RFA 04310

UNH Study of Dissolved Oxygen in the Lamprey River
Quality Assurance Project Plan

August 13, 2004
FINAL

Prepared by:

Jonathan Pennock, Ph.D.
Marine Program
University of New Hampshire
24 Colovos Road
Durham, NH 03824

Phil Trowbridge
NHEP/NHDES Project Officer
Department of Environmental Services
29 Hazen Drive, PO Box 95
Concord, NH 03302-0095

Project Manager: 8-13-04
Signature / Date
Jonathan Pennock, Ph.D., UNH

Project QA Officer: 8/17/04
Signature / Date
Jaimie Wolf, UNH

NHDES Quality Assurance Manager: 8/23/04
Signature / Date
Vincent Perelli, NHDES

NHEP/NHDES Project Officer: 8/23/04
Signature / Date
Phil Trowbridge, NHEP/NHDES

USEPA Project Officer: 8/31/04
Signature / Date
Jean Brochi, US EPA Region I

USEPA QA Manager: 08-30-04
Signature / Date
for Arthur Clark, US EPA Region I

A2 – Table of Contents

List of Appendices

Appendix A: Standard Operating Procedures for Dissolved Oxygen Sensor Calibration and Field Measurements
Appendix B: Field Data Sheets

List of Tables

List of Figures

A3 – Distribution List

Table 1 presents a list of people who will receive the approved QAPP, the QAPP revisions, and any amendments.

Table 1. QAPP Distribution List

QAPP Recipient Name	Project Role	Organization	Telephone number and Email address
Jonathan Pennock	Project Manager	UNH Marine Program	603-862-2921 jonathan.pennock@unh.edu
Jaimie Wolf	Project QA Officer	UNH JEL	603-862-2175 jswolf@christa.unh.edu
Jenn Greene	Lead Project Field Technician	UNH	603-862-2175 jenn.greene@unh.edu
Deb Lamson	Senior Field Technician	UNH	603-862-2175 dalamson@cisunix.unh.edu
Holly Abeels	Field Staff	UNH	603-862-2175 holly.abeels@unh.edu
Forbes Horton	Field Staff	UNH	603-862-2175 chorton@cisunix.unh.edu
Phil Trowbridge	NHEP/NHDES Project Officer	NHDES Watershed Management Bureau	603-271-8872 ptrowbridge@des.state.nh.us
Vincent Perelli	NHDES Quality Assurance Manager	NH DES Office of the Commissioner	603-271-8989 vperelli@des.state.nh.us
Jean Brochi	USEPA Project Manager	USEPA New England	617-918-1536 brochi.jean@epa.gov
Arthur Clark	USEPA Quality Assurance Officer	USEPA New England	617-918-8374 Clark.Arthur@epamail.epa.gov
Jennifer Hunter	NHEP Director	NH Estuaries Project	603-433-7187 jhunter@des.state.nh.us

Based on EPA-NE Worksheet #3

A4 – Project/Task Organization

The project will be completed by the UNH Marine Program. Jonathan Pennock will be the Project Manager for UNH. The Project Manager will be responsible for coordinating all program activities. The Project Manager will manage all field staff and be responsible for "stop/go" decisions for daily sampling runs. The Project Manager will also be responsible for resolving any logistical problems and communicating the results to the field staff.

At the end of the project, the Project QA Officer (Jaimie Wolf) will review the results of QA/QC checks and verify that the procedures of this QA Project Plan were completed. The QA Officer will be responsible for a memorandum to the Project Manager summarizing any deviations from the procedures in the QA Project Plan, the results of the QA/QC tests, and whether the reported data meets the data quality objectives of the project.

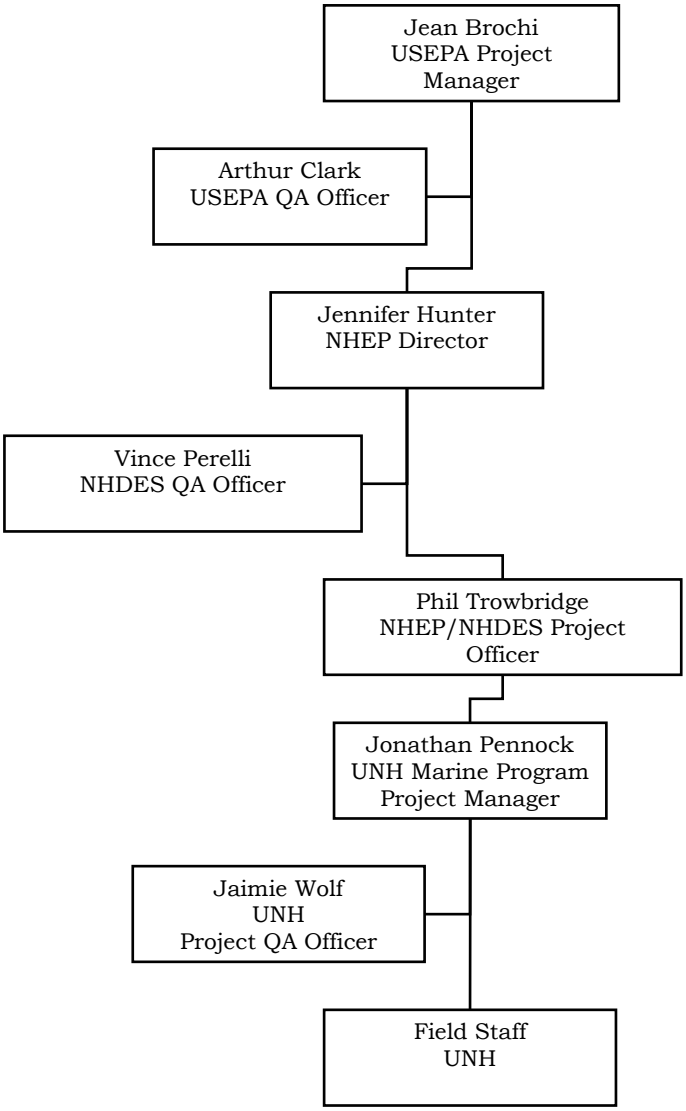
Field staff from the UNH Jackson Estuarine Laboratory include Jenn Greene, Deb Lamson, Holly Abeels, and Forbes Horton. Field staff will report any problems to the Project Manager and the Project QA Officer.

