Hudson River Environmental Conditions Observing System Water Quality and Weather Station Quality Assurance Project Plan

Prepared by:
Brittney Flaten
Environmental Analyst & HRECOS Coordinator
Hudson River Estuary Program & NEIWPCC
256 Norrie Point Way
Staatsburg, NY 12580

Prepared for:

NEIWPCC
Wannalancit Mills
650 Suffolk Street, Suite 410
Lowell, MA 01854

Version Date: January 2025

Revision: 4

Project Start and End Dates: January 2025 – January 2028

Approval Page (A2)

Project Name: HRECOS Water Quality and Weather Station Quality Assurance Project Plan

Version Date: January 2025

Plan prepared by: Brittney Flaten, HRECOS Coordinator, NEIWPCC

____ _____________
Operations/Project Manager, HRECOS Coordinator: Brittney Flaten, NEIWPCC Date

____ _____________
USGS Project Manager: Kaitlyn Finkelstein, USGS Date

____ _____________
NEIWPCC QA Designee: Richard Friesner, NEIWPCC Date

____ _____________
Ilion Station Operator: Kate Smith, NYSDEC Date

____ _____________
Ilion Station Operator: Dan Hayes, NYSDEC Date

____ _____________
Schodack, Poughkeepsie, and West Point Station Operator: Stuart Findlay, CIES Date

____ _____________
Schodack, Poughkeepsie, and West Point Station Operator: David Fischer, CIES Date

____ _____________
Piermont Station Operator: Tim Kenna, LDEO Date

____ _____________
Piermont Station Operator: Margie Turrin, LDEO Date

____ _______________
HRNERR Stations Operator: Samuel Yakubowski, NEIWPCC Date

____ _______________
HRNERR Stations Operator: Chris Mitchell, NEIWPCC Date

____ _______________
Yonkers Station Operator: Ryan Palmer, SLC CURB Date

____ _______________
Yonkers Station Operator: Katie Lamboy Roman, SLC CURB Date

____ _______________
Pier 84 and Pier 25 Station Operator: Carrie Roble, HRPT Date

____ _______________
Pier 84 and Pier 25 Station Operator: Siddhartha Hayes, HRPT Date

____ _______________
PVSC Station Operator: Rusbel Hernandez, PVSC Date

Note: This document has been approved. A signed copy is kept on file by the HRECOS Coordinator.

Table of Contents

Appendices

List of Acronyms

CDMO- Centralized Data Management Office
CIES- Cary Institute of Ecosystem Studies
CSO- Combined sewer overflow
DECODES- Device Conversion and Delivery System
DOW – Division of Water
HRECOS- Hudson River Environmental Conditions Observing System
HREP – Hudson River Estuary Program
HRNERR – Hudson River National Estuarine Research Reserve
HRPT- Hudson River Park Trust
LDEO- Columbia University Lamont-Doherty Earth Observatory
NAVD88- North American Vertical Datum of 1988
NEIWPCC- New England Interstate Water Pollution Control Commission
NERRS- National Estuarine Research Reserve System
NOAA- National Oceanic and Atmospheric Administration
NWIS- National Water Information System
NYSDEC – New York State Department of Environmental Conservation
PAR- Photosynthetically active radiation
PVSC- Passaic Valley Sewerage Commission
QA – Quality assurance
QAPP – Quality Assurance Project Plan
QC – Quality control
RIBS- Rotating Integrated Basin Studies
SLC CURB- Sarah Lawrence College Center for the Urban River at Beczak
SOA- Sonde output adapter
SOP – Standard Operating Procedure
SSO – Sanitary sewer overflow
SWMP – System-Wide Monitoring Program
USGS- United States Geological Survey

List of Tables

List of Figures

Introduction

In 2008, the Hudson River Environmental Conditions Observing System (HRECOS) was established to provide geographically distributed, high-frequency water quality and weather data on the Mohawk and Hudson Rivers, accessible to anyone in near real-time. HRECOS continuous monitoring data support an understanding of basic river conditions and their controlling factors and contribute to assessment and management needs. Scientists, educators, resource managers, mariners, and others in the Hudson River Watershed currently benefit from this integrated system. HRECOS monitoring stations are operated by a consortium of partners from governmental, academic, and non-profit institutions who collaborate to report data in real-time to a public website (www.hrecos.org). Individual stations are often built by partners to serve a local need, but their addition to HRECOS contributes to the goals and objectives of the network.

This QAPP has been prepared to delineate field methods, data review, and documentation and reporting procedures for HRECOS water quality and weather stations.

Note

The quality assurance procedures referenced in this document are applicable to HRECOS network data collected from May 2019 to the present. For quality assurance procedures that cover data collected before May 2019, reference the HRECOS Water Quality and Weather Stations Quality Assurance Program Plan, Version 2012.08. which is available at www.hrecos.org; see Appendix C.

A. Project Management and Data Quality Objectives

1. Project Organization and Personnel (A7- A10)

A list of participants and their respective responsibilities are given in Table 1. See Figure 1 for an organizational chart.

Table 1. HRECOS participants and responsibilities.

Name, Affiliation	Role(s)	Responsibilities	Contact Information
Brittney Flaten NYSDEC HREP & NEIWPCC	HRECOS Coordinator	Collaborates with USGS to manage database and real-time data collections; Maintains hrecos.org website, annual data files, and metadata files; Manages supplies budget, purchasing, and maintenance contracts; Coordinates the addition of new partners and stations; Coordinates quarterly and special meetings; Performs trainings. Maintains official approved QAPP version.	brittney.flaten@dec.ny.gov 845-889-4745 x 117
	Station Operator – Lock 8, Rexford, Albany	Monitoring the real-time data stream for abnormalities; instrument calibration, maintenance, and repair; Data transmission.	
Kate Finkelstein, USGS	Project Manager for USGS	Oversees real-time data collection. Receives calibration and deployment information from station operators. Manages data QAQC process.	kfinkelstein@usgs.gov
Kate Smith and Dan Hayes, NYSDEC DOW	Station Operators – Ilion	Monitoring the real-time data stream for abnormalities; Instrument calibration, maintenance, and repair; Data transmission.	kathryn.smith@dec.ny.gov daniel.hayes@dec.ny.gov
Stuart Findlay and David Fischer, CIES	Station Operators – Schodack Landing, Poughkeepsie, and West Point	Monitoring the real-time data stream for abnormalities; Instrument calibration, maintenance, and repair.	findlays@caryinstitute.org fischerd@caryinstitute.org
Chris Mitchell and Sam Yakubowski, NYSDEC/HRNERR	Station Operators – HRNERR Stations	Monitoring the real-time data stream for abnormalities; Instrument calibration, maintenance, and repair; Data transmission.	christopher.mitchell@dec.ny.gov samuel.yakubowski@dec.ny.gov

Ryan Palmer and Katie Lamboy, SLC CURB	Station Operators – Yonkers	Monitoring the real-time data stream for abnormalities; Instrument calibration, maintenance, and repair; Data transmission.	rpalmer@sarahlawrence.edu klamboy@sarahlawrence.edu
Tim Kenna and Margie Turrin, LDEO	Station Operators – Piermont	Monitoring the real-time data stream for abnormalities; Instrument calibration, maintenance, and repair; Data transmission.	tkenna@ldeo.columbia.edu mkt@ldeo.columbia.edu
Carrie Roble and Siddhartha Hayes, HRPT	Station Operators – Pier 84 and Pier 25	Monitoring the real-time data stream for abnormalities; Instrument calibration, maintenance, and repair; Data transmission.	croble@hrpt.ny.gov shayes@hrpt.ny.gov
Rusbel Hernandez, PVSC	Station Operator – Newark Bay	Monitoring the real-time data stream for abnormalities; Instrument calibration, maintenance, and repair; Data transmission.	rhernandez@PVSC.com

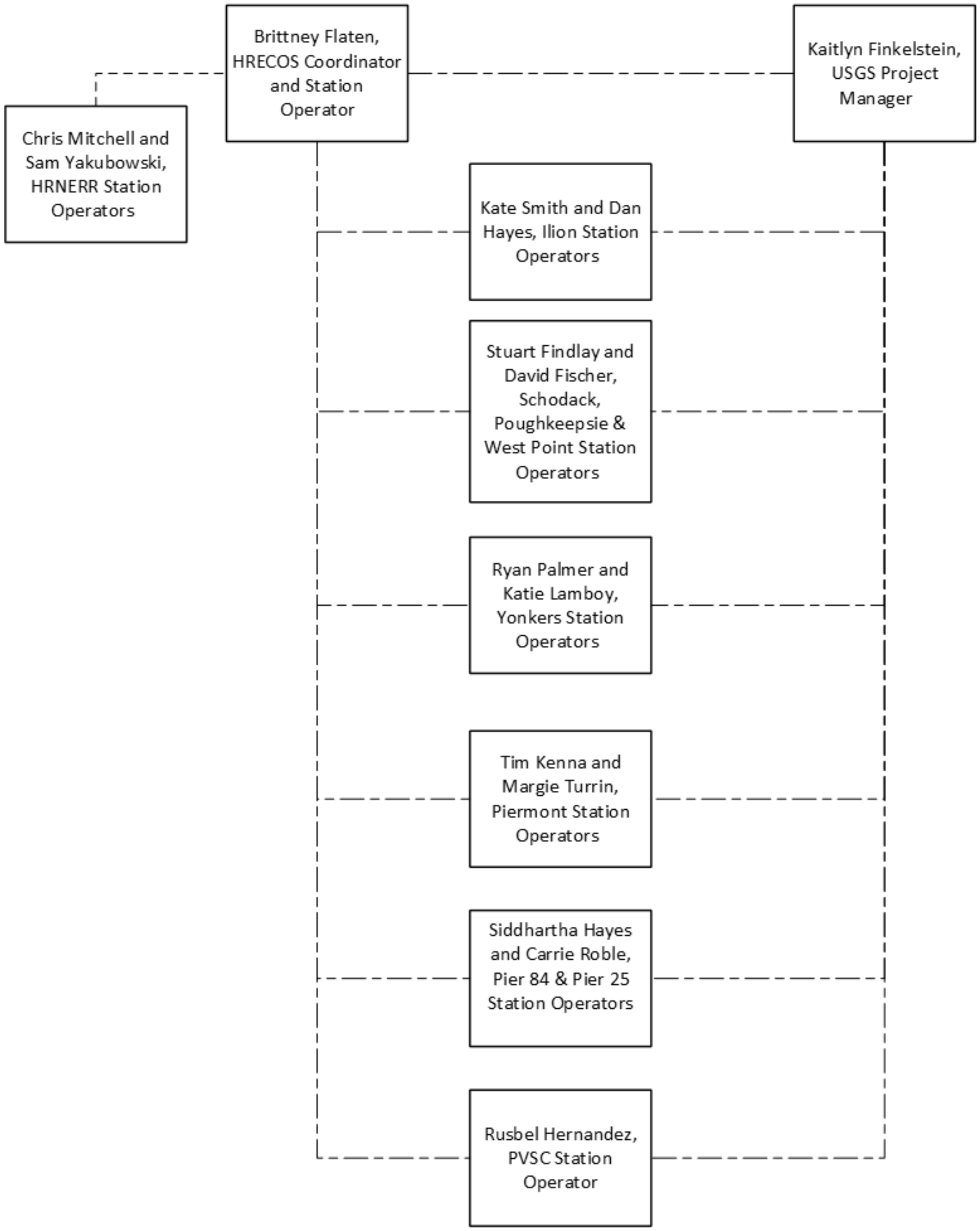

Figure 1. Organizational chart for HRECOS network.

2. Personnel Training and Certifications (A11)

The HRECOS coordinator will ensure that all individuals involved with the project receive, and are familiar with, this document to ensure proper adherence to the procedures outlined within.

New staff must perform side-by-side calibration and maintenance procedures with an experienced staff member at least three times and have demonstrated capability before operating independently. Individual station operators are responsible for training their staff and ensuring that training has been documented and communicated to the HRECOS coordinator; annual in-person trainings led by the coordinator ensure a consistent level of effort across the network.

3. Project Purpose, Problem Definition, and Background (A4)

Fundamental knowledge of the Hudson River Watershed, its resources and management has progressed dramatically over the past 25 years. Understanding the river system, however, has been hampered by manual approaches to data collection that cannot adequately capture rare events or describe rapid fluctuations in environmental conditions.

HRECOS stations established in the Mohawk and Hudson Rivers make available continuous information and real-time data on water quality and weather conditions. These data have broad use to stakeholders in the Hudson Watershed including academics, environmental managers, industry, recreation enthusiasts, and educators. For this reason, there are multiple partners external to NYSDEC who value the data and have committed their own time and resources to the maintenance and growth of this network.

HRECOS stations are used to define ambient river conditions and to assess a variety of anthropogenic impacts across the watershed. For example, permit engineers in the Division of Water track the impacts of CSOs and SSOs with the HRECOS stations in Albany and Utica.

HRECOS stations are also used to inform management of Hudson River resources. For example, salinity and temperature data from all stations help managers track anadromous fish migrations every spring and fall. Dissolved oxygen concentrations help assess conditions for fish and other aquatic organisms. The HRECOS network has been crucial in determining the impacts of episodic storm events like superstorm Sandy and tropical storms Irene and Lee. For example, high frequency data collected by HRECOS sites captured surges in precipitation and contributed to sediment discharge estimates.

Finally, NYSDEC educators have done excellent work bringing HRECOS into the classroom. Thousands of students have been able to access the Hudson and Mohawk Rivers from their classrooms via place-based educational curricula developed by NYSDEC's Hudson River Estuary Program and Hudson River National Estuarine Research Reserve.

4. Project Task Description and Schedule (A5)

HRECOS is a network of permanent monitoring locations in the Hudson River Watershed. Deployed at each site is a multiparameter sonde that records water quality conditions every 15 minutes. Some monitoring locations have a co-located weather station which also collects data every 15 minutes. A full listing of parameters can be found in the Methods section. Most stations operate year-round except Ilion, Tivoli North Bay, Tivoli South Bay, and Yonkers stations that operate seasonally to avoid equipment damage in the winter months.

Station operators are tasked with maintaining and calibrating their equipment on a quarterly basis (at minimum) and ensuring that data loggers are transmitting data to the USGS NWIS database. USGS is responsible for receiving calibration and maintenance information from the station operators and performing data validation, which occurs on a rolling basis. The coordinator is responsible for updating metadata and generating annual files to be published on the HRECOS website and assisting station operators in station maintenance and troubleshooting. See Table 2 for project schedule.

4.1 Project Limitations

Station operators from partner institutions receive a small stipend to compensate them for time spent calibrating and maintaining water quality equipment. However, due to rising labor costs, the stipend does not adequately cover the staff time needed to perform project tasks, so services are often performed in-kind. This leads to limitations on how often a station operator can service equipment, which is why the required swap interval is quarterly. Many station operators choose to perform swaps more frequently because they have adequate staffing, and it improves the quality of that station's data. Other tasks that would improve and expand upon the project, such as discrete sampling and more frequent cross-channel analyses, are similarly limited by funding and personnel.

Table 2. Project schedule.

Project Task	**Timeline**
QAPP Updates Submitted to NEIWPCC	August 2024
QAPP Approved	February 2025
Data Collection	Every 15 minutes. Data transmission occurs every hour.
Station Metadata Updates	Quarterly. Updated metadata released 2 months after quarter's end.
Data Validation and Review	Conducted on a rolling basis by USGS. Generally completed within 1 year of data collection.

5. Data Quality Objectives (A6)

5.1 Precision and Accuracy

Manufacturer precision and accuracy criteria for all parameters measured by HRECOS water quality sondes and weather stations are given in Table 3. YSI EXO2 sondes and their sensors must meet or exceed all water quality measurement criteria for data publication. Prior to deployment station operators must independently test instruments for accuracy following manufacturer guidelines (Wagner et. al, 2006, page 10). Sensors are tested for accuracy during calibration checks using NIST certified standards and if readings are within the calibration criteria defined in Wagner et.al (2006), the sensor is considered stable. Further details on equipment specifications can be found in section B6 and within the HRECOS sonde calibration and deployment guide (Appendix A).

Station operators are expected to maintain and calibrate water-quality equipment on a quarterly basis **at minimum** to ensure accurate sensor readings. Frequency of site visits should be considered when evaluating accuracy and precision as described in Wagner et. al (2006, page 38). When instruments are not swapped within the appropriate window, data from that period will be excluded from the final record. See Wagner et. al (2006) and section D1.

5.2 Representativeness

Individual HRECOS station locations were chosen to address local stakeholder needs but can be used within the network to assess regional river conditions. The following requirements ensure the HRECOS stations are representative of the river segment of interest and is not heavily influenced by localized conditions.

The placement of water quality monitoring stations must be located on structures such as a bulkhead, dock, pier, or piling, and be representative of conditions in the stream cross section. To ensure representativeness, cross channel assessments are conducted before a HRECOS station is installed at its desired location to characterize the vertical and horizontal mixing at the monitor site with the measurement surveys of vertical and horizontal cross-section variability (Wagner et. al, 2006, page 10). Results of cross channel assessments can be found in the site metadata. To ensure vertical mixing is accounted for at the station location sensors must be installed at least 0.5 meters from the river bottom. Results of cross channel assessments can be found in the site metadata.

Weather stations must be located on the shoreline and not influenced by structures or vegetation that would impact direct readings, such as shading or wind blockage from tall buildings and trees. Specific requirements for each weather sensor are provided in Table 3. For further details, consult the HRECOS Meteorological Monitoring Standard Operating Procedure (Appendix B). If localized factors that may influence weather readings are present, alternative locations must be considered. Any such factors are to be clearly indicated in the metadata.

5.3 Comparability

Beginning in 2024, all HRECOS and HRNERR water quality stations are equipped with a YSI EXO2 sonde to ensure comparability across the network. Stations may use any weather monitoring equipment if it meets the precision and accuracy requirements given in Table 3.

Prior to 2024, some stations operated using a YSI EXO2 sonde while others had a YSI 6 series sonde. Changes to monitoring equipment are documented in Table 4 and can also be found in the respective site metadata documents on the HRECOS website. There are minor differences in sensor specifications and measurement methods between these two models (Tables 5 and 6). The sensor types do not change between models, but the accuracy and resolution for several sensors improved from 6-series to EXO models. A study by the Water Resources Management Division of Newfoundland and Labrador compared the 6-series and EXO models and found that they measured similar values, particularly for water temperature and dissolved oxygen values (Government of Newfoundland and Labrador, 2016). The similarities between models allow for time-series analysis of HRECOS data, with the caveat that newer data are at a finer resolution. Finally, there are slight changes in salinity and turbidity methods between which are described in the following sections.

5.3.1 Salinity
YSI 6600 sondes calculated salinity in parts per thousand while EXO2 sondes calculate and report salinity in practical salinity units (psu). These are generally understood to be equivalent units (Thermo Scientific, 2011). Specific dates of equipment upgrades can be found in the site metadata and Table 4.

5.3.2 Turbidity
YSI 6600 sondes measured turbidity in nephelometric turbidity units (NTU) while EXO2 sondes measure turbidity in formazin nephelometric units (FNU). Measurements taken in NTU units use a white light at a 90-degree detection angle, while measurements taken in FNU use an 860 nm light with a 90-degree detection angle (YSI, 2019). In stable laboratory settings these different measurement methodologies are expected to produce similar readings, however, the variability of turbidity in environmental waters can cause these methodologies to differ by a factor of 2 or more (Gray et. al., 2002). Thus, at a given HRECOS site, turbidity is reported as two separate parameters in NWIS to identify different instrument and measurement methods. Specific dates of equipment upgrades can be found in Table 4.

5.4 Completeness
Data completeness is a measure of the number of valid water-quality readings measured compared to the total number of measurements, expressed as a percentage. For this project, it is expected that a 100% data completeness will be achieved unless unforeseen problems occur. To minimize gaps in the published record the HRECOS Coordinator, USGS, and station operators are expected to monitor the data streams to look for issues. Station operators are responsible for ensuring telemetry equipment is operational. As a backup, internal logging is utilized on each sonde, and the missing files can be retrieved and uploaded to the data stream.

Gaps in the data are minimized by performing equipment maintenance and checks on a quarterly basis, at a minimum. If equipment is not calibrated, cleaned, and checked for calibration drift, data cannot be verified by USGS standards and are not published in the final record (Wagner et al., 2006). It also is possible that some corrected data will not be reported or stored in the database because the recorded values differ from the corrected values by more than the maximum allowable limits described in Wagner et. al 2006 (*Maximum Allowable Limits for Reporting Continuous Data,* pages 37-38).

Table 3. Precision and accuracy criteria for HRECOS stations.

Water Temperature	Range	-5 to +45°C
	Resolution	0.01°C
	Accuracy	±0.15°C
Conductivity	Range	0 to 100 mS/cm
	Resolution	0.001 to 0.1 mS/cm (range-dependent)
	Accuracy	±0.5% of reading + 0.001 mS/cm
Salinity	Range	0 to 70 ppt
	Resolution	0.01 ppt
	Accuracy	±1% of reading or 0.1 ppt, whichever is greater
Dissolved Oxygen % Saturation	Range	0 to 500%
	Resolution	0.1%
	Accuracy	0-200% air saturation: +/-1% of the reading or 1% air saturation, whichever is greater 200-500% air saturation: +/- 15% or reading
Dissolved Oxygen mg/L	Range	0 to 50 mg/L
	Resolution	0.01 mg/L
	Accuracy	0-20 mg/L: +/-0.1 mg/l or 1% of the reading, whichever is greater; 20 to 50 mg/L: +/-15%
pH	Range	0 to 14 pH units
	Resolution	0.01 unit
	Accuracy	±0.2 unit
Turbidity	Range	0 to 1,000 NTU
	Resolution	0.1 NTU
	Accuracy	+/- 2 % of reading or 0.3 NTU (whichever is greater)
Chlorophyll	Range	0 to 400 ug/L chl a; 0 to 100 RFU
	Resolution	~ 0.1 ug/L
	Accuracy	0.1 ug/L chl a, 0.1% FS
Air Temperature	Range	-40ºC to +60 ºC
	Accuracy	± 0.2 ºC @ 20 ºC
Relative Humidity	Range	0 to 100% non-condensing
	Accuracy	at 20 ºC: ± 2% RH (0-90%), ±3% RH (90-100%)
Barometric Pressure	Range	500-1100 mbar
	Accuracy	+/- 0.3 mbar at +20°C
Wind Speed	Range	0 to 44 m/s
	Accuracy	±0.5 m/s; ±3% 17 to 30 m/s; 4% 30 to 47 m/s
Wind Direction	Range	0 to 358°, 2° Dead Band
	Accuracy	±5 Degrees
PAR	Range	0-1280 µA
	Accuracy	Typically, 5 µA per 1000 µmoles s-1 m-2
Precipitation	Range	Operational temp. range: 0° to 50°C
	Accuracy	±1.0% at up to 20 mm per hour

Source: HRECOS Water Quality and Weather Stations QAPP, 2012.08. See also Appendix C.

Table 4. Dates when stations were upgraded from a YSI 6 series sonde to a YSI EXO2 sonde. Stations without upgrade dates always had the EXO model. All HRNERR sites were upgraded in 2013. Specific information can be found in CDMO metadata files.

Station	USGS ID	Date upgraded to YSI EXO 2
Mohawk River at Ilion	01342732	-
Mohawk River at Lock 8	01354330	May 2024
Mohawk River at Rexford	01355475	October 2019
Port of Albany	01359165	March 2023
Schodack Landing	0135980207	August 2022
Poughkeepsie	01372043	May 2019
West Point	01374019	July 2022
Piermont	01376269	August 2023
Yonkers	01376307	July 2018
Pier 84	01376515	-
Pier 25	01376520	-
Newark Bay at PVSC	404241074072202	-

Table 5. YSI 6 series sonde specifications.

Parameter	Model	Units	Sensor Type	Range	Accuracy	Resolution
pH	6561		Glass combination electrode	0 to 14	±0.2 pH units	0.01
Specific conductance	6560	mS/cm	4-electrode nickel	0 to 100 mS/cm	0.001 to 0.1 mS/cm (range dependent)	±0.5% of reading plus 0.001 mS/cm
Water temperature	6560	Degrees Celsius	Thermistor	-5 to 50°C	±0.15°C	0.01°C
Dissolved oxygen	6150 ROX	% mg/L	Optical luminescence	0 to 500% 0 to 50 mg/L	0 – 200%: ±1% 200 – 500%: ±15% 0 – 20 mg/L: ±0.1 mg/L or 1% (whichever is greater); 20 – 50 mg/L: ±-15%	0.1% 0.01 mg/L
Turbidity	6136	NTU	Optical	0 to 1000	±2% or 0.3 NTU	0.1 NTU
Chlorophyll	6025	RFU or ug/L	Optical	0 to 100 RFU 0 to 400 ug/L	Linearity R^2 >0.9999	0.1% RFU 0.1 ug/L

Source: ysi.com/products

Table 6. YSI EXO SmartSensor specifications.

