# AVISTA CORPORATION

# 2015

# LONG LAKE HED

# TEMPERATURE MONITORING REPORT

## WASHINGTON 401 CERTIFICATION, SECTION 5.5

Spokane River Hydroelectric Project
FERC Project No. 2545

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**April 11, 2016**

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# List of Acronyms and Abbreviations

| | |
|---|---|
| °C | degrees Celsius |
| °C/m | degrees Celsius per meter |
| Avista | Avista Corporation |
| Certification | Section 401 water quality certification |
| DNR | Washington State Department of Natural Resources |
| DO | dissolved oxygen |
| Ecology | Washington State Department of Ecology |
| DO WQAP | Dissolved Oxygen Water Quality Attainment Plan |
| FERC | Federal Energy Regulatory Commission |
| Golder | Golder Associates Inc. |
| HED | hydroelectric development |
| LLFB | Long Lake Forebay monitoring station |
| LLTR | Long Lake HED tailwater monitoring station |
| m | meter(s) |
| MS5 | Hydrolab® MS5 Multiprobe® |
| Project | Spokane River Project |
| QAPP | Quality Assurance Project Plan |
| RM | River mile |
| SCCD | Stevens County Conservation District |
| Spokane Tribe | Spokane Tribe of Indians |
| TDG | total dissolved gas |
| Temperature WQAP | Long Lake Dam Reservoir and Tailrace Temperature Water Quality Attainment Plan |
| TP | Total Phosphorous |
| USFWS | United States Fish and Wildlife Service |
| WAC | Washington Administrative Code |
| WDFW | Washington State Department of Fish and Wildlife |
| WRIA | Water Resource Inventory Area |
| WQM QAPP | Water Quality Monitoring and Quality Assurance Project Plan |

# 1.0 INTRODUCTION

On June 18, 2009, the Federal Energy Regulatory Commission (FERC) issued a new license for the Spokane River Project (Project), FERC Project No. 2545 (FERC 2009a), which incorporated the Washington Department of Ecology (Ecology) Section 401 Water Quality Certification (Certification; Ecology 2009). In accordance with Section 5.10 and 5.5 of the Certification, Avista Corporation (Avista) developed the Water Quality Monitoring and Quality Assurance Project Plan (WQM QAPP; Avista 2009) and the Long Lake Dam Reservoir and Tailrace Temperature Water Quality Attainment Plan (Temperature WQAP; Avista 2011) in consultation with Ecology and the Spokane Tribe of Indians (Spokane Tribe). Avista filed the Ecology-approved WQM QAPP with FERC on August 13, 2009 and FERC approved it with modification on September 17, 2009 (FERC 2009b). Avista filed the Ecology-approved Temperature WQAP with FERC on January 26, 2011. On May 10, 2011, FERC (2011) issued an order approving and amending the 2009 WQM QAPP, pursuant to Article 401(A)(12) of the license.

As part of the Temperature WQAP, Avista is required to provide an annual summary report of the available temperature water quality monitoring results to Ecology by March 1 on an annual basis. Previous reports summarized Long Lake Hydroelectric Development (HED) temperature data collected in 2010 and 2011 (Golder 2012), in 2012 (Golder 2013), in 2013 (Golder 2014), and in 2014 (Golder 2015). This report summarizes temperature monitoring conducted for Long Lake HED during the 2015 calendar year.

# 2.0 MONITORING ACTIVITIES

## 2.1 Objectives

The overall objectives of the Temperature WQAP Monitoring Report are to:

- Document monitoring periods
- Summarize temperature monitoring results
- Document compliance with the applicable water quality standards
- Describe any proposed changes to the Temperature WQAP and WQM QAPP

In addition to the above objectives we have included information pertaining to the Spokane Tribe's water quality standards in regards to waters downstream of the Project.

## 2.2 Monitoring Locations and Periods

Water temperature data that are included in annual summary reports are from a number of water quality monitoring programs as described in the Temperature WQAP (Avista 2011). This report presents temperatures obtained as a component of monitoring programs focused on Spokane River water quality (Ecology 2016a, 2016b), Lake Spokane water quality (Ecology 2016c), and Long Lake HED tailwater

dissolved oxygen (Golder 2016). Additional temperature data related to studies outside the scope of the Temperature WQAP are available upon request.

### *2.2.1 Lake Spokane*

Temperature monitoring was conducted at two river stations upstream of Lake Spokane (inflow stations) and six stations within Lake Spokane (Table 2-1 and Figure 2-1).[1] These monitoring efforts are described in more detail below.

#### 2.2.1.1 Inflow Stations

Ecology has monitored temperature along with other water quality parameters in the Spokane River and Little Spokane River a short distance upstream of its confluence with Lake Spokane. This was done under Ecology's River and Stream Water Quality Ambient Monitoring Program, which monitors by water year.[2] Ecology's sampling effort at these two stations was conducted in accordance with the Stream Ambient Monitoring QAPP (Ecology 2003). Preliminary data for the Spokane River at Nine Mile Bridge station (54A090) and Little Spokane River near Mouth station (55B070) located on the Little Spokane River at River Mile (RM) 1.1 were accessed on January 18, 2016.

#### 2.2.1.2 Within Lake Spokane

In 2015, Avista monitored temperature and other water quality parameters through implementation of the Lake Spokane nutrient monitoring program, which it had collaboratively implemented with Ecology in 2010 and 2011, and solely implemented since 2012. This monitoring program included one sampling event in May and October, and two sampling events per month, in June through September, in order to provide baseline data. All sampling was completed in accordance with the Ecology-approved QAPP for Lake Spokane Nutrient Monitoring.[3] Sampling was conducted at the six Lake Spokane monitoring stations described in Table 2-1 and from upstream to downstream are:

- LL5, at approximately RM 54.20
- LL4, at approximately RM 51.47
- LL3, at approximately RM 46.42
- LL2, at approximately RM 42.06
- LL1, at approximately RM 37.62
- LL0, at approximately RM 32.66

[1] No measurements were made at the forebay just above Long Lake Dam (LLFB) during 2015.
[2] The "water year" is defined as the 12-month period from October 1 to September 30 of the following year.
[3] The current QAPP (Ecology 2010) as supplemented by its addendum (Lunney and Plotnikoff 2012), which was approved by Ecology on July 16, 2012 (Ross 2012).

### 2.2.2 Long Lake Dam Tailrace

Avista monitored temperature at the Long Lake Dam (LLTR), a station located 0.6 mile downstream of Long Lake Dam. All monitoring, including quality control protocols, was conducted in accordance with Avista's Detailed Dissolved Oxygen (DO) Phase II Feasibility and Implementation Plan (Avista 2010). Under this program, water temperature, total dissolved gas (TDG), and DO concentrations were monitored with Hydrolab® MS5 Multiprobe® (MS5) instruments.

In the past, Ecology has conducted monitoring at Station 54A070, which is located below Long Lake Dam. Ecology ceased monitoring at this station in 2010; hence, no new temperature data were available on January 20, 2016 (Ecology 2016d, 2016e).

## 2.3 Temperature Numeric Criteria

The Washington state numeric temperature criterion that applies to Lake Spokane and the Long Lake HED tailrace (WAC 173-201A-602, WRIA 54 Notes 1, 2, and 3) limits 1-day maximum temperature to no more than 20.0 degrees Celsius (°C) due to human activities.[4]

The numeric temperature criteria for the Spokane Tribe, whose reservation is located downstream of the Project, are applicable from the upstream Spokane Indian Reservation boundary (approximately RM 32.7) to the mouth of the Spokane River (RM 0). For reference, the upstream boundary of the Spokane Indian Reservation is located approximately 1.2 miles downstream of Long Lake Dam and approximately 0.6 miles downstream of the Avista and Ecology monitoring stations located below the dam. The Spokane River temperature criteria are the Class A 7-day average daily maximum temperature (7-DADM) criteria. The 7-DADM is calculated as the arithmetic average of seven consecutive measures of daily maximum temperatures, with the 7-DADM for any individual day calculated by averaging that day's daily maximum temperature with the daily maximum temperatures of the three days before and the three days after that date. The maximum allowable limit (7-DADM) for the Spokane River varies throughout the year as described below (Spokane Tribe 2003).

- 18.5°C between June 1 and August 31
- 13.5°C between September 1 and September 30
- 11°C between October 1 and March 31
- 13.5°C between April 1 and May 31

[4] In addition, water temperature shall not be increased by greater than 0.3°C when natural conditions exceed 20.0°C.

# 3.0 RESULTS

Results of the temperature monitoring in 2015 are discussed by monitoring location, along with a comparison to the applicable Washington State water quality criteria.

In addition, the discussion in Section 5.0, presents a comparison of the temperature results for the monitoring location below Long Lake Dam with the corresponding Spokane Tribe water quality criteria.

## *3.1.1 Lake Spokane*

Lake Spokane water temperature was monitored at eight locations: Ecology's Spokane River at Nine Mile Bridge station (54A090), Ecology's Little Spokane River station (55B070), and Avista's LL5, LL4, LL3, LL2, LL1, and LL0 stations.

### 3.1.1.1 Inflow Stations

Ecology's Spokane River at Nine Mile Bridge station (54A090) was monitored monthly from January through November. Reported water temperatures for this timeframe ranged from 4.7°C in February and March to 18.4°C in July (Table 3-1). All monitored water temperatures were less than the 20.0°C Washington State criterion.

Ecology's Little Spokane River station, 55B070, was monitored monthly from January through November. Water temperatures during this timeframe ranged from 6.0°C in January and March to 16.3°C in July (Table 3-2). All monitored water temperatures were less than the 20.0°C Washington State criterion.

### 3.1.1.2 Within Lake Spokane

Vertical profiles of water temperatures were monitored at the six Lake Spokane sampling stations in 2015. The frequency of monitoring in 2015 was once in May; twice in the months of June, July, August, and September; and once in October. Results for each of the six lake stations are described below in order from upstream to downstream.

**LL5**

LL5 water temperature measurements were conducted near the surface at 0.5 meter (m), and at 1-m intervals from 1 to 5 m below the water surface. Temperature varied more than 1.0°C throughout the water column for seven of the ten vertical profiles measured in 2015, and thermal stratification, as defined by greater than 1.0 °C/m occurred on June 10 through September 9 (Table 3-3). The results indicate the thermocline was at a depth of 0.75 m on June 10, and was 1.5 m to 2.5 m between June 24 and September 9 (Table 3-3).[5] Fourteen LL5 temperature measurements were greater than the 20.0°C Washington State

[5] Thermocline depths are presented as the mid-point between depths of temperature measurements with the greatest change in temperature per meter.

criterion, and reached up to 25.6°C on July 8. These high temperatures occurred at 0.5 m on June 10; down to 1 m on June 24 and August 25; and down to 2 m on July 8, July 22, and August 5 (Table 3-3).