This work is being done under contract for the NH Estuaries Project (NHEP) so the Project Manager will be accountable to the NHEP/NHDES Project Officer (Phil Trowbridge) and the NHEP Director (Jennifer Hunter). Funding for the NHEP is provided by the U.S. Environmental Protection Agency.

The principal users of the data from this project will be the NHEP and NH Department of Environmental Services (NHDES). The Project Manager will submit a report to the NHEP/NHDES Project Officer and the NHEP Director at the end of the project with all the data and the QA Officer's summary report.

Figure 1 shows an organizational chart for this project.

Figure 1. Project organizational chart



A5 – Problem Definition/Background

Over the past three years, the datasonde in the Lamprey River has often recorded low dissolved oxygen in the water. It is unclear whether these readings are representative of the river or if they are caused by sensor error or the particular placement of the datasonde. In order to determine whether the low dissolved oxygen values are accurate, the NHEP has contracted with UNH to lead an investigation of dissolved oxygen in the Lamprey River.

Possible causes and/or contributing factors to the low DO are: oxidation of reduced nitrogen species in the water column, WWTF effluent that is carried upstream on flood tides, isolation of bottom water as a result of stratification, long residence time of water in the river (determine using DES Shellfish Program dye study data), and the potential for longer residence time of water at the sonde versus water in the main stem of the river as a result of the bathymetry and hydrography of the system. The Lamprey River has typically not had high chlorophyll-a or SAV that produce/consume DO.

The UNH study will first evaluate whether the readings at the sonde are representative of the rest of the river. Field teams will conduct a bathymetric survey of the river and then measure 2D or 3D transects of DO across and down the river and at the sonde location. If necessary, UNH will deploy a second sonde at the LMPSONDE location to confirm the readings (see Figure 2).

If the sonde appears to be representative of the river, UNH will work with the NHEP to develop a plan to assess what the causative factors (e.g. nutrient enrichment, organic enrichment, hydrography, etc…) of the low DO conditions are. If the sonde appears to not be representative of the river, UNH and NHEP will have to decide whether the sonde location should be moved. The sonde should not be moved in the middle of the 2004 season but could be redeployed in 2005.

A6 – Project/Task Description

This project has four main tasks:

1. Prepare QA Project Plan

A QA Project Plan for study will be produced by UNH which must be approved by the NHEP/NHDES Project Officer and EPA Region I.

2. Train Project Staff

The Project Manager will organize and implement a training session for field staff. The training session will cover SOPs for field instruments and field data sheets. The training will be based on the QA Project Plan document. Field staff will sign an attendance sheet for the training. The training will be completed before sampling begins.

3. Measure Dissolved Oxygen Using In-Situ and Field Sensors

UNH will develop the capability to transmit real-time dissolved oxygen data from the Lamprey River datasonde ("LMPSONDE") to the UNH Jackson Estuarine Laboratory. Field teams will conduct a bathymetric survey of the river and then measure 2D or 3D transects of DO from across and down the river and deploy a second sonde at the LMPSONDE location to confirm the readings. At least 5 transects of at least 10 DO casts will be completed between July and October. At least three of these transects will be completed when the real-time datasonde data indicate low dissolved oxygen in the river, if such conditions occur.

4. Prepare Final Report

The final work product will be a report to the NHEP interpreting the field data and answering the central question: Is the dissolved oxygen measured by the sonde in the Lamprey River representative of conditions throughout the river? The report will also contain an Excel spreadsheet containing quality assured results of the dissolved oxygen measurements taken for the study. The final report will describe any deviations from the protocols established in the QA Project Plan. The final report will contain a map and a table of coordinates showing the sampling locations and transects used for this study.

Table 2. Project Schedule Timeline

Activity	Dates (MM/DD/YYYY)		Product	Due Date
	Anticipated Date(s) of Initiation	Anticipated Date(s) of Completion		
QAPP Preparation	7/1/04	8/6/04	QAPP Document	8/6/04
Field Team Training	8/7/04	8/10/04	Training Documentation	8/10/04
Field sampling	8/11/03	10/31/04	Data	NA
Final project report preparation	11/1/04	3/31/05	Final report	3/31/05

Based on EPA-NE Worksheet #10.

A7 – Quality Objectives and Criteria

Table 3 summarizes the performance criteria for the dissolved oxygen measurements for this project. More details on each data quality objective are provided in the paragraphs below the table.

