up to 2 units aerating at same time	Units 1, 2, 3, and 4 with up to 3 units aerating at same time	Units 1, 2, 3, and 4 with up to 3 units aerating at same time	Units 1, 2, 3, and 4 with up to 3 units aerating at same time
Aeration start and end dates, respectively	September 1 and 2	August 24 and October 19	August 2 and October 14	August 6 and October 6	July 24 and October 21	July 1 and October 31
Aeration Hours	25 unit-hours within 14 hours	684 unit-hours within 684 hours	1,687 unit-hours within 1,021 hours	1,562 unit-hours within 859 hours	2,282 unit-hours within 1,045 hours	2,204 unit-hours within 1,000 hours
Frequency LLTR Dissolved Oxygen ≥8.0 mg/L						
During Generation without Spillgate Use [f]	Test results indicate aeration could achieve DO of 7.5 and 8 mg/L while maintaining TDG% <110%	80.8% of 6,709 values	84.7% of 8,272 values	91.5% of 6,826 values	87.4% of 6,656 values	65.1% of 4,434 values
During Generation with Spillgate Use [g]		100.0% of 1,472 values	100.0% of 484 values	zero values	100.0% of 4 values	zero values
Entire Generation Period		84.2% of 8,181 values	85.5% of 8,756 values	91.5% of 6,826 values	87.4% of 6,660 values	65.1% of 4,434 values
Entire Monitoring Period (Both Generation and non-Generation)		67.2% of 11,787	67.6% of 11,786	75.0% of 11,772 values	74.3% of 11,445 values	49.4% of 11,764 values
Frequency LLTR TDG% ≤110.0%						
During Generation without Spillgate Use [f]	Test results documented that draft-chest aeration could cause TDG% >110%	99.9% of 6,676 values	96.2% of 8,262 values	88.8% of 6,825 values	86.6% of 6,773 values	88.3% of 4,420 values
During Generation with Spillgate Use [g]		0.7% of 1,467 values	4.3% of 484 values	zero values	75.0% of 4 values	zero values
Entire Generation Period		82.0% of 8,143 values	91.1% of 8,746 values	88.8% of 6,825 values	86.6% of 6,777 values	88.3% of 4,420 values
Entire Monitoring Period (Both Generation and non-Generation)		87.6% of 11,748	93.4% of 11,773	93.9% of 11,768 values	90.5% of 11,616 values	95.1% of 11,750 values

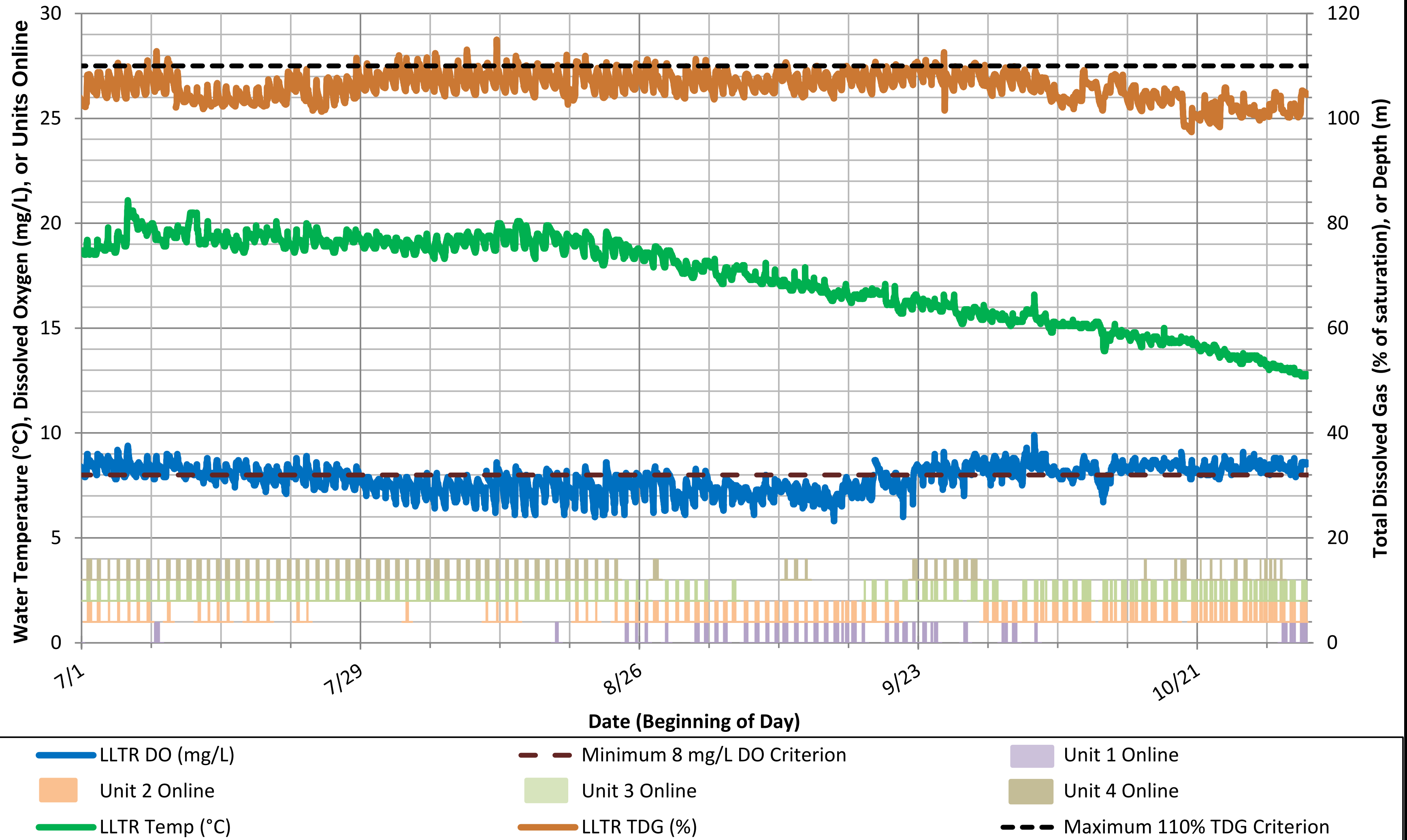
Notes:
nr = data not analyzed
[a] September 1 and 2, 2010 aeration testing is documented in HDR and REMI (2010, Section 7.0 and Appendix C).
[b] 2011 Monitoring is documented in Golder (2012).
[c] 2012 Monitoring is documented in Golder (2013).
[d] 2013 Monitoring is documented in Golder (2014).
[e] 2014 Monitoring is documented in Golder (2015).
[f] Includes periods of <200 cfs spill in 2014 and 2015.
[g] Excludes periods of <200 cfs spill in 2014 and 2015.

