

SOP 1: Sonde Operation and Field Procedures

Version 2

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1.0 Introduction

This standard operating procedure (SOP) covers steps for maintenance, deployment, error checking, cleaning, calibration, and storage of the Yellow Springs Instruments (YSI) model 6920V multiparameter sonde with a YSI 650 MDS handheld display/logger (hereafter called the “650”) used in the measurement of the core water quality parameters: water temperature, pH, specific conductivity, dissolved oxygen (DO), and turbidity (in the Taiya River only). If alternate sondes are employed in the future, the appropriate changes will be needed to make this SOP conform to new instrument specifications.

Collecting accurate, precise data requires diligent attention to initial sensor calibration, periodic calibration checks, cleaning of sensors, and proper storage and handling of sensors. The sonde error check and calibration procedures discussed below are drawn from recommendations provided by the instrument manufacturer (YSI), NPS-Water Resources Division, and USGS. They should ensure consistency in quality assurance/quality control (QA/QC) measures for calibration of sondes.

By adhering to the field operation steps below and the annual maintenance, cleaning, and calibration recommendations from the manufacturer, the sondes should perform adequately and the data will meet QA/QC processes by which questionable or erroneous data will be flagged. Due to the added cost and time commitment, this protocol does not require the use of an independent field meter at each park during each field visit, as is recommended or required by some monitoring protocols to pass rigorous tests for within-season checks on instrument fouling and drift. In this protocol, sonde performance relies upon measurements against certified calibration standards. Data evaluation and grading are based on observed sonde fouling error and calibration drift (SOP 2).

Additional information on sonde operation and care is available from the operating manuals on the YSI and the Southeast Alaska Inventory and Monitoring Network (SEAN) websites:

http://science.nature.nps.gov/im/units/sean/FQ_Toolbox.aspx

Hard copies of both manuals were also provided to each park unit with the original sondes. Please ensure that these are always readily available at the office.

2.0 Equipment and Supplies for Sonde Operation

All sondes and sensors are prepared for operation by the Project Leader prior to the initial deployment each season and should not require reassembly upon arriving at each park. The Project Leader follows instructions from the “6-Series Multiparameter Water Quality Sondes User Manual;” this manual can be referenced in the future if any questions arise about pre-season preparation.

All instrument probes must be error checked and calibrated (if necessary) before each field deployment for the 6-month (May 1- October 31) continuous monitoring season. Assuming the sondes are not inaccessible due to streamflow conditions, park leads will check them once per month to download data, clean and assess physical condition of sonde and probes, and assess whether calibrations are needed. Table SOP 1.1 lists equipment and supplies for routine sonde

cleaning and calibration. Additional information on installation and care of probes can be found directly from the manufacturer’s operation manuals (YSI 6-series). Park and Project Leads will coordinate the inventory and purchase of necessary supplies each off-season well before the start of sampling in May. Currently, SEAN carries two backup sondes and a full suite of backup sensors for in-season equipment failures.

Table SOP 1.1. Equipment and supplies (a yellow waterproof backpack should be available at each park for transporting gear to field sites).

YSI 6920V2-2 Multiparameter water quality sonde, including
pH probe (YSI 6561)
Dissolved oxygen probe (YSI 6150)
Conductivity/temperature probe (YSI 6560)
Turbidity probe (YSI 6136; <u>Taiya River only</u>)
Required for calibration
NIST-traceable thermometer
5 (or <u>7 for Taiya</u>) 500mL bottles with lids for calibration solutions
pH Standards (4, 7, and 10 standard units)
Conductivity standards (1,000 uS/cm)
Turbidity standards (0 [distilled water] and 126 NTU; <u>Taiya River only</u>)
Bottle of deionized or distilled water
Small covered waste bucket/bottle for transporting used calibration standards
Display unit/logger (YSI 650 MDS Multiparameter Display System) including field cable (YSI 6091, 25 ft.)
Clipboard with covered paper storage
Printed site visit worksheets (laser-printed waterproof paper for the field)
Laminated dissolved oxygen table
Pencils
Eight fresh unused AA-size alkaline batteries
Four fresh unused C-size batteries for 650 logger
Disposable wipes
Squirt bottles
Disposable gloves
Waders and life jacket
Probe cleaning tools: YSI 6570 maintenance kit, soft bristle toothbrush, soft cotton cloths and/or lens cleaning tissues, cotton swabs, dishwashing liquid (e.g., Dawn), small plastic bucket.
Small brush for scrubbing fouling from housing
Large brush for scrubbing fouling from inside of sonde mounting pipe

3.0 Pre-deployment Cleaning and Calibration Procedures

At the start of the field season, even though sensors will have been optimized through factory calibration, cleaning, and repair (if necessary), a full error check and memory clearing should be conducted in the office/lab prior to the seasonal field deployment. Section 9.3 of this SOP details calibration check instructions for each sensor. Memory clearing is explained in section 5.4. The “SEAN FQ site visit worksheet” (Figure SOP 1.1) must be used to record both this initial error check (without the need to fill in the sensor fouling sections) and all subsequent field checks.

The site visit worksheet filled during the pre-deployment check should be carried into the field during deployment in order to record site details.

Before the start of each field season, Park Leads must also be sure to check the condition and expiration dates of each calibration solution to ensure that dirty or expired solutions are never used. The Project Lead will ensure that each sonde has a fresh set of batteries prior to initial field installation.

4.0 Setting Up and Running EcoWatch for Windows

EcoWatch for Windows needs to be installed on an office PC in each park. At this time, Windows 7 and 8 are not compatible with EcoWatch. Please contact the SEAN Data Manager to discuss workaround options. This program has been provided on CD with the original sonde package. It may also be downloaded from www.ysi.com. To install EcoWatch, place the CD into the computer, select **Start**, then **Run** and type **d:\setup.exe** at the prompt. Press **Enter** or click on **“OK”** and the screen will display that EcoWatch is proceeding with the setup. Follow the instructions on the screen as the installation proceeds. Your user ID will typically need administrative rights on an NPS computer to perform the installation.

To run EcoWatch for Windows, select the EcoWatch icon on the desktop or from the Start Menu. For help, refer to section 4 of the “6-Series Multiparameter Water Quality Sondes User Manual.” At this time, only EcoWatch Lite runs properly on the Windows 7 operating system. If you are using EcoWatch Lite, please note the slightly different instructions below.

5.0 Pre-deployment Sonde System Setup, Enabling the Sensors, and Setting the Report to Show the Parameters of Interest

5.1 Sonde System Setup

In the office, the Project Leader connects the sonde to the computer for initial setup. The computer must have an old-style serial DB-9 connector; USB is not supported by YSI. Use the field cable and the sonde-to-PC adapter cable (YSI cable 6095B MS-8/DB-9) to connect the two units. (A 6095B cable is available at the SEAN office in Juneau, but is not routinely stocked at the parks. It is typically used only by the Project Leader to prepare the sonde for a new season.) Be aware that the software within the sonde is separate and different from the EcoWatch software installed on the PC. (If the 6095B cable is not available, initial setup may also be performed using the 650 device, though menu navigation will vary somewhat from that described below.)

