

PUBLIC UTILITY DISTRICT NO. 1 *of* CHELAN COUNTY
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February 19, 2010

VIA ELECTRONIC FILING

Honorable Kimberly D. Bose, Secretary
Nathaniel J. Davis, Sr., Deputy Secretary
FEDERAL ENERGY REGULATORY COMMISSION
888 First Street, NE
Washington, DC 20426

Subject: Rocky Reach Hydroelectric Project, FERC No. 2145
Article 401 and Appendix A, Sections 5.7(1) and (2) – Quality Assurance Project Plan

Dear Secretary Bose and Deputy Secretary Davis:

The Federal Energy Regulatory Commission (Commission or FERC) issued the "Order on Offer of Settlement and Issuing New License" (License) and "Order on Rehearing and Clarification" for the Rocky Reach Hydroelectric Project No. 2145 (Project) on February 19, 2009, and May 21, 2009, respectively. In accordance with License Article 401 and Certification Condition Numbers 5.7(1) and 5.7(2) of Appendix A – Section 401 Water Quality Certification of the License, the Public Utility District No. 1 of Chelan County (Chelan PUD) is required to file a Quality Assurance Project Plan (QAPP) within one year of License issuance and annually thereafter with the Commission.

Chelan PUD hereby files the QAPP, which includes all water quality monitoring, including TDG and temperature studies, the proposed GBT study, and monitoring water quality in shallow water habitat in the reservoir. It also includes, at a minimum, a list of parameters to be monitored, a map of sampling locations, and descriptions of the purpose of the monitoring, sampling frequency, sampling procedures and equipment, analytical methods, quality control procedures, data handling and data assessment procedures, and reporting protocols.

Appendix B provides the record of consultation with the Washington Department of Ecology in preparing the QAPP.

If you have any questions or require additional information, please contact me or Waikele Hampton at (509) 661-4627.

Sincerely,

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Enclosures: Final Quality Assurance Project Plan

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QUALITY ASSURANCE PROJECT PLAN
Rocky Reach Water Quality Monitoring and Reporting

FINAL

ROCKY REACH HYDROELECTRIC PROJECT
FERC Project No. 2145

February 19, 2010

Public Utility District No. 1 of Chelan County
Wenatchee, Washington

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ACRONYMS AND ABBREVIATIONS LIST

cfs	cubic feet per second
Chelan PUD	Public Utility District Number 1 of Chelan County
CRO	Central Region Office of Ecology
CWA	Clean Water Act
DO	dissolved oxygen
DQO	data quality objectives
Ecology	Washington State Department of Ecology
FERC	Federal Energy Regulatory Commission
kcfs	thousands of cubic feet per second
mg/L	milligrams per liter
mmHg	millimeters of mercury
MQO	measurement quality objective
N/A	not applicable
NIST	National Institute of Standards and Technology
PI	PI System® from OSIsoft®
Project	Rocky Reach Hydroelectric Project
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RPD	relative percent difference
SM	standard method
SOP	standard operating procedure
TDG	total dissolved gas
TMDL	Total Maximum Daily Load
WAC	Washington Administrative Code
WAS	Watershed Assessment Section
WQA	Water Quality Assessment

SECTION 1: BACKGROUND

The Rocky Reach Hydroelectric Project is located on the Columbia River in Chelan County, Washington, approximately seven miles upstream of the city of Wenatchee, Washington (Figure 1-1). The Project utilizes the waters of the Columbia River, whose drainage basin extends over substantial portions of northern Washington, Idaho, Montana and into Canada. The Project reservoir (Lake Entiat) extends 43 miles to Douglas County PUD's Wells Dam. The Project's installed capacity under the license is 865.76 megawatts.

This Federal Energy Regulatory Commission (FERC) licensed Project includes a reservoir with a surface area of approximately 8,235 acres and a concrete-gravity dam approximately 130 feet high and about 2,847 feet long (including the powerhouse) that spans the river. The Project consists of:

- A forebay wall, which is integral with the dam and is formed by 10 blocks of various heights and widths between the powerhouse and west abutment;
- A powerhouse approximately 1,088 feet long, 206 feet wide and 218 feet high that includes 11 generating units and a service bay;
- A spillway that is integral with the dam and consists of twelve 50-foot-wide bays separated by 10-foot-wide piers, with flow through each bay controlled by a 58-foot-high radial gate; with a combined hydraulic capacity of 980 kcfs;
- Two non-overflow east abutment blocks that are integral with the dam, each 125 feet high by 60 feet wide; and
- An east bank seepage cutoff, which is a buried structure that extends roughly 2,000 feet from the east end of the concrete portions of the dam and has a maximum depth of about 200 feet.

The Project includes passage facilities for upstream and downstream migrating fish. The upstream migrant fishway has three main entrances. These are located between spillway bays 8 and 9, at the center of the dam adjacent to powerhouse unit 11, and at the powerhouse service bay between turbine unit 1 and the west shoreline. There are also several submerged orifice entrances at each end of the powerhouse. Fish pass from the entrances into fish collection channels, which converge to guide fish to a pool and weir fish ladder with a counting station at the fishway exit that is near the west shoreline. Attraction water for the powerhouse fishway entrances is provided by three hydraulic turbine-driven pumps with a total capacity of 3,500 cfs and a gravity intake provides attraction water for the spillway entrance. The juvenile fish bypass system includes a surface collection system, turbine intake screens and collection system for turbines 1 and 2, a bypass conduit to the tailrace, and a fish sampling facility.

Figure 1-1: Project Location

The water quality monitoring program described in this Quality Assurance Project Plan (QAPP) is necessary to fulfill the requirements set forth by the Washington State Department of Ecology (Ecology) in the Section 401 water quality certification (401 Certification), Order No. 3155 issued on March 17, 2006, and incorporated into the License by Ordering Paragraph (D) on February 19, 2009. The 401 Certification incorporates, by reference, the Water Quality Management Plan, which is Chapter 2 of the Comprehensive Plan, Attachment B to the Settlement Agreement. This QAPP was prepared in accordance with the Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies (Ecology, 2004), and Field Sampling and Measurement Protocols for the Watershed Assessments Section (Ecology, 1993).

To accomplish these measures in accordance with the 401 Certification, the Public Utility District Number 1 of Chelan County (Chelan PUD) will monitor and evaluate total dissolved gas (TDG) in the Project forebay and tailrace (401 Certification, Section 5.4(1)(a)), water temperature in the Project forebay, tailrace, juvenile bypass system, and adult fishway (401 Certification, Section 5.5); and temperature, dissolved oxygen (DO) concentrations, and pH in selected macrophyte beds in the Reservoir (401Certification, Section 5.6). In addition, Chelan PUD will prepare and implement a study of gas bubble trauma (GBT). This QAPP is designed to describe the proposed sampling, monitoring and assessment methods, and subsequent reporting requirements.

In addition to the above mentioned monitoring, Chelan PUD will monitor TDG in the Rock Island forebay. This location is not included in Section 5.4(1)(a) of the 401Certification; however, Chelan PUD is required to report data from this location as per Section 5.4(4) of the 401 Certification.

Chelan PUD plans to coordinate the macrophyte bed monitoring with required resident fish monitoring (as per Chapter 6 of the Comprehensive Plan), which, because additional time is needed to prepare a study plan for the GBT study, will not be conducted until after 2010. These studies will be included in a subsequent annual QAPP update/revision. For these reasons, macrophyte bed monitoring and the GBT study will not be described in this QAPP.

Using the data collected in the first five years of the New License, Chelan PUD will run the CE-QUAL-W2 model to evaluate Project compliance with numeric temperature criteria. An additional QAPP will be drafted to address the modeling effort.

It is necessary to note that some of the monitoring described in this QAPP may not be conducted if unsafe conditions exist. At this time it is not possible to know if unsafe conditions exist, and if so, whether they are temporary or permanent. If permanently unsafe conditions exist, Chelan PUD will consult with Ecology to determine an appropriate alternative.

1.1 REGULATORY FRAMEWORK

1.1.1 Total Dissolved Gas

Washington Administrative Code (WAC) 173-201A-200(1)(f)) establishes, and Ecology administers, Washington state water quality standards for TDG during the non-fish and fish-spill seasons . The current

standard for TDG (in percent saturation) during the non-fish spill season (September 1 through March 31) is 110% for any hourly measurement.

For projects on the Snake and Columbia rivers, the current standard for TDG (in percent saturation) during the fish-spill season (generally assumed to fall between April 1 through August 31) is 120% in the tailrace of the dam spilling water for fish and 115% in the forebay of the next downstream dam, based on the average of the 12 highest consecutive hourly readings in a 24-hour period. A one-hour, 125% maximum standard for TDG also applies throughout the Project during the fish-spill season.

Prior to 2008, the method used to calculate the daily TDG compliance value during the fish-spill season was based on the average of the 12 highest hourly values in a 24-hour period, starting at 0100 hours and ending at 2359 hours. This method was based on Ecology's 1997 Water Quality Standards. In Ecology's 2006 revision to the Water Quality Standards the method for calculating the TDG compliance value was changed to the 12 highest consecutive hourly readings in a 24-hr period.

