Standard Operating Procedure –
Continuous Instream Monitoring Network

Equipment
Site Selection
Data Correction

2020

Susquehanna River Basin Commission

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FIGURES

ATTACHMENTS

I. EQUIPMENT

A. Data Sonde

- Types
  - EXO 2
  - EXO 3
  - Manta 35
  - 6600V2-4 – used only for non-real-time sites
- Sonde Assembly
  - 6600V2-4 – follow the instructions in the YSI 6600 Manual (https://www.ysi.com/File%20Library/Documents/Manuals/069300-YSI-6-Series-Manual-RevJ.pdf)
  - EXO 2 and EXO 3 – follow the instructions in the EXO Manual (https://www.ysi.com/file%20library/documents/manuals/exo-user-manual-web.pdf)
  - Manta 35 – the Manta sondes are assembled when delivered
- Short-term Storage – The sondes are stored in the SRBC sonde storage area. The sonde is stored with a calibration cap securely fastened. The calibration cap contains a sponge moistened with tap water to keep dissolved oxygen probes moist and keep pH probes functioning optimally. Short-term storage on a sonde does not exceed 60 days.

B. Datalogger

- Types (Fondriest Environmental, Inc.)
  - 3100 iSIC – cellular telemetry
  - 6100 iSIC – satellite telemetry
- Accessories
  - Steel enclosure
  - Battery
  - Antenna
- Power Source
  - Solar
  - Direct power connect – few

C. Miscellaneous

- Solar Panel
- Rain Gauge – select sites
- Pressure Transducer – select sites
- Field cable to connect data sonde and datalogger

D. SRBC-Hosted Data Sites

- Equipment is supplied and maintained by the owner
- Equipment varies between sites

II. SITE SELECTION

A. Region

- Susquehanna River Basin
- Targeted and probabilistic watersheds

B. Site Selection Criteria

- Interest in the watershed
- General water quality of the basin
- Source water protection
- Protection of high-quality streams
- Monitoring improvements in water quality

C. Field Site Selection

- Site access and permission (sites can be located on private and public lands)
- Canopy cover – solar panels power the battery to collect and transmit data
- 30-60 square mile watershed
- Suitable instream location for PVC casing
    - Flowing water
    - Water deep enough to sustain flow year-round
- Cellular coverage – used to determine if a cell or satellite datalogger unit is needed; preference is given to areas within the watershed with cellular service

III. DATA SONDE CALIBRATION

A. In-house Calibration

Specific conductance, pH, and turbidity probes are calibrated in-house. Sondes are calibrated in-house no more than seven (7) days prior to deployment. If this time period lapses, sondes are recalibrated before deployment. Calibration information is recorded on a calibration sheet (Attachment A); post-calibration information is also noted on this sheet. The calibration date, person calibrating, and any comments for each sonde calibration are also recorded on the calibration sheet. This information is entered into the "Sonde" Access database. The calibration sheet is scanned and linked to the database after the post-calibration is completed. Reference the database section for more information.

Calibration caps are used for all calibrations. Each standard used in calibration has a designated calibration cup to minimize contamination. Each parameter is calibrated according to YSI, Inc. *6-Series Multiparameter Water Quality Sondes User Manual*, *EXO Manual*, and *Eureka Water Probes Manta Manual (https://b3a3d385-13c7-4581-b536-17695817f1a5.filesusr.com/ugd/7f6545_5070d8ef8e194d888b39684c72fced62.pdf).* Prior to the initial filling of calibration caps with their designated standard, each cap is rinsed with a small amount of "used" standard saved from previous calibrations. Any wipers present on the optical probes are removed until after calibration of specific conductance and pH. All fresh calibration standards can be reused for a

series of successive calibrations, unless dirt particles begin to accumulate in the standard. In between calibrating each parameter, probes are rinsed with water and dried using a lint-free cloth to prevent contamination of the standards.

Calibration Standards Used

- BDH Buffer Solution Phosphate Type (yellow) – pH 7.00
- BDH Buffer Solution Carbonate Type (blue) – pH 10.01
- HACH Formazin Turbidity Standard – 4000 NTU – used to make 100 NTU standard
    - 12.5 mL of well-mixed 4000 NTU in 500 mL volumetric flask; the remaining volume is filled with deionized water
- YSI 3167 Conductivity Calibrator – 1,000 mS/cm

