

**SOUTHEAST WATER LEVEL NETWORK
STANDARD OPERATING PROCEDURES**

**Water Level Station Installation,
Maintenance, and Removal**

Version Control

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A. Introduction

The Southeast Coastal Ocean Observing Regional Association (SECOORA) works with partners in the four southeast U.S. states, North Carolina, South Carolina, Georgia, and Florida, to help meet ocean and coastal observing needs. SECOORA is collaborating with project team members, communities, and regional Sea Grant offices to install and operate low-cost, long term water level monitoring sensors throughout the southeast. Water level sensors are a stand-alone system that collect, store, and transmit water level data (NOAA 2012).

All potential stations will have undergone a thorough desktop and field reconnaissance prior to installation (see [Water Level Site Reconnaissance – Desktop and Field Procedures](#)). Site locations will have been deemed appropriate for water level station installation based on this reconnaissance. The purpose of this document outlines the standard operating procedures (SOPs) for Water Level Station Installation, Maintenance, and Removal.

B. Sensor Selection

The primary requirement of a water level sensor is to accurately measure water level information with low power consumption, high reliability, and defined accuracy. The typical SECOORA water level station includes a weather resistant, ultrasonic sensor that is compact and housed within a PVC housing or other protective housing. These sensors are designed to report the distance from the sensor face to the surface of the water. The sensors take water level measurements at a minimum rate of 6 Hz (i.e., 6 samples per second).

Sensor selection must be based on the deployment location. The sensor measurement range must be greater than the expected range of water level at the measurement site, and the installation should be designed to measure the full range of extreme water levels, such as highest observed and lowest observed water level data (100 years, if available). Sensor resolution is also important. For a tidal range less than or equal to 5m, the sensor resolution shall be 1mm or less. For a tidal range between 5m and 10m, the sensor resolution shall be 3mm or less, and for a tidal range greater than 10m, the sensor resolution shall be 5mm or less (NOAA 2017).

Calibration of sensor systems prior to deployment is required. Sensors should be set up in the lab and tested prior to installation.

C. Sensor Installation

Water level sensors and associated communications equipment must be installed on a pre-existing structure (e.g., dock, piling, bridge). *SECOORA does not authorize the installation of pilings or construction of docks, piers, or other structures to support a water level station.* SECOORA team members are responsible for obtaining all required permits and permissions for installation of the water level sensors. Individual SECOORA team members are also responsible for security and/or protective measures, as required, for protecting the equipment and facility while installing, maintaining, or removing a water level station.

The following requirements should be followed 1-2 weeks prior to sensor installation:

1. During field reconnaissance, the team should have identified the location to mount the water level sensor and all of the field materials required for installation.
2. Station details must be added to the internal [SECOORA sensor tracking worksheet](#).
3. Notify SECOORA Deputy Director of the new sensor location and planned installation date at least 5 days in advance of installation. The SECOORA Deputy Director will verify that the site is not within a location on the National Register of Historic Locations and notify the NOAA IOOS Environmental Compliance Coordinator of the installation location and installation date.
4. The sensor housing must have a level point clearly marked on the housing. This can be a paint spot, V notch, or small indentation. The level point indicates the location on the sensor housing where the surveyor can set up an RTK unit on the sensor housing or, if taping is required, it is the visual reference for taping. This mark should be made in the lab prior to station installation. See [Survey and Taping Guide](#).
 - a. The level point for each station should be consistent. The level point is the survey reference point and establishing a visible level point will assure repeatability with surveys (i.e., the survey is conducted on the same point on the sensor housing year after year). It also assures that the sensor offset is measured from the same point every time the measurement is taken.
5. Set up the sensor inside the housing while in the lab for testing. Test all sensors prior to deployment.

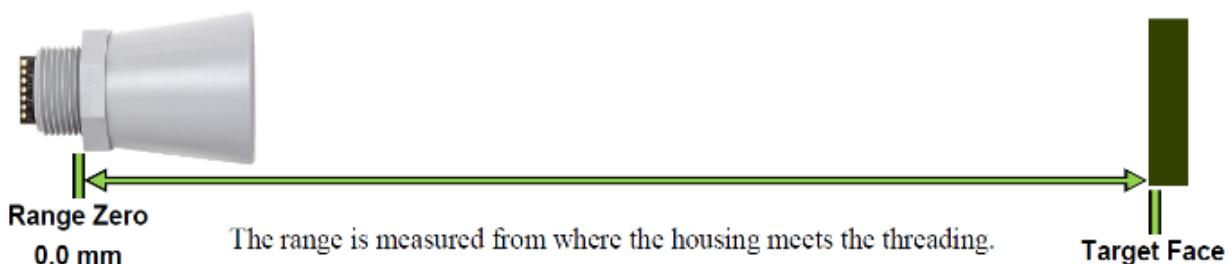


Image 1: Sensor offset measurement.