FIGURES



Source: Avista

Figure 2-1: Established Long Lake HED Long-Term Water Quality Monitoring Station Locations



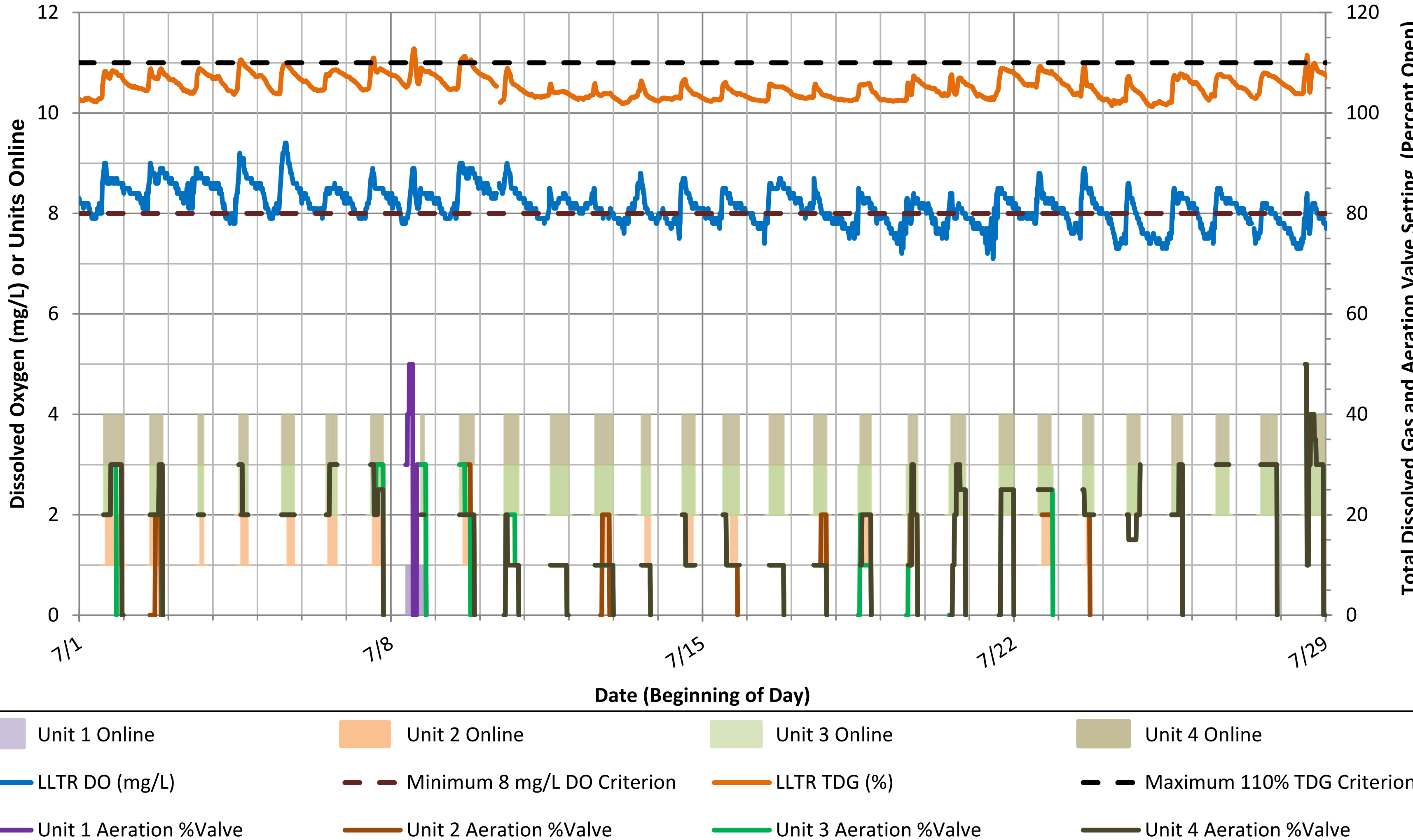
Golder Associates

Mattax Solutions LLC

Title	LLTR Water Temperature, Dissolved Oxygen, TDG%, and Operations		
Project Name	LL DO Monitoring	Project No.	073-93081-14.500
Client Name	Avista	Date	February 26, 2016