Parameter	Model	Units	Sensor Type	Range	Accuracy	Resolution
pH	577612		Glass combination electrode	0-14	±0.1 pH units within ±10°C of calibration temperature; ±0.2 pH units for entire temp range	0.01 units
Specific conductance	599870	Micro or millisiemens	4-electrode nickel	0 to 200 mS/cm	0-100 µS/cm: ±0.5% of reading or 0.001 µS/cm, whichever is greater; 100-200 µS/cm: ±1% of reading	0.0001 to 0.01 µS/cm range-dependent
Water temperature	599870	Degrees Celsius	Thermistor	-5 to +50°C	-5 to 35°C: ±0.01°C 35 to 50°C: ±0.05°C	0.001°C
Dissolved oxygen	599100-01	mg/L	Optical luminescence	0-50 mg/L	0 – 200%: ±1% 200 – 500%: ±5% 0 – 20 mg/L: ±0.1 mg/L or 1% (whichever is greater); 20 – 50 mg/L: ±-5%	0.01 mg/L
Turbidity	599101-01	FNU	Optical, 90° scatter	0-4000 FNU	0-999 FNU: 0.3 FNU or ±2% of reading, whichever is greater; 1000-4000 FNU: ±5% of reading	0-999 FNU: 0.01 FNU 1000-4000 FNU: 0.1 FNU
Chlorophyll	599102-01	RFU or ug/L	Optical sensor	0-100 RFU, 0-400 ug/L	Linearity: r^2 ≥ 0.999 for Rhodamine WT across full range	0.01 RFU or 0.01 µg/L
Phycocyanin	599102-01	RFU or ug/L	Optical sensor	0-100 RFU, 0-100 ug/L	Linearity: r^2 ≥ 0.999 for Rhodamine WT across full range	0.01 RFU or 0.01 µg/L

Source: ysi.com/products; See also EXO User Manual, Revision K, pages 78-148.

Table 7. Summary of project data quality indicators.

Data quality indicator	Quality control activities and checks	Goal
Precision	Using EXO2 sondes at each site.	Equipment meets manufacturer precision requirements during calibration.
Bias	Measure and compare the responses of reference and deployed sonde to examine the effect of fouling and/or sensor drift on sensor performance.	Results from these QC checks are used to validate station data records over the course of the deployment period and minimal data is invalidated.
Accuracy	Routine calibration of equipment.	Data collected accurately represent environmental conditions.
Representativeness	Site assessments prior to installation. Cross channel analyses.	Data collected represent site conditions.
Comparability	Routine calibration of equipment. All operators follow the USGS guidelines. Equipment must meet certain specifications.	Data collected can be compared across sites.
Completeness	USGS and HRECOS Coordinator monitor the data streams and notify a station operator of telemetry issues. Internal logging on sonde is utilized as a backup. Water-quality sondes are routinely checked for fouling and calibration drift.	It is expected that a 100% data completeness will be achieved unless unforeseen problems occur, such as equipment failure.

6. Documentation and Records Management (A12)

6.1 QAPP Distribution and Amendments

The HRECOS coordinator maintains the official approved QAPP for the HRECOS network. Any modifications to the QAPP require a signature from all the station operators, database manager, HRECOS coordinator and the appropriate NEIWPCC and NYSDEC representatives. Copies of amendments will be sent electronically, and signatures may be received electronically or via scanned copy. Once finalized, a copy will be available on the HRECOS website for reference.

6.2 Calibration Logs

Each station operator is responsible for maintaining calibration logs and post-deployment calibration checks for their own station. These are transmitted to the USGS project manager and HRECOS coordinator via JotForm (Appendix D) or email as soon as possible after the field visit takes place.

6.3 File Retention

Prior to 2019, the Stevens Institute of Technology managed the HRECOS database following the Continuous Data Handling and Archival SOP (Appendix E). Continuous water-quality data collected by station operators is managed by the USGS and is reviewed and approved, and stored in the USGS National Water Information System (NWIS), a federally supported, public facing, persistent database that stores USGS water data (https://waterdata.usgs.gov/nwis). All USGS records and documents are Federal Records and follow guidelines set forth in Federal Records Act of 1950 (Wippich, 2012).

6.3.1 Historic Data Files

Prior to 2019, the HRECOS Coordinator compiled the quarterly verified data for each station into annual data files. These files are posted to the Data Hub page of www.hrecos.org. USGS also keeps backup copies of this data on a secure server.

6.3.2 Additional Files

USGS does not maintain, review, or validate weather, chlorophyll, phycocyanin, or HRECOS-collected water elevation data. These data are transmitted and displayed on the NWIS dashboard as provisional data for 120 days from date of collection. The HRECOS coordinator is responsible for compiling this information and making it available on the HRECOS website, with the caveat that it is not quality assured by the USGS.

6.3.3 HRNERR Files

All calibration logs, post-deployment checks, and data generated from HRNERR sites are maintained by the CDMO and are available upon request from their website.

6.4 Metadata

The HRECOS coordinator maintains the metadata for each station, which includes a description of the station configuration, comments from station operators, and the results of cross channel assessments or other relevant reports. These files are updated quarterly by the coordinator with new information from station operators. Metadata PDF files are linked on the HRECOS website.

6.4.1 HRNERR Metadata

All metadata files for HRNERR sites are maintained by the CDMO and are available upon request from their website.

B. Environmental Information Operations

1. Project/Sampling Design and Rationale (B1)

1.1 Network Design

HRECOS was established to provide geographically distributed, high-frequency water quality and weather data on the Mohawk and Hudson Rivers to further knowledge of basic river conditions and long-term trends. Individual stations are selected to represent local conditions or to serve a local need (Figure 2; Table 8).

1.2 Rationale for Individual Stations

1.2.1 Mohawk River at Ilion (Ilion)

The Mohawk River at Ilion station was installed in September 2015. The primary use for this station is for NYSDEC Division of Water to monitor the impact of CSOs and SSOs on ambient river conditions, primarily dissolved oxygen.

1.2.2 Mohawk River at Lock 8 (Lock 8)

The Mohawk is the largest tributary to the Hudson, but a small percentage of monitoring and management efforts have been directed toward it. Lock 8 was selected to address this information gap.

1.2.3 Mohawk River at Rexford (Rexford)

The NYSDEC Mohawk River Basin Program funded the installation of this station to help satisfy the water quality goals of the program's Action Agenda by providing monitoring data.

1.2.4 Port of Albany

This station is located at the southern edge of the Albany pool, where monitoring the impact of CSOs on ambient river conditions is a component of water quality improvement efforts to restore the river for recreational use. The HRECOS data has been used by regulators to identify dissolved oxygen fluctuations.

1.2.5 Schodack Landing

The Schodack Landing station is one of the original stations installed in 2008. It was the most upstream station at the time and was to be used for comparison against mid and lower river sites.

1.2.6 Tivoli Bays (North and South)

The objective of these stations is to monitor surface water quality and weather conditions at the Tivoli North Bay and Tivoli South Bay component sites of the Hudson River National Estuarine Research Reserve.

1.2.7 Norrie Point

The objective of this site is to monitor surface water quality and weather conditions at the Norrie Point Environmental Center.

1.2.8 Poughkeepsie

This specific location was selected because it is a historic RIBS sampling site for the lower Hudson River and because Marist College is a motivated partner for continued maintenance and upkeep. USGS has also strategically co-located some of their monitoring equipment at the site, which does not impact HRECOS data, but provides additional data and context.

1.2.9 West Point

West Point is a location of high interest due to the dynamic activity of the Hudson River's salt front. Monitoring for conductivity at this location can help track salt front movement throughout the year.

1.2.10 Bear Mountain

The objective of this site is to monitor surface water quality at the Bear Mountain and Iona Island component site of the Hudson River National Estuarine Research Reserve.

1.2.11 Piermont

The Piermont station was one of the original HRECOS monitoring sites that was intended to represent lower river conditions.

1.2.12 Yonkers

The SLC CURB initiated this station to support their education and research goals. CURB educates over 5,000 youth annually on the Hudson River and urban watershed issues and has a research and monitoring program utilizing Sarah Lawrence College students and faculty.

1.2.13 Pier 84 and Pier 25

These site locations were chosen due to the proximity to NYC Harbor and in lower Manhattan, one of the world's most heavily developed and densely populated urban environments. Hudson River Park Trust utilizes the data for public outreach and both stations play an important role in understanding conditions in the lower Hudson.

1.2.14 Newark Bay at Passaic Valley Sewerage Commission

The Passaic Valley Sewerage Commission approached HRECOS in 2013 with a proposal to join the network and build a real-time HRECOS monitoring station. Although the station is located outside of the Hudson River Watershed, it is within the NY-NJ Harbor, which is an area of concern for HREP and NYSDEC.

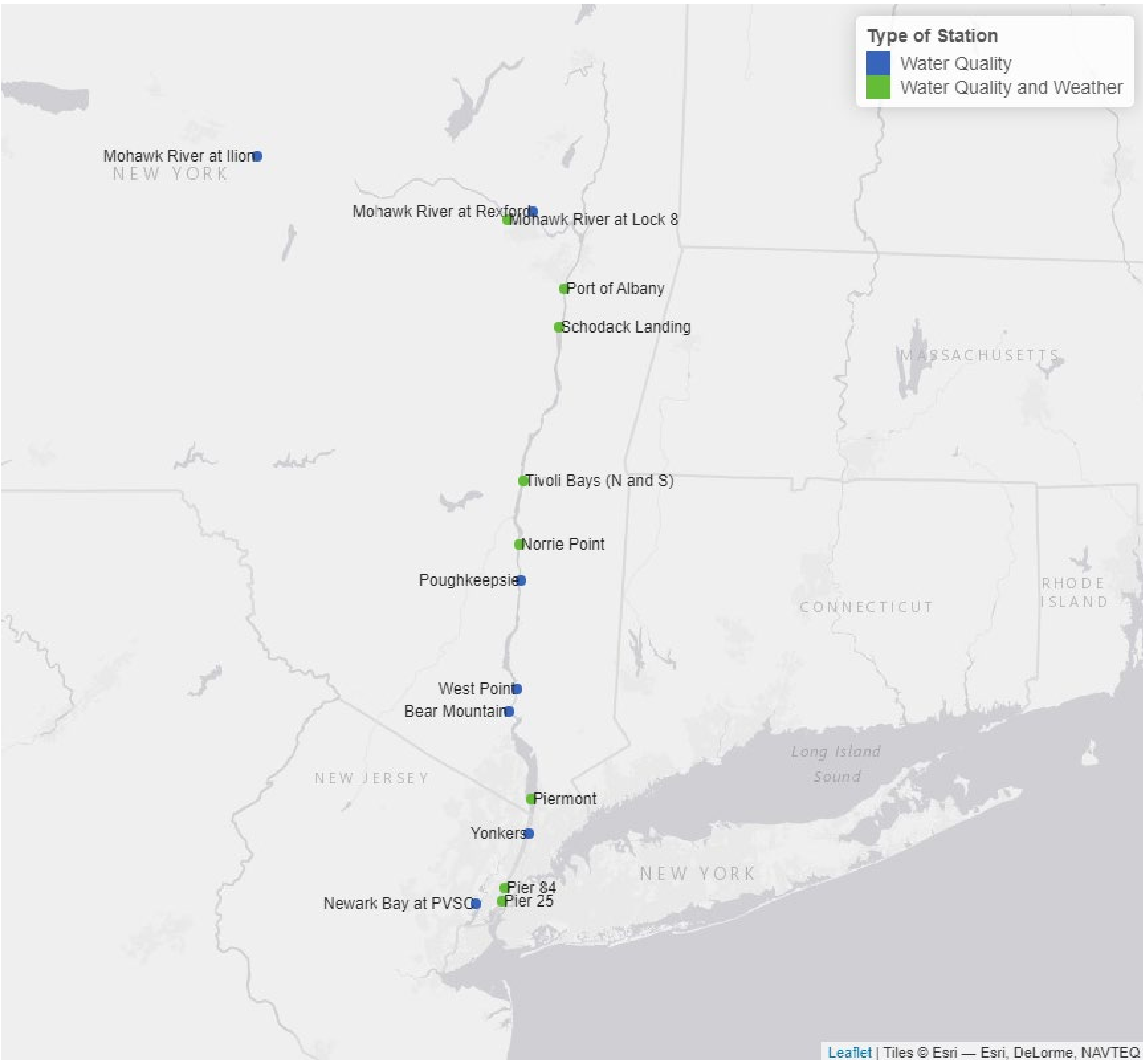

Figure 2. Map of HRECOS monitoring locations.

Table 8. Station locations.

Station	USGS ID	Water Quality Data Collected	Meteorological Data Collected	Latitude	Longitude
Mohawk River at Ilion	01342732	Yes	No	43.019750	-75.028472
Mohawk River at Lock 8	01354330	Yes	Yes	42.828100	-73.990400
Mohawk River at Rexford	01355475	Yes	No	42.851132	-73.887180
Port of Albany	01359165	Yes	Yes	42.619540	-73.758900
Schodack Landing	0135980207	Yes	Yes	42.499600	-73.776800
Tivoli North Bay		Yes	No	42.03655	-73.92532
Tivoli South Bay		Yes	No	42.02704	- 73.92596
Field Station		No	Yes	42.01820	-73.91700
Norrie Point Meteorological		No	Yes	41.83139	-73.94222
Norrie Point Water Quality		Yes	No	41.83167	-73.94194
Poughkeepsie	01372043	Yes	No	41.720600	-73.938800
West Point	01374019	Yes	No	41.386083	-73.955000
Bear Mountain		Yes	No	41.31434	-73.98522
Piermont	01376269	Yes	Yes	41.043000	-73.896000
Yonkers	01376307	Yes	No	40.936278	-73.904306
Pier 84	01376515	Yes	Yes	40.764628	-74.003186
Pier 25	01376520	Yes	Yes	40.721528	-74.015611
Newark Bay at PVSC	404241074072202	Yes	No	40.713239	-74.123086

2. Methods (B2)

2.1 Water Quality Measurements

The following water quality parameters are measured using a YSI EXO2 sonde: water temperature, specific conductance, salinity, turbidity, dissolved oxygen concentration and percent saturation, pH, and chlorophyll and phycocyanin fluorescence (Table 5). Deployed sensors are swapped at least once every 3 months with a calibrated sonde to minimize gaps in data collection. In higher biofouling environments closer to the mouth of the Hudson, swaps are conducted more frequently to minimize impacts on data. For more details on calibration and post-deployment calibration checks, consult section B6.
All sensors used by station operators for water-quality measurements are to be properly operated, maintained, and calibrated. Manufacturer's operating guidelines are carefully followed for correct operation of all field and laboratory equipment. Thorough documentation of all calibration activities associated with water-quality data collection is a critical element of the quality-assurance program.

When instruments are not calibrated correctly or not swapped within the appropriate window, data from that time period will be excluded from the final record. See Wagner et. al (2006) and section D1.

2.1.1 HRNERR Stations

Tivoli Bays, Norrie Point, Bear Mountain, and all other HRNERR component monitoring sites are operated according to the SWMP SOPs, which are listed in Table 9 and available upon request from the CDMO website.

2.2 Water Elevation and Gage Height Measurements

Water velocity, gage height, and water elevation data are collected at Lock 8, Rexford, Port of Albany, Poughkeepsie, West Point, Pier 84 and Pier 25 by USGS according to standard operating procedures described in Sauer and Turnipseed (2010) (Table 10). More information can be found on a given site's NWIS page.

2.2.1 Historic Water Elevation Data

Water elevation data at West Point, Pier 84, and Pier 25 were previously collected using the protocol shown in Figure 3. The bolt at the bottom of the deployment tube was surveyed in reference to NAVD88 at each site. On EXO2 sonde models, the depth sensor is 0.24 m from the bottom of the probe guard, which rests on the bolt. This distance was added to the vertical distance from the bolt to the benchmark to obtain the vertical correction for each site. Air pressure at each site is monitored with a Vaisala PTB110 barometric pressure sensor, which is used to offset the water depth above sonde data. Finally, the air pressure compensated depth data is added to the vertical correction to determine the water elevation in NAVD88 at each site.

2.3 Weather Measurements

The following weather parameters are measured according to the HRECOS Weather Monitoring SOP (Appendix B): air temperature, barometric pressure, photosynthetically active radiation (PAR), precipitation, relative humidity, wind speed, wind direction, wind gusts. The SOP provides the minimum operation and maintenance requirements; some stations use site specific SOPs which satisfy these minimum requirements.

2.3.1 HRNERR Stations

Tivoli Bays, Norrie Point and all other HRNERR component monitoring sites are operated according to the SWMP SOPs, which are listed in Table 9.

2.4 Data Transmission

Data are recorded by an external data logger and are transmitted to the USGS database via satellite, cellular modem, or direct internet connection. Data are also logged internally on each sonde to serve as a backup in case of a power or communication failure. In instances of failure, internal sonde data files are patched into the final data record during USGS QAQC procedures described in Wagner et al. (2006).

2.4.1 HRNERR Transmission

Data from Tivoli Bays, Norrie Point, and Bear Mountain are transmitted online according to the Telemetry Systems for Real Time SWMP Data SOP (Table 9).

Table 9. SOP quick reference guide.

Document Title	**Coverage**	**Location**
Campbell Scientific CR1000/1000X Meteorological Monitoring Station SOP v3.14	HRNERR Weather Stations	https://cdmo.baruch.sc.edu/request-manuals/
CDMO Data Management Manual v6.8	HRNERR Water Quality and Weather Stations	https://cdmo.baruch.sc.edu/request-manuals/
Guidelines and Standard Procedures for Continuous Water-Quality Monitors (Wagner et al. 2006)	HRECOS Water Quality Stations; Instrument calibration, field checks, and post-deployment checks; QAQC on HRECOS data collected after May 2019	https://pubs.usgs.gov/tm/2006/tm1D3/
HRECOS Calibration and Deployment Guide (Adapted from Wagner et al. 2006)	HRECOS Water Quality Stations; Instrument calibration, field checks, and post-deployment checks	Appendix A
HRECOS Continuous Data Handling and Archival SOP	QAQC on HRECOS data collected up to May 2019	Appendix E
HRECOS Meteorological Monitoring SOP	HRECOS Weather Stations	Appendix B
Stage Measurement at Gaging Stations	Gage height, water elevation data available at select sites	https://pubs.usgs.gov/tm/tm3-a7/tm3a7.pdf
Telemetry Systems for Real Time SWMP Data Delivery SOP v1.5	HRNERR Water Quality and Weather Stations	https://cdmo.baruch.sc.edu/request-manuals/
YSI/Xylem EXO Multi-Parameter Water Quality Monitoring SOP v2.3	HRNERR Water Quality Stations	https://cdmo.baruch.sc.edu/request-manuals/

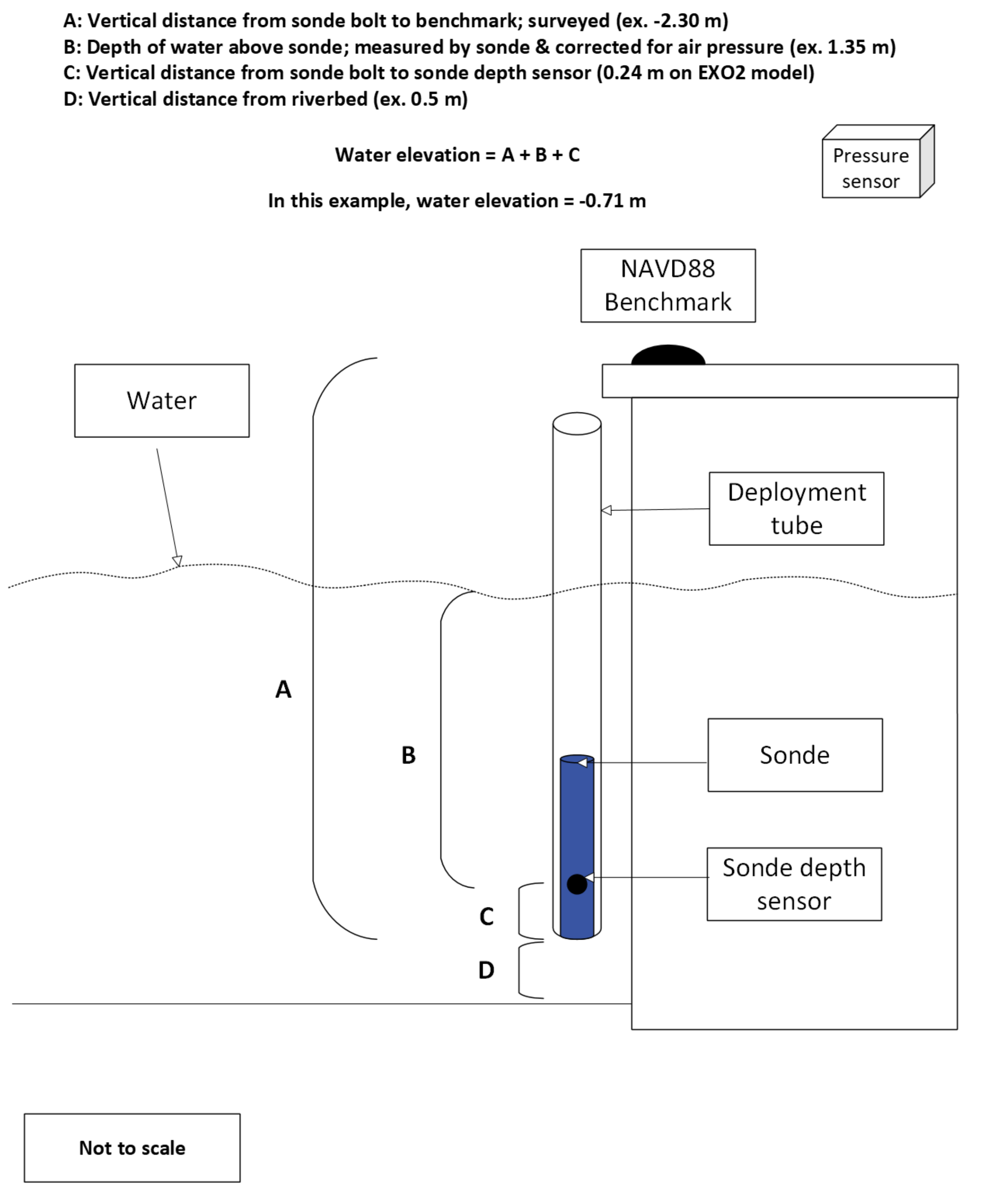

Figure 3. Diagram of sonde-derived water elevation data. Water depth may also be calculated using B+C+D.

Table 10. Parameters recorded at each HRECOS station. Seasonal monitoring locations are indicated with an asterisk. Bolded stations are maintained and operated by HRNERR according to CDMO protocol. For HRECOS stations, parameters in *italics* are only temporarily displayed on NWIS.

	Mohawk Ilion*	Mohawk Lock 8	Mohawk Rexford	Port of Albany	Schodack Landing	**Tivoli Bays (N and S)** *	**Norrie Point**	Poughkeepsie	West Point	**Bear Mountain**	Piermont	Yonkers*	Pier 84	Pier 25	Newark Bay PVSC
Water temperature	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Specific conductance	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Salinity					x	x	x	x	x	x	x	x	x	x	x
Dissolved oxygen	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Water depth relative to sonde[1]						x	x			x					
Water elevation[2] (USGS)				x				x	x				x	x	x
Gage height[2]		x	x												
pH	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Chlorophyll			x	x		x	x	x		x					
Water velocity				x											
Turbidity	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

	Mohawk Ilion*	Mohawk Lock 8	Mohawk Rexford	Port of Albany	Schodack Landing	**Tivoli Bays (N and S)***	**Norrie Point**	Poughkeepsie	West Point	**Bear Mountain**	Piermont	Yonkers*	Pier 84	Pier 25	Newark Bay PVSC
Air temperature		x		x	x	x	x				x		x	x	
Barometric pressure	x	x		x	x	x	x				x		x	x	
Relative humidity		x		x	x	x	x				x		x	x	
Wind speed & direction		x		x	x	x	x				x		x	x	
PAR		x		x	x	x	x				x				
Precipitation		x		x	x	x	x				x		x	x	

[1]Water depth measured by internal sonde sensor, which is corrected using a depth offset. Consult CDMO documentation for further details.
[2]Water elevation and gage height data are collected at co-located stations maintained by USGS.

3. Integrity of Environmental Information (B3)

Data are collected in situ and transmitted to the web via satellite, cellular modem, or direct internet connection. There are no physical samples.

4. Environmental Information Management (B7)

Real-time data from HRECOS stations are transmitted to USGS every hour. USGS handles the processing and compilation of data according to procedures outlined in the Record Computation section of Wagner et al. (2006; Table 9). See also section D1. All data are marked as provisional until review, which is clearly noted on the USGS webpage.

4.1 HRNERR Information Management

Data from HRNERR stations are processed and compiled according to CDMO guidelines, which are outlined in the CDMO Data Management Manual (Table 9). See also section D1.

5. Quality Control (B4)

There are no physical water samples collected; all measurements are taken on the sonde. In-field comparison to a newly calibrated sonde and post-deployment calibration drift checks are utilized to assess the data quality. See also section B6.1.

6. Equipment/Instrument Calibration, Testing, Inspection, Maintenance (B5)

6.1 Water Quality Instrumentation

All HRECOS and HRNERR monitoring locations are equipped with a YSI EXO2 multiparameter sonde. The number of sensors on each sonde vary by site, see Table 10 for parameters collected at each station. See Table 6 for EXO SmartSensor specifications. See Table 4 for dates when water-quality sondes were upgraded to YSI EXO2.

6.1.1 Calibration

Sondes deployed at HRECOS sites are calibrated in a temperature-controlled environment and calibrations are documented according to USGS guidelines and procedures described in Wagner et. al, (2006). Field meters that are used during field checks are calibrated and checked for accuracy and are documented following USGS guidelines. Sensors are calibrated with traceable standards following the protocol described in Wagner et al. (2006). A simplified version of the protocol can be reviewed in Appendix A.

6.1.2 Field Checks

Field checks are performed on a quarterly basis at minimum to ensure data being collected at HRECOS sites is accurate and that the dataset is complete. During a field check, a newly calibrated instrument is compared to the deployed sonde according to the standard protocol in Wagner et al. (2006, page 13). For sites where the standard protocol cannot be applied a modified approach may be used as described in the modified protocol in Wagner et. al (2006, page 15). Observations are recorded on a field sheet and sent to USGS as soon as possible via Jotform or email. Typically, the deployed instrument will be swapped with the newly calibrated one after field comparisons are completed.