Table 3. Measurement Performance Criteria for Nutrient Samples

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance
Precision-Overall	RPD < 20%	Field Duplicates
Precision-Lab	NA – No laboratory samples	NA
Accuracy/Bias	Difference <0.5 mg/l	Check by a different DO sensor
Comparability	Measurements should follow standard methods that are repeatable	NA
Sensitivity	Not expected to be an issue for this project (see discussion below)	NA
Data Completeness	4 transects of dissolved oxygen measurements with at least 10 quality assured casts	Data Completeness Check

Based on EPA-NE QAPP Workbook for 3/19/02 DES QAPP writing class.

Precision: Relative percent difference (RPD) of field duplicate samples will be used as the index of precision for DO measurements. This is defined as the absolute difference between the duplicates divided by the average of the duplicates. Duplicate DO casts will be completed after every 10th cast or at least one per field day. Precision of the measurement at each depth in the cast will be analyzed by calculating the RPD using the equation:

$$RPD = \frac{|x_1 - x_2|}{\left(\frac{x_1 + x_2}{2}\right)} \times 100\%$$

where x_1 is the original sample concentration
x_2 is the duplicate sample concentration

Accuracy/Bias. Field crews will check the accuracy of the primary DO sensor by measuring the surface DO at the cast location with two sensors before conducting the cast. If there is a difference of more than 0.5 mg/l between the two sensors, the field crews will recalibrate the primary sensor before conducting the cast. If the two sensors cannot be rectified, the cast will be rejected.

Representativeness: Dissolved oxygen samples should be collected at multiple depths at each location to ensure representativeness of the entire water column.

Comparability: Standardized field and analytical methods will be used. These methods follow the current industry standard for the types of measurements being taken. Written SOPs will be followed for field and analytical measurements (see Appendix A). Standardized field data sheets will be used (see Appendix B).

Sensitivity. The analytical method, analytical/achievable method detection limit, and the analytical/achievable laboratory quantitation limits for this project are shown below in Table 4. The sensor sensitivity is less than the project action level.

Table 4: Surface Water Target Analytes and Reference Limits

Analyte	Analytical method	Project Action Level	Analytical/Achievable Method Detection Limit	Project Quantitation Limit
Dissolved Oxygen	None. Field sensors will be used	2 mg/l	0.1 mg/L	0.1 mg/L

Based on EPA-NE Worksheet #9b and 9c.

Completeness: This study will be deemed successful if data meeting the data quality objectives is obtained for 4 of the 5 transects and that each transect contains at least 10 casts (not including field duplicates).

A8 – Special Training/Certification

The Project Manager will organize and implement a training session for field staff. The training session will cover SOPs for field instruments and field data sheets (see Appendices A and B). The training will be based on the QA Project Plan document. Field staff will sign an attendance sheet for the training, which will be retained by the Project Manager and included in the final report. The training will be completed before sampling begins.

Table 5. Special Personnel Training Requirements

Project function	Description of Training	Training Provided by	Training Provided to	Location of Training Records
Water quality sampling and field measurements	Field method SOPs and field data sheets. This training will be conducted once at the beginning of the field season.	Project Manager	All field team staff	With Project Manager and included in final report to NHEP.

Based on EPA-NE Worksheet #7.

A9 – Documents and Records

QA Project Plan

The Project Manager will be responsible for maintaining the approved QA Project Plan and for distributing the latest version to all parties on the distribution list in section A3. A copy of the approved plan will be on file with the NHEP/NHDES Project Manager Coastal Scientist at the DES offices, 29 Hazen Drive, Concord NH.

Field Data Sheets

The field data sheets for this project are attached as Appendix B. Field crews fill in these forms during the day and return them to the Project Manager upon completion. The information will be transferred to an Excel Spreadsheet. The original forms will be retained on file by the Project Manager.

Reports to Management

The Project Manager will provide a final report to the NHEP/NHDES Project Officer. The final report is due on 3/31/05.

Archiving

The QA Project Plan and final report will be kept on file with the NHEP/NHDES Project Officer at DES in Concord for a minimum of 10 years after the publication date of the final report. The original field data sheets will be retained by the Project Manager for a minimum of 10 years.

B1 – Sampling Process Design

Field teams will conduct a bathymetric survey of the river and then measure 2D or 3D transects of DO from across and down the river and deploy a second sonde at the LMPSONDE location to confirm the readings. At least 5 transects of at least 10 DO casts will be completed between July and October. At least three of these transects will be completed when the real-time datasonde data indicate low dissolved oxygen in the river, as long as such conditions occur during the sampling period.

The number of measurements for this study is summarized in Table 6. Figure 2 illustrates the study area.