FIGURE 3-1

V:\PROJECTS_2007-PROJECTS\073-93081_Avista 401 Cert\Ext 14 Temp\LLDO DO Report\Final April 2016\040816_Tables and Figures_LL_DO_Processed_Data_2015.xlsx



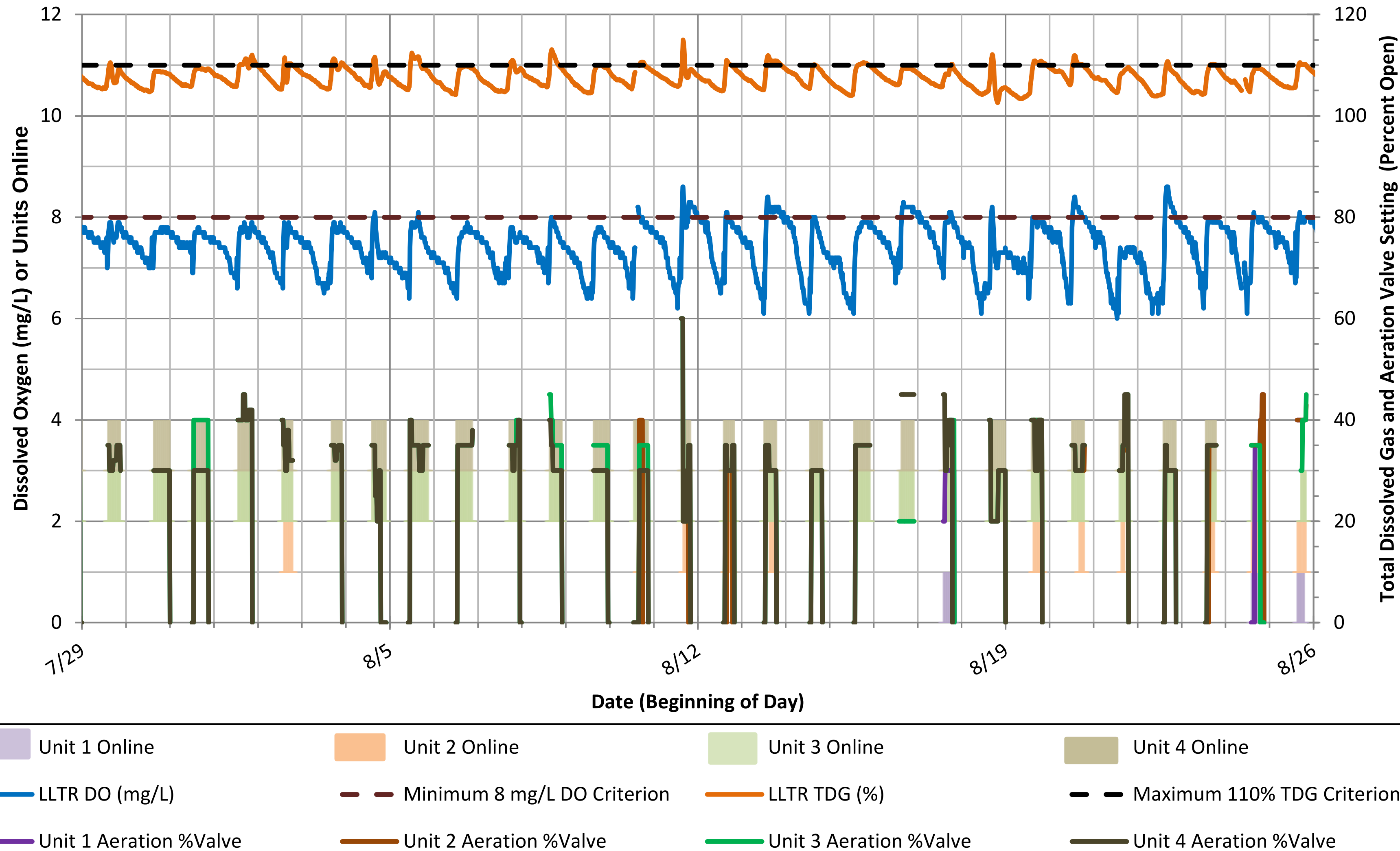
Golder Associates

Mattax Solutions LLC

Title	LLTR Dissolved Oxygen Concentration and TDG% with Operations, July 1 - July 29		
Project Name	LL DO Monitoring	Project No.	073-93081-14.500
Client Name	Avista	Date	February 26, 2016

FIGURE 3-2

V:\PROJECTS_2007-PROJECTS\073-93081_Avista 401 Cert\Ext 14 Temp\LLDO DO Report\Final April 2016\040816_Tables and Figures_LL_DO_Processed_Data_2015.xlsx