The revision did not define how to implement the new standard so on April 2, 2008 Ecology sent a letter to all Columbia and Snake river dam operators requesting the use of a rolling average method for calculating the 12 highest consecutive hourly TDG readings in a 24-hour period, beginning at 0100 hours (Ecology 2008). Using a rolling average that begins at 0100 hours results in counting the hours 1400 hours through 2359 hours twice – in the average calculations on the day they occur AND on the next reporting day. As a result, a TDG water quality criterion exceedance may be indicated on two separate days based on the same group of hours.

This "double-counting" of some of the hourly TDG values could potentially lead to critical management decisions that alter operational or physical characteristics of a particular hydroelectric project. Because there is not yet a formally established method to address this "double counting" issue, in 2009 Chelan PUD followed the methodology below to address such:

1. Calculate a moving average for each hour, including that hour and the previous eleven consecutive hours (which may or may not include the previous calendar day), resulting in a 12-hour moving average, with trailing values, associated with each daily hour.
2. Review the data to determine if there is an exceedance (12-C High > 120%).
3. When it appears an exceedance is a result of the influence of high hourly TDG levels from the previous day, filter the data set to exclude the first twelve 12-hr rolling averages of that day when an exceedance was noted.
4. Tabulate the resulting data set to reflect the maximum value observed on each specific calendar date. In other words, the greatest moving average value (including the previous eleven hours) observed through the last twelve hours of each day should be reported.

Use of the above methodology allowed for the monitoring of consecutive hours while eliminating "double counting". Chelan PUD understands and appreciates the need for consist compliance monitoring and reporting throughout the basin and will modify or replace the methodology described above at such time as Ecology provides an approved method.

1.1.2 Water Temperature

WAC 173-201A-602 designates the section of the Columbia River within the Project as a "salmonid spawning, rearing, and migration" water body (formerly Class A) and therefore water temperature must

remain below 17.5°C, as measured by the 7-day average of the daily maximum temperatures (7-DADMax). When a water body's temperature is warmer than the criteria (or within 0.3°C of the criteria) and that condition 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.

1.1.3 Dissolved Oxygen and pH

The water quality criteria for DO within the Project require that DO be greater than 8.0 milligrams per liter (mg/L). When DO is lower than the criteria (or within 0.2 mg/L of the criteria) and that condition is due to natural conditions, then human actions considered cumulatively may not cause the DO of that water body to decrease more than 0.2 mg/L (WAC 173-201A-200(1)(f)).

WAC 173-201A-200(1)(g) provides that pH shall be within the range of 6.5 to 8.5 units with a human-caused variation within the above range of less than 0.5 units.

1.2 HISTORICAL WATER QUALITY INFORMATION

The Columbia River at the Project is designated under current Washington State water quality standards as a "salmonid spawning, rearing, and migration" water body (formerly Class A). Water quality of this designation must meet or exceed the requirements for all or substantially all uses. The characteristic uses for the Project segment of the Columbia River include propagation of fish and wildlife (including salmonid species), water supply (domestic, irrigation, industrial), recreation, navigation and commerce (including power generation).

The Reservoir meets water quality standards numeric criteria for DO, pH, turbidity, and fecal coliform (Chelan PUD, 2004; Table 7 in PDEA). The mid-Columbia River, including the Reservoir is currently listed as impaired for TDG and water temperature with five sites on or near the Reservoir per the 2002/2004 candidate list (Section 303(d) of the Clean Water Act (CWA)). At times, water comes into the Reservoir with temperatures or TDG levels that exceed the numeric criteria. The existence of the Project does have the potential to increase water temperatures during the summer due to the effects of the Reservoir on total water surface area and increased travel time of water moving through the Reservoir. Spill operations at the Project can increase TDG levels in the Columbia River below the Project.

Chelan PUD has conducted water quality surveys within Rocky Reach Hydroelectric Project reservoir targeting specific water quality concerns; some of these studies include annual monitoring over multiple years. In coordination with the US Army Corps of Engineers, Chelan PUD has monitored water temperature at the fishway since 1965 and TDG in the forebay since 1982. More intensive monitoring of temperature and TDG was initiated in 1996. The monitoring data sets consist of daily temperature only (1965 - 1981), hourly temperature and TDG in the forebay (April - August, 1982 - present), and hourly TDG and temperature below the tailrace of the Rocky Reach Hydroelectric Project dam (April – August, 1997 - present). TDG monitoring with improved equipment and calibration procedures during the spring and summer seasons was initiated in 1995 for the forebay and 1997 for the tailrace (McDonald and Priest, 1997; Koehler and McDonald, 1997, 1998).

Douglas PUD has conducted comparable studies at Wells Hydroelectric Project dam, which are the headwaters to the Rocky Reach Hydroelectric Project reservoir. Transparency data are available for both the Rocky Reach Hydroelectric Project dam forebay and the Wells Hydroelectric Project dam forebay (1993 – present) from secchi disk readings from the fishways.

The Rocky Reach Project generally has no adverse effect on the objectives and narrative requirements of the water quality standards. The Project and the Reservoir maintain the water quality, habitat and accessibility necessary to support all the existing beneficial and designated uses included in the standards (WAC 173-201A). These uses include primary contact recreation; aesthetic enjoyment; sports fishing; boating; water supply for domestic, industrial, and agricultural uses; and fish and wildlife habitat, including habitat for spawning, rearing and migration of cold –water salmonid species. The Reservoir has clean, clear water with high water transparency, very low fecal coliform content, and high DO concentrations.

SECTION 2: PROJECT DESCRIPTION

According to the 401 Certification, monitoring, assessment, and reporting are required. Each will be discussed in this QAPP.

The goal of the QAPP is to determine compliance with Washington's numeric water quality criteria (WAC 173-201A). This QAPP was prepared to guide Chelan PUD in this effort. If criteria are not being met, subsequent goals may include identifying any impacts due to ongoing Project operations on the regulated parameters; and determining and implementing any reasonable and feasible solutions to exceedances.

The following are the monitoring requirements of the Rocky Reach 401 Certification. Chelan PUD must:

- Maintain two fixed monitoring stations at Rocky Reach Dam to monitor TDG levels annually from April through August, one in the forebay and one in the tailrace for the term of the New License;
- Monitor hourly water temperatures in the forebay and tailrace annually from April through October for the term of the New License;
- Monitor water temperatures in the juvenile fish bypass system and upstream fishway for one year;
- Monitor DO, temperature, and pH in shallow water habitats, including macrophyte beds, in the Reservoir for one year; and
- Prepare and implement a study of Gas Bubble Trauma.

The reporting of these data includes submitting:

- In year 5 of the effective date of the New License, a report summarizing the results of all TDG studies performed to date, and describing whether compliance with numeric criteria has been attained;
- A Gas Abatement Plan to Ecology for review and approval by April of the year of implementation;
- An annual report to Ecology in an approved format that includes the results of the TDG monitoring, including forebay monitoring data reported by the Rock Island Project, the use of any gas abatement measures, spill levels, and biological effects of GBT;
- Hourly TDG information to the public via Chelan PUD's website, as close to the time of occurrence as technologically feasible;
- An annual report to Ecology in an approved format that includes a data assessment of compliance with state water quality criteria, summaries of the data, and a list of any water quality exceedances; and
- Immediate reports to Ecology's Spills Response Program of any spills into state waters, spills onto land where contaminants could potentially drain into state waters, or cause fish kills or any other significant water quality problems.

SECTION 3: ORGANIZATION AND SCHEDULE

This section includes key personnel assigned to the project and an associated organizational chart, and time schedules for field operations, project deliverables, budgeting, and funding information.

3.1 KEY PERSONNEL

This project is to be conducted primarily by Chelan PUD personnel, with assistance as needed, to expedite the process, reduce costs, or improve quality (if needed). All personnel conducting work will have sufficient skills and experience to complete the necessary tasks at a high level of quality. This plan has been designed by Chelan PUD, and is anticipated to be conducted by the personnel outlined in Table 3-1:.

Table 3-1: Key Personnel

Personnel	Responsibility
Waikele Hampton	*Chelan PUD Environmental Permit Coordinator / Project Manager*. Lead responsible for project management, jointly responsible for report generation, data interpretation, field sampling methodology development, and sampling and monitoring.
Steven Hays	*Chelan PUD Fish and Wildlife Senior Advisor*. Jointly responsible for report generation and/or review, data interpretation, and field sampling methodology development. Senior technical review for all reports.
Michelle Smith	*Chelan PUD Licensing and Natural Resource Compliance Manager*. Responsible for QAPP and report review and approval, and funding approval.
Rosana Sokolowski	*Chelan PUD Licensing & Compliance Coordinator*. Responsible for administrative support of QAPP, sampling, data entry, and reporting.
Debby Bitterman	*Chelan PUD Administrative Assistant.* Responsible for administrative support of QAPP.
Charlie McKinney	*Ecology WQ Section Manager, Central Regional Office (CRO).* Oversees Ecology participation regarding 401 certification and Settlement Agreement.
Jon Merz	*Ecology Watershed Unit Supervisor, CRO.* Provides Ecology staff to assist PUD in compliance with 401 Certification and Settlement Agreement. Reviews Ecology work documents.
Patricia Irle	*Ecology Hydropower Projects Manager, CRO.* Lead responsible for tracking compliance with terms of 401 Certification and Settlement Agreement. Includes review of reports and the QAPP and assistance in meeting other requirements as defined in the 401 certification and Settlement Agreement.
To be determined (may be contracted out)	*Field sampler.* Responsible for field activities (including equipment maintenance), documentation and health and safety during field operations. Jointly responsible for report generation as needed.
Kris Pomianek	*Community Outreach Advisor.* Responsible for website creation and maintenance.
Jeff Mettler	*Power Management, P.I. Interface person.* Responsible for providing assistance with data management and recovery.
Ron Franklin	*Health and Safety Officer*. Responsible for overall aspects of health and safety for the QAPP project work.

