



July 16, 2010

Ms. Kimberly D. Bose, Secretary  
Federal Energy Regulatory Commission  
888 First St. N.E.  
Washington, DC 20426

**Re: Federal Energy Regulatory Commission's Spokane River Hydroelectric Project  
(FERC Project No. 2545) License, Appendix B, Section 5.6.D, Washington  
Department of Ecology's Long Lake HED Total Dissolved Gas Water Quality  
Attainment Plan**

Dear Secretary Bose:

On June 18, 2009, the Federal Energy Regulatory Commission (FERC) issued a new license for the Spokane River Hydroelectric Project, FERC Project No. 2545 (License). Ordering Paragraph E of the License incorporated the *Washington Department of Ecology (Ecology) Certification Conditions Under Section 401 of the Federal Clean water Act (Issued on May 8, 2009 and amended on May 11, 2009)*. The Conditions can be found in Appendix B of the License. On September 17, 2009, FERC issued an Order which requires Avista to file the Long Lake Dam Total Dissolved Gas Water Quality Attainment Plan (Plan) along with Ecology's approval no later than 45 days following the deadline established in the Washington 401.

Section 5.6. D of Appendix B in the License requires Avista to consult with the Washington Department of Ecology during the development of the enclosed Plan. Copies of Ecology's comments and recommendations, and Avista's responses to them, are included in Appendix C of the Plan. Ecology's letter approving the Plan is also included in the Appendix.

With this, Avista is submitting the Plan to FERC for approval. Upon FERC's approval Avista will begin implementing the Plan as appropriate. Please feel free to contact me if you have any questions or wish to discuss the Plan. I can be reached at (509) 495-4998.

Sincerely,

Elvin "Speed" Fitzhugh  
Spokane River License Manager

Enclosure

cc: Heather Campbell, FERC  
Marcie Mangold, Washington Department of Ecology

## CERTIFICATE OF SERVICE

I hereby certify that I have this day served the **Long Lake Dam Total Dissolved Gas Water Quality Attainment Plan** on Washington Department of Ecology in compliance with Ordering Paragraph J of the Spokane River Project FERC License (P-2545).

Ms. Marcie Mangold  
Washington Department of Ecology  
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Dated this 16 day of July, 2010

By:   
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# **AVISTA CORPORATION**

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## **LONG LAKE DAM TOTAL DISSOLVED GAS WATER QUALITY ATTAINMENT PLAN**

WASHINGTON 401 CERTIFICATION, SECTION 5.4(D)

Spokane River Hydroelectric Project  
FERC Project No. 2545

Prepared By:  
Golder Associates Inc.  
Redmond, WA

*July 9, 2010*

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## Acronyms and Abbreviations

%	percent
®	Registered
°C	degrees Celsius
Avista	Avista Corporation
CFD	computation fluid dynamics
cfs	cubic feet per second
Ecology	Washington Department of Ecology
EES	EES Consulting, Inc.
e.g.	<i>expempli gratia</i>
El.	elevation
ERDC	U.S. Corps of Engineer, Engineering Research and Development Center
FERC	Federal Energy Regulatory Commission
ft	feet
GBD	gas bubble disease
GBT	gas bubble trauma
Golder	Golder Associates
HED	hydroelectric development
mg/L	milligrams per liter
mm Hg	millimeters of mercury, as pressure
MW	megawatts
TDG	total dissolved gas
TDG WQAP	Long Lake Dam Total Dissolved Gas Water Quality Attainment Plan
Washington 401	Washington State section 401 water quality certification for Spokane River Project

## 1.0 INTRODUCTION

This Long Lake Dam Total Dissolved Gas Water Quality Attainment Plan (TDG WQAP) has been prepared to fulfill requirements of:

- Washington State Department of Ecology (Ecology) for a compliance schedule and TDG WQAP for Long Lake Dam within one year of license issuance, which is specified in section 5.4(D) of the amended section 401 water quality certification (Washington 401) issued on May 8, 2009 for the Spokane River Hydroelectric Project (FERC No. 2545) (Ecology 2009)
- Federal Energy Regulatory Commission (FERC) for a TDG WQAP for Long Lake Dam as specified in Article 401 of the license issued for the Spokane River Project on June 18, 2009 (FERC 2009a)
- FERC for “information regarding the frequency of monitoring, sampling procedures, and equipment to be used” for monitoring total dissolved gas (TDG) to be filed with the FERC as required by FERC’s order approving and modifying the Water Quality Monitoring and Quality Assurance Project Plan, which was issued on September 17, 2009 (FERC 2009b)

On June 18, 2009, FERC issued a license for the Spokane River Project (FERC 2009a). Article 401(a) of this license requires Avista to file the TDG WQAP for Long Lake Dam required by Washington 401 section 5.4(D) for approval prior to implementation. On September 17, 2009, FERC (2009b) issued an order which requires that Avista file the Long Lake TDG WQAP along with Ecology’s approval no later than 45 days following the deadline established in the Washington 401.

Section 5.4(D) of the Washington 401 requires the following:

*The Licensee [,Avista, ] shall monitor TDG in the forebay or generation plume and near the end of the aerated zone (the area of bubble entrainment and dissipation) of Long Lake Dam upon issuance of the FERC license.*

*The Licensee shall monitor for TDG to assess gas production from Long Lake Dam during flows close to the 7Q10.*

*Within one year of the issuance of the FERC license, the Licensee shall develop a compliance schedule and TDG Water Quality Attainment Plan for Long Lake Dam for Ecology review and approval. The plan shall include:*

1. *Submit to Ecology a Detailed Phase II Feasibility and Implementation Plan based on Long Lake Dam TDG Abatement Initial Feasibility Study Report. Avista may request a special temporary permit to spill from Long Lake Dam to achieve higher spill closer to the 7Q10. This does not guarantee that Ecology will grant this special permit. Ecology must first consult with other agencies and the Spokane Tribe before doing so;*
2. *A description of standard Project operations with regard to minimizing TDG associated with spills;*

3. *A description of how the Project will minimize all spills that produce TDG exceedances at the Project;*
4. *An evaluation of all potential and preferred structural and operational improvements to minimize TDG production;*
5. *A timeline showing when operational adjustments will occur;*
6. *A schedule for construction; and*
7. *Monitoring plans to further evaluate TDG production and to test effectiveness of gas abatement controls.*

*The Project shall operate according to the approved TDG WQAP with the objective of eliminating TDG exceedances.*

*Upon approval of the TDG WQAP, the Licensee shall immediately begin the necessary steps identified in the TDG WQAP to eliminate TDG criteria exceedances.*

*If monitoring to test the effectiveness of gas abatement controls implemented through the TDG WQAP shows the TDG abatement measures identified in the Plan and subsequently employed are not successful in meeting the water quality criterion within the ten year compliance period, and the Licensee is unable to meet water quality standards after evaluating all reasonable and feasible alternatives under WAC 173-201A-510(5)(g), then the Licensee will propose an alternative action to achieve compliance with the standards, such as new reasonable and feasible technologies or other options to achieve compliance with the standards, a new compliance schedule, or other alternatives as allowed by WAC173-201A-510.*

The organization of this plan is structured around the above seven requirements which are addressed in the same order in sections 3.0 through 9.0. This plan also includes this Introduction section, section 2.0 Background and section 10.0 Literature Cited.

Additional materials are provided in two appendices. Appendix A provides the TDG monitoring plan. Appendix B provides a record of consultation for the Long Lake Dam TDG WQAP.

## 2.0 BACKGROUND

### 2.1 Total Dissolved Gas Causes and Effects

When water plunges into a pool, air becomes entrained regardless of whether the plunge is caused by a natural waterfall or a dam spillway (Weitkamp and Katz 1980). As stated by Ecology (2005), “Fish in water with high Total Dissolved Gas (TDG) levels may not display signs of difficulty if higher water pressures at depth offset high TDG pressure passing through the gills into the blood stream. However, if the fish inhabit supersaturated water for extended periods, or rise in the water column to a lower water pressure at shallower depths, TDG may come out of solution within the fish, forming bubbles in their body tissues.” This gives rise to a condition called gas bubble disease (GBD) or gas bubble trauma (GBT) that can harm fish (Weitkamp 2000; Backman and Evans 2002; Backman et al. 2002; Ryan et al. 2000).

### 2.2 Long Lake HED Facilities

Long Lake Hydroelectric Development (HED) is the lowermost of the five hydroelectric developments of the Spokane River Hydroelectric Project (FERC No. 2545). It is located on the Spokane River at approximately river mile 34, a distance of 25-30 miles northwest of Spokane, Washington. The drainage area upstream of Long Lake Dam is approximately 5,840 square miles, and includes the Hangman Creek<sup>1</sup> and Little Spokane River watersheds, along with the watersheds that feed Coeur d’Alene Lake in Idaho. Plate 2-1 shows the primary Long Lake HED facilities.

Long Lake HED includes an L-shaped, concrete gravity dam (“main dam”) and adjacent intake structure; a concrete arch cutoff dam (“crescent dam”) located along the western shoreline approximately 700 to 800 feet upstream of the main dam; a gated spillway along the top of the main dam; and a powerhouse. The powerhouse contains four turbine-generator units with a total generating capacity of 71.7 megawatts and a combined hydraulic capacity of 6,300 cubic feet per second (cfs). The HED’s reservoir (commonly known as Lake Spokane) extends approximately 23.5 miles upstream of the main dam. It has a 5,060-acre surface area at normal full pool elevation of 1,536 feet and it has a usable storage of 66,720 acre-feet at a drawdown of 14 feet. The main dam is a 593-foot-long, 213-foot-high concrete gravity dam (plate 2-1). The top of the dam is at elevation 1,537 feet. The main dam includes a 353-foot-long, gated ogee spillway with a crest elevation of 1,508 feet. The spillway has eight 25-foot-wide by 29-foot-high vertical lift gates and a capacity of 115,000 cfs at a water surface elevation of 1,536 feet.

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<sup>1</sup> Hangman Creek is also known as Latah Creek. This document uses Hangman Creek, which is the USGS convention.





### **Plate 2-1. Long Lake Dam and Powerhouse as Viewed From Overlook**

**May 22, 2008 at 09:45 PDT**

Long Lake HED is operated as a storage facility for power generation purposes with a normal full-pool elevation of 1,536 feet. Although Avista was allowed to draw down Lake Spokane by as much as 24 feet under the previous FERC license, it voluntarily limited drawdown to approximately 14 feet (elevation 1,522 feet) beginning in the late 1980s. Article 402 of the new Federal Energy Regulatory Commission (FERC) license, which was issued on June 18, 2009, officially establishes the 14-foot drawdown limit.<sup>2</sup> Winter drawdown does not occur each year, due to variations in weather and river flows. When a drawdown occurs, its magnitude is dependent on weather conditions and other factors. The lake is normally held within 1 foot of the full-pool elevation throughout the summer recreation season.

The Long Lake Dam spillway has a crest length of 353 feet and a base width of 250 feet. The spillway itself consists of eight gated bays, numbered 1 to 8 from northeast to southwest (spill bay 8 is closest to the penstocks and powerhouse). The crest of each bay is at El. 1508 feet (project datum), and each fixed-

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<sup>2</sup> License Article 402 states that “The drawdown requirement may be temporarily modified if required by operating emergencies beyond the control of the licensee.”

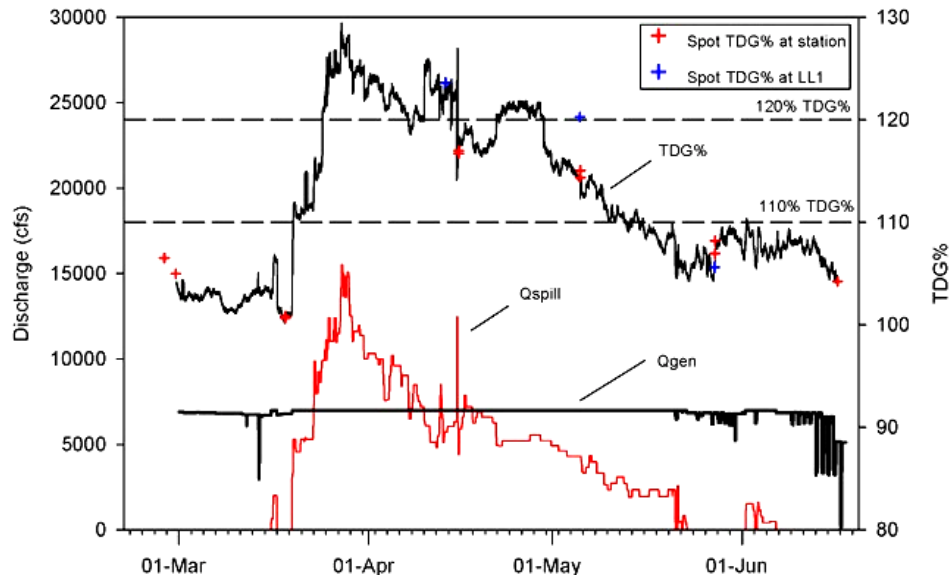
wheel vertical gate is 29-feet high by 25-feet wide. The spillway bays discharge down an ogee-shaped apron to a small stilling basin area at the toe of the dam. The stilling basin is a rock channel that makes nearly a 180-degree turn to the left immediately below the dam. Operation of the Long Lake spillway occurs during most years as river flows typically exceed the 6,800 cfs capacity of the Long Lake powerhouse during the April through July (sometimes earlier) spring runoff season. Ecology (2009) defined the 7Q10 flood magnitude as approximately 32,000 cfs.

## 2.3 Historical Conditions

During 2003 and 2004 monitoring, continuous TDG measurements for the Long Lake forebay ranged from 101 to 123 percent of saturation, and typically had daily fluctuations of less than 5 percent of saturation (Golder 2003, 2004). TDG behind Long Lake Dam is not the same throughout the water column, but varies with depth and location (Golder 2004, 2006). Evaluation of the data collected suggests that mixing of the stratified layers of water (e.g., due to wind events, dam operations, etc) likely causes significant fluctuations of TDG in the forebay.