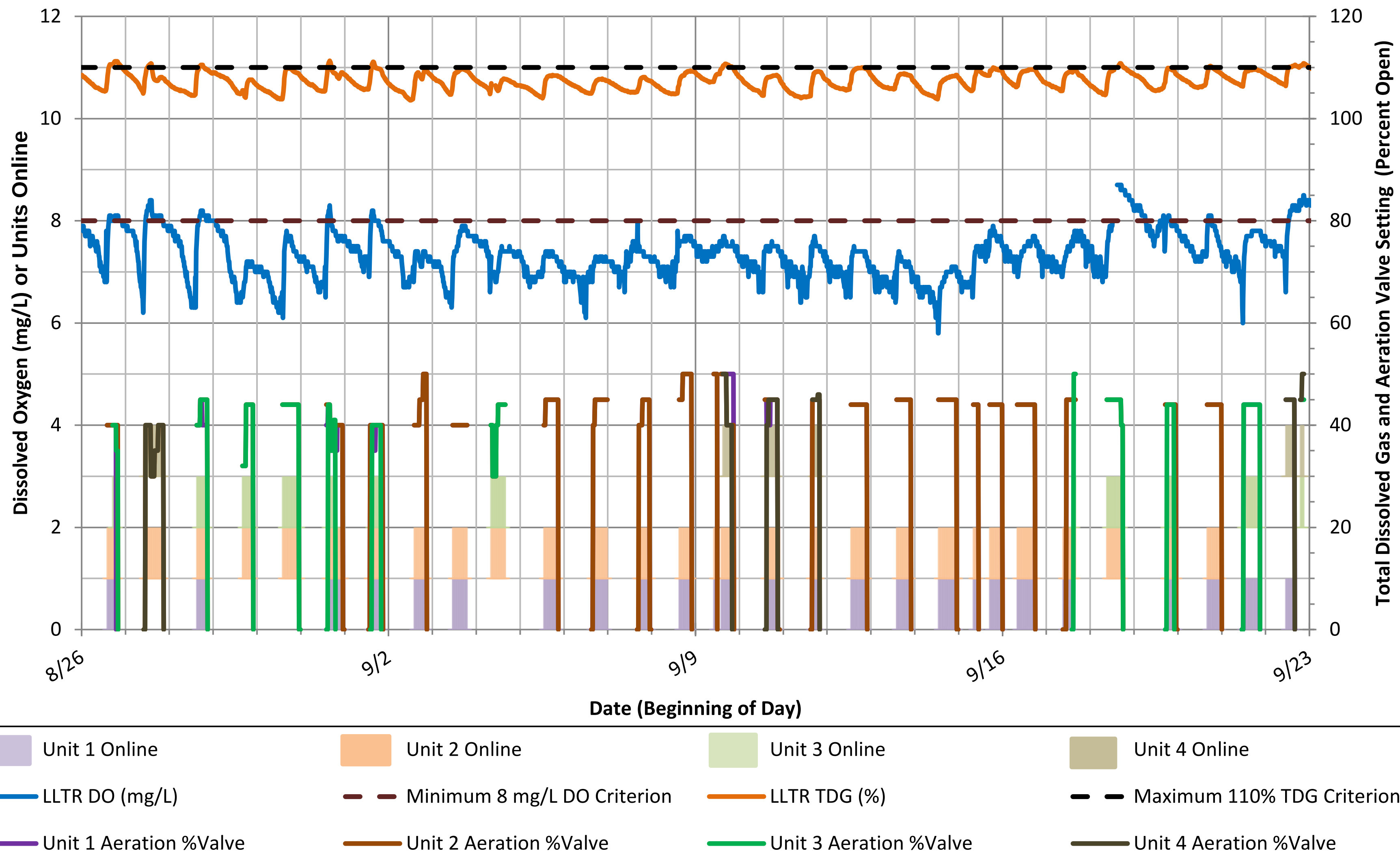
Golder Associates

Mattax Solutions LLC

Title	LLTR Dissolved Oxygen Concentration and TDG% with Operations, July 29 - August 26		
Project Name	LL DO Monitoring	Project No.	073-93081-14.500
Client Name	Avista	Date	February 26, 2016

FIGURE 3-3

V:\PROJECTS_2007-PROJECTS\073-93081_Avista 401 Cert\Ext 14 Temp\LLDO DO Report\Final April 2016\040816_Tables and Figures_LL_DO_Processed_Data_2015.xlsx