3.2 SCHEDULE

The schedules below will be closely managed to ensure that no deadlines are missed, or parameter reporting requirements overlooked, unless a Force Majeure event arises, as provided in the Rocky Reach Settlement Agreement.

3.2.1 Monitoring Schedule

The schedule that will be followed has been developed from the requirements stated in the 401 Certification.

Table 3-2: Monitoring Schedule

Parameter	Monitoring Schedule	Comments
TDG	Annually Hourly April-August	Monitors located in the forebay and tailrace of Rocky Reach and in the forebay of Rock Island.
Spill as a surrogate for TDG	Hourly (This will be necessary only during spill events outside of the fish spill season.)	Data collected during the fish spill season will be used to further refine the linear regression developed by Schneider and Wilhelms (2005)
Temperature	Annually, Hourly April - October	Forebay and tailrace
Temperature	Hourly for one year	Juvenile bypass and upstream fishway
Macrophyte beds (temp, DO, pH)	Frequency is TBD; one-year study	This study will be conducted at a later date (likely in 2011)[1]
GBT	TBD	This study will be conducted at a later date (no sooner than 2011)

[1] ***Chelan PUD plans to coordinate this study with the resident fish study (see Chapter 6 of the Settlement Agreement), which is tentatively scheduled to commence in 2011. This will allow for a side-by-side look at macrophyte bed water quality conditions and fish presence/use.***

3.2.2 Reporting Schedule

The 401 Certification provides detailed reporting requirements for water quality monitoring activities conducted by Chelan PUD, including those activities covered under this QAPP. Per Section 5.7(8) of the 401 Certification, data collected under this QAPP will be reported to Ecology on an annual basis by March 1 of each year. The annual report generally will include the results of all sampling and measurement procedures, conclusions (e.g., compliance with standards), and recommendations for further action (e.g., additional sampling), if necessary.

Additionally, per Section 5.4(4) of the 401 Certification, the TDG data collected during the fish-spill season will be included in a TDG monitoring report (the annual Gas Abatement Report). To monitor compliance with the TDG numeric criteria, Chelan PUD shall report the results of the TDG monitoring, including forebay monitoring data reported by the Rock Island Project, the use of any gas abatement measures, and spill levels. The annual reports will also include the biological effects of GBT (as measured at Rock Island Dam). This report will be submitted to Ecology by December 31 of each year and will be appended to the March 1 submittal to Ecology discussed above.

Analysis of compliance with the 110% TDG standard (non-fish-spill season) will be addressed in the March 1 submittal.

Chelan PUD will report exceedances of the water quality criteria within 48 hours to Ecology's CRO. Note that it may not be possible to provide temperature exceedances that are based on shifts in the temperature from natural because modeling is required to determine this type of exceedance.

3.3 BUDGET AND FUNDING

A preliminary budget has been developed to aid in planning for this work. For the sake of the initial budget, it is assumed that the forebay and tailrace temperature and TDG data will be collected real-time and the remainder of the temperature data will be logged and downloaded monthly or quarterly.
Chelan PUD will fund the monitoring and reporting described herein. These funds will be made available internally earmarked well in advance of the initiation of the monitoring (likely a minimum of two years prior) to ensure sufficient funding is provided.

SECTION 4: DATA QUALITY OBJECTIVES (DQO)

The primary objective for collecting data is to track compliance with water quality standards. The purpose of the QAPP is to identify the methods and standards used to make that determination/decision. Data quality objectives (DQOs) are statistical statements of the level of uncertainty that a decision-maker is willing to accept in results derived from environmental data. They describe what data are needed, and how the data will be used to address the concerns being investigated. The DQOs also establish numeric limits that ensure the data collected are of sufficient quality and quantity for data user applications.

The overall DQO is to ensure that data of known and acceptable quality are provided. Proper execution of each task will yield consistent results that are representative of the media and conditions measured. All data will be calculated and reported in conventional units to allow comparability of the data. There are two types of DQOs, including decision quality objectives and measurement quality objectives (MQOs).

The acquired data will be used to characterize the water quality of the Rocky Reach Reservoir and tailrace. Decision quality objectives to obtain this information are to:

- Generate scientific data of sufficient quality to withstand scientific and legal scrutiny.
- Gather and develop data in accordance with procedures appropriate for its intended use.
- Conduct all methods/procedures specified for this project in compliance with Ecology requirements for environmental investigations.

To ensure that the MQOs of the monitoring effort are within the limits of the work, specific criteria for data parameters have been established as appropriate.

4.1 DECISION QUALITY OBJECTIVES

For this effort, the data collection must be designed in such a manner that the results can be used to determine if the water quality criteria have been met; therefore, quality objectives at the level of the decision are required. These objectives will be met by carefully determining the number of measurements taken to represent a given condition. The Sampling Process Design (Section 5.0) addresses the requirements of the decision quality objectives.

The success of obtaining these objectives can be measured by ensuring that the representativeness, completeness and comparability are controlled. Each is described below.

4.1.1 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. For this investigation, representativeness is a qualitative parameter that is primarily concerned with proper design of the sampling program, and can be best satisfied by ensuring that the monitoring locations are properly located with a sufficient number of data collected.

4.1.2 Comparability

The comparability criterion is a qualitative characteristic that expresses the confidence with which one data set can be compared to another. Principal comparability issues are field sampling techniques, and standardized concentration units and reporting formats. Data comparability is achieved using standard

field sampling techniques and measuring methods; however, comparability is limited by the other MQOs because only when precision and bias (accuracy) are known can data sets be compared with confidence.

4.1.3 Completeness

Completeness is defined as the percentage of valid analytical determinations compared to the total number of determinations. A reasonable completeness goal is 90 percent. Typical field or electronics problems may result in completeness of less than 100 percent. Completeness will be evaluated and documented throughout all monitoring, and corrective actions taken as warranted on a case-by-case basis.

4.2 MEASUREMENT QUALITY OBJECTIVES (MQOS)

The term "data quality" refers to the level of uncertainty associated with a particular data set. Data quality associated with environmental measurement is a function of the sampling plan rationale and procedures used to collect the samples, as well as the monitoring methods and instrumentation used in making the measurements. Uncertainty cannot be eliminated entirely from environmental data. However, quality assurance (QA) programs effective in measuring uncertainty in data are employed to monitor and control deviation from the desired DQOs. Sources of uncertainty that can be traced to the sampling component are poor sampling plan design, incorrect sample handling, faulty sample transportation (if applicable), and inconsistent use of standard operating procedures (SOPs). The most common sources of uncertainty that can be traced to the analytical component of the total measurement system are calibration and contamination (i.e. equipment not "resetting" or fully equilibrating in a new sampling location).

One of the primary goals of this QAPP is to ensure that the data collected are of known and documented quality and useful for the purposes for which they are intended. The procedures described are designed to obtain data quality indicators for each field procedure and analytical method. To ensure that quality data continues to be produced, systematic checks must show that test results and field procedures remain reproducible, and that the methodology employed is actually measuring the parameters in an acceptable manner.

For the field measurements to be conducted under this QAPP (temperature and TDG) MQOs can be specified. Each of the MQOs that pertain to this QAPP is further discussed below. The goals for this effort are outlined in Table 4-1:**.**

Table 4-1: MQOs

Parameter	Smallest Reference Level for Decision Making	Range of Instrument	Precision (Duplicate Samples)	Bias/ Accuracy	Sensitivity/ Resolution
Temperature	0.3°C	-5 to 50°C	20% RPD or ±0.05 units, whichever is least	± 0.1°C	0.01°C
TDG	1% saturation	400 – 1,300 mmHg	N/A	±0.1 % of span	1 mmHg

RPD = relative percent difference
TDG = total dissolved gas
mmHg = millimeters of mercury

4.2.1 Precision

Precision is a measure of the reproducibility of an analysis or set of analyses under a given set of conditions, and generally refers to the distribution of a set of reported values about the mean. The overall precision of a sampling event has both a sampling and an analytical component. The precision provides transparency into presence of random error such as field sampling procedures, handling, and data collection/analysis method. A reduction of precision could be introduced to this work in several ways including using equipment that is not sensitive enough (see Sensitivity below), collecting measurements over a large spatial or temporal regime, using a wide range of types of equipment, etc. A means of determining the precision of a measurement is to conduct duplicate sampling (e.g. making the same measurement in the same location at approximately the same time with the same type of equipment) and looking at the variability in results.

4.2.2 Bias

Bias (otherwise known as accuracy) is the difference between the population mean and the true value of the parameter being measured. Bias in measurements obtained under this QAPP may be introduced by faults in the sampling design (e.g. all of the temperature measurements collected in one location that is not indicative of the mixed flow or strata of interest), inability to measure all forms of the parameter of interest (e.g. inability of a thermometer to reach a temperature regime needed due to physical obstacles), improper or insufficient calibration of instrumentation and/or equipment. Bias will be minimized by following standard protocols for calibration and maintenance, and by following field protocols for stabilization of meter readings.