**LL4**

LL4 temperature measurements were taken at 0.5 m and at 1-m intervals from 1 m to 8 m below the water surface. The maximum temperature change rate was greater than 1.0 °C/m for the vertical temperature profiles in June through October (Table 3-4), but had virtually no stratification in May. These results indicate the thermocline was between 4.5 m and 5.5 m and was at its deepest level in early July through early September. Thirty-five of the temperature measurements were greater than the 20.0°C Washington State criterion, and reached up to 26.0°C on July 8. These high temperatures occurred down to 4 m on June 10, and down to 5 m on June 24 through August 25 (Table 3-4).

**LL3**

LL3 temperature measurements were taken at 0.5 m, at 1-m intervals from 1 m to 10 m, at 3-m intervals from 12 m to 18 m, and within 1 meter of the bottom. Vertical temperature profiles for June 10 through August 5 had temperature change rates greater than 1.0 °C/m, and August 25 had a temperature change rate of 1.0 °C/m. All remaining periods had temperature change rates less than 1.0 °C/m (Table 3-5). The thermocline depth ranged from 2.5 m in early June to 8.5 m in late July. Fifty-two of the temperature measurements were greater than the 20.0°C Washington State criterion, and reached up to 25.4°C on July 8. These high temperatures occurred down to 5 m on June 10, 7 m on June 24 and August 25, 8 m on July 8, 9 m on August 5, and 10 m on July 22 (Table 3-5).

**LL2**

LL2 temperature measurements were taken at 0.5 m, 1-m intervals from 1 m to 10 m, 3-m intervals from 12 m to 24 m, and within 1 m of the bottom. Vertical temperature profiles had maximum temperature change rates greater than 1.0 °C/m between June 9 and August 24 (Table 3-6). The thermocline was at a depth of 3.5 m on June 9, remained at 6.5 to 7.5 m from June 23 to August 4, and was just above the bottom (24.5 m) on August 24. Forty-eight temperature measurements were greater than the 20.0°C Washington State criterion, and reached up to 24.5°C on July 7. These high temperatures occurred at a depths down to 4 m on June 9, down to 6 m on August 24, down to 7 m on June 23, down to 8 m on July 21 and August 4, and down to 9 m on July 7 (Table 3-6).

**LL1**

LL1 temperature measurements were taken at 0.5 m, 1-m intervals from 1 m to 10 m, 3-m intervals from 12 m to 33 m, and within 1 m of the bottom. Vertical temperature profiles had temperature change rates greater than 1.0 °C/m for early June through late August (Table 3-7). The thermocline was at a depth of

3.5 m on June 9, and ranged from 5.5 m to 7.5 m in late June to late July, and extended to a depth of 8.5 m in August. Forty-seven temperature measurements were greater than the 20.0°C Washington State criterion, and reached up to 24.8°C. These high temperatures occurred down to 4 m on June 9; down to 7 m on June 23, July 21, and August 4; and down to 8 m on July 7 and August 24 (Table 3-7).

**LL0**

LL0 temperature measurements were taken at 0.5 m, 1-m intervals from 1 m to 10 m, and at 3-m intervals from 12 m to 45 m, and within 1 m of the bottom. Only four of the LL0 vertical temperature profiles had maximum temperature change rates greater than 1.0 °C/m indicating thermal stratification was less persistent at LL0 than the other five lake monitoring stations. Forty-seven temperature measurements were greater than the 20.0°C Washington State criterion, and reached up to 25.4°C on July 7. These high temperatures occurred down to 4 m on June 9, down to 7 m on June 23, August 4, and August 24; and down to 8 m on July 7 and 21 (Table 3-8).

**Lake Station Temperature Profile Comparisons**

Comparison of the 2015 temperature profiles for the six sampling stations during late June, July, August, and September are displayed in Figures 3-1 through 3-4, respectively. The maximum temperature reached 23.1°C in late June, 24.6°C in late July, 21.7°C in late August, and 17.7°C in late September. In late June, very similar thermal stratification occurred at the four down-reservoir stations (LL3 through LL0), all of which had temperatures greater than 20.0°C down to a depth of 7 m (Figure 3-1). Late June temperatures were greater than 20.0°C in the uppermost meter in the reservoir's riverine zone (LL5) and down to a depth of 5 m at LL4. By late July, the epilmnion became deeper with temperatures reaching between 24°C and 25°C at the five down-reservoir stations (i.e., LL4-LL0), while the temperature in the reservoir's riverine zone (LL5) reached up to 23°C (Figure 3-2). By late August, all stations had cooled near the surface, but still exceeded 20.0°C (Figure 3-3). By late September, further cooling had occurred in the epilimnion, and none of the six stations were greater than 20.0°C (Figure 3-4). In addition, cooling had occurred throughout the rest of the reservoir's upper 24 m of the water column.

### *3.1.2 Long Lake Dam Tailrace*

Long Lake Dam tailrace (LLTR), water temperature data were collected in 15-minute intervals from July 1 through October 31 as part of the Detailed DO Phase II Feasibility and Implementation Plan (Figure 3-5). Daily maximum water temperatures ranged from 12.9°C on October 31 to 21.1°C on July 5 (Table 3-9). Temperatures of greater than the 20.0°C Washington State criterion occurred on eight days, which included seven days between July 5 and July 20 along with August 13.

Data for Ecology's Spokane River at Long Lake station (54A070) were not collected during 2015, as such were not available.

## 4.0 SCHEDULE

Avista has prepared, obtained approval for, and implemented the Temperature WQAP and WQM QAPP, as well as other plans to address Lake Spokane temperatures, nutrients, and DO. Avista will continue to coordinate implementation of measures to improve water quality with the ultimate goal of enhancing fish habitat. The list below summarizes plans that are currently being implemented along with Avista's planned actions towards this goal.

- **WQM QAPP** - Prepared WQM QAPP (Avista 2009) in consultation with Ecology and the Spokane Tribe. Approval of this plan was obtained from Ecology on August 13, 2009 and from FERC with modifications on September 17, 2009 (FERC 2009b).
- **Temperature WQAP** - Prepared the Temperature WQAP (Avista 2011) in consultation with Ecology and the Spokane Tribe. Approval of this plan was obtained from Ecology on January 25, 2011 and from FERC (2011) on May 10, 2011 in an order approving and amending the 2009 WQM QAPP, pursuant to Article 401(A)(12). Avista will continue to provide annual reports summarizing water temperature data for the Long Lake HED in accordance to the approved Temperature WQAP and WQ QAPP and WQM QAPP.
- **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 has submitted Annual Reports for the work completed in 2013, 2014, and 2015 (Avista 2014, 2015, and 2016 respectively). In accordance with the FERC-approved schedule for implementation of the DO WQAP, Avista will continue to conduct baseline monitoring in 2016. Avista will then work with Ecology to define future monitoring goals for the lake.

  The Annual Reports provide a summary of the baseline monitoring, implementation activities, effectiveness of the implementation activities, and proposed actions of the upcoming year. These implementation activities are summarized as follows and with the exception of the native tree plantings on Avista's shoreline property and the potential carp population reduction program, goals for these potential reasonable and feasible measures are primarily related to improving DO in the lake.

  - **Cold Water Fish Habitat Evaluation** – As a continuation of the 2013 efforts, Avista continued to evaluate cold water fish habitat in Lake Spokane. Preliminary analysis suggests that rainbow trout are likely inhabiting cooler water in the metalimnion and upper portions of the hypolimnion. Also, the habitat volumes for temperature and DO together, as well as separately, suggest that temperature is restricting habitat more than DO is for this species at all the lake station sites, with the exception of LL0. DO was more restrictive at LL0 later in the summer.
  - **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. Once mature, the trees will help reduce water temperature and improve habitat along the lake shoreline. One of the areas planted consists of a very steep sandy slope. The trees in this location are also expected to reduce any natural sloughing of sediment, which may contain total phosphorous (TP), into the river along with enhance shoreline habitat.

- **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 approximately 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 approximate 500 acre wetland complex.

- **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 12015, 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[6].

  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.

- **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.

- **Long Lake HED Turbine Aeration and Tailrace DO Monitoring** – Avista will continue to refine implementation of turbine aeration that was initiated in 2010, based on real-time water quality measurements that are monitored 0.6 miles downstream of Long Lake Dam from July 1 through October 30. Avista also will continue to coordinate results with the DO TMDL efforts, and evaluate the need for additional DO enhancement measures in accordance with the FERC-approved schedule (FERC 2010).

[6] 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.

- **Long Lake Dam TDG Abatement and Monitoring** – Avista will conduct Phase V through VII TDG abatement measures. Avista has awarded a construction contract and obtained the permits for the Long Lake Dam Spillway Modification Project to help abate TDG caused by Long Lake Dam. Construction of the structural modifications is expected to occur in 2016 through 2017. Following construction, the performance of the structural modifications will be tested and a spillgate protocol will be defined in 2018 through 2019. In 2018 through 2019, Avista will conduct monitoring to confirm effectiveness of the constructed structural modifications and spillgate operations and prepare annual monitoring reports.

# 5.0 DISCUSSION

## 5.1 Lake Spokane

Temperature profile monitoring conducted during 2015 indicated that the 20.0°C Washington State criterion was exceeded within Lake Spokane during June, July, and August. The maximum temperature recorded at the lake sites was 26.0°C in July, 24.0°C in June, 23.5°C in August, 18.5°C in September, and 15.9°C in October. Exceedances of 20.0°C occurred at all six lake stations in all months from June through August. Exceedances of 20.0°C within the lake occurred to depths of 10 m in July, 9 m in August, and 7 m in June. Measurements at both the Spokane River at Nine Mile Bridge station and Little Spokane River station did not exceed the 20.0°C criterion.

The exceedances reported for Lake Spokane during 2015 are indicative of the natural stratification process typical of eastern Washington and northern Idaho lakes during the summer season. Avista however is continuing to pursue reasonable and feasible mitigation measures in accordance with its Ecology-approved Temperature WQAP and Lake Spokane DO WQAP that may have positive localized effects on temperature within the lake.

## 5.2 Long Lake Dam Tailrace

During 2015, temperature measurements at the Avista monitoring station, LLTR, located downstream of the Long Lake Dam exceeded the 20.0°C Washington State criterion on eight days in July and August (Table 3-10). The maximum of these temperatures was 21.1°C, in early July.

Monitoring results indicate that except for three days at the end of August the Spokane Tribe's 7-DADM criteria established for tribal waters were exceeded July 4 through October 28 (Table 5-1, Figure 5-1). It is important to note the LLTR monitoring station from which 2015 temperature data were collected is located approximately 0.6 miles upstream from the reservation boundary, where the Tribe's criteria is applicable.

As part of a non-License Agreement, Avista provides the Spokane Tribe with funds to complete water quality improvements to help address temperature exceedances along with other water quality improvement needs downstream of the Project. To date, the Spokane Tribe has planted trees and completed stream stabilization efforts in the Chamokane Creek watershed to reduce surface water

temperatures. Avista and the Spokane Tribe will continue working together in the future to improve water quality within the reservation. These projects relate to DO, TDG, and temperature within the reservation.