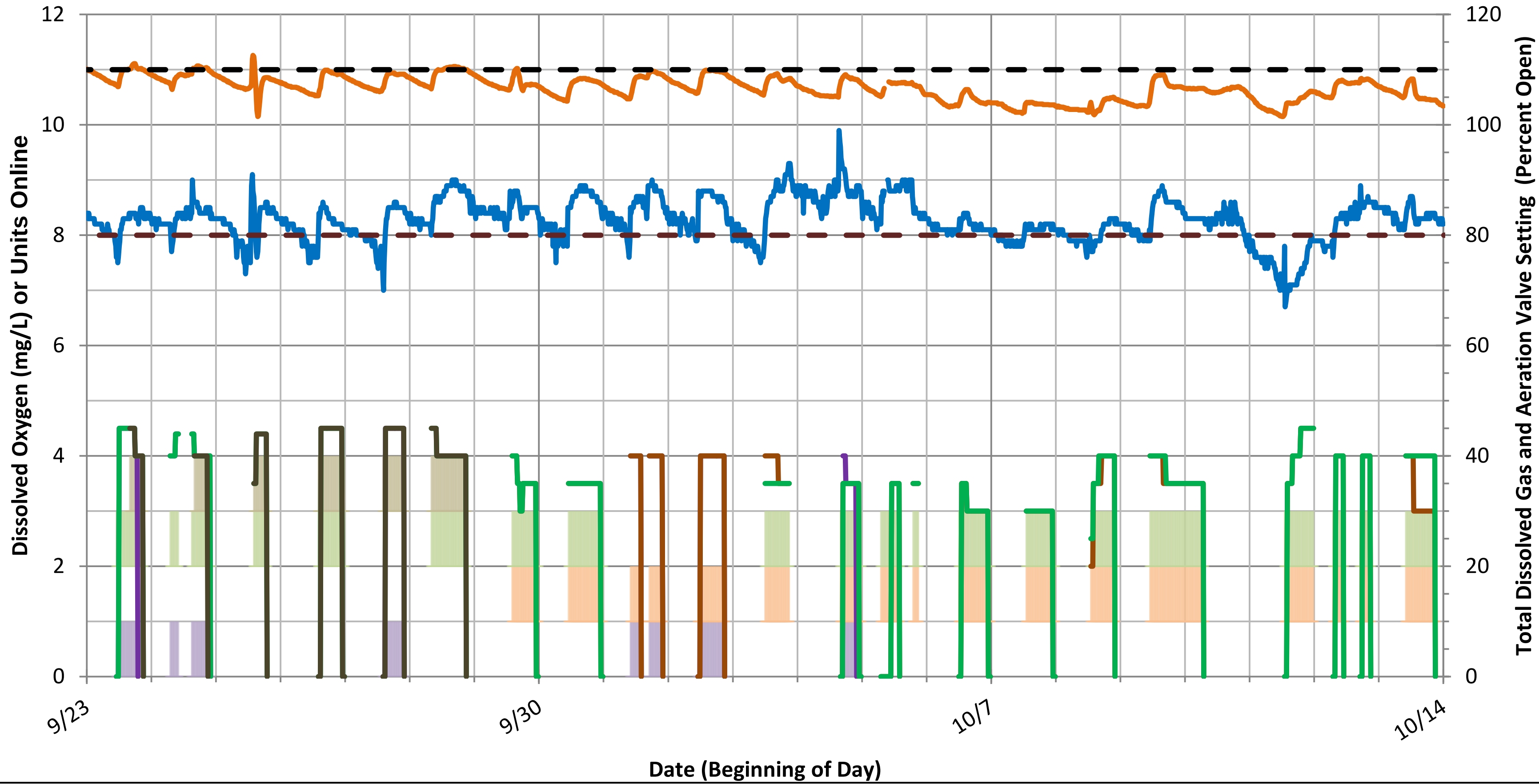


Golder Associates

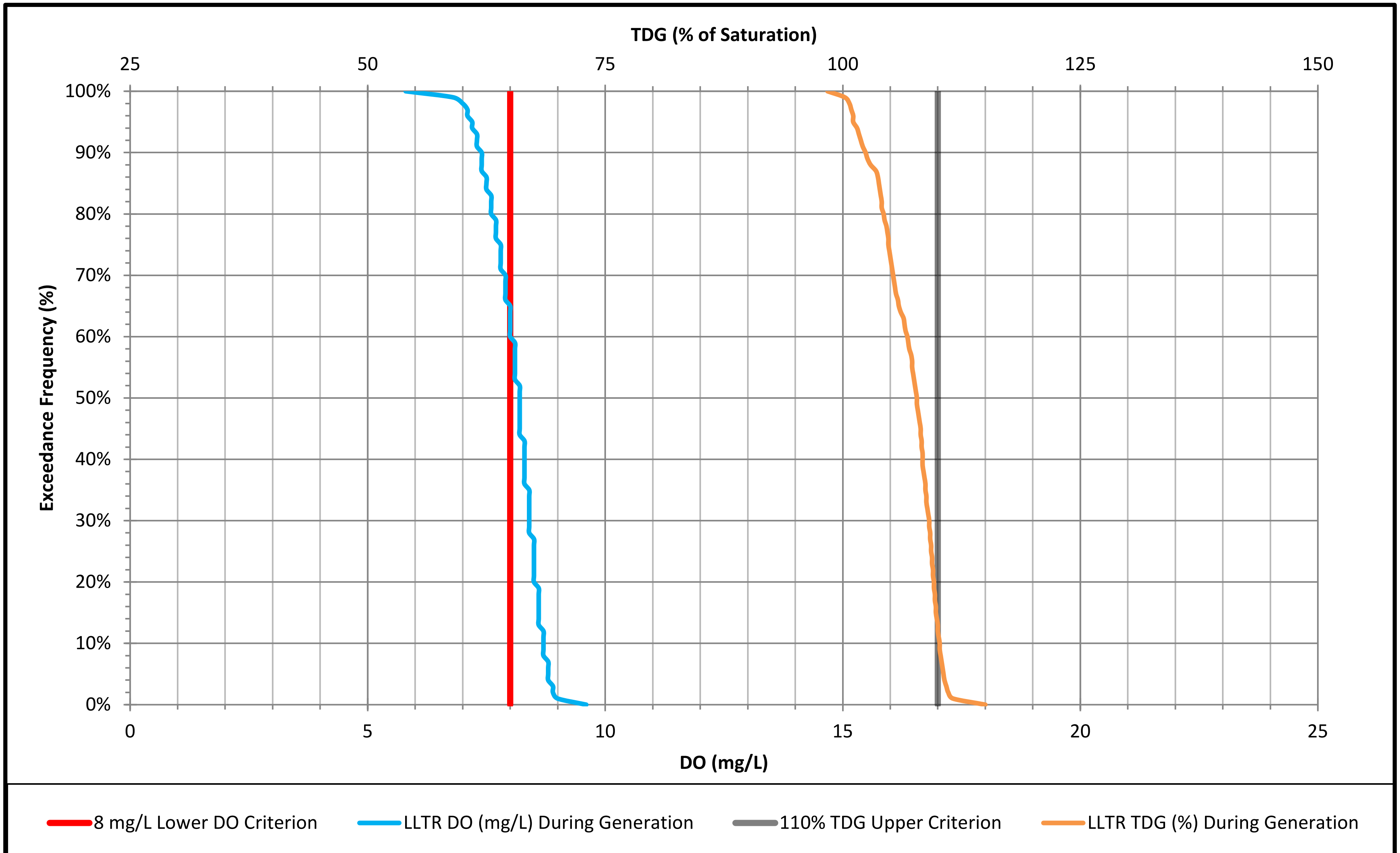
Mattax Solutions LLC

Title	LLTR Dissolved Oxygen Concentration and TDG% with Operations, August 26 - September 23		
Project Name	LL DO Monitoring	Project No.	073-93081-14.500
Client Name	Avista	Date	February 26, 2016
FIGURE 3-4			