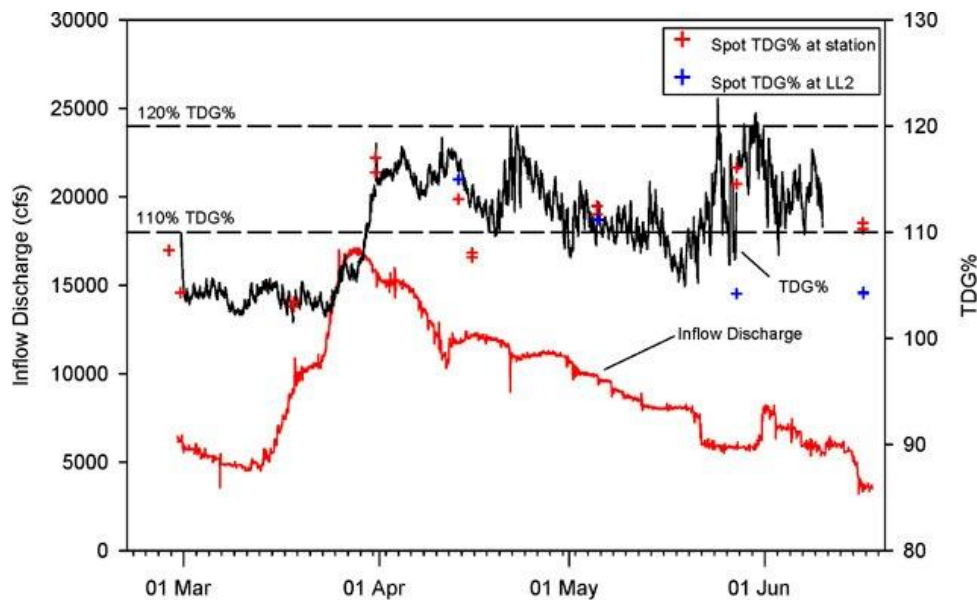
TDG measurements obtained 0.6 mile downstream of Long Lake HED reached as high as 129 and 125 percent of saturation in 2003 and 2004, respectively (Golder 2003, 2004). In 2003, TDG in the Long Lake tailrace exceeded 110 percent of saturation from March 20 to May 15, and generally exceeded 120 percent of saturation from March 24 to April 14 and from April 21 to April 29 (figure 2-1). The Long Lake tailrace also had extended periods when TDG exceeded 110 and 120 percent of saturation in 2004. TDG exceeded the 110-percent of saturation criterion during these periods when water was being spilled through the Long Lake Dam spillways.

During previous studies at lower flows following the freshet, Long Lake forebay meters recorded increasing erratic TDG levels that appeared to fluctuate randomly (figure 2-2), (Golder 2003, 2004; Mattax 2009). When periodic large reductions in TDG were recorded at these stations, concurrent reductions in water temperature and DO were also recorded. Vertical profiles conducted at forebay monitoring locations documented that forebay water was strongly stratified and that deeper water layers were cooler and had low DO concentrations. The apparently random fluctuations in TDG were assumed to be related to disturbance of the stratified water layers due to operation of the Long Lake HED powerhouse, combined with wind and wave action on the reservoir (Golder 2004). Spot and continuous TDG measurements for the generation plume varied from concurrent measurements taken near the forebay powerhouse intakes. High water velocities at the intake and generation monitoring locations posed significant challenges in deploying and maintaining continuous monitors. The monitoring data collected, however, suggests that the entrainment of different stratified water layers is not predictable or consistent and that a TDG sensor, even when deployed directly in front of the powerhouse intake, does not always equal TDG in the generation plume. Consequently, we recommended, and Ecology approved, installation of a station at a location that will enable direct monitoring of TDG within the generation plume.



**Figure 2-1 - Long Lake HED Tailrace TDG in Relation to Spill and Generation Discharge, February 24-June 17 of 2003**

Spot measurements were taken adjacent to the continuous tailrace monitoring station (“at station”) and in the spill channel (“at LL1”). (Source: Golder 2003)



**Figure 2-2 - Long Lake HED Forebay TDG in Relation to Inflows February 24-June 17 of 2003**

Spot measurements were taken adjacent to the continuous forebay monitoring station (“at station”) and in the generation plume immediately downstream of the Long Lake powerhouse (“at LL2”). Inflow discharge is the rate of Spokane River inflow to the Long Lake reservoir. (Source: Golder 2003)



## 2.4 Hydraulic Modeling Study of Long Lake Dam Spillway

The river bed at the toe of Long Lake Dam has been scouring since the dam was constructed in 1915 because the spillway does not have an energy dissipater. This led to a hydraulic model study being done for the Long Lake Dam spillway in 1992 by the Albrook Hydraulic Laboratory (Chaudhry 1992) to evaluate several conventional energy dissipater designs, such as a stilling basin, a roller bucket, and a flip bucket that could reduce erosion at the toe of the dam. The model showed that, with the existing structural arrangement (no energy dissipater), the maximum scour downstream of the spillway occurs in the two areas where the toe of the spillway meets the right and left channel banks. The maximum scour is to Elevation 1,300 feet and the areal extent of the scour increases as the flow increases. Chaundry (1992) also indicated the extent of scour and the undermining of the dam had not reached equilibrium and additional undermining of the dam was possible without additional remedial measures. Physical modeling indicates that scour at the toe of the dam, and undermining of the dam, would be reduced with removal of the left bank rock outcrop at the base of the dam.

Avista conducts a thorough surveillance and monitoring plan, which includes underwater inspections of the toe erosion and undermining, every five years and after years with peak river discharge exceeding 40,000 cfs. Avista has developed, and FERC has accepted, conservative maximum allowable scour thresholds to trigger consideration of stability reanalysis or structural remediation. Over the past 20 years, undermining of the spillway toe has been minimal (pers comm., Steve Fry, Hydro Projects Manager, Avista, dated March 22, 2010).

The Albrook Hydraulic Laboratory study identified a flip bucket as the structurally and economically viable alternative to dissipate energy at the toe of the dam because of conditions at the site and the configuration of existing structures. The stilling basin alternative was identified as infeasible because of the lack of proper development length and the need for extensive rock excavation. The roller bucket alternative was eliminated due to the lack of adequate tailwater submergence. A preliminary analysis of the conventional high-angle flip bucket designs led to the conclusion that potential designs would have to be model tested in order to verify hydraulic performance, i.e., the jet would not cause excessive erosion and would not undermine the right bank canyon wall.

## 2.5 Phase I Feasibility Study

Avista retained EES Consulting, Inc. to complete the initial identification and screening of a wide range of structural alternatives for TDG abatement that might be possible at Long Lake HED (EES 2006). The study team identified five alternatives for modifying the existing Long Lake spillway dam. These ranged from the addition of simple flow deflectors below the existing spill bays, to complex spillway chutes and downstream rock excavation efforts that divert flows away from the deep plunge pool. The Phase I study also included seven bypass options that were considered. These included: three diversion tunnels or

pipes around the development: two new spillway alternatives; and two options that add generating units in a powerhouse extension or a new powerhouse below the cut-off dam.

Following the initial concept development, Avista reviewed these options with the study team to select four alternatives that were further refined in the Phase I feasibility study. The alternatives are listed in table 2-1, along with their estimated flow capacity, TDG performance, and cost (in 2005 dollars). Alternatives recommended for further study in a final feasibility evaluation are marked with an asterisk in table 2-1.

**TABLE 2-1**  
**Phase I Summary of TDG Abatement Alternatives**

<b>Alternative</b>	<b>Hydraulic Capacity, cfs</b>	<b>Estimated TDG range at hydraulic capacity, %</b>	<b>Comparative Cost, 2005 dollars</b>	<b>Notes</b>
Spill Bay 7-8 Deflectors *	28,000	115 - 125	\$7.3 million	
Spill Bay 5-8 Deflectors	29,500	115 - 125	\$8.8 million	
Spill Bay 7-8 Deflectors with Training Walls *	28,000	110 - 120	\$13.0 million	
Spill Bay 1- 2 Deflectors *	17,600	120 - 130	\$4.8 million	
Spill Bay 3-8 Deflectors	29,500	120 - 130	\$8.2 million	Cost based on 1991 est., escalated to 2005
New Spill Bay 9	5,000	115 – 125	\$7.5 million	
Free Discharge Valves	10,000	105 - 120	\$15.6 million	
Cut-Off Dam Spillway *	29,500	110 - 130	\$38.4 million	
New Bypass Tunnel – Right Bank	29,500	120 - 124	\$47.7 million	
New Bypass Tunnel – Left Bank	29,500	120 - 124	\$61.4 million	
Reactivation of Existing Bypass Tunnel	Possibly 20,000	120 – 124	Not estimated	This alternative determined to be technically infeasible
Powerhouse Expansion – Fifth Unit	2,000	120	\$16.9 million to \$33.1 million net, with energy generation benefits	Powerhouse unit upgrades completed in 1990's. Further upgrades to existing units are not feasible. Present worth of generation benefits estimated at \$31.85 million.
New Second Powerhouse	9,500	120	\$68 million net, with generation benefits	Cost based on 1990 feasibility study, escalated to 2005 level. Present worth of generation benefits estimated at \$114.3 million.

**Notes:**

1. \* Denotes selected alternative, this concept was developed in more detail following initial screening of alternatives (Refer to EES 2006, section 6).
  2. Cost data is useful for screening comparison of alternatives only. Estimates of possible construction cost will require further development of alternative arrangements, design concept, construction quantities, and unit prices.
  3. Lower limits of TDG range reflect assumption of 120 percent of saturation TDG level in forebay.
- Source: EES (2006)

### 3.0 PHASE II FEASIBILITY AND IMPLEMENTATION PLAN

Section 5.4(D)(1) of the Washington 401 states:

*Submit to Ecology a Detailed Phase II Feasibility and Implementation Plan based on Long Lake Dam TDG Abatement Initial Feasibility Study Report. Avista may request a special temporary permit to spill from Long Lake Dam to achieve higher spill closer to the 7Q10. This does not guarantee that Ecology will grant this special permit. Ecology must first consult with other agencies and the Spokane Tribe before doing so;*

Avista has selected Northwest Hydraulic Consultants Inc. (NHC) to conduct the Phase II Feasibility Study. The Phase II Feasibility and Implementation Plan involves further development of the following five alternatives identified in the Phase I Feasibility Study (EES 2006)<sup>3</sup>, which is discussed in section 2.5:

- Alternative 1 Spill Bay 7-8 Deflectors - addition of flow deflectors on the downstream face of the spillway chute, construction of a horizontal bench cut from the rock peninsula below the spill gates, and possible infilling of a portion of the spillway plunge pool
- Alternative 2 Spill Bay 7-8 Super-elevated Spillway Extension - construction of two spillway chutes, training walls, and a flip lip to the spillway chute, and excavation of the rock peninsula below the spill gates
- Alternative 3 Spill Bay 1-2 Toe Modification and Downstream Deflector - addition of flow deflectors on the downstream face of the spillway chute, rock excavation and construction of a new training wall
- Alternative 4 Cut-off Dam Chute Spillway with Deflector - addition of a new spillway downstream of the existing cut-off dam
- Alternative 5 New Second Powerhouse – addition of a total of 120 MW generating units with a discharge capacity of 9,500 cfs

The Phase II study is scheduled for completion in June 2010 and will include conceptual design engineering configuration and costs along with numerical modeling to assess the hydraulic performance of alternatives.

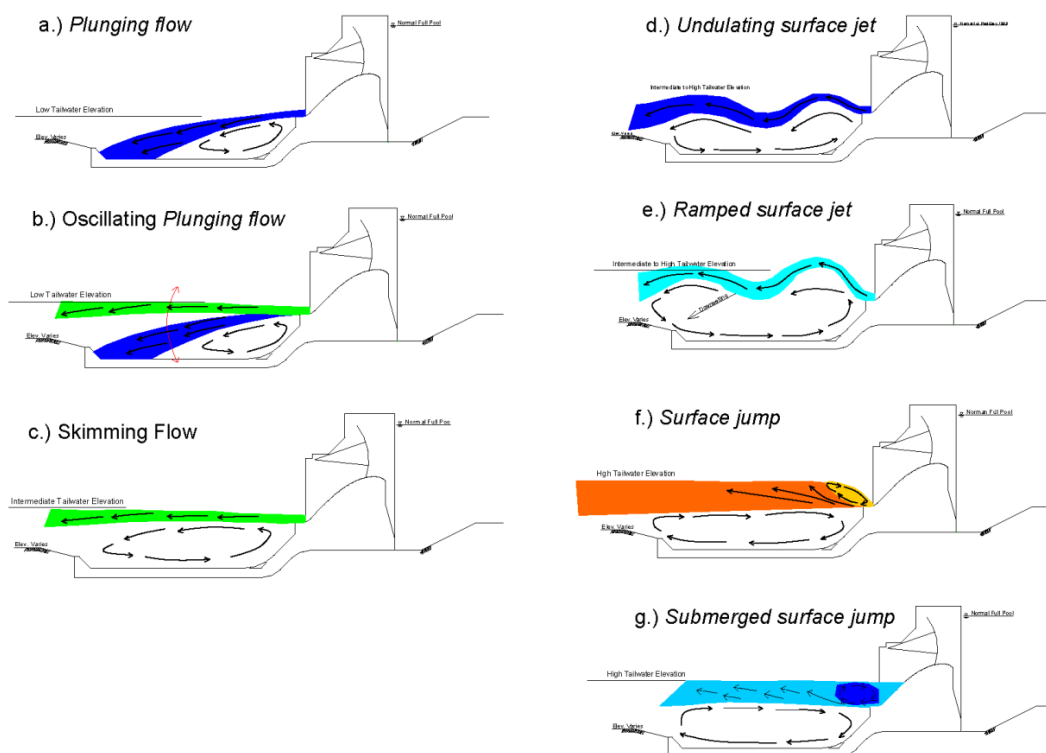
**Alternatives 1 through 4:** This phase will involve developing a preliminary configuration and then using a numerical model to evaluate the performance of Alternatives 1 through 4. Civil design work for the alternatives will include developing conceptual designs to provide sufficient detail to provide initial engineering layout and configuration, develop conceptual level cost estimates, identify constructability issues (including cofferdam and dewatering requirements), and rank the alternatives. As a part of the civil design, preliminary geotechnical analysis will include an assessment of the rock erodibility for Alternatives 1 through 3. This will include evaluating the erodibility based on rock type and joint orientation with respect to the direction of the water flow and number/frequency of joints must be identified. For this conceptual level of design, characteristics of the joints, such as the amount of separation, roughness of

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<sup>3</sup> Although the alternatives for Phase II are the same as for Phase I, their specific names were revised to clarify the structural changes that are being evaluated.

the joint surface and infilling will be obtained from a visual assessment of the rock features as well as information obtained from test borings and laboratory strength testing.