6. *Determine the sensor offset.* This is the distance from the range zero to the level point. Range zero may be the sensor head for most sensors.
7. If using a tape measure to calculate sensor offset, use the following guidelines:
 - a. Using a NIST calibrated tape measure, take 3 measurements, in mm, from the level point to the sensor head.
 - b. You should have two people for taping. Person 1 can hold the zero point at level point while Person 2 pulls the tape to the sensor head. Person 2 should record all 3 measurements.
 - c. If all 3 measurements are the same, record this number in the station logs.
 - d. If the 3 measurements vary by more than 2 mm between measurements, repeat the process.
8. The sensor offset must be recorded in station logs, on a field data sheet, and tracked in the station metadata. Record the sensor offset in mm.

- a. Downloadable Word version of the example field data sheet found here:
<https://secoora.org/wp-content/uploads/2022/10/SECOORA-Survey-Field-Data-Sheet.docx>

9. The station name should be descriptive of its location. The station name should be the same on lab records, the field data sheet, and in the metadata. Consistent station naming will reduce confusion for the project team.

The following installation requirements should be followed in the field:

10. Take all of the necessary tools and materials with you to the field.
11. Take a field data sheet with you to record information specific to the station being installed.
12. When installing the sensor and housing, make sure that that housing is level when it is installed. Take a carpenter's level to the field to verify that the station is level. This will help ensure that the sensor is looking straight down at the water.
13. Install sensors as prescribed by the sensor manufacturers and based on any installation manuals provided by the manufacturer.
14. If permits were required prior to site installation, make sure to follow any installation instructions prescribed in the permit requirement.
15. Take photos of the station after installation. Photos should be added to the field data sheet. The station name should
16. Clean up all materials and trash from the installation site.

D. Reference Datum Requirements

The water level datums are local vertical datums, which may vary at different stations within a geographical area. A geodetic datum is a fixed plane of reference for vertical control of land elevations. The North American Vertical Datum of 1988 (NAVD 88) datum is one of the accepted geodetic reference datums of the National Geodetic Spatial Reference System (NSRS) for the conterminous United States and Alaska, and is officially supported by National Geodetic Survey (NGS). The relationships of tidal datums to geodetic datums such as NAVD 88 and to ellipsoid heights support many hydrographic, coastal mapping, and engineering applications (NOAA 2017).

NAVD 88 Tie: It is ideal for each water level station to tie to at least one Geodetic Benchmark (GBM). A GBM is defined as a benchmark that:

- is useable.
- is available in the National Geodetic Survey (NGS) database.
- has a Permanent ID (PID).
- and has a NAVD 88 elevation published on the datasheet.

NGS benchmarks are available in ArcGIS. Carefully review benchmarks to assure they have a NAVD88 tie.

<https://noaa.maps.arcgis.com/apps/webappviewer/index.html?id=190385f9aadb4cf1b0dd8759893032db>.

Example NGS datasheets for GBMs with NAVD88 datum can be found here:

- https://www.ngs.noaa.gov/cgi-bin/ds_mark.prl?PidBox=BR0029
- https://www.ngs.noaa.gov/cgi-bin/ds_mark.prl?PidBox=CJ0800

Additionally, state geodetic survey offices may also have a database of benchmarks installed on state DOT maintained roads and other structures. For example, North Carolina Geodetic survey provides the following site: <https://ncgs.nc.gov/geodeticmonuments/>. Carefully review sites to assure they have a NAVD88 tie.

E. Data Transmissions

The ability to monitor water level measurement system performance in near real-time is essential, therefore, all station installations must be equipped with communications systems that allow for transmission of 6 minute water level data. Data should be made available to SECOORA via an API or via access to a secure server.

F. Metadata and Metadata Updates

- Station metadata can be accessed through the individual station pages in the SECOORA data portal and can be viewed using ERDDAP. A subset of water level metadata can also be found in the internal [SECOORA project tracking form](#).
- All metadata should be included in the station API so that anyone can access it. The details in the SECOORA [Water Level Station Log](#) should be included in the metadata.
- Specific measurements, which must be included in the metadata, are required to calculate station datum:
 - Sensor technology (Microwave, Pressure, Acoustic)
 - Sampling rate
 - Sensor survey point (elevation of the survey point on or next to the sensor)
 - Tape up/down average measurement
 - Sensor offset
 - Station datum 0 value relative to the ellipsoidal reference (e.g., some distance relative to the ellipsoid to set as station datum)

G. Quality Control and Monitoring

SECOORA follows quality control standards as outlined in specifically NOAA IOOS Quality Assurance / Quality Control of Real Time Oceanographic Data (QARTOD) manuals.

The following tests outlined in the [Manual for Real-Time Quality Control of Water Level Data](#) are implemented by SECOORA on all real-time water level data.

- Timing
- Syntax
- Range
- Spike
- Change Rate
- Flat Line
- Nearest Neighbor
- Climatology (implemented after a station has 1 year of data available)

Each water level team maintains data sharing documentation with SECOORA and this documentation is incorporated into [Appendix F - Funded Data Streams](#) of the [SECOORA Data](#)

[Management and Communications \(DMAC\) Plan](#). These records are maintained as part of SECOORAs Certification records.