V:\PROJECTS_2007-PROJECTS\073-93081_Avista 401 Cert\Ext 14 Temp\LLDO DO Report\Final April 2016\040816_Tables and Figures_LL_DO_Processed_Data_2015.xlsx



Golder Associates / Mattax Solutions LLC	Title: LLTR Dissolved Oxygen Concentration and TDG% with Operations, September 23 - October 14		
	Project Name: LL DO Monitoring	Project No.: 073-93081-14.500	FIGURE 3-5
	Client Name: Avista	Date: February 26, 2016	



Golder Associates

Mattax Solutions LLC

Title	LLTR DO Concentration and TDG% Exceedance Frequency during Generation		
Project Name	LL DO Monitoring	Project No.	073-93081-14.500
Client Name	Avista	Date	February 26, 2016

FIGURE 3-6

Golder Associates

Mattax Solutions LLC

Title: LLTR Dissolved Oxygen Concentration and Percent of Saturation along with Operations

Project Name	LL DO Monitoring	Project No.	073-93081-14.500	FIGURE 3-7
Client Name	Avista	Date	February 26, 2016	

V:\PROJECTS_2007-PROJECTS\073-93081_Avista 401 Cert\Ext 14 Temp\LLDO DO Report\Final April 2016\040816_Tables and Figures_LL_DO_Processed_Data_2015.xlsx

Action	Task	2009	2010	2011	2012	2013	2014	2015
Structural Modifications	Phase II – Apply modeling tools to determine alternatives most likely to be effective		S	S	S			
	Phase II – Identify highest priority alternative to be field tested		S					
	Phase II – Prepare Work Plan to test effectiveness of highest priority alternative		S					
	Phase II – Implement Work Plan and prepare summary report		S					
	Phase II – Determine if additional aeration measures are necessary, and prepare/implement corresponding Work Plans for testing effectiveness of additional high priority aeration measures			(S)	(S)			
	Phase III - Construct permanent modifications for preferred alternative			S	S			
	Phase IV - Evaluate need for any additional DO enhancement measures					S	S	
Monitoring	Select/design permanent monitoring stations and develop monitoring plan	M	M					
	Prepare and implement Phase II water quality monitoring plan(s) for testing of high priority alternatives		M	(M)	(M)			
	Monitor DO and other relevant water quality conditions at the 0.6 mile downstream of Long Lake Dam (LLTR)		M	M	M	M	M	
	Annual Monitoring Report			M	M	M	M	
	Five-Year Report							M

Legend

S	Structural
M	Monitoring

() Only done if testing demonstrates need for additional Long Lake HED discharge aeration measures.

Note: The FERC (2010) Order Modifying and Approving this schedule included requiring Avista to submit the annual and five-year DO Monitoring reports to Ecology and the Spokane Tribe by March 1 of each year following monitoring (starting in 2011), allowing the agencies at least 30 days to review and comment prior to submitting the final reports with the FERC by April 15, and documenting consultation with these agencies.

Figure 4-1: Approved Long Lake HED DO Feasibility and Implementation Schedule

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 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 Total Dissolved Gas	400 to 1300 mm Hg	± 0.1 % of span	1.0 mm Hg
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

Note: Sources: Hach MS5 User Manual and Solinist Levelogger User Guide [10]

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 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

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

[10] 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

Table Part 1: Barometric Pressure (BAR), Total Pressure, Total Dissolved Gas (TDG)

	RMSE [1]				MQO			RMSE - MQO (positive shaded values denote exceedance of MQO)			
Meter IDs	BAR[2]	Total Pressure[3]	TDG-cal[4]	TDG-spot[5]	BAR	Total Pressure	TDG	BAR	Total Pressure	TDG-cal	TDG-spot[5]
	mm Hg	%	%	mm Hg	mm Hg	%	%	mm Hg	%	%	%
48762	3.20	0.44	0.44	1.53	2	1	1	1.20	-0.56	-0.56	0.53
48763	2.60	0.36	0.36	1.97	2	1	1	0.60	-0.64	-0.64	0.97
Overall RMSE	2.92	0.40	0.40	N/A	2	1	1	0.92	-0.60	-0.60	N/A

Notes:

[1] RMSE calculated for each meter during calibration checks and 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%.

[5] RMSE calculated as the measured TDG divided by the group average measured TDG for each of 9 occasions.