Numerical modeling will consist of development and use of a computational fluid dynamics (CFD) model of the existing spillway, modification of the CFD spillway model to include Alternatives 1 through 3, and potentially the development of a CFD model for Alternative 4, cut-off dam spillway. The CFD model particle tracking results from Alternatives 1 through 4 will be used in conjunction with algorithms developed by the University of Minnesota to estimate TDG levels downstream for each alternative. The CFD models will be developed to sufficient level of detail to predict flow patterns on the spillway chutes, over the deflectors and within the tailrace areas downstream of the spillway and powerhouse. For Alternatives 1 through 3, the CFD model will encompass the spillway crest, chute and deflectors, the plunge pool area, the confluence with the powerhouse tailrace, and approximately 1,500 feet on the river channel downstream of the powerhouse. If Alternative 4 proves to be a feasible design, CFD modeling will be conducted for that alternative. The Alternative 4 CFD model would encompass the full length of the spillway, including the approach, crest, spillway chute, and chute terminus, plus a short reach of the tailrace channel downstream of the powerhouse. CFD results will be post-processed to produce plots for streamlines, particle tracks, velocity contours, velocity vectors, and pressure contours. In addition, a qualitative assessment of the flow deflector performance will be conducted using the flow classification criteria developed by U.S. Corps of Engineer Engineering Research and Development Center (ERDC) (figure 3-1).



**Figure 3-1 - Flow Classifications**

**Alternative 5:** This alternative includes an investigation of a new powerhouse with generating units totaling an installed capacity of 120 MW and a discharge capacity of approximately 9,500 cfs. This investigation will involve reviewing previous studies and updating information, reviewing historical flows, developing an energy evaluation model, and developing cost estimates. Since the TDG level associated with powerhouse flow is typically the same as the forebay, the extent of TDG production would be reduced as a function of the hydraulic capacity of the new generating units. This alternative would increase the HED's overall generation hydraulic capacity from approximately 6,300 cfs to 15,800 cfs, and thereby reduce the frequency and magnitude of spills at Long Lake Dam. A conservative estimate of the reduction in frequency of spill events, which is based solely on daily average Long Lake HED discharges for the years of 1979 through 2002, suggests that spill events would occur less than 15 percent of the time in comparison to nearly 40 percent of the time with the current powerhouse facilities.<sup>4</sup> Recommendations on how to pass the difference between the powerhouse and the 7Q10 will be made in the report.

A final report will be submitted to Ecology at the conclusion of the Phase II study, which is scheduled for completion in June 2010, and filed with FERC following Ecology-approval. This report will include an executive summary, background information, discussion of each alternative including costs and construction schedules, an appendix with drawings, TDG estimates, and the results of the comparison matrix to help identify the optimum alternative(s). Engineering required to carry the alternatives forward to the next level of detail will also be provided.

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<sup>4</sup> Refer to the Long Lake HED flow duration curve on page B-8 of the Spokane River Hydroelectric Project Final Application for New License (Avista 2005).

## 4.0 STANDARD PROJECT OPERATIONS

The following description of Avista's standard operating procedures is largely from Findlay Engineering (1999).

The Long Lake HED is generally operated, to the extent possible, at the normal pool elevation of 1,536 feet, but with a typical spring drawdown of 10 feet. This results in outflows typically equaling inflows except during peak load or low river flows.

The dam's spill gates are numbered 1 to 8, from north to south. The general spill gate prioritization is to first use the middle gates (Gates 3-6), then the south gates (Gates 7 and 8), and as a last resort the north gates (Gates 1 and 2). Usually Gate 4 or 5 is opened to 8 feet and then the other one of these gates is opened to 8 feet. If needed, Gate 3 or 6 is opened to 8 feet then the other one of these gates is opened to 8 feet. After Gates 3-6 are open 8 feet, Avista opens the center four gates more, starting with Gates 4 or 5 and then Gates 3 or 6 while targeting keeping them all about the same height. Opening of the four center gates is followed in order by opening Gate 8, and then Gate 7. Finally, Gates 1 and 2 are opened. Gates 1 and 2 are opened last to mitigate erosion of the protruding bedrock near the base of the spillway and undermining of the toe of the dam. Gate 8 is opened before Gate 7 for similar rock erosion concerns. The gates are opened under station power, and there is a standby generator located in the powerhouse to open the gates in the event of a power outage.

Section 5.4(D)(2) of the Washington 401 requires:

*A description of standard Project operations with regard to minimizing TDG associated with spills;*

Avista conducted spillway gate tests at Long Lake HED in 2003 and 2004 to determine TDG production from individual gates and two-gate combinations (Golder 2003, 2004). The results of these spillway gate tests are described in Section 5.2, and provide the basis for potential operational alternatives.

## 5.0 POTENTIAL STRUCTURAL AND OPERATIONAL IMPROVEMENTS

Section 5.4(D)(4) of the Washington 401 requires:

*An evaluation of all potential and preferred structural and operational improvements to minimize TDG production;*

### 5.1 Potential Structural Alternatives

The following studies have evaluated potential structural alternatives:

- Chaudhry (1992): A hydraulic model study of the Long Lake Dam spillway conducted in 1992 by the Albrook Hydraulic Laboratory to evaluate several conventional energy dissipater designs, such as a stilling basin, a roller bucket, and a flip bucket that could reduce erosion at the toe of the dam. A brief summary of this study is provided in section 2.4.
- EES (2006): Phase I Feasibility Study to identify and screen a wide range of structural alternatives for TDG abatement that might be possible at Long Lake HED. The study team identified five alternatives for modifying the existing Long Lake spillway dam. A brief summary of this study is provided in section 2.5.

#### 5.1.1 Preferred Structural Alternatives

The Phase II Feasibility Study will be conducted as described in section 3.0 to identify potential reasonable and feasible measures to be used as the basis for selecting the preferred structural alternative(s). Once the preferred structural alternative(s) is selected, Avista will continue with further refinement of TDG abatement measure(s) following the phased schedule discussed in section 8.0.

### 5.2 Potential Operational Alternatives

Spillway gate tests were conducted at Long Lake HED in 2003 and 2004. In 2003, tests were done to determine TDG production from individual gates and two-gate combinations (Golder 2003). In 2004, additional spillway gate tests were done to expand the knowledge gained from the 2003 tests (Golder 2004). Table 5-1 identifies the individual and combination gate tests that were performed in 2003 and 2004.

During the 2003 spillway gate tests, the TDG level associated with testing Gates 3 through 6 ranged between 119 percent of saturation for Gate combination 3 and 4 and 124 percent of saturation for Gate 5 (table 5-2). Tests conducted on April 15, 2003 identified substantial TDG reductions associated with discharge through Gates 1, 2, 7 or 8 as compared to Gates 3 through 6. Initial TDG levels prior to the start of the test were 123 percent of saturation produced by Gate 6 at a height of 9.5 feet. With the opening of Gate 1 to the same height, TDG levels decreased to 114 percent of saturation. This TDG level was maintained throughout individual and combination testing of Gates 1 and 2. With commencement of combination testing of Gates 2 and 7, TDG levels increased slightly to 116 percent of saturation. Individual testing of Gate 8 produced TDG levels of 115 percent of saturation. Although Gate 7 was not



tested independently, combination testing of Gates 7 and 8 produced TDG levels of 115 percent of saturation which suggests Gate 7 TDG production is only slightly greater than Gate 8.

**TABLE 5-1**

**Individual and Combination Gate Tests Performed in 2003 and 2004**

<b>Gate Number</b>	<b>2003 Testing Gate Height (ft)</b>	<b>2004 Testing Gate Height (ft)</b>
1	9.5	--
1 & 2	4.7 each	3.0 each; 3.5 each
1, 2, 7, & 8	--	1.9 each
2	9.5	--
2 & 7	4.7 each	3.7 each; 3.0 each
3	9	--
3 & 4	4.5 each	--
3, 4, 5, & 6	--	1.9 each
3 & 5	--	3.5 each; 3.0 each
4	9	--
4 & 5	4.5 each; 4 each	4.0 and 3.5
5	9	7.5
5 & 6	4.5 each	--
6	9; 24	6
3 & 6	4.5 each	4.0 and 3.5; 3.0 each
7	24	--
7 & 8	4.5 each	3.0 each; 3.5 each
8	9.5	--

Sources: Golder (2003, 2004)

**TABLE 5-2**  
**Summary of Individual and Combination Gate Tests**  
**Conducted at Long Lake HED on April 14 and 15 of 2003**

<b>Individual Gate Tests</b>						
<b>Gate Number</b>	<b>Qtotal (cfs)</b>	<b>Qspill (cfs)</b>	<b>Qgen (cfs)</b>	<b>TDGtotal (%)</b>	<b>TDGgen (%)</b>	<b>TDGspill (%)</b>
2	13,323	6,323	7,000	114	113	115
1	13,323	6,323	7,000	114	112	116
8	13,323	6,323	7,000	115	113	117
3	13,043	6,043	7,000	122	115	130
4	13,043	6,043	7,000	122	115	130
6	13,043	6,043	7,000	122	115	130
5	13,043	6,043	7,000	124	115	134
7 <sup>a</sup>	19,493	12,493	7,000	124	113	130
6 <sup>a</sup>	19,493	12,493	7,000	127	113	135
<b>Gate Combination Tests</b>						
<b>Gate Numbers</b>	<b>Qtotal (cfs)</b>	<b>Qspill (cfs)</b>	<b>Qgen (cfs)</b>	<b>TDGtotal (%)</b>	<b>TDGgen (%)</b>	<b>TDGspill (%)</b>
1 & 2	13,323	6,323	7,000	114	112	116
7 & 8	13,323	6,323	7,000	115	113	117
2 & 7	13,323	6,323	7,000	116	113	119
3 & 4	13,043	6,043	7,000	119	115	124
4 & 5	13,043	6,043	7,000	120	115	126
5 & 6	13,043	6,043	7,000	120	115	126
3 & 6	13,043	6,043	7,000	121	114	129

**Notes:**

For each gate and gate combination, Test results have been ranked from lowest to highest TDG production.

TDGspill = The predicted TDG levels from the spillways in percent of saturation

TDGtotal = TDG level at tailrace station in percent of saturation

TDGgen = TDG level in the forebay in percent of saturation

Qtotal = Total discharge in cfs

Qgen = Generation discharge in cfs

Qspill = Spill discharge in cfs

<sup>a</sup> These tests were inadvertently conducted at a higher total discharge

Source: Golder (2003)

The 2004 Long Lake HED spillway gate test results are presented in table 5-3. Tests from both 2003 and 2004 show that TDG production was lowest from Gates 1 and 2, followed by Gate 7 and 8. Gates 3, 4, 5, or 6, operated individually or in combination with each other, all produced TDG levels that were greater than Gates 1, 2, 7, and 8 when tested in the same manner. The 2003 test results suggest that split flows between two gates generally produces less TDG than discharge through a single gate. However, the 2004 test were not sufficiently detailed enough to confirm this finding. Results of multi-gate combinations in 2004 indicate substantial TDG reductions occur when flow is split among Gates 1, 2, 7, and 8 compared to Gates 3, 4, 5, and 6. Due to low river flows in 2004, testing at gate openings of

60 percent or more could not be conducted. Consequently, development of a predictive mass balance TDG model for Long Lake HED over a full range of potential flow conditions was not possible.

At the flows and forebay TDG levels measured during these gate tests, Long Lake HED tailrace TDG may approach TDG levels in the forebay if Gates 1, 2, 7 and 8 are predominantly used for spill. However, based on discussions with the Avista personnel, Gates 1 and 2 are typically not used because of erosion issues. Spill through Gates 7 and 8 is also avoided to minimize erosion of the south river bank (toe of the dam). Any change in operations should include an assessment of the erosion concerns and any structural or operational limitations. Under the current operations that primarily use Gates 3 through 6, downstream TDG level would likely be reduced by not using Gate 5 and splitting flows among Gates 3, 4, and 6.

