

Monroe, S. A., M. Dyer, S. Stumpf, C. Bliss, and C. Parker. 2016. Water quality monitoring protocol for streams and springs in the Southern Colorado Plateau Network. Natural Resource Report NPS/SCPN/NRR—2016/1298. National Park Service, Fort Collins, Colorado.

## **Standard Operating Procedure #4: Maintaining and Preparing Water Quality Monitoring Field Equipment, Version SCPN\_WATER\_QUALITY\_SOP04\_20160901**

**Contents**

Equipment . . . . . 3

1 Introduction . . . . . 3

    1.1 Hydrology Premobilization datasheet . . . . . 3

Water Quality Monitoring Protocol for Streams and Springs in the Southern Colorado Plateau Network. . . . . 3

    1.2 Equipment log books . . . . . 4

2 Maintaining discharge measurement equipment . . . . . 4

    2.1 Discharge equipment manuals and software updates . . . . . 4

    2.2 Discharge equipment premobilization check . . . . . 4

3 Checking and maintaining water quality equipment . . . . . 6

    3.1 Water quality equipment operating manuals and software . . . . . 6

    3.2 Data quality objectives for core parameters . . . . . 6

    3.3 Premobilization water quality equipment . . . . . 7

4 Revision history . . . . . 19

## Standard Operating Procedure #4: Maintaining and Preparing Water Quality Monitoring Field Equipment

| Version SCPN_Water_Quality_SOP04_20160901 |               |                       |                |             |
|-------------------------------------------|---------------|-----------------------|----------------|-------------|
| Revision History Log                      |               |                       |                |             |
| Previous version number                   | Revision date | Section and paragraph | Change(s) made | Approved by |
|                                           |               |                       |                |             |
|                                           |               |                       |                |             |
|                                           |               |                       |                |             |
|                                           |               |                       |                |             |
|                                           |               |                       |                |             |
|                                           |               |                       |                |             |
|                                           |               |                       |                |             |
|                                           |               |                       |                |             |

Only changes in this specific SOP will be logged here. Record the previous version number and date of revision; identify sections and paragraphs where changes were made, who approved the revision, and the new version number. More detailed descriptions of the changes made and the reason for the changes is provided at the end of this SOP.

This Standard Operating Procedure (SOP) describes procedures for maintaining equipment used for water quality monitoring in SCPN parks. This involves cleaning, repairing, and calibrating equipment used in measuring discharge and taking water quality core parameter data, as well as keeping a record of maintenance for each piece of equipment.

### Equipment

Please see Appendix F for a list of the equipment needed to collect field data for water quality sampling.

### 1 Introduction

The accuracy of water quality monitoring data depends in part on properly functioning and calibrated equipment. To ensure this, SCPN staff does the following on a quarterly basis:

- Checks all water quality and discharge

measurement equipment to verify that it is in optimal working condition and that batteries are charged.

- Calibrates each piece of equipment. This includes taking precalibration readings, which indicate the tendency of a particular sensor to go out of calibration between field uses. These readings can also provide an indication of the remaining sensor life and whether short term storage measures are adequate.
- Checks each instrument for accuracy against standard solutions of known pH, specific conductance, and dissolved oxygen before and after calibration.

#### 1.1 Hydrology Premobilization datasheet

Instrument information, pre- and post- calibration readings will be noted in the *Hydrology Premobilization Datasheet* (Premobilization datasheet henceforth, Figure 4-3). These readings will allow the user to compare

calibration results and measurements against allowable ranges of variation. If the calibration and accuracy check do not meet the recommended guidelines, the user must note this in the equipment log book, consult the appropriate chapter in the user manual and take action to fix the problem.

### **1.2 Equipment log books**

A log book should be established for each piece of water quality monitoring equipment. The following information will be recorded for each:

- manufacturer, model, serial number of the equipment
- date of purchase
- NPS property number and ownership
- help line numbers and contact information for support in case equipment problems arise that you cannot solve. If you've found certain tech support staff to be particularly helpful, record their names and phone number.
- dates when problems with operation of the instrument occurred and description
- dates when maintenance was performed and by whom
- dates when parts were replaced and by whom

All information about the maintenance and repair of equipment, or any other item of concern should be noted in the log book. **SCPN field staff should check the equipment log books prior to each fieldtrip.** The logbooks are to be kept in the equipment case so that they can be readily accessed in the lab. Every year, staff should scan the logbooks. The scanned copies should be included in equipment documentation folders stored on the SCPN common drive.

## **2 Maintaining discharge measurement equipment**

Several equipment options are available for measuring discharge. The specific type of equipment used will vary by site and will depend on flow conditions at the time of

each site visit. Factors influencing the choice of the appropriate equipment are discussed in SOP #5.

Prior to each monitoring trip, the trip leader must ensure that equipment required for discharge measurements in the potential range of expected conditions is available and in working order. Sources for instructions and documentation for equipment that measure discharge are provided below. Types of equipment that measure discharge are listed in Appendix F.

### **2.1 Discharge equipment manuals and software updates**

The following software/firmware are available on the SCPN common drive or online:

- FlowTracker ADV: <http://www.sontek.com/sw/flowtracker.php2.4>
- AquaCalc: <http://www.aquacalc.com/>
- Pygmy Meter: Pygmy-MH Meter manual ([http://www.forestry-suppliers.com/Documents/787\\_msds.pdf](http://www.forestry-suppliers.com/Documents/787_msds.pdf))
- Marsh-McBirney Flo-Mate Model 2000: on SCPN common drive Hach FH950: <http://www.hachflow.com/pdf/DOC026.52.80210.pdf>

### **2.2 Discharge equipment premobilization check**

#### **2.2.1 Sontek FlowTracker ADV BeamCheck**

Before each field trip, verify that the FlowTracker system is operating properly by performing a BeamCheck test with the FlowTracker connected to a PC. This procedure is described in detail in the FlowTracker Technical Manual. All BeamCheck data should be recorded on the *Premobilization Datasheet* and stored electronically as an output file, which compares measurements against allowable ranges (Figure 4-1). Sampling volume, boundary reflection, and noise level should all be within acceptable ranges, and beams should have similar values. If these do not meet recommended guidelines, the user must note this in the equipment log book, consult the appropriate chapter in the user manual and troubleshoot the problem.

