**Hudson River** (HUD) **NERR Water Quality Metadata**

**January 1st, 2021 – December 31st, 2021**

**Latest Update:** 05/05/2023

**I. Data Set and Research Descriptors**

**1) Principal investigator(s) and contact persons –**

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**2) Entry verification –**

Deployment data are uploaded from the YSI data logger to a personal computer with Windows 7 or newer operating system. Files are exported from EcoWatch in a comma-delimited format (.CDF), EcoWatch Lite in a comma separated file (CSV) or KOR Software in a comma separated file (CSV) and uploaded to the CDMO where they undergo automated primary QAQC; automated Depth/Level corrections for changes in barometric pressure (cDepth or cLevel parameters); and become part of the CDMO’s online provisional database. All pre- and post-deployment data are removed from the file prior to upload. During primary QAQC, data are flagged if they are missing or out of sensor range. The edited file is then returned to the reserve for secondary QAQC where it is opened in Microsoft Excel and processed using the CDMO’s NERRQAQC Excel macro. The macro inserts station codes, creates metadata worksheets for flagged data and summary statistics, and graphs the data for review. It allows the user to apply QAQC flags and codes to the data, remove any overlapping deployment data, append files, and export the resulting data file for upload to the CDMO. Upload after secondary QAQC results in ingestion into the database as provisional plus data, recalculation of cDepth or cLevel parameters, and finally tertiary QAQC by the CDMO and assimilation into the CDMO’s authoritative online database. Where deployment overlap occurs between files, the data produced by the newly calibrated sonde is generally accepted as being the most accurate. For more information on QAQC flags and codes, see Sections 11 and 12.

Persons responsible for data verification are the Research Assistant.

**3) Research objectives –**

The objective of this study 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, and their primary upland tributaries, Stony Creek and Saw Kill Creek respectively, are monitored using four dataloggers (YSI EXO 2 Sondes). In Tivoli North Bay and Tivoli South Bay the dataloggers monitor the ebbing and flooding Hudson River water. 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. 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.

**4) Research methods –**

As of the 2014 sampling season, four non-vented YSI EXO 2 dataloggers are deployed at the Tivoli Bays component site of the Hudson River NERR. The instruments in Saw Kill Creek and Tivoli South Bay are deployed 0.5 meters off the bottom in perforated four-inch PVC tubes that are vertically mounted to existing concrete and metal structures.

From September 2011 to December 2013 the Sawkill deployment tube was affixed to the undamaged end of the dam at a 45 degree angle, retaining the original 0.5 meters off the bottom of the creek. The station was destroyed again during the winter of 2013-2014. The station was rebuilt as vertically mounted in a four – inch PVC tube in April 2014. The sonde is still located 0.5 meters from the creek bed, and was reconstructed as close as possible to original sampling location.

The instrument at Tivoli South Bay historically used a depth sensor that was vented to the atmosphere. For the 2014 sampling season, the instrument now utilizes a non-vented sensor for depth readings.

The sonde at Bear Mountain is deployed in a vertical 4-inch PVC pipe secured to a wooden dock structure on the south side of the dock. The sonde rests 0.5 m off the river bottom on a 0.5 inch bolt. This site was initially built in 2019 and brought on for primary SWMP use in 2020.

At Stony Creek, instruments are deployed in a perforated four-inch PVC pipe set in approximately 70 pounds of concrete at such angle that when laid in a creek pool, the streambank-end of the pipe matched the grade of the bank for most of its length and the sonde, set in place by a 0.5 inch through-bolt, rests 0.25 meters above the substrate. Along the portion of the PVC in contact with dry bank, several rebar stakes, bent around and lashed through holes in the pipe, hold the deployment in place and discourage vandalism. Additionally, the tube is painted to match surrounding deadfall, the end is capped and locked and contact/project information provided to further discourage tampering.

A vertical four-inch PVC pipe is lashed to wooden pilings under the railroad culvert in Tivoli North Bay. The sonde is secured within this pipe and situated 0.5m from the substrate, resting on a 0.5 inch stainless steel bolt.

A Fifth, “Secondary SWMP” station was established at the reserve’s Norrie Point, office in 2018. This station was originally constructed in June 2008, an operated independently of SWMP until 2018. Historical data is available upon request.

The instrument at this location is identical to those mentioned above for primary SWMP use. The instrument is deployed in a ported 4” aluminum pipe, which is lashed to a large wooden piling structure. The sonde is deployed vertically in the pipe and sits on a stainless-steel bolt 0.5 meters above the river bottom.

Due to the extra depth and protection of the Norrie Point station, the sonde is deployed year-round. Dataloggers are calibrated and swapped from March through December of each year. The instrument does become “locked” in place during the ice months (December to March), and typically cannot be accessed during this time. It is retrieved as soon as ice-out occurs.

Initially, data were collected at 30-minute intervals. The interval was changed to 15 minutes on the 8/3/2006 deployment at Tivoli South, and on 8/9/2006 at Stony Creek, Saw Kill Creek, and Tivoli North. A 15 minute interval was maintained through the current data set. Each YSI EXO 2 datalogger measures depth, dissolved oxygen, temperature, conductivity, salinity, pH, and turbidity. In addition, from 10/7/09, chlorophyll is measured at Tivoli North and South locations. As of 2014 all sampling locations measure chlorophyll. Prior to deployment, calibration and maintenance are performed on each datalogger following the manufacturer's instructions (YSI EXO operations manual). Calibration standards are utilized for pH, turbidity, and conductivity. These standards are purchased from a scientific supply company. Standard Lot number is recorded before each calibration.