In 2015, the Spokane Tribe requested Avista to determine whether or not water passing through the turbines could be cooled using colder than atmospheric air through the existing aeration system. Avista hired HDR to conduct this analysis, the results of which indicated it is not feasible to reduce the Long Lake HED discharge water by cooling the air introduced into the aeration system (HDR 2016).

## 6.0 PROPOSED CHANGES TO THE TEMPERATURE WQAP AND WQM QAPP

Consistent with 2015 activities, Avista will not be monitoring water quality at LLTR, LLGEN, or LLFB during the high-flow season (typically March/April through June) throughout the Long Lake Dam Spillway Modification Project for TDG abatement, which is expected to continue through 2017. Since Avista plans to deploy an instrument at LLTR to monitor water quality in the low-flow season for the Long Lake HED Tailrace DO monitoring season, the absence of temperature data from the high-flow season is not expected to impact collection of critical temperature data.

As approved by Ecology in 2015, Avista will monitor summer critical season water quality at the LLTR station, but not at LLFB because of the complex hydraulics dynamics near the forebay intake cause substantial temperature variability near the dam over short periods. This results in measurements that are much less consistent and reliable compared with those at LL0.

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# TABLES

**Table 2-1: Long Lake HED Temperature Monitoring Stations and Periods**

| Monitoring Station | Location | NAD83 Decimal Degrees | | 2015 Monitoring Year | |
|---|---|---|---|---|---|
| | | Latitude | Longitude | Start | End |
| 54A090 | Spokane River at Nine mile Bridge approximately 0.2 miles downstream of Nine Mile Dam, at river mile (RM) 58 | 47.7767 | 117.5448 | 1/6/2015 | 11/17/2015 |
| 55B070 | On the Little Spokane River approximately 1.5 miles upstream from its confluence with Lake Spokane, at RM 1.1 | 47.7829 | 117.5305 | 1/6/2015 | 11/17/2015 |
| LL5 | Long Lake sampling site 5, at RM 54.20 | 47.7985 | 117.5692 | 5/14/2015 | 10/14/2015 |
| LL4 | Long Lake sampling site 4, at RM 51.47 | 47.8137 | 117.6106 | 5/14/2015 | 10/14/2015 |
| LL3 | Long Lake sampling site 3, at RM 46.42 | 47.8641 | 117.6668 | 5/14/2015 | 10/14/2015 |
| LL2 | Long Lake sampling site 2, at RM 42.06 | 47.8636 | 117.7014 | 5/13/2015 | 10/13/2015 |
| LL1 | Long Lake sampling site 1, at RM 37.62 | 47.8305 | 117.7612 | 5/13/2015 | 10/13/2015 |
| LL0 | Long Lake sampling site 0, at RM 32.66 | 47.8339 | 117.8349 | 5/13/2015 | 10/13/2015 |
| LLFB | Long Lake Forebay between Unit 3 and 4 intakes. | 47.8367 | 117.8397 | Not Available | |
| LLTR | On left downstream bank, at water pump house approximately 0.6 mile downstream from Long Lake Dam. | 47.8375 | 117.8503 | 7/1/2015 | 10/31/2015 |
| 54A070 | Approximately 0.6 mile downstream of Long Lake Dam, at the Highway 231 Bridge and RM 33.3. | 47.8391 | 117.8525 | Not Available | |

**Table 3-1: Spokane River at Nine Mile Bridge (54A090) Temperature Monitored in 2015**

| Date | Maximum Daily Water Temperature (°C) |
|---|---|
| 1/6/15 14:40 | 4.8 |
| 2/3/15 13:25 | 4.7 |
| 3/3/15 13:10 | 4.7 |
| 4/7/15 14:55 | 7.0 |
| 5/5/15 13:45 | 12.1 |
| 6/2/15 13:40 | 17.4 |
| 7/7/15 14:25 | 18.4 |
| 8/4/15 14:50 | 17.8 |
| 9/15/15 15:45 | 14.1 |
| 10/6/15 15:20 | 12.3 |
| 11/17/15 15:15 | 9.1 |

Notes:

On January 18, 2015, accessed preliminary data from Ecology's website: https://fortress.wa.gov/ecy/eap/riverwq/station.asp?theyear=&tab=prelim_data&scrolly=undefined&wria=54&sta=54A090&docextension=.xls&docextension=.xls

The 20.0°C criterion was not exceeded at this monitoring location in 2015.

**Table 3-2: Little Spokane River Upstream of Lake Spokane (55B070) Temperature Monitored in 2015**

| Date | Maximum Daily Water Temperature (°C) |
|---|---|
| 1/6/15 14:00 | 6.0 |
| 2/3/15 13:00 | 6.6 |
| 3/3/15 12:45 | 6.0 |
| 4/7/15 14:30 | 9.2 |
| 5/5/15 13:20 | 12.8 |
| 6/2/15 13:15 | 14.3 |
| 7/7/15 13:43 | 16.3 |
| 8/4/15 14:29 | 15.5 |
| 9/15/15 15:12 | 11.9 |
| 10/6/15 14:45 | 10.9 |
| 11/17/15 14:30 | 8.8 |

Notes:

On January 18, 2015, accessed preliminary data from Ecology's website: https://fortress.wa.gov/ecy/eap/riverwq/station.asp?theyear=&tab=prelim_data&scrolly=undefined&wria=55&sta=55B070&docextension=.xls&docextension=.xls

The 20.0°C criterion was not exceeded at this monitoring location in 2015.

**Table 3-3: LL5 Temperature Vertical Profiles in 2015**

| Depth (meters) | Water Temperature (°C) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 5/14/2015 | 6/10/2015 | 6/24/2015 | 7/8/2015 | 7/22/2015 | 8/5/2015 | 8/25/2015 | 9/9/2015 | 9/24/2015 | 10/14/2015 |
| 0.5 | 12.8 | **20.4** | **22.3** | **25.6** | **22.9** | **22.9** | **20.9** | 17.3 | 13.1 | 12.3 |
| 1.0 | 12.5 | 19.6 | **22.1** | **25.5** | **22.8** | **22.8** | **20.7** | 16.8 | 13.1 | 12.3 |
| 2.0 | 12.4 | 19.0 | 18.1 | **21.8** | **20.8** | **22.2** | 19.8 | 13.4 | 13.0 | 12.3 |
| 3.0 | 12.4 | 18.8 | 16.6 | 18.5 | 18.4 | 18.3 | 15.4 | 13.1 | 13.0 | 12.2 |
| 4.0 | 12.4 | 18.7 | 16.5 | 18.3 | 17.9 | 17.3 | 14.9 | 13.1 | 13.0 | 12.2 |
| 5.0 | 12.4 | 18.6 | 16.4 | 18.0 | 17.8 | 17.1 | 14.9 | 12.9 | 13.0 | 12.2 |
| **Max Change (°C/m)[1]** | 0.6 | **1.7** | **4.0** | **3.8** | **2.4** | **3.9** | **4.4** | **3.4** | 0.1 | 0.1 |
| **Depth of Max Change (m) [2, 3]** | 0.75 | 0.75 | 1.50 | 1.50 | 2.50 | 2.50 | 2.50 | 1.50 | 0.75 | 0.75 |

Notes:

Data provided by TetraTech on January 2. 2015; does not include results from field duplicates.

Shaded and bold values indicate an exceedance of the 20.0°C criterion.

1. The change in °C per meter of depth was calculated for each pair of adjacent measurement intervals in the table. This value represents the maximum value of the calculated change in °C per one meter of depth for each pair of adjacent measurement intervals. Bold values are >1.0°C per meter depth.

2. Depth of Max Change (m) = the shallowest depth where the greatest temperature gradient occurs.

3. N/A = not applicable (dates with 0.0°C max change)

**Table 3-4: LL4 Temperature Vertical Profiles in 2015**

| Depth (meters) | Water Temperature (°C) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 5/14/2015 | 6/10/2015 | 6/24/2015 | 7/8/2015 | 7/22/2015 | 8/5/2015 | 8/25/2015 | 9/9/2015 | 9/24/2015 | 10/14/2015 |
| 0.5 | 13.4 | **23.7** | **23.1** | **25.9** | **24.6** | **23.5** | **21.7** | 18.5 | 17.3 | 15.4 |
| 1.0 | 13.2 | **23.6** | **23.1** | **26.0** | **24.6** | **23.5** | **21.6** | 18.5 | 17.2 | 15.4 |
| 2.0 | 12.8 | **23.3** | **23.0** | **25.9** | **24.6** | **23.5** | **21.6** | 18.4 | 17.1 | 15.4 |
| 3.0 | 12.7 | **22.4** | **22.6** | **25.9** | **24.5** | **23.1** | **21.5** | 18.4 | 17.1 | 15.2 |
| 4.0 | 12.6 | **20.7** | **21.8** | **25.3** | **24.5** | **22.6** | **21.1** | 17.5 | 17.0 | 14.9 |
| 5.0 | 12.5 | 19.0 | **20.1** | **23.1** | **23.8** | **21.0** | **20.5** | 16.2 | 15.2 | 13.1 |
| 6.0 | 12.5 | 18.6 | 16.4 | 19.2 | 19.3 | 17.2 | 15.8 | 13.1 | 13.7 | 12.8 |
| 7.0 | 12.5 | 18.5 | 16.3 | 18.4 | 18.5 | 17.0 | 15.1 | 13.0 | 13.6 | 12.7 |
| 8.0 | 12.5 | 18.4 | 16.3 | 18.4 | 18.4 | 17.0 | 15.0 | 13.0 | 13.6 | 12.7 |
| **Max Change (°C/m)[1]** | 0.5 | **1.7** | **3.6** | **3.9** | **4.5** | **3.8** | **4.8** | **3.0** | **1.8** | **1.8** |
| **Depth of Max Change (m)[2]** | 0.75 | 4.50 | 5.50 | 5.50 | 5.50 | 5.50 | 5.50 | 5.50 | 4.50 | 4.50 |

Notes:

Data provided by TetraTech on January 2. 2015; does not include results from field duplicates.

Shaded and bold values indicate an exceedance of the 20.0°C criterion.

1. The change in °C per meter of depth was calculated for each pair of adjacent measurement intervals in the table. This value represents the maximum value of the calculated change in °C per one meter of depth for each pair of adjacent measurement intervals.