If unsuccessful in fixing the problem, send the unit in for repair or replacement. All BeamCheck files should be saved on the SCPN common drive.

Fill out the Sontek FlowTracker ADV BeamCheck section on page 3 of the *Premobilization datasheet* (Figure 4-3) as described below.

1. Write the FlowTracker serial number in the space provided
2. Note the location of the sampling volume center, which is the peak of the bell-shaped curve in Figure 4-1. It should typically be between 10–12 cm, and should be in the same location for both receivers. The locations are displayed at the top of the screen under “Peak Pos (cm)”.
3. Note the noise level when the FlowTracker is out of the water.
4. Note the noise level when the FlowTracker is in water.
5. Circle whether the noise levels are similar. The noise level in water should be less than 10 counts greater.
6. After evaluating the above criteria, circle whether or not the BeamCheck was acceptable.
7. Write the BeamCheck file name.
8. Note the battery power level on the FlowTracker as a percentage.

### **2.2.2 Marsh-McBirney Flo-Mate and Hach FH950**

The Marsh-McBirney Flo-Mate and Hach FH950 use the same technology, except the FH950 records data and the Marsh-McBirney does not. Because there are no moving parts, there is minimal maintenance required. Before each trip, the meter should be checked in still water to ensure that it reads 0.00 +/- 0.05 ft/sec.

1. First, clean the sensor.
2. Place the sensor in a five gallon plastic bucket of water. Keep it at least three inches away from the sides and bottom

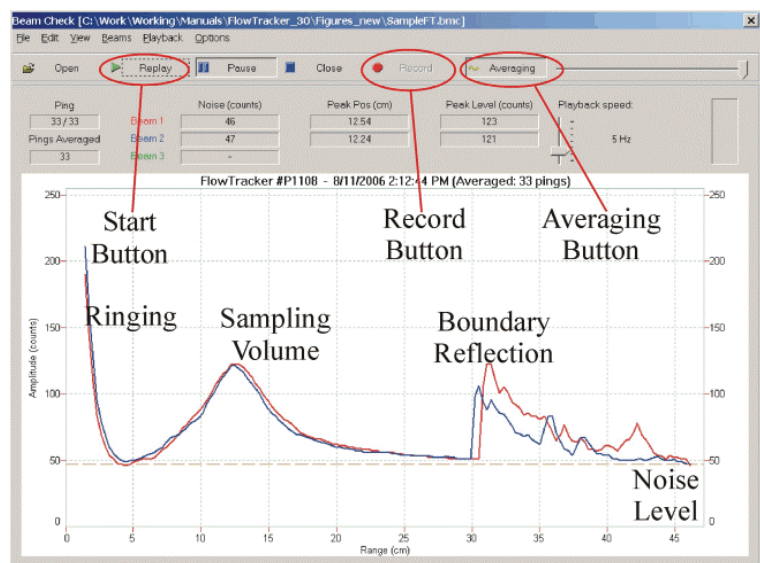


Figure 4-1. Sontek FlowTracker ADV BeamCheck signal strength plot.

- of the bucket.
3. To make sure the water is not moving, wait 10 or 15 minutes after you have positioned the sensor before taking any zero readings.
4. If the meter reads outside of 0.00 +/- 0.05 ft/s, consult the Marsh-McBirney user manual for instructions describing how to do a zero-adjustment. If a zero adjustment is made, note this on the data-sheet. This type of maintenance is not required on the Hach FH950.
5. Make sure that both meters are set to “fixed point averaging”, which is referred to as fpa. This will allow the meter to display only average velocity rather than the instantaneous velocity. The measurement time should be set to 40 seconds.

### **2.2.3 Pygmy Meter**

The pygmy meter (Figure 4-2) must be spin-checked during the premobilization and prior to sampling flow at each site to be sure that it is operating properly. The spin check should be done in a sheltered place (such as a vehicle) to avoid wind interference. The meter should spin for at least 45 seconds.

1. Visually inspect the meter according to user manual instructions regardless of spin test results, as damaged parts may

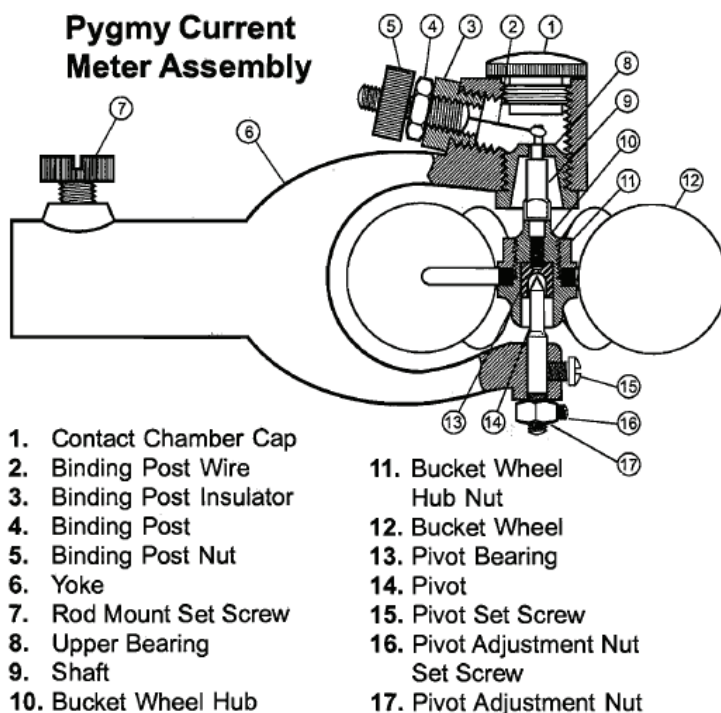


Figure 4-2. Pygmy meter diagram (from Rickly Hydrological user manual)

cause meter inaccuracy that a spin test may not reveal.

2. Inspect the pivot alignment.
3. Rotate bucket wheel and check for wobble of either the bucket wheel itself or the bucket wheel hub.
4. Ensure meter is properly oiled and cleaned, particularly the shaft, upper bearing, pivot bearing, and pivot.
5. Record timed spin test results, repairs, and meter checks in the meter logbook and the *Premobilization datasheet*.
6. If the meter fails this test, refer to the user manual for troubleshooting. If the problem cannot be fixed, send the unit in for repair, or replace.