Chlorophyll data were calibrated using a one-point calibration in 2021. The one-point calibration utilized deionized (DI) water and a zero point calibration. The YSI EXO operations manual and NERRS SWMP EXO Manual both call for a two-point calibration.

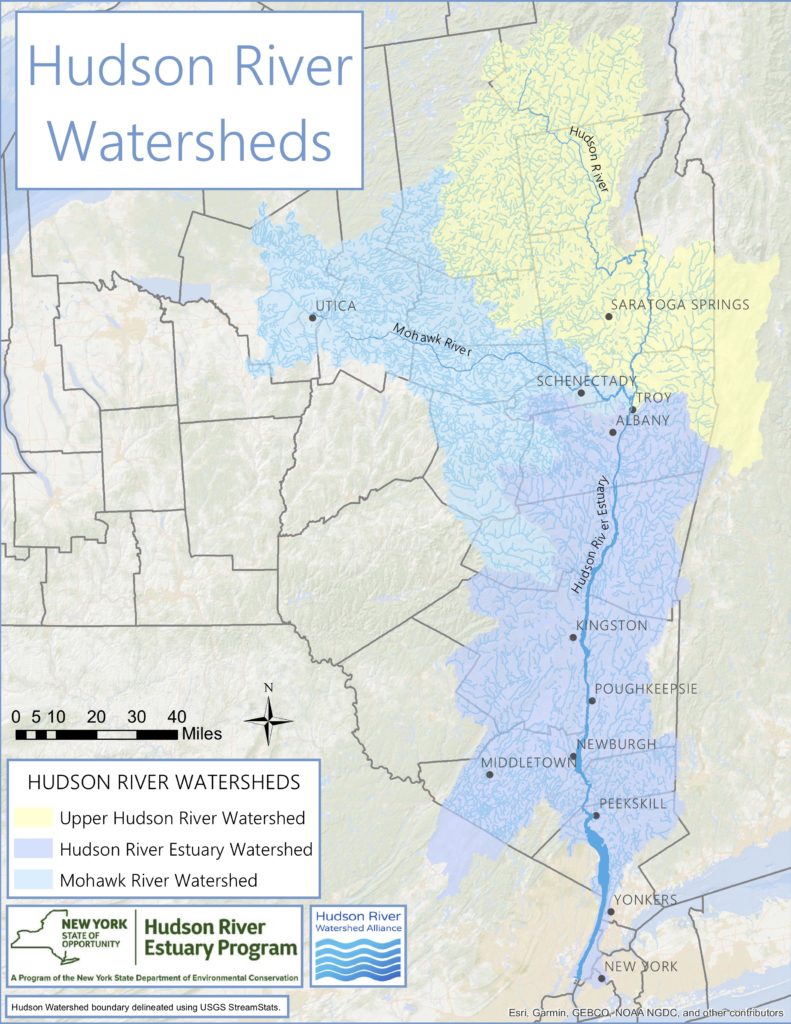
Individual instrument deployments last from two to six weeks. At the end of each deployment period, the dataloggers are swapped with newly calibrated instruments to avoid breaks in data collection. After instruments are retrieved, calibration is checked against standards and the probes are serviced. The data are uploaded to a desktop computer via cable. Graphs of each parameter are generated and examined immediately in order to identify significant problems or events that may have occurred during deployment. The data are then verified as described previously.

# A Sutron Sat-Link2 transmitter was installed at the Tivoli South station on 11/15/05 and transmits data to the NOAA GOES satellite, NESDIS ID #3B00A782. A second Sutron Sat-Link2 transmitter was also installed at the Sawkill station on in June 2012 and transmits data to the NOAA GOES satellite, NESDIS ID #3B010580. For the 2014 season, a radio and Satlink 2 combination has been installed at the Stony Creek sampling location and transmits data to the NOAA GOES satellite, NESDIS ID #3B03A08C. Beginning with the 2018 sampling season Norrie Point, a Sat-Link2 transmitter transmits data to the NOAA GOES satellite, NESDIS ID # 3B0467A6. The transmissions are scheduled hourly and contain four (4) data sets reflecting fifteen minute data sampling intervals. Upon receipt by the CDMO, the data undergoes the same automated primary QAQC process detailed in Section 2 above. The “real-time” telemetry data become part of the provisional dataset until undergoing secondary and tertiary QAQC and assimilation in the CDMO’s authoritative online database. Provisional and authoritative data are available at http://cdmo.baruch.sc.edu

**5) Site location and character –**

The research reserve spans the middle 100 miles of the Hudson River estuary and is comprised of four sites: Stockport Flats, Tivoli Bays, Iona Island, and Piermont Marsh. The entirety of the 150 mile tidal portion of the river, experiences on average a 1.5 meter tidal range, until it reaches an engineered head of tide at the Federal Dam in Troy, NY. All mainstem monitoring stations listed below (excluding SC) record similar tidal amplitudes, although the depth of the monitoring devices vary as listed below. A salinity gradient exists with freshwater prevalent primarily north of the Iona Island (BM) component site. Environmental factors such as drought and excessive rainfall may allow this salt gradient to migrate both north and south. Typical salinity is 0.1 PSU at the northern sites (TN, TS, and NP) and ranging from 0.1 – 10.0 PSU at southern monitoring location (BM).