2. Depth of Max Change (m) = the shallowest depth where the greatest temperature gradient occurs.

**Table 3-5: LL3 Temperature Vertical Profiles in 2015**

| Depth (meters) | Water Temperature (°C) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 5/14/2015 | 6/10/2015 | 6/24/2015 | 7/8/2015 | 7/22/2015 | 8/5/2015 | 8/25/2015 | 9/9/2015 | 9/24/2015 | 10/14/2015 |
| 0.5 | 15.3 | **24.0** | **23.0** | **25.4** | **24.6** | **23.5** | **21.4** | 18.3 | 17.4 | 15.7 |
| 1.0 | 15.3 | **24.0** | **23.0** | **25.4** | **24.6** | **23.5** | **21.4** | 18.3 | 17.4 | 15.7 |
| 2.0 | 15.2 | **23.8** | **23.0** | **25.2** | **24.6** | **23.5** | **21.4** | 18.3 | 17.4 | 15.7 |
| 3.0 | 14.3 | **22.3** | **23.0** | **25.1** | **24.6** | **23.5** | **21.4** | 18.3 | 17.4 | 15.7 |
| 4.0 | 14.0 | **21.2** | **23.0** | **22.7** | **24.6** | **23.5** | **21.4** | 18.3 | 17.4 | 15.7 |
| 5.0 | 13.9 | **20.6** | **22.4** | **22.0** | **24.6** | **23.5** | **21.4** | 18.3 | 17.4 | 15.7 |
| 6.0 | 13.9 | 20.0 | **21.3** | **21.0** | **24.6** | **23.5** | **21.1** | 18.2 | 17.4 | 15.7 |
| 7.0 | 13.7 | 19.3 | **20.7** | **20.5** | **23.7** | **22.1** | **20.1** | 18.1 | 17.3 | 15.7 |
| 8.0 | 13.7 | 19.1 | 19.5 | **20.1** | **22.5** | **21.4** | 19.7 | 17.9 | 17.3 | 15.7 |
| 9.0 | 13.6 | 18.6 | 18.9 | 19.5 | **21.0** | **20.9** | 19.0 | 17.7 | 17.0 | 15.6 |
| 10.0 | 13.5 | 18.3 | 18.2 | 19.2 | **20.1** | 19.9 | 18.7 | 17.5 | 17.0 | 15.3 |
| 12.0 | 13.4 | 17.5 | 17.3 | 18.7 | 18.4 | 18.9 | 17.8 | 16.9 | 16.2 | 14.4 |
| 15.0 | 12.5 | 16.8 | 17.1 | 18.0 | 18.0 | 17.7 | 16.4 | 14.9 | 14.4 | 13.7 |
| 18.0 | 11.9 | 15.7 | 17.0 | 17.1 | 17.9 | 17.6 | 16.2 | 13.8 | 14.3 | 13.6 |
| 18.5 | | 15.3 | | 17.1 | | | | | | |
| 19.0 | | | 17.0 | | 17.9 | | 16.1 | | 14.2 | |
| 19.5 | | | | | | 17.5 | | 13.7 | | 13.4 |
| **Max Change (°C/m)[1]** | 0.8 | **1.5** | **1.3** | **2.4** | **1.5** | **1.4** | 1.0 | 0.7 | 0.6 | 0.4 |
| **Depth of Max Change (m)[2]** | 2.50 | 2.50 | 7.50 | 3.50 | 8.50 | 6.50 | 6.50 | 13.50 | 13.50 | 11.00 |

Notes:

Data provided by TetraTech on January 2. 2015; does not include results from field duplicates.

Shaded and bold values indicate an exceedance of the 20.0°C criterion.

1. The change in °C per meter of depth was calculated for each pair of adjacent measurement intervals in the table. This value represents the maximum value of the calculated change in °C per one meter of depth for each pair of adjacent measurement intervals.

2. Depth of Max Change (m) = the shallowest depth where the greatest temperature gradient occurs.

**Table 3-6: LL2 Temperature Vertical Profiles in 2015**

| Depth (meters) | Water Temperature (°C) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 5/13/2015 | 6/9/2015 | 6/23/2015 | 7/7/2015 | 7/21/2015 | 8/4/2015 | 8/24/2015 | 9/8/2015 | 9/23/2015 | 10/13/2015 |
| 0.5 | 14.2 | **23.4** | **22.6** | **24.5** | **24.4** | **23.5** | **21.6** | 18.5 | 17.7 | 15.9 |
| 1.0 | 14.3 | **23.2** | **22.6** | **24.5** | **24.4** | **23.5** | **21.6** | 18.5 | 17.7 | 15.8 |
| 2.0 | 14.2 | **23.0** | **22.5** | **24.4** | **24.4** | **23.4** | **21.5** | 18.4 | 17.6 | 15.8 |
| 3.0 | 14.2 | **22.5** | **22.3** | **24.3** | **24.3** | **23.2** | **21.4** | 18.4 | 17.5 | 15.7 |
| 4.0 | 14.3 | **20.7** | **22.2** | **24.2** | **24.3** | **23.2** | **21.4** | 18.4 | 17.5 | 15.7 |
| 5.0 | 14.3 | 19.6 | **22.2** | **24.1** | **24.3** | **22.6** | **21.3** | 18.4 | 17.5 | 15.7 |
| 6.0 | 14.2 | 19.5 | **22.0** | **24.0** | **24.3** | **21.8** | **21.1** | 18.3 | 17.4 | 15.7 |
| 7.0 | 14.1 | 19.0 | **21.1** | **21.9** | **23.9** | **21.2** | 20.0 | 18.2 | 17.4 | 15.7 |
| 8.0 | 14.0 | 18.5 | 19.5 | **20.6** | **20.5** | **20.1** | 19.1 | 18.0 | 17.4 | 15.7 |
| 9.0 | 14.0 | 18.2 | 18.7 | **20.2** | 19.6 | 19.4 | 18.7 | 17.6 | 17.3 | 15.7 |
| 10.0 | 13.9 | 18.1 | 18.5 | 19.5 | 19.1 | 18.8 | 18.3 | 17.4 | 17.1 | 15.7 |
| 12.0 | 13.9 | 17.3 | 18.0 | 19.1 | 18.3 | 18.2 | 17.8 | 17.1 | 16.1 | 15.3 |
| 15.0 | 13.0 | 16.6 | 17.6 | 17.8 | 17.9 | 17.9 | 17.4 | 16.7 | 15.4 | 14.0 |
| 18.0 | 12.2 | 15.8 | 17.0 | 17.3 | 17.6 | 17.5 | 17.2 | 15.7 | 14.7 | 13.6 |
| 21.0 | 11.1 | 14.6 | 16.1 | 16.9 | 16.6 | 17.1 | 16.9 | 15.2 | 14.0 | 13.4 |
| 24.0 | 10.4 | 13.6 | 14.1 | 15.0 | 14.8 | 16.3 | 16.5 | 14.9 | 13.7 | 13.3 |
| 25.0 | | | 13.5 | 14.0 | 14.2 | 15.7 | 15.2 | | 13.7 | 13.3 |
| 25.5 | 10.3 | 13.1 | | | | | | 14.9 | | |
| **Max Change (°C/m)[1]** | 0.4 | **1.8** | **1.7** | **2.0** | **3.5** | **1.1** | **1.3** | 0.4 | 0.5 | 0.4 |
| **Depth of Max Change (m)[2]** | 19.50 | 3.50 | 7.50 | 6.50 | 7.50 | 7.50 | 24.50 | 8.50 | 11.00 | 13.5 |

Notes:

Data provided by TetraTech on January 2. 2015; does not include results from field duplicates.
Shaded and bold values indicate an exceedance of the 20.0°C criterion.

1. The change in °C per meter of depth was calculated for each pair of adjacent measurement intervals in the table. This value represents the maximum value of the calculated change in °C per one meter of depth for each pair of adjacent measurement intervals.
2. Depth of Max Change (m) = the shallowest depth where the greatest temperature gradient occurs.
3. nr = not reported

**Table 3-7: LL1 Temperature Vertical Profiles in 2015**

| Depth (meters) | Water Temperature (°C) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 5/13/2015 | 6/9/2015 | 6/23/2015 | 7/7/2015 | 7/21/2015 | 8/4/2015 | 8/24/2015 | 9/8/2015 | 9/23/2015 | 10/13/2015 |
| 0.5 | 14.8 | **23.3** | **22.3** | **24.8** | **24.3** | **23.2** | **21.3** | 18.2 | 17.4 | 15.8 |
| 1.0 | 14.8 | **23.1** | **22.2** | **24.8** | **24.3** | **23.2** | **21.3** | 18.1 | 17.4 | 15.8 |
| 2.0 | 14.8 | **22.8** | **21.9** | **24.8** | **24.2** | **23.1** | **21.2** | 18.1 | 17.3 | 15.7 |
| 3.0 | 14.8 | **22.0** | **21.9** | **24.8** | **24.1** | **23.0** | **21.2** | 18.1 | 17.3 | 15.7 |
| 4.0 | 14.8 | **20.3** | **21.8** | **24.7** | **24.1** | **23.0** | **21.2** | 18.1 | 17.2 | 15.7 |
| 5.0 | 14.7 | 19.4 | **21.7** | **24.6** | **23.9** | **22.6** | **21.1** | 18.1 | 17.2 | 15.7 |
| 6.0 | 14.7 | 19.0 | **21.2** | **24.5** | **21.9** | **21.8** | **21.0** | 18.1 | 17.2 | 15.7 |
| 7.0 | 14.7 | 18.6 | **20.8** | **23.7** | **20.2** | **20.7** | **21.0** | 18.1 | 17.2 | 15.7 |
| 8.0 | 14.7 | 18.4 | 19.8 | **20.4** | 19.4 | 20.0 | **20.6** | 18.1 | 17.1 | 15.6 |
| 9.0 | 14.6 | 18.1 | 19.0 | 19.3 | 19.2 | 18.9 | 19.1 | 18.1 | 17.1 | 15.6 |
| 10.0 | 14.6 | 17.8 | 18.6 | 19.1 | 18.9 | 18.5 | 18.8 | 18.1 | 17.1 | 15.6 |
| 12.0 | 14.6 | 17.4 | 18.1 | 18.6 | 18.4 | 18.2 | 18.2 | 17.8 | 16.1 | 15.3 |
| 15.0 | 13.3 | 16.9 | 17.5 | 17.4 | 18.1 | 17.8 | 17.5 | 16.5 | 15.5 | 14.4 |
| 18.0 | 12.4 | 16.3 | 17.0 | 17.0 | 17.3 | 17.2 | 17.2 | 16.2 | 15.0 | 14.1 |
| 21.0 | 11.8 | 15.2 | 15.6 | 16.2 | 16.7 | 16.8 | 16.9 | 15.7 | 14.4 | 13.7 |
| 24.0 | 11.2 | 13.8 | 14.3 | 14.9 | 15.3 | 15.8 | 15.8 | 15.4 | 14.1 | 13.6 |
| 27.0 | 10.6 | 12.7 | 12.5 | 13.3 | 12.7 | 13.0 | 14.1 | 14.9 | 14.0 | 13.4 |
| 30.0 | 10.1 | 11.9 | 11.5 | 11.7 | 11.8 | 12.1 | 12.4 | 12.8 | 13.8 | 13.3 |
| 33.0 | 9.8 | 10.9 | 11.1 | 11.4 | 11.4 | 11.5 | 11.9 | | 12.8 | |
| 33.5 | | | | | | | | 11.9 | | 13.2 |
| **Max Change (°C/m)[1]** | 0.4 | **1.8** | **1.1** | **3.3** | **2.0** | **1.1** | **1.5** | 0.7 | 0.5 | 0.3 |
| **Depth of Max Change (m)[2]** | 13.50 | 3.50 | 7.50 | 7.50 | 5.50 | 8.50 | 8.50 | 28.50 | 11.00 | 13.50 |

Notes:

Data provided by TetraTech on January 2. 2015; does not include results from field duplicates.