4.2.3 Sensitivity

Sensitivity denotes the rate at which the analytical response varies with the concentration of the parameter being measured, or the lowest concentration of a parameter that can be detected (often referred to as "resolution" for water quality equipment). For this work, equipment must be selected that provides tight enough tolerances to ensure that the data collected are described to the necessary precision. For example, if water criterion for temperature is concerned with a temperature shift of greater than 0.3 degrees Celsius, then the equipment should be able to measure the water temperature with sensitivity less than 0.3 degrees Celsius, preferably by an order of magnitude. Often, the accuracy is much larger than the resolution. If this is the case, the accuracy is the smallest verifiable value reported by the instrument.

SECTION 5: SAMPLING PROCESS DESIGN

The sampling process design includes the parameters of interest, the measurement location and the frequency of monitoring. The goal of the sampling process design is to ensure that the quality objectives for this effort can be met. The 401 Certification has outlined the requirements for the parameters, frequency, basic location, and schedule of sampling (see Table 5-1).

Table 5-1: Monitoring Parameters, Locations, Frequency, and Criteria

Parameter	Location(s)	Frequency	Metric	Standards
Temperature	Rocky Reach Forebay and Tailrace Rock Island Forebay	Hourly, April-October	degrees Celsius	17.5[1]
Temperature	Juvenile Fish Bypass, Adult Fishway	Hourly for one year	degrees Celsius	17.5[1]
TDG	Rocky Reach Forebay and Tailrace Rock Island Forebay	Hourly, April-August	% Saturation	120% in tailrace 115% of forebay (as per special fish passage criteria) 110% during outside of fish spill season

[1] When a water body's temperature is warmer than the criteria (or within 0.3°C (0.54°F) of the criteria) and that condition 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 (0.54°F).
When the background condition of the water is cooler than the criteria, the allowable rate of warming up to, but not exceeding, the numeric criteria from human actions is restricted as follows:
(A) Incremental temperature increases resulting from individual point source activities must not, at any time, exceed 28/(T+7) as measured at the edge of a mixing zone boundary (where "T" represents the background temperature as measured at a point or points unaffected by the discharge and representative of the highest ambient water temperature in the vicinity of the discharge); and
(B) Incremental temperature increases resulting from the combined effect of all nonpoint source activities in the water body must not, at any time, exceed 2.8°C (5.04°F).

5.1 MONITORING LOCATION AND DEPTH

The general locations for measurements have been identified in the 401 Certification and are more specifically define below. These locations are included in Table 5-1.

5.1.1 Forebay and Tailrace TDG and Temperature

Annual hourly TDG and temperature data will be measured at Chelan PUD's existing fixed monitoring stations, located in the forebay and tailrace of the Project, as well as in the forebay of the Rock Island Project. The fixed monitoring stations are installed to a depth of approximately 15 feet. This depth varies as the forebay and tailrace river elevations fluctuate with river flows. This depth variation is not expected to affect the accuracy of either the TDG or temperature readings because the instruments are located below the depth where gas bubbles form on the membrane and are deep enough in the water column to not be affected by near surface temperature gradients.

The Rocky Reach forebay fixed monitoring station is located on the upstream side of the dam, affixed to the corner between the powerhouse and spillway, approximately mid-channel. The tailrace fixed monitoring station is located approximately 0.38 mile downstream of the dam. The standpipe is affixed to the downstream side of a pier nose supporting the juvenile bypass system outfall pipe. This location is

east of mid-channel, and is minimally impacted by powerhouse flows when the project is passing water over the spillway (Schneider and Wilhelms, 2005). See Figure 5-1:.

The Rock Island forebay fixed monitoring station is affixed to the project, located on the west side of the river, near the right bank fishway and Powerhouse 2 (Figure 5-2:). The standpipe is installed to a depth of approximately 15 feet, though this depth varies as the forebay river elevation fluctuates with river flows and project operations.

Figure 5-1: Locations of the Forebay and Tailrace Fixed Monitoring Stations at Rocky Reach.

Figure 5-2: Location of the Rock Island Forebay Fixed Monitoring Station.

5.1.2 Juvenile Bypass System Temperature

Downloadable data loggers will be deployed in the juvenile bypass system where gatewell water enters the system and at the juvenile sampling facility. Chelan PUD has not yet determined precisely how these instruments will be mounted in the bypass system, but it is likely they will be bolted to the structure at depths that will remain under water for the duration of the study. Method of mounting the loggers will be provided to Ecology after installation.

A data logger previously deployed in the entrance to the system will also be used to monitor temperature data in the juvenile fish bypass system.

5.1.3 Upstream Fishway Temperature

Downloadable data loggers will be deployed in two locations of the upstream fishway. Two loggers will be installed at the exit of the fishway, at depths of 703' elevation and near the bottom of the exit to collect data from both shallow and deep portions of the water column. A third logger will be installed near the bottom of the ladder section above where pumped attraction water from the tailrace enters the fishway. Chelan PUD has not yet determined precisely how these instruments will be mounted in the fishway, but again, it is likely they will be bolted to the structure at depths that will remain under water for the duration of the study. Method of mounting the loggers will be provided to Ecology after installation.

SECTION 6: MONITORING PROCEDURES

The following sections present the monitoring procedures that will be used to implement the requirements of the 401 Certification.

6.1 FREQUENCY

Table 5-1 provides the frequency that each water quality parameter will be measured. These frequencies follow the requirements of the 401 Certification, which provide that forebay and tailrace TDG and temperature be monitored on an hourly basis, April to August and April to October, respectively. Hourly temperature monitoring in the juvenile bypass system and upstream fishway will be initiated upon approval of this QAPP and will be conducted for one year, unless Ecology determines, in consultation with the Rocky Reach Fish Forum, that additional monitoring is necessary.

6.2 EQUIPMENT

Forebay and tailrace temperature and TDG data will be collected using instruments that can immediately transmit the data to Chelan PUD headquarters, allowing for real-time data recording. The fishway and juvenile fish bypass temperature data will be collected using a logging device that can be downloaded on a monthly or quarterly basis.

All temperature monitoring equipment will be of sufficient quality to meet the MQOs (Table 4-1:). The monitoring equipment will be Hydrolab's DataSondes or MiniSondes, or Hobo Water Temperature Pro Data Logger, or equivalent. Specifications for all types of equipment described herein are provided in Appendix A. Any of these types of monitoring equipment are referred to as merely equipment in the following discussion.

TDG will be measured using Hydrolab DataSondes or MiniSondes, which use a pressure transducer mounted behind a rigid gas-permeable silicone membrane to measure amount of total dissolved gaseous compounds dissolved in a liquid. The measurement quality objectives, range, precision, accuracy, and resolution of the TDG sensor are provided in Table 4.1. (See Appendix A for Equipment Specifications). TDG will be measured in mmHg and then converted to percent saturation using barometric pressure measurements recorded by a certified barometer located at the project. The conversion equation is as follows:

TDG in percent saturation = (TDG mmHg/barometric pressured mmHg) x 100

To the extent possible, sampling methods will follow protocol established by Hydrolab (or alternative manufacturer), the most current version of the Ecology Field Sampling and Measurements Protocols for the Watershed Assessment Section (Ecology, 1993), and this QAPP.

SECTION 7: QUALITY CONTROL

Field sampling and measurement protocols will follow those described in the Watershed Assessment Section (WAS) protocol manual (Ecology, 1993). Prior to deployment, instruments will be calibrated in a lab and the calibration verified by side-by-side readings. Specific quality control for each parameter measurement is described as follows.

7.1 TEMPERATURE QUALITY CONTROL

For all field-deployed equipment, a pre-and post-calibrated protocol will be conducted in accordance with the manufacturer's recommendations to document instrument bias and performance at representative temperatures. The accuracy of the field thermometers (data loggers and real-time equipment) will be maintained by a two-point comparison between the field equipment and a certified reference thermometer. This comparison will be made prior to and after logger deployment, and at a minimum of annually for real-time equipment. The certified reference thermometer to be used will have a National Institute of Standards and Technology (NIST) Traceable certification. If the mean difference between the NIST-certified thermometer and the field equipment differs by more than the manufacturer's reported specifications during the pre-study calibration, then the thermometer of interest (Sonde or logger) will not be deployed.

Additionally, each month or quarter when the data are downloaded from the loggers Chelan PUD staff will inspect the equipment to ensure it has not been damaged, has sufficient battery power (with the exception of equipment that does not show battery life, which will be replaced prior to expected battery failure), shows no signs of biofouling, and is generally in good condition. It will be cleaned as needed and replaced if damaged. The real-time equipment will be inspected and maintained in accordance with the manufacturer's recommendations.

7.2 TDG QUALITY CONTROL

Calibration and maintenance of the individual sensors of the Hydrolab® multi-probes will continue to follow the manufactures recommendations and regionally accepted methods used by other resource agencies conducting similar monitoring programs, such as the USGS, U.S. Army Corps of Engineers, and other mid-Columbia River Dam operators. The general calibration, maintenance, and deployment methods for the multi-probes also follow regionally accepted methods.

SECTION 8: DATA MANAGEMENT PROCEDURES

Data management will vary depending on whether it is transmitted in real-time or logged and downloaded periodically. The data that are collected in real-time will be automated to be transmitted directly into Chelan PUD's P.I. system as they are collected. This data management system is used on a regular basis across the Chelan PUD to manage power, flows, temperatures and many other parameters. Data that are logged and downloaded monthly or quarterly will be manually added to the P.I. system for consistent ease of availability and safe, archived keeping.