### 3 Checking and maintaining water quality equipment

SCPN will use a Hydrolab MiniSonde 5 (MS5) multi-parameter sonde and a personal digital assistant (PDA) or laptop to measure the NPS core water quality parameters of water temperature, pH, specific conduc-

tance, and dissolved oxygen in the field. The PDA utilizes Hydras 3 Pocket Software to communicate with the MS5 and interfaces with desktop or laptop computers through ActiveSync and Hydras 3LT software. A Hach 2100P Turbidimeter will be used to measure turbidity. The most current version of all required software should be loaded onto all Water Resources staff office and field computers (see section 3.1). Water Resources staff should be thoroughly familiar with all equipment and software prior to going into the field.

SCPN has two additional water quality meters: the Hanna Combo meter (HI98129) and YSI ProODO meter. These meters are used at small or remote springs and may serve as back-ups for pH, specific conductance, and dissolved oxygen in case the Hydrolab MS5s are not functioning properly. Equipment used for obtaining water quality measurements are listed in Appendix F.

#### 3.1 Water quality equipment operating manuals and software

For all manuals and software, refer to SCPN common drive or to the appropriate online resource.

- Trimble Recon (PDA): [www.trimble.com](http://www.trimble.com)
- Hydrolab MS-5 (multi-parameter sonde): [www.hydrolab.com](http://www.hydrolab.com)
- Model 2100P turbidimeter – [www.hach.com](http://www.hach.com)
- [Hanna Combo meter \(HI98129\)](http://hannainst.com/downloads/dl/file/id/1743/manhi_98129_98130.pdf) - [http://hannainst.com/downloads/dl/file/id/1743/manhi\\_98129\\_98130.pdf](http://hannainst.com/downloads/dl/file/id/1743/manhi_98129_98130.pdf)

#### 3.2 Data quality objectives for core parameters

An instrument must be properly calibrated so that the data produced will be acceptable. In this regard, calibration is a component of quality assurance. Acceptable ranges of variance from a calibration standard for multi-parameter sondes have been recommended by Gibbs et al. 2012 and are listed in Table 4-1. These are the values against which pre-mobilization post-calibration values should be

compared to indicate that the sensors are working properly.

### 3.3 Premobilization water quality equipment

#### 3.3.1 Hydrolab MS5 multiparameter sonde

The Hydrolab must be used with a PDA. Before going in the field, take the following steps:

1. Set the clocks in the PDA and the sonde to local time at the monitoring site.
2. Synchronize the PDA clock with the sonde internal clock.
3. Make sure that sufficient memory is free in both instruments.
4. Check battery levels in both instruments. Have backup batteries available for both devices.

Equipment should be calibrated for specific conductance and pH using high quality standard solutions, whereas calibration for dissolved oxygen should be done with oxygen-saturated water and checked with oxygen-depleted water. Complete calibration instructions, adapted from Gibbs et al. 2012, are provided below.

Equipment should be calibrated for specific conductance prior to calibrating for pH. This avoids contamination by the pH standards, which possess conductivities much higher than the conductivity standards. For the same reason, **do not change to the pH reference salt solution until after conductance calibration** and checks have been performed.

For all calibrations, always use fresh calibration standard solutions. However, when performing a pre-calibration rinse with a standard, utilize the used standards (i.e. those used in previous calibrations) whenever possible. Follow the steps below when calibrating, both in the lab and in the field.

1. Rinse off sensors with DIW.
2. Perform a triple-rinse with used standard solution. Do the following 3 times:

Table 4-1. Acceptable post-calibration ranges for core parameter measurements with water quality sondes (Gibbs et. al. 2012).

| Core parameter                                             | Acceptable post-calibration range                                                                                  |
|------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
| Water temperature                                          | $\pm 0.2^{\circ}\text{C}$                                                                                          |
| pH                                                         | $\pm 0.2^{\text{a}}$                                                                                               |
| Specific conductance                                       | $\pm 5 \mu\text{S}/\text{cm}$ if $\leq 100 \mu\text{S}/\text{cm}$ or $\pm 3\%$ if $\geq 100 \mu\text{S}/\text{cm}$ |
| Dissolved oxygen                                           | $\pm 0.3 \text{ mg/L}$ , $\pm 3\%$ saturation                                                                      |
| <sup>a</sup> If drifting persists allow $\pm 0.3$ pH units |                                                                                                                    |

- fill the cal-cup about 20% full
  - screw the cal-cup on to the MS5 and swish the liquid to thoroughly coat all sensor surfaces
  - unscrew the cal-cup and discard the liquid
  - Shake the excess liquid from the sensors
3. Fill the cal-cup to the fill line with new standard solution and screw it on to the MS5.
  4. Perform three inverted turns on the MS5 to ensure that the standard is well-mixed.
  5. Wait until sensor readings have stabilized before accepting a calibration value.
  6. Pour the used standard into a small carry bottle (to be used for rinsing).
  7. In the **Calibration Data** section of the *Premobilization datasheet* (page 1), record the name of the instrument, the calibration time, and the standard lot numbers.
  8. Take pre- and post-calibration readings of standard solutions for pH and specific conductance, and of oxygen-saturated tap water for dissolved oxygen. After all the calibrations are finished for each parameter, triple-rinse the sensors and use new calibration standards to check that the calibrations are within the ranges listed in Table 4-1. Record all of these values on the *Premobilization datasheet* as described below.

### **3.3.2 Specific conductance sensor maintenance and calibration**

(Adapted from Hach Conductivity Calibration Video Transcript)

*Introduction.* The conductivity sensor measures the ability of water to conduct electricity across a set distance between graphite conductors of a known size. When the conductivity is known, the salinity and total dissolved solids can be calculated and displayed.

*Maintenance.* The only maintenance required is cleaning of the probe's cell and body. The inside of the cell should be cleaned out with a cotton swab or small brush, periodically or after a long term deployment. In addition, all sensors should be cleaned prior to calibration. Any residue or debris on the sensors may contaminate the conductivity standards and change their value, resulting in an inaccurate calibration, which will negatively affect the accuracy and stability of the readings.

*Calibration.* Two-point calibrations will be performed with standards that bracket the measurements normal to SCPN streams. When calibrating, make sure there is not an air bubble in the conductivity sensor.