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-3 (Continued): Difference Between RMSE and MQOs by MS5

Table Part 2: Temperature and Dissolved Oxygen (DO)

Meter IDs	RMSE				MQO		RMSE - MQO (positive shaded values denote exceedance of MQO)			
	Temperature[1]		Dissolved Oxygen[2]		Temp	DO	Temperature[1]		Dissolved Oxygen[2]	
	Calibration	Spot[3]	Calibration	Spot[3]			Calibration	Spot[3]	Calibration	Spot[3]
	°C	°C	mg/L	mg/L	°C	mg/L	°C	°C	mg/L	mg/L
48762	0.11	0.02	0.15	0.14	0.5	0.5	-0.39	-0.48	-0.35	-0.36
48763	0.17	0.02	0.19	0.15	0.5	0.5	-0.33	-0.48	-0.31	-0.35
Overall RMSE	0.14	N/A	0.17	N/A	0.5	0.5	-0.36	N/A	-0.33	N/A

[1] For Calibration, RMSE calculated from the difference between the meter and calibration thermometer at all calibration checks. Spot differences are average differences between measured values from group averagefor each of 10 occasions.

[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 for each of 10 occasions.

[3] RMSE calculated as the measured TDG divided by the group average measured TDG for each of 9 occasions.

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 a measurement is to its "true" value (low bias). Throughout this seasonal DO monitoring study, the MS5s underwent calibration and verification procedures.

Instrument accuracy was evaluated through the calibration and maintenance activities along with paired spot measurements (Table A-3). MQOs for DO, temperature, and total pressure were met for both meters. The BAR 2-mm Hg MQO was exceeded by 1.20 mm Hg for the primary MS5 (#48762) and by 0.60 for the secondary MS5 (#48763). The accuracy of total pressure varied. The TDG% 1-percent MQO was met for the calibration of both MS5s, although the spot measurements exceeded the TDG% MQO by 0.53 percent for the primary MS5 (#48762) and 0.97 percent for the secondary MS5 (#48763).

Discharge and aeration data were obtained from Avista, which uses a well-established monitoring program. Golder Associates Inc. (Golder) reviewed the variability of these data to determine whether values were appropriate based on expectations. All discharge and aeration data were deemed acceptable.

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 DO 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 downstream long-term monitoring station (LLTR) monitored in the past and monitoring in the LLFB standpipe constructed in 2009 and used in 2010, 2011, 2012, and 2013.

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 DO data collection period consisted of 11,808 15-minute periods. DO and all remaining parameters had completeness of greater than 99 percent, which met the goal of 90 percent.

Table A-5 summarizes the number of specific DQ Codes applied to LLTR data.

Table A-4: Project Completeness

	LLTR	
	Count	**Completeness (%)**
Monitoring Period	11,808	--
Water Temperature (°C)	11,770	99.7%
Dissolved Oxygen (mg/L)	11,764	99.6%
BAR (mm Hg)	11,808	100.0%
TDG (mm Hg)	11,750	99.5%
TDG (% of saturation)	11,750	99.5%
Dissolved Oxygen (% of saturation)	11,764	99.6%

Table A-5: Number of Specific DQ Codes during the Monitoring Period, July 1 at 0:00 PDT through October 31 at 23:45 PDT of 2015

DQ Code	DQ Code Description	LLTR						
		Temp (°C)	TDG (mmHg)	Depth (meters)	DO (mg/L)	Batt (volts)	Level (m H2O)	ATemp (°C)
997	Equilibrating after deployment	0	20	0	0	0	0	0
993	Out of water for calibration/servicing	38	38	38	38	38	0	0
303	Unrealistic DO value, suspect erratic or low voltage	0	0	0	6	0	0	0
-102	Between "minimum operating voltage" (<9 volts) and 7 volts, but other data appear reliable	61	61	61	61	61	0	0
-1000	Spot Measurement	7	7	7	7	7	0	0
0	No data qualifiers	11,702	11,682	11,702	11,696	11,702	11,808	11,808
Monitoring Period		11,808	11,808	11,808	11,808	11,808	11,808	11,808

APPENDIX B

CONSULTATION RECORD

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

February 29, 2016

Patrick McGuire, 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. McGuire:

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.

The following summarizes the status of the projects required under Section 5.4 of the Certification:

- *Long Lake Total Dissolved Gas (TDG) Monitoring*
  In accordance with the approved revised Long Lake HED TDG Compliance Schedule, Avista did not conduct TDG monitoring at its Long Lake Hydroelectric Development (HED) during 2015. Additionally, Avista will not be monitoring TDG during 2016 and 2017, during the Long Lake Dam Spillway Modification project for TDG abatement, which is scheduled to be completed in 2017.

- *Nine Mile TDG Monitoring*
  In accordance with Ecology's letter dated February 17, 2012, Avista did not conduct TDG monitoring at its Nine Mile HED during 2015. As indicated in the Ecology Letter, Avista will resume monitoring TDG the first season following the removal of sediment in front of the sediment bypass intake and the replacement of turbine units 1 and 2. This will ensure Nine Mile HED is operating under normal Project operations prior to resuming TDG monitoring. Also, as required by FERC in their September 24, 2014 letter, Avista will provide an update on the projected schedule to resume TDG monitoring, updates to the sediment bypass construction schedule, and the anticipated date for completion of the replacement of turbine units 1 and 2 by September 1, 2016 to both Ecology and FERC.

The following summarizes the enclosed 2015 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report (Report) required under Appendix B, Section 5.6.B of the Certification.

The Report includes the results of the 2015 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. Additionally, this report also provides a summary of the monitoring results from the past six years (2010-2015); analyzes the effectiveness of the measures implemented to improve DO; and evaluates whether additional DO measures and monitoring in the Long Lake Dam tailrace are needed.

As stated in the Report, Avista plans to continue with the aeration program in 2016, and to continue monitoring DO and TDG at the Long Lake Dam Tailrace Station.