Shaded and bold values indicate an exceedance of the 20.0°C criterion.

1. The change in °C per meter of depth was calculated for each pair of adjacent measurement intervals in the table. This value represents the maximum value of the calculated change in °C per one meter of depth for each pair of adjacent measurement intervals.

2. Depth of Max Change (m) = the shallowest depth where the greatest temperature gradient occurs.

**Table 3-8: LL0 Temperature Vertical Profiles in 2015**

| Depth (meters) | Water Temperature (°C) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 5/13/2015 | 6/9/2015 | 6/23/2015 | 7/7/2015 | 7/21/2015 | 8/4/2015 | 8/24/2015 | 9/8/2015 | 9/23/2015 | 10/13/2015 |
| 0.5 | 16.4 | **21.1** | **21.8** | **25.4** | **24.1** | **22.6** | **21.3** | 18.2 | 17.1 | 15.4 |
| 1.0 | 16.4 | **20.8** | **21.5** | **25.4** | **24.0** | **22.6** | **21.3** | 18.1 | 17.1 | 15.4 |
| 2.0 | 16.4 | **20.7** | **21.5** | **25.4** | **24.0** | **22.5** | **21.3** | 18.1 | 17.1 | 15.4 |
| 3.0 | 16.3 | **20.6** | **21.4** | **25.4** | **23.9** | **22.5** | **21.3** | 18.1 | 17.1 | 15.4 |
| 4.0 | 16.4 | **20.1** | **21.3** | **25.1** | **22.2** | **22.4** | **21.2** | 18.1 | 17.1 | 15.4 |
| 5.0 | 16.3 | 19.5 | **21.1** | **24.5** | **21.6** | **22.1** | **21.2** | 18.1 | 17.1 | 15.4 |
| 6.0 | 16.3 | 19.0 | **21.1** | **23.6** | **20.9** | **21.3** | **21.1** | 18.1 | 17.1 | 15.4 |
| 7.0 | 16.3 | 18.3 | **20.6** | **21.9** | **20.5** | **20.5** | **20.8** | 18.1 | 17.1 | 15.4 |
| 8.0 | 16.2 | 18.0 | 19.0 | **20.4** | **20.1** | 19.9 | 19.6 | 18.1 | 17.1 | 15.4 |
| 9.0 | 15.2 | 17.8 | 18.5 | 19.4 | 19.7 | 19.4 | 18.4 | 18.1 | 17.0 | 15.4 |
| 10.0 | 15.3 | 17.6 | 18.3 | 18.9 | 19.1 | 19.1 | 18.1 | 17.9 | 16.7 | 15.4 |
| 12.0 | 15.0 | 17.3 | 17.6 | 18.1 | 18.6 | 18.3 | 17.8 | 17.2 | 16.2 | 15.2 |
| 15.0 | 14.6 | 16.9 | 17.0 | 17.2 | 18.1 | 17.7 | 17.5 | 16.6 | 15.5 | 14.6 |
| 18.0 | 12.6 | 15.9 | 16.5 | 16.7 | 17.7 | 17.3 | 17.2 | 16.1 | 14.9 | 14.2 |
| 21.0 | 11.8 | 14.6 | 15.6 | 16.1 | 17.2 | 16.8 | 16.8 | 15.7 | 14.5 | 13.9 |
| 24.0 | 11.0 | 13.7 | 14.4 | 15.4 | 15.5 | 15.5 | 16.1 | 15.3 | 14.3 | 13.6 |
| 27.0 | 10.5 | 12.7 | 12.8 | 12.9 | 13.4 | 13.2 | 13.7 | 13.9 | 13.8 | 13.3 |
| 30.0 | 10.1 | 11.5 | 11.9 | 11.8 | 12.0 | 12.2 | 12.3 | 12.6 | 13.1 | 13.1 |
| 33.0 | 9.7 | 10.6 | 11.0 | 10.9 | 11.2 | 11.5 | 11.5 | 12.1 | 11.9 | 12.7 |
| 36.0 | 9.0 | 9.6 | 10.0 | 10.0 | 10.4 | 10.5 | 10.9 | 11.1 | 11.3 | 11.4 |
| 39.0 | 8.8 | 9.3 | 9.3 | 9.5 | 9.7 | 9.9 | 10.1 | 10.2 | 10.4 | 10.5 |
| 42.0 | 8.8 | 9.1 | 9.2 | 9.3 | 9.4 | 9.6 | 9.8 | 9.9 | 10.0 | 10.3 |
| 45.0 | 8.7 | 9.0 | 9.1 | 9.2 | 9.3 | 9.5 | 9.7 | 9.7 | 9.8 | 10.1 |
| 47.0 | | | | | 9.2 | | | 9.7 | 9.7 | |
| 47.5 | 8.7 | 8.9 | 9.0 | 9.2 | | 9.4 | 9.6 | | | 10.1 |
| **Max Change (°C/m)[1]** | 1.0 | 0.7 | **1.6** | **1.6** | **1.7** | 0.8 | **1.3** | 0.5 | 0.4 | 0.4 |
| **Depth of Max Change (m)[2]** | 8.50 | 6.50 | 7.50 | 6.50 | 3.50 | 6.50 | 7.50 | 25.50 | 31.50 | 34.50 |

Notes:

Data provided by TetraTech on January 2. 2015; does not include results from field duplicates.

Shaded and bold values indicate an exceedance of the 20.0°C criterion.

1. The change in °C per meter of depth was calculated for each pair of adjacent measurement intervals in the table. This value represents the maximum value of the calculated change in °C per one meter of depth for each pair of adjacent measurement intervals. Bold values are >1.0°C per meter depth.

2. Depth of Max Change (m) = the shallowest depth where the greatest temperature gradient occurs.

**Table 3-9: LLTR Daily Maximum Temperature in 2015**

| Day | June | July | August | September | October | November |
|---|---|---|---|---|---|---|
| 1 | Not Monitored | 19.2 | 19.3 | 18.2 | 15.7 | Not Monitored |
| 2 | | 19.2 | 19.2 | 18.3 | 15.7 | |
| 3 | | 19.8 | 19.3 | 17.9 | 15.9 | |
| 4 | | 19.6 | 19.5 | 18.0 | 16.6 | |
| 5 | | **21.1** | 19.4 | 18.0 | 15.7 | |
| 6 | | **20.6** | 19.4 | 17.7 | 15.3 | |
| 7 | | **20.1** | 19.4 | 18.1 | 15.3 | |
| 8 | | 20.0 | 19.6 | 17.8 | 15.4 | |
| 9 | | 19.7 | 19.6 | 17.3 | 15.2 | |
| 10 | | 19.9 | 19.4 | 17.7 | 15.3 | |
| 11 | | **20.5** | 20.0 | 17.9 | 15.3 | |
| 12 | | **20.5** | 20.0 | 17.4 | 15.2 | |
| 13 | | **20.1** | **20.1** | 17.3 | 14.9 | |
| 14 | | 19.6 | 20.0 | 16.8 | 14.8 | |
| 15 | | 19.6 | 19.5 | 17.1 | 14.7 | |
| 16 | | 19.4 | 19.9 | 16.6 | 14.6 | |
| 17 | | 19.7 | 19.8 | 16.8 | 15.0 | |
| 18 | | 19.9 | 19.5 | 16.9 | 14.5 | |
| 19 | | 19.8 | 19.4 | 17.1 | 14.6 | |
| 20 | | **20.1** | 19.6 | 17.0 | 14.5 | |
| 21 | | 19.6 | 19.3 | 16.3 | 14.2 | |
| 22 | | 19.7 | 19.6 | 16.6 | 14.2 | |
| 23 | | 20.0 | 19.2 | 16.4 | 14.0 | |
| 24 | | 19.8 | 19.1 | 16.4 | 13.8 | |
| 25 | | 19.2 | 18.8 | 16.6 | 13.8 | |
| 26 | | 19.2 | 18.7 | 16.6 | 13.7 | |
| 27 | | 19.7 | 18.9 | 15.9 | 13.7 | |
| 28 | | 19.7 | 18.7 | 16.0 | 13.3 | |
| 29 | | 19.4 | 18.7 | 16.1 | 13.2 | |
| 30 | | 19.6 | 18.2 | 15.8 | 13.1 | |
| 31 | | 19.3 | 18.1 | --- | 12.9 | |

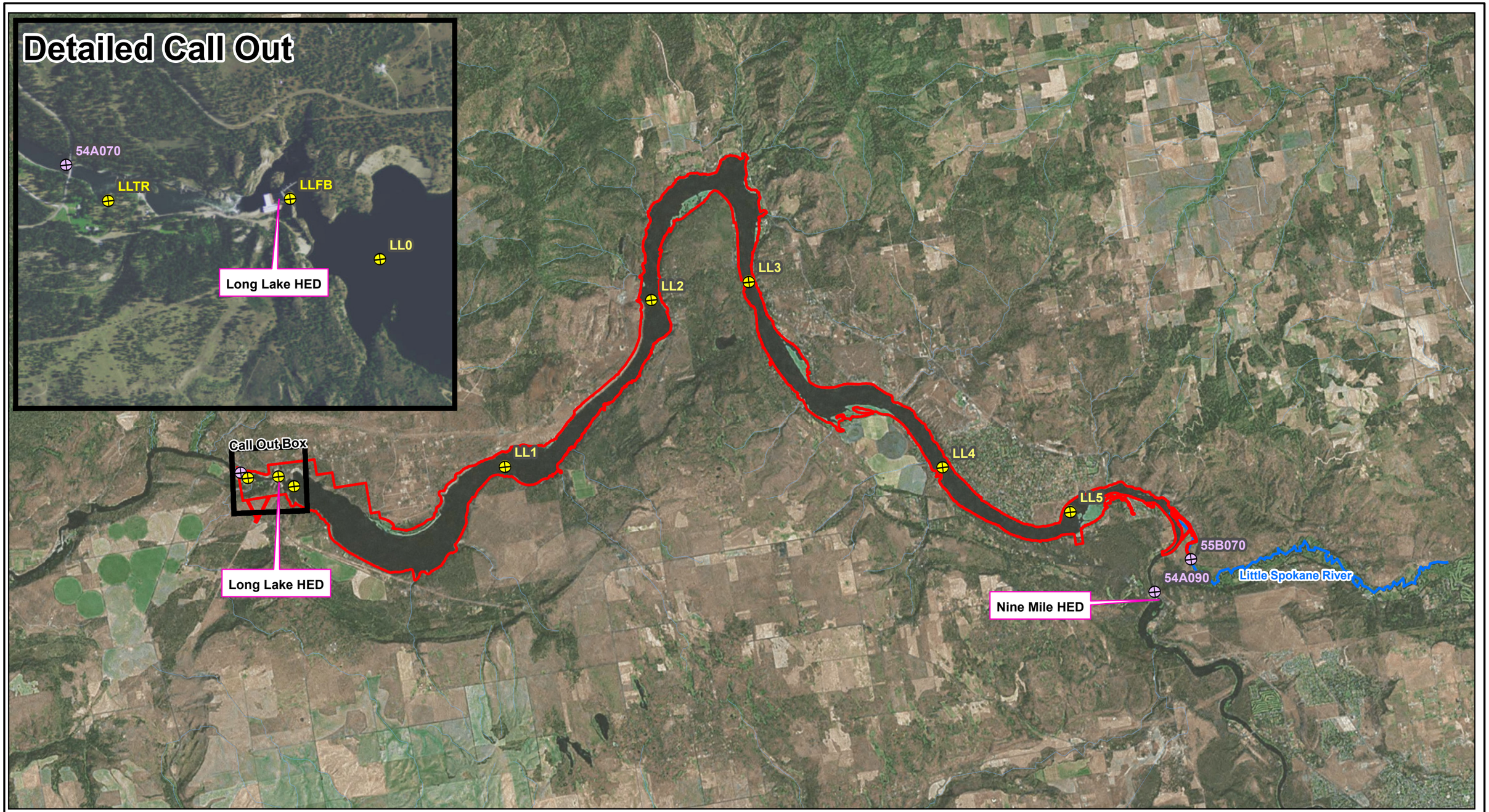
Notes:
--- = not applicable
Shaded and bold values indicate an exceedance of the 20.0°C criterion.
Data collected as part of Avista's Washington Detailed DO Phase II Feasibility and Implementation Plan.