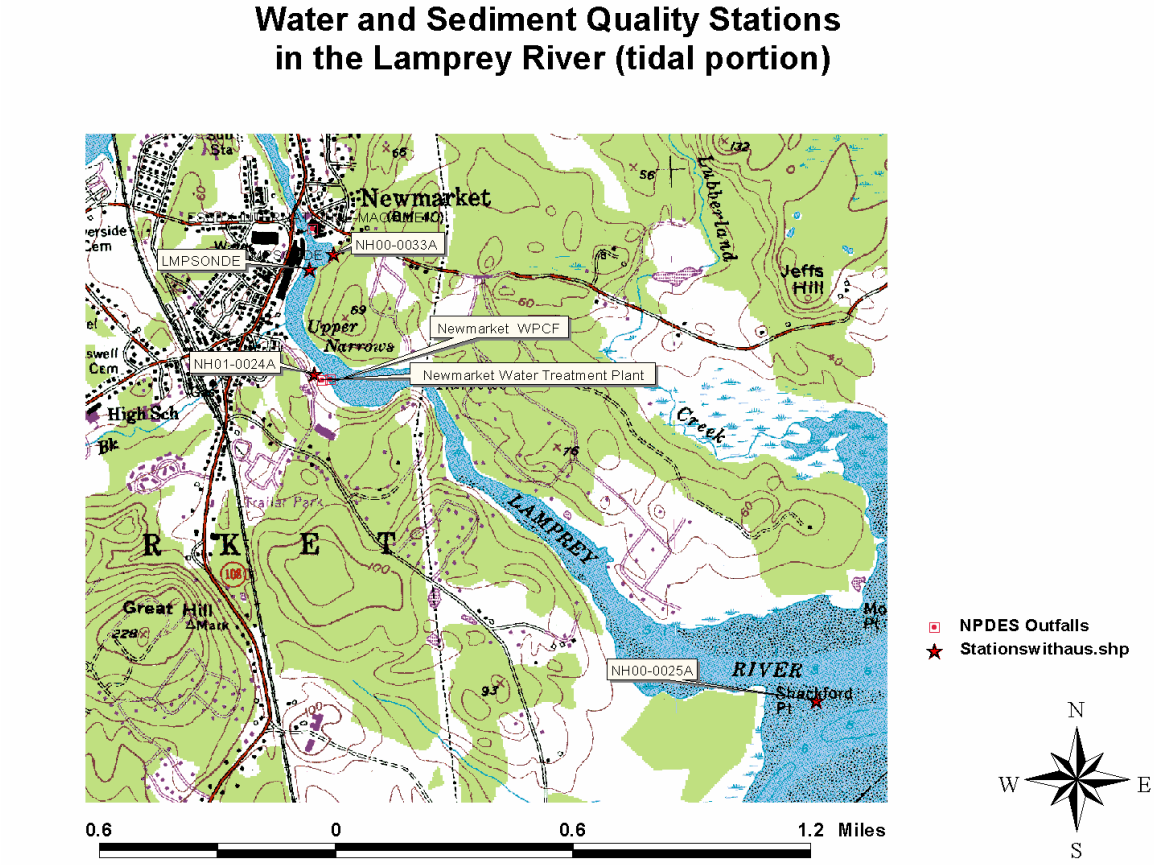
Table 6: Sampling design

Parameter	No. of sampling locations	Samples per event per site	Number of sampling events	Number of field duplicates	Number of bottle blanks	Total number to lab
Measured in the field						
Dissolved Oxygen	10 casts at a minimum	1 to 3 measurements per cast at a minimum	5 days	5 casts at a minimum (1 per sampling day)	Not applicable	measured *in situ*

Based on EPA-NE Worksheet #9c.

The preceding paragraph describes the plan for the experiment. The Project Manager is responsible for adjusting this plan as needed to handle any problems or non-standard situations that arise. The Project Manager will consult with the NHEP Coastal Scientist if any major problems are encountered such that the experimental design needs to be changed.

Figure 2: Lamprey River Study Area



B2 – Sampling Methods

Field measurements will be made from a boat at all the stations. Dissolved oxygen at multiple depths will be measured by completing a cast with the DO sensor. Only measurements from the down-cast should be recorded. The minimum number of measurements per cast is listed below:

- Shallow sites (<2 m): 1 measurement at mid-depth
- Nominal depths (2-5 m): 2 measurements at 0.5 m from the surface and at 1m intervals to 1 m from the bottom
- Deep sites (>5 m): 3 measurements at 0.5 m from the surface and at 1m intervals to 1 m from the bottom.

B3 – Sample Handling and Custody

No samples will be collected for this study

B4 – Analytical Methods

No analytical measurements will be made for this study.

B5 – Quality Control

For the dissolved oxygen measurements, the field duplicate measurements (every 10^{th} measurement) and the check between the two independent sensors before each cast will serve as the quality control. Section A7 describes how the data quality objectives will be evaluated.

The Project Manager will verify that the field crews are following the protocols correctly during the field sampling audit (see Section C1).

Databases of results will be checked for transcription errors and bad data using two methods. First, the entire data set will be printed and checked against the entries in each field or laboratory data sheet by the Project QA Officer. Second, the Project QA Officer will construct box-plots and other graphical tools (such as residual plots) to determine if there are outliers in the data set. The Project QA Officer will report any outliers to the Project Manager, who will determine whether these data should remain in the dataset.

B6 – Instrument/Equipment Testing, Inspection, Maintenance

Dissolved oxygen measurements will be made using field sensors: YSI 6600 Datasondes and a YSI-85 Multi-parameter Field Probe. No special decontamination procedures are needed for the DO measurements. Field teams are responsible for reporting sampling method problems to the Project Manager who is responsible for taking corrective action. Field teams will follow the SOP for using and calibrating the DO sensors in Appendix A.

B7 – Instrument/Equipment Calibration and Frequency

See section B6.

B8 – Inspection/Acceptance Requirements for Supplies and Consumables

No supplies or consumables will be used in this study.

B9 – Non-direct Measurements

Not applicable. No non-direct measurements will be used for this project.

B10 – Data Management

Field data will be recorded on standard field data sheets (see Appendix B) and transferred to Excel data files, which will be transferred to the NHEP/NHDES Project Officer as part of the final report. The NHEP/NHDES Project Officer will be responsible for uploading the data to the NHDES Environmental Measurement Database (STORET compatible). Management of hardcopy data and documents is described in Section A9.