**TABLE 5-3**  
**Summary of Individual and Combination Gate Tests**  
**Conducted at Long Lake HED on March 30, April 5, and May 4 of 2004**

<b>Individual Gate Tests</b>						
<b>Gate Number</b>	<b>Qtotal (cfs)</b>	<b>Qspill (cfs)</b>	<b>Qgen (cfs)</b>	<b>TDGtotal (TDG%)</b>	<b>TDGgen (TDG%)</b>	<b>TDGspill (TDG%)</b>
6	11,080	4,080	7,000	117	112 <sup>a</sup>	126
5	11,990	4,990	7,000	119	112	129
<b>Paired-gate Tests</b>						
<b>Gate Numbers</b>	<b>Qtotal (cfs)</b>	<b>Qspill (cfs)</b>	<b>Qgen (cfs)</b>	<b>TDGtotal (TDG%)</b>	<b>TDGgen (TDG%)</b>	<b>TDGspill (TDG%)</b>
1 & 2	11,990	4,990	7,000	111	111	111 <sup>b</sup>
1 & 2	11,250	4,250	7,000	112	112 <sup>a</sup>	112 <sup>b</sup>
7 & 8	11,250	4,250	7,000	113	112 <sup>a</sup>	115
7 & 8	11,990	4,990	7,000	112	110	115
2 & 7	12,380	5,380	7,000	114	113	115
4 & 5	11,250	4,250	7,000	114	112 <sup>a</sup>	117
2 & 7	11,250	4,250	7,000	114	112 <sup>a</sup>	117
3 & 5	11,250	4,250	7,000	115	112 <sup>a</sup>	120
3 & 5	12,380	5,380	7,000	117	114	121
3 & 5	11,990	4,990	7,000	115	110	122
4 & 5	12,380	5,380	7,000	117	112	124
3 & 6	11,250	4,250	7,000	117	112 <sup>a</sup>	125
3 & 6	12,380	5,380	7,000	119	112	128
<b>Multi-gate Tests</b>						
<b>Gate Numbers</b>	<b>Qtotal (cfs)</b>	<b>Qspill (cfs)</b>	<b>Qgen (cfs)</b>	<b>TDGtotal (TDG%)</b>	<b>TDGgen (TDG%)</b>	<b>TDGspill (TDG%)</b>
1, 2, 3 & 4	11,990	4,990	7,000	111	110	112
3, 4, 5 & 6	11,990	4,990	7,000	115	110	122

**Notes:**

For each gate and gate combination, Test results have been ranked from lowest to highest TDG production.

TDGspill = The predicted TDG levels from the spillways in percent of saturation

TDGtotal = TDG level at tailrace station in percent of saturation

TDGgen = TDG level in the forebay in percent of saturation

Qtotal = Total discharge in cfs

Qgen = Generation discharge in cfs

Qspill = Spill discharge in cfs

<sup>a</sup> forebay TDG during tests on 4 May were likely inaccurate. Spot measurements at LL2 of 112 TDG% recorded on 5 May were used instead of the forebay TDG data.

<sup>b</sup> TDG did not increase in the tailrace when compared to forebay values.

Source: Golder (2004)

### 5.2.1 Preferred Operational Alternatives

Spill gate testing conducted in 2003/2004 along with consideration of erosive power indicate the following:

- Although TDG levels could be reduced by using Gates 1, 2, 7 and 8, use of these gates causes erosion in critical areas and therefore should be minimized
- TDG levels could be reduced by splitting flows between Gates 3, 4, and 6 and not using Gate 5

Based on results of these studies, the following Interim Spill Gate Procedures will be implemented in the order listed:

1. Open Gate 4 to 4 feet
2. Open Gate 3 to 4 feet
3. Open Gate 6 to 4 feet
4. Open Gate 4 to 8 feet
5. Open Gate 3 to 8 feet
6. Open Gate 6 to 8 feet
7. Open Gates 3, 4 and 6 further one-by-one while attempting to keep all the gates open the same amount
8. Open Gate 5, if needed
9. Only use Gates 1, 2, 7 or 8 if necessary

After construction of the selected reasonable and feasible structural modification(s), the spill gate protocol will be revised so that gates that have undergone structural modifications will be used first. This shift in gate-usage priority will be a phased process which follows the construction of modifications. Section 7.0 provides the schedule for operational and structural modifications. Following construction of the reasonable and feasible structural modification(s), any need for additional TDG abatement measures will be based on TDG monitoring results. In the event that further TDG abatement is needed for Long Lake Dam, Avista will conduct spill gate tests for this purpose, and implement appropriate reasonable and feasible spill gate procedures.

## 6.0 POTENTIAL OPERATIONS TO MINIMIZE SPILLS THAT PRODUCE TDG EXCEEDANCES

Section 5.4(D)(3) of the Washington 401 requires:

*A description of how the Project will minimize all spills that produce TDG exceedances at the Project;*

As discussed in section 5.2, monitoring will determine the need for operational alternatives if, after structural and preferred operational changes have been implemented, spill at the dam causes TDG production which results in exceedances of the TDG standard.

## 7.0 TIMELINE FOR OPERATIONAL ADJUSTMENTS

Section 5.4(D)(5) of the Washington 401 requires:

*A timeline showing when operational adjustments will occur*

The timeline for evaluating and implementing operational adjustments is provided in table 7-1.

TABLE 7-1

## Schedule for Operational Adjustments and Structural Modifications to Address TDG Production at Long Lake Dam

Action	Task	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
General Monitoring	Select/design permanent monitoring stations and develop monitoring plan	M	M								
	Monitor TDG and other relevant water quality conditions at the Unit 4 generation plume (LLGEN) and the tailrace (LLTR)		M	M	M	M	M	M	M	M	M
	Annual Monitoring Report			M	M	M	M	M	M	M	M
Operational Changes - Spill Protocols	Continue historical preferential use of spill gates	O	O								
	Develop reasonable and feasible interim spill gate protocol based on the 2003/2004 spill testing		O								
	Implement selected reasonable and feasible interim spill gate protocol based on 2003/2004 spill testing			O	O	O					
	Implement revised spill gate protocol, which takes advantage of constructed structural modifications						O	O	O	O	O
Structural Modifications	Phase II Feasibility Study- Evaluation of Alternatives		S								
	Phase III Feasibility Study - Select Alternatives, Physical Model			S							
	Phase IV - Formulate Design, Plans, and Specs				S						
	Phase V - Bid, Start Construction					S					
	Phase VI - Construction						S				
	Phase VII - Testing and Performance Evaluation							S			
	Evaluate need for any additional TDG enhancement measures								S		
Effectiveness Monitoring	Confirm effectiveness of structural modifications with revised spill gate protocols							M	M	M	M

## Notes

S	Structural
O	Operations
M	Monitoring



## 8.0 SCHEDULE FOR CONSTRUCTION

Section 5.4(D)(6) of the Washington 401 requires:

*A schedule for construction*

The schedule for evaluating and constructing structural changes is provided along with operational measures in table 7-1.

## 9.0 MONITORING PLANS

Section 5.4(D)(7) of the Washington 401 requires:

*Monitoring plans to further evaluate TDG production and to test effectiveness of gas abatement controls*

Avista developed the Long Lake HED TDG Monitoring Plan as part of the Washington TDG Monitoring Plan. The objectives of the Long Lake HED TDG Monitoring Plan are to:

- Collect data for modeling the effectiveness of using selected structural measures to reduce gas production by Long Lake dam spillway(s)
- Test the effectiveness of selected operational and structural TDG abatement measures for Long Lake HED
- Collect data to test the efficacy of using selected operational measures to reduce gas production by Long Lake Dam spillway(s)
- Confirm that Long Lake Dam does not cause exceedances of the TDG standard after implementation of selected operational and/or structural measures

The overall long-term monitoring strategy consists of TDG monitoring at a station in the Unit 4 generation plume (LLGEN) and at a location 0.6 mile downstream of the Long Lake Dam (LLTR). Permanent facilities will be constructed at both of these stations by Avista personnel with technical assistance from Golder. In addition, spot measurements of TDG will be done at each of the TDG monitoring stations being operated at the time. This will occur during site visits at approximately 2-week intervals. Spot measurements also will be taken at a location on the right downstream bank, across river from LLTR station, if any of the Long Lake Dam spillways are being used.

Water quality parameters that will be recorded consist of TDG (mm Hg), dissolved oxygen concentration (mg/L), and water temperature (°C). Water depth (meters) will also be recorded and used in conjunction with water temperature to identify if and when MS5s emerge from the water and when MS5s are above the minimum TDG compensation depth.

Seasonal monitoring of TDG and associated parameters (water temperature and barometric pressure) will be conducted to document baseline conditions, effectiveness of reasonable and feasible operational measures done before construction of any structural modification, effectiveness of reasonable and feasible operational measure(s) in combination with reasonable and feasible structural modification(s) as presented in the schedule provided in table 7-1. Annual seasonal monitoring will continue at the long-term TDG stations until compliance with the applicable TDG standard is documented or the end of the 10-year compliance period, whichever occurs first.

Following the end of each annual TDG monitoring season, Golder will compile all data collected during the previous TDG monitoring season and prepare an annual TDG report. Annual TDG reports will include time series charts of TDG along with spill and generation flows, and charts of TDG in the tailrace compared with TDG in the generation plume. Each annual TDG report also will provide an evaluation of compliance with the applicable TDG standard. Avista will submit the annual report to Ecology, the Spokane Tribe, and to FERC.

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**APPENDIX A**  
**WASHINGTON TOTAL DISSOLVED GAS MONITORING PLAN**  
**SECTIONS THAT APPLY TO LONG LAKE HED**

# **AVISTA CORPORATION**



## **WASHINGTON TOTAL DISSOLVED GAS MONITORING PLAN**

WASHINGTON 401 CERTIFICATION, SECTION 5.4(A)

Spokane River Hydroelectric Project  
FERC Project No. 2545

Prepared By:  
Golder Associates, Inc.

*March 26, 2010*

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## 1.0 INTRODUCTION

This Total Dissolved Gas Monitoring Plan (Plan) has been prepared to fulfill requirements of:

- Washington Department of Ecology (Ecology) for a total dissolved gas monitoring plan as specified in section 5.4 of the amended section 401 water quality certification (WQC) issued on May 8, 2009 for the Spokane River Hydroelectric Project (FERC No. 2545) (Ecology 2009)
- Federal Energy Regulatory Commission (FERC) for a Total Dissolved Gas monitoring plan as specified in Article 401 of the license issued for the Spokane River Project on June 18, 2009 (FERC 2009a)
- FERC for "information regarding the frequency of monitoring, sampling procedures, and equipment to be used" for monitoring total dissolved gas to be filed with the FERC as required by FERC's order approving and modifying the Water Quality Monitoring and Quality Assurance Project Plan, which was issued on September 17, 2009 (FERC 2009b)

Avista recognizes the need to address the potential negative effects of total dissolved gas (TDG) production caused by water spilling through the Long Lake spillway, and as a result proposed a protection, mitigation, and enhancement measure (PME) as part of its license application to the FERC (Avista 2005). This PME, referred to as SRP-WQ-1 "Total Dissolved Gas Control and Mitigation Program", has the overall goal of reducing the project's production of elevated TDG levels to the extent necessary for Project compliance with applicable water quality standards.

Ecology issued and amended a 401 water quality certification (WQC) for the four Spokane River Project hydroelectric developments that are located in Washington (i.e., Upper Falls, Monroe Street, Nine Mile and Long Lake HEDs). Section 5.4 of this WQC provides Avista's requirements to address the HEDs' effects on TDG. The general requirements of each of its subsections are:

- Section 5.4(A) mandates Avista to provide a TDG monitoring plan within one year of license issuance
- Section 5.4(B) states that the seven-day, ten-year frequency flood (7Q10) for the Long Lake Dam and Nine Mile Dam is 32,000 cfs
- Section 5.4(C) describes Nine Mile Dam monitoring requirements and conditions which would require a TDG Water Quality Attainment Plan (TDG WQAP) for Nine Mile Dam
- Section 5.4(D) describes Long Lake Dam monitoring requirements, and the required contents and schedule for a TDG Water Quality Attainment Plan (TDG WQAP) for Long Lake Dam

On June 18, 2009, FERC issued a license for the Spokane River Project (FERC 2009a). Article 401(a) of this license requires Avista to file the TDG monitoring plan required by WQC section 5.4(A) and the TDG WQAP for Long Lake Dam required by WQC section 5.4(D) for approval prior to implementation.

Since the TDG monitoring requirements and goals for the Long Lake and Nine Mile HEDs are distinctly different, this plan addresses the HEDs separately in sections 2.0 and 3.0, respectively. Appendix A provides a record of consultation for the Long Lake Hydroelectric Development (HED) and Nine Mile HED

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TDG monitoring plans and Appendix B provides comments and responses to the comments on earlier drafts of these TDG monitoring plans.

### 1.1 TDG Causes and Effects

When water plunges into a pool, air becomes entrained regardless of whether the plunge is caused by a natural waterfall or a dam spillway (Weitkamp and Katz 1980). As stated by Ecology (2005), "Fish in water with high TDG levels may not display signs of difficulty if higher water pressures at depth offset high TDG pressure passing through the gills into the blood stream. However, if the fish inhabit supersaturated water for extended periods, or rise in the water column to a lower water pressure at shallower depths, TDG may come out of solution within the fish, forming bubbles in their body tissues." This gives rise to a condition called gas bubble disease (GBD) or gas bubble trauma (GBT) that can harm fish (Weitkamp 2000; Backman and Evans 2002; Backman et al. 2002; Ryan et al. 2000).

### 1.2 Water Quality Standards

Washington State's TDG standard is designed to protect fish. Under this standard, TDG is not to exceed 110 percent of saturation [WAC 173-201A-200(1)(f)] when stream flows are at or less than the seven-day, ten-year frequency flood [7Q10; WAC 173-201A-200(1)(f)(i)]. This numeric criterion is not applicable when stream flows exceed the 7Q10, which Ecology (2009) specified as 32,000 cfs for the Spokane River at Long Lake Dam and Nine Mile Dam. Starting approximately 1.5 mile downstream of Long Lake Dam, the Spokane Tribe of Indians water quality standards, which also is set at 110 percent of saturation but does not include a 7Q10 exception (Spokane Tribe 2003, § 9(2)(c)(iii)), applies to the Spokane River.