Calibration Procedures

- Specific conductance – one-point calibration. The specific conductance probe is calibrated for SpCond from the conductivity calibration menu. The calibration cap is filled with enough 1.0 mS/cm standard to cover the vent hole in the probe with the sonde in an inverted position and the sonde is rotated to ensure all bubbles are removed from the sensor. Temperature is equalized for at least a minute before calibration process begins. Once the specific conductance readings stabilize, the calibration is accepted and the probe is rinsed in tap water.
- pH – two-point calibration. Enough buffer standard of pH 7.00 is placed into a short calibration cap; the probe is positioned in an upright position, with the tip of the probe submerged in the solution and the temperature equalizes for at least a minute. The calibration process is started and accepted after the readings stabilize for 30 seconds. The probe is rinsed with tap water and positioned in a second calibration cup with pH 10.01 buffer standard and the process is repeated.
- Turbidity – two-point calibration. Tighten a clean wiper at 180 degrees from turbidity optics. Place approximately 500 mL of 0 NTU standard (distilled water) in a calibration cap and position the probe in the solution. Run the wiper 1-2 times to remove anything from the sensor. Once the readings stabilize, the calibration is accepted. Wipe the probes dry and place in a second calibration cup with approximately 500 mL of 100 NTU standard and repeat the process. Note: the 100 NTU standard may need to be confirmed using a turbidity meter immediately after mixing. If the standard is not 100 NTU, the true value is used in place of 100. In between successive sonde calibrations, the mixed standard will need to be re-agitated by inverting the sonde and connected cup 1-2 times.
- When all in-house calibration is complete, the pH mV parameter (6600 sondes) is disabled under “Reports” and a clean wiper with a brush is placed on the dissolved oxygen probe, at 180 degrees from optics. A calibration cap with a moist sponge is placed over the probes until deployment. Conductance and pH standards used during calibration are saved in clearly marked containers for later use. All calibration cups are rinsed with distilled water to prevent residue build-up.

B. In-field Calibration

Dissolved oxygen, depth, and turbidity sensors are calibrated onsite. Calibration occurs directly before deploying the sonde. Calibration information is recorded on a field calibration sheet (Attachment B) and these data are then entered into the Access database. The calibration cap is used for all calibrations. Each parameter is calibrated according to YSI, Inc. and Eureka Water Probes Manuals (see links above).

- Dissolved oxygen – one-point calibration for percent saturation. The probe is placed in a calibration cap with about 1/8 inch of water in it and is vented by not tightening all the threads. Wait 10 minutes to allow the temperature and oxygen pressure to equilibrate. Barometric pressure is needed for calibration. The hand-held indicates the barometric pressure for calibration. Once the barometric pressure is entered, calibration begins. After the reading stabilizes for at least 30 seconds, calibration is complete.
- Depth – make sure the probe is in air. Pressure-Abs (6600) or Depth (EXO and Manta) is selected from the calibration menu – unvented sensor. Zero (0) feet is entered and when the readings stabilize for at least 30 seconds, calibration is complete.
- Turbidity (6600 sonde) – Collect a sample of stream water with the calibration cap, making sure not to disturb any sediment. Measure the turbidity with turbidity meter. Select one-point calibration from the turbidity calibrated menu. Enter the instream turbidity value for the calibration standard value. Run the wiper 1-2 times, wait for readings to stabilize, and accept calibration.

C. Post-Calibration and Sonde/Probe Cleaning

a. Post-Calibration

Post-calibration of the probes occurs no more than five (5) days after the sonde is removed from a stream and before the sonde and probes are cleaned (accounts for fouling drift). Post-calibration is completed in the SRBC lab and on the following probes: pH, specific conductance, turbidity, DO, and depth.

Prior to post-calibration, turbidity and dissolved oxygen wipers are removed. If either wiper is missing or is oriented incorrectly (i.e., not 180 degrees from optics), this is noted on the post-calibration sheet. The pH mV parameter is enabled under "Reports" before post calibration begins (6600 sondes).

Post-calibration is completed by placing each of the probes in a known standard solution and then recording what the probe reads. Post-calibration data are recorded on the calibration sheet, which is scanned and placed in an Access database.

b. Cleaning

After a sonde has been post-calibrated, the sonde and the probes are cleaned with water and lens paper, soft cloth, or brush (conductance). A small amount of commercial detergent (Liquinox) is

used if necessary. Special attention is paid to make sure the specific conductance cell is cleared of all debris. The depth sensor is also flushed clean using a syringe. After all probes have been cleaned, a clean calibration cap with a moist sponge is placed over the probes.