**Table 5-1: Comparison of LLTR 2015 Values to Tribe WQ Standards**

| Day | July | August | September | October |
|---|---|---|---|---|
| 1 | N/A | **19.4** | **18.2** | **16.0** |
| 2 | N/A | **19.4** | **18.1** | **15.9** |
| 3 | N/A | **19.3** | **18.0** | **15.8** |
| 4 | **19.9** | **19.4** | **18.0** | **15.7** |
| 5 | **20.1** | **19.4** | **18.0** | **15.7** |
| 6 | **20.1** | **19.5** | **17.8** | **15.6** |
| 7 | **20.1** | **19.5** | **17.8** | **15.5** |
| 8 | **20.3** | **19.5** | **17.8** | **15.4** |
| 9 | **20.2** | **19.6** | **17.7** | **15.3** |
| 10 | **20.1** | **19.7** | **17.6** | **15.2** |
| 11 | **20.0** | **19.8** | **17.5** | **15.2** |
| 12 | **20.0** | **19.8** | **17.4** | **15.1** |
| 13 | **19.9** | **19.8** | **17.3** | **15.0** |
| 14 | **19.9** | **19.9** | **17.1** | **14.9** |
| 15 | **19.8** | **19.8** | **17.0** | **14.8** |
| 16 | **19.7** | **19.7** | **16.9** | **14.7** |
| 17 | **19.7** | **19.7** | **16.9** | **14.7** |
| 18 | **19.7** | **19.6** | **16.8** | **14.6** |
| 19 | **19.7** | **19.6** | **16.8** | **14.5** |
| 20 | **19.8** | **19.5** | **16.7** | **14.4** |
| 21 | **19.8** | **19.4** | **16.7** | **14.3** |
| 22 | **19.7** | **19.3** | **16.6** | **14.2** |
| 23 | **19.7** | **19.2** | **16.6** | **14.0** |
| 24 | **19.6** | **19.1** | **16.4** | **13.9** |
| 25 | **19.6** | **19.0** | **16.4** | **13.8** |
| 26 | **19.6** | **18.9** | **16.3** | **13.6** |
| 27 | **19.5** | **18.7** | **16.2** | **13.5** |
| 28 | **19.4** | **18.6** | **16.1** | **13.4** |
| 29 | **19.5** | 18.5 | **16.0** | N/A |
| 30 | **19.5** | 18.4 | **15.9** | N/A |
| 31 | **19.4** | 18.3 | --- | N/A |

Notes:
N/A = not enough days to calculate the 7-DADM
Shaded and bold values indicate an exceedance of the Tribe's 7-DADM Criteria.
Data collected as part of Avista's Washington Detailed DO Phase II Feasibility and Implementation Plan.

# FIGURES




LEGEND

- Long Lake HED Boundary
- Little Spokane River

**Temperature Monitoring Stations**

**Sampling Entity**

- Avista
- Ecology

0 1 2 Miles

Map Projection:
NAD 1983 StatePlane Washington
North FIPS 4601 Feet

Source:
ESRI (Aerial Imagery, Little Spokane River),
Avista (Avista HED), Golder Associates (Long Lake Boundary,
Tempurature Monitoring Locations)

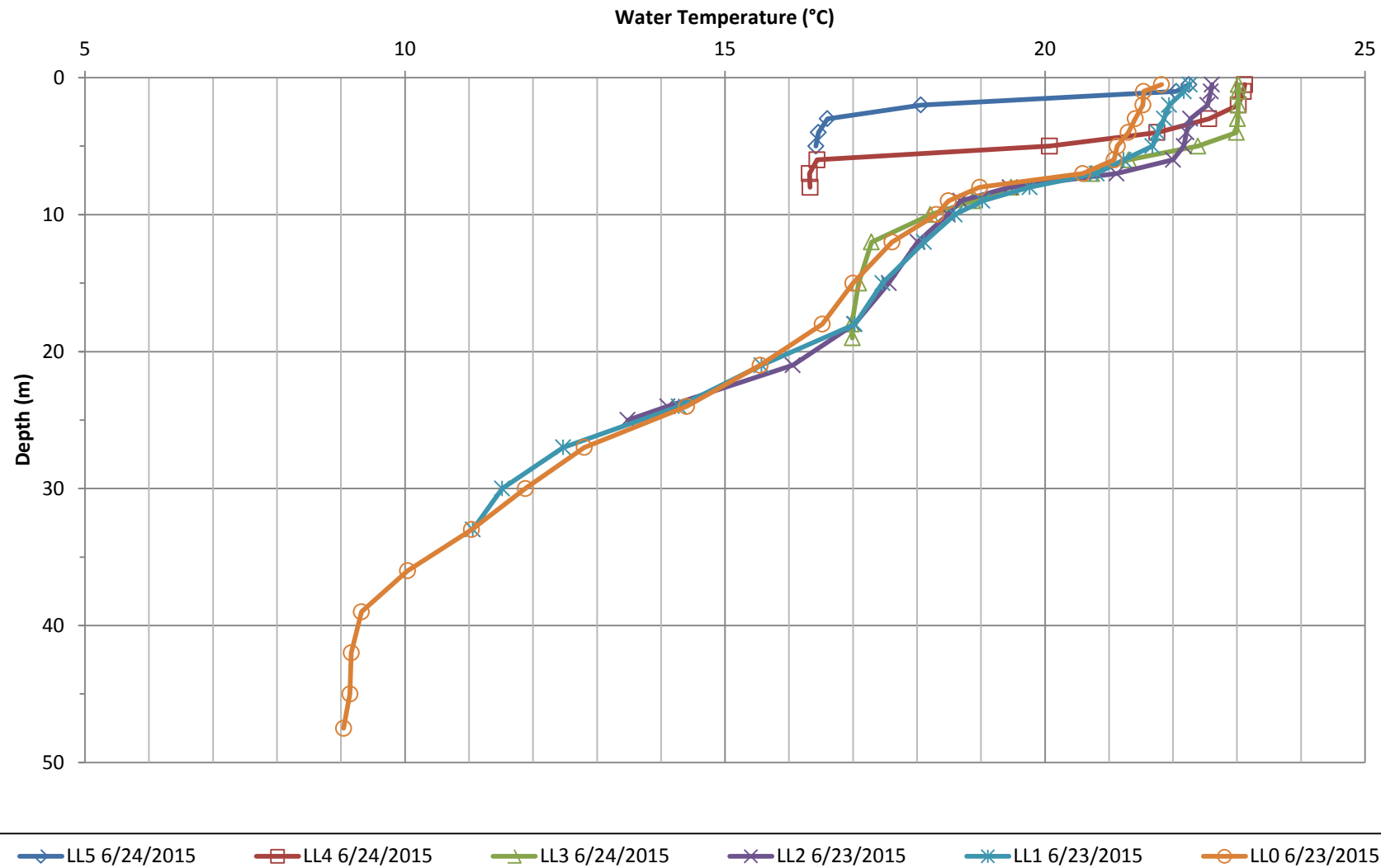
N

This figure was originally produced in color. Reproduction in black and white may result in a loss of information.

FIGURE **2-1**
**Long Lake HED 2015**
**Temperature Monitoring Stations**

Golder Associates
Mattax Solutions LLC

Path: G:\Avista\Long_Lake\99_PROJECTS\07393081_16\02_PRODUCTION\MXD\FIGURES\RevA\07393081_16_F2_1_RevALakeSpokane_Temp_Monitoring_Sites Fig_2_1.mxd THAMMOND