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## 2.0 LONG LAKE HED TDG MONITORING PLAN

Long Lake Hydroelectric Development (HED) is the lowermost of the five hydroelectric developments of the Spokane River Hydroelectric Project (FERC No. 2545). It is located on the Spokane River at approximately river mile 34, a distance of 25-30 miles northwest of Spokane, Washington. The drainage area upstream of Long Lake Dam is approximately 5,840 square miles, and includes the Hangman Creek<sup>1</sup> and Little Spokane River watersheds, along with the watersheds that feed Coeur d'Alene Lake in Idaho. Plate LL1 shows the primary Long Lake HED facilities.



Plate LL1. Long Lake Dam and Powerhouse as Viewed From Overlook,  
May 22, 2008 at 09:45 PDT

## 2.1 Hydroelectric Development Description

Long Lake HED includes an L-shaped, concrete gravity dam ("main dam") and adjacent intake structure; a concrete arch cutoff dam ("crescent dam") located along the western shoreline approximately 700 to 800 feet upstream of the main dam; a gated spillway along the top of the main dam; and a powerhouse.

<sup>1</sup> Hangman Creek is also known as Latah Creek. This document uses Hangman Creek, which is the USGS convention.

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The powerhouse contains four turbine-generator units with a total generating capacity of 71.7 megawatts and a combined hydraulic capacity of 6,300 cfs. The HED's reservoir (commonly known as Lake Spokane) extends approximately 23.5 miles upstream of the main dam. It has a 5,060-acre surface area at normal full pool elevation of 1,536 feet and it has a usable storage of 66,720 acre-feet at a drawdown of 14 feet. The main dam is a 593-foot-long, 213-foot-high concrete gravity dam (plate LL1). The top of the dam is at elevation 1,537 feet. The main dam includes a 353-foot-long, gated ogee spillway with a crest elevation of 1,508 feet. The spillway has eight 25-foot-wide 29-foot-high vertical lift gates and a capacity of 115,000 cfs at a water surface elevation of 1,536 feet.

Long Lake HED is operated as a storage facility for power generation purposes with a normal full-pool elevation of 1,536 feet. Although Avista was allowed to draw down Lake Spokane by as much as 24 feet under the previous FERC license, it voluntarily limited drawdown to approximately 14 feet (elevation 1,522 feet) beginning in the late 1980s. Article 402 of the new Federal Energy Regulatory Commission (FERC) license, which was issued on June 18, 2009, officially establishes the 14-foot drawdown limit.<sup>2</sup> Winter drawdown does not occur each year, due to variations in weather and river flows. When a drawdown occurs, its magnitude is dependent on weather conditions and other factors. The lake is normally held within 1 foot of the full-pool elevation throughout the summer recreation season.

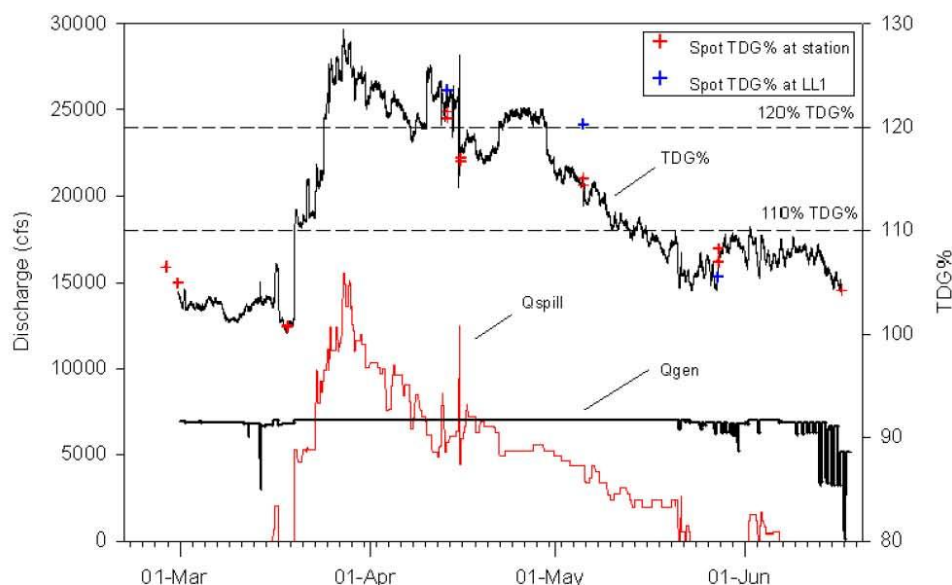
## 2.2 Historical Conditions

During 2003 and 2004, continuous TDG measurements for the Long Lake HED forebay ranged from 101 to 123 percent of saturation, and typically had daily fluctuations of less than 5 percent of saturation (Golder 2003, 2004). TDG behind Long Lake Dam is not the same throughout the water column, but varies with depth and location (Golder 2004, 2006). Evaluation of the data collected suggests that mixing of the stratified layers of water (e.g., due to wind events, dam operations, etc) likely causes significant fluctuations of TDG in the forebay.

TDG measurements obtained 0.6 mile downstream of Long Lake HED reached as high as 129 and 125 percent of saturation in 2003 and 2004, respectively (Golder 2003, 2004). In 2003, TDG in the Long Lake tailrace exceeded 110 percent of saturation from March 20 to May 15, and generally exceeded 120 percent of saturation from March 24 to April 14 and from April 21 to April 29 (figure LL1). The Long Lake tailrace also had extended periods when TDG exceeded 110 and 120 percent of saturation in 2004. TDG exceeded the 110-percent of saturation criterion during these periods when water was being spilled through the Long Lake Dam spillways.

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<sup>2</sup> License Article 402 states that "The drawdown requirement may be temporarily modified if required by operating emergencies beyond the control of the licensee."



**Figure LL1. Long Lake HED Tailrace TDG in Relation to Spill and Generation Discharge, February 24-June 17 of 2003**

Spot measurements were taken adjacent to the continuous tailrace monitoring station ("at station") and in the spill channel ("at LL1"). (Source: Golder 2003)

During previous studies at lower flows following the freshet, Long Lake forebay meters recorded increasing erratic TDG levels that appeared to fluctuate randomly (figure LL2), (Golder 2003, 2004; Mattax 2009). When periodic large reductions in TDG were recorded at these stations, concurrent reductions in water temperature and DO were also recorded. Vertical profiles conducted at forebay monitoring locations document that forebay water was strongly stratified and that deeper water layers were cooler and had low DO concentrations. The apparent random fluctuations in TDG were assumed to be related to disturbance of the stratified water layers due to operation of the Long Lake HED powerplant, combined with wind and wave action on the reservoir (Golder 2004). Spot and continuous TDG measurements for the generation plume varied from concurrent measurements taken near the forebay powerplant intakes. High water velocities at the intake and generation monitoring locations posed significant challenges in deploying and maintaining continuous monitors. The monitoring data collected, however, suggests that the entrainment of different stratified water layers is not predictable or consistent and that a TDG sensor, even when deployed directly in front of the powerplant intake, does not always

equal TDG in the generation plume. Consequently, we recommend installation of a station at a location that will enable direct monitoring of TDG within the generation plume.



**Figure LL2. Long Lake HED Forebay TDG in Relation to Inflows,  
February 24-June 17 of 2003**

Spot measurements were taken adjacent to the continuous forebay monitoring station ("at station") and in the generation plume immediately downstream of the Long lake powerhouse ("at LL2"). Inflow discharge is the rate of Spokane River inflow to the Long Lake reservoir. (Source: Golder 2003)

## 2.3 TDG Monitoring

### 2.3.1 Objectives

Section 5.4(D) of the WQC requires that within one year of license issuance Avista develop a compliance schedule and TDG WQAP for Long Lake Dam for Ecology review and approval, and that the plan include:

1. Detailed Phase II Feasibility and Implementation Plan based on Long Lake Dam TDG Abatement Initial Feasibility Study Report (EES 2006)
2. Description of standard project operations with regard to minimizing TDG associated with spills
3. Description of how the project will minimize all spills that produce TDG exceedances at the Project

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4. An evaluation of all potential and preferred structural and operational improvements to minimize TDG production
5. A timeline showing when operational adjustments will occur
6. A schedule for construction
7. Monitoring plans to further evaluate TDG production and to test effectiveness of gas abatement controls

The purpose of this study plan, hereafter referred to as the Long Lake HED TDG Monitoring Plan, is to address the seventh component of section 5.4(D) requirements as it pertains to conducting a TDG monitoring concurrent with the implementation of a TDG abatement strategy for Long Lake Dam. The objectives of this plan are to:

- Collect data to test the efficacy of using selected operational measures to reduce gas production by Long Lake dam spillway(s)
- Collect data for modeling the effectiveness of using selected structural measures to reduce gas production by Long Lake dam spillway(s)
- Test the effectiveness of selected operational and structural TDG abatement measures for Long Lake HED
- Confirm that Long Lake dam does not cause exceedances of the TDG standard after implementation of selected operational and/or structural measures

### 2.3.2 Monitoring Stations

For Long Lake Dam, the WQC requires Avista to “monitor TDG in the forebay or generation plume and near the end of the aerated zone (the area of bubble entrainment and dissipation) of Long Lake Dam upon issuance of the FERC license.”<sup>3</sup> Golder has worked with Avista to determine whether the forebay or generation plume should be monitored and has designed permanent monitoring station facilities to be used for this monitoring along with other water quality monitoring.

TDG monitoring for Long Lake Dam will need to be done for several purposes (see Objectives, above), which will require a somewhat flexible approach for selecting monitoring locations to facilitate meeting multiple objectives.

The overall long-term monitoring strategy will consist of TDG monitoring at a station in the Unit 4 generation plume and at a location 0.6 mile downstream of the Long lake Dam (table LL1). Permanent facilities will be constructed at both of these stations by Avista personnel with technical assistance from Golder. The permanent stations will consist of a length of 4-inch-diameter aluminum pipe stilling-well (standpipe), which is sealed at the pipe’s submerged end to prevent the TDG probe from falling out of the pipe. Each standpipe will have ½-inch-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 will be anchored to the dam face at LLGEN and

<sup>3</sup> Emphasis added



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anchored to the concrete base of the pumphouse and a rock outcrop at LLTR. Depending on the perceived need for security, the top end of each standpipe will be protected by either a locked metal access door and break-out box attached to the end of the pipe, or simply by a threaded metal cap. Armored flex conduit will be used to protect data power cables should the need to have external power be required at the station. A more detailed description of the potential configuration of each long-term monitoring station is provided in Golder (2009).

**TABLE LL1**  
**Long Lake HED TDG Monitoring Stations**

Station Code	Description	UTM Coordinates	Monitoring Type
LLGEN	Long Lake HED Unit 4 generation plume	11T 437069E 5298473N	Long-term
LLTR	On left downstream bank, at a water pumphouse approximately 0.6 mile downstream from Long Lake dam	11T 436381E 5298603N	Long-term
LLTRSP1	On right downstream bank, across river from LLTR station	11T 436315E 5298725N	Spot during spillway use

During site visits done at approximately 2-week intervals, a spot measurement of TDG will be done at each of the TDG monitoring stations being operated at the time. Spot measurements also will be taken at LLTRSP1 if any of the Long Lake dam spillways are being used.

### 2.3.3 Monitoring Equipment

Since 1998, Avista has purchased a moderate amount of TDG monitoring equipment from two main manufacturers, Common Sensing Inc. and Electronic Data Solutions (EDS). Golder conducted a review of Avista's existing inventory of TDG monitoring equipment in August 2009 to assess the total number of reliable TDG monitors that could be used to conduct evaluation and compliance monitoring for the Spokane River Project (Golder 2009). The review determined that the majority of the Common Sensing equipment has significant reliability issues due to obsolescence and component failure. The newer EDS equipment was determined to be more reliable and the three units available likely could be used effectively to conduct long-term monitoring at one location, but additional units would have to be purchased to meet all monitoring objectives. The EDS equipment, however, was found to have several design limitations, such as a fixed probe cable length, a less robust design, and a relatively complex user interface that would limit deployment location options and use of the equipment as a portable monitor.<sup>4</sup>

In anticipation of the need to obtain additional new equipment, Golder conducted a review of the Hydrolab® MS5 Multiprobe® (MS5) platform, which identified several strengths suggesting Hydrolab equipment to likely be the most appropriate for long-term TDG monitoring at Long Lake HED (see Golder 2009). The MS5s are self-contained data loggers powered by an internal battery pack consisting of eight

<sup>4</sup> Note that Avista must also conduct TDG monitoring at the Post Falls HED, as required by section (H) of the FERC license (FERC 2009).

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AA batteries. They are as 29.5-inches long, have an outer diameter of 1.75 inches, and a total weight with battery pack of 2.9 pounds. The MS5 internal memory allows recording up to 120,000 measurements. The primary strength identified was that the sensor array on MS5 can be configured to monitor a variety of water quality parameters in addition to TDG. For example, the same equipment could be configured to monitor TDG, dissolved oxygen (DO) concentrations, and temperature. This will enable use of the MS5s for multiple purposes associated with Long lake development, including monitoring TDG during high flows in spring and summer, DO and TDG during low flow in late summer and fall. The availability of a low maintenance optical DO sensor is a significant strength, which would enable accurate DO monitoring over longer deployment periods than other instrumentation.

Hydrolab<sup>®</sup> MS5 Multiprobe<sup>®</sup> (referred to as MS5) instruments with TDG, optical DO, temperature, and depth sensors will be purchased from Hach Company Inc. Each MS5 deployed at a location with an alternating current power source available will be connected to a surface data hub by a power/data download cable. With an external power source, the battery pack in the MS5 will serve as a backup source of power for periods as long as two weeks in case of power failure.