Freshwater dominates all but the lower 40 river miles of the Hudson River. The river flows for a total of 315 miles, with the only the lower 153 miles classified as an estuary. The upper portion of the river drains a total of 4,590 square miles spanning 3 states and majority of the Adirondack Mountains of New York State. A significant freshwater input from the Mohawk River, with its confluence located just north of the head of tide, provides a significant source of additional freshwater. (Figure – 1A)



|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Station Code** | **Station Name** | **Location** | **Avg Depth (M)** | **Salinity** | **Benthic Profile** | **Pullutants** |
| TS | Tivoli Bay South | 42° 1' 37.34 N, 73° 55' 33.45 W | 1.50 | 0.1 PSU | Soft Sediment/Silty | Residual PCB |
| TN | Tivoli Bay North | 42° 2' 11.56 N, 73° 55' 31.17 W | 1.25 | 0.1 PSU | Soft Sediment/Silty | Residual PCB |
| SC | Stony Creek | 42° 2' 46.68 N, 73° 54' 38.88 W | 0.25 | 0.1 PSU | Cobble, Boulder | Agriculture Runoff |
| NP | Norrie Point | 41°49'54.0"N 73°56'31.0"W | 3.00-5.00 | 0.1 PSU | Soft Sediment/Silty | Residual PCB |
| BM | Bear Mountain | 41°18’53.19” N  73°59'6.78"W | 3.00-5.00 | 0.1-10 PSU | Soft Sediment/Silty | Residual PCB |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Station Code** | **SWMP Status** | **Station Name** | **Location** | **Active Dates** | **Reason Decommissioned** | **Notes** |
| TS | P | Tivoli Bay South | 42° 1' 37.34 N, 73° 55' 33.45 W | 05/01/1995 00:00 –current | NA | NA |
| TN | P | Tivoli Bay North | 42° 2' 11.56 N, 73° 55' 31.17 W | 07/01/1999 00:00 –current | NA | NA |
| SK | D | Saw Kill | 42° 1' 1.82 N, 73° 54' 53.86 W | 05/01/1995 00:00 –12/3/2019 | The attachment point (dam) is scheduled for demolition | NA |
| SC | P | Stony Creek | 42° 2' 46.68 N, 73° 54' 38.88 W | 04/01/2002 00:00 –12/07/21 | Changes at the site no longer allow for successful monitoring. Flow has been reduced due to upstream slope failure, beaver activity etc. | 2021 will be the end of monitoring at this location. Equipment has been relocated to a main-stem river site at “Ferry Landing” |
| NP | S | Norrie Point | 41°49'54.0"N 73°56'31.0"W | (06/27/2008)  \*01/01/2018 00:00 -Current | NA | \*Secondary SWMP status confirmed as of 01/01/2018, prior data may be available per request |
| BM | P | Bear Mountain | 41°18’53.19” N  73°59'6.78"W | 01/01/2020 00:00 -Current | NA | New Site established for the 2020 sampling season. Will replace SK as primary station |

**6) Data collection period –**

YSI 6-series datalogger sampling at Saw Kill Creek (SK) and Tivoli South Bay (TS) began in May 1995. Sampling at Tivoli North Bay (TN) began in July 1996 but ceased in 1997-1998 due to instrument exposure at low tide. In 1999, an alternate site was established for TN and sampling began again in July of 1999. Sampling began at Stony Creek (SC) in April 2002. Sampling is continuous from April through December but is not conducted from approximately mid-December through the end of March due to winter storms and ice on the Hudson River and the tributaries.

A YSI 6600 Extended Deployment System (EDS) sonde was deployed at Tivoli South Bay starting on 04/08/2003. The EDS differs from the other 6600 instruments in that a large wiper is positioned centrally to the probes and wipes them prior to every sample. This wiper requires that the pH probe not have a guard over the glass bulb, and a new flat pH probe was deployed on the EDS starting 09/25/2003. Otherwise, the EDS sonde is identical to the other 6600 dataloggers. YSI 6600 V2’s been utilized at Tivoli South Bay and Tivoli North Bay since the addition of the Chlorophyll probes on 10/7/09.

All component sites were switched to YSI EXO 2 sondes during the 2014 sampling season. All sites now contain non-vented equipment.

Dates and times for site deployments and retrievals for 2021

Site

TS

|  |  |
| --- | --- |
| **Deployment** | **Retrieval** |
| NO INSTRUMENT DEP | LOYED DUE TO ICE |
| 03/31/21 @ 11:00 | 04/15/21 @ 10:15 |
| 04/15/21 @ 10:30 | 05/12/21 @ 10:45 |
| 05/12/21 @ 11:00 | 06/15/21 @ 11:45 |
| 6/15/21 @ 12:15 | 7/28/21 @ 12:00 |
| 7/28/21 @ 12:30 | 8/10/21 @ 10:30 |
| 8/10/21 @ 10:45 | 9/24/21 @ 9:00 |
| 9/24/21 @ 9:45 | 11/09/21 @ 11:15 |
| 11/09/21 @ 11:30 | 12/7/21 @ 11:00 |

Site

TN

|  |  |
| --- | --- |
| **Deployment** | **Retrieval** |
| NO INSTRUMENT DEP | LOYED DUE TO ICE |
| 03/31/21 @ 10:45 | 04/14/21 @ 10:00 |
| 04/14/21 @ 10:30 | 05/12/21 @ 10:00 |
| 05/12/21 @ 10:15 | 06/15/21 @ 09:15 |
| 6/15/21 @ 11:45 | 7/28/21 @ 11:30 |
| 7/28/21 @ 11:45 | 8/11/21 @ 10:00 |
| 8/11/21 @ 10:15 | 9/24/21 @ 8:45 |
| 9/24/21 @ 9:15 | 11/09/21 @ 10:45 |
| 11/09/21 @ 11:00 | 12/7/21 @ 10:30 |