Start EcoWatch or EcoWatch Lite from the PC’s Start button. In EcoWatch, select **Comm**, then **Sonde** from the menus to open communication between the PC-based software and the sonde-based software. In EcoWatch Lite, select **File**, then **New Connection**. In EcoWatch, select the proper “com port” radio button and confirm by clicking **OK**. EcoWatch Lite should automatically open the correct port. If you are unsure which com port is being used by the sonde, try each one until you discover one that responds. Once the software recognizes the sonde a “Sonde” window with a # sign appears. The remaining instructions are accurate for both EcoWatch and EcoWatch Lite. Type **“Menu”**, press **Enter**, and the sonde Main menu will be displayed. (If the sonde has been previously used, then the **Main menu**, rather than the # sign, may appear when communication is established, and you will not need to type **“Menu.”**)

The sonde software is menu-driven. Select functions by typing the corresponding numbers. There is no need to press Enter afterwards. Type the **0** or **Esc** key to return to the previous menu.

At the Main menu, select **System**.

Select **1- Date & time**. An asterisk will appear next to each selection to confirm the entry. Select “m/d/y” as the format. Check “4 digit year”. Verify the correct date and time. Local time (Alaska Standard Time [AST] or Alaska Daylight Time [ADT]) is employed. ADT fully covers the current field season (the sonde does not automatically switch between AST and ADT, should the season be extended).

Select **0** to return to the **System setup** menu

Select **4- Instrument ID** from the System setup menu to record the instrument ID/serial number and press **Enter**. Type in the serial number of the sonde at the prompt. The serial number is printed on a waterproof label on the exterior of the sonde. This step may be skipped if the correct serial number is already entered.

Select **0** or **Esc** to return to the **System setup** menu, then press **0** or **Esc** again to return to the **Main menu**.

5.2 Enabling the Sensors

To activate the sensors in the sonde, from **Sonde Main menu**, select **Sensor**. Select numbers corresponding to every sensor that is installed on the sonde. An asterisk will indicate when a sensor is enabled.

Select **0** to return to the **Main menu**

5.3 Setting the Parameters of Interest

To activate the display of specific parameters, select **Report** from the Main menu. You will see a report set up displaying the sensors that are available and enabled on the sonde. *NOTE: These and only these parameters must be enabled.*

Date
Time hh:mm:ss
Temp C
SpCond mS/cm
pH
ODO sat %
ODO mg/L
Battery volts
Turbid+ NTU (Taiya only)

It is essential these exact parameters be specified. Subsequent data management processes require them. For parameters with multiple unit options (e.g., temperature can be reported in degrees Celsius or Fahrenheit), a submenu will appear that allows for the selection of the unit

type. After configuring the display with the correct parameters, press **Esc** or **0** to return to the Main Menu.

5.4 Clearing the Sonde Memory

Before deploying a sonde for the season, previous data must be erased from the flash memory to free up capacity. It also prevents the previous season's data from being duplicated in the data deliverables. To clear the sonde memory, select **File** from the main menu, choose the option "6-Delete all files," and confirm the choice.

NOTE: Be absolutely certain that all prior data have been retrieved and processed before clearing memory. It is not possible to recover sonde data once the memory has been cleared.

6.0 Setting up the YSI 650 MDS

At the start of each season replace the 650 batteries in order to prevent failure in the field; one set of fresh batteries should be adequate. The batteries for the 650 are located at the back of unit. To access, loosen the 4 captive screws using a Phillips or slotted screwdriver and then remove the lid completely. Insert four fresh C cells between the battery clips, being sure to follow the polarity as indicated on the bottom of the battery compartment. Make certain that the gasket is properly installed on the battery lid, reinstall battery lid, tighten the 4 captive screws securely and evenly (using the Phillips or slotted screwdriver). Do not over tighten. It is possible for the batteries to be seated slightly wrong, even after tightening the screws, so if the handheld does not power up, this should be the first item to troubleshoot.

Be sure the settings on the 650 are adjusted for the project purposes prior to the start of the monitoring season. After turning the instrument on to display the **650 Main menu**, use the arrow keys to highlight the **System setup** selection and press **Enter** (the enter key has a small arrow with 90-degree bent line). Set '**Date & Time**' to match the sonde as specified in 5.1. Press the **Esc** key to return to the System setup menu.

Highlight the **Shut off time (minutes)** selection to change the number of minutes programmed that the 650 waits to shut down to save batteries. Values can be integers (20 minutes is recommended). Do not enter "0" which disables the shutoff completely

Highlight the **Instrument ID** selection and press Enter. Under the "System setup" menu that then appears, scroll down to "ID=" and input (using the alphanumeric keys) "YSI 650". Press **Esc** and return to the **650 Main menu**.

Several other setup options are available though not commonly used; refer to pages 3-19 to 3-20 in the 6-Series user manual.

7.0 Monthly Site Integrity Check

Upon arriving at the water quality monitoring site, and before initiating any of the monthly data downloads and fouling/calibration checks on the sensors, Park Leads should make a few general notes at the top section of the "SEAN FQ site visit worksheet" (Figure SOP 1.1) regarding the physical condition of the site. Near the top of the worksheet, under "Site and sonde conditions", the Park Lead needs to indicate if the physical integrity of the site is good or not, if the sonde is accessible due to flow conditions, and if so, whether the battery supply is adequate or was spent

since the last site visit. At the Salmon River site, staff should check to see if the angle-iron mount is secure and vertical; at the Indian and Taiya River sites, staff should make sure that the stabilizing bolts to the bedrock are holding. Any problems should be indicated on the appropriate “comments” line on the sheet and repaired as soon as possible. The Park Lead should also check the pipe housing for debris or fouling and take the appropriate measures to clean it both inside and outside if necessary. A toilet bowl brush with an extended handle or small diameter fireplace chimney brush works well to clean the inside of the pipe.

8.0 Data Uploading from the Sonde to the YSI 650 MDS Handheld Unit

Unless this is the first site visit for the monitoring season, the next step after a general site integrity check is to connect the field cable and upload data to the 650. The procedure for uploading the month’s collection of continuous water quality data off the sonde in the field and sending the data to the Project Leader from the office is detailed in SOP 3.

9.0 Sensor Cleaning, Calibration, and Error Checking

9.1 Overview

Before the season’s initial deployment the sonde has already been properly calibrated as described in section 3.0, so this does not need to be done in the field. For subsequent visits, after the Park Lead has uploaded data from the sonde to the 650 according to SOP 3, the next step is to check each sensor and to restore performance, if necessary, through cleaning and/or recalibration.

Sensor readings can undergo measurement drift over the course of extended use, so it is important to quantify this drift and recalibrate the sensors, if needed, to maintain accurate and precise performance. The sensors are susceptible to fouling over time, even those equipped with automatic wipers. If probes are fouled, their performance is compromised, and therefore most probes will need to be cleaned periodically during the monitoring season. The Project Lead ensures that Park Leads have the cleaning supplies necessary to properly clean the instruments.

Before performing any calibration procedure, the sonde and display must stabilize (warm-up) at least 15 minutes. In most cases, the sonde will not need to warm-up because of its continual deployment in the field; however, warm-up is necessary during the initial calibration and during any subsequent events when it is turned off for more than a few minutes (e.g., following a battery failure or change).