The first calibration point is done with a 100  $\mu\text{S}/\text{cm}$  standard. Triple-rinse the sensors with de-ionized water and dry them thoroughly. Fill the calibration cup with the standard, take the pre-calibration reading and note it on the datasheet. Then calibrate with a 1413  $\mu\text{S}/\text{cm}$  standard. The sensor is now calibrated. To check the linearity of the sensor, test with a 5,000  $\mu\text{S}/\text{cm}$  standard, but do not calibrate. Record this post-calibration reading.

Then check with the 100 and 1413  $\mu\text{S}/\text{cm}$  standards. Write these values in the "post-calibration reading" column on the *Premobilization datasheet*.

If the values should fall within the ranges specified in Table 4-1, the sensor is ready for field use. If not, sensor troubleshooting (see

the Hydrolab MS5 manual) or replacement may be required.

### **3.3.3 Maintaining and calibrating the pH sensor**

(Adapted from Hach pH Calibration Video Transcript available at: <http://hydrolab.com/Resources/VideoIndex.asp>)

*Introduction.* The pH sensor has two electrodes: The measuring electrode is surrounded by a glass bulb; the reference electrode is surrounded by an electrolyte solution and is separated from the water sample by a porous junction. By measuring the electrical potential between these two electrodes in millivolts, the sensor can determine the hydrogen ion activity and calculate the pH for a given water sample.

*Maintenance.* In order to give consistently accurate readings, the pH sensor should be maintained on a regular basis. Oils, sediment, and biological contaminants on the bulb or reference junction will result in errant readings or a very slow response. Leaching or dilution of the electrolyte solution in the reference will cause the readings to drift over time. The glass bulb is very thin and fragile. Care should always be taken not to damage it when servicing the instrument. For instructions on maintaining the pH sensor, refer to the Hydrolab MS5 manual at [www.hach.com](http://www.hach.com) or on the SCPN common drive.

The reference junction is a threaded cap with a sleeve of porous Teflon in the center. The Teflon allows the reference electrolyte to make an electrical connection to the sample water while preventing them from mixing freely. Replace the reference junction if it is visibly fouled. Water with strong biological activity tends to foul the junction more rapidly.

Replace the electrolyte solution regularly. Water with very low levels of dissolved solids or high flow rates will leach the salts out of the solution and dilute it more quickly. To maintain the saturation level of the electrolyte, add a salt tablet to the reference electrolyte. The specific water conditions and the

frequency of use of the probe will determine how often this should be done. Once the cap is replaced, a small amount of electrolyte should be forced out of the junction. If this does not happen, the junction may be clogged and must be replaced.

The pH sensor should not be allowed to dry out for extended periods. When not in use, store the sensor in pH 4 buffer or clean tap water. Do not store the sensor in de-ionized water. DI water will damage the sensor bulb.

The pH sensor is now ready to be calibrated. In addition to calibrations prior to field work, pH sensor performance will be tracked over time by recording the millivolts generated by the sensor in each calibration buffer as explained in Ritz and Collins 2008. In order to track probe performance, these numbers will be used to calculate the slope percentage of the pH probe in buffers bracketing the ranges found in SCPN streams, usually pH 7 and 10. This process is described below.

*Calibration.* Two point calibrations will be made with standards that bracket the anticipated pH of SCPN streams; this is normally between pH 7 and 10. Make sure standards are at ambient air temperature before beginning laboratory calibration.

1. Calibrate with pH 7 buffer. When the readings are stable, note the pre-calibration value on the *Premobilization datasheet*, and type a value of 7.00 into the box, adjusted for temperature if standard is not at 25°C (Table 4-2), and click 'Calibrate'. A "Calibration Successful" message should appear.
2. If the pH readings continue to drift for more than a minute, or jump up and down, the sensor may need to be cleaned or replaced.
3. With the probe still in the pH 7 buffer, record the mV generated by the electrode on the *Premobilization Datasheet*.
4. Next, calibrate with pH buffer 10. When the reading stabilizes, note the pre-calibration value and type the labeled value

Table 4-2. Aqua Solutions pH buffer standard values

| Temperature, °C | pH 7 | pH 10 |
|-----------------|------|-------|
| 0               | 7.13 | 10.34 |
| 5               | 7.10 | 10.26 |
| 10              | 7.07 | 10.19 |
| 15              | 7.05 | 10.12 |
| 20              | 7.02 | 10.06 |
| 25              | 7.00 | 10.00 |

of the solution into the box, adjusted for temperature if standard is not at 25°C (Table 4-2), and click 'Calibrate'. When the "Calibration Successful" message appears, the sensor is calibrated.

5. With the probe still in the pH 10 buffer, record the mV generated by the electrode on the datasheet.
6. Finally, use a pH 4 buffer to test the linearity of the calibration. Repeat the process described for the previous calibrations, but do not click the calibrate button again. This value should be between 3.8 and 4.2 as shown in Table 4-2. Write this value on the *Premobilization datasheet*.
7. Check the calibration by taking readings in the pH 7 and 10 solutions, but do not re-calibrate. Write these values on the *Premobilization datasheet* under the "post-calibration" column.
8. If the "Calibration Failed" message appears repeatedly, the sensor may need to be replaced and another Hydrolab should be used.
9. After calibrating the sensor, perform the following steps to calculate the slope percentage of the pH probe:
  - Calculate the difference in mV between results obtained from the higher buffer and the lower buffer
  - Divide the difference in mV by the difference in the pH of the buffers
  - Divide this number by the theoretical maximum slope (59.16 mV/pH unit at 25°C) and multiply by 100 to get a percentage. Write this percent-

age on the *Premobilization datasheet*

- The slope percentage of properly working electrodes should be between 95 and 102%. At 94% or less, the pH sensor should be replaced.

### **3.3.4 Hach Luminescent Dissolved Oxygen Sensor Calibration**

(from Hach LDO Sensor Instruction Sheet and Calibration Video Transcript )

*Introduction.* The Hach luminescent dissolved oxygen (LDO) sensor is an in-situ optical probe that determines the dissolved oxygen concentration in a given water sample. The sonde can display the oxygen either as a concentration from 0–20 mg/L or as a percent saturation with either air saturated water or water-saturated air serving as the 100% reference point.

*Maintenance.* The Hach LDO sensor is not affected by fouling or other debris, unless the growth is an organism that locally consumes or produces oxygen, such as algae growing on the sensor cap. Nevertheless, the manufacturer recommends periodic maintenance to remove contaminants such as oil, biological growth, dirt, etc. Sensor maintenance should be conducted after every deployment cycle.