6.1.3 Post-Deployment Calibration Checks

After a field check, the sonde retrieved from the field is further cleaned and assessed for calibration drift to verify the sensor was functioning properly and to gather necessary data for the water-quality record.

Calibration checks are documented according to USGS protocols described in Wagner et al. (2006). Calibration check information is sent to the USGS as soon as possible via Jotform or email.

6.1.4 Record Management

Calibration information is stored on the EXO sonde and SmartSensors and can be retrieved using the KOR software such that it is traceable to individual instruments. Calibration information and serial numbers are also recorded on the forms that are transmitted to USGS. Forms are archived and preserved in accordance with the USGS records disposition requirements and the Federal Records Act 36 CFR 1220.14. Calibration and field check information is brought into USGS Aquarius time-series database where field visits are stored.

6.1.5 HRNERR Protocol

Sondes at HRNERR sites are calibrated, checked, and maintained using the procedures outlined in the YSI/Xylem EXO Multi-Parameter Water Quality Monitoring SOP v2.3 (Table 8).

6.2 Meteorological Instrumentation

Weather stations may use sensors that meet the requirements outlined in Table 3. See Tables 11-15 for station specific details. This information is also documented in site metadata.

6.2.1 Field Inspection

HRECOS weather equipment is routinely checked and cleaned according to the HRECOS Meteorological Monitoring SOP (Appendix B).

6.2.1.1 HRNERR Meteorological Sites

Field inspections are performed monthly according to the CDMO Campbell Scientific CR1000/1000X Meteorological Monitoring Station SOP v3.14.

6.2.2 Calibration

HRNERR weather station equipment is serviced and calibrated every two years, according to the Campbell Scientific CR1000/1000X Meteorological Monitoring Station SOP v3.14 (Table 9). HRECOS weather stations adhere to the two-year interval where funding is possible. More information can be found in the site metadata documents.

Table 11. Sensor specifications for Lock 8 and Port of Albany weather stations.

Parameter	Make and Model	Sensor Type	Units	Range	Accuracy
Air temperature	Vaisala HMP45AC	Platinum resistance thermometer	°C	-40°C to +60°C	±0.2°C at 20°C
Relative humidity	Vaisala HMP45AC	Capacitive polymer	%	0 to 100% non-condensing	At 20°C: ±2% (0-90%); ±3% (90-100%)
Barometric pressure	Vaisala PTB110	Silicon capacitive	mbar	500-1100 mbar	±0.3 mb @ +20°C; ±0.6 mb @ 0° to 40°C; ±1.0 mb @ -20° to +45°C; ±1.5 mb @ -40° to +60°C
Precipitation	Texas Electronics TE525WS	Tipping bucket	in		Up to 1 in./hr: ±1% 1 to 2 in./hr: +0, -2.5% 2 to 3 in./hr: +0, -3.5%
PAR	LI-COR LI190SB	Silicon PV detector (400-700 nm)	mmoles/m^2	Light spectrum waveband: 400 to 700 nm	Temperature Response: 0.15% per °C Stability: <±2% change over 1 yr Operating Temperature: -40°C to 65°C; Humidity: 0 to 100% Sensitivity: 5 µA per 1000 µmoles s^{-1} m^{-2} Calibration: ±5% traceable to the U.S. National Institute of Standards Technology (NIST)
Wind direction --- Wind speed	RM Young 05103-45/5	Mechanical vane --- Mechanical propeller	Degrees --- m/s	355° electrical --- 0 to 100 m/s	±3° --- ±0.3 m/s or 1% of reading

Table 12. Sensor specifications for Schodack Landing weather station.

Parameter	Make and Model	Sensor Type	Units	Range	Accuracy
Air temperature	Rotronic HC2S3	Resistance thermometer	°C	-40°C to +60°C	±0.1°C at 23°C
Relative humidity	Rotronic HC2S3	Capacitive polymer	%	0 to 100% non-condensing	±0.8% at 23°C
Barometric pressure	Vaisala PTB110	Silicon capacitive	mbar	500-1100 mbar	±0.3 mb @ +20°C; ±0.6 mb @ 0° to 40°C; ±1.0 mb @ -20° to +45°C; ±1.5 mb @ -40° to +60°C
Precipitation	Texas Electronics TE525WS	Tipping bucket	in		Up to 1 in./hr: ±1% 1 to 2 in./hr: +0, -2.5% 2 to 3 in./hr: +0, -3.5%
PAR	LI-COR LI190SB	Silicon PV detector (400-700 nm)	mmoles/m^2	Light spectrum waveband: 400 to 700 nm	Temperature Response: 0.15% per °C Stability: <±2% change over 1 yr Operating Temperature: -40°C to 65°C; Humidity: 0 to 100% Sensitivity: 5 µA per 1000 µmoles s^{-1} m^{-2} Calibration: ±5% traceable to the U.S. National Institute of Standards Technology (NIST)
Wind direction --- Wind speed	RM Young 05103-45/5	Mechanical vane --- Mechanical propeller	Degrees --- m/s	355° electrical --- 0 to 100 m/s	±3° --- ±0.3 m/s or 1% of reading

Table 13. Sensor specifications for HRNERR operated weather stations.

Parameter	Make and Model	Sensor type	Units	Range	Accuracy
Air temperature	Eletktronik EE181	Platinum resistance	Degrees Celsius	-40°C to +60°C	±0.2 °C
Relative humidity	Elektronik EE181	Capacitive	%	0 to 100% non-condensing	–15 to 40 °C: ≤90% RH ± (1.3 + 0.003 • RH reading) –15 to 40 °C: >90% RH ± 2.3% RH –25 to 60 °C: ± (1.4 + 0.01 • RH reading) –40 to 60 °C: ± (1.5 + 0.015 • RH reading)
Barometric pressure	Vaisala CS-106 PTB110	Capacitive	Millibars	600 to 1060 mbars	± 0.3 mb @ 20°C; +/- 0.6 mb @ 0°C to 40°C; +/- 1.0 mb @ -20°C to 45°C ; ; +/- 1.5 mb @ -40°C to 60°C
Precipitation	TB3	Heated tipping bucket	Mm	Temperature: -20° to +70°C; Humidity: 0 to 100%	±1.0% up to 1 in./hr; +0, -3% from 1 to 2 in./hr; +0, -5% from 2 to 3 in./hr
PAR	Apogee SQ-110	High stability silicon photovoltaic detector (blue enhanced)	mmoles m-2 (total flux)	Light spectrum waveband: 360 to 1120 nm	Temperature Response: < 1% at 5° to 40°C Stability: <±2% change over 1 yr Operating Temperature: -40°C to 70°C; Humidity: 0 to 100% Sensitivity: 5 W m-2 mV-1 (0.2 mV W-1 m-2)
Wind direction --- Wind speed	RM Young 05103	Mechanical vane --- Mechanical propeller	Degrees --- m/s	360° mechanical, 355° electrical (5° open) --- 0-100 m/s	±3° --- 1% of reading

Table 14. Sensor specifications for Piermont weather station.

Parameter	Make and Model	Sensor type	Units	Range	Accuracy
Air temperature	Rotronic HC2S3	Resistance thermometer	Degrees Celsius	-40°C to 60°C	±0.1°C at 23°C
Relative humidity	Rotronic HC2S3	Capacitive polymer	%	0 to 100% non-condensing	±0.8% at 23°C
Barometric	Vaisala CS-106 PTB110	Silicon capacitive	mbar	500-1100 mbar	±0.3 mb @ +20°C; ±0.6 mb @ 0° to 40°C; ±1.0 mb @ -20° to +45°C; ±1.5 mb @ -40° to +60°C
Precipitation	Texas Electronics TE525WS	Tipping bucket	in		Up to 1 in./hr: ±1% 1 to 2 in./hr: +0, -2.5% 2 to 3 in./hr: +0, -3.5%
PAR	Apogee SQ-500	High stability silicon photovoltaic detector	mmoles m^2 (total flux)	389 to 692 nm	Temperature Response: -0.11 ± 0.04% / °C Stability: <±2% change over 1 yr Operating Temperature: -40°C to 70°C; Humidity: 0 to 100% Sensitivity: 0.01 mV per mmole m^2/s
Wind direction --- Wind speed	RM Young 05106	Mechanical vane -- Mechanical propeller	Degrees --- m/s	360° mechanical, 355° electrical (5° open) --- 0-100 m/s	±3° --- 1% of reading

Table 15. Sensor specifications for Pier 84 and Pier 25 weather stations. Both Piers have an all-in-one Vaisala WXT530.

Parameter	Make and Model	Units	Range	Accuracy
Air temperature	WXT530	Degrees Celsius	-50°C to 60°C	±0.3°C
Relative humidity	WXT530	%	0 to 100%	±3 at 0 to 90 ±5 at 90 to 100
Barometric pressure	WXT530	hPa	500 to 1100 hPa	±0.5 at 0-30°C ± 1 at -52°C to 0°C ± 1 at 30-60°C
Precipitation	WXT530	in	0 to 7.87 in/hr	Within 5% of daily accumulation
Wind direction --- Wind speed	WXT530	Degrees --- m/s	0 to 360° --- 0 to 60 m/s	3° at 10 m/s --- ±3%

7. Inspection/Acceptance of Supplies and Services (B6)

The HRECOS coordinator handles all supply orders, though individual station operators are responsible for inspecting supplies upon receipt and communicating any defects or damages to the coordinator. See list of required supplies in Tables 16 and 17.

7.1 Calibration Standards

NIST traceable calibration standards are ordered from a reputable vendor such as Fondriest or Fisher Scientific. A vendor is selected depending on stock availability and pricing. Individual station operators are responsible for checking their standards and ensuring they are not expired. The lot numbers and expiration dates are also reported to USGS on the calibration forms.

7.2 Repairs and Factory Re-Calibration

Equipment is assessed for repair needs when performing field inspections and swaps. Repair and factory calibration services are provided by the manufacturer. Station operators can request repair services themselves or work with the coordinator.

Table 16. Required supplies to run a HRECOS water quality station. Miscellaneous supplies such as cleaning tools and hardware are not listed.

Item	**Purpose**
YSI EXO2 sonde equipped with conductivity/temperature, pH, turbidity, and dissolved oxygen sensors	Monitors basic suite of water quality parameters
Sonde cable	Connects sonde to output adapter
Sonde output adapter (SOA)	Connects sonde to datalogger
Campbell Scientific datalogger	Controls sonde and modem
Cell modem	Enables remote connectivity to station for data acquisition and troubleshooting
Battery	Provides power to station in the field
Solar panel	Collects solar radiation
Solar regulator	Regulates incoming voltage from solar panel to recharge the battery
Calibration standards	Used to calibrate and perform post-deployment checks on sondes

Table 17. Required supplies to run a HRECOS weather station. Models may vary if they meet the requirements.

Item	**Purpose**
Air temperature and relative humidity sensor	Measures air temperature and relative humidity
Barometer	Measures barometric pressure
Rain bucket	Measures precipitation
PAR sensor	Measures photosynthetically active radiation
Wind monitor	Measures wind speed and direction
Campbell Scientific datalogger	Controls weather sensor measurements and collects data; Controls communications

Cell modem	Enables remote connectivity for data acquisition and troubleshooting
Battery	Provides external power to the station in the field

C. Assessment, Response Actions, and Oversight

1. Assessments, Oversight, and Response Actions (C1 & C2)

Communications regarding project status occur via email. There is an open line of communication between the station operators, USGS, and the HRECOS coordinator to troubleshoot, document calibration and maintenance activities, and submit forms.

Calibration forms serve to assess compliance with protocols and assist in data validation. They are required to be submitted on a quarterly basis or as often as sonde maintenance events occur. If there is missing information or something is unclear, the operator and HRECOS coordinator are notified via email by USGS to resolve the issue.

NEIWPCC may implement, at its discretion, various audits, or review of this project to assess conformance and compliance to the Quality Assurance Project Plan in accordance with the NEIWPCC Quality Management Plan. NEIWPCC may issue a stop work order and require corrective action(s) if nonconformance or noncompliance to the Quality Assurance Project Plan is found.

2. Reports to Management (C2)

Station operators are expected to submit quarterly reports that detail their calibration, maintenance, and other activities to NEIWPCC, which are reviewed by the HRECOS coordinator. USGS also receives calibration forms on a rolling basis as station operators perform their duties which serve as an additional check.

D. Data Review and Usability

1. Data Review (D1)

HRECOS station data are reviewed by USGS according to the procedures described in Wagner et al. (2006), which are summarized below.

First, raw data are continuously transmitted to the Device Conversion and Delivery System (DECODES) then stored in NWIS. Data are reviewed within USGS databases for errors in transmission, instrument failure, and data spikes. Erroneous and rejected data will be at the discretion of the USGS hydrographer and data approver by using methods described in Wagner et al. (2006). Sensor ranges (described in Table 6) will be considered when evaluating erroneous data. Rejected data will be justified and reviewed.

USGS receives field check and calibration check information from station operators via Jotform or email, which is then entered into the Aquarius time-series database. The USGS hydrographer uses Aquarius time-series to compute and apply fouling and drift corrections for each parameter. All continuous water-quality data and corrections will be reviewed and approved following published USGS methods in Wagner et. al (2006). OSW Technical Memorandum 2017.10 outlines Procedures for Processing, Approving, Publishing, and Auditing Time-Series Records for Water Data and provides links to time series guidance that contains, amongst other things, station analysis templates for various types of surface-water records.

Quality control measures are established in Wagner et. al (2006) and include data screening and maximum allowable limits. As described in Wagner et. al (2006, *Maximum Allowable Limits for Reporting Continuous Data,* pages 37-38), "if the recorded values differ from the corrected values by more than the maximum allowable limits, the corrected data are not reported or stored in the database." Maximum allowable limits are typically exceeded due to instrument drift, probe fouling, or sensor malfunction. A USGS hydrographer screens the data and decides whether data is published.

Complete and accurate field forms, calibration forms, and calibration check forms are necessary for the data to be corrected. USGS receives these forms from station operators and reviews them for completeness. In some cases, data will be excluded from the finalized record and cannot be validated by USGS due to incomplete calibration information, incomplete field forms, erroneous field form values, excessive sensor fouling, and actions that do not follow USGS protocol described in Wagner et. al (2006). If a station is consistently producing unusable data, the HRECOS coordinator will work with the station operators to address the problem.

1.2 Data Review by CDMO

HRNERR data are reviewed and finalized according to the procedures described in the SWMP Data Management Manual (NOAA NERRS; Table 9).

First, raw data are reviewed and flagged automatically during primary QAQC when they are sent to the CDMO. Primary QAQC flags missing data and values that fall outside of the sensor range for each parameter. During secondary QAQC, research reserve staff review the data using Excel macros where additional flags and comments can be added to make note of instrument errors, atypical environmental conditions, etc. The data are then re-submitted to the CDMO, where they undergo a final review to produce the authoritative dataset.

Unlike the USGS protocol described in Wagner et. al (2006) and section D1 the CDMO does not apply any corrections to data.

2. Project Evaluation- Usability Determination (D2)

Usability for HRECOS data and HRNERR data is determined by USGS and the CDMO, respectively according to the procedures outlined in section D1. Data are flagged and have comment codes included to indicate usability.

2.1 Usability Statements

All disclaimers and distribution terms for these datasets are documented in their respective metadata documents. On the HRECOS website, metadata documents include a quality assurance statement that directs readers to the QAPP, sensor specifications described in Table 6 and Tables 11-15, flag and comment code definitions, special remarks regarding salinity and turbidity data which are described in section A5.3, and site-specific information. Within the data files provided on the website, flag codes and comments are used to denote the usability of data (ex. Suspicious, appears to fit conditions, outside of sensor range, etc.). CDMO metadata documents include a quality assurance statement, sensor specifications, flag and comment code definitions, special remarks regarding salinity and turbidity data which are described in section A5.3, and site-specific information. Data files downloaded from the CDMO have flags and comments to denote the usability of data.

References

Government of Newfoundland and Labrador, 2016, Comparison of Multiparameter Instruments: YSI 6600, Exo2, and Hydrolab HL4, Department of Environment and Climate Change, Water Resources Management Division. accessed August 19, 2024, at https://www.gov.nl.ca/ecc/files/waterres-rti-rtwq-reports-6600-exo2-hl4-comparison.pdf

Gray, J.R. and Glysson G.D., 2002, Breakout Session 1, 56p. accessed July 30, 2024, at https://pubs.usgs.gov/circ/2003/circ1250/pdf/circ1250.book_web.pdf

HRECOS Water Quality and Weather Stations Quality Assurance Program Plan, 2012.08. See Appendix C.

NOAA National Estuarine Research Reserve (NERRS), 2024, Campbell Scientific CR1000/1000X Meteorological Monitoring Station Standard Operating Procedure, v3.14: Centralized Data Management Office, 52p. accessed May 15, 2024, at https://cdmo.baruch.sc.edu/request-manuals/

NOAA National Estuarine Research Reserve System (NERRS), 2024, System-wide Monitoring Program Data Management Manual, v6.8: Centralized Data Management Office, 201p. accessed May 15, 2024, at https://cdmo.baruch.sc.edu/request-manuals/

NOAA National Estuarine Research Reserve (NERRS), 2024, Telemetry Systems for Real Time Data Delivery Standard Operating Procedure, v1.5: Centralized Data Management Office, 64p. accessed May 16, 2024, at https://cdmo.baruch.sc.edu/request-manuals/

NOAA National Estuarine Research Reserve System (NERRS), 2024, YSI/Xylem EXO Multi-Parameter Water Quality Monitoring Standard Operating Procedure, v2.3: Centralized Data Management Office: 37p. accessed May 15, 2024, at https://cdmo.baruch.sc.edu/request-manuals/

Office of Surface Water, and Office of Ground Water, 2017, Procedures for Processing, Approving, Publishing, and Auditing Time-Series Records for Water Data, Office of Surface Water Technical Memorandum 2017.10, accessed August 15, 2024, at https://water.usgs.gov/water-resources/memos/

Sauer, V.B., and Turnipseed, D.P., 2010, Stage measurement at gaging stations: U.S. Geological Survey Techniques and Methods book 3, chap. A7, 45 p. accessed May 15, 2024, at https://pubs.usgs.gov/tm/tm3-a7/tm3a7.pdf

Thermo Scientific, 2011, Applications Tip of the Week, Conductivity and Salinity: Tip sheet. Accessed July 30, 2024 at https://static.fishersci.com/cmsassets/downloads/segment/Scientific/pdf/WaterAnalysis/Log92TipConductivitySalinity.pdf

Wagner, R.J., Boulger, R.W., Jr., Oblinger, C.J., and Smith, B.A., 2006, Guidelines and standard procedures for continuous water-quality monitors—Station operation, record computation, and data reporting: U.S. Geological Survey Techniques and Methods 1–D3, 51 p. + 8 attachments; accessed May 15, 2024, at http://pubs.water.usgs.gov/tm1d3

Wippich, Carol, 2012, Preserving science for the ages—USGS data rescue: U.S. Geological Survey Fact Sheet 2012–3078, 4 p., available at https://pubs.usgs.gov/fs/2012/3078.

YSI/Xylem, Exo User Manual, Revision K, accessed August 22, 2024 at https://www.ysi.com/File%20Library/Documents/Manuals/EXO-User-Manual-Web.pdf

YSI/Xylem, 2019, Turbidity Units and Calibration Solutions: Technical Instructions, accessed July 30, 2024 at https://www.ysi.com/File%20Library/Documents/Technical%20Notes/T627_Turbidity_Units_and_Calibration_Solutions.pdf

Appendix A

HRECOS Sonde Calibration and Deployment Guide

LAST UPDATED: MARCH 2024

Contents

About this Document

HRECOS follows the USGS Continuous Water-Quality Monitoring protocol (Wagner et al. 2006). For more details, please refer to that document. Much of the guidance in this document was adapted from USGS guidance, as well as the EXO user manual and the EXO University video library.

Links to JotForms

Field comparison form: https://form.jotform.com/203204632262039

Post deployment calibration/drift form: https://form.jotform.com/203435608499161

Pre-Deployment Calibration

Before deploying the sonde, it must be calibrated. If this sonde has just been removed from the field, use the Post-Deployment Procedure. Since most parameters are temperature dependent, you should start by checking your sonde's temperature probe. In general, it is a good idea to calibrate in the following order:

1) Temperature
2) Specific Conductance
3) DO
4) pH
5) Turbidity

According to the USGS protocol, you do not need to recalibrate the probe if its measurement falls within the limits of Table 2. However, it is recommended by the manufacturer to recalibrate the instrument regardless of the reading.

Table 1. Calibration criteria indicating when recalibration is required for a given probe. Adapted from Wagner et al. 2006.

Measurement	Calibration Criteria (Variation outside the value shown requires recalibration)
Temperature	± 0.2 ºC
Specific Conductance	± 5 µS/cm or ± 3% of the measured value, whichever is greater
Dissolved Oxygen	± 0.3 mg/L
pH	± 0.2 pH unit
Turbidity	± 0.5 turbidity unit or ± 5% of the measured value, whichever is greater

A Note on Rinsing

You will see better results if you rinse the sonde with the solution that you are about to calibrate it in. For example, after calibrating in pH 7 buffer, you rinse the sonde with pH 10 buffer before immersing it in a calibration cup filled with pH 10 buffer. You can save used calibration standards in extra bottles (label it with the contents and “rinse”) and use them as rinse for your next calibration. **USGS protocol suggests performing a rinse of the sonde and calibration cup three times when switching between standards.**

Temperature

The thermistor on the temperature/conductivity probe is highly stable. It cannot be user calibrated in the KOR software. However, you can periodically check on its accuracy by comparing it to a NIST traceable thermometer.

1. Fill a bucket or the calibration cup with tap water.
2. Connect your sonde to a laptop or handheld device that will allow you to view live readings.
    a. In KOR, you can view this on the Live Data tab
3. Wait a moment for readings to stabilize.
4. Compare the sonde’s live temperature reading to the NIST thermometer.
5. Is the temperature within +/- 0.2 degrees of the NIST thermometer?
    a. **Yes**- No further action needed.
    b. **No**- Your thermometer could be expired. Check the date on the back.
        i. **The thermometer is expired-** Ask for a replacement.
        ii. **The thermometer isn’t expired**- Your C/T probe probably needs to be replaced or cleaned.

Specific Conductance

In KOR, there are several options to choose from when calibrating the conductivity sensor. For best results, you should calibrate in specific conductance.

1. Connect your sonde to a laptop or handheld device that will allow you to view live readings.
2. Clean and dry the conductivity probe with a Kim wipe or paper towel.
3. Take a reading in air. The specific conductance should be at or near 0 in air. If this is not the case, the probe is not sufficiently clean or dry.

Specific conductance is only a one-point calibration. **You should use a standard that is closest to the average readings you see in the field.**

4. Fill a clean calibration cup to the top line with the appropriate standard for your site.
5. Immerse the sonde. You can rotate or gently tap the sonde up and down to disperse bubbles.
6. In the “Calibration” menu, select “Sp Cond”.
7. Enter the correct standard value in the first box. **BE MINDFUL OF UNITS.**
8. Wait for the data stability to change from “Unstable” to “Stable”.
9. Hit “Apply”

10. You can also **check** your sonde's calibration by immersing it in your other conductivity standards and making note of the live readings. **Do not calibrate the sonde in this step.**
    a. If the live readings fall outside the criteria in the table, you can recalibrate using the appropriate standard from Step #4 and check again.

Dissolved Oxygen

1. Fill calibration cup with 1/8 inch of deionized water.
2. Dry off the dissolved oxygen and conductivity probes using a Kim wipe or towel.
3. Place sonde into the calibration cup, but do not tighten the cup to the sonde.
4. Set a timer for 10-15 minutes.
5. Use a barometer to determine the air pressure.
    a. If you have a handheld, there may be a built-in pressure sensor.
6. In the "Calibration" menu, select DO (% Sat)
7. Choose AirSat from the drop-down menu if it isn't selected by default.
11. Enter the barometric pressure.
12. Enter the theoretical dissolved oxygen value in the standard value box.
    a. https://water.usgs.gov/water-resources/software/DOTABLES/
    b. Remember that if you're using DI water the conductance is zero.
13. Wait for the data stability to change from "Unstable" to "Stable".
14. Hit "Apply"

pH

While a 1-point pH calibration is possible, using a 2 or 3-point calibration is recommended for greater accuracy.

1. Always start with pH 7 solution. Fill a clean calibration cup to the bottom line.
2. Navigate to the "Calibration" menu.
3. pH reading is temperature dependent. Using the temperature on the calibration screen and the pH-temperature dependency table on the box your buffer came in, enter the theoretical pH in the standard value box for maximum accuracy.
4. Wait for the data stability to change from "Unstable" to "Stable".
5. Hit "Apply"
6. Click "Add another calibration point".
7. Fill a clean calibration cup to the bottom line with the pH 10 buffer.
8. Determine the theoretical pH reading based on the temperature and enter the value.
9. Wait for the data stability to change from "Unstable" to "Stable".
10. Hit "Apply"
11. Repeat steps 6-9 with pH 4 buffer if desired.

Turbidity

1. Fill a clean calibration cup with deionized water and immerse the sonde.
2. Gently move the sonde up and down to disperse any bubbles.