With this, Avista is submitting the 2015 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report for Ecology's review and approval. We would like to receive any comments or recommendations that you may have by **March 31, 2016**, which will allow us time to file the report with FERC by April 15, 2016.

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

Sincerely,

Meghan Lunney
Aquatic Resource Specialist

Enclosure (1)

cc: Chad Brown, Ecology
Brian Crossley, Spokane Tribe
Speed Fitzhugh, Avista

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
4601 N Monroe Street • Spokane, Washington 99205-1295 • (509)329-3400

March 31, 2016

Ms. Meghan Lunney
Aquatic Resource Specialist
Avista Corporation
1411 East Mission Avenue, MSC-1
Spokane, WA 99220-3727

RE: Request for Ecology Review and Approval – *2015 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report.* Spokane River Hydroelectric Project, No. P-2545

Dear Ms. Lunney:

The Department of Ecology (Ecology) has reviewed the *2015 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report* sent to us on February 29, 2016. The report is a requirement of Appendix B, Section 5.6B of the 401 Certification.

Ecology APPROVES the *2015 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report* as submitted.

The Avista transmittal also includes a status report of the Spokane River projects as required in Section 5.4 and 5.6B of the 401 Water Quality Certification. Ecology acknowledges that the information provided by Avista satisfies the 401 Water Quality Certification requirements.

Please contact me at (509) 329-3567 or pmcg461@ecy.wa.gov if you have any questions.

Sincerely,

Patrick McGuire
Eastern Region FERC License Coordinator
Water Quality Program

PDM:jab

cc: Elvin "Speed" Fitzhugh, Avista

ECOLOGY COMMENTS AND AVISTA RESPONSES

Ecology Comment
Ecology did not provide any comments in their approval letter.

Avista Response
Avista appreciates Ecology's review and approval of the 2015 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report.

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

February 29, 2016

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, TDG and DO Reporting Requirements

Dear Mr. Crossley:

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 a report for your review and comment.

The following summarizes the status of the projects required under Section 5.4 of the Certification:

- *Long Lake Total Dissolved Gas (TDG) Monitoring*
  In accordance with the approved revised Long Lake HED TDG Compliance Schedule, Avista did not conduct TDG monitoring at its Long Lake Hydroelectric Development (HED) during 2015. Additionally, Avista will not be monitoring TDG during 2016 and 2017, during the Long Lake Dam Spillway Modification project for TDG abatement, which is scheduled to be completed in 2017.

- *Nine Mile TDG Monitoring*
  In accordance with Ecology's letter dated February 17, 2012, Avista did not conduct TDG monitoring at its Nine Mile HED during 2015. As indicated in the Ecology Letter, Avista will resume monitoring TDG the first season following the removal of sediment in front of the sediment bypass intake and the replacement of turbine units 1 and 2. This will ensure Nine Mile HED is operating under normal Project operations prior to resuming TDG monitoring. Also, as required by FERC in their September 24, 2014 letter, Avista will provide an update on the projected schedule to resume TDG monitoring, updates to the sediment bypass construction schedule, and the anticipated date for completion of the replacement of turbine units 1 and 2 by September 1, 2016 to both Ecology and FERC.

The following summarizes the enclosed 2015 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report (Report) required under Appendix B, Section 5.6.B of the Certification.

The Report includes the results of the 2015 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. Additionally, this report also provides a summary of the monitoring results from the past six years (2010-2015); analyzes the effectiveness of the measures implemented to improve DO; and evaluates whether additional DO measures and monitoring in the Long Lake Dam tailrace are needed.

As stated in the Report, Avista plans to continue with the aeration program in 2016 and to continue monitoring DO and TDG at the Long Lake Dam Tailrace Station.

With this, Avista is submitting the 2015 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report for your review. We would like to receive any comments that you may have by **March 31, 2016**, which will allow us time to file the report with FERC by April 15, 2016.

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

Sincerely,

Meghan Lunney
Aquatic Resource Specialist

Enclosure (1)

cc: Patrick McGuire, Ecology
Speed Fitzhugh, Avista

Spokane Tribal Natural Resources
P.O. Box 480 ● Wellpinit, WA 99040 ● (509) 626 - 4400 ● fax 258 - 9600

3/31/2016

Meghan Lunney
1411 East Mission Avenue
PO Box 3727 MSC-25
Spokane WA 99220

Dear Megan:

I have reviewed the 2015 dissolved oxygen/total dissolved gas and temperature monitoring reports with the assistance of Casey Flanagan, Water & Fish Project Manager. These reports focus on Long Lake Dam and its effects on dissolved oxygen, total dissolved gas and temperature. Thank you for the analysis conducted on potential temperature reductions via cooling the air source to the aeration tubes. We have no significant comments on the reports and thank you for providing them for our review.

We are anxious to see the improvements and the post project monitoring at Long Lake to improve total dissolved gas.

Sincerely,

Brian Crossley
Water & Fish Program Manager
crossley@spokanetribe.com

cc: Patrick McGuire, Dept. of Ecology
BJ Kieffer, Director Dept. of Natural Resources
Matt Wynne, Tribal Council

SPOKANE TRIBE COMMENTS AND AVISTA RESPONSES

Spokane Tribe Comment
The Spokane Tribe did not provide comments on the Long Lake HED Tailrace Dissolved Oxygen Monitoring Report.

Avista Response
Avista appreciates the Spokane Tribe's review of the 2015 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report and will continue to work with them in the future.