Site

BM

|  |  |
| --- | --- |
| **Deployment** | **Retrieval** |
| 12/21/20 @ 12:00 | 01/21/2021 @ 11:45 |
| 01/21/2021 @ 12:00 | 03/24/2021 @ 12:30 |
| 03/24/2021 @ 13:00 | 4/21/21 @ 12:00 |
| 4/21/21 @ 12:15 | 5/19/21 @ 10:45 |
| 5/19/21 @ 11:00 | 6/23/21 @ 12:45 |
| 6/23/21 @ 13:00 | 7/22/21 @ 13:15 |
| 7/22/21 @ 13:30 | 9/27/21 @ 9:15 |
| 9/27/21 @ 9:30 | 10/15/21 @ 11:00 |
| 10/15/21 @ 11:30 | 11/15/21 @ 12:45 |
| 11/15/21 @ 13:00 | 12/14/21 @ 10:45 |
| 12/14/21 @ 11:00 | 01/26/22 @ 11:45 |

Site

SC

|  |  |
| --- | --- |
| **Deployment** | **Retrieval** |
| NO INSTRUMENT DEP | LOYED DUE TO ICE |
| 03/30/21 @ 14:15 | 05/28/21 @ 11:30 |
| 05/28/21 @ 12:00 | 6/28/21 @ 11:45 |
| 6/28/21@ 12:15 | 8/5/21 @ 10:00 |
| 8/5/21 @ 10:15 | 9/29/21 @ 12:15 |
| 9/29/21 @ 12:45 | 10/28/21 @ 11:45 |
| 10/28/21 @ 12:00 | 12/07/21 @ 10:00 |

Site

NP

|  |  |
| --- | --- |
| **Deployment** | **Retrieval** |
| 12/21/20 @ 14:45 | 03/29/21 @ 10:15 |
| 03/29/21 @ 10:30 | 5/27/21 @ 10:15 |
| 5/27/21 @ 10:00 | 7/15/21 @ 9:15 |
| 7/15/21 @ 9:30 | 8/31/21 @ 14:30 |
| 8/31/21 @ 14:45 | 11/01/21 @ 12:45 |
| 11/01/21 @ 13:00 | 12/17/21 @ 14:30 |
| 12/17/21 @ 15:00 | 01/02/22 @ 17:45 |

**7) Distribution –**

NOAA retains the right to analyze, synthesize and publish summaries of the NERRS System-wide Monitoring Program data.  The NERRS retains the right to be fully credited for having collected and processed the data.  Following academic courtesy standards, the NERR site where the data were collected should be contacted and fully acknowledged in any subsequent publications in which any part of the data are used.  The data set enclosed within this package/transmission is only as good as the quality assurance and quality control procedures outlined by the enclosed metadata reporting statement.  The user bears all responsibility for its subsequent use/misuse in any further analyses or comparisons.  The Federal government does not assume liability to the Recipient or third persons, nor will the Federal government reimburse or indemnify the Recipient for its liability due to any losses resulting in any way from the use of this data.

Requested citation format:

NOAA National Estuarine Research Reserve System (NERRS). System-wide Monitoring Program. Data accessed from the NOAA NERRS Centralized Data Management Office website: <http://www.nerrsdata.org/>; *accessed* 12 October 2021.

NERR water quality data and metadata can be obtained from the Research Coordinator at the individual NERR site (please see Principal Investigators and Contact Persons), from the Data Manager at the Centralized Data Management Office (please see personnel directory under the general information link on the CDMO home page) and online at the CDMO home page [www.nerrsdata.org](http://www.nerrsdata.org).  Data are available in comma delimited format.

**8) Associated researchers and projects –**

As part of the SWMP long-term monitoring program, XXX NERR also collects 15-minute meteorological data and monthly grab and diel samples for nutrient/pigment data which may be correlated with this water quality dataset. These data are available at [www.nerrsdata.org](http://www.nerrsdata.org).

**II. Physical Structure Descriptors**

**9) Sensor specifications –**

HUDNERR deployed YSI EXO 2 dataloggers at all sites (see Section 4). All probes are titanium in construction and wiped by a central wiper unit.

Parameter: Temperature

Units: Celsius (C)

Sensor Type: Thermistor

Model#: 599870-01

Range: -5 to 50 C

Accuracy: -5 to 35: +/- 0.01, 35 to 50: +/- 0.05

Resolution: 0.001 C

Parameter: Conductivity

Units: milli-Siemens per cm (mS/cm)

Sensor Type: 4-electrode cell with autoranging

Model#: 599870-01

Range: 0 to 200 mS/cm

Accuracy: 0 to 100: +/- 0.5% of reading or 0.001 mS/cm; 100 to 200: +/- 1% of reading

Resolution: 0.001 mS/cm to 0.1 mS/cm (range dependent)

Parameter: Salinity

Units: practical salinity units (psu)/parts per thousand (ppt)

Sensor Type: Calculated from conductivity and temperature

Range: 0 to 70 psu

Accuracy: +/- 1.0% of reading pr 0.1 ppt, whichever is greater

Resolution: 0.01 psu

Parameter: Dissolved Oxygen % saturation

Sensor Type: Optical probe w/ mechanical cleaning

Model#: 599100-01

Range: 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: +/- 5% or reading

Resolution: 0.1% air saturation

Parameter: Dissolved Oxygen mg/L (Calculated from % air saturation, temperature, and salinity)

Units: milligrams/Liter (mg/L)

Sensor Type: Optical probe w/ mechanical cleaning

Model#: 599100-01

Range: 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: +/- 5% of the reading

Resolution: 0.01 mg/L

Parameter: Non-vented Level - Shallow (Depth)

Units: feet or meters (ft or m)

Sensor Type: Stainless steel strain gauge

Range: 0 to 33 ft (10 m)

Accuracy: +/- 0.013 ft (0.004 m)