3. Navigate to the “Calibration” menu and select turbidity FNU.
4. Wait for the data stability to change from “Unstable” to “Stable”.
5. Hit “Apply”
6. Click “Add another calibration point”.
7. Fill a clean calibration cup to the bottom line with 124 FNU turbidity standard. Pour very slowly and tilt the cup so that the standard splashes/bubbles as little as possible.
8. Rinse the sonde with a small amount of 124 FNU turbidity standard.
    a. Tip: you can save the old standard in an extra bottle and use it as a rinse for the next calibration.
9. Immerse the sonde and gently move it up and down to disperse bubbles.
    a. Tip: scroll down to “Advanced” in the calibration window and click “Wipe sensors” to ensure the face of the sensor is clean and free of bubbles.
10. Wait for the data stability to change from “Unstable” to “Stable”.
11. Hit “Apply”
12. Repeat steps 6-11 with an additional standard if desired.

Field Check

The USGS protocol calls for monitor fouling checks in the field. This is where you compare a monitor, the sonde that is currently deployed, to a field meter, like a sonde you just calibrated. It is especially helpful to have a laptop, Android smartphone, or EXO handheld device to connect to your device(s) for this process.

Before Cleaning

1. Place the field meter in the water adjacent to the deployed sonde.
2. Make note of the time.
3. Record the readings of both devices using your preferred method (paper, Jotform, Notes app)
4. Remove the deployed sonde and clean it. Recommended steps:
    a. Wipe the faces of the optical sensors with a Kim wipe or other gentle wipe.
    b. Use a cotton swab to **CAREFULLY** clean around the glass bulb on the pH sensor.
    c. If you have a non-wiped C/T sensor gently insert a cotton swab into the holes to clean out debris. You can also use the syringe or small brush that came with the sonde.
    d. Wipe off or rinse the sensor guard if it is particularly muddy.

After Cleaning

5. Put the sonde you cleaned back into the water.
6. Make note of the time.
7. Record the readings of both devices using your preferred method (paper, Jotform, Notes app)

8. If you are performing a sonde swap, proceed to Deployment Templates. If you will be taking the field sonde back to the lab without performing a swap, proceed to the Post-Deployment Check section.

Deployment Templates

It is good practice to double check that your deployment templates are set up properly if you are going to perform a sonde swap.

1. Connect to the sonde that is currently deployed.
2. Navigate to the "Deployment" tab and click "Create Template from Sonde".
3. In the bottom left corner, click "Save Template"
4. Disconnect from the field sonde.
5. Connect to the new sonde that you will be deploying.
6. Click "Open Template" in the "Deployment" menu
7. Look for the template you just saved and click "View selected deployment"
8. At the bottom left, click "Save and Apply to Sonde"
9. You will then be asked if you'd like to log internally, click "**YES"**
    a. This will ensure that even if your telemetry malfunctions, data will be stored on the sonde and can be downloaded later.
10. Choose "**Next Interval**" as the deployment start time and click "Start"

Post-Deployment Drift Check

The USGS protocol requires that you perform a calibration drift check on a sonde that you pulled from the field after a deployment. This is where you make note of the **sonde's readings in standards prior to making any adjustments**. **These values need to be recorded** for USGS to be able to calculate and correct data.

While this procedure is much like calibrating your sonde, you do not actually need to recalibrate your sonde during this procedure, unless you are planning to swap it soon. If it is just going to sit in a lab for a few weeks, you only need to perform checks.

A Couple Reminders

Cleaning: To maintain your equipment in the long-term, it is a good idea to perform a more thorough cleaning once you have brought the sonde back to your lab. You can use mild dish soap, an old toothbrush, Kim wipes, and cotton swabs to accomplish this.

Rinsing: Remember that you should rinse your sonde with some used solution, which will produce better results when calibrating and performing calibration checks.

Writing down results: It is highly recommended that you use the Jotform (https://form.jotform.com/203435608499161) to complete these steps as it will walk you through all the necessary steps and required values.

Temperature

The thermistor cannot be user calibrated in the KOR software. However, you can check on its accuracy by comparing it to a NIST traceable thermometer.

1. Fill a bucket or the calibration cup with tap water.
2. Connect your sonde to a laptop or handheld device that will allow you to view live readings.
    a. In KOR, you can view this on the Live Data tab
3. Wait a moment for readings to stabilize.
4. Compare the sonde's live temperature reading to the NIST thermometer.
5. **Record these values.**
6. Remember that if your sonde's temperature reading falls outside the acceptable range (+/- 0.2 degrees) your NIST thermometer or your C/T probe is probably expired.

Specific Conductance

Reminder: record all values in specific conductance. SpCo is only a 1-point calibration, but you will check the readings in 3 standards.

1. Connect your sonde to a laptop or handheld device that will allow you to view live readings.
2. Clean and dry the conductivity probe with a Kim wipe or paper towel.
3. Take a reading in air. The specific conductance should be at or near 0 in air. **Make note of the reading in air!**
4. Fill a clean calibration cup to the top line with your lowest standard.
5. Immerse the sonde. You can rotate or gently tap the sonde up and down to disperse bubbles.
6. **Make note of the reading.**
7. Fill a clean calibration cup to the top line with your next highest standard.
8. Immerse the sonde. You can rotate or gently tap the sonde up and down to disperse bubbles.
9. **Make note of the reading.**
10. Repeat the process with your highest standard and **make note of the reading.**
11. If you want to recalibrate your sonde, remember to use the standard that is closest to your expected values in the field.

Dissolved Oxygen

1. Fill calibration cup with 1/8 inch of deionized water.
2. Dry off the dissolved oxygen and conductivity probes using a Kim wipe or towel.
3. Place sonde into the calibration cup, but do not tighten the cup to the sonde.
4. Set a timer for 10-15 minutes.
5. Use a barometer to determine the air pressure.
    a. If you have a handheld, there may be a built-in pressure sensor.

6. Use the theoretical dissolved oxygen table to determine what the value *should* be based on the barometric pressure.
    a. https://water.usgs.gov/water-resources/software/DOTABLES/
7. **Make note of the barometric pressure, the theoretical concentration and saturation, and the actual concentration and saturation.**

pH

For post-deployment calibration, you must make note of the pH millivolt reading in your notes, or in the appropriate location on the Jotform. You can see this value on the calibration screen or on the live data screen.

1. Always start with pH 7 solution. Fill a clean calibration cup to the bottom line.
2. Go to the "Live Data" screen.
3. pH reading is temperature dependent. Using the temperature from your sonde and the pH-temperature dependency table on the box your buffer came in, **make note of what the pH *should* be and the reading from your sonde.**
4. Next, fill a clean cup with the pH 10 solution.
5. Rinse your sonde with a small amount of pH 10 solution, if desired. Then immerse it in the cup.
6. **Use the temperature and your buffer box to determine what the pH *should* be and write it down, along with your sonde's live reading.**
7. Repeat steps 4-6 with the pH 4 buffer.

Turbidity

1. Fill a clean calibration cup with deionized water and immerse the sonde.
2. Gently move the sonde up and down to disperse any bubbles.
3. View the live data and **record the reading.**
4. Fill a clean calibration cup to the bottom line with 124 FNU turbidity standard. Pour very slowly and tilt the cup so that the standard splashes/bubbles as little as possible.
5. Rinse the sonde with a small amount of 124 FNU turbidity standard.
    a. Tip: you can save the old standard in an extra bottle and use it as a rinse for the next calibration.
6. Immerse the sonde and gently move it up and down to disperse bubbles.
    a. Tip: run the wiper to clear bubbles from the sensor face as well.
7. Wait for the data to stabilize and **make note of the reading.**

After Post-Deployment Checks

Once you have completed the calibration checks, you should store your sonde appropriately. If it is going to be idle for several months, consider following long-term maintenance guidelines such as storing your pH probe in the solution it came in, making sure the dissolved oxygen probe stays hydrated, using tap water instead of field water, etc. See the EXO University video for more: https://video.ysi.com/exo-maintenance-sonde-and-sensor

References

Wagner, R.J., Boulger, R.W., Jr., Oblinger, C.J., and Smith, B.A., 2006, Guidelines and standard procedures for continuous water-quality monitors—Station operation, record computation, and data reporting: U.S. Geological Survey Techniques and Methods 1–D3, 51 p. https://pubs.usgs.gov/publication/tm1D3

Additional Resources

The manufacturer of EXO sondes has a video library with tutorials on installation, maintenance, calibration, and more. Visit https://video.ysi.com/ysi-university-exo to view the full library.

Appendix 1: Total Algae-Phycocyanin Sensor

Making the Standards

You will need:

- Rhodamine WT 2.5% solution
- 2 1000 mL volumetric flasks with caps
- High-accuracy pipette capable of measuring 5 mL
- Pipette tips
- Transfer pipette (a standard eyedropper)
- 2 1000 mL amber bottles
- Labels and marker

It is highly recommended that you watch the EXO University video if you are new to the standard preparation process. https://video.ysi.com/exo-standard-preparation-total

1. Fill your volumetric flask about 90% of the way with deionized water.
2. Use the high-accuracy pipette to transfer 5 mL of rhodamine dye into the water. Rinse the pipette in the water 2-3 times to ensure all the dye is transferred.
    a. Watch the video linked above if you don't understand what this means.
3. Use the transfer pipette to fill the flask all the way to the 1000 mL line with more deionized water.
4. Put the cap on the flask and invert it 3 times to ensure the solution is well-mixed.
5. Pour solution into amber bottle labelled "Rhodamine 125 mg/L solution."
    a. This can be stored in the fridge for up to 2 years.
6. Get a new volumetric flask.
7. Fill your volumetric flask about 90% of the way with deionized water.
8. Use the high-accuracy pipette to transfer 5 mL of the **125 mg/L solution** (made in steps 1-5) to the flask. Rinse the pipette in the water 2-3 times to ensure all the dye is transferred.
9. Use the transfer pipette to fill the flask all the way to the 1000 mL line with more deionized water.

10. Put the cap on the flask and invert it 3 times to ensure the solution is well-mixed.
11. Pour the solution into an amber bottle labelled “Rhodamine 625 ug/L solution.”
    a. **Use this solution within 24 hours of preparation.**

Calibration

USGS recommends **performing checks more often than performing calibrations**. Adequate time and preparation are key to successfully completing this process. Environmental conditions must also be considered: ideally this should be performed in a lab with minimal or no sunlight interference.

Note: the total algae sensors must be calibrated for specific channels (chlorophyll or phycocyanin) AND for desired units (RFU and mg/L). **Unlike other sensors, calibrating one parameter will not calibrate the others.** You will have to repeat the procedure up to 4 times if you want to measure chlorophyll and phycocyanin in both RFU and mg/L.

1. Put the sonde into a calibration cup filled with clean water.
    a. Note: Deionized water is optional here. If you feel confident that your tap water is free of fluorescent particles, it should be fine to use.
2. Navigate to the “Calibration” menu and select the TAL-PC sensor.
3. Choose “Chl” to start with Chlorophyll calibration. Choose RFU as the units.
4. Enter a standard value of 0 and wait for the data to stabilize.
5. Hit “Apply”.
6. Click “Add Another Cal Point”.
7. Fill a clean calibration cup with the **625 ug/L solution**, which was made in steps 6-11 in the previous section.
8. Use the temperature reading on the sonde and the table below to determine the standard concentration. **Pay attention to units in the column header and the units you’re currently calibrating in!**
9. Enter the value from step 8 as the standard value.
10. Wait for the data to stabilize.
11. Click “Apply.”
12. Repeat steps 1-11 with other parameter and unit combinations as desired.

Drift Checks

1. Put the cleaned sonde in a clean calibration cup filled with clean water.
    a. Reminder: deionized water optional.
2. On the “Live Data” screen, **make note** of the temperature, chlorophyll, and phycocyanin readings.
3. **Record what the chlorophyll and phycocyanin values *should* be as well.** In this case, they should be zero.
4. Next, put the sonde in a clean calibration cup filled with the **625 ug/L** solution.

5. On the “Live Data” screen, **make note** of the temperature, chlorophyll, and phycocyanin readings.
6. Use the table below to determine what these values ***should be*** and **record these as well.**

Table 1. Temperature-compensated values for total algae sensors. Taken from EXO user manual.

	Chlorophyll 0.625 mg/L Rhodamine		Phycocyanin 0.625 mg/L Rhodamine	
Solution Temperature (˚C)	Chl RFU	µg/L chlorophyll	PC RFU	µg/L phycocyanin
30	14.0	56.5	11.4	11.4
28	14.6	58.7	13.1	13.1
26	15.2	61.3	14.1	14.1
24	15.8	63.5	15.0	15.0
22	16.4	66	16.0	16.0
20	17.0	68.4	17.1	17.1
18	17.6	70.8	17.5	17.5
16	18.3	73.5	19.1	19.1
14	18.9	76	20.1	20.1
12	19.5	78.6	21.2	21.2
10	20.2	81.2	22.2	22.2
8	20.8	83.8	22.6	22.6

Appendix B

Meteorological Monitoring Standard Operating Procedure

For the HRECOS Meteorologic Stations

January 7, 2010

This document was adapted from: " National Estuarine Research Reserve System-Wide Monitoring Program (SWMP) Campbell Scientific CR1000 Meteorological Monitoring Station Standard Operating Procedure" October 25, 2006. Version 3.

INTRODUCTION

This document outlines the standard operating procedures (SOP) for the site selection, hardware connections, programming, maintenance and calibration of a HRECOS meteorological weather station.

The procedures and hardware listed in this SOP are the MINIMUM requirements for operating the met station; therefore all HRECOS sites must follow these procedures. HRECOS sites may have additional sensors and procedures to supply additional data and ensure quality data collection, but by following the procedures in this SOP, all sites will be capable of collecting quality data and will be able to effectively QA/QC the data after collection.

This document is separated into seven sections:

I. Sensor placement
II. Communication,
III. Maintenance, and
IV. Calibration.
V. Manufacturer Contact Information

The SOP is designed to help site managers and research assistants carry out meteorological data collection at their site, minimize the collection of inaccurate data, and ensure consistent operating procedures.

I. Sensor placement

Temperature and Relative Humidity

The temperature and relative humidity sensor must be mounted in a gill radiation shield designed for the sensor used. The unit should be placed at an elevation of 1.75 meters above the surface; this is a standard National Weather Service height. The sensors should be over typical vegetation for the area to ensure recording natural values.

Barometric Pressure

The barometric pressure sensor should be mounted inside the datalogger enclosure. While the enclosure is watertight, it has been demonstrated that the newer enclosures are airtight to some degree. Subsequently, a piece of ¼" tubing should be placed on the nipple of the Barometric Pressure sensor and lead the outside of the enclosure below. Plumbers putty is used to plug the remainder of the hole provided for the tubing. Care must be taken so the intake vent of the sensor is not plugged and the tubing isn't compressed or kinked, impeding the flow of outside air to the sensor.

Wind Sensors

Standard heights for wind sensors are 2, 3, or 10 meters above the surface; any of these heights are acceptable for HRECOS. The wind sensors should be located at the top of the support structure, only the lightning rod should project higher. The sensor and tower must be securely anchored to prevent swaying and directional shift of the units, both of which can cause errors in wind direction and speed. The wind direction sensor should be positioned based on **True North.** Depending on the site location; deviation of magnetic north can be from 0 to 22 degrees in the continental US. Contact your local United States Geological Survey office for the current declination for your area.

Rain Gauge

The rain gauge should be mounted as far as possible away from the tower as feasible and upwind from the prevailing wind direction. This will prevent the water dripping off the tower from falling into the bucket and also minimizes the effects of eddy currents induced by the tower. The unit must be level and high enough to avoid splash back into the bucket from the surface. In northern areas the unit should be mounted high enough to remain above any accumulated snowfall. Rain gauges are a preferred site for roosting and eating not only of birds but other animals (ex. raccoons), so protective measures must be employed to keep the units in working order.

Solar Radiation

The photosynthetically active radiation (PAR) sensor must be mounted on the southern side of the tower and as high as practical. Placing on the southern side prevents any shadows on the sensor from taller pieces of the tower. Mounting near the top decreases the potential of reflected energy on the sensor from the tower. However the sensor needs to be easily accessible to check for any debris on the sensor, cleaning and to check for level. It is important that the sensor be mounted level or errors in the data values will occur. The location should be checked throughout the first day to make sure no object shadows the sensor.

Solar Panel

If the unit is battery operated with a solar panel recharging system, the panel should also be on the south side of the tower positioned below the PAR but higher and/or opposite the temperature and humidity sensor. The angle of the sensor for optimum performance varies based on latitude, check the solar panel manual for the angle for your location.

Enclosure, Datalogger and Peripheral Equipment
The enclosure can be mounted on the tower/support structure or separately. A separate location might reduce the risks from lightning strikes on the tower. The enclosure should be mounted at a convenient working height to access the equipment inside. All openings for sensor leads should be sealed via a cable entry gland or by the use of plumber's putty around the leads to prevent access of water or insects. All sensor wires should loop below the unit to drain water, and enter the enclosure from the bottom. The enclosure should be locked to prevent unauthorized access into the unit.

II. Communications

Communication with the datalogger for data transfer and programming can be done by several methods. The simplest is through direct connection to a laptop computer. For long distance communication various methods are available including an RF transmitter, a standard dial-up modem, and cellular telephone connectivity. For wiring and setup of these units please refer to the instruction manuals.

III. Maintenance

The following procedures are the recommended quarterly maintenance guidelines. Depending on local conditions more frequent maintenance might be necessary. If plugging of the precipitation gauge, evidence of debris on the PAR, or salt buildup on the Temperature and RH screen are a problem a modified maintenance schedule is warranted.

1. Check to verify the data logger has correct time and date. If the date/time is incorrect, record the difference and correct the value.

2. Record data values on the monthly log sheet. Record data values from external instrumentation at the site. If any corresponding data values have large differences proceed with maintenance procedures and then recheck data values. If values are still in error, check with secondary instruments to verify need for recalibration.

3. Check the battery voltage. Battery voltage should normally be greater than 11.0 volts and never more than 16.0 volts.

4. The temperature and humidity gill shield must be cleaned of any salt or organic debris buildup. The sensor should be removed from the gill shield and the probe end shield should be inspected for any debris or salt buildup. The shield can be removed and rinsed in distilled water to remove any salt buildup (this could be a common problem in coastal areas). Make sure the shield is completely dry before reinstalling or erroneous readings will occur. When servicing the shield try to keep the sensor in a shaded area.

5. The vent tube of the barometric pressure sensor should be inspected for any obstructions.

6. Inspect wind speed direction sensor by listen for any grinding or rubbing sounds during normal operation. Also observe for any jerking or sporadic movements of the sensors. These would indicate the need for unit refurbishing.

7. Check rain gauge operation after data download by comparing daily rainfall totals versus a known external value for the area during the past month. *Note: Some external stations may have different reporting times for daily totals, so examine event totals if possible.*

8. The rain gauge funnel and screen are to be removed and cleaned. The tipping buckets are then to be inspected for any debris or insect deposits. Be careful not to tip buckets during inspection and cleaning, if this happens note it and modify rain data. *Note: the bottoms of the buckets are hollow and provide ideal habitat for certain insects*.

9. The surface of the PAR is to be cleaned with distilled water and a soft cloth. **Do not use alcohol, organic solvents, abrasives or strong detergents to clean the sensor**.

10. The solar panel is to be cleaned of any accumulated debris and checked for correct positioning.

11. Check the enclosure for any cracks or other problems and for any loose fittings along the tower. Check that the grounding system is intact.

IV. Calibration

The recommended calibration schedule and typical price is listed below. Quarterly overview of the data should also be performed to determine if there is any major drifting or failure of the sensors. It is recommended that a second set of sensors be purchased so that a recently calibrated set of sensors can be installed with minimal data loss. The older sensors should be held until approximately 2-3 months prior to the scheduled replacement and then returned to the manufacturer for recalibration. Following this procedure the sensors will not have a long shelf life after recalibration prior to redeployment. The precipitation gauge can be calibrated in-house, see below.

It should be noted that the wind sensors are typically not recalibrated, but inspected for worn parts. If there is sign of wear the parts will be replaced. In addition some recalibrations have the option of NIST traceable documentation; this option can add greatly to the price of each sensor recalibration and is not required for HRECOS.

Sensor Recalibration Frequency:
Temp and RH, every year
PAR, every 2 years
Barometric Pressure, every 2 years
Wind Direction, every year
Wind Speed, every year
Wind Monitor, every 2 years
Precipitation Gauge, every year (in -house calibration)

Calibration Procedures for Tipping Bucket Rain Gauges

There are two possible methods to calibrate a tipping bucket rain gauge; static and dynamic. The dynamic method is simpler but more time consuming, while the static method usually gives better results. The numbers included in the procedures are for the NERRs standard 8-inch diameter opening rain gauge measuring in increments of 0.01 inches. If the rain gauge has a different opening or measuring increment, follow the procedure described below to calculate the proper volumes. The standard NERRs gauges with an opening of 8 inches has a funnel opening area of 50.27 square inches, therefore one tip of the buckets will equal 0.5027 cubic inches (50.27*0.01) and 0.5027 cubic inches equals 8.24 milliliters (1 cubic inch equals 16.39 ml).

Dynamic Calibration

To perform a dynamic test in the field obtain a one-liter container that the flow can be regulated from (simple as a small hole in the bottom). The time to empty the liter container should be between 45 and 60 minutes. To begin calibration make sure the funnel is clean and the buckets are clean and properly lubricated with a silicon type lubricant. Make sure the bottoms of the buckets are free from insect debris. Before calibration the funnel and buckets should be wetted. Fill the bottle with 824 ml of water and place it over the funnel. Record the number of tips to empty the bottle. If the tips are between 99 and 101 the gauge is calibrated at ± 1%.
To recalibrate the rain gauge remove the outside cylinder of the gauge to gain access to the adjusting screws. If the number of tips is higher than 101 then the screw stops under the buckets must be lowered. A half turn on each stop will cause a 2-3% change. If the number of tips is less than 99 raise each stop to decrease the amount of water needed before each tip. After adjustment perform the calibration again.

Static Calibration

To perform a static test, clean the buckets and lubricate with silicon based lubricant. Using a pipette add water one drop at a time to measure how many ml it takes to tip each bucket. Repeat the procedure at least 10 times for each bucket and average the results. If the average amount of water needed to tip each bucket is between 8.15 and 8.32 ml the gauge is calibrated at ± 1%. If it takes more than 8.32 ml to tip a bucket then the adjusting screw under the opposite bucket must be raised. If it takes less than 8.15 ml to tip the bucket then the adjusting screw under the opposite bucket must be lowered. This method allows the buckets to be calibrated separately and is typically more accurate. Once the buckets have been adjusted perform a complete calibration again and average the volume of 10 tips per bucket.

HRECOS Meteorological Monthly Log

This log was modified from the NERRS SWMP Meteorological Monthly Log

Reserve: ____________ **Station:** ____________ **Date:** ________ mm/dd/yyyy

Technician(s): ____________________ **Time** (std. time): ________ hh:mm (24hr)

Inspection

Wind Speed and Direction
Visual free movement of sensors: ________
Audible free movement of sensors: ________

PAR
Sensor surface clean: ________

Temperature and Humidity
Gill radiation shield clean: ________
Sensor shield clean: ________

Barometric Pressure
Vent not obstructed: ________

Rain Gauge
Funnel clean and free of debris: ________
Tipping buckets clean: ________

Solar Panel(s)
Panel clean: ________

Grounding system secure: ________
Enclosure and hardware secure: ________

Desiccant replaced: ________

Data Check

		Check	Data Source
Time (if differs from standard)	________	________	________
Temperature:	________ °C	________ °C	________
Relative humidity:	________ %	________ %	________
Barometric pressure:	________ mb	________ mb	________
Wind direction:	________ degrees	________ degrees	________
Wind speed:	________ m/s	________ m/s	________
Rain gauge:	________ mm	________ mm	________
PAR:	________ mmole/m^2	________ mmole/m^2	________
Battery voltage:	________ volts		

Data Transfer

Method of file retrieval: ____________
Raw data file name: ____________
Formatted file name: ____________

Data transfer successful? ________
Date macro execution: ________
(mm/dd/yyyy)

Date of Last Recalibration

Temperature - RH: ________ Wind: ________ Precipitation Gauge: ________
Barometric Pressure: ________ PAR: ________

Comments: ____

Appendix C

HRECOS Water Quality and Weather Stations
QUALITY ASSURANCE PROJECT PLAN

December 1, 2012
Version 2012.08

New York State Department of Environmental Conservation

Approval Signatures (on file with the HRECOS Coordinator)

____ Date _________
Alene Onion, HRECOS Coordinator, QA Officer for non NYSDEC DOW stations and Station Operator: Albany and Mohawk stations

____ Date _________
Michael Bocchi, Station Operator: Mohawk at Utica Water Quality Station

____ Date _________
Stuart Findlay, Station Operator: Schodack Island and Piermont Water Quality stations

____ Date _________
Wade McGillis, Station Operator: Piermont Pier Weather station

____ Date _________
Gary Wall, Station Operator: Schodack Island Weather station

____ Date _________
Sarah Fernald, Station Operator: Norrie Point and Tivoli stations

____ Date _________
Carrie Roble, Station Operator: Pier 84 Station

____ Date _________
Dave Runnels, HRECOS Database Manager

____ Date _________
Jason Fagel, DOW QA Officer

TABLE OF CONTENTS

LIST OF TABLES

DISTRIBUTION LIST

The following individuals must receive a copy of the approved QAPP in order to complete their role in this project. Note if copy will be electronic or hard copy.