A shortcoming of the MS5s being self-contained and entirely submerged when deployed is the need for an independent barometric pressure readings when the unit is used to monitor TDG. Solinst<sup>®</sup> produces a cost-effective, small, weatherproof, and reliable barologger that is powered by a 10-year battery (Solinst 2009). One of these barologgers or equivalent instrumentation will be used to monitor barometric pressure at the Long Lake HED pumphouse or powerhouse. Data recorded by this instrument will be corrected when used to calculate supersaturation at other stations. The correction will account for differences in elevations between the monitoring station where the barologger is located and the TDG monitoring stations that are located at different elevations.

In order to provide a backup source of barometric pressure readings, two barologgers will be used to record barometric pressure at the Nine Mile HED and/or Long Lake HED. In seasons that TDG monitoring occurs at both Long Lake HED and Nine Mile HED, data from the barologger at the Nine Mile HED forebay will be used if the barologger at Long Lake HED fails. In seasons that TDG monitoring only occurs at the Long Lake HED, the backup barologger will be deployed at a second location associated with the Long Lake HED (i.e. a baralogger will be deployed at the Long Lake powerhouse and pumphouse).

A MS5 equipped with a short power/data cable and a Hydrolab Surveyor 4a<sup>®</sup> will be used as a portable TDG meter to obtain spot measurements at long-term and short-term TDG monitoring stations. These spot readings will be used to verify the quality of data from the MS5s deployed at the stations. The Surveyor 4a will have an internal barometer and barometric pressure data from this instrument will be used to evaluate the quality of both recorded and elevation-adjusted barometric pressure values for each operational station.

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### 2.3.4 TDG Monitoring Procedures

Water quality parameters that will be recorded consist of TDG (mm Hg), dissolved oxygen concentration (mg/L) and water temperature (°C). Water depth (meters) will also be recorded and used in conjunction with water temperature to identify if and when MS5s emerge from the water and when MS5s are above the minimum TDG compensation depth. The range, accuracy, and resolution for each measured parameter are provided in Table LL2. Even though external alternating current power will be used for most of the monitoring, internal battery voltage will be recorded to monitor power consumption and determine any need for battery replacement. To produce a consistent set of measurements that are taken at the same times, MS5s that are deployed will be programmed to sample and record values on the hour and at 15, 30, and 45 minutes after the hour. This will be accomplished by delaying sampling and logging until the beginning of the next 15-minute period and logging at 15-minute intervals.

**TABLE LL2**  
**Range, Accuracy and Resolution of Parameters That Will be Recorded**  
**Under the Long Lake HED TDG Monitoring Plan**

Parameter	Range	Accuracy	Resolution
Total Dissolved Gas	400 to 1300 mm Hg	±0.1 % of span	1.0 mm Hg
Temperature	-5 to 50°C	±0.10°C	0.01°C
Depth (0-25 m)	0 to 25 m	±0.05 m	0.01 m
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
Barometric Pressure	500 to 800 mm Hg	±3.5 mm Hg within 6 months of zero calibration at 25°C	0.1 mm Hg
Relative Barometric Pressure	1.5 m, typically 30-100 cm	0.1 cm	0.002% of full scale

#### 2.3.4.1 Calibration and Maintenance

##### 2.3.4.1.1 External Barometer Calibration

Barometric pressure will be measured with a Hydrolab Surveyor 4a, Solinst® barologger, or equivalent instrumentation. These instruments will be maintained following the corresponding manufacturer's instructions. Before using one of these instruments for pre-deployment or post-recovery field verification sessions, the values recorded will be compared to a known National Institute of Standards and Technology (NIST) pressure source at either a nearby USGS gage station or airport.

##### 2.3.4.1.2 Annual Factory Calibration and Servicing

Each year before deployment of the TDG monitoring equipment, all MS5s will be sent to Hach for factory calibration and adjustment. Annual factory calibration is a critical component that will help ensure reliable recording of quality data. Factory calibration also will provide an auditable track to verify equipment has been maintained in proper working order.

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#### 2.3.4.1.3 Pre-Deployment Field Verification

Each year, field personnel will conduct pre-deployment field testing no more than two weeks before the planned initial deployment of MS5s. This will include the following steps for each instrument to be used for TDG monitoring:

- The clock of each MS5 and Solinst® barologger will be synchronized to the correct date and time, and then a test will be done to confirm that each instrument will log and download data.
- The TDG silastic membrane will be removed from each MS5 and the recorded TDG value will be compared to ambient barometric pressure of a recently calibrated external barometer (either a Surveyor 4a or the Solinst® barologger).
- The patency of each TDG silastic membrane will be confirmed by pressurizing the membrane using carbonated soda water and confirming that a substantial pressure change is registered.
- A mass verification of the MS5s will be conducted, likely at the LLTR monitoring station under elevated TDG levels. Each unit will be delay started to the same time and set to log data at one-minute intervals. All units will then be tied together and deployed so that the TDG sensor of each unit is at a depth of about 10 feet below the water's surface. After a total deployment period of approximately one hour, the units will be downloaded and concurrent TDG, water temperature, depth, at the 20 and 50 minute mark will be compared for all units and any differences noted.
- The barologgers also will be tested to confirm that they record values are similar to one another.

#### 2.3.4.1.4 Deployment Maintenance and Servicing

During each service period, each MS5 will be retrieved and the pull time recorded. Each service session will include verification of logging status and downloading of the data to a portable field computer. The Solinst® barologgers also will be downloaded. For each data file downloaded, the data file name and location will be recorded and the logged data start and end date and times will be recorded. If the MS5 has lost power, an attempt will be made to determine the cause of the power loss and the backup batteries will be checked and replaced, if appropriate. If the MS5 was operational upon retrieval, the internal and external voltage reading as reported by the unit will be recorded.

Patency of the original TDG membrane will be confirmed by pressurizing the sensor with soda water and all damaged, unresponsive TDG membranes will be marked. Each MS5's TDG membrane will be removed, cleaned and allowed to dry. With the TDG sensor exposed to air, the barometric pressure will be recorded and compared to a barometric pressure reading from either a Surveyor 4a or a Solinst® barologger. A one-point calibration will be conducted if the TDG pressure reading in air differs from the secondary source by more than 2 mm Hg. Once calibrated, a new membrane will be installed and patency confirmed by again pressurizing the sensor with soda water. Air temperature, depth and internal battery voltage will also be recorded. Depth, temperature and DO sensors will then be calibrated according to the manufacturer's instruction and the difference between the pre- and post- calibrated value recorded.

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Once all MS5 sensors are calibrated, the field crew will initiate and verify data logging. Initiating data logging will include synchronizing the logger clock, ensuring the correct parameters are selected for logging, confirming that the logging interval is set to 15 minutes, and setting the delay log start time to the nearest quarter hour interval (ie. 15, 30, 45 or 60 minute mark each hour). The logging end date will be set to one year after start up. This step is crucial to avoid premature shutdown of the unit. To confirm log initiation, the field crew will select the audible tone feature so that each unit emits a series of beeps prior to logging and a single beep while in standby mode. Upon confirmation of logging, the MS5 will be reinstalled in the standpipe, and the deployment time recorded. At stations where a Solinst® barologger is to be deployed, the barologger's clock will be synchronized with the laptop, the local altitude entered, linear logging at 15-minute intervals, setting the logging start time to the nearest quarter hour interval (ie. 15, 30, 45 or 60 minute mark each hour), and the barologger deployed. Before leaving the area, all doors and locks will be checked and noted in the written log to verify the station is secure.

#### 2.3.4.1.5 Post-Recovery Field Verification

At the end of each annual TDG monitoring study, all MS5s and Solinst® barologgers used during the monitoring season will undergo post-verification following procedures nearly identical to pre-deployment field calibration, with the exception that mass *in situ* verification will not be conducted. All differences in TDG pressure, dissolved oxygen, temperature, depth, and barometric pressure will be recorded. These differences, if substantial, will be used to qualify and correct the data for periods when the unit was out of calibration.

#### 2.3.4.2 Data Quality Control and Quality Assurance

Golder will document records of factory calibration in its project files. This will include records of when the equipment is sent to and received from the manufacturer along with a record of servicing done by the manufacturer. All calibration done by Golder, as outlined above, will be recorded on datasheets. The hardcopies for all field forms will be scanned and saved as PDF files on a Golder file server. As a redundant protective measure, field notes and calibration forms will also be photocopied and the original stored in a fire-proof area.

In the absence of an automated download system, data download would be conducted at approximately 2-week intervals in conjunction with TDG instrument maintenance and calibration. Both the MS5 and Solinst® barologger data downloaded will be documented in the field on each datasheet. Excel® spreadsheets will be used to inspect all downloaded data and verify the start and end dates. A backup copy of the electronic file will be saved to a USB drive as well as on the computer. Once a station's data download has been successful and verified, the MS5 will be initialized under delay start mode with the integrated audible tone feature to verify the unit is logging data. If a remote data download system is incorporated into the design of any Long Lake HED stations, data will be downloaded from the station(s) more frequently. A status check of each TDG station would be conducted for early identification of any problems.

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Golder will use Excel® spreadsheets to identify and remove outliers from downloaded data and operations data, provided by Avista. A second reviewer will verify the “cleaned” data and then all TDG data along with qualifiers will be imported into an Access® database. The cleaned data will be plotted using either Excel or Access during the initial review process, and, if required, to produce figures for interim memorandums. A more sophisticated charting package, such as Sigmaplot®, will be required for final report figures of TDG and discharge data, especially during spillway and other TDG mitigation testing.

Data quality objectives (DQOs) 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 precision, accuracy, measurement range, representativeness, completeness, and comparability. Measurement Quality Objectives (MQOs) specify how good the data must be in order to meet the objectives of the project. 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. The measurement quality objectives (MQOs) that will be used for this monitoring plan are displayed in table LL3. Golder will calculate and report the station-specific root mean squared error (RMSE) of the calibration corrections applied after each calibration, and an overall RMSE for each station based on the average time for calibration corrections.

**TABLE LL3**  
**Measurement Quality Objectives (MQOs)**  
**for Long Lake HED TDG Monitoring Plan**

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

TDG meters, like other field monitoring equipment, are subject to bias due to systematic errors introduced by calibration, equipment hardware or software functioning, or field methods. Bias will be minimized by following standard protocols for calibration and maintenance, and by following field protocols for stabilization of meter readings. Bias is difficult to assess for TDG field measurements, because a more accurate verification method, such as a laboratory standard, is not available. No DQOs are being set for bias.

Precision refers to the degree of variability in replicate measurements; however, the precision of the results from continuous monitoring instruments cannot be estimated from replicate measurements. Therefore, the potential variability of TDG results may be indicated by agreement among the

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simultaneous results from two or more instruments, either during calibration or in the field. Instrument precision will be evaluated through the calibration and maintenance activities described in Section 2.3.4.1. Most TDG measurements are expected to be within the range of 100 to 140 percent of saturation. The Washington State criterion is currently set at 110 percent of saturation. MQOs are equal to DQOs and equal to 1 percent of saturation. MQOs will be met if TDG meter readings are within 1 percent saturation or 5 mm Hg of spot measurements taken using portable Hydrolabs. If MQOs are not met, the differences will be evaluated but the data will not be qualified or discarded unless other information indicates a problem with the data.

TDG percent of saturation values are dependent on barometric pressure readings so MQOs are also necessary for the barometric pressure measurements taken using portable Hydrolabs and Solinst® barologgers. The target for this project will be an MQO of 2 mm Hg for the field barometer readings. The barometric pressure MQO will be evaluated by paired readings with a field barometer, Hydrolab pressure sensor with the TDG membrane removed, or a known National Institute of Standards and Technology (NIST) pressure source at either a nearby USGS gage station or airport.

Water temperature data also will be collected because it can influence TDG. Since this is a parameter of secondary importance to the study, DQOs have not been established, but an MQO has been set at 0.5°C. Data will be reported if post-calibration shows that the temperature is within the MQO. Data that do not fall within the MQO will not be reported.

The quality of existing data will be evaluated where available. Sources within well-established programs will be acceptable based on the credibility of the source (such as the National Weather Service or U.S. Geological Survey data). The variability of data will be reviewed to evaluate for whether it is appropriate based on expected values and comparison between data sets. Data with too much or too little variability will not be used.

Accuracy is a measure of confidence that describes how close a measurement is to its "true" value, or the combination of high precision and low bias. Refer to table LL2 for the accuracy of each measured parameter. At the end of each seasonal TDG monitoring study, all MS5s and Solinst® barologgers used for the monitoring season will undergo post-verification procedures as described in Section 2.3.4.1.5. All differences between TDG pressure, dissolved oxygen, temperature, depth, and barometric pressure will be recorded and these differences, if substantial, used to qualify and correct the data for periods when the unit was out of calibration.

Measurement Range is the range of reliable readings of an instrument or measuring device, as specified by the manufacturer. Refer to table LL2 for the range for each measured parameter. Annual maintenance of field sampling equipment will be conducted in a manner consistent with the manufacturer's

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recommendations and records of all maintenance activities will be recorded and included with the field notes.

Representativeness qualitatively reflects the extent to which sample data represent a characteristic of actual environmental conditions. For this project, representativeness will be addressed through proper design of the sampling program which will ensure that the monitoring locations are properly located and sufficient data are collected to characterize TDG at that location. This includes comparing spot measurements at both the long-term monitoring stations and at other stations to confirm complete mixing.

Completeness is the comparison between the amounts of data that has been planned to be collected and how much usable data is actually collected, expressed as a percentage. Data may be determined to be unusable in the validation process if the data set does not meet the completeness designated for the project. A project completeness of greater than 90 percent is expected under normal operating conditions. If project completeness falls below 90 percent, then corrective measures including resampling or reanalysis will be employed. Completeness will be evaluated and documented throughout all monitoring activities and corrective actions taken as warranted on a case-by-case basis.