D. Maintenance

a. Sonde

- Maintenance – sondes are serviced by Fondriest Environmental, Inc. (Fondriest), Eureka Water Probes, and YSI, Inc. as needed.
- O-rings – any time an o-ring is exposed, it is visually inspected for defects and lightly greased.
- Probe and cable ports – are covered at all times if they do not have a probe or cable connected to them.

b. Probes

- Dissolved Oxygen – probe is always stored moist. The sensor membrane is only cleaned with moist (water) lens paper. It is recommended that optical DO membrane is replaced annually to ensure the most accurate DO readings.
- Temperature – no maintenance is required.
- Specific Conductance – the openings are cleaned with the cleaning brush from the maintenance kit after each deployment/post calibration.
- pH – water and lens paper or a soft cloth are used to remove all debris from the glass bulb. A small amount of commercial detergent is used if necessary. pH probes can become slow to stabilize after one year, so it is recommended that pH probes or modules be replaced annually.
- Depth – the through-hole above the sonde bulkhead is flushed with water using a syringe.
- Turbidity – the probe face is cleaned with lens paper after each deployment. Wipers are replaced as needed.
- All probes and sondes not correctly reading standards are sent to Fondriest Environmental, Inc., YSI, Inc., or Eureka Water Probes for service or replacement.

c. Firmware

Firmware updates to the sonde are made as needed. Updates are done in-house and follow the procedure outlined by YSI, Inc. and Eureka Water Probes.

IV. PARAMETERS COLLECTED

A. All SRBC sites

- pH
- Dissolved Oxygen
- Turbidity
- Specific Conductance

- Temperature
- Depth (unvented)

B. Select Sites

- Chloride
- Nitrate
- Ammonium
- Precipitation
- Pressure (discharge)
- Chlorophyll-a
- Photosynthetically Active Radiation (PAR)
- Total algae

C. All SRBC Hosted Sites

- pH
- Temperature
- Turbidity

D. Select SRBC Hosted Sites

- Total Organic Carbon (TOC)
- Dissolved Oxygen
- Conductance
- Oxidation Reduction Potential (ORP)
- Chlorophyll

V. STATION INSTALLATION

A. Real-Time Instream

- 10-foot section of 4-inch PVC is secured to the streambank (Figure 1)
    - Holes drilled into the bottom 2-feet of pipe to allow for water flow-through
    - Carriage bolt through bottom of pipe to stop sonde from sliding out
    - PVC cap on top
    - PVC can be secured with brackets or hose clamps
    - PVC can be secured to rocks, trees, rebar
- Safety cable – coated wire cable is secured to the sonde and a stable, secure object out of the water (i.e., tree)
- Field cable is ran from the sonde to the iSIC unit
    - Cable is trenched if in an area that will be high traffic or mowed
- If a streambank installation is not feasible, a 4-foot PVC pipe is installed and secured in the center of the stream

Figure 1. Instream Sonde Installation

B. Stand-Alone Instream (data are stored on the sonde)

- Follows the same installation as real-time with the exception of the field cable

C. iSIC Datalogger Installation

- The steel enclosure that houses the iSIC unit is attached to steel poles (Figure 2)
  - The steel poles are secured in the ground with concrete
  - In some cases, the steel enclosure is attached to trees or buildings
- The battery is placed in the steel enclosure and attached to the unit
- Grounding rod is driven into the ground and attached to the steel enclosure
- Field cable is run from data sonde instream to datalogger
- Converters for iSIC units – the units are set up to accept data by SDI-12
  - EXO 2 and 3 sondes – run field cable to converter in steel enclosure
  - Manta 35 sondes – field cable connects to a converter cable that attaches to the datalogger

Figure 2. Datalogger

D. Solar Panel Installation

- The solar panel is attached to one of the steel poles; it can also be attached to a tree or building
- The solar panel is tilted upward and should face south or west if possible
- The cable from the solar panel is run into the steel enclosure and attached to the battery

E. Other Equipment

- Pressure transducer
  - Housed in a 1 ¼ inch steel pipe with a 90 degree elbow at the bottom of the pipe so the pressure transducer cannot exit the bottom of the pipe
  - Secured to trees, bridges, rocks, etc. with brackets – install as vertical as possible
  - AccuStage and APG-PT-500 pressure transducers have a cable that wires into the steel enclosure; data are transmitted to the in-house database

    - In-Situ pressure transducers store the data in itself and are stand-alone
- Rain Gauge
    - Types
        - RM Young 52203 Tipping Rain Gauge
        - Ott Pluvio2 Precipitation Gauge
    - These are both wired directly to the iSIC unit and are transmitted to the in-house database
- AutoSampler
    - ISCO sampler
    - Automated sampler used a discrete sites for specific projects

VI. DATA COLLECTION, STORAGE, AND TRANSMISSION

A. Data Collection

- 15-minute interval

B. Data Storage

- Data are stored in the iSIC unit
- The iSIC unit can hold about 6 months of data
- Once data storage is full, it will begin to overwrite the older data

C. Data Transmission

- Cellular service sites
    - Transmitted to an in-house database
    - Transmitted every 2 hours
    - All 15 minute readings are transmitted
- Satellite service sites
    - Transmitted to an in-house database
    - Transmitted every 4 hours
    - One 4-hour average is transmitted