The reported data are anticipated to include the location of collection, the time of collection (by the interval determined if real-time), hourly data (averaged over the hour if more than one reading is collected per hour), and the date of collection.

SECTION 9: ADAPTIVE MANAGEMENT

The 401 Certification incorporates by reference Adaptive Management as defined in the Settlement Agreement. Additionally, conditions within the 401 Certification set forth Adaptive Management processes and measures to achieve full compliance with standards and constitute a water quality attainment plan under WAC 173-201A-510(5). Under Adaptive Management, it may be necessary to revise/modify sampling procedures/locations, as necessary to ensure quality data collection.

SECTION 10: AUDITS AND REPORTS

A process is needed to ensure that the QAPP is implemented correctly, that the quality of the data is acceptable, and that corrective actions are implemented in a timely manner.

10.1 AUDITS

In order to assure that the proper measurement procedures are taking place and to determine if changes in the procedures are needed, two forms of audits will be conducted: field audits and reporting audits, each of which is discussed below.

10.1.1 Field Audits

Once per year the project manager will accompany or oversee Chelan PUD water quality field staff (or contractor) in the field to monitor and audit all field activities including calibrations, maintenance, and multi-probe deployment methods, and safety activities. The auditor will focus on ensuring that all SOPs are followed, calibrations are conducted in compliance with manufacturers' specifications when applicable, and this QAPP is followed. The auditor will provide a brief write up of their observations including any deviations from QAPP and whether it should be changed or the process in the field needs to be addressed. The project manager will be responsible for ensuring that, if needed, any corrective actions meet Ecology and FERC approval, and that each corrective action is implemented. A subsequent audit may be required to ensure that the change has been successfully implemented.

10.1.2 Reporting Audits

It is the responsibility of the Chelan PUD to ensure that all of the reporting requirements of the 401 Certification have been met. The project manager and Licensing and Compliance Coordinator will be responsible for keeping track of the mandated reporting and confirming that it has been met. Specifically, the project manager will access the website monthly or quarterly, as appropriate, to check that the necessary data are present, legible and correct. Additionally, the project manager will review the annual reports to make sure that the data presented are accurate, and verifiable (see Section 12). Any deviations from requirements will be rectified and Ecology will be notified of the deviation and corrective action.

10.2 REPORTS

Reporting will be conducted in a variety of ways, which will depend primarily on the frequency of monitoring.

10.2.1 Periodic Updates

Data collected will be evaluated and flagged to indicate any water quality exceedances and measures taken by the Chelan PUD to address the exceedances. The Chelan PUD will report exceedances of the water quality criteria within 48 hours to the Ecology CRO.

10.2.2 Annual Reports

The 401 Certification provides detailed reporting requirements for water quality monitoring activities conducted by Chelan PUD, including those activities covered under this QAPP. Per Section 5.7(8) of the 401 Certification, data collected under this QAPP will be reported to Ecology on an annual basis by March 1 of each year. The annual report generally will include the results of all sampling and

measurement procedures, conclusions (e.g., compliance with standards), and recommendations for further action (e.g., additional sampling), if necessary.

Additionally, per Section 5.4(4) of the 401 Certification, the TDG data collected during the fish-spill season will be included in a TDG monitoring report (the annual Gas Abatement Report). To monitor compliance with the TDG numeric criteria, Chelan PUD shall report the results of the TDG monitoring, including forebay monitoring data reported by the Rock Island Project, the use of any gas abatement measures, and spill levels. The annual reports will also include the biological effects of GBT (as measured at Rock Island Dam). Presentation of the TDG monitoring results in the annual report should include the following:

- Flow during the preceding year (cfs over time);
- Spill during the preceding year (cfs and duration);
- Reasons for spill;
- TDG levels during spill (hourly);
- Summary of exceedances and what was done to correct the exceedances;
- Results of the fish passage efficiency (FPE) studies and survival per the HCP; and
- Analysis of monitoring data for confirmation or refinement of the regression equations in the WQMP used to predict compliance with TDG standards.

This report will be submitted to Ecology by December 31 of each year and will be appended to the March 1 submittal to Ecology discussed above.

Analysis of compliance with the 110% TDG standard (non-fish-spill season) will be addressed in the March 1 submittal.

SECTION 11: DATA REVIEW, VERIFICATION, AND QUALITY ASSESSMENT

Data will be downloaded from the meters or the P.I. system to a spreadsheet and reviewed for outliers and values not conforming to the MQOs. If the objectives have not been met, the project manager will decide how to qualify the data and how the data should be used in the analysis or whether the data should be rejected. As appropriate, the project manager will assign additional data qualifiers where necessary or reject data from further use. Data that is rejected from further use will be recorded in a deleted data database with a description of why the data was rejected, as well as any adjustments needed to correct the reason for the data rejection. These deleted data will then be presented in the annual water quality monitoring report under the QA/QC sections.

Data completeness will be adequate if monitoring is completed with data meeting the MQOs at least 85 percent of the time. A lower rate of data completeness may be acceptable, which will be determined in an overall review of data. All data meeting MQOs will be used.

The results analyses will be evaluated for compliance with acceptance criteria. This evaluation will include collection of temperature data for subsequent modeling, and a statistical evaluation of other data to the numeric criteria. It is anticipated that the average and variance of all data will be assessed to determine the frequency that any numeric water quality criteria have been exceeded, if any. Once the data have been reviewed, verified, and validated, the project manager will determine if the data are of usable quality to make decisions for which the study was designed.

SECTION 12: REFERENCES

APHA, AWWA, and WEF, 1995. Standard Methods for the Examination of Water and Wastewater, Nineteenth Edition. American Public Health Association, American Water Works Association, and Water Environment Federation. Washington, D.C.

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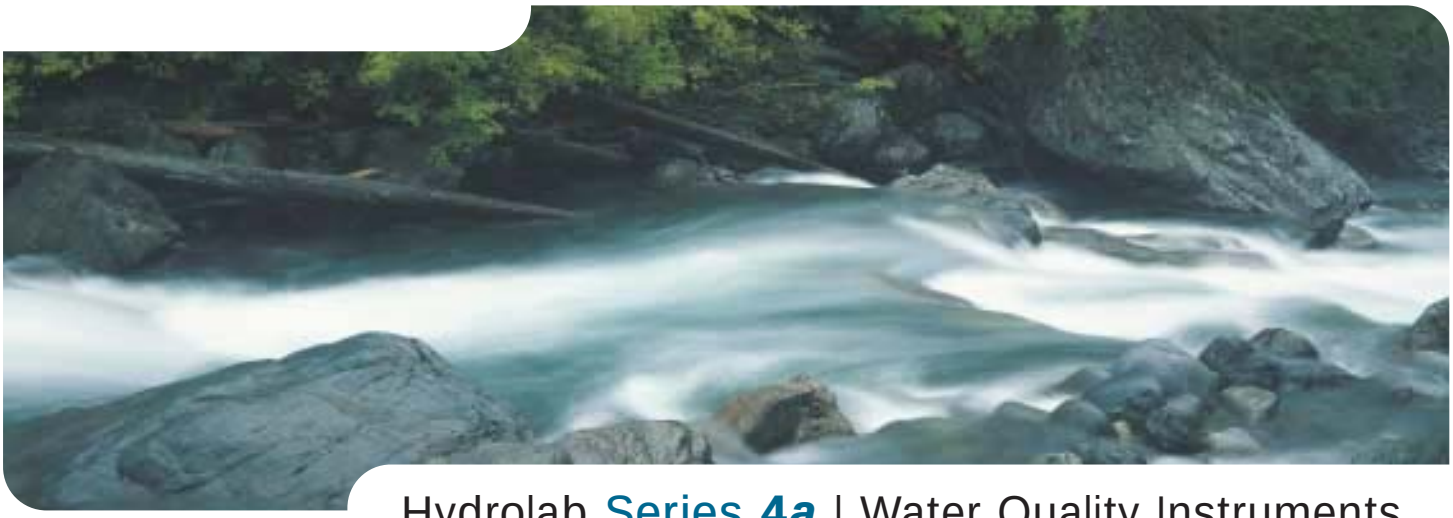
APPENDIX A: SPECIFICATIONS FOR PROPOSED EQUIPMENT

HYDROLAB®
A HACH COMPANY BRAND

THE WORLD LEADER IN MULTI-PARAMETER WATER QUALITY MONITORING INSTRUMENTATION

> Superior sensor technology > Unsurpassed reliability > Best warranty in the industry