1. Flush the entire instrument with clean, fresh water. Use Simple Green and a soft brush to clean the outer surfaces.
2. Soak the entire instrument in fresh water for at least 30 minutes.
3. Visually inspect the sensor cap, which should be covered with a luminescent material. Use optical tissue or a cotton swab with soapy water to clean the sensor cap. Rinse with fresh water. The cap should have at least 50% of the luminescent material remaining on the surface in order to work properly.
4. The sensor cap should not be removed unless it is being replaced or the sensor is reading erratically. Consult the Hach LDO instruction sheet at [www.hach.com](http://www.hach.com) or on the SCPN common drive for

instructions on sensor cap removal. If the cap is sealed properly using the top O-ring seal, no water should be present between the sensor cap and the clear plastic window at the top of the probe. If water is present, remove the cap and thoroughly dry the inside of the cap and the clear plastic window. The cap may need to be replaced.

*Calibration.* Dissolved oxygen (DO) concentration is expressed as either a concentration in mg/L or as a percent saturation, relative to 100% water saturated air or air saturated water. There are three standard methods for calibrating the Hach luminescent dissolved oxygen (LDO) sensor. These methods include calibrating with (1) air-saturated water, (2) water-saturated air, and (3) a known calibration standard. Each method requires a single point calibration for measurement of concentration in mg/L. In order to calibrate the sensor for percent saturation reading, the local barometric pressure must be determined independently by the user and input into the software during calibration. During premobilization, SCPN will perform a single point calibration with air-saturated water and check the linearity of the calibration with a 0% DO solution.

In order to retain calibration accuracy between deployments, store the LDO sensor in its storage cap with at least 10 cc of water. Below are air-saturated water calibration instructions:

1. Determine the barometric pressure in mmHg. In the lab, go to: <http://www.weather.gov> and find the Flagstaff forecast page. Click on the “3 day history” link below the Flagstaff airport weather station. Use the most current station pressure, but make sure to use the “station pressure”, which has not been corrected to sea level and should be approximately 23 inHg. Convert inHg to mmHg by multiplying by 25.4. Record this value to the nearest whole number when calibrating the MS5 as well as on the *Premobilization datasheet*.

2. In the field, barometric pressure is measured by a handheld barometer. The readings should be compared to the Flagstaff airport weather station readings and noted on the *Premobilization datasheet*.
3. A recommended method for calibration is producing air-saturated water and using it to calibrate the sensor is as follows:
  - Take a bottle and fill 25% with water. Use water that has been at equilibrium with local atmospheric pressure and temperature for at least 12 hours; tap water must be allowed to sit in an open bottle well in advance of calibration.
  - Seal the bottle and shake it very vigorously for 40 seconds, pour into calibration cup.
  - Make sure the water comes close to the top of the calibration cup. Place the calibration cup cap upside down (concave upward) on top of the calibration cup. Do not tightly seal or otherwise raise the barometric pressure in the calibration cup.
4. Wait until the temperature readings on the sonde stabilize. Note the pre-calibration DO percentage on the datasheet. Hit the “Calibrate” button. If “Calibration Failed!” appears, it is likely because the temperature was changing at the time and the calibration button will need to be pressed again. After “Calibration Successful” appears, repeat step 3 to obtain a post-calibration reading, and check to see if the DO reading is within the acceptable range listed in Table 4-1.
1. Prepare a 0% DO solution in a 1-liter glass jar as follows. Fill the jar with de-ionized water. Add 1g of  $\text{Na}_2\text{SO}_3$  and a few crystals of  $\text{CoCl}_2$ . Close lid and invert several times to aid dissolution of the crystals, keeping a minimum amount of headspace to aid oxygen consumption.
2. After crystals have dissolved, allow several minutes for oxygen scavenging to occur.
3. Position sonde so that sensors are completely immersed in the 0% DO solution. Readings are stable when there is no appreciable change for at least 30 seconds. It may take several minutes for this to occur. Note the percentage on the *Premobilization datasheet*.
4. The 0% DO solution is good for no more than a week if there is no headspace. Otherwise, the solution retains its low DO for only a day. After use, the solution may be disposed of in the sink.

### **3.3.5 Thermometer/Thermistor Calibration (adapted from Wilde 2006)**

*Introduction.* Because recorded values, such as pH, dissolved oxygen, and specific conductance, are temperature compensated, calibration of thermometers is especially critical. Hydrolabs are equipped with thermistor thermometers, calibrated by the manufacturer. Thermistors are one of the more accurate and stable sensors and require the least maintenance. They should be checked for accuracy against a National Institute of Standards and Technology (NIST) traceable thermometer during premobilization.

*Check for linearity: the 0% DO Solution Check.* This method is used during premobilization in order to check the linearity of the calibration in a no-oxygen environment—it is not used to perform a two point calibration. This procedure uses sodium sulfite ( $\text{Na}_2\text{SO}_3$ ), an oxygen scavenger, and cobalt chloride ( $\text{CoCl}_2$ ) as a catalyst. **Because cobalt chloride is a suspected carcinogen, always wear gloves when handling this solution.**

Once pH and specific conductance calibration has been completed, fill a sink with water and place the hydrolabs, Hanna Check-temp and a NIST-traceable liquid-in-glass thermometer (not a field thermometer) into the water bath and take temperature readings while circulating the water. The objective is to compare the field thermometers to a reliable NIST-traceable thermometer that does not get exposed to the rigors of field work. Each network lab should be equipped

with a NIST -traceable digital calibration thermometer (preferred) or a liquid-in-glass thermometer graduated at 0.1 °C, with a minimum range of –5 to + 45 °C. Liquid-in-glass thermometers should be stored upright; this will prevent the liquid column from separating.

*Calibration.* Prior to conducting fieldwork, temperature sensors to be used should be tested against NIST certified thermometers, which are used for lab testing of temperature equipment. A second NIST -traceable digital thermometer may also be appropriate for field use and may best serve to field check the thermistor-based measurements of the multiparameter sonde and to measure ambient air temperatures when at the monitoring station. All temperature readings should be made and reported in units of degrees Celsius (°C).