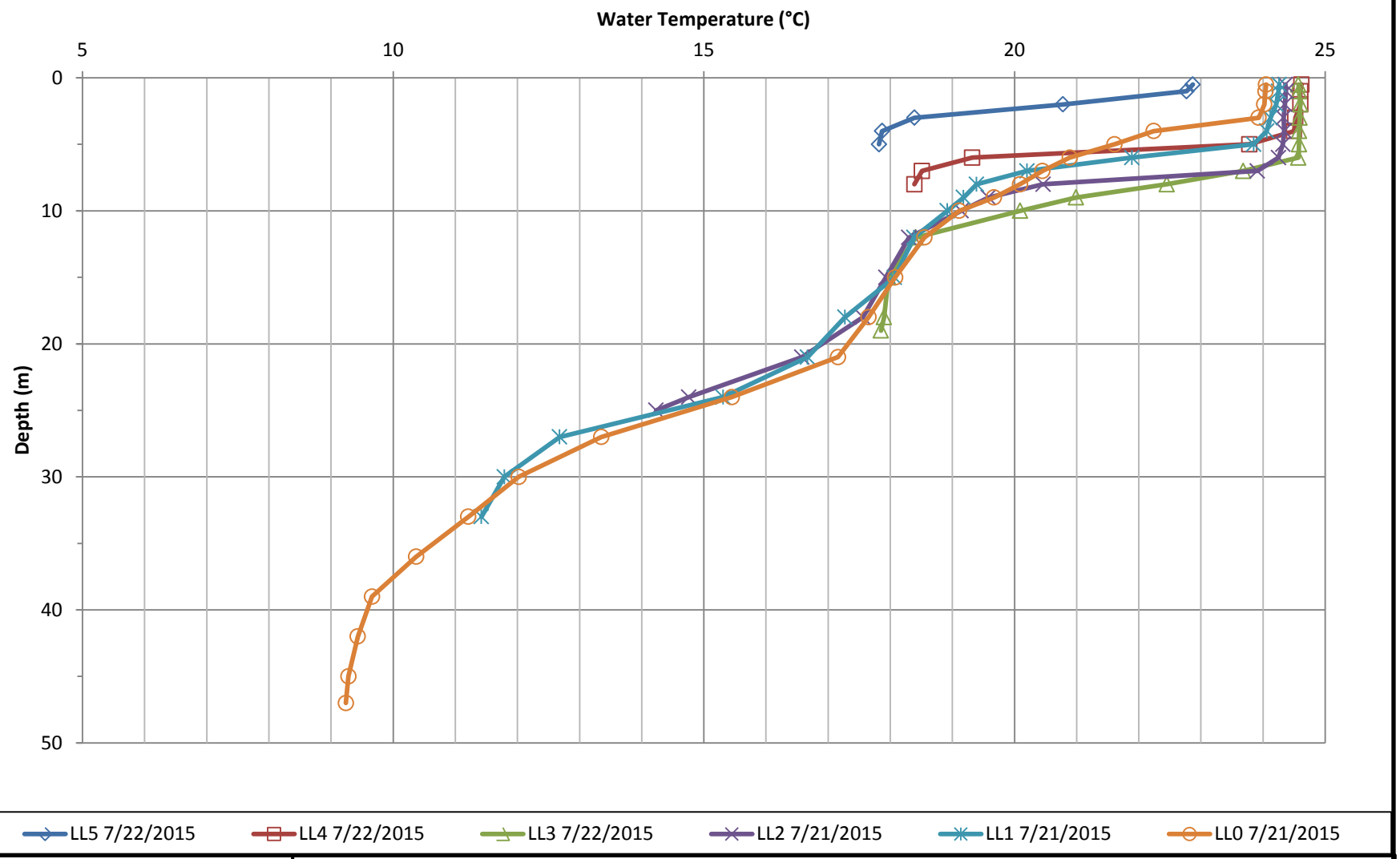



Golder Associates

Mattax Solutions LLC

| | | | |
|---|---|---|---|
| Title | Lake Spokane Temperature Vertical Profiles, Late June 2015 | | |
| Project Name | LL HED Temp Monitoring Report | Project No. | 073-93081-16 |
| Client Name | Avista | Date | 2/26/2016 |

FIGURE 3-1

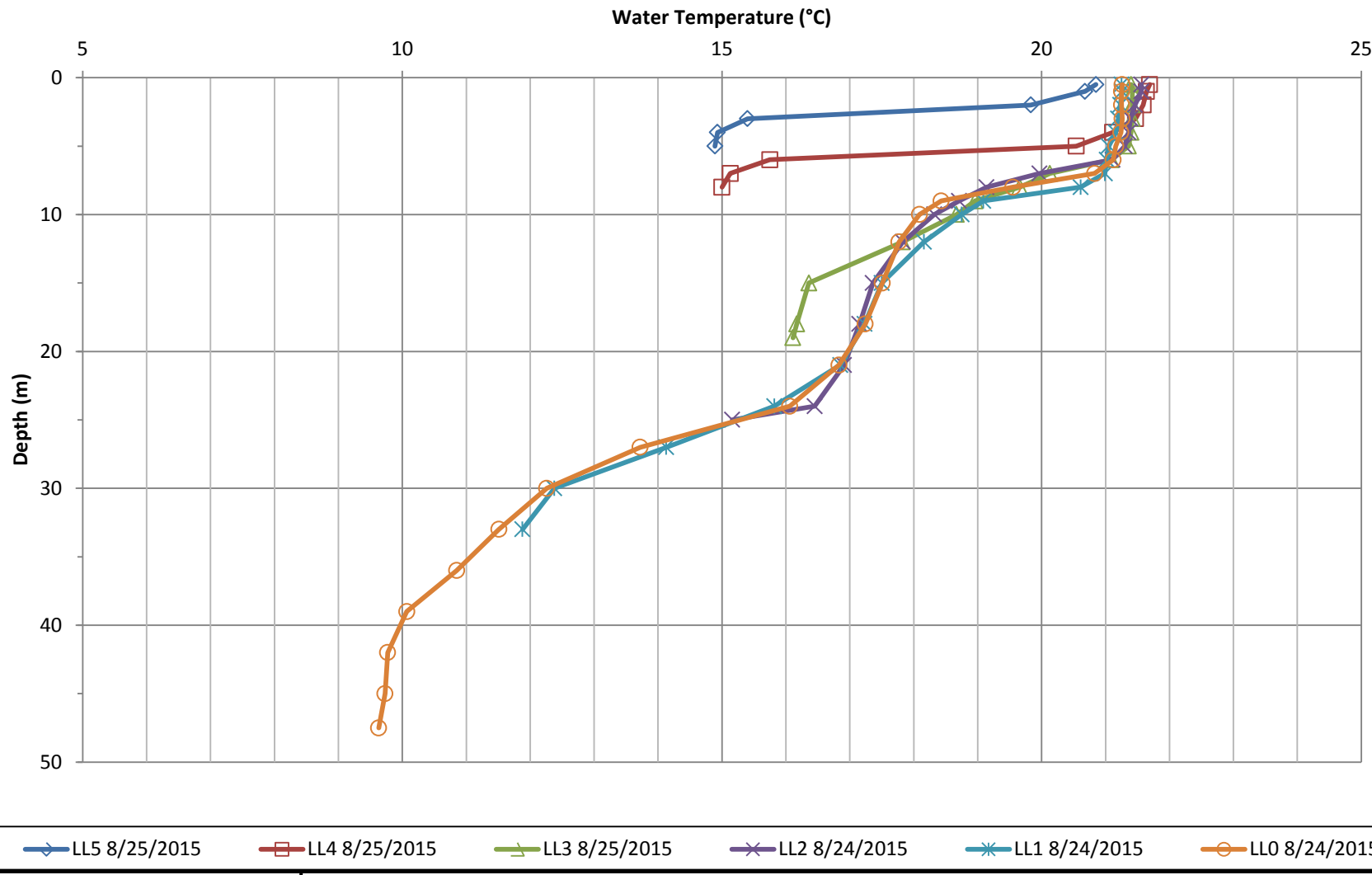



Golder Associates

Mattax Solutions LLC

| | | | |
|---|---|---|---|
| Title | Lake Spokane Temperature Vertical Profiles, Late July 2015 | | |
| Project Name | LL HED Temp Monitoring Report | Project No. | 073-93081-16 |
| Client Name | Avista | Date | 2/26/2016 |

FIGURE 3-2

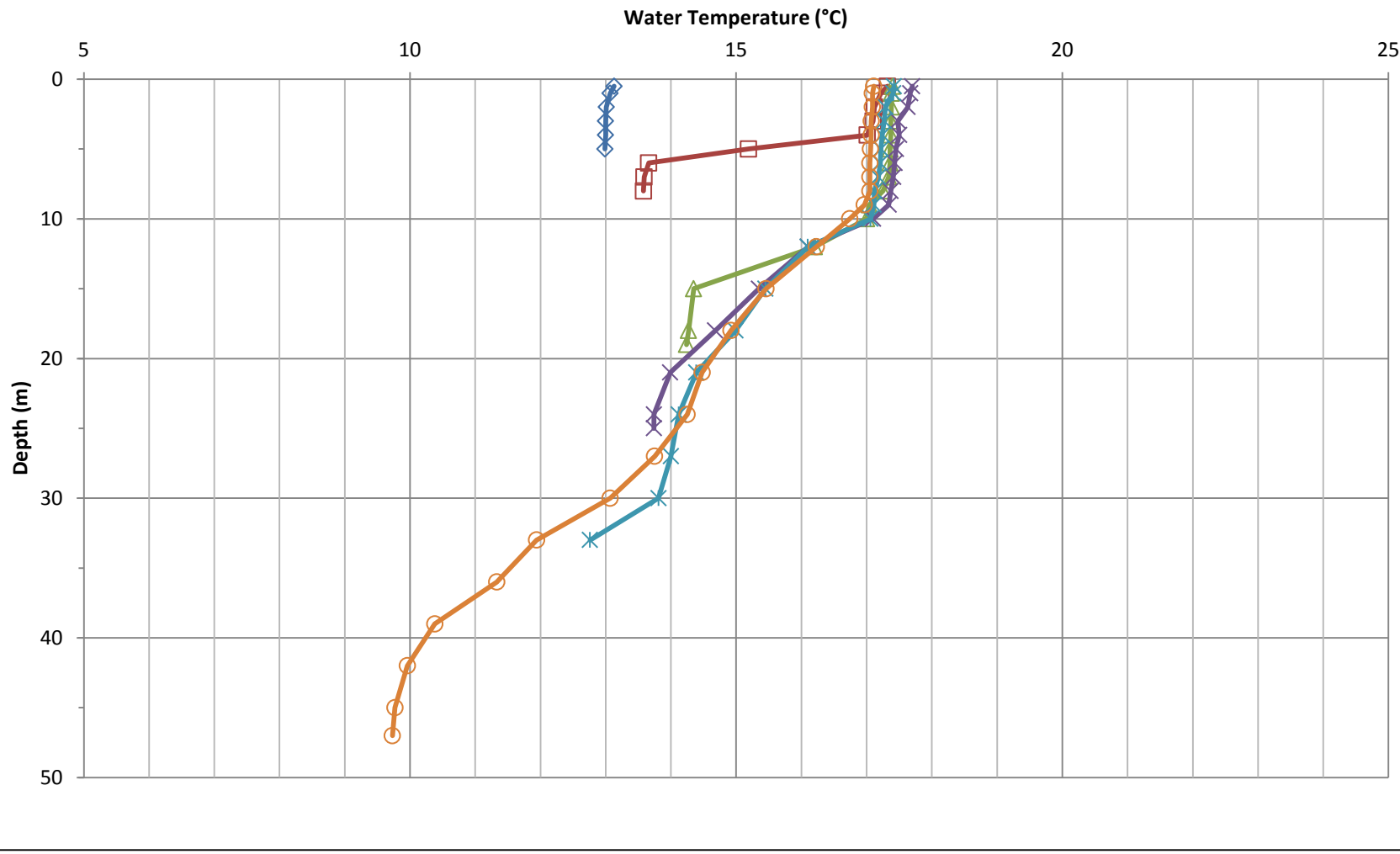



Golder Associates

Mattax Solutions LLC

| | | | |
|---|---|---|---|
| Title | Lake Spokane Temperature Vertical Profiles, Late August 2015 | | |
| Project Name | LL HED Temp Monitoring Report | Project No. | 073-93081-16 |
| Client Name | Avista | Date | 2/26/2016 |