VII. STATION O&M

A. Real-Time Data Sonde

- Sonde is switched at each site on a 90-day cycle
- Calibration, post-calibration, and cleaning follow the protocol listed in Section III
- If communication is lost at the site or the data sonde malfunctions, the site is visited for O&M at shorter interval

B. Stand-Alone Data Sonde

- Sonde is switched at each site every 30-60 days
- Calibration, post-calibration, and cleaning follow the protocol listed in Section III

C. Datalogger

- Little maintenance is needed

- If communication is lost with the unit:
  - Check fuse panels
  - Check wires to confirm none are loose
  - Confirm battery is connected
  - Confirm antenna is connected
- Do firmware updates as needed
- Data usage is tracked by independent software to isolate sites that have been hacked

D. Solar Panel

- Clean surface needed
- Check regulator if battery is not holding charge

E. Field Cables

- Check for cuts when communication is lost with the data sonde

VIII. DATA NOTIFICATIONS TO STAFF

A. Parameter Email Alarms

- Triggered when data are transmitted to SRBC's internal database (very 2 or 4 hours)
- Alarms trigger for the following:
  - Above threshold
  - Below threshold
  - Sonde out of water

B. Daily Email

- Indicates which sites have not transmitted data

IX. DATA STORAGE AT SRBC

A. Databases

- iChart – first storage location; data are transmitted from the field to this database
- SQL – data are pulled from iChart and stored in a SQL database
- Aquarius Time-Series – on a daily basis, data are imported from the SQL database

B. Use of Databases

- SQL – data available on the CIM website are pulled from this database
- Aquarius Time Series – database that allows staff to manipulate provisional data and mark as final

X. DATA CORRECTION

A. Software – Aquarius Time-Series Next Generation (NG)

B. Completed On An Annual Basis

C. Protocols Used

- SRBC Data Correction Protocol – majority of stations
- PADEP CIM Data Correction Protocol – select stations

XI. SRBC SONDE DATABASE

All information related to CIM stations is stored in this database.

A. Sonde Calibration

- Pre-Calibration readings
- Post-Calibration readings
- Physical hardcopy of calibration log is scanned and attached to the database (Attachment A)

B. Sonde Site O&M

- Tracks sonde at each site
- Date and time of sonde install or swap
- Indicates when a sonde has been at a site for 90 days and needs O&M
- Tracks number of days a sonde was installed at a site
- Tracks any equipment or communication issues at each site

C. Data Date Ranges

- Tracks beginning and ending (if station is no longer active) dates for data
- Tracks the date range for final (corrected) data

D. Equipment Information

- Records all serial numbers for equipment
- Tracks maintenance completed by outside vendors
- Tracks which equipment is at each site

Attachment A

Calibration Sheet

Pre-deployment calibration

Initials:_____ Date:_____ Sonde: _____

Batteries in unit?	Y	N	Firmware updated?	Y	N
Turbidity Wiper Replaced?	Y	N	Wiper Parks 180 deg from Optics?	Y	N
D.O. Wiper Replaced?	Y	N	Wiper Parks 180 deg from Optics?	Y	N

Cond (meas): _____ Cond (stnd): _____

pH 7.00: _____ pH 7 (mV): _____ Turb (0 NTU): _____

pH 10.01: _____ pH 10 (mV): _____ Turb (100 NTU): _____

pH 4: _____ pH 4 (mV): _____ Turb (0.5) _____

Note: Millivolt span between either pH 4 and 7 or 7 and 10 should be ~ 165 to 180 mV.

Cal Constants (record after calibration):

Param	*Displayed*	*Default*	*Operating Range*	*Comments*
Cond		5	4 to 6	Traditional cell constant
DO gain		1	0.5 to 2.0	
mV offset		0	-100 to 100	
pH offset		0	-400 to 400	
pH gain		-5.0583	-6.07 to -4.22	
Turb offset		0	-10 to 10	
Turb A1		500	0.6 to 1.5	Range is ratio of M1 to A1
Turb M1		500		
Turb A2		1000	0.6 to 1.5	Range is ratio of (M2-M1) to (A2-A1)
Turb M2		1000		

Notes:

Post-deployment check

Initials:_____ Date:_____ Sonde:_____

Cond (meas): _____ Cond (stnd): _____

pH 7.00: _____ pH 7 (mV): _____ Turb (0 NTU): _____

pH 10.01: _____ pH 10 (mV): _____ ODO % Sat.: _____

pH 4: _____ pH 4 (mV): _____ ODO mg/L: _____

BP:_____ mmHg Depth: _____

Notes:

Attachment B

Field Calibration Sheet

Site	**Sonde In**	**Date In**	**Time In**	**Barometric Pressure**	**% DO**	**Sonde Out**	**Date Out**	**Time Out**