Name	Organization	Document type
Alene Onion	New England Interstate Water Pollution Control Commission for the NY State Department of Environmental Conservation	Electronic
Michael Bocchi	NYS DEC DOW	Electronic
Stuart Findlay	Cary Institute	Electronic
David Fischer	Cary Institute	Electronic
Wade McGillis	Lamont-Doherty Earth Observatory	Electronic
Diana Hsueh	Lamont-Doherty Earth Observatory	Electronic
Gary Wall	US Geological Survey	Electronic
Sarah Fernald	Hudson River National Estuarine Research Reserve	Electronic
Christopher Mitchell	Hudson River National Estuarine Research Reserve	Electronic
Carrie Roble	Hudson River Park Trust	Electronic
David Runnels	Stevens Institute of Technology	Electronic
Jason Fagel	NY State Department of Environmental Conservation	Electronic

INTRODUCTION

The Hudson River Environmental Conditions Observing System (HRECOS) was established in 2008 to provide high frequency real-time data geographically distributed across large rivers in the Hudson River watershed. HRECOS consists of water quality and weather stations operated by a consortium of partner institutions from the government and research community who collaborate to report data in real-time to a public website (www.hrecos.org).

This QA project plan has been prepared to clearly delineate the field methods, data review, and documentation and reporting procedures for the HRECOS water quality and weather stations. These stations include: Mohawk at Lock 8, Port of Albany, Schodack Island, Tivoli Bays, Norrie Point, Marist Pump Station, Piermont Pier, and Pier 84.

The HRECOS Pump Station at Marist College includes a water quality sonde and equipment for collecting grab water samples under specified conditions. The operation of the water quality sonde is defined by this QAPP. The operation of all other equipment is defined by a separate document: The HRECOS Pump Station Quality Assurance Project Plan.

The HRECOS equipment on board the Sloop Clearwater is purely for educational purposes and is operated by external partners using external funds. For these reasons, this QAPP no longer applies to the equipment on board the Sloop Clearwater.

I. PROJECT MANAGEMENT

1. Organization/Responsibilities

A list of participants and their respective responsibilities are given in Table 1.

Organization Chart

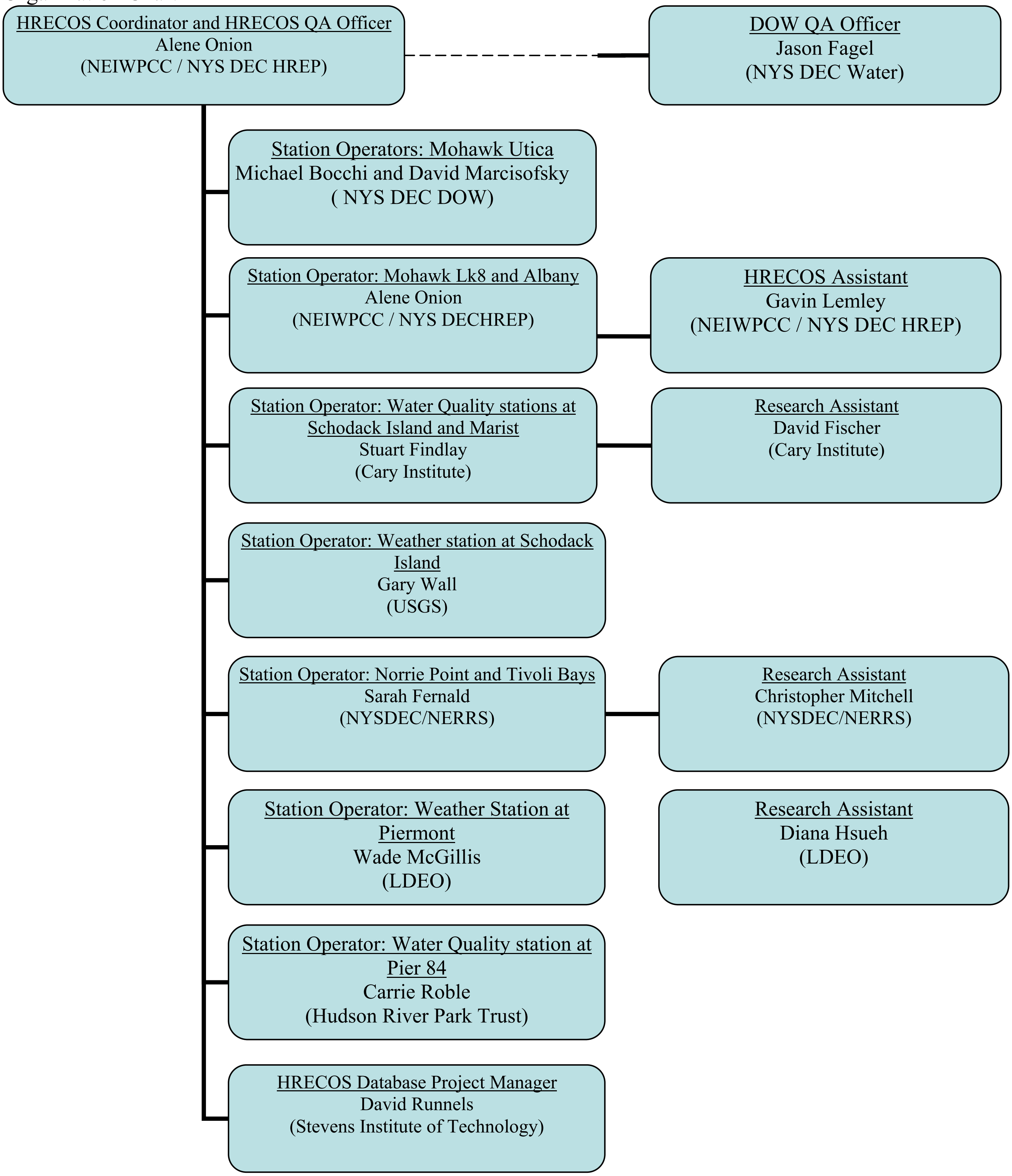

Table 1. HRECOS Estuary Participants

	Title	Responsibilities	Contact Information
Jason Fagel	DOW QA Officer	The DOW QA Officer will review and approve this QAPP and all associated SOP documents and will perform audits of NYSDEC DOW station managers.	jrfagel@gw.dec.state.ny.us 518 402 8156
Alene Onion NYSDEC HREP	HRECOS Coordinator	Manages HRECOS Budget including but not limited to the construction of new stations and the purchase and distribution of spare parts and consumables. Coordinates quality control and corrective actions. Maintains all metadata files in collaboration with the station operators. Collaborates with the HRECOS Database Manager to manage HRECOS database.	amonion@gw.dec.state.ny.us. 518-402-8166
	HRECOS QA Officer	Coordinates quality control and corrective actions. Performs annual audits of all station managers who are not NYSDEC DOW personnel.	amonion@gw.dec.state.ny.us. 518-402-8166
	Station Operator – Mohawk Lk 8 and Albany	Monitoring the real-time data stream for abnormalities. Instrument calibration, maintenance, and repair. Data flagging.	amonion@gw.dec.state.ny.us. 518-402-8166
Gavin Lemley NYSDEC HREP	HRECOS Assistant	Assists the HRECOS coordinator with data management and station operation tasks.	gmlemley@gw.dec.state.ny.us
Michael Bocchi and David Marcisofsky NYS DEC Water	Station Operator – Utica Water Quality	Monitoring the real-time data stream for abnormalities. Instrument calibration, maintenance, and repair. Data flagging.	mjbocchi@gw.dec.state.ny.us 315 793 2561 demarcis@gw.dec.state.ny.us
Stuart Findlay Cary Institute of Ecosystem Studies	Station Operator – Schodack Island, Marist and Piermont Water Quality.	Supervision of the Research Assistant. Monitoring the real-time data stream for abnormalities. Performs HRECOS assessments of site representativeness	findlays@caryinstitute.org 845-677-7600 x 138
David Fischer Cary Institute of Ecosystem Studies	Research Assistant – Schodack Island,Marist and Piermont Water Quality	Instrument calibration, maintenance, and repair. Data flagging.	fischerd@caryinstitute.org
Gary Wall USGS	Station Operator – Schodack Island Weather	Monitoring the real-time data stream for abnormalities. Instrument calibration, maintenance, and repair. Data upload and management. Data flagging.	grwall@usgs.gov 518-285-5621
Sarah Fernald NYSDEC/NERRS	Station Operator – Tivoli Bays and Norrie Point Water Quality and Weather	Supervision of the Research Assistant. Monitoring the real-time data stream for abnormalities. Managing the HRNERR Monitoring Budget.	shfernal@gw.dec.state.ny.us 845-889-4745 x 111
Christopher Mitchell NYSDEC/NERRS	Research Assistant – Tivoli Bays and Norrie Point Water Quality and Weather	Instrument calibration, maintenance, and repair. Station programming, maintenance and repair. Data upload and management. Data flagging.	cgmitche@gw.dec.state.ny.us 845 889 4745 (119)
Wade McGillis LDEO	Station Operator - Piermont Pier Weather	Supervision of the Research Assistants.	wade.mcgillis@columbia.edu 845 677 7600 x138
Diana Hsueh LDEO	Research Assistant – Piermont Pier Weather	Monitoring the real-time data stream for abnormalities. Instrument calibration, maintenance, and repair. Data upload and management. Data flagging.	hsueh.diana@gmail.com
David Runnels Stevens Institute of Technology	HRECOS Database Project Manager	Manages the HRECOS database and the HRECOS website in collaboration with the HRECOS Coordinator.	drunnels@stevens.edu
Carrie Nobel Hudson River Park Trust	Station Operator – Pier 84 Water Quality	Monitoring the real-time data stream for abnormalities. Instrument calibration, maintenance, and repair. Data flagging.	croble@hrpt.ny.gov

2. Background – Description of Problem

Fundamental knowledge of the Hudson River Watershed, its resources and management has progressed dramatically over the past 25 years. Understanding of the river system, however, has been hampered by manual approaches to data collection that cannot adequately capture rare events or describe rapid fluctuations and episodic pulses in environmental conditions.

The HRECOS stations established in the major rivers of the Hudson River Watershed make available continuous information and real-time data on water quality and weather conditions. These data have broad use to the communities of the Hudson Watershed including academic, environmental management, industrial, recreational and educational purposes. For this reason, there are multiple partners external to the NYS DEC who value the data and have committed their own time and resources to the maintenance and growth of this network.

The NYS DEC is committed to the continued operation of this network primarily for the purpose of environmental management. HRECOS stations are used to define ambient river conditions and to assess a variety of anthropogenic impacts across the watershed. For example, permit engineers in the Division of Water track the impacts of CSOs and SSOs with the HRECOS stations in Albany and Utica.

HRECOS stations are also used to manage the Hudson River resources. For example salinity and temperature data from all stations help managers to track anadromous fish migrations every spring and fall. Dissolved oxygen concentrations help managers to assess the beneficial impacts of submerged aquatic vegetation (SAV). Most significantly, the HRECOS network has been crucial in determining the impacts of episodic storm events like superstorm Sandy and tropical storms Irene and Lee. For example, these high frequency data captured surges in primary production, dramatic losses in SAV populations, and contributed to sediment discharge estimates which for tropical storms Irene and Lee were 2.75 million tons.

Finally, NYS DEC educators have done excellent work bringing HRECOS into the classroom. Although this isn’t the primary purpose of the network, it is a significant benefit. Thousands of students have been able to access the Hudson and Mohawk Rivers from their classrooms via place-based educational curricula developed by NYS DEC’s Hudson River Estuary Program and Hudson River National Estuarine Research Reserve Program.

3. Project/Task Description

3.1 Network Description

A network of stations is established in the Hudson River Watershed which record water quality and weather data once every fifteen minutes. All stations operate year round except the Tivoli Bays water quality stations where instruments are removed during the ice season (January – April) to avoid equipment damage and because of dangerous conditions. The complete list of parameters for every station is given in Table 2 and a map of all station sis given in figure 2.

3.2 Funding Status

At this time, HRECOS is partially funded and dependent on the voluntary contribution of equipment and time from the partner institutions.

3.3 Project Schedule

The schedule for implementing this project is outlined in Table 3.

Table 2: Parameters Recorded at Each HRECOS Station

Parameter	Mohawk Utica	Mohawk Lock 8	Albany	Schodack Island	Tivoli Bays	Norrie Point	Marist Pump St.	Piermont	Pier 84
Water Temperature	√	√	√	√	√	√	√		√
Specific Conductivity	√	√	√	√	√	√	√		√
Salinity				√	√	√	√		√
Dissolved Oxygen	√	√	√	√	√	√	√		√
Depth			√	√	√	√			√
Water Elevation		√	√	√	√	√	√		
pH	√	√	√	√	√	√	√		√
Turbidity	√	√	√	√	√	√	√		√
Chlorophyll					√	√			
Air Temperature	√	√	√	√	√	√		√	√
Barometric Pressure	√	√	√	√	√	√		√	√
Relative Humidity	√	√	√	√	√	√		√	√
Wind Speed	√	√	√	√	√	√		√	√
Wind Direction	√	√	√	√	√	√		√	√
Radiation	√	√	√	√	√	√		√	
Rainfall	√	√	√	√	√	√		√	√

Figure 2. Sample Distribution/Map

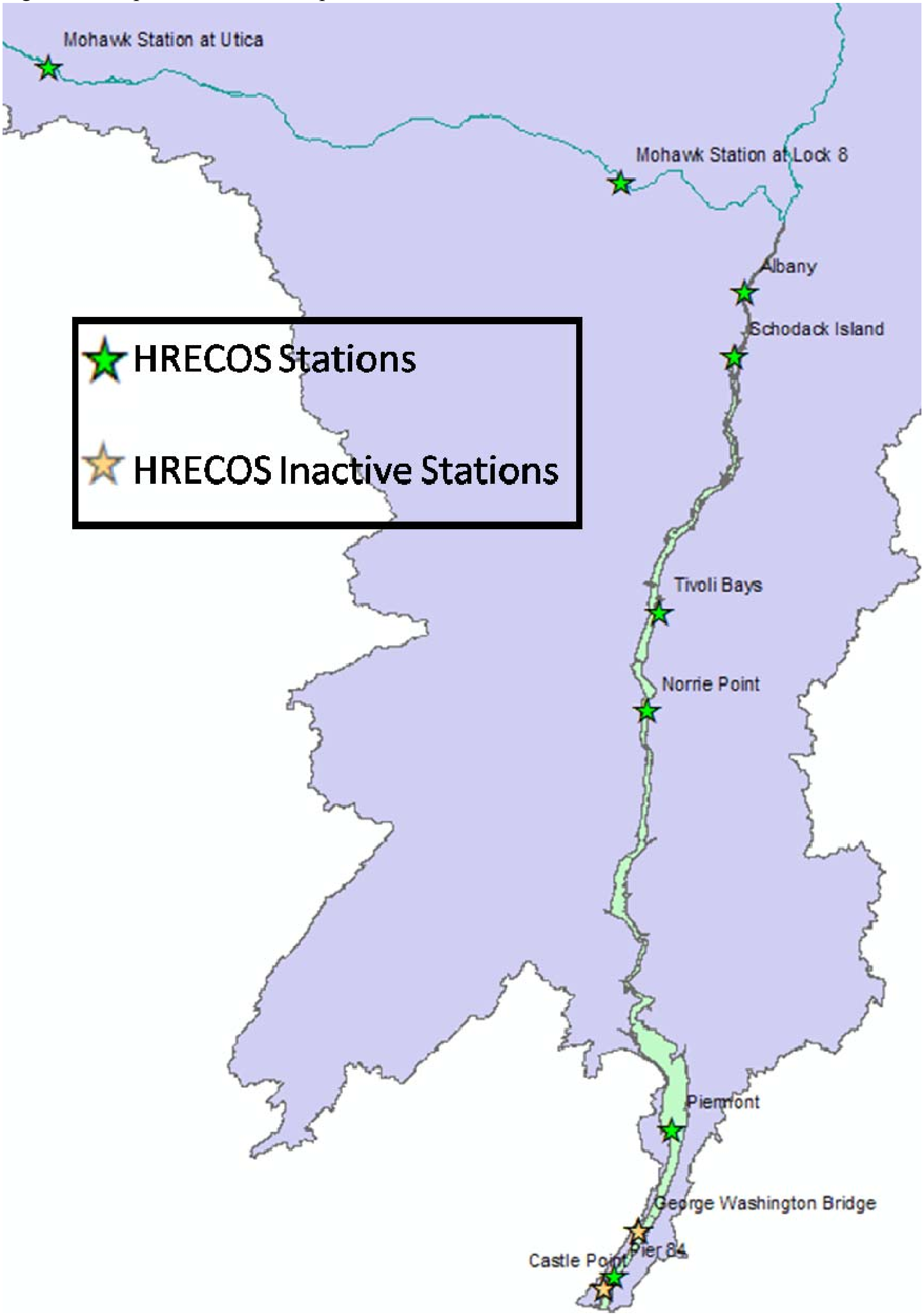

Table 3: Project Schedule

Task	Completion Date
QAPP and SOPs submitted for review	December 1, 2012
QAPP and SOPs approved	December 31, 2012
Sample Collection	Every 15 minutes
Quarterly Flagging Procedures Completed	Within 3 months of the end of the quarter
Final annual files and metadata files	Within 3 months of the end of the year.

4. Quality Objectives and Criteria

4.1 Precision and Accuracy

The precision and accuracy criteria for all parameters measured by HRECOS water quality and weather stations are given in Table 4. In addition, total dissolved solid samples are collected and analyzed by an ELAP certified laboratory for the Annual Assessment of Site Representativeness. These analyses must have an accuracy of at least +/- 0.1 mg/L and a precision of at least 20 relative percent difference (RPD).

4.2 Representativeness

Basin wide representativeness is not a goal of this project. Instead, the station locations are chosen to address a local need (see Section II for each local justification). The following requirements ensure the HRECOS stations are representative of the local conditions:

4.2.1 Ensuring Site Representativeness for Water Quality Stations

4.2.1.1 Station Location

Water quality stations must be located on structures such as a bulkhead, dock, pier, or piling which capture as close to main channel conditions as possible. For the same reason, sensors must be installed at least 0.5 meters from the river bottom. The location also must avoid influence by local outfalls, tributaries, and/or marsh systems. Ideally, cross channel conditions should be uniform both for solutes and particulates.

4.2.1.2 Assessment of Site Representativeness

Since conditions are subject to change, a cross channel assessment should be conducted annually if funding allows or at least once every five years to properly describe the representativeness of each HRECOS station for the user community.

4.2.2 Ensuring Site Representativeness for Weather Stations

Weather stations must be located on the shoreline and far enough away from tall buildings or trees to prevent shading during any time of the day. Specific requirements for each weather sensor are provided in the HRECOS SOP 2012.02: Weather Monitoring Standard Operating Procedure.

4.3 Comparability

In order to ensure comparability across the network, all HRECOS stations must use a YSI EXO2, a YSI 6600 V2 or YSI 6920 V2 water quality sonde with attached YSI 6560 or EXO temperature / conductivity probe, YSI 6150 or EXO dissolved oxygen probe, YSI 6589 or EXO ph probe, and the YSI 6136 or EXO turbidity probe. We have found that sondes from different manufacturers provide significantly different results.

Stations may use any depth sensor or weather monitoring equipment as long as it meets the precision and accuracy requirements given in Table 4.

4.4 Completeness

Our goal is to record and accept after QAQC checks at least 90% of the total possible observations. Since a measurement is collected once every fifteen minutes, the maximum number of observations would be 35040 per year for every parameter. Therefore, it is our goal that each station records at least 31536 observations per year for every parameter.

Table 4. Precision and Accuracy Criteria for HRECOS Water Quality and Weather Stations

Temperature	Range	-5 to +45°C
	Resolution	0.01°C
	Accuracy	±0.15°C
Conductivity	Range	0 to 100 mS/cm
	Resolution	0.001 to 0.1 mS/cm (range-dependent)
	Accuracy	±0.5% of reading + 0.001 mS/cm
Salinity	Range	0 to 70 ppt
	Resolution	0.01 ppt
	Accuracy	±1% of reading or 0.1 ppt, whichever is greater
Dissolved Oxygen % Saturation	Range	0 to 500%
	Resolution	0.1%
	Accuracy	0-200% air saturation: +/-1% of the reading or 1% air saturation, whichever is greater 200-500% air saturation: +/- 15% or reading
Dissolved Oxygen mg/L	Range	0 to 50 mg/L
	Resolution	0.01 mg/L
	Accuracy	0-20 mg/L: +/-0.1 mg/l or 1% of the reading, whichever is greater; 20 to 50 mg/L: +/-15%
Acidity	Range	0 to 14 pH units
	Resolution	0.01 unit
	Accuracy	±0.2 unit
Depth	Range	0 to 9 m
	Resolution	0.001 m
	Accuracy	0-3m: +/- 0.003 m; 3-9.1m: +/- 0.018 m
Turbidity	Range	0 to 1,000 NTU
	Resolution	0.1 NTU
	Accuracy	+/- 2 % of reading or 0.3 NTU (whichever is greater)
Chlorophyll	Range	0 to 400 ug/L chl a; 0 to 100 RFU
	Resolution	~ 0.1 ug/L
	Accuracy	0.1 ug/L chl a, 0.1% FS
Air Temperature	Range	-40ºC to +60 ºC
	Accuracy	± 0.2 ºC @ 20 ºC
Relative Humidity	Range	0 to 100% non-condensing
	Accuracy	at 20 ºC: ± 2% RH (0-90%), ±3% RH (90-100%)
Barometric Press.	Range	500-1100 mbar
	Accuracy	+/- 0.3 mbar at +20ºC
Wind Speed	Range	0 to 44 m/s
	Accuracy	±0.5 m/s; ±3% 17 to 30 m/s; 4% 30 to 47 m/s
Wind Direction	Range	0 to 358°, 2° Dead Band
	Accuracy	±5 Degrees
Radiation	Range	0-1280 µA
	Accuracy	typically 5 µA per 1000 µmoles s-1 m-2
Precipitation	Range	Temperature: -20° to +70°C; Humidity: 0 to 100%
	Accuracy	±1.0% at up to 20 mm per hour

5. Training Requirements/Certifications

The HRECOS Coordinator will ensure that all individuals involved with the project receive and are familiar with this document to ensure proper adherence to the procedures outlined within.

New staff must perform side-by-side calibration and maintenance procedures with an experienced staff member at least three times and have demonstrated capability before operating independently. Individual station managers are responsible for training their staff and insuring that training has been documented; annual audits ensure a consistent level of effort across the network.

6. Documentation and Records

6.1 HRECOS QAPP Distribution and Amendments

The HRECOS Coordinator maintains the official approved Quality Assurance Project Plan for the HRECOS Water Quality and Weather Stations. Any modifications to the QAPP require a signature from all the station operators, the HRECOS Database Manager, the HRECOS Coordinator and the NYSDEC DOW Quality Assurance Officer. Copies of the amendments will be sent electronically and signatures may be received by mail or as scanned copies.

6.2 Calibration Logs

Each Station Operator is responsible for maintaining calibration logs for their own station. Updated metadata files must be sent to the HRECOS Coordinator within three months after the end of the calendar year.

6.3 Results of the Assessment of Site Representativeness

Each water quality station must be assessed at least once every five years for site representativeness. These results are summarized in the metadata file for each station.

6.3 HRECOS Database

The HRECOS database is managed by the HRECOS Coordinator and the Stevens Institute of Technology according to the Data Handling and Archival Standard Operating Procedure (HRECOS SOP 2012.07).

6.4 Annual Historical Files and Metadata Files

Within three months after the end of the calendar year, the HRECOS Coordinator compiles all the verified data for a station into an annual data file. She also compiles all the metadata for each station including specific comments from each station operator, instrument calibration results, and the results of the cross channel assessment. Both the annual files and the metadata are posted to the historical data page of the HRECOS website: www.hrecos.org. The metadata files are also associated with each station in the "Current Conditions Page." As a backup, the HRECOS Coordinator will maintain a copy of all the annual files and metadata files on her desktop computer for at least 20 years.

II. DATA GENERATION AND ACQUISITION

1. Sampling Methods

1.1 Water Quality Measurements

The following water quality parameters are recorded by a YSI EXO2, 6600 or 6920 sonde according to the Water Quality Monitoring Standard Operating Procedure (HRECOS SOP 2012.12): water temperature, conductivity, salinity, turbidity, dissolved oxygen, dissolved oxygen saturation, acidity, and water depth. Sondes are swapped with newly calibrated instruments at the end of each deployment to avoid breaks in data collection and are assessed (within one week) by a post calibration to determine instrument drift. Sondes are never deployed for a period longer than three months.

Water depth is measured by an OTT bubbler at the Albany, Mohawk Lock 8 and Marist stations. These instruments are maintained according to USGS standard operating procedure.

For the Assessment of Site Representativeness: Total suspended sediments samples collected according to the DOWSOP 201-12: Collection of Ambient Water Quality Samples and are processed by an ELAP certified lab which may use any equipment that meet the required detection limit given in section I.4.

The specific equipment found at each water quality and weather station are given in Table 5.

1.2 Weather Measurements

The following weather parameters are measured according to the Weather Monitoring Standard Operating Procedure (HRECOS SOP 2012.02): air temperature, barometric pressure, dew point, radiation, rainfall, relative humidity, wind speed, wind direction, wind gusts. The purpose of this document is to provide the minimum operation and maintenance requirements; some stations use site specific SOPs which satisfy these minimum requirements. Tivoli Bays and Norrie Point station operators use the site specific HRECOS SOP 2012.04: National Estuarine Research Reserve SWMP Campbell Scientific CR1000 Weather Monitoring Station Standard Operating Procedure. Piermont station operators use site specific HRECOS SOP 2012.03 Piermont Meteorology Station Standard Operating Procedure.

1.3 Power Supply

All stations are powered by a solar panel with a backup marine battery.

1.4 Data Recording and Transmission

Data are recorded by a data logger and transmitted to the HRECOS database via satellite, cellular modem, wireless transmitter, or direct internet connection. Operation of the solar panel, data logger and data transmitter are performed according to the manufacturer's instructions.