During the warm-up period, check the battery level of the sonde using the 650. Connect the powered up 650 to the sonde, highlight “Sonde Run,” using the arrow keys, press **Enter**, and the display screen will show the properties of the sonde itself, and not the 650. Confirm this by looking for the “sonde” display icon on the bottom right hand corner. If either the gauge shows less than half a charge or if this is halfway through the season (July site visit), the sonde batteries need to be replaced to avoid future data loss and potential corrosion caused by aging, leaky batteries (section 9.2).

During error checking, probes are typically rinsed with distilled water before and after immersion in the calibration solutions. Because specific conductance and pH are temperature-dependent, the entire temperature probe must be covered with solution during calibration of the

conductivity and pH probes. Dissolved oxygen is also temperature-dependent, but it is calibrated with a water-saturated air procedure, and the sensor is not immersed in solution. Detailed error checking and calibration instructions are provided below.

When conducting calibrations in the field, personnel must be sure to store used calibration standard solutions in a waste bucket or bottle with a lid so that all waste material is properly poured down a sink drain with running tap water and not disposed of at the study site.

The full “SEAN_ FQ site visit worksheet” (Figure SOP 1.1) must be printed off in the park unit office prior to the site visit so that the Park Leads can fill them out with a pencil in the field. Print the waterproof paper worksheet on a laser, not inkjet, printer; most inkjet ink dissolves in rain. A protective clipboard/case will protect the sheet from inclement weather. On return, the Park Lead will then need to enter the data into the electronic version of the site visit worksheet. This MS Excel formatted file will later be transferred to the Project Leader as FQ_C (see instructions in SOP3). The file naming convention for this electronic field form is: FQ_C_4-letter park code_2-letter site code_site_visit_date.xlsx. For example:

FQ_C_SITK_IN_SITE_VISIT_20100604.XLSX.

Site codes are IN for Indian River, SA for Salmon, and TA for Taiya.

When completing this worksheet, all dates and times must reflect the GMT-8 time zone, which currently coincides with Alaska Daylight Time. If the visit occurs after daylight time ends in November, dates and times must still reflect GMT-8 / ADT. This ensures the worksheet grades can be properly applied to the sonde data points, as sonde data are always stamped using GMT-8.

9.2 Sonde Battery Replacement

The battery lid is located on the top of the sonde. Position the bail perpendicular to the sonde and use it as a lever to unscrew the battery cap by hand. Then slide the battery lid up and over the bulkhead connector. Replace batteries with 8 AA-size alkaline batteries. Pay attention to the orientation of the spent batteries and reinstall fresh batteries using the correct polarity. Make sure there are no contaminants between the O-ring and the sonde. Lightly lubricate the o-rings on the bottom of the threads and on the connector stem using the lubricant included in the YSI 6570 maintenance kit. Return the battery lid and tighten by hand, without over tightening.

9.3 Instructions for Error Checking, Cleaning, Calibration, and Troubleshooting Each Probe

The instructions below correspond to the data entry prompts for the “SEAN WQ site visit” worksheet (Figure SOP 1.1). It is important to ensure you are using the most recent version of the worksheet, which can always be found at the SEAN water quality toolbox:

http://science.nature.nps.gov/im/units/sean/FQ_Toolbox.aspx

Worksheets will typically be filled out with a pencil in the field, and then entered electronically after the site visit. Note that in the electronic version, solid yellow boxes must be filled in manually by the user, while lighter yellow gradient boxes will be filled automatically.

When conducting these calibrations and checks, the sonde needs to be connected to the 650 via the field cable. Turn the 650 on, and you will be in the “650 Main menu.” Select **Sonde Run**, press Enter, and note that the icon on the bottom right has changed from the 650 to the sonde. In this mode, you will see the live display of the values of the selected parameters being measured off the sonde. Hit the **Esc** key at any time to return to the Main menu.

SEAN Freshwater Water Quality Monitoring		Contact: Project Leader: Chris Sergeant	
Site Visit Worksheet		National Park Service - SEAN	
Version 2013-03-26		3100 National Park Road	
		Juneau, AK 99801	
Date of this visit		phone: (907) 364-1541	
Operator		email: Christopher_Sergeant@nps.gov	
Site name			
SITE AND SONDE CONDITIONS			
Physical integrity of site ok?		If no, comment:	
Sonde accessible? (Yes/No)		If no, comment:	(If not accessible, end worksheet here)
Time sonde pulled (hh:mm)		Time redeployed:	
Battery replaced? (Yes/No)		If yes, did battery fail since last visit?	Battery replacement: SOP 1, Section 9.2
Upload data to 650 MDS unit and scan most recent entries. Obvious that data quality is questionable? (Yes/No)			
FOULING AND CALIBRATION CHECKS AND CORRECTIONS -- USE SOP 1, Section 9			
TEMPERATURE - SOP 1, Section 9.3.1			
(Single Point Error Check with NIST-Certified or NIST-Traceable Thermometer; Calibration done by manufacturer prior to field deployment)			
Water Temp (NIST thermometer)			
Water Temp (YSI sonde)			
Error			
Within allowable error range: +/- 1? (Yes/No)		If no, contact Project Leader for replacement.	
Comments:			
SPECIFIC CONDUCTANCE - SOP 1, Section 9.3.2			
<u>Standard</u>	<u>Sonde Reading prior to cleaning and recalibration</u>	<u>Within allowable error range? (Yes/No)</u>	
1000 us/cm ref standard		(between 950-1050?)	
If allowable, specific conductance check completed. If not allowable, clean probe, and remeasure:			
<u>Standard</u>	<u>Sonde Reading following cleaning</u>	<u>Within allowable error range? (Yes/No)</u>	
1000 us/cm ref standard		(between 950-1050?)	
If allowable, specific conductance check completed. If not allowable, ensure probe is clean, and perform recalibration:			
<u>Standard</u>	<u>Sonde Reading following calibration</u>	<u>Within allowable error range? (Yes/No)</u>	
1000 us/cm ref standard		(between 950-1050?)	
post-calibration K-cell constant (acceptable high range conductivity K-cell = 5.0 ± 0.5)			
Recalibrate again? (if yes, override cells above with new calibration) Yes/No			
Comments			

Figure SOP 1.1. SEAN freshwater water quality monitoring site visit worksheet (version March 26, 2013).