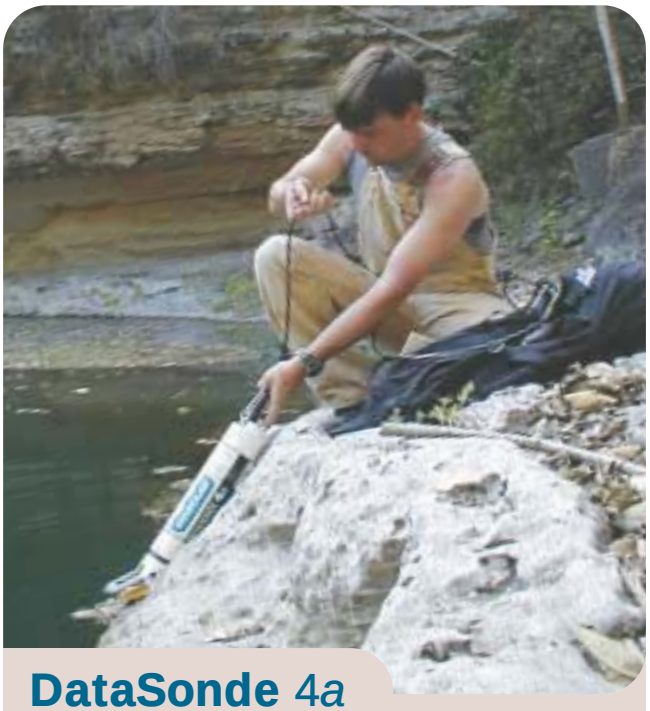


Hydrolab Series ***4a*** | Water Quality Instruments

Helping you preserve the world's water

Hydrolab Series **4a** | Water Quality Instruments

> *For over 40 years Hydrolab has been known for manufacturing reliable water quality instruments.*
> *The Series 4a continues that tradition with several enhancements that provide you with even greater value.*
> *Now, as part of Hach Company, you can expect continuous innovation from Hydrolab, now and into the future!*



DataSonde 4a

- Seven built-in expansion ports
- Designed for in-situ and flow-through applications
- Measures up to 15 parameters
- Excellent long-term deployment capability

*Both the **DataSonde 4a** and the **MiniSonde 4a** are well suited for profiling and spot-checking applications, and are available with battery packs and memory to use for long-term monitoring. Data can be downloaded to the **Surveyor 4a** or a PC.*

MiniSonde 4a

- Four built-in expansion ports
- 1.75" diameter housing – ideal for ground water monitoring, portability, and limited space environments
- Measures up to 10 parameters

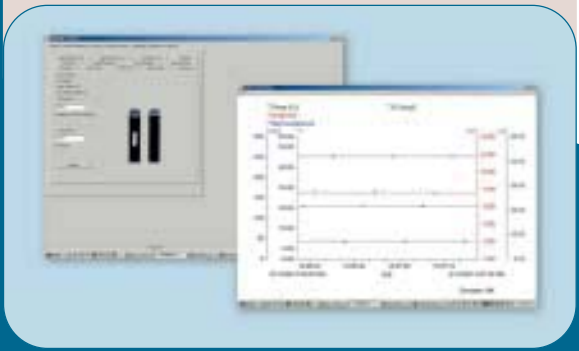
Series **4a** water quality instruments provide the best long-term value: > Easy to use and maintain

Surveyor 4a

- Rugged, waterproof (NEMA 6) case with hand strap
- Displays parameters in real-time or stores data automatically (up to 375,000 measurements)
- Data presented in real-time graphical form or tabular format
- Optional GPS and barometric pressure

Hydras3 LT

- Easy-to-use GUI
- Real-time multiparameter time series graphs *and* vertical profiling
- Simple calibration of any parameter
- Set-up data logging runs in a snap
- One click download for field data collection
- Simultaneous, multiple probe download capability
- Available for free download at www.hydrolab.com



*Superior **Sensor** Technology*

At the heart of the Series 4a instruments is Hydrolab's superior sensor technology. Advanced design and sensor technology make these instruments the most reliable in the field. The Series 4a features watertight sensors based on superior technology to produce instruments that are longer lasting, more reliable, less expensive, and easier to maintain. This means lower operating costs in the long run, and better value for you.

*The **DataSonde 4a** and **MiniSonde 4a** system, proven during years of field testing, provides the following advantages:*

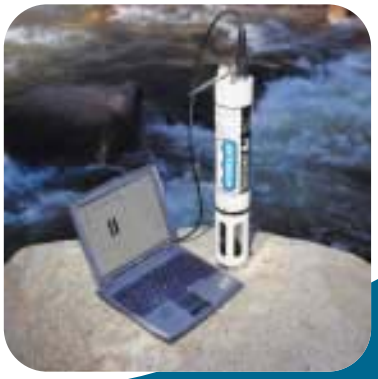
- *Sensor connection is protected from the environment*
- *Fewer components for smoother, glitch-free operation*
- *Sensors cannot become loose or trap water or debris*

> Superior sensor technology > Unsurpassed reliability > Guaranteed after-sale support

Hydrolab Series **4*a***

Engineered for dependable performance and durability in the field, Series 4*a* water quality instruments by Hydrolab can measure up to 15 parameters at once. These rugged instruments offer the highest long-term value, providing you years of reliable water quality data.

The three components of Hydrolab's Series 4*a* product line are the DataSonde 4*a*, MiniSonde 4*a* and Surveyor 4*a*. These instruments come with a two-year warranty – the best you'll find in the industry.



- > Configured to fit your specific need
- > Profiling or long-term deployment
- > Surface or ground water
- > Remote or attended monitoring

Hydrolab Series 4*a*: DataSonde 4*a* | MiniSonde 4*a* | Surveyor 4*a*

- Temperature
- Conductivity
- Dissolved Oxygen
- Rebuildable pH
- ORP
- 4-Beam Turbidity
- Self-Cleaning Turbidity
- Level & Depth
- Chlorophyll a
- Blue-Green Algae
- Rhodamine WT
- Li-Cor® Ambient Light
- Ammonium/Ammonia
- Nitrate
- Chloride
- GPS
- Barometric Pressure
- Transmissivity
- Total Dissolved Gas

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TYPICAL PERFORMANCE SPECIFICATIONS

	RANGE	ACCURACY	RESOLUTION	AVAILABLE INSTRUMENT *
Temperature	-5 to 50° C	±0.10° C	0.01° C	D, M
Specific Conductance	0 to 100 mS/cm	±1% of reading; ±0.001 mS/cm	4 digits	D, M
pH	0 to 14 units	±0.2 units	0.01 units	D, M
Dissolved Oxygen	0 to 50 mg/L	±0.2 mg/L at ≤ 20 mg/L ±0.6 mg/L at > 20 mg/L	0.01 mg/L	D, M
ORP	-999 to 999 mV	±20 mV	1 mV	D, M
Depth Vented Level	0 to 10 m	±0.003 m	0.001 m	D, M
0-25 m	0 to 25 m	±0.05 m	0.01 m	D, M
0-100 m	0 to 100 m	±0.05 m	0.01 m	D, M
0-200 m	0 to 200 m	±0.1 m	0.1 m	D, M
Salinity	0 to 70 ppt	±0.2 ppt	0.01 ppt	D, M
4-Beam Turbidity	0 to 1000 NTU	±5% of reading; ±1 NTU	0.1 NTU (<100 NTU) 1 NTU (≥100 NTU)	D
Self-Cleaning Turbidity	0 to 3000 NTU	±1%, up to 100 NTU ±3%, 100-400 NTU ±5%, 400-3000 NTU	0.1, up to 400 NTU 1.0, 400-3000 NTU	D, M
Ammonium/Ammonia	0 to 100 mg/L-N	Greater of ±5% of reading or ±2 mg/L-N (typical)	0.01 mg/L-N	D, M
Nitrate	0 to 100 mg/L-N	Greater of ±5% of reading or ±2 mg/L-N (typical)	0.01 mg/L-N	D, M
Chloride	0.5 to 18,000 mg/L	Greater of ±5% of reading or ±2 mg/L (typical)	4 digits	D, M
Total Dissolved Gas	400 to 1300 mmHg	±0.1% of span	1.0 mmHg	D, M
Ambient Light	0 to 10,000 µmol $s^{-1}m^{-2}$	±5% of reading or ±1 µmol $s^{-1}m^{-2}$	1 µmol $s^{-1}m^{-2}$	D
Chlorophyll *a*	0 to 500 µg/L 0 to 50 µg/L 0 to 5 µg/L	±3% for signal level equivalents of 1ppb Rhodamine WT dye	0.01 µg/L	D, M
Rhodamine WT	0 to 1000 ppb 0 to 100 ppb 0 to 10 ppb	±3% for signal level equivalents of 1ppb Rhodamine WT dye	0.01 ppb	D, M
Blue-Green Algae	100 to 2,000,000 cells/mL 100 to 200,000 100 to 20,000	±3% for signal level equivalents of 1ppb Rhodamine WT dye	0.01 cells/mL	D, M
Barometric Pressure	500 to 850 mmHg	±10 mmHg	0.1 mmHg	S
Global Positioning System	-90 to 90° Latitude -18 to 180° Longitude	25 m CEP (50%) without SA and DGPS 2 m CEP (50%) with DGPS	0.1”	S

* D = DataSonde 4*a* M = MiniSonde 4*a* S = Surveyor 4*a*

INSTRUMENT SPECIFICATIONS

Computer Interface	RS-232, SDI-12
Memory	DataSonde 4*a* – 120,000 measurements MiniSonde 4*a* – 120,000 measurements Surveyor 4*a* – 375,000 measurements
Battery Supply	DataSonde 4*a* – 8 C batteries MiniSonde 4*a* – 8 AA batteries Surveyor 4*a* – rechargeable nickel metal hydride
Typical Battery Life (1-hour intervals)	DataSonde 4*a* – 313 days MiniSonde 4*a* – 114 days Surveyor 4*a* – 12-16 hours
Operating Temperature	-5 to 50° C
Maximum Depth	DataSonde 4*a* & MiniSonde 4*a* – 225 m
Size	DataSonde 4*a*: Outer diameter – 3.5”/8.9 cm; Length – 23”/58.4 cm; Weight – 7.4 lbs/3.35 kg MiniSonde 4*a*: Outer diameter – 1.75”/4.4 cm; Length – 21”/53.3 cm; Weight – 2.2 lbs/1.0 kg with extended battery pack: 29.5”/74.9 cm, Weight – 2.9 lbs/1.3 kg Surveyor 4*a*: 11x4x5”/27.9x10.2x3.8 cm, Weight – 2 lbs/0.9 kg