1.5 Real-Time Data Calculations

In near-real time the HRECOS database calculates the following parameters: daily rainfall accumulation, water elevation relative to NAVD88 (Hudson River) or NGVD29 (Mohawk River), dew point, and corrected depth (for Schodack Island only whose depth sensor is not vented to the atmosphere).

1.6 Quarterly Data Calculations

Once per quarter, the HRECOS Coordinator updates the Database with data modifications. First, the HRECOS Coordinator calculates and uploads corrected depth measurements for Tivoli North (whose depth sensor is not vented to the atmosphere but cannot be corrected in real-time). Second, the HRECOS Coordinator inserts any data that were lost due to data transmission issues. Specifics for the maintenance of the HRECOS database and website are provided in the Data Handling and Archival Standard Operating Procedure (HRECOS SOP 2012.07).

1.7 Assessments of Site Representativeness

Assessments of site representativeness are performed every year or as funding permits: To determine how well the shore-mounted sites capture variability across the channel, water samples are collected from the river transect and analyzed for total suspended solids (TSS), turbidity, conductivity, pH, dissolved oxygen, and temperature. These parameters match those collected by the HRECOS water quality stations except TSS. We added TSS because turbidity is often used as a proxy for TSS and many of our users are interested in the local accuracy of this correlation.

Three points along the east/west river transect are sampled; at each point, two samples are collected each from the surface, mid-depth and the near-bottom for a total of 18 samples. The turbidity, conductivity, pH, dissolved oxygen, and temperature measurements are collected using a YSI 6600 sonde. A grab sample is collected according to DOW SOP 201-12: Collection of Ambient Water Quality Samples and submitted to an ELAP certified laboratory for analysis of total suspended solids (TSS) according to Standard Methods for Examination of Water and Wastewater, #2540D. Total Suspended Solids Dried at 103-105^{o}C.

That same day, an ISCO Automatic Sampler is deployed for 24 hours at a location within 6 meters of the HRECOS station being analyzed. This sampler collects twenty four (24) discrete hourly grab-samples according to the Grab Sample guidelines provided in section 8 of DOWSOP 301-11: Wastewater Sample Collection. These samples are collected at the end of the 24h collection period and sent to an ELAP certified laboratory for analysis of total suspended solids (TSS) according to Standard Methods for Examination of Water and Wastewater, #2540D. Total Suspended Solids Dried at 103-105^{o}C.

Custody procedures for the total dissolved solid samples collected for this assessment are defined by DOWSOP 301-11: Wastewater Sample Collection which requires a chain of custody form for each sample collection.

Any participants riding or driving a boat are required to have a NYS Boating Safety Certificate.

The Schodack Island Water Quality Station Operator, Research Assistant, and the HRECOS Coordinator will be responsible for collecting these samples and transporting them to the laboratory.

1.8 Station Specific Information

1.8.1 Mohawk Utica Station

Justification:

The new HRECOS station in the Mohawk River at Utica will be installed in March 2013. The primary use for this station will be to monitor the impact of CSOs and SSOs on ambient river conditions. This community is investing considerable effort and resources to improving the water quality in this section of the Mohawk River.

Instrumentation

The Mohawk Utica station is a water quality station only. A YSI Harbor Buoy will be installed in the main channel of the Mohawk River upstream of the Frankfort Marina (43.04479 N latitude,-75.069559 W longitude). The water depth at this location is approximately 5m. Sensors will be deployed 2.5 meters from the surface and will report Acidity, Dissolved Oxygen, Specific Conductance, Turbidity, and Water Temperature.

Location Access:
The Mohawk Utica station is located in the mid channel of the Mohawk River northwest of the Frankfort Marina. The river channel is open to public access but instruments are secured in a locked enclosure. Researchers interested in accessing these enclosures to co-locate monitoring equipment or to collect grab samples must obtain permission from the HRECOS Coordinator, Alene Onion (amonion@gw.dec.state.ny.us, 518 402 8166).

1.8.2 Mohawk Lock 8 Station
Justification:
The HRECOS station at the Lock 8 was installed primarily to provide advanced flood warnings to Schenectady County Emergency Managers. This reach of the lower Mohawk River has chronic ice jam problems, particularly between the Stockade District and Rexford Knolls where water levels can rise 4.5 meters or more. High frequency water level data from this station will provide forecasts and life- and property-saving flood warnings.

The Mohawk is the largest tributary to the Hudson (and the greatest source of sediment) but a small percentage of monitoring and management efforts have been directed toward it. High frequency monitoring at the HRECOS Mohawk Lock 8 station will greatly improve existing models of water quality, tidal flow and sediment transport in the Hudson Estuary system.

Instrumentation
The water quality station for Mohawk Lock 8 is at the downstream end of the sheet piling below Lock 8 (42.828147 N latitude,-73.990376 W longitude). Water depth at this location is approximately 5.5 meters when the locks are down (June – December) and approximately 2 meters when the locks are up. Sensors are deployed approximately 1.5 meters off the bottom and report Acidity, Dissolved Oxygen, Specific Conductance, Turbidity, and Water Temperature. Water elevation relative to NGVD29 is calculated from water depth in real-time by the HRECOS database (Water Elevation = 60.96m + water depth).

The weather station for Mohawk Lock 8 is just north of the lock 8 buildings (42.830139 N latitude,-73.992523 W longitude). Sensors are installed on a 3 meter tower that is above nearby vegetation and over 15 meters from any nearby structure. Sensors report air temperature, barometric pressure, radiation, rainfall, relative humidity, wind speed, wind direction, wind gusts. Dew point and cumulative rainfall are calculated by the HRECOS database in real-time.

Location Access
The Lock 8 Mohawk water quality station is located at Lock 8 of the Erie Canal. The grounds are public property and easily accessed but instruments are secured in locked enclosures. Researchers interested in accessing these enclosures to co-locate monitoring equipment or to collect grab samples must obtain permission from the HRECOS Coordinator, Alene Onion (amonion@gw.dec.state.ny.us, 518 402 8166).

1.8.3.Albany Station
Justification
The Albany Port station is located at the southern edge of the Albany pool, where the impact of CSOs on ambient river conditions is the focus of a considerable water quality improvement effort to restore the river for recreational use. The HRECOS data has already been used by regulators to identify dissolved oxygen fluctuations that were missed by less frequent monitoring.

Instrumentation

The water quality station for Albany is on the concrete reinforced shoreline just to the south of the Cargill Grainery on the western edge of the Port of Albany (42.61954 N latitude, -73.75890 W longitude). The channel depth at this location is 10 meters. Sensors are deployed 2.5 meters from the surface and report Acidity, Dissolved Oxygen, Specific Conductance, Turbidity, Water Temperature, and Water Depth. Water Elevation relative to NAVD88 is calculated from water depth in real-time (Water Elevation = -2.0514m + water depth).

The weather instrumentation is also on the concrete reinforced shoreline just to the south of the Cargill Grainery on the western shore of the Port of Albany (42.61954 N latitude, -73.75890 W longitude). Sensors are installed on a 3 meter tower that is above nearby vegetation and over thirty meters from nearby structures. Sensors report air temperature, barometric pressure, dew point, radiation, cumulative rainfall, rainfall, relative humidity, wind speed, wind direction, wind gusts.

Location Access:

Albany station is located within the Port of Albany. The Albany Port is not publically accessible and the HRECOS instruments are secured in locked enclosures. Researchers interested in accessing these enclosures to co-locate monitoring equipment or to collect grab samples must obtain permission from the HRECOS Coordinator, Alene Onion (amonion@gw.dec.state.ny.us, 518 402 8166) and Richard Hendrick, Port of Albany General Manager (518 463 8763).

1.8.4 Schodack Island Stations

Justification:

The Schodack Island water quality station was installed by external partners the year the HRECOS network began. The purpose of this station was to provide a shallow water, upriver comparison to the mid and lower river stations already in place.

Instrumentation

The water quality station for Schodack Island is immediately south of the Schodack Island State Park boat launch and is fixed to the steel bulkhead. Total water depth is approximately 2m at this location. Sensors are deployed 0.5m from the river bottom and report Acidity, Dissolved Oxygen, Specific Conductance, Turbidity, Water Temperature, and Water Depth. Water depth measurements are corrected in real-time because the depth sensor is not vented to the atmosphere (Corrected Depth = Depth + ((1013- Barometric Pressure) * .0102)). Water Elevation relative to NAVD88 is calculated from water depth in real-time (Water Elevation = -1.48265 + water depth).

The weather instrumentation is on a small island (42°30'4.32"N, 73°46'49.37"W) just west of Schodack Island State Park (SISP) and just south of the I-90 by-pass bridge. Sensors are attached to the tower holding the navigation aids (marker # 197) and report air temperature, barometric pressure, radiation, rainfall, relative humidity, wind speed, wind direction, wind gusts. Dew point and cumulative rainfall are calculated by the HRECOS database in real-time. The island is at least 130 m from either shore so there is no interference from nearby vegetation or ridgelines. The island is owned by the U.S. Coast Guard.

Location Access:

The Schodack Island water quality station is publically accessible but instruments are secured in locked enclosures. The weather station is on private property and is not publically accessible. Researchers interested in accessing the locked water quality enclosure to co-locate monitoring equipment or to collect grab samples must obtain permission from the HRECOS Coordinator, Alene Onion (amonion@gw.dec.state.ny.us, 518 402 8166). Researchers interested in accessing the weather station must obtain permission from the HRECOS Coordinator as well as the U.S. Coast Guard Saugerties, NY office ((845) 246- 7612).

1.8.5 Tivoli Bays Stations

Justification:

The objective of this station is to monitor surface water quality at the Tivoli Bays component of the Hudson River National Estuarine Research Reserve (NERR). Two tidal freshwater wetlands, Tivoli North Bay and Tivoli South Bay are monitored using four dataloggers (YSI 6600 sondes). In Tivoli North Bay and Tivoli South Bay the dataloggers monitor the ebbing and flooding Hudson River water. These data are included in the HRECOS network also. In Stony Creek and Saw Kill Creek, the dataloggers are deployed above the area of tidal influence and monitor the quality of water entering the Tivoli Bays via stream flow. These data are not included in the HRECOS network but may be accessed through the NERR website: http://www.hrnerr.org/. Thus, the relative importance of stream flow and tidal exchange and the potential impacts of intertidal areas on the water quality of the Tivoli Bays can be determined.

Monitoring the water quality of the tributaries is important because it has previously been determined that urban and residential land use practices are markedly influencing the water chemistry of the tributaries, especially Saw Kill Creek. Since residential coverage continues to increase, we hope that the intensive monitoring of the surface waters in these watersheds will identify trends associated with this rapid development. Examining the influence of tidal exchange allows identification of long-term trends in the water quality of the Hudson River Estuary at this location and the potential inputs to the Estuary from the Tivoli Bays. Finally, the influence of intertidal areas on water quality within the Tivoli Bays is interesting because of the potential impacts of both floating and emergent invasive plant species present in this system.

Instrumentation:

The Tivoli weather station is located at the Bard College Field Station in Annandale, NY (42°01'05.46"N 73°55'01.13"W). Sensors are elevated on a 30 foot, aluminum tower and record air temperature, barometric pressure, radiation, rainfall, relative humidity, wind speed, wind direction, wind gusts. Dew point and cumulative rainfall are calculated by the HRECOS database in real-time. Although trees surround the area, the tree line begins approximately 18 meters from the tower in most directions. The trees are at similar heights to the tower, but the sensors are not shaded at that location. The tower is approximately 1.2 miles southeast of the Tivoli South Bay water quality monitoring station, and 2.3 miles southeast of the Tivoli North Bay water quality monitoring station.

There are two water quality stations in the Tivoli Bays: one in the South Bay and a second in the North Bay. The water quality station in Tivoli South Bay is fixed to the concrete sidewall of the northernmost outlet (latitude 42° 01' 37.336" N, longitude 73° 55' 33.445" W). The depth at the sampling location ranges from 0.5 to 2.5 meters. Water quality sensors are deployed 0.5 meters off the bottom and record acidity, dissolved oxygen,chlorophyll, specific conductance, turbidity, water temperature, and water depth. Water Elevation relative to NAVD88 is calculated from water depth in real-time (Water Elevation = 0.175m + water depth).

The water quality station in Tivoli North Bay is fixed to an abandoned piling in the southernmost outlet (latitude 42° 02' 11.56464" N, longitude 73° 55' 31.16645"). The depth at the sampling location ranges from 0.5 to 3.0 meters. Water quality sensors are deployed 0.5 meters from the substrate and record Acidity, Dissolved Oxygen, Specific Conductance, Turbidity, Water Temperature, chlorophyll, and Water Depth. Water Elevation relative to NAVD88 is calculated from water depth in real-time (Water Elevation = 0.076m + water depth). Corrected water depth is calculated retroactively once per quarter because the depth sensor is not vented to the atmosphere yet a real-time calculation is not possible (Corrected Depth = Depth + ((1013- Barometric Pressure) * .0102)).

Location Access:
Tivoli Weather and Tivoli North and Tivoli South Water Quality Stations are located within the NYS DEC Tivoli Bays Wildlife Management Area and within the boundary of the Hudson River National Estuarine Research Reserve. Researchers interested in accessing locked instrument housings to co-locate monitoring equipment or to collect the grab sample must obtain permission from the HRNERR Research Coordinator, Sarah Fernald (shfernald@gw.dec.state.ny.us, 845 889 4745 x 119) and Nathan Ermer, Manager of Tivoli Bays Wildlife Management Area (nmermer@gw.dec.state.ny.us, 845-256-3047).

1.8.6 Norrie Point Stations
Justification:
The Norrie Point water quality station was installed by external partners the year the HRECOS network began. Since the Tivoli stations monitor primarily marsh waters, a new station was added to monitor mid river conditions in comparison to the upriver and lower river stations.

Instrumentation
The Norrie Point water quality station is located on a piling off of the dock at the Norrie Point Environmental Center (41°49'53.80114"N 73°56'31.53180"W). The depth at the sampling location ranges from approximately 1.0 to 2.5 meters. Sensors are deployed approximately 1.0 meters off the bottom and report Acidity, Dissolved Oxygen, Specific Conductance, Turbidity, Water Temperature, and Water Depth. Water Elevation relative to NAVD88 is calculated from water depth in real-time (Water Elevation = -2.184 + sonde depth).

The Norrie Point weather station is located on the terrace of the Norrie Point Environmental Center in Staatsburg, NY (41°49'53.80114"N 73°56'31.53180"W). Sensors are mounted to a 30 foot tower and report Air Temperature, Barometric Pressure, Radiation, Rainfall, Relative Humidity, Wind Direction, Wind Gust, and Wind Speed. The tower is located approximately 40 yards from a building, and the sensors are not shaded at that location. The tower is approximately 130 yards southeast of the Norrie Point water quality monitoring station.
Location Access:
Norrie Point Weather and Norrie Point Water Quality Stations are located in the publically accessible Margaret Lewis Norrie State Park. Researchers interested in accessing locked instrument housings to co-locate monitoring equipment or to collect the grab sample must obtain permission from the HRNERR Research Coordinator, Sarah Fernald (shfernald@gw.dec.state.ny.us, 845 889 4745 x 119).

1.8.7.Marist Pump Station
Justification:
The Marist Pumped Monitoring Station was constructed for NYS DEC's Rotating Integrated Basin Studies program. This novel sampling technology allows researchers and regulators to collect water samples from the mid channel remotely or in response to a spike in water quality parameters including DO, turbidity, temperature, or conductivity. This specific location was selected because it is a historic RIBS sampling site for the lower Hudson River and because Marist College is a motivated partner for the continued maintenance and upkeep.

Instrumentation:
This QAPP will only address the water quality monitoring equipment at the Marist Pump Station. A description of all other instrumentation may be found in the HRECOS Pump Station Quality Assurance Project Plan.

The intake for the pump station is located 91 meters from the main channel and is raised by a tripod approximately 3 meters from the river bottom (41.720993 N,-73.942569 W). Water depth is 18 meters at this location. Water is pumped from this location into the pump house where water quality sensors record Acidity, Dissolved Oxygen, Specific Conductance, Turbidity, and Water Temperature. A separate sensor records water elevation from the southern edge of the Marist Boat dock (41.720585 N,-73.938794 W).

Location Access:
The Marist Pump Station is a locked facility on the Marist campus. Researchers interested in accessing the station to co-locate monitoring equipment or to use the pump facility to collect samples must obtain permission from the HRECOS Coordinator, Alene Onion (amonion@gw.dec.state.ny.us, 518 402 8166), Marist College (Neil Fitzgerald, Neil.Fitzgerald@marist.edu, (845) 575-3000 ext. 2491), and USGS (Gary Wall, grwall@usgs.gov, 518 256 3016).

1.8.8 Piermont Stations
Justification:
This station was constructed by Lamont Doherty Earth Observatory as part of their laboratory located at the end of Piermont Pier in Piermont, NY. Scientists at this laboratory examine a wide range of topics including air/water gas exchange and ambient toxics concentrations.

Instrumentation:
The water quality station at Piermont Pier was destroyed by superstorm Sandy.

The weather station is on the roof of the Lamont Doherty Earth Observatory laboratory at the end of Piermont Pier in the village of Piermont, NY (41° 2' 35.6784"N, 73° 53' 47.6448"W). Sensors are mounted to a 15 foot tower and record air temperature, barometric pressure, solar radiation, relative humidity, rain, wind direction, wind gust, and wind speed. Dew point and cumulative rainfall are calculated by the HRECOS database in real-time. The building is at least 3 m from tree growth and the sensors are not shaded at this location.

Location Access:
Piermont Pier is publically accessible but instruments are secured in locked enclosures. Researchers interested in accessing locked instrument housings to co-locate monitoring equipment must obtain permission from the Piermont station operator, Wade McGillis (wade.mcgillis@columbia.edu, 845 677 7600 x138).

1.8.9. Hudson River Park – Pier 84 Station
Justification
The purpose of the Hudson River Park Pier 84 station is to generate a consistent and precise stream of water quality and atmospheric data for the general public and interested stakeholders. The goal in collecting this data is to ultimately inform Hudson River management policies, restoration efforts, and extreme event planning. This station was selected due to its location near the NYC Harbor and in lower Manhattan, one of the world's most heavily developed and densely populated urban environments.

Instrumentation
The Hudson River Park Pier 84 water quality station is located on the southeastern piling at the end of Pier 84's finger pier (40.7646 N,-74.0032 W). The total depth at this location ranges from 4.5 to 6 meters. Sensors are deployed approximately 2 meters off the bottom and record Dissolved Oxygen (mg/L and %sat), pH, Specific Conductance (µS/cm) and Salinity (ppt), Turbidity (NTU), Depth (m), and Water Temperature (°C).

The meteorological station is anticipated to be installed when power is restored at the Hudson River Park Trust classroom building at Pier 84 (40.7646 N,-74.0032 W). Power was lost at the building late October 2012 during Hurricane Sandy. The station will be located approximately 3 meters above Pier 84 and simultaneously record Air Temperature (°C), Relative Humidity (%), Wind Speed (m/s), Gust Speed (m/s), Wind Direction (°), Precipitation (mm), Solar Radiation (mmoles m-2) and Barometric Pressure (mbar).

Location Access
Pier 84 is publically accessible, but the instruments are strategically located and locked to prohibit tampering. Researchers interested in accessing the instrument are required to contact Carrie Roble (croble@hrpt.ny.gov) at Hudson River Park Trust to receive proper permitting and permission.

Table 5. Instrument Specifications

Water Quality		Mohawk Utica	Mohawk Lock 8	Albany	Schodack	Tivoli N	Tivoli S	Norrie	Marist	Pier 84
General Information	Date first operational	expected 3/2013	12/09/2011	01/04/2011	05/09/2008	07/01/1996	05/01/1995	06/16/2008	10/25/2012	12/19/2012
	Date of first transmission	expected 3/2013	01/04/2012	01/04/2011	05/09/2008	10/03/2006	11/15/2005	07/01/2008	10/25/2012	12/21/2012
	Data Logger Model	CR1000-ST-SW-NC	CR1000-ST-SW-NC	CR1000-ST-SW-NC	CR10X_PB	YSI 6600	YSI 6600 EDS	YSI 6600 V2/4	CR1000-ST-SW-NC	ISS-SER-CR200-C
	Data Transmitter	900 MHz spread spectrum Radio	900 MHz spread spectrum Radio	900 MHz spread spectrum Radio	Airlink Raven Cellular Modem	Sutron Model #SL2-G312-1 geo-stationary satellite data transmitter	Sutron Model #SL2-G312-1 geo-stationary satellite data transmitter	Sutron Model #SL2-G312-1 geo-stationary satellite data transmitter	Airlink Raven Cellular Modem	Raven XT Cellular Modem
	Collection Interval	15 minutes	15 minutes	15 minutes	15 minutes	15 minutes	15 minutes	15 minutes	15 minutes	15 minutes
Temperature	Units	Celsius (°C)	Celsius (°C)	Celsius (°C)	Celsius (°C)	Celsius (°C)	Celsius (°C)	Celsius (°C)	Celsius (°C)	Celsius (◦C)
	Sensor type	Thermistor	Thermistor	Thermistor	Thermistor	Thermistor	Thermistor	Thermistor	Thermistor	Thermistor
	Model #	YSI 6560	YSI 6560	YSI 6560	YSI 6560	YSI 6560	YSI 6560	YSI 6560	YSI 6560	EXO2 - 599870-01
	Range	-5 to 45 °C	-5 to 45 °C	-5 to 45 °C	-5 to 45 °C	-5 to 45 °C	-5 to 45 °C	-5 to 45 °C	-5 to 45 °C	-5 to 35 °C
	Accuracy	+/-0.15 °C	+/-0.15 °C	+/-0.15 °C	+/-0.15 °C	+/-0.15 °C	+/-0.15 °C	+/-0.15 °C	+/-0.15 °C	±0.01 °C
	Resolution	0.01 °C	0.01 °C	0.01 °C	0.01 °C	0.01 °C	0.01 °C	0.01 °C	0.01 °C	0.001 °C
	Collection	One point	One point	One point	One point	One point	One point	One point	One point	One point
Salinity	Units				parts per thousand (ppt)	parts per thousand (ppt)	parts per thousand (ppt)	parts per thousand (ppt)	parts per thousand (ppt)	parts per thousand (ppt)
	Sensor type				Calculated from conductivity and temperature	Calculated from conductivity and temperature	Calculated from conductivity and temperature	Calculated from conductivity and temperature	Calculated from conductivity and temperature	Calculated from conductivity and temperature
	Range				0 to 70 ppt	0 to 70 ppt	0 to 70 ppt	0 to 70 ppt	0 to 70 ppt	0 to 70 ppt
	Accuracy				+/- 1.0% of reading or 0.1 ppt, whichever is greater	+/- 1.0% of reading or 0.1 ppt, whichever is greater	+/- 1.0% of reading or 0.1 ppt, whichever is greater	+/- 1.0% of reading or 0.1 ppt, whichever is greater	+/- 1.0% of reading or 0.1 ppt, whichever is greater	+/- 1.0% of reading or 0.1 ppt, whichever is greater
	Resolution				0.01 ppt	0.01 ppt	0.01 ppt	0.01 ppt	0.01 ppt	0.01 ppt
	Collection				One point	One point	One point	One point	One point	One point

Table 5. Instrument Specifications (continued)

Water Quality		Mohawk Utica	Mohawk Lock 8	Albany	Schodack	Tivoli N	Tivoli S	Norrie	Marist	Pier 84
Conductivity	Units	mS/cm	mS/cm	mS/cm	mS/cm	mS/cm	mS/cm	mS/cm	mS/cm	mS/cm
	Sensor type	4-electrode cell with autoranging	4-electrode cell with autoranging	4-electrode cell with autoranging	4-electrode cell with autoranging	4-electrode cell with autoranging	4-electrode cell with autoranging	4-electrode cell with autoranging	4-electrode cell with autoranging	4-electrode cell with auto ranging
	Model #	YSI 6560	YSI 6560	YSI 6560	YSI 6560	YSI 6560	YSI 6560	YSI 6560	YSI 6560	EXO2 - 599870-01
	Range	0 to 100 mS/cm	0 to 100 mS/cm	0 to 100 mS/cm	0 to 100 mS/cm	0 to 100 mS/cm	0 to 100 mS/cm	0 to 100 mS/cm	0 to 100 mS/cm	0 to 200 mS/cm
	Accuracy	+/-0.5% of reading + 0.001 mS/cm	+/-0.5% of reading + 0.001 mS/cm	+/-0.5% of reading + 0.001 mS/cm	+/-0.5% of reading + 0.001 mS/cm	+/-0.5% of reading + 0.001 mS/cm	+/-0.5% of reading + 0.001 mS/cm	+/-0.5% of reading + 0.001 mS/cm	+/-0.5% of reading + 0.001 mS/cm	0 to 100: ±0.5% of reading or 0.001 mS/cm, w.i.g.; 100 to 200: ±1% of reading
	Resolution	0.001 mS/cm to 0.1 mS/cm (range dependent)	0.001 mS/cm to 0.1 mS/cm (range dependent)	0.001 mS/cm to 0.1 mS/cm (range dependent)	0.001 mS/cm to 0.1 mS/cm (range dependent)	0.001 mS/cm to 0.1 mS/cm (range dependent)	0.001 mS/cm to 0.1 mS/cm (range dependent)	0.001 mS/cm to 0.1 mS/cm (range dependent)	0.001 mS/cm to 0.1 mS/cm (range dependent)	0.0001 to 0.01 mS/cm (range dependent)
	Collection	One point	One point	One point	One point	One point	One point	One point	One point	One point

Table 5. Instrument Specifications (continued)