pH - SOP 1, Section 9.3.3					
Sonde Reading prior to cleaning and recalibration					
Standard	pH reading	°C reading	Expected pH (from table)	Error (expected-reading)	Allowable range? (error <= 0.1)
7.00					
10.00					
If allowable, pH check completed. If not allowable, clean probe, and remeasure:					
Sonde Reading following cleaning					
Standard	pH reading	°C reading	Expected pH (from table)	Error (expected-reading)	Allowable range? (error <= 0.1)
7.00					
10.00					
If allowable, specific conductance check completed. If not allowable, ensure probe is clean, and perform recalibration:					
Sonde Reading following calibration					
Standard	pH reading	°C reading	Expected pH (from table)	Error (expected-reading)	Allowable range? (error <= 0.1)
7.00					
10.00					
4.00					
Recalibrate again? (if yes, override cells above with new calibration) Yes/No					
Comments					
DISSOLVED OXYGEN - SOP 1, Section 9.3.4					
(Check calibration using water saturated air method)					
Temperature		° C			
Barometric pressure		mmHG			
Calculated DO Level		mg/L	(Refer to DO saturation table if in the field)		
DO meter reading		mg/L			
Allowable?		(allowable if within 0.5 mg/L of calculated value)			
If allowable, DO check completed. If not allowable, clean probe, and remeasure:					
Sonde Reading following cleaning					
DO meter reading		mg/L			
Allowable?		(allowable if within 0.5 mg/L of calculated value)			
If allowable, specific conductance check completed. If not allowable, ensure probe is clean, and perform recalibration:					
Sonde Reading following calibration					
DO meter reading		mg/L			
Allowable?		(allowable if within 0.5 mg/L of calculated value)			
Recalibrate again? (if yes, override cells above with new calibration) Yes/No					
Comments					
TURBIDITY (Taiya River only) - SOP 1, Section 9.3.5					
Standard	Sonde Reading prior to cleaning and recalibration			Within allowable error range? (Yes/No)	
0 NTU ref (distilled water)				(between 0.0-0.5?)	
126 NTU ref standard				(between 119-133?)	
If allowable, turbidity check completed. If not allowable, clean probe, and remeasure:					
Sonde Reading following cleaning					
Standard				Within allowable error range? (Yes/No)	
0 NTU ref (distilled water)				(between 0.0-0.5?)	
126 NTU ref standard				(between 119-133?)	
If allowable, specific conductance check completed. If not allowable, ensure probe is clean, and perform recalibration:					
Sonde Reading following calibration					
Standard				Within allowable error range? (Yes/No)	
0 NTU ref (distilled water)				(between 0.0-0.5?)	
126 NTU ref standard				(between 119-133?)	
Recalibrate again? (if yes, override cells above with new calibration) Yes/No					
Comments					

Figure SOP 1.1. SEAN freshwater water quality monitoring site visit worksheet (continued).

9.3.1. Temperature

Each probe (except turbidity) relies on temperature readings for accurate measurements; therefore, the temperature sensor should be checked prior to calibration of the other sensors. Although the sonde temperature sensor is very reliable, it must be error-checked against a National Institute of Standards and Technology (NIST)-certified or -traceable thermometer before each field deployment.

Note: The accuracy comparison of $\pm 1.0^{\circ}\text{C}$ in this SOP is based on the quality of the NIST-traceable thermometers. This thermometer is not necessarily more accurate than the YSI probe. The purpose of comparing the YSI probe to a NIST-traceable thermometer is to get a general, although not highly accurate, validation of the temperature measurements.

Calibration:

The temperature sensor cannot be calibrated. If it fails, it must be replaced.

Error Checking:

1. Prepare a container filled with water (either tap water if performing check in the lab/office, or with stream water if working in the field).
2. Next, place the NIST thermometer and sonde into the water, wait for both temperature readings to stabilize, and record the temperature values on the worksheet. (Note: On the 650, you will need to be in the 650 Main Menu/ Sonde Run mode to view the temperature readings off the sonde).
3. Compare the two measurements. The sonde's temperature sensor must agree with the reference thermometer within $\pm 1.0^{\circ}\text{C}$. If the measurements do not agree, the instrument may not be working correctly and the Project Leader must be contacted.

Troubleshooting:

The temperature probe should be relatively trouble-free. If a discrepancy between a NIST thermometer and sonde temperature sensor in liquid is greater than 1.0°C , the cause must be investigated. On the YSI 6920 sondes, remove the 6560 temperature / conductivity probe (refer to the YSI user manual for proper removal and installation technique). The sonde display should read -9.99°C with the probe removed. If the display reads any number other than -9.99°C , contamination of the port or circuit malfunction is the most likely cause. Follow the sonde port connector cleaning procedures available from the manufacturer. If cleaning the sonde port connector does not solve the problem, factory servicing is needed.

9.3.2. Specific Conductance/ Conductivity

Conductivity is a measure of the ability of an aqueous solution to carry an electrical current. Specific conductance is the conductivity value corrected at 25°C . In the event of an uncorrected sensor recording where only conductivity can be measured, specific conductivity can be calculated using conductivity and water temperature:

$$C_{25} = C_m / (1 + 0.019(tm - 25))$$

Where, C_{25} =corrected conductivity value adjusted to 25°C

C_m =actual conductivity measured before correction; and

tm =water temperature at time of C_m measurement

Error checking, cleaning, and calibration:

Perform a single point error check with the 1,000 uS/cm YSI solution. The 1,000 uS/cm solution from YSI is the recommended standard for specific conductivity calibrations. This new single point error check was implemented at the beginning of the 2013 season. See the previous protocol for past two-point error checking routines.

Important: when the sonde has been installed in the field, do not clean the probe before performing this initial error check. This check allows for determination of sensor drift since the last error check.

1. Triple rinse all sensors with deionized or distilled water; excess water may be dabbed with a towel
2. Fill the calibration cup with enough 1,000 uS/cm solution to submerge the temperature and conductivity probes, and insert the probes. (Important: make sure that no air bubbles are trapped inside the conductivity cell.) It may help to invert the sonde once the calibration cup is screwed back on so that less calibration standard is used. Alternatively, since conductivity and temperature are measured on the same probe, you may fill the Project Lead-supplied scintillation vial with standard and slide that over the probe. Select Sonde Run.
3. Once stabilized, record the specific conductivity value as “Sonde Reading prior to cleaning and recalibration” for the 1,000 uS/cm solution.
4. If the results are within 5% of the known standard value (between 950 and 1050 uS/cm), you may move on to checking pH. Any obvious buildup on the sensor may be cleaned at this time. If the results are not within 5% of the known standard value, then clean the probe per instructions below.
5. Probe cleaning: If the openings on the probe have biofouling or trapped sediment, they can be gently rinsed with deionized or distilled water directed through the openings using the syringe provided with the 6570 YSI maintenance kit, or else with a squirt bottle. Oily, salty, or other chemical residues can be removed using a biodegradable detergent solution. Additionally, use the small cleaning brush in the Maintenance Kit by dipping it in clean water and brushing the openings (those that allow fluid access to the conductivity electrodes) 15–20 times. Mild detergent may be used with the brush if oily, salty, or other chemical residues have formed deposits on the electrodes.
6. Repeat steps 1–3, recording the new reading under “sonde reading following cleaning”
7. If the results are still not within 5% of the known standard values, the sensor should be recalibrated, as instructed below.
8. Calibration instructions:
 - a) Rinse all probes with deionized or distilled water.
 - b) Pour a small amount (approx. 25 mL) of 1,000 uS/cm solution in the calibration cup, thread the cup onto the sonde, shake the sonde rinsing the sensors with solution, then discard solution.
 - c) Fill the calibration cup or scintillation vial with enough 1,000 uS/cm solution to submerge the temperature and conductivity probes, and insert the probes.
Important: ensure that no air bubbles are trapped inside the conductivity cell.
 - d) From the sonde display main menu, select Sonde Menu / Calibrate / Conductivity / SpCond, and press Enter.