Resolution: 0.001 ft (0.001 m)

Parameter: pH

Units: pH units

Sensor Type: Glass combination electrode

Model#: 599701(guarded) or 599702(wiped)

Range: 0 to 14 units

Accuracy: +/- 0.01 units within +/- 10° of calibration temperature, +/- 0.02 units for entire temperature range

Resolution: 0.01 units

Parameter: Turbidity

Units: formazin nephelometric units (FNU)

Sensor Type: Optical, 90 degree scatter

Model#: 599101-01

Range: 0 to 4000 FNU

Accuracy: 0 to 999 FNU: 0.3 FNU or +/-2% of reading (whichever is greater); 1000 to 4000 FNU +/-5% of reading

Resolution: 0 to 999 FNU: 0.01 FNU, 1000 to 4000 FNU: 0.1 FNU

Parameter: Chlorophyll

Units: micrograms/Liter

Sensor Type: Optical probe

Model#: 599102-01

Range: 0 to 400 ug/Liter

Accuracy: Dependent on methodology

Resolution: 0.01 ug/L chl a, 0.1% FS

**Dissolved Oxygen Qualifier (rapid pulse / Clark type sensor):**

The reliability of dissolved oxygen (DO) data collected with the rapid pulse / Clark type sensor after 96 hours post-deployment for non-EDS (Extended Deployment System) data sondes may be problematic due to fouling which forms on the DO probe membrane during some deployments (Wenner et al. 2001). The YSI 6600 EDS data sondes increased DO accuracy and longevity by reducing the environmental effects of fouling. Optical DO probes have further improved data reliability. The user is therefore advised to consult the metadata for sensor type information and to exercise caution when utilizing rapid pulse / Clark type sensor DO data beyond the initial 96-hour time period. Potential drift is not always problematic for some uses of the data, i.e. periodicity analysis. It should also be noted that the amount of fouling is very site specific and that not all data are affected. If there are concerns about fouling impacts on DO data beyond any information documented in the metadata and/or QAQC flags/codes, please contact the Research Coordinator at the specific NERR site regarding site and seasonal variation in fouling of the DO sensor.

**Depth Qualifier:**

The NERR System-Wide Monitoring Program utilizes YSI data sondes that can be equipped with either vented or non-vented depth/level sensors.  Readings for both vented and non-vented sensors are automatically compensated for water density change due to variations in temperature and salinity; but for all non-vented depth measurements, changes in atmospheric pressure between calibrations appear as changes in water depth.  The error is equal to approximately 1.02 cm for every 1 millibar change in atmospheric pressure, and is eliminated for vented sensors because they are vented to the atmosphere throughout the deployment time interval.

Beginning in 2006, NERR SWMP standard calibration protocol calls for all non-vented depth sensors to read 0 meters at a (local) barometric pressure of 1013.25 mb (760 mm/hg).  To achieve this, each site calibrates their depth sensor with a depth offset number, which is calculated using the actual atmospheric pressure at the time of calibration and the equation provided in the SWMP calibration sheet or digital calibration log.  This offset procedure standardizes each depth calibration for the entire NERR System.  If accurate atmospheric pressure data are available, non-vented sensor depth measurements at any NERR can be corrected.

In 2010, the CDMO began automatically correcting Depth/Level data for changes in barometric pressure as measured by the reserve’s associated meteorological station during data ingestion. These corrected Depth/Level data are reported as cDepth and cLevel, and are assigned QAQC flags and codes based on QAQC protocols. Please see sections 11 and 12 for QAQC flag and code definitions.

**NOTE: older Depth data cannot be corrected without verifying that the depth offset was in place and whether a vented or non-vented depth sensor was in use. No SWMP data prior to 2006 can be corrected using this method.** The following equation is used for corrected Depth/Level data provided by the CDMO beginning in 2010:

((1013-BP)\*0.0102)+Depth/Level = cDepth/cLevel.

**Salinity Units Qualifier:**

In 2013, EXO sondes were approved for SWMP use and began to be utilized by reserves. While the 6600 series sondes report salinity in parts per thousand (ppt) units, the EXO sondes report practical salinity units (psu). These units are essentially the same and for SWMP purposes are understood to be equivalent, however psu is considered the more appropriate designation. Moving forward the NERR System will assign psu salinity units for all data regardless of sonde type.

**Turbidity Qualifier:**

In 2013, EXO sondes were approved for SWMP use and began to be utilized by reserves. While the 6600 series sondes report turbidity in nephelometric turbidity units (NTU), the EXO sondes use formazin nephelometric units (FNU). These units are essentially the same but indicate a difference in sensor methodology, for SWMP purposes they will be considered equivalent. Moving forward, the NERR System will use FNU/NTU as the designated units for all turbidity data regardless of sonde type. If turbidity units and sensor methodology are of concern, please see the Sensor Specifications portion of the metadata.

**Chlorophyll Fluorescence Disclaimer:**

YSI chlorophyll sensors (6025 or 599102-01) are designed to serve as a proxy for chlorophyll concentrations in the field for monitoring applications and complement traditional lab extraction methods; therefore, there are accuracy limitations associated with the data that are detailed in the YSI manual including interference from other fluorescent species, differences in calibration method, and effects of cell structure, particle size, organism type, temperature, and light on sensor measurements.