Water Quality		Mohawk Utica	Mohawk Lock 8	Albany	Schodack	Tivoli N	Tivoli S	Norrie	Marist	Pier 84
Dissolved Oxygen Saturation	Units	percent air saturation (%)	percent air saturation (%)	percent air saturation (%)	percent air saturation (%)	percent air saturation (%)	percent air saturation (%)	percent air saturation (%)	percent air saturation (%)	percent air saturation (%)
	Sensor type	Optical probe w/ mechanical cleaning	Optical probe w/ mechanical cleaning	Optical probe w/ mechanical cleaning	Optical probe w/ mechanical cleaning	Optical probe w/ mechanical cleaning	Optical probe w/ mechanical cleaning	Optical probe w/ mechanical cleaning	Optical probe w/ mechanical cleaning	Optical probe w/ mechanical cleaning
	Model #	YSI 6150 ROX	YSI 6150 ROX	YSI 6150 ROX	YSI 6150 ROX	YSI 6150 ROX	YSI 6150 ROX	YSI 6150 ROX	YSI 6150 ROX	EXO2 - 599199-01
	Range	0 to 500% air saturation	0 to 500% air saturation	0 to 500% air saturation	0 to 500% air saturation	0 to 500% air saturation	0 to 500% air saturation	0 to 500% air saturation	0 to 500% air saturation	0 to 500% air saturation
	Accuracy	0-200% air saturation: +/- 1% of the reading or 1% air saturation, whichever is greater 200-500% air saturation: +/- 15% or reading	0-200% air saturation: +/- 1% of the reading or 1% air saturation, whichever is greater 200-500% air saturation: +/- 15% or reading	0-200% air saturation: +/- 1% of the reading or 1% air saturation, whichever is greater 200-500% air saturation: +/- 15% or reading	0-200% air saturation: +/- 1% of the reading or 1% air saturation, whichever is greater 200-500% air saturation: +/- 15% or reading	0-200% air saturation: +/- 1% of the reading or 1% air saturation, whichever is greater 200-500% air saturation: +/- 15% or reading	0-200% air saturation: +/- 1% of the reading or 1% air saturation, whichever is greater 200-500% air saturation: +/- 15% or reading	0-200% air saturation: +/- 1% of the reading or 1% air saturation, whichever is greater 200-500% air saturation: +/- 15% or reading	0-200% air saturation: +/- 1% of the reading or 1% air saturation, whichever is greater 200-500% air saturation: +/- 15% or reading	0 to 200%: ±1% of reading or 1% saturation, w.i.g.; 200 to 500%: ±5% of reading
	Resolution	0.1% air saturation	0.1% air saturation	0.1% air saturation	0.1% air saturation	0.1% air saturation	0.1% air saturation	0.1% air saturation	0.1% air saturation	0.1% air saturation
	Collection	One point	One point	One point	One point	One point	One point	One point	One point	One point

Table 5. Instrument Specifications (continued)

Water Quality		Mohawk Utica	Mohawk Lock 8	Albany	Schodack	Tivoli N	Tivoli S	Norrie	Marist	Pier 84
Dissolved Oxygen	Units	milligrams/Liter (mg/L)	milligrams/Liter (mg/L)	milligrams/Liter (mg/L)	milligrams/Liter (mg/L)	milligrams/Liter (mg/L)	milligrams/Liter (mg/L)	milligrams/Liter (mg/L)	milligrams/Liter (mg/L)	milligrams/Liter (mg/L)
	Sensor type	Calculated from % air saturation, temperature, and salinity	Calculated from % air saturation, temperature, and salinity	Calculated from % air saturation, temperature, and salinity	Calculated from % air saturation, temperature, and salinity	Calculated from % air saturation, temperature, and salinity	Calculated from % air saturation, temperature, and salinity	Calculated from % air saturation, temperature, and salinity	Calculated from % air saturation, temperature, and salinity	Calculated from % air saturation, temperature, and salinity
	Model #	YSI 6150 ROX	YSI 6150 ROX	YSI 6150 ROX	YSI 6150 ROX	YSI 6150 ROX	YSI 6150 ROX	YSI 6150 ROX	YSI 6150 ROX	EXO2 - 599199-01
	Range	0 to 50 mg/L	0 to 50 mg/L	0 to 50 mg/L	0 to 50 mg/L	0 to 50 mg/L	0 to 50 mg/L	0 to 50 mg/L	0 to 50 mg/L	0 to 50 mg/L
	Accuracy	0-20 mg/L: +/- 0.1 mg/l or 1% of the reading, whichever is greater; 20 to 50 mg/L: +/- 15% of the reading	0-20 mg/L: +/- 0.1 mg/l or 1% of the reading, whichever is greater; 20 to 50 mg/L: +/- 15% of the reading	0-20 mg/L: +/- 0.1 mg/l or 1% of the reading, whichever is greater; 20 to 50 mg/L: +/- 15% of the reading	0-20 mg/L: +/- 0.1 mg/l or 1% of the reading, whichever is greater; 20 to 50 mg/L: +/- 15% of the reading	0-20 mg/L: +/- 0.1 mg/l or 1% of the reading, whichever is greater; 20 to 50 mg/L: +/- 15% of the reading	0-20 mg/L: +/- 0.1 mg/l or 1% of the reading, whichever is greater; 20 to 50 mg/L: +/- 15% of the reading	0-20 mg/L: +/- 0.1 mg/l or 1% of the reading, whichever is greater; 20 to 50 mg/L: +/- 15% of the reading	0-20 mg/L: +/- 0.1 mg/l or 1% of the reading, whichever is greater; 20 to 50 mg/L: +/- 15% of the reading	0 to 20 mg/L: ±0.1 mg/L or 1% of reading, w.i.g.; 20 to 50 mg/L: ±5% of reading
	Resolution	0.01 mg/L	0.01 mg/L	0.01 mg/L	0.01 mg/L	0.01 mg/L	0.01 mg/L	0.01 mg/L	0.01 mg/L	0.01 mg/L
	Collection	One point	One point	One point	One point	One point	One point	One point	One point	One point
Water Level (shallow depth)	Units	meters (m)	meters (m)	meters (m)	meters (m)	meters (m)	meters (m)	meters (m)	meters (m)	meters (m)
	Sensor type	OTT Bubbler Sensor	OTT Bubbler Sensor	OTT Bubbler Sensor	Stainless steel strain gauge	Stainless steel strain gauge	Stainless steel strain gauge	Stainless steel strain gauge	OTT Bubbler Sensor	Pressure Transducer
	Vented to Atmosphere	vented	vented	vented	Non-vented (corrected for barometric pressure in real-time since EST 9/23/2011 00:00:00)	non-vented (corrected for barometric pressure in real-time since EST 9/23/2011 00:00:00)	vented	vented	vented	integral; non-vented
	Range	0-15.24 m	0-15.24 m	0-15.24 m	0 to 9.1 m	0 to 9.1 m	0 to 9.1 m	0 to 9.1 m	0-15.24 m	0-10 m
	Accuracy	0-4.6m: +/- 0.003 m; 4.6-10.7m: +/- 0.065%; 10.7-15.2m: +/- 0.006m	0-4.6m: +/- 0.003 m; 4.6-10.7m: +/- 0.065%; 10.7-15.2m: +/- 0.006m	0-4.6m: +/- 0.003 m; 4.6-10.7m: +/- 0.065%; 10.7-15.2m: +/- 0.006m	0-3m: +/- 0.003 m; 3-9.1m: +/- 0.018 m	0-3m: +/- 0.003 m; 3-9.1m: +/- 0.018 m	0-3m: +/- 0.003 m; 3-9.1m: +/- 0.018 m	0-3m: +/- 0.003 m; 3-9.1m: +/- 0.018 m	0-4.6m: +/- 0.003 m; 4.6-10.7m: +/- 0.065%; 10.7-15.2m: +/- 0.006m	±0.04% FS (±0.004 m or ±0.013 ft)
	Resolution	0.9 m/min	0.9 m/min	0.9 m/min	0.001 m	0.001 m	0.001 m	0.001 m	0.9 m/min	0.001 m
	Collection	One point	One point	One point	One point	One point	One point	One point	One point	One point

Table 5. Instrument Specifications (continued)

Water Quality		Mohawk Utica	Mohawk Lock 8	Albany	Schodack	Tivoli N	Tivoli S	Norrie	Marist	Pier 84
Acidity	Units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units
	Sensor type	Glass combination electrode	Glass combination electrode	Glass combination electrode	Glass combination electrode	Glass combination electrode	Glass combination electrode	Glass combination electrode	Glass combination electrode	Glass combination electrode
	Model #	YSI 6589 Flat Glass	YSI 6589 Flat Glass	YSI 6589 Flat Glass	YSI 6589 Flat Glass	YSI 6561 Flat Glass	YSI 6561 Flat Glass	YSI 6561 Flat Glass	YSI 6589 Flat Glass	EXO2 - 599702
	Range	0 to 14 units	0 to 14 units	0 to 14 units	0 to 14 units	0 to 14 units	0 to 14 units	0 to 14 units	0 to 14 units	0 to 14 units
	Accuracy	+/- 0.2 units	+/- 0.2 units	+/- 0.2 units	+/- 0.2 units	+/- 0.2 units	+/- 0.2 units	+/- 0.2 units	+/- 0.2 units	±0.1 pH units within ±10°C of calibration temp; ±0.2 pH units for entire temp range
	Resolution	0.01 units	0.01 units	0.01 units	0.01 units	0.01 units	0.01 units	0.01 units	0.01 units	0.01 units
	Collection	One point	One point	One point	One point	One point	One point	One point	One point	One point
Turbidity	Units	nephelometric turbidity units (NTU)	nephelometric turbidity units (NTU)	nephelometric turbidity units (NTU)	nephelometric turbidity units (NTU)	nephelometric turbidity units (NTU)	nephelometric turbidity units (NTU)	nephelometric turbidity units (NTU)	nephelometric turbidity units (NTU)	nephelometric turbidity units (NTU)
	Sensor type	Optical, 90 ° scatter, with mechanical cleaning	Optical, 90 ° scatter, with mechanical cleaning	Optical, 90 ° scatter, with mechanical cleaning	Optical, 90 ° scatter, with mechanical cleaning	Optical, 90 ° scatter, with mechanical cleaning	Optical, 90 ° scatter, with mechanical cleaning	Optical, 90 ° scatter, with mechanical cleaning	Optical, 90 ° scatter, with mechanical cleaning	Optical, 90 ° scatter, with mechanical cleaning
	Model #	YSI 6136	YSI 6136	YSI 6136	YSI 6136	YSI 6136	YSI 6136	YSI 6136	YSI 6136	EXO2 - 599101-01
	Range	0 to 1000 NTU	0 to 1000 NTU	0 to 1000 NTU	0 to 1000 NTU	0 to 1000 NTU	0 to 1000 NTU	0 to 1000 NTU	0 to 1000 NTU	0-4000 NTU
	Accuracy	+/- 2 % of reading or 0.3 NTU (whichever is greater)	+/- 2 % of reading or 0.3 NTU (whichever is greater)	+/- 2 % of reading or 0.3 NTU (whichever is greater)	+/- 2 % of reading or 0.3 NTU (whichever is greater)	+/- 2 % of reading or 0.3 NTU (whichever is greater)	+/- 2 % of reading or 0.3 NTU (whichever is greater)	+/- 2 % of reading or 0.3 NTU (whichever is greater)	+/- 2 % of reading or 0.3 NTU (whichever is greater)	0 to 999 NTU: 0.3 NTU or ±2% of reading, w.i.g.; 1000 to 4000 NTU: ±5% of reading
	Resolution	0.1 NTU	0.1 NTU	0.1 NTU	0.1 NTU	0.1 NTU	0.1 NTU	0.1 NTU	0.1 NTU	0 to 999 NTU = 0.01 NTU; 1000 to 4000 NTU = 0.1 NTU
	Collection	One point	One point	One point	One point	One point	One point	One point	One point	One point

Table 5. Instrument Specifications (continued)

Water Quality		Mohawk Utica	Mohawk Lock 8	Albany	Schodack	Tivoli N	Tivoli S	Norrie	Marist	Pier 84
Chlorophyll	Units					micrograms/Liter (ug/L)	micrograms/Liter (ug/L)	micrograms/Liter (ug/L)		
	Sensor type					optical fluorescence sensor	optical fluorescence sensor	optical fluorescence sensor		
	Model #					6025	6025	6025		
	Range					0 to 400 ug/L chl a; 0 to 100 RFU	0 to 400 ug/L chl a; 0 to 100 RFU	0 to 400 ug/L chl a; 0 to 100 RFU		
	Detection Limit					~ 0.1 ug/L	~ 0.1 ug/L	~ 0.1 ug/L		
	Resolution					0.1 ug/L chl a, 0.1% FS	0.1 ug/L chl a, 0.1% FS	0.1 ug/L chl a, 0.1% FS		
	Collection					One point	One point	One point		

Table 5. Instrument Specifications (continued)

Weather		Mohawk Lock 8	Albany	Schodack	Tivoli Bays	Norrie Point	Piermont Pier	Pier 84
General Information	Date first operational	01/04/2011	01/04/2011	04/25/2008	07/15/1999	01/17/2008	04/25/2008	12/19/2012
	Date of first transmission	01/04/2011	01/04/2011	04/25/2008	11/14/2005	02/15/2008	04/25/2008	12/21/2012
	Data Logger Model	CR1000-ST-SW-NC	CR1000-ST-SW-NC	CR10X_PB accessed from shore by a Campbell RF401 spread spectrum radio	Campbell CR1000	Campbell CR1000	HOBO Weather Station Data Logger	ISS-SER-CR200-C
	Data Transmitter	900 MHz spread spectrum Radio	900 MHz spread spectrum Radio	Airlink Raven Cellular Modem	Sutron Model #SL2-G312-1 geo-stationary satellite data transmitter	Directly connected to a DSL internet feed.	SolarStream Wireless Data Transceiver	Raven XT Cellular Modem
	Collection Interval	15 min	15 min	15 min	15 min	15 min	15 min	15 minutes
Temperature	Sensor Type	Platinum resistance temperature detector	Platinum resistance temperature detector	resistive platinum sensors	Platinum resistance temperature detector	Platinum resistance temperature detector	12-Bit Temperature/RH Smart Sensor	capacitive measurement
	Sensor Model	HMP45C Temperature and Relative Humidity	HMP45C Temperature and Relative Humidity	Vaisala HMP45A/D	HMP45C Temperature and Relative Humidity	HMP45C Temperature and Relative Humidity	HOBO S-THB-M002	WXT520
	Units	Celsius	Celsius	Celsius	Celsius	Celsius	Celsius	Celsius (∘C)
	Operating temperature	-40℃ to +60 ℃	-40℃ to +60 ℃	-40℃ to +60 ℃	-40℃ to +60 ℃	-40℃ to +60 ℃	-40°C to 75°C	-52 to 60 °C
	Range	-40℃ to +60 ℃	-40℃ to +60 ℃	-40℃ to +60 ℃	-40℃ to +60 ℃	-40℃ to +60 ℃	-40°C to 75°C	±0.3 °C
	Accuracy	± 0.2 ℃ @ 20 ℃	± 0.2 ℃ @ 20 ℃	± 0.2 ℃ @ 20 ℃	± 0.2 ℃ @ 20 ℃	± 0.2 ℃ @ 20 ℃	0.2°C @ 0°C to 50°C	0.1 °C
	Collection	One point	One point	One point	One point	One point	One point	Average (sampling rate: every minute)

Table 5. Instrument Specifications (continued)

Weather		Mohawk Lock 8	Albany	Schodack	Tivoli Bays	Norrie Point	Piermont Pier	Pier 84
Relative Humidity	Sensor Type	Platinum resistance temperature detector	Platinum resistance temperature detector	Vaisala HUMICAP© 180 capacitive thin film polymer	Vaisala HUMICAP© 180 capacitive relative humidity sensor	Vaisala HUMICAP© 180 capacitive relative humidity sensor	[12-Bit Temperature/RH Smart Sensor]()	capacitive measurement
	Sensor Model	HMP45C Temperature and Relative Humidity	HMP45C Temperature and Relative Humidity	Vaisala HMP45A/D	HMP45C Temperature and Relative Humidity	HMP45C Temperature and Relative Humidity	HOBO S-THB-M002	WXT520
	Units	Percent	Percent	Percent	Percent	Percent	Percent	Percent
	Operating temperature	N/A	N/A	N/A	N/A	N/A	-40°C o 5°C	n/a
	Temperature Dependence	± 0.05% RH/°C	± 0.05% RH/°C	± 0.05% RH/°C	± 0.05% RH/°C	± 0.05% RH/°C	NA	see "Accuracy" below
	Range	0 to 100% non-condensing	0 to 100% non-condensing	0.8 to 100% RH	0 to 100% non-condensing	0 to 100% non-condensing	0 to 100% RH	0-100%
	Accuracy	at 20 °C: ± 2% RH (0-90%), ±3% RH (90-100%)	at 20 °C: ± 2% RH (0-90%), ±3% RH (90-100%)	at 20 °C: ± 2% RH (0-90%), ±3% RH (90-100%)	at 20 °C: ± 2% RH (0-90%), ±3% RH (90-100%)	at 20 °C: ± 2% RH (0-90%), ±3% RH (90-100%)	±2.5% from 10 to 90% RH	±3 %RH within 0-90 %RH ±5 %RH within 90-
	Collection	One point	One point	One point	One point	One point	One point	Average (sampling rate: every minute)
Barometric Pressure	Sensor Type	CS-1056Vaisala Barocap© silicon capacitive pressure sensor	CS-1056Vaisala Barocap© silicon capacitive pressure sensor	Vaisala BAROCAP Barometer	CS-105 Vaisala Barocap© silicon capacitive pressure sensor	CS-105 Vaisala Barocap© silicon capacitive pressure sensor	HOBO Barometric Pressure smart sensor	capacitive measurement
	Sensor Model	Campbell Scientific CS106	Campbell Scientific CS106	PTB110	#PTB101B	#PTB101B	HOBO S-BPA-CM10	WXT520
	Units	mbar	mbar	mbar	Millibars	Millibars	Millibars	hPa
	Humidity	Non-condensing	Non-condensing	Non-condensing	non-condensing	non-condensing		Non-condensing
	Range	500-1100 mbar	500-1100 mbar	500-1100 mbar	Pressure: 600 to 1060 mb; Temperature: -40°C to +60°C	Pressure: 600 to 1060 mb; Temperature: -40°C to +60°C	660 mb to 1070 mb Temperature -40°C to 70°C	600-1100 hPa
	Accuracy	±0.3 mb @ +20°C; ±0.6 mb @ 0° to 40°C; ±1.0 mb @ -20° to +45°C; ±1.5 mb @ -40° to +60°C	±0.3 mb @ +20°C; ±0.6 mb @ 0° to 40°C; ±1.0 mb @ -20° to +45°C; ±1.5 mb @ -40° to +60°C	+/- 0.3 mbar at +20°C	± 0.5 mb @ 20°C; +/- 2 mb @ 0°C to 40°C; +/- 4 mb @ -20°C to 45°C; +/- 6 mb @ -40°C to 60°C	± 0.5 mb @ 20°C; +/- 2 mb @ 0°C to 40°C; +/- 4 mb @ -20°C to 45°C; +/- 6 mb @ -40°C to 60°C	±3.0 mbar over full pressure range at 25°C (77°F) Maximum Error of ±5.0 mbar over -40°C to 70°C	±0.5 hPa at 0 ... +30 °C (+32 ... +86 °F) ±1 hPa at -52 ... +60 °C (-60 ... +140 °F)
	Collection	One point	One point	One point	One point	One point	One point	Average (sampling rate: every minute)

Table 5. Instrument Specifications (continued)

Weather		Mohawk Lock 8	Albany	Schodack	Tivoli Bays	Norrie Point	Piermont Pier	Pier 84
Wind Speed	Sensor Type	balanced anodized aluminum vane	balanced anodized aluminum vane	3-cup anemometer	18 cm diameter 4-blade helicoids propeller molded of polypropylene	18 cm diameter 4-blade helicoids propeller molded of polypropylene	3-cup anemometer	Ultrasound via 3 transducers
	Sensor Model	MetOne model 034B	MetOne model 034B	MetOne model 034B	R.M. Young 05103 Wind Monitor	R.M. Young 05103 Wind Monitor	Onset Wind Speed and Direction Smart Sensor S-WCA-M003	WXT520
	Units	m/s	m/s	mph	m/s	m/s	m/s	m/s
	Range	0 to 50 m/s	0 to 50 m/s	0-100 mph	0-60 m/s (130 mph); gust survival 100 m/s (220 mph)	0-60 m/s (130 mph); gust survival 100 m/s (220 mph)	0 to 44 m/s	0-60 m/s
	Accuracy	±0.11 m/s (0.25 mph) when less than 10.1 m/s (22.7 mph) or	±0.11 m/s (0.25 mph) when less than 10.1 m/s (22.7 mph) or	<22.7mph=0.25mph, >22.7 ±1.1%	±2%	±2%	±0.5 m/s ±3% 17 to 30 m/s ±4% 30 to 47 m/s	±3% at 10 m/s
	Collection	Averaged over 15 minutes	Averaged over 15 minutes	Averaged over 15 minutes	Averaged over 15 minutes	Averaged over 15 minutes	Averaged over 15 minutes	Average (sampling rate: 4 times a second)
Wind Direction	Sensor Type	balanced anodized aluminum vane	balanced anodized aluminum vane	balanced anodized aluminum vane	balanced vane, 38 cm turning radius	balanced vane, 38 cm turning radius	balanced aluminum vane	Ultrasound via 3 transducers
	Sensor Model	MetOne model 034B	MetOne model 034B	MetOne model 034B	R.M. Young 05103 Wind Monitor	R.M. Young 05103 Wind Monitor	Onset Wind Speed and Direction Smart Sensor S-WCA-M003	WXT520
	Units	degrees	degrees	degrees	degrees	degrees	degrees	degrees
	Range	360° mechanical, 356° electrical	360° mechanical, 356° electrical	360° mechanical, 356° electrical	360° mechanical, 355° electrical (5° open)	360° mechanical, 355° electrical (5° open)	0 to 358°, 2° Dead Band	0-360 degrees
	Accuracy	±4 degrees	±4 degrees	±4 degrees	±5%	±5%	±5 Degrees	±3 degrees
	Collection	Averaged over 15 minutes	Averaged over 15 minutes	Averaged over 15 minutes	Averaged over 15 minutes	Averaged over 15 minutes	Averaged over 15 minutes	Average (sampling rate: 4 times a second)

Table 5. Instrument Specifications (continued)

Weather		Mohawk Lock 8	Albany	Schodack	Tivoli Bays	Norrie Point	Piermont Pier	Pier 84
Radiation	Sensor Type	High stability silicon photovoltaic detector (blue enhanced)	High stability silicon photovoltaic detector (blue enhanced)	ISO-9060 Secondary Standard compliant	High stability silicon photovoltaic detector (blue enhanced)	High stability silicon photovoltaic detector (blue enhanced)	Silicon Pyranometer Sensor	n/a
	Sensor Model	LI190SB	LI190SB	Kipp & Zonen CM 11	LI190SB	LI190SB	HOBO S-LIB-M003	n/a
	Units	mmoles m-2 (total flux)	mmoles m-2 (total flux)	W/m^2	mmoles m-2 (total flux)	mmoles m-2 (total flux)	W/m^2	n/a
	Light Spectrum Waveband	400 to 700 nm	400 to 700 nm	305-2800 nm	400 to 700 nm	400 to 700 nm	300 to 1100 nm	n/a
	Temperature Dependence	0.15% per °C maximum	0.15% per °C maximum	<±1% (-10 to 40deg C)	0.15% per °C maximum	0.15% per °C maximum	0.38 W/m^2/°C from 25°C (0.21 W/m^2/°F from 77°F)	n/a
	Stability	<±2% change over 1 yr	<±2% change over 1 yr	NA	<±2% change over 1 yr	<±2% change over 1 yr	<±2% change over 1 yr	n/a
	Operating temperature	-40°C to 65°C; Humidity: 0 to 100%	-40°C to 65°C; Humidity: 0 to 100%	-40°C to 80°C	-40°C to 65°C; Humidity: 0 to 100%	-40°C to 65°C; Humidity: 0 to 100%	-40°C to 75°C	n/a
	Sensitivity	typically 5 µA per 1000 µmoles s-1 m-2	typically 5 µA per 1000 µmoles s-1 m-2	4-6 mV/W/m^2	typically 5 µA per 1000 µmoles s-1 m-2	typically 5 µA per 1000 µmoles s-1 m-2	NA	n/a
	Collection	One point	One point	One point	One point	One point	One point	n/a

Table 5. Instrument Specifications (continued)

Weather		Mohawk Lock 8	Albany	Schodack	Tivoli Bays	Norrie Point	Piermont Pier	Pier 84
Precipitation	Sensor Type	6 inch diameter tipping bucket	6 inch diameter tipping bucket	12 inch diameter tipping bucket	Tipping Bucket Rain Gauge (heated)	Tipping Bucket Rain Gauge (heated)	6" diameter Tipping Bucket Rain Gauge	acoustic: detects in the impact of individual rain drops - converts to accumulated rainfall
	Sensor Model	Campbell Scientific TE525WS-L30	Campbell Scientific TE525WS-L30	Handar 444B	TE525	TB3	HOBO Rain Gauge Smart Sensor S-RGA-M002	WXT520
	Units	millimeters (mm)	millimeters (mm)	millimeters (mm)	millimeters (mm)	millimeters (mm)	Millimeters (mm)	mm
	Rainfall per tip	0.254 mm	0.254 mm	1 mm	0.01 inch	0.01 inch	0.2 mm	n/a
	Range	NA	NA	NA	Temperature: 0° to +/- 50°C; Humidity: 0 to 100%	Temperature: -20° to +70°C; Humidity: 0 to 100%	10 cm or 0" to 5" per hour; Temperature 0° to 50°C	0-200 mm/hr
	Accuracy	Up to 1 in./hr: ±1%; 1 to 2 in./hr: +0, -3%; 2 to 3 in./hr: +0, -5%	Up to 1 in./hr: ±1%; 1 to 2 in./hr: +0, -3%; 2 to 3 in./hr: +0, -5%	±3.0% up to 100 mm/hr	±1.0% up to 1 in./hr; +0, -3% from 1 to 2 in./hr; +0, -5% from 2 to 3 in./hr	±1.0% up to 1 in./hr; +0, -3% from 1 to 2 in./hr; +0, -5% from 2 to 3 in./hr	±1.0% at up to 20 mm or 1" per hour	5%
	Collection	One point	One point	One point	One point	One point	One point	Sum of acoustic detection

2. Sample Custody Procedures

2.1 Water Quality Instruments

Water quality equipment is installed in a PVC or aluminum casing with a locked lid. The casing itself is attached by screws to a piling, dock, or buoy.