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BENEFITS & SPECIFICATIONS

- Uses a pH glass sensor
- Both feature a single refillable, flowing junction reference electrode OR optional low ionic strength electrode
- Standard reference electrode is more reliable, lasts longer, is easily maintained, and refills in seconds
- Reference electrode is maintained and refilled independently of pH and/or ORP
- Two-year warranty

pH SENSOR

Range	0 to 14 pH units
Accuracy	±0.2 units
Resolution	0.01 units

ORP SENSOR

Range	-999 to 999 mV
Accuracy	±20 mV
Resolution	1 mV

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BENEFITS & SPECIFICATIONS

DISSOLVED OXYGEN SENSOR

- Uses field-proven Clark Cell technology
- Provides a continuous steady-state reading
- Low maintenance – no need to recondition the sensor
- Two-year warranty

Range	0 to 50 mg/L
Accuracy	±0.2 mg/L for 20 mg/L or less ±0.6 mg/L for over 20 mg/L
Resolution	0.01 mg/L

SPECIFIC CONDUCTANCE SENSOR

- Hydrolab uses the four graphite electrode cell methodology:
  - Increases sample exchange
  - Open cell design provides more reliable data
  - Reduces measurement error due to fouling and air bubbles (bubbles rise above the electrodes out of the way and debris and sediment fall below)
  - Easily maintained without damaging electrodes
  - Resists corrosion
- Also measures salinity, resistivity, and TDS
- Two-year warranty

Range	0 to 100 mS/cm
Accuracy	±1% of reading, ±0.001 mS/cm
Resolution	4 digits

SAMPLE CIRCULATOR

Only Hydrolab offers a sample circulator for more reliable readings. The DataSonde 4*a* and MiniSonde 4*a* integrated sample circulator facilitates fast, accurate, steady-state dissolved oxygen measurements. Other sensors receive similar benefits.

- Creates a flow of water past the sensors
- Provides “sufficient sample flow across membrane surface” in accordance with Standard Methods Article 4500-OG
- Reduces response time – important to detect moving contaminant plumes or movement within water column
- Reduces sensor fouling – sweeps away inert debris and biological growth
- Allows deployment in any environment, even in poorly mixed areas

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HOBO® Water Temp Pro

AWARD-WINNING TECHNOLOGY AE50 HOBO® WEATHER STATION HOBO® WATER TEMP PRO

Size/Weight: 11.4 x 3.0 cm (4.5" X 1.19") with 6.4 mm (0.25") hole in mounting bail
42 grams (1.5 oz)

$110

The durable HOBO Water Temp Pro has 12-bit resolution and a precision sensor for ±0.2°C accuracy over a wide temperature range. A temperature-compensated real time clock provides better than ± 1 minute per month time accuracy. Designed with a durable streamlined case for extended deployment in fresh or salt water up to 50°C, the Water Temp Pro is equipped with an infrared (IR) interface for data offload in the field, even when the logger is wet.

Key Specifications

Measurement Range: 0° to 50°C (32°F to 122°F) in water (nonfreezing); –20°C to 70°C (-4°F to 158°F) in air

Waterproof: To 120 m (400 ft)

Accuracy: ±0.2°C at 0 to 50°C (± 0.36°F at 32° to 122°F)

Resolution: 0.02°C at 25°C (0.04°F at 77°F)

Time accuracy: Better than ±1 minute per month

Capacity: 21,580 12-bit measurements

CE Compliant with all relevant directives in the European Union (EU)

Bp BoxCar®Pro-compatible

Features

Accurate:

12-bit resolution and precision sensor for ±0.2°C accuracy at 0° to 50°C (±0.36°F accuracy at 32°F to 122°F)
Includes a NIST-traceable accuracy certificate at room temperature
Real-time clock for better than ±1 minute per month time accuracy

Easy to Use:

High-speed infrared (IR) interface offloads full logger <30 seconds
Programmable start time/date
User-selectable sampling interval: 1 second to 9 hours
Uses popular BoxCar® Pro 4.3+ for system launch and data retrieval

Reliable:

Factory-replaceable battery lasts 6 years (typical); temperature extremes will reduce battery life
Battery level indication at launch
Offload data, check logger and battery status while logging using BoxCar Pro
Non-volatile EEPROM memory retains measurements even if battery fails
Blinking LED confirms operation with option to suppress signal during logging
UV-stable plastic for long-term immersion in fresh or salt water*
Rugged, streamlined case design withstands years of use in stream conditions
Rated for use up to 50°C in water, 70°C in air
The dark gray case blends in, minimizing chances of tampering
Optional protective boot for high water flow, flooding, or conditions with debris *(see pg. 38)*

Detailed Specifications

Response Time: 5 minutes in water, 12 minutes in air moving 2 m/sec, typical to 90%
Memory modes: Stop when full or Wrap-around when full
Data offload: Readout full logger in < 30 seconds while logging or when stopped
Buoyancy: +13 grams (0.5 oz) (fresh water at 25°C); +17 grams (0.6 oz) with optional boot
Battery : One 3.6 V Lithium, factory replaceable ONLY
Battery Life: 6 years typical, temperature extremes reduce battery life
Drop proof to 1.5 m (5')
Note: NIST-traceable certification at additional temperature points is also available through Onset at additional cost.

The HOBO Water Temp Pro received an AE50 award for product innovation from the American Society of Agricultural Engineer's Resource *magazine.*

** Not for prolonged exposure to chlorinated water.*

IR Basestation for HOBO® Water Temp Pro

Operating Range: 0° to 40°C (32° to 104°F) 0 to 95% RH
Size/Weight: 3.2 x 6.4 x 1.5 cm (1.3 x 2.5 x 0.6 in.); 54 g (2.0 oz)

$60

The Infrared (IR) Basestation is required for communications between the HOBO Water Temp Pro and the PC. Simply place the logger 4 to 5 inches away from an IR Basestation (connected to a PC) within the 30° angle of view to read out the Water Temp Pro. The IR Basestation requires a 9-pin serial port in the PC. For use with USB port, see USB-to-Serial Adapter (pg 43). The Water Temp Pro is not compatible with IR ports on PCs or laptops.

Note: The IR Basestation is not waterproof.

HOBO Water Temp Pro Ordering

Description	Part No.	Qty. 1-9	10-99	100+
HOBO Water Temp Pro	H20-001	$110	$102	$94
IR Basestation	BST-IR	$60	$56	$51
Protective boot—black	BOOT-BLK	$15	$14	$13
Protective boot—white	BOOT-WHT	$15	$14	$13
Factory replacement battery service		$35		
Replacement caps				
Cap for Water Temp Pro (without Boot)	85-CAPLUG-H20	$2		
Cap for Boot-BLK	85-CAPLUG-H20-B	$2		
Cap for Boot-WHT	85-CAPLUG-H20-W	$2		
Software				
BoxCar Pro 4.3 Starter Kit (Windows®)	BCP4.3-ON	$95	$88	$81

Note: A BoxCar Pro Starter Kit and IR Base Station are required to operate the HOBO Water Temp Pro. Each starter kit includes software, computer interface cable and software manual. See page 42 for software information. Use with USB port requires USB-Serial Adapter (pg 43) and BoxCar Pro 4.3+.

underwater

StowAway® TidbiT®

$119

Small size: approx.
3.0 x 4.1 x 1.7 cm thick
(1.2 x 1.6 x 0.65"); 23 gm (0.8 oz)

The StowAway TidbiT is Onset's smallest data logger and is widely used for monitoring temperatures in streams, lakes, oceans, and soils. Small size, rugged case and alarm indication also make this a popular choice for monitoring conditions in shipping applications.

Key Specifications

Ideal for underwater applications up to 30° C

StowAway TidbiT: Model TBI32-05+37

Range†: -4° to 37°C (24° to 99°F)
Accuracy: ±0.2° at 20°C (±0.4° at 70°F)
Resolution: 0.16° at 20°C (0.29° at 70°F)

StowAway TidbiT: Model TBI32-20+50

Range†: -20° to 50°C (-4° to 122°F)
Accuracy: ±0.4°at 20°C (±0.8° at 70°F)
Resolution: 0.3°C at 20°C (0.6° at 70°F)

Capacity: 32,520 measurements

† *Specified range is narrower than nominal range due to precision calibration process. Using TidbiT Temp loggers in wet environments (>90% RH) over 86°F (30°C) for extended periods of more than 8 weeks cumulative may lead to premature failure. For applications over 30°C, use the HOBO Water Temp Pro (pg 35).*
Note: For Onset's lowest cost underwater temperature monitoring solutions, see HOBO Pendant Temp (pg 17). For depths greater than 300m see HOBO Stainless Temp (pg 18).