The following equipment is required to perform calibration checks for thermometers/thermistors:

- Calibration thermometer, liquid-in-glass or digital, traceable to NIST standards, always stays in lab; temperature range at least –5 to +45°C; 0.1°C graduated; calibrated accuracy of 0.1°C
- Field thermistors to be tested: Hydrolab, CheckTemp, HOBO pendants; calibrated accuracy within 0.1°C to 0.2°C; digital readout to at least 0.1°C
- Three small coolers, one filled with tap water that has been left at room temperature overnight
- Deionized water

- Laptop and reader for operating HOBO Pendants
- Log book for recording all calibrations, maintenance, and repairs

To calibration check a thermometer, instrument readings are checked across a range of temperatures against a NIST-traceable thermometer accurate to 0.1°C. Check the certificate of calibration for the NIST thermometer before calibration checking field thermometers. Record the thermistor make, model, and serial numbers on the *Premobilization datasheet*. Field checking thermometer calibration by comparing readings with another field thermometer does not substitute for required laboratory calibration procedures. In addition to the single-point comparisons done during the premobilization, once per year all SCPN thermistors should be calibration checked at three temperatures: 0°C, room temperature, and 40°C. HOBO pendants should be checked once per year on a rotating basis. Thermistors found to be out of calibration by more than 0.2°C must be returned to the appropriate manufacturer for proper calibration and (or) repairs. The manufacturer-provided resolutions and accuracies for the SCPN thermistors are listed in Table 4-3.

Prepare the water baths as follows:

0°C temperature check - Fill a small cooler with cold water and plenty of ice, mix until NIST-traceable thermometer reads 0.0°C in all parts of the cooler.

Room temperature (about 25°C) check - Use a small cooler filled with tap water that has been allowed to equilibrate in an area of the room where the temperature is fairly constant.

Warm water (about 40°C) check - Fill a small cooler with warm tap water and stir constantly while comparing thermometers and repeat the procedure described above.

When measuring water temperature in each of the water baths

1. Check the meter batteries prior to

Table 4-3. Manufacturer-provided resolutions and accuracies of SCPN thermistors

| Meter                       | Resolution | Accuracy |
|-----------------------------|------------|----------|
| Hydrolab MS5                | 0.01       | ±0.1     |
| Hanna Combo Meter (at 20°C) | 0.1        | ±0.5     |
| YSI DO                      | 0.1        | ±0.3     |
| HOBO Pendant (at 25°C)      | 0.10       | ±0.47    |
| Hanna Checktemp             | 0.1        | ±0.3     |

testing.

2. Submerge the bulb and liquid column of the glass thermometer, if using one.
3. Position the thermistors so that they are properly immersed, in a similar location, and so that the scales can be read.
4. Periodically stir the water bath and allow at least 2 minutes for the thermometer readings to stabilize.
5. When the readings stabilize, compare the temperature of one test thermometer at a time with that of the NIST-traceable thermometer. Without removing the temperature sensor(s) from the test bath, read the test thermometer(s) to the nearest graduation (0.1 to 0.5°C) and the NIST-traceable thermometer to the nearest 0.1°C.
6. Take three readings for each thermometer within a 5-minute span.
7. Calculate the mean of the three temperature readings for each thermometer and compare its mean value with the NIST thermometer.
8. Record the calibration data in the instrument log book and on the *Premobilization datasheet* for each thermistor thermometer.
9. If the test thermistor is found to be within  $\pm 0.2^\circ\text{C}$  of the NIST-traceable thermometer, set it aside for calibration checks at higher temperatures using the same procedure. If it is not, then it will need to be repaired, replaced, and the dataset will need to be adjusted.

Accurate determination of other field measurements depends on accurate temperature measurements. This must be underscored for thermistors incorporated in specific electrical conductance, dissolved-oxygen and pH instruments because these thermistors are used for automatic temperature compensation of the measurement being made. Thermistors found to be out of calibration by more than  $0.2^\circ\text{C}$  must be returned to the appropriate manufacturer for proper calibration and (or) repairs.

### **3.3.6 Turbidimeter**

*Introduction.* Turbidity is measured and reported in nephelometric turbidity units (NTU) using the Hach 2100P portable turbidimeter. The turbidimeter should be calibrated in the lab or office at least once every three months during premobilization equipment checks. Additional calibration may be necessary if field calibration checks indicate instrument drift. After calibration, values are assigned to Gelex standards which will be used to check the calibration in the field. When calibrating, record the date, lot numbers and expiration dates for the calibration standards, and meter readings for the Gelex standards in the log book and on the *Premobilization datasheet*.

We recommend that SCPN Water Resources staff read the USGS National Field Manual Chapter section on Turbidity (Anderson 2005). The following information about equipment calibration and maintenance is taken from both the National Field Manual and the Hach 2100P turbidimeter equipment manual. For the HACH 2100P Instrument and Procedure Manual, refer to common drive equipment folder or find it online at [www.hach.com](http://www.hach.com).

#### *Maintenance and care.*

- Protect turbidimeter from extreme temperatures and shield it from sunlight.
- Check and replace batteries regularly.
- Follow the Hach manual for specific calibration procedures with the formazin standards
- Formazin standards are affected by temperature. To avoid the effects of temperature changes on the calibration, perform the Formazin calibration and the Gelex readings at room temperature in the lab.
- Conduct instrument checks against the Gelex standards in the field.
- Discard turbidity standards that have expired. Never pour used standard solution back into a stock container.
- Keep sample cells clean inside and out.

Wash sample cells with non-phosphate detergent between each use and rinse with deionized water so that all detergent is removed.

- Store cells with some deionized water in them so that water spots do not form on the inside of the glass.

*Calibration.* The turbidimeter should be calibrated at least every three months with primary (formazin) standards. Refer to the instrument manual for specific instructions on how to do this. SCPN will use HACH StablCal™ Stabilized Formazin standards in <0.1, 20, 100, and 800 NTU solutions for calibration.

Immediately after calibration, three secondary (gelex) standards in the ranges of 0-10, 0-100, and 0-1000 NTU should be read. The readings from each standard is its “assigned value”, which is recorded in the equipment logbook and in the **Turbidity Calibration** section of the *Premobilization datasheet*. These Gelex standards will be used again in the field prior to each subsequent sample measurement to verify that the calibration is still acceptable.