**10) Coded variable definitions –**

Sampling station: Sampling site code: Station code:

Tivoli North Bay TN hudtnw

Tivoli South Bay TS hudtswq

Bear Mountain BM hudbmwq

Stony Creek SC hudscwq

Norrie Point NP hudnpwq

**11) QAQC flag definitions –**

QAQC flags provide documentation of the data and are applied to individual data points by insertion into the parameter’s associated flag column (header preceded by an F\_). During primary automated QAQC (performed by the CDMO), -5, -4, and -2 flags are applied automatically to indicate data that is missing and above or below sensor range. All remaining data are then flagged 0, passing initial QAQC checks. During secondary and tertiary QAQC 1, -3, and 5 flags may be used to note data as suspect, rejected due to QAQC, or corrected.

-5 Outside High Sensor Range

-4 Outside Low Sensor Range

-3 Data Rejected due to QAQC

-2 Missing Data

-1 Optional SWMP Supported Parameter

0 Data Passed Initial QAQC Checks

1 Suspect Data

2 *Open - reserved for later flag*

3 Calculated data: non-vented depth/level sensor correction for changes in barometric pressure

4 Historical Data: Pre-Auto QAQC

5 Corrected Data

**12) QAQC code definitions** –

QAQC codes are used in conjunction with QAQC flags to provide further documentation of the data and are also applied by insertion into the associated flag column. There are three (3) different code categories, general, sensor, and comment. General errors document general problems with the deployment or YSI datasonde, sensor errors are sensor specific, and comment codes are used to further document conditions or a problem with the data. Only one general or sensor error and one comment code can be applied to a particular data point, but some comment codes (marked with an \* below) can be applied to the entire record in the F\_Record column.

General Errors

GIC No instrument deployed due to ice

GIM Instrument malfunction

GIT Instrument recording error; recovered telemetry data

GMC No instrument deployed due to maintenance/calibration

GNF Deployment tube clogged / no flow

GOW Out of water event

GPF Power failure / low battery

GQR Data rejected due to QA/QC checks

GSM See metadata

Corrected Depth/Level Data Codes

GCC Calculated with data that were corrected during QA/QC

GCM Calculated value could not be determined due to missing data

GCR Calculated value could not be determined due to rejected data

GCS Calculated value suspect due to questionable data

GCU Calculated value could not be determined due to unavailable data

Sensor Errors

SBO Blocked optic

SCF Conductivity sensor failure

SCS Chlorophyll spike

SDF Depth port frozen

SDG Suspect due to sensor diagnostics

SDO DO suspect

SDP DO membrane puncture

SIC Incorrect calibration / contaminated standard

SNV Negative value

SOW Sensor out of water

SPC Post calibration out of range

SQR Data rejected due to QAQC checks

SSD Sensor drift

SSM Sensor malfunction

SSR Sensor removed / not deployed

STF Catastrophic temperature sensor failure

STS Turbidity spike

SWM Wiper malfunction / loss

Comments

CAB\* Algal bloom

CAF Acceptable calibration/accuracy error of sensor

CAP Depth sensor in water, affected by atmospheric pressure

CBF Biofouling

CCU Cause unknown

CDA\* DO hypoxia (<3 mg/L)

CDB\* Disturbed bottom

CDF Data appear to fit conditions

CFK\* Fish kill

CIP \* Surface ice present at sample station

CLT\* Low tide

CMC\* In field maintenance/cleaning

CMD\* Mud in probe guard

CND New deployment begins

CRE\* Significant rain event

CSM\* See metadata

CTS Turbidity spike

CVT\* Possible vandalism/tampering

CWD\* Data collected at wrong depth

CWE\* Significant weather event

**13) Post deployment information** –

**BM**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Date Deployed | Sonde Name | Sp Cond 1or10mS | ROX  DO | pH  7 | pH 10 | Turb 0 NTU | Turb 124NTU | Depth (m) | Chl 0 ug/l |
| 1/21/21 | Kingpin | -10 |  |  |  | 0 | -124 | 0 |  |
| 3/24/21 | Flash | 0.9887 | 100.5 | 7.17 | 10.12 | -1.73 | 118.33 | 0.05(0.054) | 0.03 |
| 4/21/21 | Elektra | 9.8182 | 101.7 | 7.05 | 10.1 | 0.27 | 131.27 | 0.166 | 0.05 |
| 5/19/21 | Daredevil | 9.665 | 101.4 | 7.13 | 10.17 | 3.5 | 126.77 | 0.146(0.15) | 0.04 |
| 6/23/21 | Batman | 9.7607 | 104.8 | 7.25 | 9.9 | 3.63 | 114.6 | 0.069(0.068) | -0.02 |
| 7/22/21 | C. America | 9.8207 | 100.4 | 7.12 | 10.02 | 1.15 | 75.91 | -0.025(-0.014) | 0.24 |
| 9/27/21 | Daredevil | 9.7615 | 99.9 | 7.11 | 10.13 | 0.13 | 165.68 | 0.015(0.014) | 0.1 |
| 10/15/21 | Batman | 9.7076 | 102.1 | 7.05 | 10.05 | 0.71 | 122.23 | 0.161(0.139) | -0.08 |
| 11/15/21 | Kingpin | 9.568 | 100.6 | 6.92 | 10.02 | 3.5 | 116.18 | 0 | 0.36 |
| 12/14/21 | Batman | 0.997 | 102.2 | 6.95 | 9.85 | -0.74 | 127.32 | 0.158(0.15) | -0.09 |

**NP**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Date Deployed | Sonde Name | Sp Cond 1.000 mS | ROX  DO | pH  7 | pH 10 | Turb 0 NTU | Turb 124NTU | Depth (m) | Chl 0 ug/l |
| 3/29/21 | C. America | 0.8894 | 102.2 | 7.13 | 10.3 | 0.05 | 127.2 | 0.037(0.054) | 0.66 |
| 5/26/21 | Gambit | 0.9371 | 100.5 | 7.27 | 10.04 | 5.77 | 126.27 | -0.412(0.027) | 0.08 |
| 7/15/21 | Daredevil | 1.0226 | 99.5 | 7.13 | 10.19 | 20.74 | 106.31 | -0.026(-0.014) | 6.48 |
| 8/31/21 | Loki | 0.9457 | 99.9 | 7.21 | 10.11 | 8.52 | 133.01 | -0.054 | 1.58 |
| 11/1/21 | Hawkeye | 0.9275 | 101 | 7.03 | 10.09 | 3.63 | 123.45 | 0.052(0.068) | 0.05 |
| 12/17/21 | Loki | 0.981 | 101.2 | 7.1 | 9.98 | -0.21 | 129.26 | 0.253(0.231) | -0.1 |

**SC**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Date Deployed | Sonde Name | Sp Cond 1.000 mS | ROX  DO | pH  7 | pH 10 | Turb 0 NTU | Turb 124NTU | Depth (m) | Chl 0 ug/l |
| 3/30/21 | Batman | 0.8675 | 99.8 | 7 | 9.91 | 1.83 | 125.8 | 0.041(0.054) | 0.24 |
| 5/28/21 | Kingpin | 0.9737 | 100.8 | 7.22 | 10.12 | 4.14 | 118.1 | 0.104(0.095) | 0.89 |
| 6/28/21 | Flash | 0.9604 | 99.9 | 7.21 | 9.9 | 6.29 | 126.5 | 0.081(0.082) | 0.13 |
| 8/5/21 | Iron Man | 0.9634 | 101.6 | 7.29 | 9.99 | 1.75 | 81.29 | 0.126(0.122) | 0.05 |
| 9/29/21 | Juggernaut | 0.4648 |  | 7.1 | 9.93 | 18.26 | 15.01 | -0.0050(0.0) | 0.07 |
| 10/28/21 | Daredevil | 0.9411 | 103.8 | 7.1 | 9.98 | 6.73 | 115.36 | 0.017(0.014) | 0.22 |

**TN**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Date Deployed | Sonde Name | Sp Cond 1.000 mS | ROX  DO | pH  7 | pH 10 | Turb 0 NTU | Turb 124NTU | Depth (m) | Chl 0 ug/l |
| 3/31/21 | Iron Man | 0.9956 | 100.6 | 6.94 | 9.99 | 0.65 | 127.63 | -0.085(-0.068) | 0.01 |
| 4/14/21 | Loki | 0.9971 | 101 | 7.07 | 10.11 | 7.65 | 146.05 | -0.095 | 0.81 |
| 5/12/21 | Iron Man | 0.963 | 100.1 | 7.32 | 10.34 | 3.72 | 126.49 | 0.02(0.027) | 0.16 |
| 6/15/21 | Hawkeye | 0.9842 | 99.5 | 7.16 | 10.08 | 7.42 | 99.44 | -0.032(-0.027) | 0 |
| 7/28/21 | Gambit | 0.9379 | 100.8 | 7.16 | 10.06 | 5.5 | 119.49 | -0.107(0.054) | 0.16 |
| 8/11/21 | Juggernaut | 0.9921 | 100.8 | 7.36 | 10.05 | 3.97 | 90.06 | 0.041(0.054) | 0.07 |
| 9/24/21 | Flash | 0.9356 | 101.3 | 7.17 | 9.85 | 2.54 | 133.21 | 0.17(0.054) |  |
| 11/9/21 | Aqua Man | 0.9687 | 101.4 | 6.96 | 9.98 | 3.71 | 114.6 | 0.0050(0.027) | 0 |

**TS**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Date Deployed | Sonde Name | Sp Cond 1.000 mS | ROX  DO | pH  7 | pH 10 | Turb 0 NTU | Turb 124NTU | Depth (m) | Chl 0 ug/l |
| 3/31/21 | Hawkeye | 0.9914 | 100.7 | 6.96 | 9.95 | 0.59 | 123.46 | -0.089(-0.068) | 0.33 |
| 4/15/21 | Gambit | 0.9604 | 101.7 | 7.1 | 10.05 | 1.37 | 117.46 | 0.081(0.095) | 0.45 |
| 5/12/21 | Flash | 0.9607 | 99.2 | 7.25 | 10.23 | 3.9 | 119.83 | 0.024(0.027) | 0.21 |
| 6/15/21 | Loki | 0.9818 | 99.8 | 7.25 | 9.76 | 12.84 | 128.84 | -0.023(-0.027) | 0.58 |
| 7/28/21 | Elektra | 0.9147 | 101 | 7.02 | 9.97 | 1.31 | 125.07 | 0.048(0.054) | 0.02 |
| 8/10/21 | Kingpin | 0.9716 | 101.5 | 7.21 | 9.97 | 4.38 | 88.32 | 0.049(0.041) | 0.4 |
| 9/24/21 | Elektra | 0.9732 | 100.2 | 7.03 | 9.87 | 157.0 | 134.24 | 0.052(0.041) | -0.02 |
| 10/28/21 | C. America | 0.9527 | 101.2 | 7.13 | 10.09 | 4.72 | 122.87 | 0.079(0.054) | 0.36 |
| 11/9/21 | Loki | 0.9727 | 99.3 | 6.99 | 9.89 | 4.28 | 0.15 | 0.0010(0.014) | 0.15 |

**14) Other remarks/notes –**

Data are missing due to equipment or associated specific probes not being deployed, equipment failure, time of maintenance or calibration of equipment, or repair/replacement of a sampling station platform. Any NANs in the dataset stand for “not a number” and are the result of low power, disconnected wires, or out of range readings. If additional information on missing data is needed, contact the Research Coordinator at the reserve submitting the data.

ChlFluor data were calibrated using a one-point calibration in 2021. The one-point calibration utilized deionized (DI) water and a zero point calibration. The YSI EXO operations manual and NERRS SWMP EXO Manual both call for a two-point calibration. Therefore all ChlFluor data are marked 1 SIC CSM during 2021.

Throughout 2021 there were deployments that extended beyond the 6-weeks allowed for EXO sondes at the sites. These deployments are marked CSM in the F Record column unless otherwise noted below. They are listed below:

**BM:**

**1/21**

**SC:**

**3/30**

**8/5**

**BM:**

As noted above the 1/21 deployment at BM went over the 6-week mark ending on 3/24. There was no post information available for this sonde. However, after comparing data to deployments around it along with field data we believe that data fit conditions. However, all parameters are marked 1 CSM after the 6-week mark.

pH data during the 3/24 deployment is odd. There is a chance that the probe was calibrated with contaminated standard but we cannot say with absolutely certainty. The pH data during this deployment are marked suspect.

Turbidity data during the following deployments were calibrated with standard that had gone bad. The turbidity data during these deployments are marked 1 SIC CSM.

7/21

9/24

**SC:**

On 4/5 1:15 the depth at SC became impacted but we believe was vandalism. We believe someone pulled on the cable causing it to sit at the wrong depth. The sonde sat at the wrong depth until the end of the deployment on 5/28 11:30. Depth data are marked 1 GSM CWD during this time. Other parameters do not appear to be impacted by the changed in depth and are marked 0 GSM CWD.

On 9/6 15:30 the depth at SC became impacted but we believe was vandalism. We believe someone pulled on the cable causing it to sit at the wrong depth. The sonde sat at the wrong depth until the end of the deployment on 9/29. Depth data are marked 1 GSM CWD during this time. Other parameters do not appear to be impacted by the changed in depth and are marked 0 GSM CWD.

pH data from 7/7 23:45 to 7/23 3:15 appear to be impacted by wastewater discharge upstream and a weather event. Because data fit conditions they are marked 1 GSM CDF.

Turbidity data during the following deployments were calibrated with standard that had gone bad. The turbidity data during these deployments are marked 1 SIC CSM.

10/27

**TN**:

Turbidity data during the 4/14 deployment may have been impacted by a contaminated standard used at the calibration but we cannot say for sure. Data are marked suspect during this deployment.

Turbidity data during the 6/15 deployment are odd. We believe they were impacted by a power failure and the sensors not being wiped for weeks. The data during this deployment are marked 1 SWM CSM.

Turbidity data during the 8/11 deployment appear to have been impacted by the probe being on the edge of failure. The data during this deployment were marked 1 SSM CSM.

**TS:**

Turbidity data from 8/25 to 9/25 are marked 1 SPC CBF. We believe the sonde was impacted by the length of the deployment and the fouling on the probes.

**Data Coded <CRE> or <CWE> Significant Rain or Significant Weather Event**

**TN, SC, TS**

**2/15 @ 9/15 – 2/16 @ 0:00**

**3/38 @ 9:30 – 3/29@ 0:00**

**7/17 @ 16:30 – 7/18 @ 0:00**

**10/24 @ 21:00 – 10/27 @ 00:00**

**11/12 @ 4:45 – 11/13 @ 00:00**

**NP**

**3/26 @ 02:15 – 3/26 @ 23:45**

**3/28 @ 15:00 – 3/29 @0:00**

**5/28 @ 15:00 – 5/30 @ 23:45**

**7/12 @ 12:30 – 7/13 @ 0:00**

**8/22 @ 12:45 – 8/23 @ 23:459/01 @ 07:15 – 9/02 @ 0:00**

**9/23 @ 17:30 – 9/25 @ 0:00**

**10/3 @ 22:30 – 10/5 @ 0:00**

**10/24 @ 21:00 – 10/27 @0:00**

**11/12 @ 04:45 – 11/13 @ 00:00**

**Data Code [GIC] No instrument deployed due to ice**

The following data are coded -2 [GIC]. During these times no instruments were deployed due to thick ice at the sampling locations

**SC:**

**1/1 @ 00:00 – 3/30 @ 14:00**

**12/7 @ 10:15 – 12/31 @ 23:45**

**TN:**

**1/1 @ 00:00 – 3/31 @ 10:45**

**12/7 @ 10:45 - 12/31 @ 23:45**

**TS:**

**1/1 @ 00:00 – 3/31 @ 10:45**

**12/7 @ 11:15 – 12/31 23:45**

**Data Coded [CIP] Surface Ice Present**

The following data are coded 0 [CIP]. This data indicates times where surface ice was observed at or in close proximity to the sampling locations. Data may also be coded once the temperature approaches 0C to encompass any ice presence that could not be physically observed. The presence of ice may have an impact on the data, however in its current quantity did not pose a threat to the safety of the instrumentation or prohibit instrument retrieval/deployment.

**BM:**

**1/21 @ 12:15 – 3/9 @ 10:30**

**NP:**

**1/6 @ 08:15 – 03/10 @ 16:00**

**Data Coded [CDA] DO Hypoxia**

**SC**

At numerous points throughout the summer months, flow in Stony Creek is greatly reduced occasionally resulting in DO hypoxia. These events are usually remedied by rain storms and return back to normal levels in the fall.

**Data Coded [GOW] Sonde out of Water and [GSM] (CLT)**

At numerous points during the year, stream flow conditions are low enough that the sonde depth port emerges from the water surface. When the sonde was impacted by low water but not out of the water data were marked <1> [GSM] (CLT). If data for other parameters show signs of emerging as well, data will be coded as <-3>[GOW].