Comparability is the degree to which data can be compared directly to previously collected data. Comparability will be achieved for this project through External Barometer Calibration activities (refer to Section 2.3.4.1.1).

### **2.3.5 Study Coordination and Schedule**

Effective coordination and communication is critical to successfully meeting the objectives identified in section 2.3.1. This is particularly challenging due to the various levels of communication which are needed (i.e., agency, management, and field) and multiple parties (Avista, Ecology, Spokane Tribe, FERC, Golder and the Feasibility Study Consultant) being involved in different aspects of this effort. Figure LL3 and table LL4 show the organization and communication channels associated with this monitoring effort. Avista will directly communicate with Ecology, the Spokane Tribe, and the FERC.

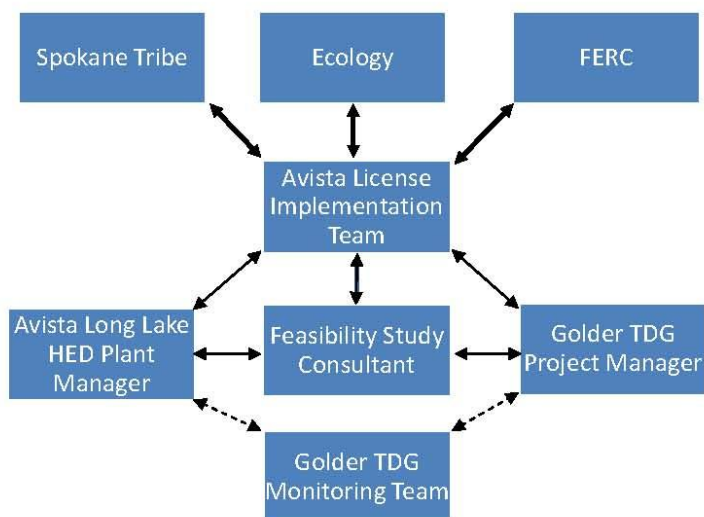
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**Figure LL3. Project Organization and Communication Channels  
for Long Lake HED TDG Monitoring Plan**

Thick solid arrows indicate agency and public communication, thin solid arrows indicate management level communication, dashed arrows indicate field level communication.

**TABLE LL4**

**Long Lake HED TDG Monitoring Plan Project Contacts**

Position	Name
Ecology	Marcie Mangold
FERC	George Taylor
Spokane Tribe	Brian Crossley
Avista License Implementation Team	Speed Fitzhugh, Hank Nelson
Avista Long Lake Plant Manager	Bill Maltby
Golder TDG Project Manager	Brian Mattax
Golder TDG Monitoring Team	Paul Grutter, Max Birdsell
Feasibility Consultant	Lisa Larson

For the feasibility study, Avista, Golder, and the consultant selected to conduct the feasibility study, will communicate as a team keeping each other informed of technical needs, Long Lake HED operational schedules, and any challenges that occur in meeting the needed products. Avista has selected northwest hydraulic consultants inc. (nhc) as to be the Phase II Feasibility Study Consultant. The Golder TDG Project Manager will ensure that the TDG Monitoring Plan is implemented concurrently with planned TDG abatement operational tests conducted during for the feasibility study. Golder and the Feasibility Study

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Consultant also will coordinate all monitoring and operational testing efforts with Avista's Long Lake HED Plant Manager and ensure information regarding timing and implementation are relayed to field personnel responsible for conducting the TDG abatement tests and concurrent TDG monitoring. Golder will collect, compile and conduct a quality review of the TDG data and Long Lake operations data, which are provided by Avista. Then the results of TDG monitoring will be communicated to the Feasibility Study Consultant Project Manager and the Avista License Implementation Team. The Avista License Implementation Team will be responsible for communicating study progress and results to Ecology, the Spokane Tribe, and the FERC. Any requests for additional information will be submitted to the Avista Management Team, who will communicate these requests to the Feasibility Study Consultant Project Manager and/or Golder TDG Project Manager, as appropriate. In the field, it is assumed that the engineering and TDG field personnel will likely operate independently of each other.

Following the selection and implementation of TDG abatement measures, Golder will collect, compile and conduct a quality review of the TDG data and Long Lake HED operations data, which are provided by Avista. Golder will use the "cleaned data" to evaluate the effectiveness of measures implemented and identify any need for additional feasibility studies to reduce the dam's TDG production, and communicate this information to the Avista License Implementation Team. The Avista License Implementation Team will determine an approach to meet identified needs. As for the feasibility study period, the Avista License Implementation Team will be responsible for communicating study progress and results to Ecology, the Spokane Tribe, and the FERC.

Work associated with further evaluating the feasibility of potential TDG abatement measures at Long Lake Dam will begin in 2010, and is expected to continue for 2-4 years. This will include monitoring TDG and associated parameters (water temperature and barometric pressure) while operating Long Lake HED according to a spillway gate test matrix schedule, which identifies the spillway and gate height, to be tested should flow conditions permit. The time period to test spillway operations near 7Q10 flows may be limited to brief periods in a high flow year during the ascending and descending limbs of the hydrographs. Depending on the availability of high flow, the results of the spillway gate tests, and other factors affecting the feasibility of operation and/or structural TDG abatement measures, the initial test matrix schedule may be revised and tested in the following year. Annually, seasonal monitoring will continue at the long-term TDG stations until compliance with the applicable TDG standard is documented or the end of the 10-year compliance period, whichever occurs first.

### ***2.3.6 Adaptive Revisions to Monitoring Plan***

The signatories to this monitoring plan recognize that there may be advantages to monitoring TDG at specific locations and times, which have not been identified in this plan, to better determine the feasibility of specific potential TDG abatement measures. The Avista License Implementation Team and Feasibility Study Consultant will jointly identify desired changes in the:

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- Timing and duration of TDG monitoring
- Installation of new temporary monitoring stations
- Increased frequency of data reporting
- Additional spot TDG measurements

The Avista License Implementation Team will communicate these desires with the Golder TDG Project Manager, who will provide Avista feedback on the perceived need for requested changes. Should Avista decide to request a change in the monitoring plan, the Avista License Implementation Team will notify Ecology, the Spokane Tribe, and FERC of the desired change and provide the rationale for the requested change. All changes will be dependent upon approval by Ecology and the FERC prior to implementation.

### **2.3.7 Reporting**

Data reporting for the feasibility study will consist of interim technical memorandums that summarize data recorded for particular phases of operational spillway gate tests that require TDG data to be available to the Feasibility Study Consultant within 2 to 4 weeks of test completion. We assume that interim reports will only be required in situations that demand that TDG from the previous test be reviewed and interpreted before subsequent tests can be conducted. The format and content of interim reports will be defined through a discussion between the Avista License Implementation Team, Golder TDG Project Manager and the Feasibility Study Consultant. Golder will conduct QA/QC on all data before inclusion in any interim report. Before beginning the planned spillway gate tests, the Feasibility Study Consultant, Avista License Implementation Team, and Golder TDG Project Manager will establish a reporting schedule so that personnel and appropriate resources can be assigned. A reporting schedule for any data collection activities after the Phase II feasibility study is completed will be established, as needed.

Following the end of each annual TDG monitoring season, Golder will compile all data collected during the previous TDG monitoring season and prepare an annual TDG report. Annual TDG reports will include time series charts of TDG with the 110-percent of saturation criterion along with spill and generation flows, charts of TDG in the tailrace compared with TDG in the generation plume, and a description of the frequency and periods of TDG standard exceedances. Avista will submit the annual report to Ecology, the Spokane Tribe, and the FERC.

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## APPENDIX A

### CONSULTATION RECORD

Consultation associated with development and approval of the Washington Total Dissolved Gas Plan included:

- August 7, 2009 – Avista submitted to Ecology for review and approval its draft Water Quality Monitoring and Quality Assurance Project Plan and draft Technical Memorandum for Long Lake and Nine Mile HED Monitoring Stations, and provided these documents to the Spokane Tribe
- August 13, 2009 – Ecology provided comments and approved the draft Water Quality Monitoring and Quality Assurance Project Plan and draft Technical Memorandum for Long Lake and Nine Mile HED Monitoring Stations
- August 13, 2009 – Avista filed with FERC its Water Quality Monitoring and Quality Assurance Project Plan pursuant to Article 401(A)(12)
- September 17, 2009 – FERC issued order modifying and approving Water Quality Monitoring and Quality Assurance Project Plan pursuant to Article 401(A)(12)
- January 5, 2010 – Avista (Hank Nelson) submitted Draft Washington TDG Monitoring Plan to Spokane Tribe (Brian Crossley)
- January 22, 2010 – Spokane Tribe (Brian Crossley) provided comments on Draft Washington TDG Monitoring Plan to Avista (Hank Nelson)
- February 11, 2010 - Avista (Hank Nelson) letter regarding responses to Tribe's comments on Draft Washington TDG Monitoring Plan to Spokane Tribe (Brian Crossley)
- February 12, 2010 – Avista (Speed Fitzhugh) submitted Revised Washington TDG Monitoring Plan to Ecology (Marcie Mangold) for review
- February 18, 2010 – Spokane Tribe (Brian Crossley) email Re: revised WA TDG monitoring plan ... to Avista (Hank Nelson)
- March 17, 2010 – Ecology (Marcie Mangold) email approving plan and offering comments to Avista (Speed Fitzhugh)

**APPENDIX B**  
**COMMENTS AND RESPONSES**

1/5/10

Brian Crossley  
Spokane Tribe of Indians  
P.O. Box 480  
Wellpinit, WA 99040

Brian,

Attached is a draft of the Washington Total Dissolved Gas (TDG) Monitoring Plan as required by Section 5.4 of the 401 Water Quality Certification issued by the Washington Department of Ecology and Article 401 of the FERC license for the Spokane River Projects. Please send me your comments within 30 days.

Section 2.3.5 of this plan references feasibility studies which will occur for Long Lake HED. Avista has issued an RFP to conduct a Phase II TDG Abatement Study. The resulting proposals are still being evaluated.

Feel free to call me with any questions as you review this draft. I'd also be happy to meet with you if you prefer. I can be reached at 509-495-4613. I look forward to your comments by 2/3/10.

Sincerely,

  
Hank Nelson  
Environmental Coordinator



**Nelson, Hank**

**From:** Brian Crossley [crossley@spokanetribe.com]  
**Sent:** Friday, January 22, 2010 9:51 AM  
**To:** Nelson, Hank  
**Cc:** 'Brian Crossley'; 'Chris Butler'; bjk@spokanetribe.com; 'theodore knight'  
**Subject:** RE: draft TDG monitoring plan comments

Hank, Chris Butler and I have had a chance to review the Draft TDG Monitoring Plan;

The comments are listed in chronological order as we reviewed the plan.

- 1 { P3, Water Quality Standards; our standard is the same as the State's therefore I had to think about this. The Tribes Standard doesn't have the 7Q10 flow exclusion; when two standards are placed up against each other the more stringent applies. Maybe just a mention of the downstream standard as it applies to flow over 32 kcfs.
- 2 { P11, Table LL2 Barometric pressure should be listed and recorded in this table and subsequent QA procedures; especially if you are using a separate piece of equipment (Solinst); and the Hydrolab Surveyor is +/- 10 mmHg.
- 3 { P13, 2.3.4.2 2<sup>nd</sup> paragraph "conducted" spelling
- 4 { P18, Study Coordination and Schedule, Clarification? Monitoring will occur during the evaluation and feasibility phase; which is projected out 2-4 years starting in 2010; is there a schedule for anything post?
- 5 { P22, 3.2 Historical Conditions "Because of the high TDG levels produced by the Spokane Falls and (add Monroe St HED) , TDG levels measured in the Nine Mile HED forebay ..... There have been many changes to the Spokane Falls therefore the HED should be identified as well as any other things that have changed the flow dynamics upstream.
- 6 { P22, 3.3 TDG Monitoring (at Nine Mile) we support the proposed idea that based on the expected construction of the pneumatic gates beginning in 2010 monitoring at the HED would not generate usable data in determining effects of the HED on total dissolved gas. We would hope that construction would be expeditious and not delay potential high flow TDG monitoring for more than two seasons.

If you have any questions about these comments please feel free to call or email me.

Brian Crossley  
 Water & Fish Program Manager  
 Spokane Tribe  
[crossley@spokanetribe.com](mailto:crossley@spokanetribe.com)  
 509-626-4409

**Nelson, Hank**

**From:** Brian Crossley [crossley@spokanetribe.com]  
**Sent:** Thursday, February 18, 2010 1:56 PM  
**To:** Nelson, Hank  
**Subject:** RE: revised WA TDG monitoring plan...

Hank, everything looks good except one thing. I would like to look at the historical photos of the Spokane Falls and have a discussion about the changes that have been made in support of your (Golder) determination that the Monroe St. HED doesn't significantly alter the hydrodynamics of the river. This is an honest request; I've only seen a couple of historical photos and would like more insight on this topic because I'm still not comfortable with the conclusion until I see additional evidence.

I think this "determination" was made during the ALP studies and I don't remember if the supporting photos were included in that report. There may have been changes pre-HED that altered the flow; I would just like to understand the whole thing. I'm willing to come in and take a look at photos or reports to help me understand this better.

Thanks, Let me know

Brian

---

**From:** Nelson, Hank [mailto:hank.nelson@avistacorp.com]  
**Sent:** Thursday, February 11, 2010 2:03 PM  
**To:** crossley@spokanetribe.com  
**Subject:** revised WA TDG monitoring plan...

Hi Brian,

Attached is a cover letter and the revised TDG monitoring plan. I'll also mail you a hard copy. Speed is sending the plan to Ecology for review.