When reading the standards, as well as sample water, ensure that “**signal averaging**” and “**auto-range**” are on by checking the lower portion of the turbidimeter display. Subsequent readings within  $\pm 5\%$  of the original values assigned to the Gelex standards indicate that the calibration is still acceptable. If the reading is not within 5% of the previously established value, recalibrate the instrument with StablCal Stabilized Formazin Primary Standard or formazin primary standard.

## Hydrology and Water Quality Premobilization Datasheet

Date: \_\_\_\_\_ Observer(s): \_\_\_\_\_

### Water Quality Instrument Information

|                           | Instrument 1                 | Instrument 2 | Instrument 3 | Instrument 4 | Instrument 5 |
|---------------------------|------------------------------|--------------|--------------|--------------|--------------|
| Instrument make/<br>model |                              |              |              |              |              |
| Instrument serial #       |                              |              |              |              |              |
| Instrument SCPN ID        |                              |              |              |              |              |
| Instrument Battery %      |                              |              |              |              |              |
| PDA make/model            |                              |              |              |              |              |
| NOAA Station P (in Hg):   | Conversion to mm Hg (×25.4): |              | Kestrel BP:  |              |              |

### Calibration Data

Calibration time: \_\_\_\_\_ Water quality instrument: \_\_\_\_\_ SCPN name: \_\_\_\_\_

| Std. Temp.<br>(°C) | Std. value | Std. lot # | Calibrated or<br>checked? | Pre-calibrate<br>reading | Post-calibrate<br>reading | Stable?<br>(Y/N, Table 1) | Stabilization<br>time | AMS |
|--------------------|------------|------------|---------------------------|--------------------------|---------------------------|---------------------------|-----------------------|-----|
|                    | pH 7       |            |                           |                          |                           |                           |                       |     |
|                    | pH 10      |            |                           |                          |                           |                           |                       |     |
|                    | pH 4       |            |                           |                          |                           |                           |                       |     |
|                    | 100        |            |                           |                          |                           |                           |                       |     |
|                    | 1413       |            |                           |                          |                           |                           |                       |     |
|                    | 5000       |            |                           |                          |                           |                           |                       |     |
|                    | LDO 100%   |            |                           |                          |                           |                           |                       |     |
|                    | LDO 0%     |            |                           |                          |                           |                           |                       |     |

pH 7 mV: \_\_\_\_\_ pH 10 mV: \_\_\_\_\_ Slope %: \_\_\_\_\_

Notes:

Calibration time: \_\_\_\_\_ Water quality instrument: \_\_\_\_\_ SCPN name: \_\_\_\_\_

| Std. Temp.<br>(°C) | Std. value | Std. lot # | Calibrated or<br>checked? | Pre-calibrate<br>reading | Post-calibrate<br>reading | Stable?<br>(Y/N, Table 1) | Stabilization<br>time | AMS |
|--------------------|------------|------------|---------------------------|--------------------------|---------------------------|---------------------------|-----------------------|-----|
|                    | pH 7       |            |                           |                          |                           |                           |                       |     |
|                    | pH 10      |            |                           |                          |                           |                           |                       |     |
|                    | pH 4       |            |                           |                          |                           |                           |                       |     |
|                    | 100        |            |                           |                          |                           |                           |                       |     |
|                    | 1413       |            |                           |                          |                           |                           |                       |     |
|                    | 5000       |            |                           |                          |                           |                           |                       |     |
|                    | LDO 100%   |            |                           |                          |                           |                           |                       |     |
|                    | LDO 0%     |            |                           |                          |                           |                           |                       |     |

pH 7 mV: \_\_\_\_\_ pH 10 mV: \_\_\_\_\_ Slope %: \_\_\_\_\_

Notes:

Figure 4-3a. Hydrology and Water Quality Premobilization Datasheet, page 1

| Core Parameter       | Acceptable post-calibration range                                                            |
|----------------------|----------------------------------------------------------------------------------------------|
| Water temperature    | $\pm 0.2^{\circ}\text{C}$                                                                    |
| pH                   | $\pm 0.2$                                                                                    |
| Specific conductance | $\pm 5\ \mu\text{S/cm}$ if $<100\ \mu\text{S/cm}$ or $\pm 3\%$ if $\geq 100\ \mu\text{S/cm}$ |
| Dissolved oxygen     | $\pm 0.3\ \text{mg/L}$ , $\pm 3\%$ saturation                                                |

(Use this format for filename: Date\_Instrument name\_premob)

SCPN name: \_\_\_\_\_

SCP name: \_\_\_\_\_

SCPN name: \_\_\_\_\_

SCP name: \_\_\_\_\_

SCP name: \_\_\_\_\_

[illegible]

Figure 4-3b. Hydrology and Water Quality Premobilization Datasheet, page 2.

Date: \_\_\_\_\_ Observer(s): \_\_\_\_\_

### Turbidity Calibration

| Primary (Formazin ) Standards: Calibration (to be done at least every 3 months) |                      |       |                 |                               |
|---------------------------------------------------------------------------------|----------------------|-------|-----------------|-------------------------------|
| Manufacturer                                                                    | Standard Value (NTU) | Lot # | Expiration date | Pos-calibration reading (NTU) |
|                                                                                 |                      |       |                 |                               |
|                                                                                 |                      |       |                 |                               |
|                                                                                 |                      |       |                 |                               |
|                                                                                 |                      |       |                 |                               |

### Secondary (Gelex) Standards: Value assignment and check

| Manufacturer | Standard Value Range (NTU) | Assigned Value (NTU) | Acceptable Range ( $\pm 5\%$ ) |
|--------------|----------------------------|----------------------|--------------------------------|
|              |                            |                      |                                |
|              |                            |                      |                                |
|              |                            |                      |                                |

### Sontek FlowTracker ADV BeamCheck

FlowTracker Serial number (SN): \_\_\_\_\_

|                                                                   |   |   |             |
|-------------------------------------------------------------------|---|---|-------------|
| BeamCheck performed                                               | Y | N | Battery (%) |
| Sampling volume center (should be in 11–13 cm range)              |   |   | Notes:      |
| Noise level out of water (normal)                                 |   |   |             |
| Noise level in water (should be less than 10 counts above normal) |   |   |             |
| Noise level in Beams similar                                      | Y | N |             |
| BeamCheck acceptable                                              | Y | N |             |
| Beamcheck file name:                                              |   |   |             |
|                                                                   |   |   |             |