2.2 Weather Instruments

Weather instruments are difficult to access which protects them from vandalism. They are installed at a significant height and in hard to reach locations such as a building top or an island. In addition, instruments at Mohawk Lock 8, Norrie Point and Tivoli Bay are locked in place.

2.3 Data Loggers and Transmission Equipment

All stations have locked strong boxes that hold the data loggers, transmission equipment, and battery. These boxes are fixed to a permanent structure above the high water line.

2.4 Samples Collected for the Site Assessments for Water Quality Stations

The total dissolved solid samples collected for the Annual Site Assessment for Water Quality Stations are collected according to DOWSOP 301-11: Wastewater Sample Collection which requires a chain of custody form for each sample collection.

3. Maintenance and Calibration

3.1 Maintenance and Calibration Procedures

3.1.1 Water Quality Sensors

All water quality sensors are calibrated immediately before and after deployment according to the Water Quality Monitoring Standard Operating Procedure (HRECOS SOP 2012.01). A sensor is never deployed if it fails calibration. As a further precaution, measurements from two sets of sensors are compared at least once per quarter. Since water quality sensors are swapped for newly calibrated instruments at the end of each deployment this is easily accomplished by comparing the readings before and after the swap. Finally, sensors are serviced by the manufacturer at least once every five years and preferably once every two years.

3.1.2 Weather Sensors

Weather instruments are inspected once per quarter according to the Weather Monitoring Standard Operating Procedure (HRECOS SOP 2012.02). Instruments are calibrated as funding permits.

3.2 Maintenance Records

Station operators are responsible for keeping all maintenance records. Within three months after the end of each quarter, station operators must submit calibration results *only* for water quality stations and any problems identified at the weather stations to the HRECOS Coordinator to update station metadata files.

3.3 Calibration Materials and Replacement Equipment

Calibration materials and replacement equipment are distributed by the HRECOS coordinator to the station operator once per year. It is the responsibility of the station operator to properly store these materials until needed. Should a station need unexpected repairs or equipment replacement, station operators and the HRECOS coordinator collaborate on a repair plan and work together to secure funding for this purpose.

3.4 Frequency of Maintenance.
Water Quality instruments must be calibrated at least once per quarter. Instruments are calibrated more frequently if a statistically significant and unexpected trend is observed in the output. Weather instruments will be inspected quarterly.

4. Data Management
Data handling and archive will follow the procedures of the Data Handling and Archival Standard Operating Procedure (HRECOS SOP 2012.07).

III. ASSESSMENT AND OVERSIGHT

1. Quality Control and Corrective Actions
The following measurements and corrective actions are used to ensure the quality of the data generated in this project.

1.1 Accuracy
1.1.1 Water Quality Sensors
If a water quality sensor does not match (within accuracy limits) the duplicate sensor during the instrument swap, then it is recalibrated. If a sensor displays a statistically significant change over the course of a deployment, then it is removed and recalibrated. If a water quality sensor fails calibration it is sent to the manufacturer for a certified calibration. If it fails this calibration also, it is removed from the deployment cycle.
1.1.2 Weather Sensors
If weather sensors do not match (within 10x the accuracy limits) two sets of external instruments, then it is sent to the manufacturer for a certified calibration. Also, if a rain gauge fails the annual calibration, then it is also returned for a certified calibration. If any sensor fails the manufacturer's calibration, then it is removed from the HRECOS network.
1.1.3 Time Records
If, during the quarterly check, the recorded time differs from EST by more than 5s, then the clock is reset and the change is noted in the metadata.

1.2 Precision
1.2.1 Water Quality Sensors
If a water quality sensor fluctuates during calibration by a value larger than the accuracy limit (see table 4), then the sensor must be returned to the manufacturer for a certified calibration. If the sensor fails the manufacturer's calibration then it is removed from the HRECOS network.
1.2.2 Weather Sensors
If a weather sensor fails the manufacturer's calibration then it is removed from the HRECOS network.
1.2.3 Time Records

If the time recorded by a data logger drifts by more than five seconds over the course of a deployment then the data logger is returned to the manufacturer for a certified calibration. If the logger fails the manufacturer's calibration, it is removed from the HRECOS network.

1.3 Representativeness
If the results of the annual site assessment for a water quality station indicate that main channel conditions are significantly different from those measured by a HRECOS water quality station, then the HRECOS management team will investigate alternative locations.

1.4 Comparability
Procedures described in A, B and C will ensure comparability across stations.

1.5. Completeness
1.5.1 Response to Failed Data Transmission
If a station fails to report for 12 hours or more, the Station Operator receives an automated notice. If an instrument fails to report for 12 consecutive hours, the Station Operator will visit the station to check if the data transmission program is running. If transmission is running, the Station Operator will check the instrumentation and make any changes necessary.

1.5.2 Quarterly Assessment of Data Completeness
At every quarterly meeting, the HRECOS Coordinator reports the percentage of total possible records a station has reported. Our goal is to record at least 90% of the total possible observations. Deficiencies will be discussed at the quarterly meeting. In some cases, solutions will require postponement if insufficient funding is available. If a station fails to follow any of the QC requirements for more than one quarter than the Management Team will consider removing the station from the network.

2. Data Review
2.1 Data Flagging
Data will be reviewed once per quarter. Those data that do not meet the following quality criteria will be flagged.

2.1.1 Automatic Flagging
The automatic flags defined in table 6 are added in real-time by the HRECOS database; the seasonal averages are based on the previous year's data.

2.1.2 Quarterly Data Flagging
Within three months after the end of the quarter, the HRECOS Coordinator adds any missing data. recalculates the automatic flags using actual seasonal averages and compiles data files for review by station operators and research assistants.

All Station Operators or their designated research assistants review the automatic flags and make a final determination for the public record according to the following standard operating procedures:
Water Quality data review and editing Standard Operating Procedure (HRECOS SOP 2012.05)
Weather data review and editing Standard Operating Procedure (HRECOS SOP 2012.06)

All quarterly flagging procedures are completed and uploaded to the HRECOS database within three months after the end of the quarter.

3. Performance and System Audits

The HRECOS Coordinator will visit each Station Operator once per year to observe maintenance procedures. Discrepancies are addressed immediately. Significant discrepancies are addressed at the quarterly meeting.

In addition, those stations funded and maintained by the NYS DEC DOW will be audited by the NYSDEC QA Officer to assess compliance with this quality assurance plan.

For those projects funded by NEIWPCC, NEIWPCC may implement, at their discretion, various audits or reviews of this project to assess conformance and compliance to the quality assurance project plan in accordance with the NEIWPCC Quality Management Plan.

4. Reports to Management

4.1 Annual Data Files

Finalized data is uploaded to the HRECOS database for public download within three months after the end of the quarter. Finalized annual files with inserted missing records are uploaded to the www.hrecos.org historical data website within three months after the end of the year.

4.2 Metadata Files

A single metadata file will be associated with every water quality and weather station.
Metadata files for water quality stations must include the following information:

- Disclaimer for Data Use
- Contacts for the Station
- Distribution and Attribution for HRECOS Data
- Description of How Data are Verified
- A Summary of Site Location and Character including assessments of representativeness
- Data Collection Period including all Deployment and Retrieval Dates
- Post Deployment Measurements for Dissolved Oxygen % Saturation, Specific Conductivity, pH, and Turbidity.
- Other remarks/notes including data coded as “See Metadata”
- Sensor Specifications
- QAQC Flag Definitions

Metadata files for weather stations must include the following information:

- Disclaimer for Data Use
- Contacts for the Station
- Distribution and Attribution for HRECOS Data
- Description of How Data are Verified
- A Summary of Site Location and Character
- Data Collection Period
- Inspection Results
- Other Remarks / Notes including data coded as “See Metadata”
- Sensor Specifications
- QAQC Flag Definitions

Table 6. Automatic and Manual Data Flags and Comment Codes

Provisional Data Flags

0	Acceptable data
5	Data that demonstrate a significant increase or decrease from the previous value
6	Flat lined data
30	Data outside three standard deviations of the seasonal mean
40	Data outside four standard deviations of the seasonal mean
100	Data outside the range of the instrument

Final Data Flags

0	Data determined to be acceptable after a final review by the site manager
10000	Suspicious data according to a final review by the site manager
20000	Corrected data
500000	Rejected data according to a final review by the site manager

General Errors
[GIM] instrument malfunction
[GIT] instrument recording error, recovered telemetry data
[GMC]no instrument deployed due to maintenance/calibration
[GIC] no instrument deployed due to ice
[GNF] deployment tube clogged/no flow
[GPF] power failure/low battery
[GQR] rejected due to QAQC checks
[GSM] see metadata
[GOW] out of water event
[GMT] instrument maintenance
[GDP] power down
[GIM] program reload

Sensor Errors
water quality stations only
[SBO] blocked optic
[STF] catastrophic temperature sensor failure
[SCF] conductivity sensor failure
[SDF] depth port frozen
[SDP DO membrane puncture
[SDO] DO suspect
[SIC] incorrect calibration/contaminated standard
[SNV] negative value
[SPC] post calibration out of range
[SSDN] sensor drift, record not corrected
[SSDC] sensor drift, record corrected
[SSM] sensor malfunction
[SOW] sensor out of water
[SSR] sensor removed (not deployed

[STS] turbidity spike
[SWM] wiper malfunction/loss
weather stations only:
[SIC] incorrect calibration constant, multiplier or offset
[SNV] negative value
[SSN] not a number/unknown value
[SOC] out of calibration
[SSM] sensor malfunction
[SSR] sensor removed

Comments
water quality stations only
[CAF] acceptable calibration/accuracy error of sensor
[CBF] biofouling
[CCU] cause unknown
[CDA] DO hypoxia <28 percent saturation
[CDB] disturbed bottom
[CDF] data appear to fit conditions
[CFK] fish kill
[CIP] surface ice present at sample station
[CLT] low tide
[CND] new deployment begins
[CRE] significant rain event
[CSM] see metadata
[CTS] turbidity spike
[CWD] data collected at wrong depth
[CAP] depth sensor in water, affected by atmospheric pressure
[CAB] algal bloom
[CVT] possible vandalism/tampering
[CMC] in field maintenance/cleaning
[CMD] mud in probe guard
weather stations only
[CAF] acceptable calibration/accuracy error of sensor
[CDF] data appear to fit conditions
[CRE] significant rain event
[CSM] see metadata
[CVT] possible vandalism/tampering

New York State Department of Environmental Conservation
Division of Water
Bureau of Program Resources, 4th Floor
625 Broadway, Albany, New York 12233-3507
Phone: (518) 402-8267 • **FAX:** (518) 402-9029
Website: www.dec.ny.gov

Joseph Martens
Commissioner

M E M O R A N D U M

TO: Jason Fagel, NYSDEC DOW QA Officer

FROM: Alene Onion, HRECOS Coordinator

SUBJECT: Minor changes to the HRECOS QAPP

DATE: April 11, 2013

The following changes were made to the HRECOS Water Quality and Weather Stations Quality Assurance Project Plan on April 11, 2013:

The following sentence was added to 3.1.2 to clarify that weather station instruments are only calibrated as funding permits:
"Weather instruments are inspected once per quarter according to the Weather Monitoring Standard Operating Procedure (HRECOS SOP 2012.02). Instruments are calibrated as funding permits."

Two sentences were added to 1.8.5 Tivoli Bays Stations to clarify that only the tidal stations are part of the HRECOS network and to provide a weblink to access data for the Stony Creek and Saw Kill Creek data:
"The objective of this station is to monitor surface water quality at the Tivoli Bays component of the Hudson River National Estuarine Research Reserve (NERR). Two tidal freshwater wetlands, Tivoli North Bay and Tivoli South Bay are monitored using four dataloggers (YSI 6600 sondes). In Tivoli North Bay and Tivoli South Bay the dataloggers monitor the ebbing and flooding Hudson River water. These data are included in the HRECOS network also. In Stony Creek and Saw Kill Creek, the dataloggers are deployed above the area of tidal influence and monitor the quality of water entering the Tivoli Bays via stream flow. These data are not included in the HRECOS network but may be accessed through the NERR website: http://www.hrnerr.org/. Thus, the relative importance of stream flow and tidal exchange and the potential impacts of intertidal areas on the water quality of the Tivoli Bays can be determined."

cc: G. Lemley
M. Novak

Appendix D

CONTINUOUS WATER-QUALITY MONITOR FIELD FORM

Please contact the USGS HRECOS team if you have any questions! Email: gs-w-ny_hrecos@usgs.gov

Do you need to see the Standard Operating Procedures?

- ○ Yes
- ○ No

Station Number

Station Name *

Please Select

Jotform Now create your own Jotform - It's free! Create your own Jotform

Monitor Inspected By Monitor Inspected By * Email Address Email Address *

Date(YYYY/MM/DD)/Time(24:00) *

2024/06/25 | 09:02

Date | Hour Minutes

Time Datum *

- ◯ EST
- ◯ EDT

Monitor Make/Model Monitor Make/Model * Monitor Serial Number

Monitor Serial Number *

Field Meter Make/Model Field Meter Make/Model * Field Meter Serial Number

Field Meter Serial Number *

Weather

☐ Cold	☐ Cool	☐ Warm	☐ Hot	☐ Rain
☐ Mist	☐ Sleet	☐ Snow	☐ Humid	☐ Dry
☐ Cloudy	☐ Pt Cloudy	☐ Overcast	☐ Clear	☐ Windy
☐ Gusty	☐ Breeze	☐ Calm		

Comments

Jotform

Now create your own Jotform - It's free!

Create your own Jotform

How were fouling check readings taken? *

- ◯ In stream
- ◯ In a bucket

MONITOR FOULING CHECKS

	BEFORE CLEANING: Recorded/Live Monitor Reading	BEFORE CLEANING: Field Meter Reading	AFTER CLEANING: Recorded/Live Monitor Reading	AFTER CLEANING: Field Meter Reading
Time				
Temp (C)				
pH (units)				
DO (mg/L)				
SC (uS/cm)				
Turbidity (FNU/NTU)				
Chlorophyll (ug/L)				
Chlorophyll (RFU)				
Phycocyanin (ug/L)				
Phycocyanin (RFU)				

Jotform Now create your own Jotform - It's free! Create your own Jotform

fDOM (RFU)				

pH Millivolts

Do you need to troubleshoot any of the sensors?

- ◯ Yes
- ◯ No

Maintenance Record for Continuous Monitor

Battery Changed? *

◯ Yes ◯ No

Sensors cleaned? *

◯ Yes ◯ No

Type of fouling: *

Jotform

Now create your own Jotform - It's free!

Create your own Jotform

- Yes
- No

Probe Tracking

	Make/Model	Serial Number	New Serial Number (if swapped)
Multi-parameter meter			
Temperature			
Condictivity			
pH			
Dissolved Oxygen			
Turbidity			
Total Algae			
fDOM			

Comments/Observations

Type here...

Photos

Browse Files

Jotform Now create your own Jotform - It's free! Create your own Jotform

Submit

Jotform

Now create your own Jotform - It's free!

Create your own Jotform

CONTINUOUS WATER-QUALITY MONITOR CALIBRATION DRIFT FORM

Please contact the USGS HRECOS team if you have any questions! Email: gs-w-ny_hrecos@usgs.gov

Do you need to see the Standard Operating Procedures?

- Yes
- No

Station Name *

Please Select

Station Number

Jotform Now create your own Jotform - It's free! Create your own Jotform

Monitor Inspected By Monitor Inspected By * Email Address Email Address *

Date(YYY/MM/DD)/Time(24:00) *

2024/06/25 | 09:03

Date | Hour Minutes

Time Datum *

- ◯ EST
- ◯ EDT

Monitor Make/Model Monitor Make/Model * Monitor Serial Number Monitor Serial Number *

Comments

Do you need the Water Temperature calibration procedures and criteria?

- ◯ Yes
- ◯ No

Water Temperature

Jotform Now create your own Jotform - It's free! Create your own Jotform

Time		
Temperature (C)		

Do you need the Specific Conductance calibration procedures and criteria?

- ◯ Yes
- ◯ No

Specific Conductance (please put standard concentrations from lowest to highest for drift correction calculation)

	Concentration	Standard Lot No.	Standard Type	Expiration Date	Calibration Check Standard Temp (C)	Calibration Check SC Reading (uS/cm)	Rec S T
Time							
Standard 1 (low)							
Standard 2 (mid)							
Standard 3 (high)							

SC reading in air:

Do you need Dissolved Oxygen calibration procedures and criteria and/or saturation values?

- ◯ Yes
- ◯ No

Jotform Now create your own Jotform - It's free! Create your own Jotform

Dissolved Oxygen

	Calibration Check	Recalibration
Time		
Temp (C)		
Barometric Pressure (mm Hg)		
DO Table Reading (mg/L)		
DO Reading (mg/L)		

Do you need pH calibration procedures and criteria?

- Yes
- No

pH

	Theoretical from pH Table	Buffer Lot No.	Buffer Expiration Date	Calibration Check Standard Temp (C)	Calibration Check pH Reading	Recalibration Standard Temp (C)	Recalibrat pH Readi
Time							
pH 7							
pH 10							
pH 4							

Do you need the Turbidity calibration procedures and criteria?

- Yes
- No

Jotform Now create your own Jotform - It's free! Create your own Jotform

Turbidity (please put standard concentrations from lowest to highest for drift correction calculation)

	Lot Number	Concentration	Calibration Check Standard Temp (C)	Calibration Check Reading	Recalibration Standard Temp (C)	Recalibration Reading
Time						
Zero						
Standard 1						
Standard 2						

Do you need the Chlorophyll & Phycocyanin calibration procedures and criteria?

- ◯ Yes
- ◯ No

Chlorophyll & Phycocyanin

	Expiration Date of First Dilution	Standard Value from Table	Calibration Check Standard Temp (C)	Calibration Check Reading	Recalibration Standard Temp (C)	Recalibration Reading
Time						
Chlorophyll ug/L (Zero)						
Chlorophyll ug/L (Std 1)						
Chlorophyll RFU (Zero)						
Chlorophyll RFU (Std 1)						

Jotform Now create your own Jotform - It's free! Create your own Jotform

RFU (Zero)					
Phycocyanin RFU (Std 1)					

Do you need the fDOM calibration procedures and criteria?

- ◯ Yes
- ◯ No

fDOM

	Standard Value from Table -OR- DI/Tonic	Calibration Check Standard Temp (C)	Calibration Check Reading	Recalibration Standard Temp (C)	Recalibration Reading
Time					
fDOM QSE (Zero)					
fDOM QSE (Std 1)					
fDOM RFU (Zero)					
fDOM RFU (Std 1)					

Was or will a sonde/probe swap be performed?

- ◯ Yes
- ◯ No

Jotform Now create your own Jotform - It's free! Create your own Jotform

Browse Files

Drag and drop files here

Submit

Jotform

Now create your own Jotform - It's free!

Create your own Jotform

Appendix E

HRECOS

Continuous Data Handling and Archival

Standard Operating Procedure

April 8, 2010

Prepared by: Alene Onion______________ **Date:** April 8, 2010

Approved by:__________________ **Date:**

Table of Contents

1. Scope and Applicability

1.1 The Continuous Data Handling and Archival (DHA) SOP covers the collection of Live data, logger data, and verified data that are generated as part of HRECOS monitoring activities. This SOP recommends what sampling data are to be filed electronically and the length of time these data should be kept and by whom.

1.2 The SOP is applicable to all HRECOS monitoring activities, regardless of funding sources.

1.3 This SOP is to be followed unless project objectives or physical conditions make it inappropriate. In such a case, the exact procedures followed, or deviations from the SOP must be documented and submitted to the HRECOS Quality Assurance Officer for possible incorporation into future updates to this SOP.

2. Summary of Method

2.1 The DHA SOP begins with the development the Quality Assurance Project Plan (QAPP) by the individual Station Operators in collaboration with the HRECOS Coordinator. The QAPP deals with sample collection, data transmission, analysis of the results and a final report. Within the QAPP are references to HRECOS SOPs that are specific to the needs and function of the project (i.e., Meteorological Monitoring, Water Quality Monitoring, Water Quality Data Review). This SOP covers the handling and archival of continuous data and assigns responsibility for maintaining these files.

2.2 Station Operators in collaboration with the HRECOS Coordinator and the HRECOS Database Project Manager are responsible for the collection of the field and meta data. The data to be collected is determined by the QAPP.

2.3 All data records are maintained in the HRECOS Database. This database was constructed by David Runnels with the Stevens Institute. It is currently operated by the HRECOS Database Project Manager.

3. Definitions

3.1 *Live Data*: data transmitted from the instruments to the HRECOS database in near real-time.

3.2 *Logger Data*: data downloaded from the data logger.

3.3 *Verified Data*: data that have been reviewed by a Station Operator.

3.4 *Historical Data*: historical data with inserted missing dates and times provided in batch files for easy download by a user.

4. **Procedure -** A map of the architecture of the HRECOS database is given in Figure 1.

4.1 Processed in Near Real-Time

4.1.1 The *Live Data* are transmitted in near real-time according to the QAPP.

4.1.2 Upon receipt by the HRECOS database, all Automatic flags described by the QAPP are added. Historical data are used to identify data outside 3 and 4 st deviations of the seasonal mean.

4.1.3 Once per day, at 0600 hours, daily averages are calculated for each station/parameter combination.

4.2 Processed As Available

4.2.1 Station Operators download data from the data loggers and send these files to the HRECOS Coordinator. Any data that needs to be corrected by the Station Operator is done so before it is submitted to the HRECOS Coordinator.

4.2.2 The HRECOS Coordinator confirms that the time stamps are in EST and adds the Automatic flags described by the QAPP.

4.2.3 The HRECOS Coordinator calculates the daily averages for each station/parameter combination excluding records with flags $\geq$100.

4.2.4 All data are submitted to the database through an external website.

4.3 Processed Quarterly

4.3.1 *Processing Automatic Flags*

4.3.1.1 The HRECOS Coordinator applies all automatic flags to the quarterly data using the actual seasonal averages for the quarter.

4.3.1.2 Data are submitted to the database through an external website.

4.3.2 Verified Data

4.3.2.1 At the end of each quarter, the HRECOS Coordinator collects data from the database and prepares files for review by the station operators.

4.3.2.2 Station Operators add or modify flags and comments according to the QAPP and send the completed files back to the HRECOS Coordinator.

4.3.2.3 For each file, the HRECOS Coordinator confirms that the time stamps are in EST, and checks that only the flags and comments and not the data records were modified.

4.3.2.4 All data are submitted to the database through an external website.

4.3.3 Metadata

4.3.3.1 The metadata are recorded by the Station Operator according to the QAPP and are collected by the HRECOS Coordinator as available. Annual records must be finalized within three months of the end of the year.

4.3.3.2 All metadata files are posted at www.hrecos.org by the HRECOS Coordinator.

4.3.3.3 All metadata files are associated with the "Current Conditions" page by the Database Manager.

4.4 Outputs

4.4.1 Historical Data Files

4.4.1.1 Within three months of the end of the year, the HRECOS Coordinator collects data from the database, inserts missing records, and aligns parameters with matching dates and times. A record is considered missing if there is a gap that is 30 minutes or greater.

4.4.1.2 The Historical Data Files are posted at www.hrecos.org.

4.4.2 Web Interface

4.4.2.1 The following website allows users to view or download data in near real-time: http://hudson.dl.stevens-tech.edu/hrecos/d/index.shtml.

4.4.2.2 The time series plot does not display data that are outside the range of the instrument or that have been flagged for rejection by the Station Operator. Suspicious data (flag 10,000) are displayed as a lighter color.

4.4.2.3 Users may plot one or two station/parameter combinations for any time period less than three months, plot daily averages for one or two station/parameter combinations for any time period less than one year, or download data from one station/parameter combination for any timer period less than six months.

4.5 Warning System

4.5.1 Once per day, at 0600 hours, a script checks to see that all stations have reported data. If a station has failed to transmit data for more than 12 hours, an e mail will be sent automatically by the database to the Station Operator, the Database Project Manager, and the HRECOS Coordinator.

5. Data and Records Management

5.1 All data records are maintained in the HRECOS Database. This database is designed and operated by the HRECOS Database Manager, David Runnels with the Stevens Institute. The HRECOS database is backed up locally once per week.

5.2 *Historical Data* batch files and metadata files are held at www.hrecos.org.

5.3 In addition, backup copies of all data files are maintained by the HRECOS Coordinator at the NYS DEC. This back up is updated on the last day of every month.

Figure 1. Architecture framework for the HRECOS Database