C1 – Assessments and Response Actions

In order to confirm that field sampling, field analysis and laboratory activities are occurring as planned, the Project Manager and field staff shall meet, after the first sampling event, to discuss the methods being employed and to review the quality assurance samples. At this time, all concerns regarding the sampling protocols and analysis techniques shall be addressed and any changes deemed necessary shall be made to ensure consistency and quality of subsequent sampling. The Project Manager will have the authority to resolve any problems encountered. Assessment frequencies and responsible personnel are shown in the following table.

Table 7. Project Assessment Table

Assessment Type	Frequency	Person responsible for performing assessment	Person responsible for responding to assessment findings	Person responsible for monitoring effectiveness of corrective actions
Field sampling audit	Once after first sampling day	Project Manager	Project Manager	Project Manager

Based on EPA-NE Worksheet #27b.

C2 – Reports to Management

The Project Manager will provide a final report to the NHEP/NHDES Project Officer. The final report will answer the questions listed in Section A6(4). Data from the final report will be used in the 2006 §305(b) Water Quality Assessments.

D1 – Data Review, Verification and Validation

The Project Manager will be responsible for reviewing and verifying the data according to the procedures listed in Section D2.

D2 – Verification and Validation Procedures

The Project QA Officer will prepare a memorandum to the Program Manager summarizing any deviations from the procedures in the QA Project Plan and the results of the QA/QC tests. The Project QA Officer will review all field data sheets and final computer data files for completeness and quality as described in Section B5 based on the criteria described in Section A7. The Project QA Officer will also *affirmatively* verify that the methods used for the study followed the procedures outlined in this QA Project Plan. If questionable entries or data are encountered during the review process (see methods in Section B5), the Project QA Officer will contact the appropriate personnel to determine their validity.

The Project Manager will review the memorandum from the QA Officer to see if there have been deviations from the QA Project Plan. Any decisions made regarding the usability of the data will be left to the Project Manager, however the Project Manager may consult with project personnel, the NHEP Project Manager, or with personnel from EPA-NE, if necessary.

D3 – Reconciliation with User Requirements

Any problems with the data analysis and interpretation will be reconciled by the Project Manager after consultation with New Hampshire Estuaries Program staff. The overall goal of the project is to understand the spatial and temporal heterogeneity of dissolved oxygen in the Lamprey River. Therefore, regardless of the whether the individual data quality objectives are met, the project will be considered a success if the final report is able to provide credible evidence for spatial or temporal heterogeneity. Limitations in the data will be clearly defined for potential end users in all reports produced.

References

None

Appendix A

National Estuarine Research Reserve System-Wide Monitoring Program (*SWMP*)

YSI 6-Series Multi-Parameter Water Quality Monitor Standard Operating Procedure

Version 3.0

December 2000

INTRODUCTION

This document outlines the standard operating procedures (SOP) for the collection of data using YSI 6000 and 6600 Multi-Parameter Water Quality Monitors (sondes) for the National Estuarine Research Reserve's (NERR) System-Wide Monitoring Program (SWMP). **This SOP does not replace the YSI 6-Series manual**, **the CDMO Operations Manual, nor the YSI 6-Series Data Review and Editing Protocol of the CDMO Operations Manual,** thus the user must become familiar with procedures in these manuals. The purpose of the SWMP SOP is to standardize instrument handling, maintenance, calibration, deployment, and post deployment procedures for the NERRS SWMP. **The procedures in this SOP are the MINIMUM requirements for operating the YSI 6-Series instruments; therefore all NERR sites must follow these procedures.** Participating NERR sites may undertake additional procedures to 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.) Pre-deployment, II.) Deployment, III.) Retrieval, IV.) Post deployment, V.)YSI 6-Series Lab Calibration, Deployment, and Retrieval Log sheet (Tracking Sheet), VI.) Viewing and Printing the PC6000 or ECOWatch Graph, and VII.) Probe care and storage**.**

The SOP is designed to help research coordinators and technicians carry out the water quality data collection at their site, minimize the collection of inaccurate data, and ensure consistent operating procedures. As you use this document and the associated tracking sheet, keep notes on what changes you would like to see that could streamline the procedure without jeopardizing the quality of the data we are collecting. Bring these comments to the annual NERRA Workshop. If you have any question or comments about this document, contact **Chuck Nieder @ (845)758-7013 or email at wcnieder@gw.dec.state.ny.us**.

I. PREDEPLOYMENT

Before the instrument can be deployed it must be calibrated and several maintenance steps performed. The instrument should be visually inspected for any abnormalities, such as a cracked pH probe or cracked bulkhead. A **YSI 6-Series Lab Calibration, Deployment, and Retrieval Log sheet** (Tracking Sheet) must be completed for each instrument calibration, deployment, and retrieval procedures (see section V).

I.A: Probe Calibration Procedures:

During the calibration of the probes **NEVER** accept any calibrations that you have been given a warning message on. You must determine the cause of the problem, correct the problem, and recalibrate the probe before deploying the instrument. Standards must be active (check expiration date) and fresh for all calibrations. Previously used standards may be used to rinse probes but must not be used to calibrate. Discard and replace all expired standards. Calibrations should only be done with a PC (e.g., desktop, laptop, palmtop). The DM610 will automatically accept the turbidity calibration which can lead to a calibration corruption (see section I.A.6). Therefore the DM610 should only be used to transfer or collect data.

System diagnostic parameters (e.g., DO charge, ISE charge, conductivity cell constant) are found in different menus depending on which 6-Series instrument you are using (6000 or 6600). For

the 6000, most are found in the "Diagnostics" menu. For the 6600, most are found in the "Cal-Constant" menu which you get to by selecting "Advanced" on the "Main" menu.

I.A.1.a: Dissolved Oxygen

The dissolved oxygen membranes are to be replaced before each deployment. The oxygen probe needs to rest for a minimum of 6 hours (12 hours is optimal) after the membrane is changed to allow the probe to stabilize electro-chemically. Calibration must be done in the following order:

1. Replace DO membrane;
2. Place probe (or sonde) in calibration cup with a wet sponge and let rest for 6-12 hours;
3. After 6-12 hours, run instrument in discrete sample mode until the DO % reading stabilizes. If the DO probe is working correctly, the past 24 numbers (one screen width) should be the same indicating the probe has stabilized (do not worry about the actual number, you have not calibrated the probe yet);
4. Calibrate the DO sensor following YSI's instructions for 100% air saturation calibrations.
5. Check the DO charge and gain. For the 6000: look for these in the "Diagnostics" screen. For the 6600: the DO gain is in the "Cal-constants" screen; the DO charge must be added to the report menu (remember to remove this from the report menu prior to programming). DO charge should be in the range of 25-75 counts. Counts below this range indicate low electrolyte or a tear in the membrane and counts above may be due to oxidation of the electrodes.
6. Perform a high/low transmission test. Start another discrete sampling. If the %saturation is at or above 100% and then drifts down (or slightly up) to 100%, the probe is functioning properly. If the %saturation is very low or negative and then climbs to 100%, the probe is failing due to reverse polarity of the electrodes. If this happens, the probe is either in dire need of a reconditioning or will need to be replaced. Record either pass/fail on tracking sheet. **Do not deploy the probe if it fails this test. The data will not be valid.**

I.A.1.b.: YSI Alternate method (not required for NERR SWMP).

The following method is not required but is recommended for NERR sites that exchange instruments during deployment (therefore will have no data gaps) and have the technical support to spend more time operating the instruments.

The above protocol (I.A.1.a.) is sufficient for collecting data at the accuracy we are striving for and will also identify a faulty probe. The benefits of this alternate method are to: 1) provide additional time to identify a faulty probe prior to deployment; 2) allow a greater stability to the DO probe; and 3) provide additional data prior to deployment (6 to 12 hours of data) which can aid in the determination of the cause of invalid data.
Calibration procedures must be done in the following order:

1. Replace the DO membrane;
2. Place the sonde in the calibration cup with a wet sponge and wait five minutes. Calibrate the DO sensor. After calibration confirm that the charge, gain, and high/low transition tests pass (see section I.A.1.a). Record diagnostic numbers on the tracking sheet. NOTE: this is only a DO calibration check, the final probe calibration will be completed after the probe rests with the new

membrane for 6 to 12 hours;
3. Calibrate pH (I.A.4);
4. Calibrate depth (I.A.2);
5. Calibrate conductivity (I.A.5);
6. Calibrate turbidity (I.A.6);
7. After calibration is completed, begin the unattended sampling for 6 to 12 hours before deployment. This will allow the DO probe to stabilize. Just prior to deployment, calibrate the DO probe one last time (this can be done with the sonde still in unattended mode). Do not run the sonde in discrete mode for 12 hours as an alternative. The pre-deployment data that will now be in the data record will be a valuable tool to identify problems encountered during deployment.

I.A.2: Depth/Pressure

The depth sensor is calibrated to sea level or level of your lab. **CAUTION:** When calibrating the 6600 with vented depth you must use a vented cable during the calibration procedure. Failure to do so will result in a 3-4 meter shift in the water depth.

I.A.3: Temperature

The temperature probe does not require calibration.

I.A.4: pH

Check the ISE charge (pH mV) before calibration:
For 6000: check the "Diagnostics" screen.
For 6600: pH mV must be added to the report menu then run discrete sampling. Remember to remove pH mV from report before programming.

For both instruments, the ISE charge (pH mV) in pH 4 is 180 $\pm$40mV, in pH 7 is 0 $\pm$40mV and pH 10 is -180 $\pm$40mV. Analog voltages above or below may indicate a problem with the sensor or the sonde. Note the diagnostic milli-volt numbers on tracking sheet. Note the span between the 7 and 10 pH milli-volt numbers and confirm that all meet specifications.

Buffer solutions of pH 7, 10, (or 4 depending on anticipated range of pH measurements) for the two point pH calibration are purchased pre-made from a scientific supply house. Old solutions can be used for rinsing probes, but guard against cross contamination of solutions. The pH calibration solutions are certified at a temperature of 25^{o}C (see bottle label), and calibrations far outside of this range should be avoided.

I.A.5: Salinity and / or Conductivity

The salinity and conductivity standards are obtained from filtered seawater taken from the local area and analyzed using an osmometer (or counter top meter) OR should be purchased from a chemical supply company. After a correct calibration, the conductivity cell constants should be 4.6 - 5.45 as seen in the "Diagnostics" or “Cal-Constants”screen. Also note any change between

the last calibration and the cell constant of the most recent. A probe that suddenly goes out of range usually means that either the standard used was contaminated, the probe had a trapped air bubble, or not enough standard was used to cover the vent hole on the side of the sensor.

I.A.6: Turbidity

You are no longer required to record Aux adc or turbidity offset. Though important diagnostic numbers for a YSI technician, these numbers mean very little to the end user of the instruments. If these numbers are indicative of a problem, the end user will already have received an error message when they try to calibrate the probe.

Do not use plastic beakers or opaque plastics for this calibration. Best results are obtained using **glass beakers** where you can see into the standard and watch for air bubbles near the optics and also check to make sure the wiper parks 180^{o} from the optics. The probe face must be kept a minimum of 1 inch from the container bottom. Calibrations should also only be done over a **flat black surface since glare can interfere with the probe reading.**

Carefully check the set screw on the turbidity wiper block for tightness and inspect wiper sponge for wear and color (the wiper should be white). It is recommended that the wiper be changed before all deployments. For turbidity, the calibration software setting should be 1 wipe (the default), but may need to be increased depending on fouling. The averaging interval for turbidity should be the default of 8. Turbidity calibration solutions are purchased at 100, 200, 800, or 1000 NTU concentrations (other NTU standards can be special ordered). Two-point turbidity calibrations may not be needed at every deployment and all should only be performed in the lab**.** YSI recommends that the two-point calibration only be done once a month (or when drift is evident). Low end (0.0 NTU) calibrations are the most critical and must be done for every deployment.

CAUTION: It is possible to corrupt the internal turbidity calibration constant of the instrument. Once this is done, **slightly negative or positive values will be recorded for 0.0 NTU (greater than +/- 2.0 NTU)**. This corruption occurs when either the probe is not clean, an air bubble intercepts the light beam, or the 0.0 NTU standard is contaminated when you accept the calibration for 0.0 NTU. Care is therefore essential to insure the standard is clean and nothing is interfering with the probe (hence the need to use clear glass when calibrating turbidity). Once the calibration constant has been corrupted, you will need to contact YSI to reset (the YSI technician can walk you through the procedure). Until this is done, all future calibrations will be inaccurate and all turbidity data collected will be erroneous. In the PC environment you are given a choice to accept the calibration, however, using the DM610 you are not given this acceptance step so it is easier to cause this internal corruption problem when calibrating turbidity with the DM610.

CAUTION: Never accept a calibration when the message "high probe off-set" appears. This indicates that either the sensor is malfunctioning or the standard is contaminated.

II. DEPLOYMENT

II.A.: Pre-Deployment Settings

When programming for unattended sampling, specify the site description to include information

such as location, month, day, and year. The sample interval is to be set for readings to be taken every 30 minutes or less. If less than 30 minutes, readings must be taken in an even multiple of 30 (1, 3, 5, 6, 10 or 15 minutes) since you are responsible for reporting 30 minute data to the CDMO. Time convention used must be Local Standard Time and sampling must start on the half hour. Parameters measured must include: temperature, specific conductance, salinity, dissolved oxygen saturation, dissolved oxygen concentration, depth, pH, and turbidity. It is also recommended you collect battery voltage during the deployment since these data can help identify an electrical short (battery voltage data will not be submitted to the CDMO). After entering the program, check the battery voltage, battery life, and memory in the "set-up information" screen. If the battery life or memory is not sufficient for the length of the deployment, take appropriate action such as changing batteries or deleting files (format flash disk). The YSI 6-Series operates best with single use alkaline batteries. **Rechargeable alkaline batteries** can be used effectively, however, NERR sites using these must **test the batteries under load before every use** to ensure they are providing maximum power to the instruments. In order to test the batteries under load, the site will need a battery tester (approx. $15.00) and will have to closely track all the batteries being used (track the number of times they have been recharged). Also, if you use rechargeable alkaline batteries be sure to select this option in the sonde setup menu. Using rechargeable batteries will not save on battery costs but will save on number of batteries disposed of.

II.B.: Deployment Methods

All sondes are to be deployed so that the probes stay submerged at low tides and are at a fixed distance off the bottom to allow for tidal and flow amplitude measurements. Suggested methods include a perforated PVC (or other plastic) tube attached to a pile of bridge abutment or a steel cage resting on the bottom (be sure probes are 0.25 to 0.5 meter off bottom). If you use a perforated tube, this tube must be periodically inspected for fouling and cleaned. The length of time the instrument is deployed is dependent on the rate of fouling at your site. This will range from less than a week to up to three weeks.

III. RETRIEVAL

Retrieve the sonde from the water and visually examine the probes for fouling and damage. Gently clean the sonde of debris and place it in a secure container that will prevent any severe vibrations to the unit during transportation.

IV. POST DEPLOYMENT

IV.A.: Post Deployment Calibration Check

In the laboratory a calibration check must be performed on **oxygen, conductivity, and pH probes before cleaning** and on the **turbidity probe after cleaning (to prevent contamination of the 0.0 NTU standard)**. Rinse each probe in the calibration standard (previously used is acceptable) and then compare the readings in fresh calibration standard with the instrument in discrete sample mode. Also, if previously used standards (that have **NOT** been contaminated with even DI water) are used to check calibrations, ensure these standards are never used for the primary calibrations (section I.A.). To check if the DO saturation calibration strayed, place the sonde in a calibration cup with a wet sponge, allow adequate time for the air to become saturated and temperature to stabilize (15 minutes to 2 hours depending on sonde temperature), and record the percent saturation. Post calibration checks should be done for DO %, depth, specific

conductance/salinity, turbidity, and pH.