Hank <<comment.docx>> <<021110bm1\_WA TDG Monitoring Plan.pdf>>



February 11, 2010

Ms. Marcie Mangold  
Washington Department of Ecology  
Eastern Region Office  
4601 N. Monroe St.  
Spokane, WA 99205

**Re: Federal Energy Regulatory Commission's Spokane River Hydroelectric Project  
(FERC Project No. 2545-091) License, Appendix B, Section 5.4.A, Washington  
Department of Ecology's Total Dissolved Gas Requirements**

Dear Ms. Mangold:

On June 18, 2009, the Federal Energy Regulatory Commission (FERC) issued a new license for the Spokane River Hydroelectric Project (FERC Project No. 2545). Ordering Paragraph E of the FERC license incorporated the *Washington Department of Ecology (Ecology) Certification Conditions Under Section 401 of the Federal Clean water Act (Issued on May 8, 2009 and amended on May 11, 2009)*. The Conditions can be found in Appendix B of the license.

In accordance with the License, Avista is required to provide a Total Dissolved Gas Monitoring Plan (Plan) for the Long Lake and Nine Mile Hydroelectric Developments for Ecology's review and approval within one year of license issuance. The Spokane Tribe of Indians has reviewed the Plan and provided comments, which are included in Appendix B, followed by our responses.

With this, and in order for us to meet our consultation requirements, we request your review of the enclosed Plan by March 15, 2010. After we receive your comments we are required to submit the Plan to FERC for their review and approval by June 18, 2010. If you have any questions or wish to discuss anything, I can be reached at (509) 495-4998. In my absence please feel free to contact Hank Nelson at (509) 495-4613.

Sincerely,

A handwritten signature in blue ink that reads 'Speed Fitzhugh'.

Elvin "Speed" Fitzhugh  
Spokane River License Manager

Enclosure

cc: Brian Crossley, Spokane Tribe of Indians  
Hank Nelson, Avista

**Fitzhugh, Speed (Elvin)**

**From:** Mangold, Marcie (ECY) [DMAN461@ECY.WA.GOV]  
**Sent:** Wednesday, March 17, 2010 3:04 PM  
**To:** Fitzhugh, Speed (Elvin)  
**Cc:** Baldwin, Karin K. (ECY); Bellatty, James (ECY); Nelson, Hank  
**Subject:** TDG monitoring report

Speed,

- 8 { The Department of Ecology approves the TDG monitoring report for Nine Mile and Long Lake Dams as stated in sections 5.4.C.6 and 5.4.D.7 respectively of the 401 Certification.

We have the following comments to offer;

- 9 { 1. The Corps had been working with the MiniSonde probes that you are planning on switching to and experienced some problems with data drift. I believe Pend Oreille PUD has had similar problems. The Corps was working the QA problems out with Hach Environmental. TJ Sisson, the Hach rep. that is likely working with you can probably assist or share knowledge on these issues.
- 10 { 2. In sections 2.3.7 and 3.3.7 could use the inclusion of the comparison to the standards and frequency of exceedances. In the Historical Conditions sections, you describe critical periods and times of exceedance of the criteria. A similar summary of the annual data graphically and/or narratively is important to include. This will likely be part of the annual reports but would be nice to be spelled out in the reporting sections.

Thank you,

*D. Marcie Mangold*  
Department of Ecology  
Water Quality Program  
phone (509) 329 3450  
fax (509) 329 3570

**Table B-1**  
**Responses to Comments**

<b>Comment #</b>	<b>Response</b>
<b>Comments on Draft Plan</b>	
1	A discussion of the Spokane Tribe's TDG standards was incorporated into section 1.2 Water Quality Standards.
2	Table LL2 was revised to include the specifications for barometric pressure measurements with a Hydrolab Surveyor 4a <sup>®</sup> and Solinst <sup>®</sup> barologger. In addition, QA procedures for the Hydrolab Surveyor 4a <sup>®</sup> and Solinst <sup>®</sup> barologgers were incorporated into section 2.3.4 TDG Monitoring Procedures and section 3.3.4 TDG Monitoring Procedures.
3	Revised, as requested.
4	The schedule was clarified in section 2.3.5 Study Coordination and Schedule.
5	The discussion of upstream effects on TDG in the Nine Mile HED forebay, which is in section 3.2 Historical Conditions, was expanded.
6	We appreciate your support on this issue, and have indicated this support in section 3.3.1 Objectives.
<b>Comments on Revised Plan</b>	
7	Avista will work with Brian Crossley of the Spokane Tribe to arrange a mutually agreeable time to view historic photographs of the Spokane Falls.
8	We appreciate your approval of the plan.
9	We will consult T.J. Sisson of Hach Environmental to gain an understanding of relevant MiniSonde potential data drift and corresponding solutions.
10	We have revised sections 2.3.7 and 3.3.7 to include additional detail on reporting related to TDG standard exceedances.

## **APPENDIX B CONSULTATION RECORD**

Consultation associated with development and approval of the Long Lake Dam Total Dissolved Gas WQAP included:

- April 2, 2010 - Avista (Hank Nelson) submitted Draft Plan to Spokane Tribe (Brian Crossley)
- April 23, 2010 - Spokane Tribe (Brian Crossley) provided comments on Draft Plan to Avista (Hank Nelson)
- June 8, 2010 - Avista (Speed Fitzhugh) submitted Revised Plan to Ecology (Marcie Mangold)
- July 9, 2010 – Ecology (Marcie Mangold) approved the Revised Plan

**APPENDIX C**  
**COMMENTS AND RESPONSES**

Avista Corp.  
1411 East Mission PO Box 3727  
Spokane, Washington 99220-3727  
Telephone 509-489-0500  
Toll Free 800-727-9170



4-2-2010

Brian Crossley  
Spokane Tribe of Indians  
P.O. Box 480  
Wellpinit, WA 99040

RE: Long Lake Dam Total Dissolved Gas Water Quality Attainment Plan

Brian,

As required by Section 5.4 of the 401 Water Quality Certification issued by the Washington State Department of Ecology (Ecology) and Article 401 of the FERC license for the Spokane River Projects is a draft of the Long Lake Dam Total Dissolved Gas Water Quality Attainment Plan (WQAP) for your review.

Please note that this is the companion document to the Long Lake Dam Total Dissolved Gas Monitoring Plan which has previously been reviewed by the Spokane Tribe and approved by Ecology. The portions of the TDG Monitoring Plan that pertain to this TDG WQAP can be found in Appendix A.

Please feel free to call me to discuss any items in this draft plan. I look forward to your comments within 30 days.

Sincerely,

A handwritten signature in cursive script, appearing to read "Hank Nelson".

Hank Nelson  
Environmental Coordinator  
Avista Utilities



**Nelson, Hank**

**From:** Brian Crossley [crossley@spokanetribe.com]  
**Sent:** Friday, April 23, 2010 2:35 PM  
**To:** Nelson, Hank  
**Cc:** 'Brian Crossley'  
**Subject:** Comments on Draft LLD TDG WQAP

April 23, 2010

I appreciate the opportunity to comment on the Draft Total Dissolved Gas Water Quality Attainment Plan.

1 { As you already are aware the total dissolved gas is the largest water quality issue facing the Spokane Tribe on the Spokane River with regards to hydroelectric operations. When I'm asked by DNR and Tribal management about the status of improvements on the Spokane River I have eagerly pointed out that we are going to see some of the largest water quality improvements in the Spokane River within the next few years. I feel Avista has been diligent in pursuing and understanding those issues related to improving total dissolved gas and dissolved oxygen. And although the cost of implementing these needed changes may seem possibly insurmountable the impacts to the fisheries and to all those levels that depend upon that fishery has been affected since the dam was built in 1915.

2 { The general recommendation from the Tribe would be to consider the alternatives, consider the improved water quality, and also consider the potential need to create fish passage. There are many factors that Avista has to consider as they operate facilities over such a large time period and I only know about and understand some of them.

Specific comments:

3 { P1 The purpose of the WQAP should be identified in the introduction to meet water quality standards as stated in the 401 certification. There are citations about "minimizing" TDG whereas the purpose of the plan is to "attain".

4 { P4 Isn't the spillway situated facing north? Either way; identify which gates are closest to the powerhouse?

5 { While working to optimize TDG reductions engineers and modelers need to be aware of the temperature and dissolved oxygen issues and how each alternative may be evaluated for all of its improvement potential.

6 { Chris mentioned the possible alternative of lowering Little Falls Pool to decrease the depth of the plunge pool. I'm not sure if the plunge pool is affected by Little Falls elevation.

7 { There was mention of positioning a generation plume monitor; I remember vaguely about the variability of the forebay TDG levels and the lack of correlation between downstream measurements. There was also some spot measurements taken in 2003/04; did the variability between the fixed monitoring site and the spot measurements give rise to the measuring of the generation plume? I think this idea could be clarified.

Brian Crossley  
 Water & Fish Program Manager  
 Spokane Tribe of Indians.



June 8, 2010

Ms. Marcie Mangold  
Washington Department of Ecology  
4601 N. Monroe St.  
Spokane, WA 99205

**Re: Federal Energy Regulatory Commission's Spokane River Hydroelectric Project  
(FERC Project No. 2545-091) License, Appendix B, Section 5.4.D, Washington  
Department of Ecology's Total Dissolved Gas Water Quality Attainment Plan**

Dear Marcie:

On June 18, 2009, the Federal Energy Regulatory Commission (FERC) issued a new license for the Spokane River Hydroelectric Project (FERC Project No. 2545). Ordering Paragraph E of the FERC license incorporated the *Washington Department of Ecology (Ecology) Certification Conditions Under Section 401 of the Federal Clean water Act (Issued on May 8, 2009 and amended on May 11, 2009)*. The Conditions can be found in Appendix B of the License.

In accordance with License Appendix B, Section 5.4.D, Avista is required to provide a Long Lake Dam Total Dissolved Gas Water Quality Attainment Plan (Plan) for Ecology's review and approval within one year of license issuance. The Spokane Tribe of Indians has reviewed the Plan and provided comments, which are included in Appendix B, followed by our responses.

With this, and in order for us to meet our consultation requirements, we request your review of the enclosed Plan by July 9, 2010. After we receive your comments we are required to submit the Plan to FERC for their review and approval by August 1, 2010. If you have any questions or wish to discuss anything, I can be reached at (509) 495-4998. In my absence please feel free to contact Hank Nelson at (509) 495-4613.

Sincerely,

A handwritten signature in blue ink that reads "Speed Fitzhugh".

Elvin "Speed" Fitzhugh  
Spokane River License Manager

Enclosure

cc: Brian Crossley, Spokane Tribe of Indians  
Hank Nelson, Avista



STATE OF WASHINGTON  
DEPARTMENT OF ECOLOGY

4601 N Monroe Street • Spokane, Washington 99205-1295 • (509)329-3400

July 9, 2010

Mr. Elvin "Speed" Fitzhugh  
Spokane River License Manager  
Avista Corporation  
1411 East Mission Ave., MSC-1  
Spokane, WA 99220-3727

RE: Request for approval – Spokane River Hydroelectric Project No. 2545  
Submittal of the Long Lake Dam Total Dissolved Gas Water Quality Attainment Plan  
Washington 401 Certification, Section 5.4(D)

Dear Mr. Fitzhugh:

We have reviewed the Long Lake Dam Total Dissolved Gas Water Quality Attainment Plan that was emailed to the Department of Ecology (Ecology) on June 8, 2010.

Ecology approves the Long Lake Dam Total Dissolved Gas Water Quality Attainment Plan.

Please feel free to contact me at (509) 329-3450 or by email at [dman461@ecy.wa.gov](mailto:dman461@ecy.wa.gov) if you have any further questions regarding this matter.

Sincerely,

D. Marcie Mangold  
Water Quality Program

DMM:dw

cc: Brian Crossley, Spokane Tribe of Indians  
Hank Nelson, Avista  
Tom Young, Ecology/ATG  
James M. Bellatty, Ecology/WQP



**Table C-1**  
**Responses to Comments**

<b>Comment #</b>	<b>Response</b>
<b>Comments on Draft Plan</b>	
1	We acknowledge the importance of TDG to the Tribe. Avista appreciates the Tribe's recognition for pursuing and understanding TDG and DO issues even though the costs associated with these issues will be substantial.
2	As stated in section 1, this plan was developed to fulfill requirements for a TDG WQAP which are set by the Washington 401 section 5.4(D) and FERC License Article 401 along with FERC's September 17, 2009 order approving and modifying the Water Quality Monitoring and Quality Assurance Project Plan. These requirements do not include evaluating the potential need to create fish passage, hence it is not included in this plan.
3	To better identify the purpose for this plan, the entire Washington 401 section 5.4(D) is now quoted in the Introduction (section 1).
4	Spill bay 8 is closest to the penstocks and powerhouse. As requested, section 2.2 has been revised to clarify the position of specific spill bays by number.
5	We agree that TDG, DO, and temperature are closely linked to one another. Avista and its contractors strive to consider both the positive and negative effects of these interactions while evaluating potential TDG abatement and DO enhancement measures for Long Lake HED.
6	The elevation of Little Falls pool can effect water elevations of Long Lake powerhouse tailwater and may potentially affect the elevation of Long Lake Dam spillway plunge pool. Long Lake HED tailrace rating curves indicate Little Falls pool elevation can affect the powerhouse tailwater elevation about 1.5 feet at the turbine hydraulic capacity, which is the flow when the spillways typically begin. As flow increases, this potential effect substantially diminishes to 0.2 feet in the powerhouse tailrace at 15,000 cfs. Effects in the spillway plunge pool are even smaller.
7	Monitoring results indicate forebay monitoring is an impractical method to obtain TDG values representative of the entire penstock inflow when the forebay is thermally stratified (refer to section 2.3 Historical Conditions). Therefore, we proposed and Ecology approved establishing a long-term TDG monitoring station in the generation plume (refer to Washington TDG Monitoring Plan which was approved by Ecology on March 17, 2010).