- e) Enter the standard concentration 1.000 mS/cm and press Enter. Important: double check that the concentration is entered as milli-Siemens /cm, not micro-Siemens/cm.
 - f) After the specific conductivity reading has stabilized, press Enter and wait for the “Calibrated” message to appear. Record the “calibrated” value in the comments section of the field sheet.
12. Record the K cell constant by selecting Sonde Menu / Advanced / Cal Constant.
 13. Check the calibration by reading the 1,000 uS/cm standard by repeating steps 1–3, and recording the result in the “sonde reading following calibration” column.
 14. If the results are not within 5% of the known standard values, then recalibrate the probe. If repeated calibration does not result in satisfactory performance, go to Troubleshooting, below.

Troubleshooting: The conductivity K cell constant generated during calibration should be used as an indicator of potential problems. The K cell constant should be 5.0 ± 0.5 . Any significant change in this number between readings of different conductivity solutions indicates a potential problem. First, check to make sure proper calibration procedures were followed and that the conductivity solutions are not expired. The conductivity value should read 0.00 (or very close to it) when either in distilled water or when dried and in air. If the probe reports a conductivity value when placed in a non-conductive medium, remove the 6560 temperature / conductivity probe (CAUTION: removing the probe from the port can be tricky if the probe has been deployed for some time. Fine sediments may have lodged in the port connectors, making it difficult to remove the probe without breaking the connector pins. If you come across resistance removing the probe, consider not removing it for this troubleshooting exercise and waiting for factory servicing). Refer to the YSI User Manual for more detailed removal instructions. With the probe removed, the sonde display should read -9.99°C for temperature and $0.00 + 10$ uS/cm for conductivity. If the conductivity immediately drops when the probe is removed, then the probable cause is water leakage into the sensor. If the conductivity reading remains, clean the probe and port.

9.3.3 pH

The pH of a sample is determined electrometrically using a glass electrode. For SEAN rivers, expected values will fall between pH 6 and pH 9. The calibration procedure below will outline the steps for a 2-point calibration with pH 7 and pH 10 and an error check using pH 4 solution. Always calibrate with pH 7 first. Important: when the sonde has been installed in the field, do not clean the probe before performing this initial error check. This check allows for determination of sensor drift since the last error check.

Error checking, cleaning, and calibration:

1. Triple rinse all of the probes on the sonde with deionized or distilled water. Shake off excess water or dab lightly with a towel.
2. Rinse all probes with a small amount of pH 7 solution.
3. Fill the calibration cup with enough pH 7 solution to submerge the temperature and pH probes, and insert the probes. It helps to invert the sonde so that less calibration

standard is used. Alternatively, the probes can be dipped into a soft pastic bag such as a whirlpack. Select Sonde Run.

4. Based on the temperature displayed on the 650, record the temperature-corrected expected value for pH 7 and pH 10 buffers in the appropriate field sheet boxes. Note that the electronic field sheet will automatically fill these values. The pH buffer labels on each bottle list the temperature-corrected values, but below is the same table for reference. Choose the expected value that is closest to the temperature you are currently reading on the 650 (e.g., if the pH standard is 12°C, choose the expected value for 10°C).

Oakton brand temperature-corrected pH buffer values

°C	pH 4.0	pH 7.0	pH 10.0
0	4.00	7.11	10.32
10	4.00	7.06	10.18
20	4.00	7.01	10.06

5. Once stabilized, record the pH value under “Sonde Reading prior to cleaning and recalibration” for the pH 7 solution. Stabilization can take up to 2 or 3 minutes under warmer or colder conditions.
6. Rinse all probes on the sonde with deionized or distilled water. Shake off excess water or dab lightly with a towel.
7. Rinse sensors with small amount (approx. 25 mL) of pH 10 solution. This can be achieved using a squirt bottle filled with solution, or by pouring a small amount in the calibration cup, threading it onto the sonde, and swirling it vigorously.
8. Repeat step 3, but with pH 10 solution, allow measurements to equilibrate, then write down result of the measurement on the log sheet (also under “Sonde Reading prior to cleaning and recalibration”, but for the pH 10 solution.)
9. Check if both pH 7 and pH 10 buffers read back to within 0.10 pH units of the temperature-corrected expected buffer values. If they do, the pH sensor checks out fine and can be redeployed as is. You can clean any obvious buildup on the sensor at this time. If the sensors were not in range, clean the sensor according to directions below.
10. Probe cleaning: Use clean water and a soft clean cloth, lens cleaning tissue, or cotton swab to remove all foreign material from the glass bulb and platinum button or ring. Then use a moistened cotton swab to carefully remove any material that may be blocking the reference electrode junction of the sensor. (Caution: Be certain not to damage the glass bulb. If using a swab, do not force it between the probe guard and glass). If this does not adequately restore the performance of the probe: (1) Soak the probe for 10–15 minutes in clean water containing a few drops of biodegradable liquid dishwashing detergent; (2) GENTLY clean the glass bulb and platinum button by rubbing with a cotton swab soaked in the cleaning solution; (3) Rinse the probe in clean water, wipe with a cotton swab saturated with clean water, and then re-rinse with clean water.
10. Repeat steps 1–9, recording the new readings under “sonde reading following cleaning”

11. If the results are still not within 0.1 pH units of the temperature-corrected expected buffer values, the sensor should be recalibrated, as instructed below.

12. Calibration instructions:

- a) Allow the buffered samples to equilibrate to the ambient temperature. Ideally, calibration solutions should mimic temperatures likely to be experienced in the field.
- b) Triple rinse all of the probes with deionized or distilled water. Shake off excess water or dab lightly with a towel.
- c) Pour a small amount (approx. 25 mL) of pH 7 buffer in the calibration cup, thread the cup onto the sonde, shake the sonde rinsing the sensors with solution, then discard buffer. Repeat this step two more times.
- d) Fill the calibration cup with enough pH 7 calibration solution to submerge the temperature and pH probes, and insert the probes.
- e) Select Sonde Menu / Calibrate / ISE1 pH / 2 point.
- f) Input temperature-corrected expected buffer value and press Enter.
- g). Wait for the value of pH to stabilize, and press Enter. Wait for "Calibrated" message and record the pH value as the "Sonde reading following calibration." If an "Out of Range" message appears, do not accept.
- h). Triple rinse probe and calibration cup with deionized or distilled water and shake off excess water.
- i) Triple rinse the sensors and calibration cup with pH 10 buffer similar to Step 3 above.
- j) Fill the calibration cup with pH 10 calibration standard and immerse the probes. Press Enter.
- k). When prompted, enter the temperature-corrected expected buffer value, wait for "Calibrated" message, record the pH value as the "Sonde reading following recalibration," and press Enter to continue.

13. Check the calibration by performing readings of the pH 4 standard by repeating steps 1-9, and filling in the results in the "sonde reading following calibration" column.

14. If the post-calibration readings of the 3 standards are not within 0.10 units of the temperature-corrected expected buffer values, then recalibrate the probe. Record the pH millivolt values in the comments section of the field sheet. If repeated calibration does not result in satisfactory performance, go to Troubleshooting, below. At this point, it is likely that a large amount of standard has been used. Contact the Project Leader as soon as possible if more standard is needed for future error checking.

Troubleshooting: Use the slope of the pH sensor based on the pH millivolt values as a diagnostic key. The slope is calculated by determining the difference between the two calibration point millivolt readings (i.e., pH 7 millivolts – pH 10 millivolts *or* pH 4 millivolts – pH 7 millivolts). Millivolt values should be as follows: pH 4=180 ± 50 mv; pH 7=0 ± 50 mv; pH 10=-180 ± 50 mv. The acceptable range for slope is 165 to 180. If the slope drops below 160, the sensor should be taken out of service.

pH standards are highly buffered and provide optimal pH measurement conditions, unlike poorly buffered environmental waters. Low ionic strength waters with a specific conductivity < 50 uS/cm may cause pH measurement stability problems with some probes, resulting in the probe to drift slowly in one direction up to several hundredths of a

pH standard unit per minute. If this situation occurs, a low ionic strength sensor must be used. Often, probes will calibrate fine in high ionic strength buffers, but will not read accurately in lower ionic strength waters. Using low ionic strength buffers can remedy this problem.

For further details on making accurate pH measurements, YSI has a relatively informative PowerPoint presentation available online:
<http://www.ysi.com/media/support/YSI-Making-Good-pH-Measurements-web.pdf>

9.3.4. Dissolved Oxygen

Dissolved oxygen content in water is measured using an optical sensor. The DO probe must be calibrated using the calibration cup provided with the sonde or using a wet, white towel wrapped around the sensor guard. Calibration of the DO probe requires that the sonde has information on the current barometric pressure. The 650 display has an internal barometer and automatically provides this during the calibration procedure. Important: when the sonde has been installed in the field, do not clean the probe before performing this initial error check. This allows for determination of sensor drift since the last error check.

Error checking, cleaning, and calibration:

1. Triple rinse all of the probes on the sonde with deionized or distilled or tap water. Shake off excess water or dab lightly with a towel.
2. Take the sonde out of Run mode. Place approximately 3 mm of water in the calibration cup. Only engage the cup threads one turn to ensure the DO probe is vented to the atmosphere. Alternatively, use a wet towel wrapped around the sensor guard in place of the calibration cup. Do not allow water to touch the DO membrane or temperature sensor and ensure the sonde is not in direct sunlight. Allow the sonde to sit at least 10 minutes prior to proceeding so the air around the DO membrane becomes saturated with water vapor.
3. Note the temperature and barometric pressure on the site visit worksheet. Use the DO calculator worksheet or refer to the DO saturation table to find the approximate expected DO level (based on pressure and temperature).
4. Select Sonde Run, and wait for the DO reading to stabilize.
5. Record the dissolved oxygen in mg/l and % under “sonde reading before cleaning and calibration”. The dissolved oxygen value should be within 0.5 mg/l of the calculated saturation value. If it is, the dissolved oxygen sensor check is complete. You may clean any obvious buildup on the sensor at this time. If the reading was not acceptable, clean the sensor according to the directions below.
6. Probe cleaning instructions: The optical DO probe is equipped with a wiper that can be activated manually or automatically (using the 650) to clean the sensor lens. The wiper sponge will need to be replaced periodically (see YSI User Manual), but this should not be necessary to do more than once a year, and it is preferable to leave it to the factory to do this as part of the annual servicing between field seasons. If the wiper is not adequately cleaning the sensor, the best method of cleaning the membrane is just to GENTLY wipe away any fouling with a piece of lens cleaning tissue which has been moistened with water only. Under NO circumstances should one use organic solvents (including alcohol) to clean the sensor membrane.

7. Repeat steps 1–5, entering the new reading under “sonde reading following cleaning”.
8. If the results are still not within 0.5 mg/l, the sensor should be recalibrated, as instructed below.
9. Calibration instructions
 - a. With the probes still in calibration cups (with 3mm of water and threads engaged only one turn to ensure ventilation), select Sonde Menu / Calibrate / Optic T-Dissolved Oxy. Then, select ODOsat% and then 1-Point. Note: Calibration of dissolved oxygen by the DO% procedure also results in the calibration of the DO mg/l mode and vice versa.
 - b. Enter the current barometric pressure in mm of Hg. The correct pressure will often be provided but cross-check with the reading provided in the lower right hand corner of the sonde display.
 - c. Press Enter and wait for the DO% reading to equilibrate. The current values of all enabled sensors will be shown on the screen and change with time as they stabilize. Observe the readings under ODO%.
 - d. When the ODO% readings show no significant change for approximately 30 seconds, press Enter. The screen will indicate that the calibration has been accepted and prompt you to press Enter again to return to the Calibrate menu.
 - e. Select Sonde Run, and wait for the DO reading to stabilize. Record the value under “sonde reading following calibration.” If the reading is within 0.5 mg/l of the calculated value, the DO sensor is properly calibrated.
10. If the post-calibration reading was not satisfactory (within 0.5 mg/l of the calculated value), then recalibrate the probe. If repeated calibration does not result in satisfactory performance, the sensor membrane may need replacement. Contact the Project Leader to determine next steps. If the DO probe is not reading properly, but the other probes work well, you may reinstall the sonde in the field until a replacement sensor is ready to install.

9.3.5. Turbidity (Taiya River only)

The turbidity reading is based upon a comparison of intensity of light scattered by a sample under defined conditions with the intensity of light scattered by a standard reference solutions. Keeping the lens covering on the detection unit clean during calibration and field use is critical. The turbidity probe includes an automated optic wiper. This wiper can be activated using the sonde display.

The turbidity calibration solution comes in small quantities and is fairly expensive. Therefore, rather than filling the entire calibration cup (immersing all sensors) with turbidity solution, immerse only the turbidity probe (still attached to the sonde).

Important: when the sonde has been installed in the field, do not clean the probe before performing this initial error check. This check allows for determination of sensor drift since the last error check. The Project and Park Leads should also be aware of the turbidity standard that is specific to the YSI 6136 turbidity probe: the turbidity standard sold by YSI (item 6073G) reads 126 NTU for the 6136 probe (used on SEAN sondes), and 100 NTU on the 6026 probe. Currently, this standard must be purchased for accurate readings. Other brands and materials may not work properly.

Error checking, cleaning, and calibration:

1. Triple rinse all of the probes on the sonde with deionized or distilled water. Shake off excess water.
2. Fill the calibration cup with enough distilled water (acting as 0 NTU reference standard) to submerge the turbidity probe, and insert the probe.
3. From display/logger main menu, select Sonde Run.
4. Allow the measurement to equilibrate, then write down the result on log sheet under “Sonde Reading prior to cleaning and recalibration” for the 0 NTU solution.
5. Clean the probe with deionized or distilled water and shake off excess water or dab lightly with a towel.
6. Repeat step 2, but with the 126 NTU reference standard solution, wait for the measurement to stabilize, and record the result.
7. Readings of calibration solutions should fall between 0.0-0.5 NTU for the 0 NTU standard, and between 119-133 NTU for the 126 NTU standard. If they do, the sonde is ready to be reinstalled and you may clean any obvious buildup from the sensor at this time. If the readings fail to meet these criteria, clean the sensor according to the directions below:
8. Probe cleaning: The optical turbidity probe is equipped with a wiper that can be activated manually or automatically (using the 650) to clean the sensor lens. The wiper sponge will need to be replaced periodically (see under “Troubleshooting” below), but this should not be necessary to do more than once a year, and it is preferable to let the factory do this as part of the annual servicing between field seasons. If the wiper is not adequately cleaning the sensor, the best method of cleaning the membrane is just to GENTLY wipe away any fouling with a piece of lens cleaning tissue which has been moistened with water only. Lint-free cloths can be used to wipe off any fingerprints or smudges from the optics as well.
9. Repeat steps 1–7, entering the new readings under “sonde reading following cleaning”.
10. If the results are still not allowable, the sensor should be recalibrated, as instructed below, in Step 11:

11. Calibration instructions:

- a. Triple rinse all of the probes with deionized or distilled water. Shake off excess water.
- b. Place a small amount (approx. 25 mL) of distilled water (acting as 0 NTU reference standard) in the calibration cup, thread the cup onto the sonde, and gently swirl the probe in the solution. Discard the water and repeat this step twice.
- c. Pour turbidity standard into the calibration cup slowly, ensuring no air is bubbled into the solution. If air bubbles are present, tap the cup until bubbles are removed. Note: It is strongly recommended that the calibration cup provided be used for turbidity calibration. If glassware must be used, install the sensor guard first. Plastic beakers or containers can reflect the infrared light beam of the optical sensor and cause errors.
- d. From the sonde display, select Sonde Menu / Calibrate / Turbidity / 2-point, and press Enter.

- e. Enter "0.0" as the first calibration standard and press enter. Always calibrate with 0.0 NTU solution first to prevent cross-contamination of higher turbidity solutions.
 - f. Select the "clean optics" option to activate the automated wiper. Once the cleaning process is completed, wait for the turbidity measurement to equilibrate, and press Enter.
 - g. Rinse all the probes with deionized or distilled water. Shake off excess water.
 - h. Place the probe in the 126 NTU standard.
 - i. Press Enter to continue calibration.
 - j. Enter "126.0" as the second calibration standard and press Enter. Again, select the "clean optics" option to activate the automated wiper. Once the cleaning process is completed, wait for the turbidity measurement to equilibrate, and press Enter.
12. Check the sensor by repeating steps 1–6, recording the new values under "sonde reading following calibration." If the results are still not allowable, recalibrate. If problems persist, go to *Troubleshooting*, below.

Troubleshooting:

The 6136 optical turbidity sensor used on the YSI 6920 sondes is equipped with a wiper that cleans biofouling from the optical lens. Ensure that the wiper is parking approximately 180 degrees from the optic lens. It is very important not to turn the wiper manually as this will damage the internal gears and void the probe warranty. If the wiper is not parked approximately 180 degrees from the optic lens, select Sonde Run and select "clean optics." The wiper will turn in each direction and park in the correct position. Occasionally the "clean optics" option may need to be selected two or three times to get the wiper to park correctly.

If a calibration error occurs, there are several possible sources of the problem, including air bubbles on the optical surface, contamination of the standard, or internal malfunction of the probe optical system. Whatever the problem, do not override the calibration error message. With the sonde in the Run mode, remove the sensor guard or calibration cup and place a thumb or finger over the probe optics. A high ($> 1,000$ NTU) reading should be reported if the probe is responding correctly. If no response is reported, the probe must be returned for servicing. If the probe is functioning properly, return the probe to the 0.0 NTU solution (distilled water), activate the wiper, and perform a 2-point calibration. Observe the readings of the 0.0 NTU solution. If a value of >5 NTU is reported, it is possible the 0.0 NTU solution was contaminated from debris on the probe(s) or sensor guard carried over from previous field use. Discard the solution, rinse the sonde, and place in new solution. If the new reading is <5 NTU, proceed to the second calibration point. If not, contact the Project Lead to discuss next steps. If a calibration error occurs on the second point, use a new source of standard and perform calibration again.

Occasionally slightly negative turbidity readings may be experienced in very clear waters, as may be encountered in non-glacial rivers in SEAN. The cause is usually due to one of two sources: contaminated 0.0 NTU turbidity solution (distilled water) or interference from the calibration cup during the 0.0 NTU calibration. Avoid contaminated

turbidity solutions by thoroughly cleaning all probes and the calibration cup prior to turbidity calibration procedures. Interference from the calibration cup may be a result of: 1) using a calibration cup with a gray (rather than black) bottom, 2) using a calibration cup with a black bottom contaminated with impurities, or 3) having the probe too close to the calibration cup bottom. To overcome these problems, use a clean, black cup and only thread the cup one turn onto the sonde to keep the cup as far from the probe as possible. If the sensor needs replacement, contact the Project Leader to determine next steps. Removal of the turbidity probe by the user will void the factory warranty.

9.4 Additional Troubleshooting Procedures

Occasionally, problems are encountered during a calibration and the instrument must be reset to return the instrument to factory settings. This is performed using these steps:

1. Access the desired parameter to reset in the calibrate menu.
2. When prompted to input a number for a standard, hold the Enter key down and press the Escape key. Highlight the “yes” key and press Enter.
3. For additional troubleshooting refer to the YSI User manual or call YSI technical support at 1-800-897-4151 and ask for technical support. Before making decisions to modify equipment or software, it is best to check with the Project Lead before proceeding. It is better to lost one day of data than a several weeks due to an avoidable repair or damages equipment.

10.0 Sonde Storage and Handling

In case the sonde needs to be taken out of active monitoring for maintenance or at the end of the field season, it will need appropriate handling and storage until transported back to the office and/or sent to the Project Leader. In the field, the sonde sensor guard should be unscrewed and replaced with the calibration cup with wetted sponge inside, threaded securely onto the sonde, and the communication cables disconnected. The sonde unit should be packed securely into the supplied carrying case to ensure minimal physical disturbance while hiking or driving back to the office. In the office, all probes should remain connected to their sonde ports but should be carefully cleaned using tap water and gently wiped clean if necessary with a cotton cloth (moistened with water only) and/or soft toothbrush (gentle around the optical sensors!) prior to being placed in the calibration cup for longer term storage and shipping to the manufacturer by the Project Leader for annual servicing.

Although some probes do not require wet storage, all probes may be stored wet. The optical DO sensor **MUST** be stored in water or at least a water-saturated air environment and the pH probe should also be stored in a moist environment. The best way of storing the sonde with all probes attached is by threading it onto the calibration cup that holds a water-soaked sponge (a yellow sponge is included with the instrument but may be replaced with any commercial sponge cut to size). If a sponge is not available and water alone is temporarily used, use tap water (or stream water for short time periods) and not distilled water, as the latter may damage the pH probe with prolonged contact.

Storage for each of the individual probes is as follows. However, as mentioned elsewhere in this protocol, the probes generally should not be removed from the sonde by the user unless s/he is certain of the need for this action. After being deployed in the field, the pins holding the probes to the sondes are easily damaged when trying to unscrew the probes. It is best to let the

manufacturer unscrew the probes during the annual maintenance service so as not to incur damage that may not be covered by the instrument warranty.

- **The temperature/conductivity probe and the optical turbidity probe** require no special storage; they can be stored wet or dry. For their long-term storage, the user may wish to remove the probe from the sonde, replace it with a port plug, and store the probe in dry air to minimize cosmetic degradation of the probe body and to maximize the life of the turbidity wiper.
- **The pH probe** (specifically, the reference electrode junction) may be damaged if stored dry or in distilled or deionized or distilled water. Therefore, make sure that it is always stored in a moist environment (ideally in the sonde storage/ calibration cup with a water-soaked sponge). If the probe is disconnected from the sonde for prolonged storage, it should be stored in the vessel (plastic boot or bottle) the probe was delivered in. The vessel should contain a solution of 2 M potassium chloride. Make sure that the vessel is sealed to prevent evaporation of the storage solution.
- **The optical DO probe** must be stored in a wet environment: either water-saturated air (preferred) or water. If stored while connected to the sonde, the storage/calibration cup covering all the probes should contain a water-soaked sponge that will maintain a water-saturated air environment. If the probe is being stored separately, use the protective plastic cap and enclosed sponge provided with the sensor; simply soak the sponge in water and replace the cap on the probe tip. Inspect the sponge every 30 days to make sure it is still moist. If the sensor membrane is allowed to dry out by exposure to ambient air, it must be rehydrated in order to avoid drift at the start of the next deployment. To do so, place approximately 400 mL of water in a 600 mL beaker or similar glass vessel and heat the water on a hotplate or in an oven so that a consistent temperature of $50 \pm 5^\circ\text{C}$ is realized. Place the probe tip containing the sensor membrane in the warm water and leave it at that temperature for approximately 24 hours, covering the vessel if possible to avoid evaporation. After rehydration is complete, store the probe in either water or water-saturated air prior to deployment and calibration.

When the sonde is packed for shipment to YSI, additional steps are required as specified in Chapter 9 of the user manual.

11.0 Setting up the Sonde to Begin Automated Monitoring

Once the sonde is cleaned, recalibrated, and otherwise ready to be (re)deployed for automated monitoring, the sonde needs to be programmed (using the 650) to log measurements. Again, detailed instruction on setting up and using the 650 are provided in the operating manual, but the essential instructions are provided below.

Use the **650 Sonde menu** selection to access **Sonde Run/ 2. Unattended sample**. The Unattended sample menu will be displayed. Use the following example to understand the unattended sampling option.

Follow the prompts on the “Unattended sample” screen as described below:

To verify and/or correct the time and date, enter **4-Status** or **5-System** menu from the Main menu. You may enter the correct date and time from either of these submenus.

Select **1-Interval** and enter the desired time between samples (for hourly measurements, use 01:00:00)

Select **2-Start Date** and **3-Start Time** to set the time that data will begin to log to sonde memory. (If you do not make any change to these entries, then the study will automatically begin at the next integral time interval once you have pressed **C-Start logging.**)

Select **4- Duration** and set the length of the study in days. In most cases, you will want to stop the unattended study manually or allow the batteries to be expended. Set the duration to a value longer than the anticipated deployment so that if you cannot retrieve the sonde at the expected time, data will continue to be acquired as long as battery power is present. The protocol calls for checking the sonde every 4 weeks; therefore, set the duration to at least 8 weeks, especially for rivers such as the Taiya that may have prolonged periods of high flow in the summer that will prohibit access to the instrument. It will generally be OK to set the duration to the entire season length.

Select **5-File** and enter the formal name of the file, which is used to record the entire data set throughout the season. The file name is exactly six characters of the form SSYYYY where:

SS=the two character site code as defined in Appendix A of the protocol (as of this writing, IN for Indian River, SA for Salmon River, TA for Taiya)

YYYY=the four character year (e.g., 2010)

Double check that the name entered is correctly. It is not easy to change once set.

Select **6-Site** and enter your site name. This name will appear in the sonde file directory, which will be convenient for distinguishing among files if the instrument is used in multiple locations during the season. The site name, however, does not get saved in the data file and is not available to users.

Check **7-Battery** to make certain that the estimated battery life is suitable for the length of the study that you are about to begin.

Select **B-View Parameters to log** to confirm that the sensor and report setups are configured correctly (done in section 5). In some cases, this screen only identifies the raw parameters that are used in the calculation of the parameters selected in the Report setup. For example, although DO mg/L is selected in the Report setup, it does not appear under **View parameters to log** because it is calculated from DO saturation %, Temperature, and Conductivity. Similarly, specific conductance is calculated from Conductivity and Temperature, and it does not appear although selected in Report setup.

After making these entries, the sonde software will automatically estimate the expected battery life and the time it will take for the sonde memory to be filled. The battery change schedule and sampling frequency have been established so that there should be ample power and memory. If the machine reports a deficiency, remedial action should be taken to resolve the issue.

Press **C-Start logging**, followed by **1-Yes** to confirm, and the screen will change to the “Logging” display. This display shows the next date and time for logging, and the stop date and time for the logging study. Verify they are correct.

The Unattended study will terminate when the duration you specified has expired or the batteries are expended. If you want to terminate sooner, simply select **2-Unattended** sample from the Run menu, then **B-Stop logging**. Select **1-yes** and return to the Unattended setup menu.

Power down and disconnect the 650. Seal the sonde data connection outlet and connect the tether line to sonde. Lower the sonde into the ABS housing to begin (or resume) sampling. Secure the tether to a solid point and be sure to take up slack in the tether line so it does not catch debris floating downstream.

12.0 Off-season Maintenance and Storage

At the end of the season, Park Leads will store and package the sonde and probes according to section 10.0 of this SOP. After the sonde and probes are cleaned and stored in the padded case, pack the contents into a cardboard box for shipping to the SEAN Project Leader. In total, pack the sonde, connected probes, data logger (650), field cable, and any spare YSI parts (probes, maintenance kits, or other hardware). Other remaining field supplies listed in Table SOP 1.1 can be retained at each park. With the SEAN shipment, please include a note listing the remaining volumes of each calibration standard and their expiration dates. List remaining field supplies such as squirt bottles, paper, clipboard, etc. This list will assist the Project Leader ordering process for the next field season. Instead of a note, this list can also be transmitted via email to the Project Leader.

Please pack carefully. If the size of the cardboard box allows contents to move, pad the box to minimize movement. If there are any remaining questions regarding how the sonde and probes should be stored prior to shipping, refer to the YSI user manual.

After receiving each park’s sonde and probes, the Project Leader will note the condition of each park’s equipment and prepare for sending to YSI for annual maintenance. The Project Leader will ensure that sondes are properly decontaminated in 70% isopropyl alcohol or a solution of ¼ cup bleach for every 1 gallon tap water. This decontamination should also occur in the unlikely event that sondes are transferred between watersheds within a season.

Upon receiving sondes and probes from YSI after annual maintenance, The Project Leader will ensure that sondes are stored correctly for long-term storage before the next field season.

Before May 1 each year, the Project Leader will conduct individual on-site training with water quality monitoring staff in each park, ensure that each staff has the necessary equipment to conduct a successful monitoring season, and assist in the initial sonde installation. After initial sonde installation, monthly service and data downloading will be conducted by Park Leads and support staff.