H. Operation and Maintenance

The station operator must monitor the near-real-time water level data on a daily basis for indications of sensor malfunction or failure, and for other causes of degraded or invalid data, such as marine fouling. SECOORA provides daily emails that identify individual station performance. These emails outline individual QARTOD test performance (pass/suspect/fail) and these records are a good indicator of whether stations are experiencing communications problems and/or sensor malfunctions. Also, it is worthwhile to ask the community point of contact to visit the site and try to identify any problems and take photos of the station and send the photos back to the operator. For some simple issues, the community point of contact may be able to assist with bringing the site back online. Desktop data quality checks and community support are helpful prior to a site maintenance visit as it can potentially target the point of failure (e.g., battery, sensor) so that the specific station hardware can be prepped prior to the maintenance trip.

All stations must be visited annually to ensure the sensor and sensor housing are in good working order and that mounting brackets or other station mounting structures are intact and the sensor cone is free of insects, nests, or webs. Stations should be visited between annual maintenance trips if the data appears compromised in any way, or there is reason to believe the sensor or sensor function may have degraded following an extreme event. For stations that are functioning properly, the local community POCs can assist by visiting the site and sending photos back for project teams to review. This type of “maintenance” trip may be sufficient for the project team if the photos are of good quality and the photos capture all sides of the sensor and below the sensor (towards the water) to assure that hardware, mounting brackets, and the structure the sensor is deployed on are in good condition.

All station repairs, adjustments, replacements, cleaning, or other actions potentially affecting sensor output or collection of data shall be documented in the field data sheet while on site and maintained in maintenance logs.

Field maintenance logs must be maintained on all stations. An example field maintenance log sheet (Word document) is found here: <https://secoora.org/wp-content/uploads/2023/05/Example-Field-Maintenance-Log.docx>. Maintenance logs are useful when submitting progress reports and reporting on lower reporting (i.e., under 85%) performance tracking. For teams that do not do their own maintenance, they should still work with community partners to record this information. This documentation could include, but not be limited to, the following information:

- purpose of the trip
- date/time of the maintenance activity
- date/time of adjustments in sensor, updated sensor offset and date and time of the change in the sensor offset
- personnel conducting the work
- parts/components replaced (e.g., Maxbiotx, antenna, solar panel)
- component serial numbers before and after the maintenance
- Any actions that could not be completed and will need to be completed at a future date

All stations (sensors and benchmarks) must be surveyed every two years. When a sensor has to undergo maintenance, such as a sensor swaps, adjustments, cleaning, etc. or if the sensor is removed and a new sensor re-installed, the team should conduct a vertical elevation survey for the sensor. You may not need to survey the benchmarks when surveying during general maintenance activities. See [SECOORA SOP for Acquiring Vertical Elevation of Water Level Sensors](#).

Each team member must track the station offset and update the value in the metadata any time the sensor is swapped. The team must also notify the Axiom Data Science of the change so that the data processing for the station is updated. Email dmac@secoora.org.

I. Station Removal

Station removal requirements are adapted from NOAA 2017.

- Document why the station is being removed and submit notice of removal to the SECOORA Deputy Director at least 2 weeks prior to the station being removed. The notice of removal should identify the station name, location, removal date, and detailed reason for removal.
- Remove station from operator's active station worksheet to the decommissioned station worksheet: https://docs.google.com/spreadsheets/d/10KN3sdkzaUR-Kf_TbC-YI0d1mcCqWH6pvWowcQVbB8o/edit?usp=sharing
- Remove the water level measurement system (i.e., sensor, housing, mounting brackets, mounting supplies) and restore premises to pre-water level condition (reasonable wear and tear is accepted).
- Dispose of expendable or unusable components in an environmentally friendly manner.
- Terminate of any utilities or communications contracts (i.e. cellular communications)
- Close-out or terminate any license agreement which may have been entered into with the property owner

J. References

NOAA 2012: Sevary, B.L., CO-OPS Water Level and Meteorological Site Reconnaissance Procedures. Updated February 2012.

NOAA 2017: Engineering Division, Center for Operational Oceanographic Products and Services National Ocean Service, NOAA. CO-OPS Specifications and Deliverables for Installation, Operation, and Removal of Water Level Stations, Updated December 2017.

K. Appendix A: Field Maintenance Log Sheet

Field Maintenance Log

Station Name:

Maintenance Date:

Deployed sensor serial number:

Person conducting maintenance:

Description of the problem/purpose of the trip:

Field Assessment - what is the condition of the sensor, platform/dock it is mounted on. List any concerns:

Was the water level sensor/sensor housing removed: Yes/No

If Yes:

What is the new sensor offset (in m):

List the new sensor serial number:

A new survey or taping for the sensor must be completed for any sensors that are swapped. The new sensor offset and survey details must be updated in the station metadata and a notice sent to dmac@secoora.org notifying them of the updates.

Other maintenance activities conducted while on site:

Reference Documents:

[SECOORA SOP for vertical elevation of water level sensors](#)

[SECOORA Survey and Taping Guide](#)