### Marsh-McBirney Flo-Mate or Hach FH950 Zero-Check

|                                                            |   |   |
|------------------------------------------------------------|---|---|
| Flo-Mate or Hach FH950 SN:                                 |   |   |
| Velocity in still water (should be within $\pm 0.05$ ft/s) |   |   |
| Zero adjustment performed?                                 | Y | N |
| Notes:                                                     |   |   |
|                                                            |   |   |

### Pygmy Meter Spin Test

|                                                                   |   |   |
|-------------------------------------------------------------------|---|---|
| Pygmy meter SN:                                                   |   |   |
| Spin test results (should be $>45$ s, if not, clean/adjust meter) |   |   |
| Meter cleaned, lubricated, inspected                              | Y | N |
| Notes:                                                            |   |   |
|                                                                   |   |   |

### Temperature Sensor/Logger Calibration Check

NIST Thermometer type/SN: \_\_\_\_\_

Temperature sensor manufacturer/Model/SN: \_\_\_\_\_ Battery% \_\_\_\_\_ Is sensor within  $\pm 0.2^\circ\text{C}$ ? \_\_\_\_\_

| Water bath target temp. | NIST | Test sensor | NIST | Test sensor | NIST | Test sensor | Median NIST reading | Median test sensor reading |
|-------------------------|------|-------------|------|-------------|------|-------------|---------------------|----------------------------|
| 0°C (ice water)         |      |             |      |             |      |             |                     |                            |
| 25°C                    |      |             |      |             |      |             |                     |                            |
| 40°C                    |      |             |      |             |      |             |                     |                            |

Notes:

Figure 4-3c. Hydrology and Water Quality Premobilization Datasheet, page 3.

NIST Thermometer type/SN: \_\_\_\_\_

Temperature sensor manufacturer/Model/SN: \_\_\_\_\_ Battery% \_\_\_\_\_ Is sensor within  $\pm 0.2^{\circ}\text{C}$ ? \_\_\_\_\_

| Water bath target temp. | NIST | Test sensor | NIST | Test sensor | NIST | Test sensor | Median NIST reading | Median test sensor reading |
|-------------------------|------|-------------|------|-------------|------|-------------|---------------------|----------------------------|
| 0°C (ice water)         |      |             |      |             |      |             |                     |                            |
| 25°C                    |      |             |      |             |      |             |                     |                            |
| 40°C                    |      |             |      |             |      |             |                     |                            |
| Notes:                  |      |             |      |             |      |             |                     |                            |
|                         |      |             |      |             |      |             |                     |                            |

NIST Thermometer type/SN: \_\_\_\_\_

Temperature sensor manufacturer/Model/SN: \_\_\_\_\_ Battery% \_\_\_\_\_ Is sensor within  $\pm 0.2^{\circ}\text{C}$ ? \_\_\_\_\_

| Water bath target temp. | NIST | Test sensor | NIST | Test sensor | NIST | Test sensor | Median NIST reading | Median test sensor reading |
|-------------------------|------|-------------|------|-------------|------|-------------|---------------------|----------------------------|
| 0°C (ice water)         |      |             |      |             |      |             |                     |                            |
| 25°C                    |      |             |      |             |      |             |                     |                            |
| 40°C                    |      |             |      |             |      |             |                     |                            |
| Notes:                  |      |             |      |             |      |             |                     |                            |
|                         |      |             |      |             |      |             |                     |                            |

NIST Thermometer type/SN: \_\_\_\_\_

Temperature sensor manufacturer/Model/SN: \_\_\_\_\_ Battery% \_\_\_\_\_ Is sensor within  $\pm 0.2^{\circ}\text{C}$ ? \_\_\_\_\_

| Water bath target temp. | NIST | Test sensor | NIST | Test sensor | NIST | Test sensor | Median NIST reading | Median test sensor reading |
|-------------------------|------|-------------|------|-------------|------|-------------|---------------------|----------------------------|
| 0°C (ice water)         |      |             |      |             |      |             |                     |                            |
| 25°C                    |      |             |      |             |      |             |                     |                            |
| 40°C                    |      |             |      |             |      |             |                     |                            |
| Notes:                  |      |             |      |             |      |             |                     |                            |
|                         |      |             |      |             |      |             |                     |                            |

NIST Thermometer type/SN: \_\_\_\_\_

Temperature sensor manufacturer/Model/SN: \_\_\_\_\_ Battery% \_\_\_\_\_ Is sensor within  $\pm 0.2^{\circ}\text{C}$ ? \_\_\_\_\_

| Water bath target temp. | NIST | Test sensor | NIST | Test sensor | NIST | Test sensor | Median NIST reading | Median test sensor reading |
|-------------------------|------|-------------|------|-------------|------|-------------|---------------------|----------------------------|
| 0°C (ice water)         |      |             |      |             |      |             |                     |                            |
| 25°C                    |      |             |      |             |      |             |                     |                            |
| 40°C                    |      |             |      |             |      |             |                     |                            |
| Notes:                  |      |             |      |             |      |             |                     |                            |
|                         |      |             |      |             |      |             |                     |                            |

NIST Thermometer type/SN: \_\_\_\_\_

Temperature sensor manufacturer/Model/SN: \_\_\_\_\_ Battery% \_\_\_\_\_ Is sensor within  $\pm 0.2^{\circ}\text{C}$ ? \_\_\_\_\_

| Water bath target temp. | NIST | Test sensor | NIST | Test sensor | NIST | Test sensor | Median NIST reading | Median test sensor reading |
|-------------------------|------|-------------|------|-------------|------|-------------|---------------------|----------------------------|
| 0°C (ice water)         |      |             |      |             |      |             |                     |                            |
| 25°C                    |      |             |      |             |      |             |                     |                            |
| 40°C                    |      |             |      |             |      |             |                     |                            |
| Notes:                  |      |             |      |             |      |             |                     |                            |
|                         |      |             |      |             |      |             |                     |                            |

Figure 4-3d. Hydrology and Water Quality Premobilization Datasheet, page 4.

## 4 Revision history

Provide the following information for each revision made to SOP #4

*New version:*

SCPN\_WATER\_QUALITY\_SOP04\_YYYYMMDD

Date:

Author:

Sections affected:

Changes & reasons:

