OPERATIONS QUALITY ASSURANCE PROJECT PLAN

WATER QUALITY MONITORING

ENLOE HYDROELECTRIC PROJECT
(FERC PROJECT NO. 12569)

APRIL 2012

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ACRONYMS AND ABBREVIATIONS

7-DADMax	7-day average of the daily maximum
CD	compact disc
cfs	cubic feet per second
°C	degrees Celsius
District	Public Utility District No. 1 of Okanogan County
DO	dissolved oxygen
DQO	data quality objective
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
FLA	Final License Application
FW	Fish Workgroup
GPS	global positioning system
LDO	Luminescent Dissolved Oxygen
mg/L	milligrams per liter
Minisonde5	Hydrolab® Minisonde5 multi-parameter meters

mmHg	millimeters of mercury
MQO	measurement quality objective
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
Project	Enloe Hydroelectric Project
PVC	polyvinyl chloride
QAPP	Quality Assurance Project Plan
QC	quality control
RM	river mile
RPD	relative percent difference
SCADA	Supervisory Control and Data Acquisition
SOP	Standard Operating Procedure
TDG	total dissolved gas
TFW	Timber, Fish, and Wildlife
WAC	Washington Administrative Code
WQMP	Water Quality Management Plan

1.0 QUALITY ASSURANCE/SAMPLING AND ANALYSIS PLAN

1.1 PROJECT BACKGROUND

The Public Utility District No. 1 of Okanogan County (District) is obtaining a Federal Energy Regulatory Commission (FERC) license to redevelop and operate a hydroelectric power generation project at the existing Enloe Dam site. The Enloe Hydroelectric Project (Project) will be located on the Similkameen River about 3.5 miles northwest of the City of Oroville, in north-central Washington.

1.2 HYDROELECTRIC PROJECT DESCRIPTION

The existing concrete gravity arch dam is owned by the District and was completed in 1920 by the Okanogan Valley Power Company for the purpose of power generation. The dam is a 54 foot high structure designed to be overtopped. The crest of the spillway is at 1,044.3 feet, and replacement of removable 5 foot flashboards by crest gates that will raise the normal water surface elevation to 1,048.3 feet for most of the year except during spring runoff when the gates will be lowered and the water surface elevation will be controlled by the existing spillway crest. Over the years, much of the reservoir has been filled with sediment. The dam now creates a pool approximately two miles long and 200-feet wide with an average depth of nine feet and a surface area of approximately 50 acres.

The Project will redevelop hydroelectric power generation by building a new power plant on the east bank of the river closer to the dam, instead of restoring the existing power plant. The existing plant was decommissioned over 50 years ago. As part of the Project, the existing dam will be refurbished to meet current dam safety requirements and to extend its service life.

The Project will operate in a run-of-river mode, meaning that flow through the turbines will be regulated to match the natural flow in the river so that inflow and outflow from Enloe Reservoir are similar. When river flow exceeds turbine hydraulic capacity (1600 cfs), the surplus will be discharged over the existing spillway.

The new proposed Project configuration reduces potential environmental impacts to water quality immediately downstream of the dam by moving the powerhouse upstream closer to the dam and replacing sections of penstock with open channel, thereby reducing the bypass reach from about 900 feet to the roughly 370 feet between the dam and the natural waterfall below it. This modification also provides continuous flow downstream of the falls. Constructing the headworks of the Project will involve excavating an entrance to the approach channel on the northeast bank of the reservoir just upstream from the dam. Preliminary design concepts include a tapered trapezoidal approach channel between the river and an intake structure at the head of two penstocks which deliver water to the new hydro powerhouse. A tailrace channel will return water from the powerhouse to the Similkameen River near the base of the existing waterfall.

Following extensive consultation and analyses to develop a Clean Water Act §401 water quality certification, the Project will provide the following minimum instream flows in the river reach below Enloe Dam and above the Project tailrace: 30 cfs from mid-July to mid-September, and 10 cfs for the rest of the year. To regulate the bypass flows and protect water quality for limited fish use and aesthetic benefits, water is proposed to be released through an existing penstock intake in the west abutment of the dam where it will be piped to a point of discharge to the existing plunge pool at the base of the dam.

1.3 WATER QUALITY STANDARDS

The Water Quality Standards for Surface Waters of the State of Washington (Chapter 173-201A WAC) were most recently updated effective December 21, 2006 (Ecology 2006), and the standards were approved by the Environmental Protection Agency (EPA) on February 11, 2008. Among the designated uses for the lower Similkameen River[1] are salmonid spawning, rearing and migration. The numerical criteria within the standards that will be most pertinent to operations of the Project are those criteria developed to protect designated uses from potential impacts to water temperature, dissolved oxygen, and total dissolved gas.

1.3.1 Water Temperature Criteria

The aquatic life maximum temperature criterion to protect salmonid spawning, rearing and migration is 17.5 degrees Celsius (°C), measured by the 7-day average of the daily maximum (7-DADMax) temperatures. When a water body's temperature is warmer than the criterion and that temperature is due to natural conditions, then human actions considered cumulatively may not cause the 7-DADMax temperature of that water body to increase more than 0.3°C. In applying this standard to hydroelectric projects, Washington State Department of Ecology (Ecology) has interpreted natural conditions to be the water temperature regime before construction of any dams or other human influences. In addition, Ecology has identified the Similkameen River below Enloe Dam as a water body requiring special protection for spawning and incubation (Ecology 2006). This special criterion identifies a maximum 7-DADMax temperature of 13°C at the initiation of spawning for salmon and at fry emergence for salmon and trout. The maximum 0.3°C maximum increase also applies to the seasonal criteria for spawning and incubation. These requirements are applied to the Similkameen River below Enloe Dam from February 15 through June 15.

1.3.2 Dissolved Oxygen Criteria

The one-day minimum dissolved oxygen (DO) concentration for salmonid spawning, rearing and migration is 8.0 milligrams per liter (mg/L) (Ecology 2006). When a water

[1] The pool above Enloe Dam does not have a mean water detention time of greater than 15 days, so water quality standards for lakes do not apply to the Project.

body's DO is lower than this criterion (or within 0.2 mg/L of the criterion) and that DO concentration is due to natural conditions, then human actions considered cumulatively may not cause the concentration to decrease more than 0.2 mg/L.

1.3.3 Total Dissolved Gas Criterion

Total dissolved gas (TDG) shall not exceed 110 percent of saturation at any point of sample collection (Ecology 2006). This TDG criterion does not apply when the river exceeds the 7-day, 10-year frequency flood. The standards provide allowances for the criterion to be adjusted to aid fish passage over hydroelectric dams when consistent with an Ecology-approved gas abatement plan. However, this allowance does not apply to Enloe Dam because the Project will not be providing spillage to aid fish passage.

2.0 WATER QUALITY MONITORING

The Clean Water Act §401 certification for the Project requires water quality monitoring, assessment and reporting during operation of the project. This QAPP identifies the organization, schedule, data quality objectives, sampling design, field and laboratory procedures, quality control, and data management and reporting associated with implementing the WQMP. The purpose of the QAPP is to provide detailed procedures to (1) guide the District in determining compliance with water quality standards, and (2) inform adaptive management decisions during Project operations. A separate QAPP will be developed for water quality monitoring requirements during Project construction.

In addition to the water quality monitoring procedures described in this document for determining compliance with water quality standards and informing adaptive management decisions, water quantities will be monitored at several locations during Project operations. Releases to the bypass reach will be measured using a pipe flow meter at the instream flow outlet, and water level sensors in the spillway plunge pool and downstream spawning reach will be used to monitor the potential for fish stranding. The approaches to collecting supplemental information on water quantities are described in Appendix A.

The following parameters constitute the monitoring requirements of the Enloe Hydroelectric Project §401 water quality certification during operation of the project:

- Hourly monitoring of water temperature at four locations from July 1 through September 30, the months when the Similkameen River has the potential to exceed temperature criteria. The four locations are (1) the Project Area upriver from the reservoir pool, (2) the forebay, (3) the bypass reach pool at the base of Enloe Dam, and (4) downriver from the Project tailrace. Specific locations will be selected in the field to ensure that they are reasonably accessible, and the downriver location will be at least 100 yards below the tailrace to allow mixing with river flows.
- Hourly monitoring of DO at four locations from July 1 through September 30, the months when the Similkameen River has the potential to drop below the minimum DO criterion. Monitor at the same locations specified for temperature monitoring.
- Hourly monitoring of TDG at three locations from April 1 through June 30, the snowmelt season when the Similkameen River has the potential to exceed TDG criteria. The locations are (1) the forebay, (2) in the pool at the base of the dam; and (3) downriver from the Project tailrace.
- At least weekly visual monitoring of the powerhouse tailrace for a visible sheen indicating petroleum products. More frequent observations will be made whenever the dam operator or other District personnel are on site, and anytime when equipment maintenance indicates that a leak of lubricant or other petroleum product may have occurred.

The reporting requirements for these monitoring data are:

- Water quality data posted to the District's Project website on a monthly basis (no later than the 30th day of the month following the monitoring period) from May through October. Large volumes of raw data would not be posted, but would be retained and made available upon request. Posting would be limited to data summaries that show compliance (or non-compliance) with criteria as follows:
    - Excel (or equivalent) table of hourly TDG measurements in percent saturation at 2 sites, including a line graph that shows upstream and downstream sites and a line for the 110% saturation criterion (April through June).
    - Excel table showing daily minimum DO measurements (mg/L) at 4 sites and the difference between background and downstream sites; including one line graph that shows upstream and downstream sites with lines for the water quality criteria, and another graph plotting the difference between background and downstream sites (July through September).
    - Excel table of 7-DADMax temperatures calculated for each site, with graphs similar to the FLA document that plot the lines for all 4 sites together, and graphs that show the difference between sites compared to the 0.3 C max increase (July through September). Figure 1 (Figure E.2-8 from the FLA) shows an example where 7-DADMax temperatures are graphed from 6 sites using data collected in July and August 2006. Figure 2 (Figure E.2-5 from the FLA) shows an example where the difference between two sites was compared to the 0.3^{o}C maximum increase allowed by the water quality standard for temperature, again using monitoring data from 2006.

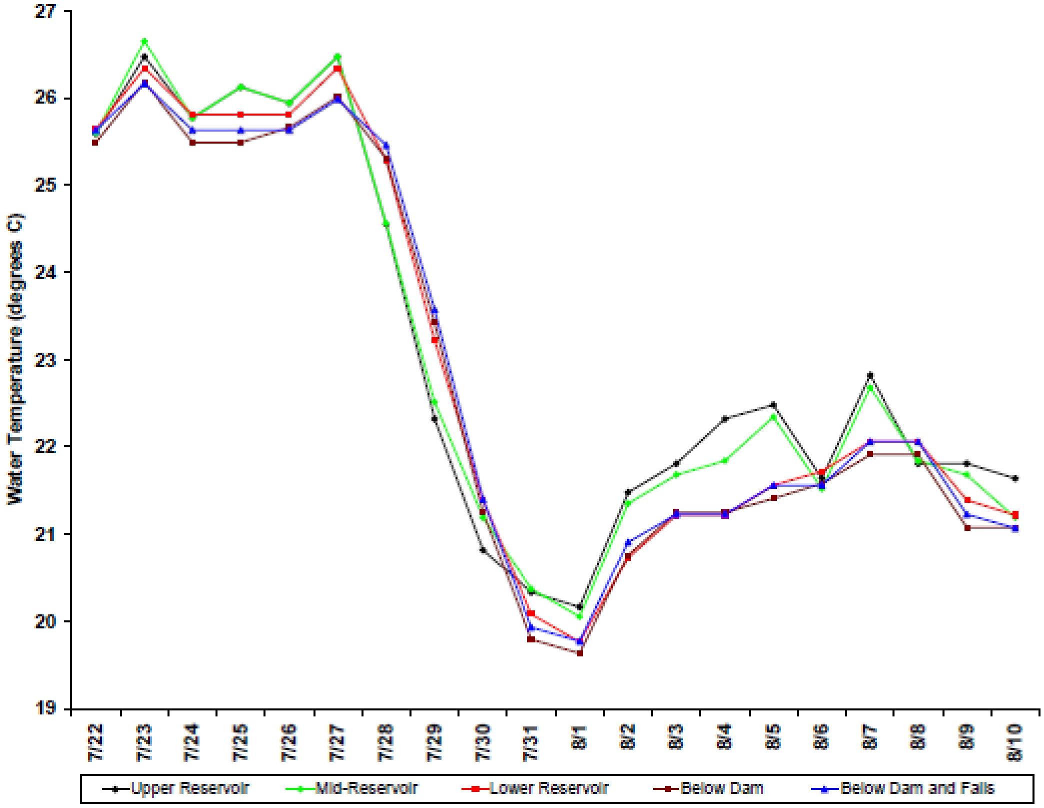

Figure 1. Daily Maximum Water Temperatures at Six Lower Similkameen River Monitoring Locations During Late July and Early August 2006.

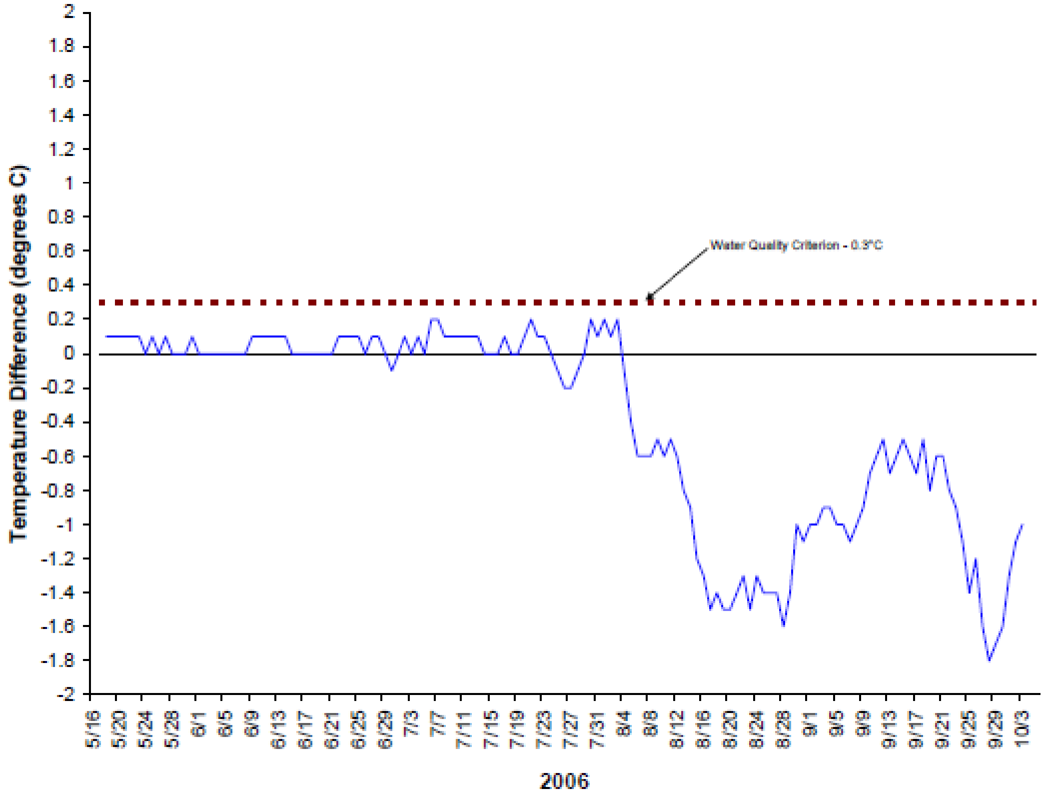

Figure 2. Difference between the 7-DADMax Temperatures below the Falls and Enloe Dam (RM 8.8) and the Upper Reservoir (RM 10.3)

- The annual report is primarily a compilation of these monthly data summaries for the ops monitoring that is limited to April through September, so that leaves the last quarter of the year to wrap up the annual report. Once the formats are established and routine. The annual report is also where you propose any changes to the monitoring requirements, particularly if the data support reducing the work.
- An annual data report to Ecology in an approved format that includes a data assessment of compliance with water quality data, summaries of monitoring data, a tabulation of water quality criteria exceedances, if any, and a description of any adaptive management actions that were implemented in response to monitoring results.
- A report of observed dead or dying fish, an apparent sheen on the water surface, or any other apparent excursion from narrative water quality standards within 48 hours, with an explanation of cause and notification for any course of action.

2.1 KEY PERSONNEL

Water quality management during Project operations will be conducted primarily by District personnel, with contractor assistance as needed to expedite the monitoring activities and reporting, reduce costs, or assure quality. All monitoring project personnel will have sufficient training and experience to complete assigned activities at a high level of quality. Anticipated staff assignments are identified in Table 1.

Table 1. Key Personnel

Assigned Staff	**Responsibility**
Dan Boettger	*Okanogan PUD Regulatory and Environmental Affairs Director.* Responsible for Enloe Hydroelectric Project management, 401 compliance, including QAPP and report review and approval, and funding approval.
Nick Christoph	*Okanogan PUD Environmental Coordinator.* Responsible for monitoring project management, monitoring activities, data management and interpretation, and reporting.
Water Quality Specialist	*Water Quality Specialist.* Responsible for technical review and quality assurance for QAPP development, monitoring data collection, data interpretation and reporting.
Charlie McKinney	*Ecology Central Regional Office Water Quality Program Section Manager.* Responsible for oversight of Ecology participation in implementing the §401 water quality certification.
Patricia Irle	*Ecology Central Regional Office Hydropower Projects Manager.* Responsible for project management and tracking compliance with §401 water quality certification requirements.
Okanogan PUD Webmaster	*Okanogan PUD Webmaster.* Responsible for maintaining the Project website and posting monthly operations monitoring data, construction monitoring data, and annual water quality monitoring reports.
Field Data Technician	*Field Data Collection Team.* Responsible for the maintenance, calibration, deployment, data downloading, and retrieval of water quality monitoring instruments. Also responsible for health and safety during field operations, and documentation of field activities, including equipment maintenance and calibration.

2.2 ORGANIZATIONAL DIAGRAM

The organizational relationships between persons responsible for implementing this QAPP are illustrated in Figure 3. In the course of implementing the WQMP and QAPP, unforeseen field conditions may lead the team to deviate from specific details of these plans to best meet monitoring objectives. Any deviations from the WQMP or QAPP will be communicated as soon as possible to the District's Environmental Coordinator and Ecology's Hydropower Projects Manager.

Figure 3. Organizational Diagram

2.3 SCHEDULE

2.3.1 Monitoring Schedule

The monitoring schedule is based on the §401 water quality certification monitoring requirements described in Section 2. Monitoring will begin on April 1 after the initiation of Project operations, or immediately upon the initiation of Project operations if that occurs between April 1 and September 30. All monitoring sites are within Project boundaries and so no external permission will be required to access these locations. However, the District will coordinate with any mining claim holders at the specific locations where monitoring equipment will be deployed. It will also be necessary to secure a Hydraulic Project Approval permit to install and operate the monitoring equipment. Monitoring will continue through the life of the license, according to the schedule in Table 2.

Table 2. Operations Monitoring Schedule

Parameter	Monitoring Schedule	Comments
Temperature	Hourly from July 1 through September 30	This is the period when historical data indicate there is a potential for water temperature criteria to be exceeded.
DO	Hourly from July 1 through September 30	This is the period when historical data indicate there is a potential for DO to drop below the minimum criterion.
TDG	Hourly from April 1 through June 30	This is the snowmelt runoff season when TDG has the potential to exceed the criterion.
Petroleum Products	Weekly visual inspection upon initiation of Project operations.	The Similkameen River downriver from the tailrace will be inspected for evidence of sheen.

2.3.2 Reporting Schedule

Water quality data will be posted to the District's Project website on a monthly basis throughout the monitoring period for the duration of the project, unless the frequency is reduced in writing by Ecology. The data will be available no later than the 30th of the month following the previous month of monitoring. Water temperature data will include hourly measurements, daily averages, and calculations of the rolling 7-DADMax at each of the four locations. The data presentation will highlight any times when temperature criteria are exceeded. Temperature and DO data will be posted monthly from August through October (i.e. each month after monitoring). DO and TDG data will include hourly measurements and daily averages, and the data presentation will highlight any time criteria are exceeded. TDG data will be posted monthly from May through July. Evidence of oil sheen, if any, will be reported by telephone and e-mail with 48 hours after observation. All monitoring data will be summarized each year in an annual water quality data report that will be submitted to Ecology in December and posted to the Project website.

2.4 MONITORING PROJECT BUDGET AND FUNDING

A preliminary budget has been developed to assist with Project planning (Table 3). This budget anticipates that consultants will be used during the first year of monitoring to conduct the initial purchasing, preparation, installation, and deployment of monitoring equipment; and to train District staffs in the servicing, data downloading, and reporting of data from the monitoring instruments. A Water Quality Specialist will remain involved throughout the monitoring project with responsibilities for quality assurance, data interpretation, and annual report preparation. The District will fund the monitoring and reporting. If, within five years, monitoring does not provide substantial evidence that the Project is causing violations of water quality standards, the District in consultation with the FW, may submit a written request to Ecology to reduce the frequency and extent of monitoring. The proposed new plan is subject to review and approval by Ecology.

This budget estimate excludes initial and annual costs for instream flow release and water level monitoring costs which are provided separately in Sections 6.0 and 7.0. .

Table 3. Summary of Estimated Budget for Monitoring and Reporting

Year	Equipment/Expenses	Labor	Total
1	$45,000	$45,000	$ 89,000
2	$ 4,000	$16,000	$ 20,000
3	$ 4,000	$16,800	$ 20,800
4	$ 4,000	$17,640	$ 21,640
5	$ 4,000	$18,500	$ 22,500
Total			**$174,940**

3.0 DATA QUALITY OBJECTIVES

The primary objectives for water quality monitoring data are to evaluate compliance with water quality standards and inform adaptive management decisions. The purpose of the QAPP is to identify specific methods and standards used to obtain data of sufficient quality to meet these objectives. Data quality objectives (DQOs) are statistical statements of the level of uncertainty that a decision-maker is willing to accept as reflected in the results derived from environmental data. DQOs describe what data are needed and how the data will be used to address the water quality questions being investigated. The DQOs also establish numeric limits to ensure that data collected are of sufficient quality and quantity for data user applications.

The overall DQO is to ensure that the monitoring project produces data of known and acceptable quality. Proper execution of this QAPP will yield consistent results that are representative of Similkameen River water and the conditions present during monitoring. All monitoring data will be summarized and reported in conventional units to facilitate comparability.

There are two types of DQOs: decision quality objectives and measurement quality objectives (MQOs). The decision quality objectives are to:

- Generate monitoring data of sufficient quality to withstand scientific and regulatory scrutiny
- Collect data with methods and procedures appropriate to meet monitoring objectives
- Implement monitoring methods and procedures in compliance with Ecology requirements for the §401 certification

3.1 DECISION QUALITY OBJECTIVES

The monitoring program is designed to determine if water quality standards, including specific numeric criteria, are met during operations of the Project. The Monitoring Design (Section 5) addresses the requirements for representativeness, comparability and completeness to meet decision quality objectives.

3.2 REPRESENTATIVENESS

Representativeness is the degree to which monitoring data reflect the true magnitude and variability of environmental conditions present in the Project Area and during the period of interest. For this monitoring program, representativeness is a qualitative professional judgment exercised in the monitoring design, and is satisfied by ensuring that monitoring instruments are properly located and the frequency of measurements is sufficient to capture the variability of conditions in the Similkameen River. Because the monitoring program is limited to real-time, in-place measurements, the representativeness of results will not be vulnerable to changes during sample handling and preservation.

3.2.1 Comparability

Comparability is a qualitative professional judgment of the confidence with which one data set can be compared to another. For this monitoring program, water quality data will be compared between monitoring locations and compared to water quality criteria. Comparability will be achieved by consistently implementing monitoring methods and procedures at all field locations throughout the monitoring program, following standard operating procedures (SOPs) for monitoring instrument maintenance and calibration, and using consistent procedures for data management and reporting.

3.2.2 Completeness

Completeness is the number of valid monitoring results compared to the total number of monitoring results intended by the monitoring program design. Water quality monitoring instrument malfunctions are common in the field and typically result in completeness of less than 100 percent. A generally accepted goal for completeness is 90 percent. Duplicate deployments of thermographs for temperature monitoring and protective casings for the meters used for DO and TDG monitoring are monitoring program design features developed to help achieve the completeness goal. Completeness will be evaluated and documented throughout the monitoring program and corrective actions will be taken, as necessary, to maximize completeness.

3.3 MEASUREMENT QUALITY OBJECTIVES

For many of the field measurements to be conducted under this QAPP, MQOs are specified to determine if monitoring instruments are measuring the water quality parameters in an acceptable manner (Table 4). No MQOs are established for petroleum observations, a simple yes or no visual check.

Table 4. Measurement Quality Objectives

Parameter	Smallest Reference Level for Decision Making	Range of Instrument	Precision (Duplicate Measurements)	Bias/ Accuracy	Sensitivity/ Resolution
Temperature	0.3 °C	-5 to 50 °C	20% RPD	± 0.2 °C	0.1 °C
DO	0.2 mg/L	0 to 50 mg/L	20% RPD	± 0.2 mg/L	0.01 mg/L
TDG	1% saturation	400 to 1,300 mmHg	20% RPD	± 0.1 % of span	1 mmHg
Instream Flow	1 cfs	0 to 35 cfs	NA	± 5%	1% of span
Water level	1 inch	0 to 200 inches	NA	± 0.1 % of span	0.01% of span

RPD = relative percent difference
DO = dissolved oxygen
mg/L = milligrams per liter
TDG = total dissolved gas
mmHg = millimeters of mercury

3.3.1 Precision

Precision, the reproducibility of measurements under a given set of conditions, is a measure of the scatter of data when more than one measurement is made. Precision can be expressed as the relative percent difference (RPD) between duplicate measurements. For water temperature, duplicate measurements will be obtained from deployment of two thermographs at each location. Duplicate measurements of DO and TDG during monitoring instrument deployment and retrieval will provide data for calculating precision.

3.3.2 Bias / Accuracy

Accuracy is the degree of agreement between a measured value and its accepted “true” value, and is a measure of bias in a system. Bias will be minimized by following SOPs for monitoring instrument calibration and maintenance.

3.3.3 Sensitivity

Sensitivity is the increment of change in an environmental parameter that is detected by the measurement method. For this monitoring program, sensitivity is the resolution or smallest increment recorded by the monitoring instruments for each water quality parameter.

4.0 MONITORING PROGRAM DESIGN

Based on existing information and extensive consultation with Ecology and other stakeholders (see Section 1.4), the water quality monitoring program design is focused on the compliance of Project operations with water quality standards for water temperature, DO and TDG. Compliance will be monitored at three locations to represent areas where the Project has the potential to affect water quality: within the reservoir near the powerhouse intake, within the bypass reach, and downstream from the Project tailrace. A fourth location within the Project Area and upriver from the reservoir will provide water quality data on reference conditions in the Similkameen River immediately upriver from potential Project effects.

Operations monitoring will begin as soon as water is diverted from the main river channel for power production, and continue through the first five years of Project operations. Within this five-year period, monitoring of different water quality parameters will begin on April 1 of each year and continue through September 30. TDG will be monitored hourly between April 1 and June 30, the snowmelt runoff season when TDG has the potential to exceed the water quality criterion. Water temperature and DO will be monitored hourly between July 1 and September 30, the warm season when historical records indicate that there is a potential for excursions from the water quality criteria for these parameters.

4.1 WATER TEMPERATURE

Water temperature monitoring will document water temperature conditions in the Enloe Project Area during the critical warm season and may be used to (1) evaluate Project compliance with water temperature criteria, and (2) inform decisions on adaptive management measures. Lower Similkameen River monitoring indicates that water temperatures near the Canadian border and at Oroville typically exceed the freshwater aquatic life criteria during the summer months, and water temperatures increase as the river flows downstream (Ecology 2005; Webber and Stewart 2001). Water Quality Standards for Surface Waters of the State of Washington (Chapter 173-201A WAC) state that when a water body's temperature is warmer than the criteria and that condition is due to natural conditions, then human actions considered cumulatively may not cause the 7-DADMax temperatures of that water body to increase more than 0.3ºC. The baseline for evaluating compliance with this standard is the pre-dam condition for which temperature monitoring data are not available; therefore, a direct comparison to determine temperature changes due to all human actions is not possible. The temperature monitoring data will be used to determine whether the 7-DADMax temperature increases in different reaches of the Project Area and by how much. These data may be used to help determine and evaluate adaptive management measures, such as adjusting the amounts, timing or delivery methods for minimum instream flows in the bypass reach.

The monitoring design involves deploying and operating water temperature recorders (i.e. thermographs) from July 1 through September 30 at four locations: approximately

2.4 miles upriver from the dam (river mile [RM] 11.3), in the reservoir forebay near the new powerhouse intake (RM 8.9), in the bypass reach between the spillway and the waterfall (RM 8.8), and downstream from the Project tailrace (RM 8.6). These river mile designations are approximate. Specific locations will be determined in the field to select pool habitats where (1) thermographs will remain submerged through the summer, and (2) deployment/retrieval cables can be securely fastened to existing structures or rock features. A global positioning system (GPS) unit will be used to record coordinates at each instrument deployment. The coordinates will be plotted on a map and used to help locate the instruments during data downloading events. For safety considerations, temperature recorders in the reservoir forebay and river locations will be accessed from shore and will not require a boat.

Onset StowAway TidbiT (or equivalent) thermographs will be deployed for continuous temperature monitoring at 60-minute intervals. Thermographs will be calibrated according to manufacturer specifications and accuracy will be verified using comparisons to a National Institute of Standards and Technology (NIST)-certified thermometer. To protect against physical damage, each thermograph will be fastened inside a protective cover with holes drilled for water circulation. At the three river locations the thermographs will be deployed in deep waters to minimize the risk of vandalism, tampering, or loss. The thermographs deployed in the reservoir will be located in a restricted access area close to the dam and intake canal. To further protect against loss of monitoring data, duplicate temperature recorders will be placed near each location.

Except for in the reservoir, the river water is assumed to be well-mixed all year, and placement of the thermographs in deep water will be representative of the overall river flow. In the reservoir where there is potential for vertical stratification, thermographs will be placed at three depths: mean reservoir depth to monitor compliance within the reservoir, the elevation of the old penstock intake that will be used for diverting water to the bypass reach, and near the reservoir surface.

Beginning in August, the thermographs from each location will be retrieved monthly to download data, and then returned to the river. Temperature data will be downloaded with a data logger and then transferred into spreadsheets, reduced by deleting measurements that occurred during deployment and retrieval, and inspected for any outliers or unusual patterns. Daily mean and maximum stream temperatures will be derived from the data collected by each temperature recorder. The arithmetic average of seven consecutive measures of daily maximum temperature (7-DADMax) will also be calculated for each 7-day period at each monitoring location. These averages will be used to compare upstream and downstream temperatures and make comparisons to water quality standards.

4.2 DISSOLVED GAS

DO and TDG monitoring will document water quality conditions in the Enloe Project Area during the critical warm season and during the peak snowmelt runoff season and may be used to (1) evaluate Project compliance with water quality criteria, and (2) inform decisions on adaptive management measures. Previous monitoring efforts have shown that DO in the Similkameen River drops below 9 mg/L in the summer and may approach the 8.0 mg/L minimum water quality criterion. Potential water quality concerns for dissolved gas are that diverting a portion of the Similkameen River between Enloe Dam and the tailrace outlet may (1) reduce the aeration and DO increase that occurs when all of the river flow passes over the dam and falls, and (2) result in relatively stagnant water in the bypass reach, including warmer summer water temperatures and lower DO concentrations. Conversely, diverting the water and reducing the flows over the dam may improve conditions of TDG supersaturation below the falls. To address the reduced aeration from diverting river flows through the powerhouse, the Project design will include aeration in the turbine flow tubes. However, aeration will not be provided during the spring snowmelt season when TDG supersaturation is present. Minimum instream flows through the bypass reach are designed to provide continuous circulation and maintain adequate temperature and DO conditions in the bypass reach. This monitoring program is designed to determine the effectiveness of these mitigation measures in meeting water quality criteria, and inform adaptive management decisions, such as changes to the timing of aeration introduced to power-generating flows.

The monitoring design involves deploying and operating Hydrolab® Minisonde5 multi-parameter meters (Minisonde5) or equivalent, equipped with a tensiometer probes, for measurement of TDG from April 1 through June 30, at two locations: approximately 2.4 miles upriver from the dam (RM 11.3), and downriver from the Project tailrace (RM 8.6). For measurement of DO from July 1 through September 30, Minisonde5 or equivalent, equipped with luminescent DO sensors, will be deployed at the two sites used for TDG monitoring, plus two additional sites: in the reservoir forebay near the new powerhouse intake (RM 8.9) and in the bypass reach between the spillway and the waterfall (RM 8.8).Specific locations will be determined in the field to select pool habitats where (1) meter sensors will remain submerged through the summer, and (2) a protective housing can be securely fastened to existing structures or rock features. A recording barometric pressure meter will also be installed at the powerhouse to collect the hourly ambient barometric pressure readings necessary to convert TDG sensor readings in millibars of mercury to units of percent saturation. A GPS unit will be used to record coordinates at each instrument deployment and the coordinates will be plotted on a final monitoring site map. For safety considerations, meters in the reservoir forebay and river locations will be accessed from shore and will not require a boat.

Minisonde5 or equivalent will be deployed for continuous monitoring at 60-minute intervals. The meters will be calibrated according to manufacturer specifications before deployment and after each month of monitoring, data are downloaded to a datalogger. To protect against physical damage, each meter will be fastened to a cable and lowered inside a protective steel pipe (i.e. meter housing). The housing will have holes drilled to allow river water to circulate past the sensors, and will be fitted with a locking cap to prevent theft or tampering. The housings will be bolted to structures or rock formations at each monitoring site, and extend at an angle away from shore and into pool habitat

(Figure 4). Although the meters will only be used seasonally, the meter housings will generally remain in-place all year. The recording barometer will be mounted in a secure location near the powerhouse.

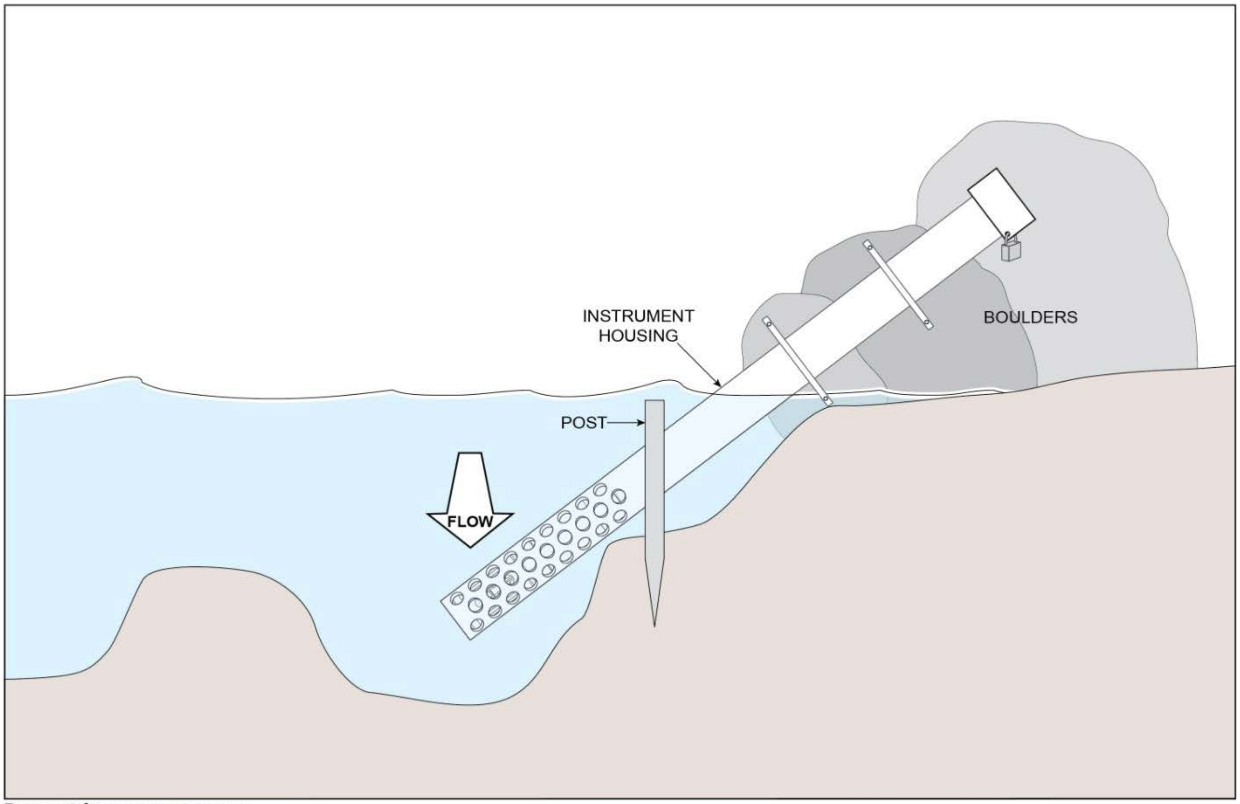

Figure 4. Typical Instrument Housing for Similkameen River Monitoring Enloe Dam Hydroelectric Project

Except for in the reservoir, the river water is assumed to be well-mixed all year, and placement of the meters in pool habitats will be representative of the overall river flow. In the reservoir where there is potential for vertical stratification, the meter will be placed at mean reservoir depth to monitor compliance within the reservoir.

Beginning in May, the meters will be retrieved monthly to download data, perform routine maintenance, and re-calibrate, before they are re-deployed for the next month of monitoring. TDG and DO data will be downloaded with a data logger and then transferred into spreadsheets, reduced by deleting measurements that occurred during deployment and retrieval, and inspected for any outliers or unusual patterns. Daily mean and maximum TDG, and daily mean and minimum DO, will be derived from the data collected by each meter. These data summaries will be used to compare upstream and downstream temperatures and make comparisons to water quality standards.

5.0 MEASUREMENT METHODS

5.1 WATER TEMPERATURE MONITORING

The field sampling and measurement protocols for water temperature monitoring, as modified below, are those described in the Stream Sampling protocols for the Environmental Monitoring and Trends Section manual (Ecology 2001) and/or the Timber, Fish, and Wildlife (TFW) Monitoring Program Method Manual for the Stream Temperature Survey (Scheutt-Hames et al. 1999).

StowAway® TidbiT® or equivalent continuous measuring data loggers (thermographs), manufactured by Onset Computer Corporation, will be used for water temperature monitoring. The operating temperature of these thermographs is +37 to -5 °C, with a stated accuracy of no greater than ±0.4 °C at 16 °C and resolution of 0.29 °C. In our experience, after verifying thermistor performance against an NIST-certified thermometer the accuracy has been ±0.2 ºC or better. The internal battery will operate for up to 5 years, depending on the time interval selected for recording temperature measurements. The accuracy of the thermographs will be verified using the methods described under Quality Control Procedures (Section 7.1). TidbiTs® will be deployed before July 1 of each year, after the peak flows recede but before water temperatures begin to rise to stable levels of potential concern.

Two Tidbits® or equivalent will be deployed separately at three river locations (stations) designated as upriver, bypass reach, and downriver (i.e., upper end of the Project Area above the reservoir, in the pool at the base of the dam, and below the tailrace). The redundancy provided by two thermographs at each location should help reduce loss of data that might result from equipment malfunctions or vandalism of instruments.

Mooring devices thermographs deployed in the river and bypass reach stations will generally consist of a cement pier block. A weighted ball (25 to 30 lbs.) may also be attached to the pier block to help hold the mooring device in one palace after deployment. If used, the weighted ball will be fastened to the pier block with a few feet of wire cable (3/8 inch). An additional length of cable will be fixed to the pier block and used to deploy and retrieve the mooring assembly. The opposite end of this cable will be bolted to a boulder or rock formation at the riverbank to prevent loss.

TidbiTs® or equivalent used at the river stations will be enclosed in a protective plastic cap (PVC, 2-inch diameter) and bolted directly to the cement pier block. The caps have drilled holes that allow free access to river water. Each thermograph will be approximately eight inches above the bottom of the river with this mounting. Both thermograph assemblies at any given river location will be positioned in the deepest water available so that they remain submerged during low flows and visibility is minimized.

In addition to the three river sites, two TidbiT® or equivalent arrays will be deployed in the lower reservoir. Both arrays will be located near the intake approach structure in the forebay. Each array will consist of three TidbiTs® or equivalent suspended in the water column at depths selected to represent water from the average reservoir depth based on bathymetry, water entering the new intake approach (and/or possibly the gate regulating minimum instream flow to the bypass reach), and water from the average depth at the old penstock intake (could be used for piping water to the bypass reach).

Similar to the reservoir deployments, each reservoir TidbiT® or equivalent will be fastened inside a polyvinyl chloride (PVC) pipe cap (1½-inch diameter) for protection against (1) debris that might be carried by the current, and (2) damage during deployment and retrieval. Each reservoir thermograph array will be suspended on a stainless steel wire cable that forms a taut loop through two eyebolts attached near the top and bottom of a pipe (instrument housing) bolted vertically to the intake approach structure (see Dissolved Gas Monitoring below). A cable stop, mounted on the cable loop, will halt the cable and thermograph array as it descends so that each TidbiT® or equivalent in the array is positioned at the appropriate depth (see above). The loop will be tethered at the top eyebolt with a locking device so that the TidbiTs® or equivalent can be retrieved for downloading and maintenance and then redeployed using the looped cable to raise or lower the thermographs.

All TidbiT® or equivalent data loggers will be pre-set to launch (i.e. begin recording measurements) at midnight of the annual deployment date, using Onset Computer Company's Hoboware Pro® software program (v 3.1.1). Temperature will be recorded at hourly intervals during deployment. Temperature data will be downloaded from the TidbiT®s or equivalent and reported monthly during the monitoring season. All TidbiTs® or equivalent and associated rigging equipment will be removed from the river in October of each monitoring year. The pipe housing mounted on the intake approach structure at the dam will remain in place at all times.

Temperature data will be downloaded onto a HOBO Waterproof Shuttle® after the TidbiTs® or equivalent are removed from the protective caps. Once the data are stored, the shuttle re-launches the thermograph using the initial recording interval. The TidbiTs® or equivalent are then refastened in their protective caps and redeployed. The shuttle also updates the TidbiT® or equivalent clock if there is any discrepancy between the shuttle and TidbiT® or equivalent clocks. The shuttle clock will be updated by computer just before each scheduled data retrieval event.

Downloaded temperature data will be copied or transferred to a computer and backed up on compact disc (CD) as soon as possible after data retrieval. A thermograph downloading kit containing detailed instructions, replacement TidbiTs® or equivalent, the HOBO® shuttle, rigging supplies and other equipment will be used during each data retrieval and maintenance event.

The accuracy of the Onset TidbiT® or equivalent thermographs will be evaluated, prior to each annual deployment, by a two-point comparison to a NIST-certified thermometer, as described in the Parametrix Standard Operating Procedure (SOP) for Thermometer and Thermistor Use (PMX-SOP-CAL-1). If the mean difference between the NIST-certified thermometer and a TidbiT® or equivalent thermograph is greater than the manufacturer's reported specifications, that thermograph will not be used for monitoring.

After retrieval in October, post-retrieval comparisons of the TidbiT® or equivalent thermographs to the NIST-certified thermometer will also be conducted to verify that they were functioning properly and still meet the stated data quality objectives. This post-retrieval comparison will also serve as the pre-deployment comparison for the next year of the program.

5.2 DISSOLVED GAS MONITORING

The instruments for measurement of DO and TDG will be Minisonde5 or equivalent equipped with luminescent dissolved oxygen (LDO), specific conductivity (necessary for LDO calibration), temperature, and depth sensors. Two of the Minisonde5 will also have TDG sensors. A Hydrolab® Surveyor4® data logger and display unit (SVR4) will be used to calibrate the Minisonde5s or equivalent and to download and transfer data to a PC for analysis and reporting. The SVR4 will be configured with (1) a barometer for Minisonde5 or equivalent calibration, (2) extended memory, and (3) an internal battery pack. A barometer capable of recording barometric pressure at the same hourly intervals as the sondes will be located near the powerhouse. Accurate and precise ambient barometric pressure data are required to convert the TDG measurements from millimeters of mercury to percent saturation.

Two of the Minisonde5 or equivalent will be deployed by April 1 of each year, before the river rises to the annual peak flows. They will be deployed at the same upriver and downriver sites as the TidbiT® thermographs. Two additional Minisonde5s or equivalent will be deployed by July 1 of each year at the forebay and bypass reach sites used for temperature monitoring. Each MiniSonde5® or equivalent will be inspected, calibrated, and field tested by a staff water quality specialist prior to initial deployment. All of the Minisonde5 or equivalent will be pre-set to launch at midnight on the deployment date. DO and TDG measurements will be recorded at hourly intervals during deployment. All of the Minisonde5s or equivalent will be removed after September 30. The instrument housings will remain in place all year.

Exact location of monitoring sites will be flexible to allow the use of fixed structures or natural features in the river (e.g. intake canal, boulders, rock bluffs) to attach the monitoring instrument housing. Housings will be designed and constructed to protect continuous monitoring instrumentation and to position the sensors near mid-depth of the water column during low flows.

Instrument housings will consist of PVC or stainless steel pipes with holes or slots perforating the lower few feet to allow free flow of water around the sensors of the Minisonde5 or equivalent. The pipes will be secured in place in a manner to prevent the Minisonde5 or equivalent from being removed or vandalized by casual visitors to the Project site. Housings at the forebay station will descend into deep water vertically. River station instrument housings will probably extend from shore into a deep pool at an angle. Examples of deployment structures and monitoring instrument housings are shown in Figures 4 and 5.

Dissolved gas data will be retrieved and data downloaded from the Minisonde5s® or equivalent to the SVR4 monthly. Depending on battery life, batteries may need to be replaced more often. Each Minisonde5 or equivalent will be inspected, calibrated, and redeployed at each monthly data retrieval and maintenance event.

Downloaded temperature data will be copied or transferred to a computer and backed up on CD or flash drive as soon as possible after data retrieval. DO and TDG data will be reported monthly during the monitoring season. A Hydrolab® maintenance kit containing batteries, replacement parts, and servicing tools for the Minisonde5 and SVR4 or equivalent will be used during the monthly data retrieval and maintenance events.

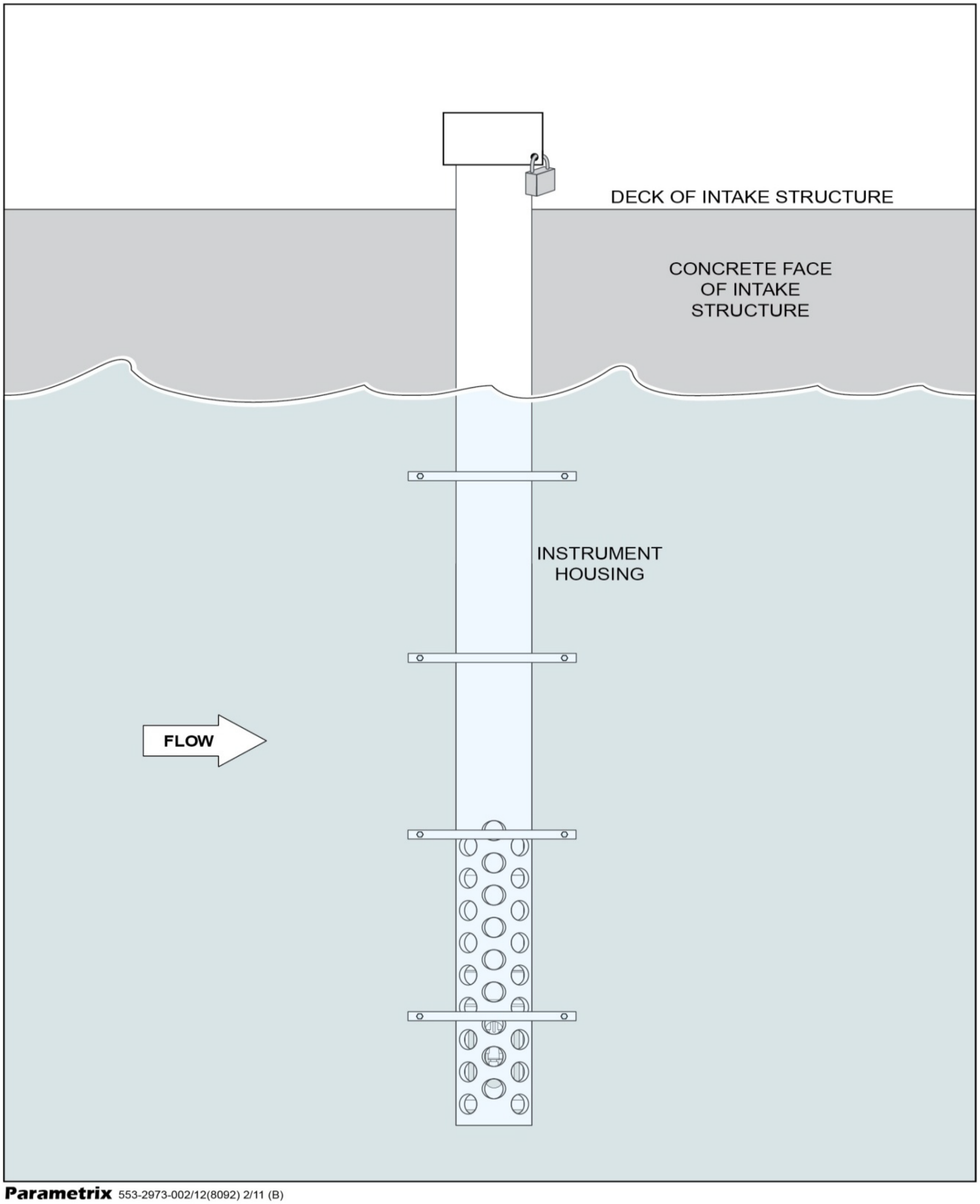

Figure 5. Typical Instrument Housing for Similkameen River Monitoring Enloe Dam Hydroelectric Project Quality Control

5.3 MONITORING INSTRUMENTATION

The instruments for measurement of DO and TDG will be a Minisonde5 with a SVR4 data logger/display unit for calibration or equivalent, downloading, and transfer of monitoring data. All of the Minisonde5s and the SVR4 or equivalent used in this monitoring project will be new and performance-tested by technicians at the factory to ensure that the sensors are meeting all stated specifications and that the integrated electronic system of each Minisonde5 or equivalent is functioning as it should. The Minisonde5 and the SVR4 or equivalent will be performance-tested and evaluated at the factory on an annual basis thereafter.

A detailed SOP describing calibration, deployment, data downloading, and maintenance for the Minisonde5 or equivalent will be followed for pre-deployment, monthly maintenance, and post-deployment calibrations and quality control (QC). A copy of this SOP will be taken in the field for reference during every data retrieval/maintenance event.

Prior to the each annual deployment, the specific conductivity and LDO sensors will be calibrated to verify proper function and accuracy before leaving for the field. The LDO sensor will then be recalibrated at the Project site to adjust or correct for differences in altitude. The TDG sensor will have been calibrated at the manufacturer’s service and maintenance facility and should not require calibration before or during deployment.

The depth-measuring unit of the Minisonde5 or equivalent will be calibrated in the field prior to deployment by setting it to zero depth at the surface of the water. This procedure takes into account the effects of barometric pressure on depth measurement that can occur with changes in elevation or extremes of weather conditions.

The Minsonde5 and all sensors will be inspected, serviced, tested, and recalibrated as necessary after the data are downloaded during each monthly data retrieval and maintenance event. A calibration log will be maintained to document the dates and times of Minisonde5 or equivalent calibration, and any calibration problems and corrective actions taken (e.g. replacing electrolyte solution in the pH probe). This log will be kept with the SOP and Hydrolab® maintenance kit that are taken to the field. The calibration log will be retained in the monitoring project files.

Calibration of the Minisonde5 or equivalent instruments before redeployment will be performed as described in the SOP, with the following additional stepwise procedures for data downloading and redeployment:

- Retrieve the Minisonde5 or equivalent and download the data as described in the Field Data Download, Maintenance, and Calibration Protocol.
- Inspect and clean the Minisonde5 and sensors or equivalent as described in the Field Data Download, Maintenance, and Calibration Protocol.

- When the Minisonde5 or equivalent is clean, remove the housing and replace the batteries as described in the Field Data Download, Maintenance, and Calibration Protocol.
- Replace the housing and tighten it securely. Do not over-tighten the housing.
- Perform the final rinse of the sensors as described in the Field Data Download, Maintenance, and Calibration Protocol.
- Following the final distilled water rinse, calibrate the conductivity sensor and verify the calibration by comparing the post-calibration measured value to the QC calibration solution.
- Calibrate the LDO sensor and verify the calibration by comparing the post-calibration measured value to the expected value for the ambient temperature and barometric pressure (kept in the calibration log).
- When calibration is complete, the MiniSonde5® or equivalent is ready for re-deployment.

The accuracy of the recording barometer will be verified prior to deployment and at every monthly data retrieval event by comparison to the SVR4 barometer or equivalent. The accuracy of the SVR4 barometer or equivalent will be verified prior to the start of the monitoring season, mid-monitoring season and post-retrieval. The easiest way to verify the SVR4 barometer or equivalent accuracy may be a side-by-side comparison (or as near as possible) with a National Oceanic and Atmospheric Administration (NOAA) barometer at the nearest airfield with a NOAA-maintained weather recording and reporting station.

6.0 INSTREAM FLOW MONITORING

6.1 INTRODUCTION

This Section addresses monitoring of instream flow releases within the 370-foot-long river reach between Enloe Dam and Similkameen Falls. This information is placed in a separate section since it is related to the amount of water that is delivered to the river in this area to maintain fish habitat rather than the District's plan to monitor and protect water quality components. Although both aspects are important in determining fish habitat, this subsection is focused on instream flow within the project area.

6.2 GOALS

The District proposes to maintain minimum instream flow releases in the 370-foot-long bypass between Enloe Dam and Similkameen Falls to protect fish habitat. The goal of instream flow monitoring is to verify compliance with these minimum instream flow release requirements.

6.3 INSTREAM FLOW RELEASE CRITERIA

Proposed minimum instream flows are 30 cfs from mid-July to mid-September, and 10 cfs the rest of the year.

6.4 PROPOSED MONITORING EQUIPMENT

Minimum instream flow compliance will be assured by measuring flow in the proposed instream flow outlet pipeline from the existing penstock in the west abutment of the dam to the proposed instream flow discharge valve downstream of the dam. Rate of flow of water will be measured with a pipe flowmeter.

The pipe flowmeter will either be a magnetic or acoustic flowmeter designed for precise flow measurement in pipework. Typical magnetic flowmeters are the Krohne Enviromag, McCrometer Ultra Mag, Rosemount 8705 or equivalent. Typical acoustic flowmeters are GE Panametrics Panaflow, Accusonic Model 798 or equivalent. Selection of the flowmeter will depend on quality, price, and suitability for the particular installation.

The flow measurement range will be 1 cfs to 35 cfs.

6.5 SAMPLING AND MEASUREMENT PROCEDURES

The flowmeter will provide continuous instream flow measurements as an analogue 4-20 milliamp electrical output which will be converted to average hourly flow data by a data logger. Communication of flow sensor data to the powerhouse supervisory control and data acquisition (SCADA) system will be accomplished by either a communications cable or a wireless digital data communication system.

6.6 DATA QUALITY OBJECTIVES

Field measurements of flow of water are approximate. Data quality objectives (DQOs) are statistical statements of the acceptable level of uncertainty or accuracy in information derived from the data. There are two types of DQOs, decision quality objectives and measurement quality objectives (MQOs) which are described in Chapter 3.

6.7 QUALITY CONTROL

The new flow meter will be factory calibrated and installed following the manufacturer's instructions for testing and calibration. Calibration and operation of the instream flow flowmeter will be checked after installation by using a clamp-on acoustic flowmeter. The flowmeter will be recalibrated on a regular basis per manufacturer's recommendations

6.8 DATA MANAGEMENT

Real-time flow sensor data will be transmitted to the powerhouse supervisory control and data acquisition (SCADA) system. The project SCADA system will monitor instream flow release and be set to create an alarm on variance from flow release targets and report exceptions. The instream flow release valve will be remotely operable to adjust the rate of flow.

Time series flow data with a sampling time interval of one hour will be stored in a data archive in the project SCADA system. Instream flow measurements will be output for compliance monitoring purposes as spreadsheet files. Compliance data will be published as described in Section 9.

6.9 BUDGET COST ESTIMATE

Estimated initial costs for installation of a 16-inch-diameter magnetic flowmeter with data communications to the powerhouse is $25,000. Estimated average annual operations and maintenance cost including data management is $5,000/year. If, within five years, monitoring does not provide substantial evidence that the Project is causing violations of water quality standards, the District, in consultation with the FW, may submit a written request to Ecology, to reduce the frequency and extent of monitoring. The proposed new plan is subject to review and approval by Ecology.

7.0 WATER LEVEL MONITORING

7.1 INTRODUCTION

This Section addresses monitoring of river water level fluctuations within the 370-foot-long river reach between Enloe Dam and Similkameen Falls and in the river below the Project. This information is placed in a separate section since it is related to the fluctuation of water within the river water to prevent fish from stranding on the shore of the river due to the water level dropping quickly. Like water quality and the amount of instream flow in the river, water level fluctuation is needed to maintain overall aquatic habitat.

7.2 GOAL

The goal of water level monitoring is to assure that water level fluctuation (ramping) requirements are met, with the intent of protecting fish within the 370 foot long river reach between Enloe Dam and Similkameen Falls and in the river below the Project. Water level ramping requirements are prescribed to protect fish from stranding on the shores of the river due to potential rapid reduction of water level that could occur during shutdown of the power plant.

7.3 WATER LEVEL RAMPING CRITERIA

The District proposes to implement interim ramping rates based on Washington State guidelines (Hunter, 1992) to protect aquatic resources downstream of the powerhouse tailrace (see Table 5).

Table 5. Proposed Ramping Rates (Source: Hunter 1992)

Season	Daylight[a]	Night[b]
February 16 to June 15	No ramping	2 inches per hour
June 16 to October 31	2 inches per hour	1 inch per hour
November 1 to February 15	2 inches per hour	2 inches per hour

Notes:
a Daylight is defined as the period from 1 hour before sunrise to 1 hour after sunset.
b Night is defined as the period from 1 hour after sunset to 1 hour before sunrise.

The ramping rates would apply to decreases in hourly water elevations caused by normal powerhouse start-up and shut-down. Temporary modifications to ramping rates may be needed to address operating emergencies or planned outages. Further information regarding proposed ramping rates can be found within the project fish management plan.

Additionally, the District proposes to identify water level thresholds (a range where stranding could be an issue) for decreases in water level in the bypass reach to protect aquatic resources in the bypassed reach during times when the crest gates are closed. The topography of the bedrock river channel in the bypassed reach is such that there are areas where fish would likely be stranded if spillage over the dam is reduced at a rate that does not allow fish to successfully vacate these areas. In other areas, the banks of the river are steep so that stranding of fish would not occur.

7.4 PROPOSED MONITORING EQUIPMENT

Water level fluctuations in the Similkameen River downstream of the project will be monitored by installing a water level sensor in representative salmon spawning habitat. The proposed location is near River Mile 8.0 at a suitable location considering streambed morphology for spawning and access.

To assist in resolving uncertainty regarding the possibility of stranding of fish and the need for ramping constraints in the 370 foot long bypass reach between the dam and Similkameen Falls, a temporary water level sensor will be maintained in the spillway plunge pool for five years to measure water levels and rates of water level fluctuation. The purpose would be to monitor project induced decreases in water level in the spillway plunge pool during closure of the crest gates. The sensor would be removed at the end of the five year period unless it is determined that ramping rates are necessary.

Water levels will be monitored using bottom mounted pressure transducers that measure water level by sensing water pressure. Typical sensors are Campbell CS 450, Stevens SDX and the GE PTX 1230. The sensors would be installed in steel pipelines that are anchored to the streambed. During the annual spring freshet the sensors may be removed to reduce potential for damage during high flow periods when ramping constraints will not be needed.

The typical measurement range for each sensor will be 0 to 15 feet. The range selected will depend on conditions at the monitoring site including the proposed depth of the sensor.

7.5 SAMPLING AND MEASUREMENT PROCEDURES

The water level sensor will provide a continuous stream of digital water pressure data, which will be transmitted to a datalogger which will process and store 5 minute frequency water level data and prepare it for transmission.

Communication of water level data to the powerhouse supervisory control and data acquisition (SCADA) system will be accomplished by a wireless digital data communication system. The specific communications system will be selected after considering factors such as terrain, positioning, reliability and power requirements.

Water level will be monitored during times when the powerhouse is being shutdown to assure compliance with ramping criteria. It is expected that there will be a range of water stage in the spawning reach that will be of concern for stranding of fish. Once this range is established, project shutdown and operation of crest gates on the bypass reach will be regulated to meet the criteria within this range using the water level monitoring data both as control feedback and data for compliance monitoring.

7.6 DATA QUALITY OBJECTIVES

Field measurements of flow of water are approximate. Data quality objectives (DQOs) are statistical statements of the acceptable level of uncertainty or accuracy in information derived from the data.

Water level measurements in streams are approximate and are affected by factors such as waves, turbulence, changes in streambed morphology, backwater from downstream obstructions and local water velocity. High water velocities, turbulence and waves in the spillway plunge pool during times when the spillway is in operation are also expected to affect the accuracy of water level measurement.

Decision quality objectives (DQOs) and measurement quality objectives (MQOs) are described in Chapter 3.

7.7 QUALITY CONTROL

The new water level sensors will be factory calibrated and installed following the manufacturer's instructions for testing and calibration.

Validation of operation and accuracy of water level monitoring equipment will be accomplished by simultaneous manual measurement of water level relative to nearby precise level benchmarks established for this purpose In the event of sensor movement or drift, the relationship between water pressure and water surface elevation will be recalibrated or the sensor replaced.

7.8 DATA MANAGEMENT

Real time communication of water level data to the powerhouse SCADA system will be accomplished by a wireless digital data communication system. The specific communications system will be selected after considering factors such positioning, gain, antenna tuning, atmospheric conditions, time of day, ambient frequency, noise, and terrain. The data will be used as control feedback for power plant operations.

Monitoring of water levels downstream of the project in spawning habitat for anadromous fish at about River Mile 8 will be carried out at times when there is potential for stranding of fish due to shutdown of the project.

Monitoring of water level in the pool at the toe of the dam will be carried out at times when there is potential for stranding of fish due to closure of the spillway crest gates.

Hourly water level data for the above periods for ramping compliance monitoring will be output in spreadsheet files and published as described in Section 9.

7.9 BUDGET COST ESTIMATE

Estimated initial costs for installation of each bottom mounted water level sensors with radio communications, solar power supply, enclosure etc. is $15,000. Estimated average annual operations and maintenance costs including data management for each water level sensor is $8,000/year. If, within five years, monitoring does not provide substantial evidence that the Project is causing violations of water quality standards, the District, in consultation with the FW may submit to Ecology a request to reduce the frequency and extent of monitoring. The proposed new plan is subject to review and approval by Ecology.

8.0 DATA MANAGEMENT PROCEDURES

After each monthly monitoring event, field crew personnel will conduct a review of all field data, including field logbooks, prior to entry into the monitoring project files. The District will evaluate data to ensure that its collection was conducted according to procedures specified in the QAPP. Abnormal or irregular values will be identified and resolved or isolated as soon as possible. A summary narrative in the form of a technical memorandum to the District's Environmental Coordinator will document any procedural deviations, data qualifications, or problems identified in the review of monitoring records.

8.1 WATER TEMPERATURE DATA

The District will transfer downloaded temperature data directly from the datalogger into spreadsheets, reduced by deleting measurements that occurred during deployment and retrieval, and inspected for any outliers or unusual patterns. From the reduced data collected from each temperature monitoring station, the daily maxima and averages will be determined. The arithmetic average of 7-DADMax will also be calculated for each 7-day period at each monitoring location.

8.2 DO AND TDG DATA

The District will download DO and TDG data directly from the SVR4 into spreadsheets, reduced by deleting measurements that occurred during deployment and retrieval, and inspected for any outliers or unusual patterns. From the reduced data collected from each monitoring station, the daily minima and averages will be determined. Data from the ambient barometric pressure logger will also be transferred directly into the same spreadsheet and used to calculate TDG percent saturation from the recorded values of TDG concentration in millimeters of mercury. The daily maxima and averages of TDG saturation will then be calculated for each monitoring site.

9.0 DOCUMENTATION AND REPORTS

Thorough documentation and reporting will provide sufficient information to allow independent verification of the monitoring results. All water monitoring field activities at the Project will be documented in field notebooks and instrument calibration logs. Evidence of an oil sheen, spill, or excursion from water quality standards, if any, will be reported to Ecology by telephone and e-mail with 48 hours after observation. Electronic copies of raw data files downloaded from the monitoring instruments, and spreadsheet files used for data reduction and analysis, will be available to Ecology on request. Copies of technical memoranda used to document any procedural deviations, data qualifications, or problems identified in the review of monitoring records will also be available for review. Summaries of monitoring results will be posted to the District's Project website on a monthly basis throughout the monitoring period each year. Finally, all monitoring data will be summarized each year in an annual water quality data report that will be submitted to Ecology in December and posted to the Project website.

9.1 FIELD NOTEBOOK

Detailed notes on field activities will be maintained in a monitoring project-specific, bound field notebook or equivalent. Notebook entries for each day in the field will include:

- Date
- Weather conditions
- Personnel present
- Time arriving and departing each location
- Sequence of activities
- Description of any conditions that might affect the monitoring results (e.g. instrument condition, water quality observations)
- Any deviations from this QAPP and SOPs
- Descriptions of any photographs taken
- Signature of field team leader

The field notebook will be a detailed chronological record of all field work. It is intended to serve as a permanent record of activities sufficient to recreate all mobilization, data collection, instrument maintenance, and demobilization activities conducted in the field. The information will be permanently recorded in a bound notebook with sequentially numbered pages. No pages will be removed from the notebook, and any blank pages will be marked "Page Intentionally Left Blank". Notebook entries must be dated, legible written in permanent ink, factual, and accurate. Corrections will be made by crossing a line through the erroneous entry, writing in the correct information, and initialing and dating the correction. Unused portions of notebook pages will be crossed out, signed and dated at the end of each work day.

9.2 CALIBRATION LOG

A calibration log will be maintained to document the dates and times of MiniSonde5® calibration and maintenance. Any calibration problems and corrective actions taken (e.g. replacing electrolyte solution in the pH probe) will be recorded on the log forms. This log will be kept with the SOP and Hydrolab® maintenance kit that are taken to the field. Calibration log forms will also be used to document thermograph temperature comparisons to an NIST-certified thermometer. The calibration log will be retained in the monitoring project files and available for inspection upon request.

9.3 WEBSITE UPDATES WITH MONITORING DATA

The District will post summaries of monitoring data to the Project website monthly after the beginning of the monitoring season each year. For water temperature, the data summaries will include daily maximum, daily mean, and 7-DADMax temperatures for each monitoring location, as described in Section 8.1. For DO and TDG, the data summaries will include daily minimum and daily average for DO, and daily maximum and daily average percent saturation for TDG (see Section 8.2). The data will be posted no later than the 30th of the month following each month of monitoring.

9.4 INCIDENT REPORTING

Any incidence of an excursion from water quality criteria, including any observed sheen, will be reported to Ecology's Central Regional Office within 48 hours. The occurrence of any detection will be detailed in a notification describing the likely cause of the sheen and the proposed or implemented corrective action. In the case of a spill, provisions of the Spill Response Plan will apply. These provisions include the immediate report of any spills to Ecology's 24-hour phone number (1-800-258-5990), the National Response Center (1-800-424-8802) and submittal of a detailed report to Ecology within five days of the incident.

9.5 ANNUAL REPORTS

Formal annual reports will be submitted to Ecology by December 31 of each year, providing the data assessments required to determine compliance with water quality standards (Chapter 173-201A WAC). The reports will summarize the information from all field activities, summarize results from the data quality assessments, describe any deviations from this QAPP and monitoring project SOPs, present the results of monitoring data with comparisons to water quality criteria, summarize the contents of any incident reports, and draw conclusions regarding water quality standards compliance and any recommendations for further action or changes to the monitoring program. The reports will also include a site map illustrating the locations of monitoring sites, and a table of coordinates for each location. Report appendices will include copies of the calibration log forms, any incident reports, photographs of the monitoring sites and equipment, and memoranda prepared to summarize field audits.

10.0 AUDITS AND DATA VERIFICATION

Both field audits and reporting audits will be conducted to ensure that the monitoring program is following the requirements of this QAPP. Data review and verification will occur monthly after information is downloaded from the monitoring instruments, as described in Section 8. In addition, the Water Quality Specialist will prepare a data quality assessment to performance in achieving MQOs.

10.1 FIELD AUDITS

Once per year the District Regulatory Environmental Affairs Director will send an additional person into the field to observe and document all field activities including equipment retrieval and re-deployment, data downloading, instrument maintenance and calibration, and documentation in the field notebook and calibration log. The auditor will prepare a technical memorandum addressed to the Environmental Coordinator that addresses conformance to this QAPP and the monitoring project SOPs. The memo will include any recommendations on how the monitoring practices or the plans should be changed to minimize the need for future deviations from the plans. The Environmental Coordinator will be responsible for ensuring that if needed, any corrective actions meet Ecology’s approval and are implemented.

10.2 REPORTING AUDITS

The District is responsible to ensure that all of the §401 certification reporting requirements are met. The Environmental Coordinator will be responsible for tracking and confirming that requirements are met timely. This responsibility will include checking to see if the field notebook and calibration log are complete, data review and verification has been conducted properly, monthly website updates are correctly posted during the monitoring season, and annual reports contain the required information, including documentation of any deviations and corrective actions.

10.3 DATA REVIEW, VERIFICATION, AND QUALITY ASSESSMENT

Sections 8.1 and 8.2 describe the process for monthly data reduction that will take place after the monitoring instruments are downloaded and the results converted to spreadsheets. Data recorded during deployment and retrieval will be removed from the datasets and any outliers or results indicative of instrument failure will be identified and qualified as unusable by the District Regulatory Environmental Affairs Director. The truncated data and outliers will be reported in data appendices, but not included summary statistics. Duplicate measurements from thermographs deployed in close proximity at monitoring sites will allow for calculating the overall precision of the temperature monitoring method. Results of the data quality assessments will be included in the annual monitoring reports, including a description of the rationale for excluding any monitoring results from the data analyses, any corrective actions taken, a summary of precision calculations, and an assessment of data completeness.

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