Features and Specifications

Waterproof to 300 m (1000 feet)
IR communications and Optic Shuttle for readout when wet—even underwater!
Programmable start time/date or triggered start on location with Optic Coupler or magnet
Small Size and Alarm Indication
5-year, non-replaceable battery (typical use*)
NIST-traceable temperature accuracy certificate available
Multiple sampling with minimum, maximum or averaging
Mounting tab
Time accuracy: ±1 minute per week at 20°C (68°F)
Memory modes: Stop when full, Wrap-around when full
Response time in water: 5 minutes (typical to 90%)
Response time in air moving 1m/second: 20 minutes

** 16 three-month deployments in water (35° to 80°F) with 4 minute or longer intervals (no multiple sampling)*

Optic Shuttle™

$199

Size/Weight: 132 x 20 x 25 mm
(5.25 long x 0.8 tall x 1.0" thick)
without coupler; 28.35 g (1 oz)

The pocket-sized Optic Shuttle provides a convenient way to readout and relaunch TidbiT data loggers and bring the data back to your host PC.

Features and Specifications

Waterproof to 15 psi (30 feet)
128K capacity enough for 4 full 32K loggers
Data offload time from logger: 6 minutes typical from 32K logger
Data readout time to PC: 3 minutes typical for complete offload
TidbiT Coupler and Optic Coupler included
Uploads the same data to a PC as if the data were read out directly from the logger
6 year factory-replaceable battery (typical)

Optic Base Station™

$80

Size/Weight: 132 x 20 x 25 mm
(5.25 long x 0.8 tall x .95" thick)
without coupler; 56.7 g (2 oz)

The Optic Base Station is used to communicate between the host computer and either a StowAway TidbiT data logger or an Optic Shuttle. An Optic Coupler and TidbiT Coupler for connecting the base station to loggers are also included.

StowAway TidbiT Ordering

Description	Part No.	Qty. 1-9	10-99	100+
32K StowAway TidbiT				
(-4° to 37°C)	TBI32-05+37	$119	$110	$101
(-20° to 50°C)	TBI32-20+50	$119	$110	$101
Optic Base Station for TidbiT	DSA	$80	$74	$68
Optic Shuttle for TidbiT	DTA128B	$199	$183	$169
Software				
BoxCar Pro 4.3 Starter Kit (Windows)	BCP4.3-ON	$95	$88	$81
BoxCar 3.7 Starter Kit (Windows)	BC3.7-ON	$20	$19	$17

Note: A BoxCar Pro 4.3 or BoxCar 3.7 starter kit and an Optic Base Station are required to operate the TidbiT loggers. Each starter kit includes software, computer interface cable and software manual. The Optic Base Station includes an Optic Base Station, Optic Coupler and TidbiT Coupler. See pages 42-43 for software information. Use with USB port requires USB-Serial Adapter (pg 43) and BoxCar Pro 4.3+.

B BoxCar®-compatible

Bp BoxCar®Pro-compatible

CE Compliant with all relevant directives in the European Union (EU)

APPENDIX B: CONSULTATION RECORD

B.1 Comments Letters Received

Email From Patricia Irle
Received January 1, 2010

Hi, Kelee -

I've attached a copy of the draft QAPP with some comments. However, I think it would be helpful if you could address the comments below, and submit it for another review. At that time, I'll send Section 4 to our in-house expert… (I think he needs some of the following information to do a thorough job…)

General comments:

1) TDG. How will determine whether TDG standards are being met during non-fish-spill season?
2) Temperature. QAPP notes (page 3) that data collected will be used to run the CE-QUAL-W2 model. The QAPP seems to imply that temperature data from the forebay will be adequate to run the model. Please explain.
3) Temperature in the bypass. How do you expect to apply the standard here?
4) Please include all sampling locations.

Thanks!
Pat
(509) 454-7864

B.2 Response to Comments

Date	Section	Agency Comment	Chelan PUD Response
1/5/10	General	How will Chelan PUD determine whether TDG standards are being met during non-fish-spill season?	As per Section 5.4 (1)(a) of the 401 Certification which states: "Outside of the fish spill season, Chelan PUD may use spill as a surrogate for TDG levels," Chelan PUD will use spill as a surrogate for TDG levels outside the fish spill season. This use of spill as a surrogate for TDG levels is made possible by a linear regression developed by Schneider and Wilhelms (2005). Chelan PUD will continue to refine said regression using data collected during the April – August fish spill season.
		Temperature in the bypass. How do you expect to apply the standard here?	Monitoring will confirm whether temperatures in the bypass system increase from the entrance (forebay) to exit (sampling facility). Any observed temperature increases will be evaluated to determine impact on Columbia River temperatures.
		Please include all sampling locations.	Forebay and tailrace TDG and temperature locations have been identified in Section 5.1.1. Juvenile bypass temperature collection locations are stated in Section 5.1.2. Fishway temperature locations are stated in Section 5.1.3.
	Section 1 3rd paragraph	Says three, then lists four groups….	Language has been revised in response to comment.
	Section 1	QAPP notes that data collected will be used to run the CE-QUAL-W2 model. The QAPP seems to imply that temperature data from the forebay will be adequate to run the model. Please explain.	This may be a misinterpretation of what is written. As per Section 5.5(1)(b) of the 401 Certification, "Chelan PUD will collect or compile meteorological and water temperature data, including hourly water temperature data from the Wells Dam tailrace, for at least the first 5 years of New License; such data shall be of sufficient quality to meet technical peer review group standards for running the model." As stated previously in the Section and in the 401, Chelan PUD will collect temperature data in the forebay, fishways, juvenile bypass, and tailrace, as well as use data collected at Wells Dam.
	Table 3-2	"This study will be conducted at a later date (no sooner than 2011)." Why not?	Chelan PUD plans to coordinate this study with the resident fish study (see Chapter 6 of the Settlement Agreement), which is tentatively scheduled to commence in 2011. This will allow for concurrent analyses of macrophyte bed water quality conditions and fish presence/use. Note added to the table to clarify this.
	Table 5-1	Regarding standards column: This does not make sense in terms of the two locations identified.	Chelan PUD does not fully understand your comment, as these *are* the numeric criteria, but the table has been revised to clarify.
	5.1.1 1st Paragraph	Note that there is a slight temperature gradient. Please discuss how this may affect the results.	The monitoring device is located deep enough in the water column to not be effected by near surface temperature gradients. Language has been added to the section in response to comment.
	5.1.1 2nd Paragraph	Can you cite the study?	Citation added.
	5.1.1 3rd Paragraph	Explain how this will affect the accuracy of the TDG results…	The monitoring device is located below the depth at which bubbles form on the membrane; therefore, no effect in accuracy is expected. Language has been added to the section in response to comment.

Date	Section	Agency Comment	Chelan PUD Response
	5.1.2 1st Paragraph	This should be part of this report.	Language revised in response to comment.
	5.1.2 1st Paragraph	When do you expect to provide this?	Method of mounting the loggers will be provided after installation. Language added in response to comment.
	5.1.3 1st Paragraph	When do you expect to provide this?	Method of mounting the loggers will be provided after installation. Language added in response to comment.
	Section 9	I don't know that we need this. If the project changes, it will require changes to the overall objectives. Why include here?	Chelan PUD does not intend to change any projects. This adaptive management section is intended to addresses the potential need to revise/modify procedures/locations to ensure quality data collection. The language in this section has been revised in an attempt to clarify the intent of the section.
	Section 9 3rd Paragraph	This, then, isn't adaptive management…. And shouldn't be in this section.	Paragraph deleted.
	General	Suggested grammatical, formatting, etc revisions.	Chelan PUD appreciates your time and effort in making these suggestions. The suggested changes have been accepted as appropriate.
2/4/10	Section 1	Our primary concern is with regard to collecting data for a future computer temperature model run. It is stated (page 3) that an additional QAPP will be drafted to address this modeling effort. Because the model is to be run based in the first five years of data, it is critical that a QAPP be prepared immediately, to address collection of this data. Please include a data for completing that QAPP.	This is a valid point. Water temperature data to be used in the model is addressed in this QAPP; however, we agree it is necessary to draft a second QAPP that addresses the climatic data that will be used in the model. In order to proceed with the additional QAPP, Chelan PUD feels it is necessary to work collaboratively with Ecology to decide what climatic data sources should be used in this effort. Once that is determined, we can proceed with the drafting of the climatic data QAPP. Because we do not have an anticipated completion date for the second QAPP, we have not added/revised language in this QAPP to address this comment.
		The draft document describes two annual reports that will be sent to Ecology as part of this QAPP; one due in April, one in December (see pages 9 and 25 of the report). It is not clear which document will include the results and analysis for the 110% standards. Please clarify.	Clarifying language added in response to comment. Please note that the December submittal will address TDG only. This report will be appended to the March 1 submittal that is to address all parameters addressed in this QAPP.
	Table 3-2	It is indicated that spill as a surrogate for TDG will collected hourly. A minor suggestion: for consistency, could you move the comment "This will be necessary only during spill events outside of the fish season" into the second column?	Table revised in response to comment.
	Table 3-2	TDG: You should be monitoring or compiling information at each of three sites: forebay and tailrace of Rocky Reach, and forebay of Rock Island. Please clarify.	Table revised in response to comment.
	Table 5-1	TDG: Please include Rock Island forebay in the table under "Locations". And, 110% under "standards".	Table revised in response to comment.