FIGURE 3-3



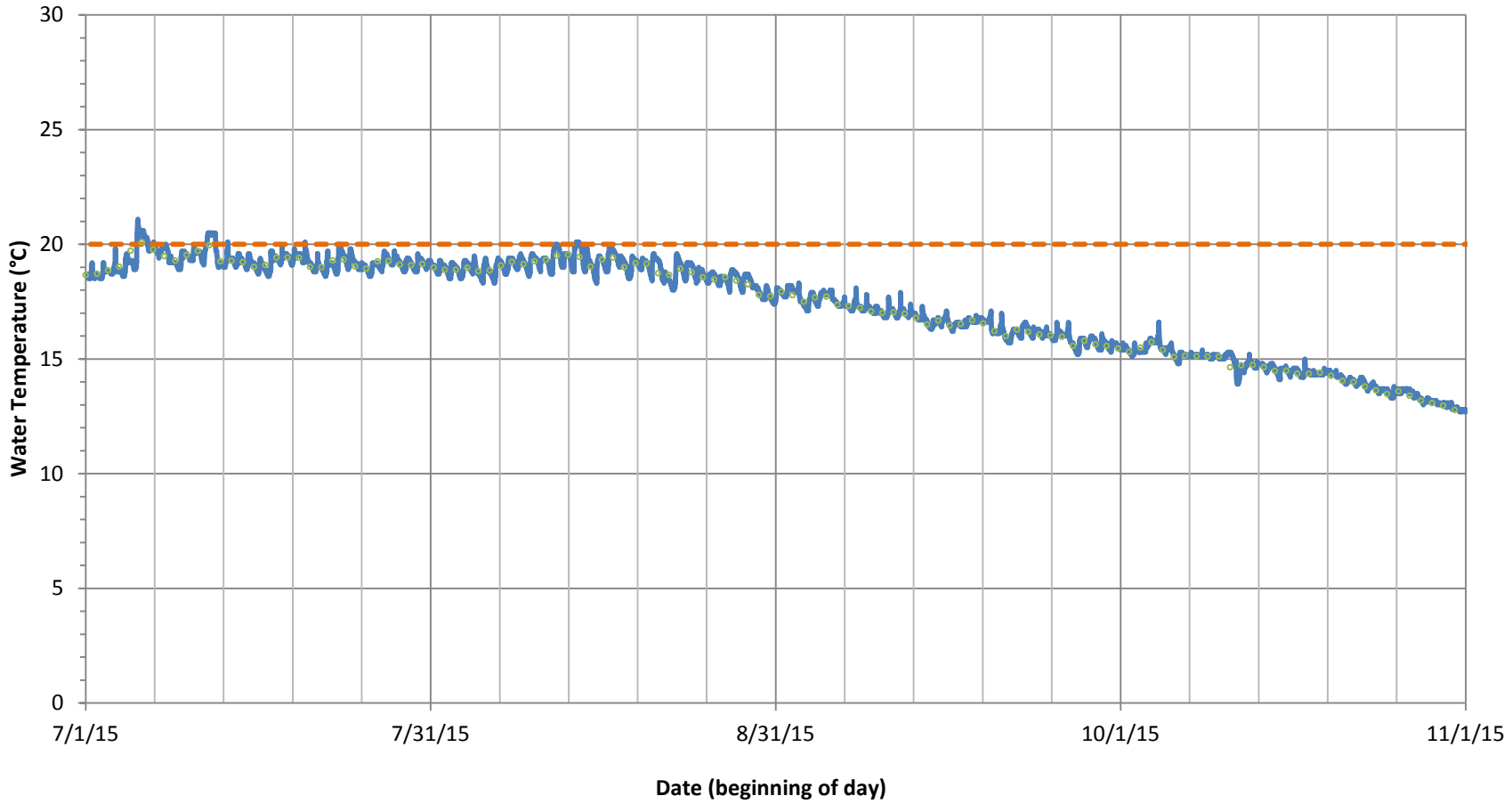

Golder Associates

Mattax Solutions LLC

Title: Lake Spokane Temperature Vertical Profiles, Late September 2015

| | | | |
|---|---|---|---|
| Project Name | LL HED Temp Monitoring Report | Project No. | 073-93081-16 |
| Client Name | Avista | Date | 2/26/2016 |

FIGURE 3-4

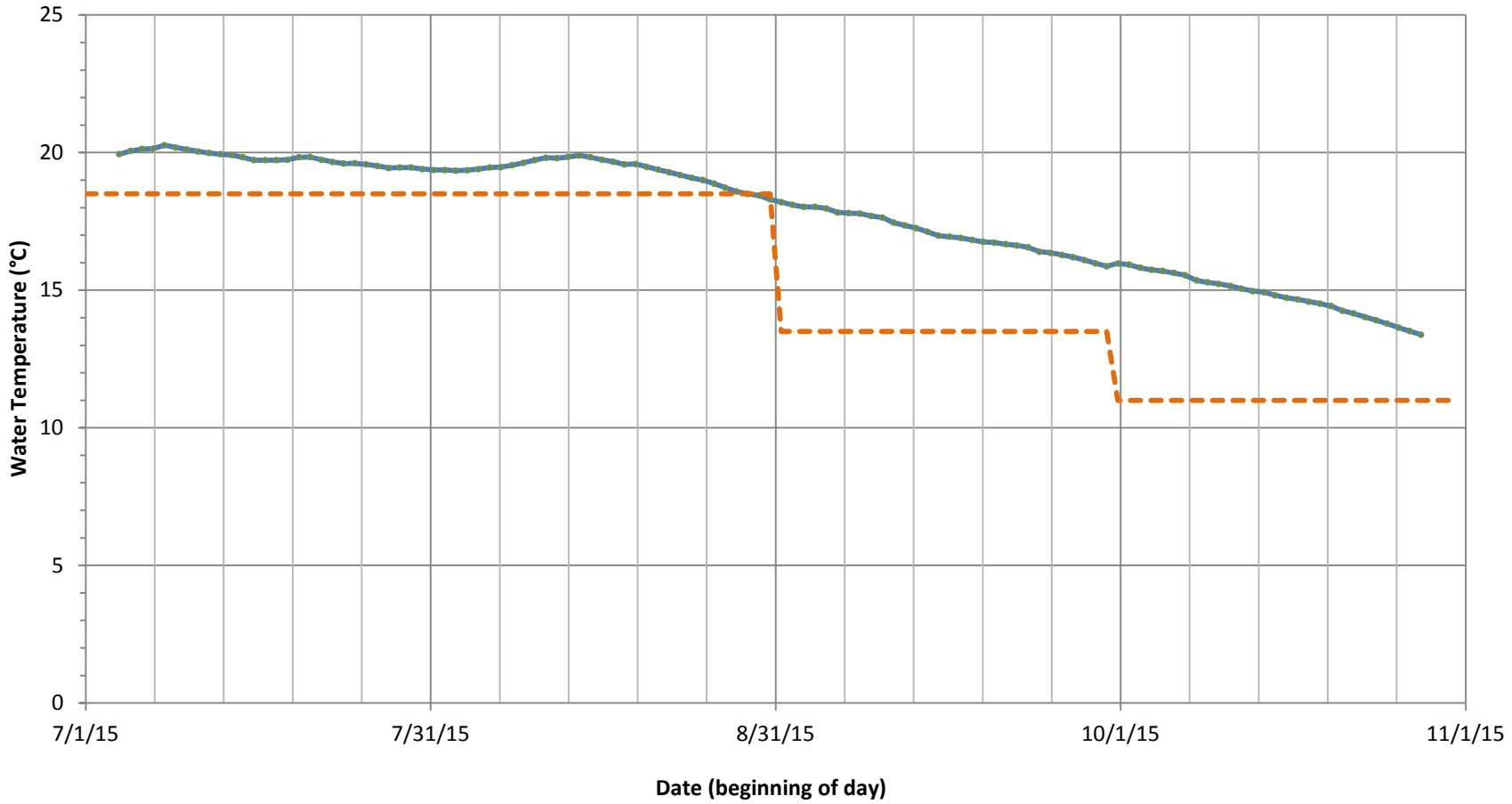



Golder Associates

Mattax Solutions LLC

| | | | |
|---|---|---|---|
| Title | LLTR Temperature Time Series, 2015 | | |
| Project Name | LL HED Temp Monitoring Report | Project No. | 073-93081-16 |
| Client Name | Avista | Date | 2/26/2016 |

FIGURE 3-5




Golder Associates

Mattax Solutions LLC

| | | | |
|---|---|---|---|
| Title | LLTR 7-DADM Time Series, 2015 | | |
| Project Name | LL HED Temp Monitoring Report | Project No. | 073-93081-16 |
| Client Name | Avista | Date | 2/26/2016 |

FIGURE 5-1

# APPENDIX A
# CONSULTATION RECORD

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: Spokane River Hydroelectric Project, FERC Project No. 2545**
**2015 Long Lake Hydroelectric Development Temperature Monitoring Report**

Dear Mr. McGuire:

I have enclosed the 2015 Long Lake Hydroelectric Development Temperature Monitoring Report (Temperature Monitoring Report) for your review and approval. The Temperature Monitoring Report was completed in accordance with the Long Lake Dam Reservoir and Tailrace Temperature Water Quality Attainment Plan, which was required by the Federal Energy Regulatory Commission (FERC) Spokane River Hydroelectric Project License Appendix B, Section 5.5.B.

We request your review and approval by **March 31, 2016**. This will allow us time to incorporate your comments and recommendations as appropriate, and submit the Temperature Monitoring Report to FERC by April 15, 2016.

Please feel free to call me at (509) 495-4643 if you have any questions about the Temperature Monitoring 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 Temperature Monitoring Report.* Spokane River Hydroelectric Project, No. P-2545

Dear Ms. Lunney:

The Department of Ecology (Ecology) has reviewed the *2015 Long Lake HED Temperature Monitoring Report* sent to us on February 29, 2016. The report is a requirement in FERC License Appendix B, Section 5.5.B.

Ecology APPROVES the *2015 Long Lake HED Temperature Monitoring Report* as submitted.

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

Sincerely,

Pat McGuire

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 Temperature Monitoring Report.

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: Spokane River Hydroelectric Project, FERC Project No. 2545**
**2015 Long Lake Hydroelectric Development Temperature Monitoring Report**

Dear Mr. Crossley:

I have enclosed the 2015 Long Lake Hydroelectric Development Temperature Monitoring Report (Temperature Monitoring Report) for your review and approval. The Temperature Monitoring Report was completed in accordance with the Long Lake Dam Reservoir and Tailrace Temperature Water Quality Attainment Plan, which was required by the Federal Energy Regulatory Commission (FERC) Spokane River Hydroelectric Project License Appendix B, Section 5.5.B.

Per the October 2008 Settlement Agreement between Avista and the Spokane Tribe, we would like to receive any comments that you may have on the Temperature Monitoring Report by **March 31, 2016**. This will allow us time to incorporate your comments as appropriate, and submit the Temperature Monitoring Report to FERC by April 15, 2016.

Please feel free to call me at (509) 495-4643 if you have any questions about the Temperature Monitoring 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 Temperature Monitoring Report.

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