IV.B.: Probe Cleaning

Prior to or after the sonde is cleaned the data may be uploaded to a Personal Computer (PC) or YSI 610DM and then uploaded into a PC.

Once the post deployment calibration check is completed the sonde body and probes should be completely cleaned. Remove the sonde guard and clean all of the sensors according to the instructions in the YSI 6-Series Operations Manual. You need to pay extra attention to the instructions below.

IV.B.1: pH Probe

This probe should be removed from the guard to insure adequate cleaning. If fouling is not a problem, you may not need to do this for every deployment. These probes are also easily cracked so care must be taken during the cleaning process. Although cleaning with DI water is acceptable, YSI recommends cleaning this probe with tap water to ensure a full probe life.

IV.B.2.: DO/Cond/Temp

If significant solid material has built up near the threads of the probe, the probe should be removed from the bulkhead and cleaned. Remove the old DO membrane and inspect the probe surface. If silver electrodes show significant darkening, follow the instructions to resurface the probe face with a fine sandpaper disk found in the 6035 DO reconditioning kit. Alternatively, you can use 2400 grit sandpaper. When you change the dissolved oxygen membrane, be careful not to touch the surface of the membrane that covers the probe. Clean the conductivity sensor with the brush provided in the maintenance kit. Wet the cavities and brush, then brush both cavities several times and rinse thoroughly with water (you can also brush the cavities under running water).

IV.B.3.: Turbidity

Inspect the turbidity wiper and replace if worn. Under normal use, the wiper will last up to 30 days of deployment time but excess fouling will shorten the life of the wiper. A dirty or disintegrating wiper is likely to cause incorrect parking of the wiper assembly during deployment. Also, a disintegrated wiper sponge may come dislodged during deployment.

V. YSI 6-Series LAB CALIBRATION, DEPLOYMENT, and RETRIEVAL LOG SHEET (Tracking Sheet)

One of the attached tracking sheets must be filled out with every instrument deployment. This sheet will aid in data QA/QC procedures and help identify faulty equipment. After completion, this sheet, along with the PC6000 or ECOWatch graph (section VI) should be reviewed by the NERR staff in charge of SWMP at the site (in most cases this will be the research coordinator). Careful review of these two documents is vitally important to NERR staff in identifying anomalous data and faulty sondes/probes.

VI. VIEWING and PRINTING the PC6000 or ECOWatch GRAPHS

The final step in data collection is to view and print the PC6000/ECOWatch graph of all data collected during the deployment and look for patterns and outliers that can identify faulty probes and instruments (see Appendix B of the CDMO Operations Manual). This graph must be kept with the YSI 6-Series Lab Calibration, Deployment, and Retrieval Log Sheet (tracking sheet). Both the tracking sheets and these graphs will be your best tools during the QA/QC processing of the data.

CAUTION: Always note the scales which are automatic by default in these programs and can mask a problem with the data set if you assume a linear scale from 0 (zero) to the probes acceptable maximum measurement.

VII. PROBE CARE AND STORAGE

Most of the probes, especially pH and DO, have a limited life span. The pH probes have a maximum life of 2 years (rarely longer), so any pH probes over 1 year old are near needing replacement. If probes will not accept calibrations or are slow to respond to standards, suspect aging. DO and pH probes also have a limited shelf life, so do not purchase replacements too far in advance. Dissolved oxygen probes have a life expectancy of 2-3 years.

VII.A.: Storage

The procedure for storage is different for short-term (1 month or less) or long-term (greater than 1 month).

VII.A.1.: Short-term Storage

For short term storage, it is important to keep the probes moist but not immersed in water. Keep probes attached to the sonde and place the sonde in approx. 0.5in of water (not distilled) in the calibration cup. A moist sponge can be used in place of the 0.5in of water.

VII.A.2.: Long-term Storage

Dissolved oxygen/conductivity/temperature and dissolved oxygen probes should be stored with membrane and electrolyte in place and place sonde in a water filled transport or calibration cup (it is important to ensure that water completely covers the DO sensor). If the probe is removed from the sonde, it should be stored with membrane and electrolyte in place and submerged in water (the conductivity cells should also be submerged). The pH probe should be removed from the sonde and stored with the pH storage cap containing 2-4 molar KCL or buffer (check manufacturers specifications). No special precautions are necessary for the turbidity probe or depth/level probes.

SWMP YSI 6-Series LAB CALIBRATION, DEPLOYMENT, and RETRIEVAL LOG

I: Calibration:

Date (MM/DD/YY):_____ **Datalogger ID**:_____ **Conductivity ID**:_____

Check Time (LST) (circle one): YES NO **Turb. Probe ID:**_____ **DO Probe ID:**_____

Battery Volts:_____ (change if below 10.0 volts) Changed Batteries: Y N

Calibration: (enter standard) DO%:_____ error message:_____

pH (7 and 10):_____ error message:_____

Spec. Cond. :_____ error message:_____

Turbidity (1 or 2 pt.):_____ error message:_____

Depth (remove from cup):_____ error message:_____

DO Membrane Changed: Y N ; Turbidity Wiper Changed: Y N ; Wiper parks ~180^{o} from optics: Y N

Record the following diagnostic numbers after calibration:

Conductivity Cell Constant	_____	(range 4.6 to 5.45)
DO Charge	_____	(range 25 to 75)
DO Gain	_____	(range 0.8 to 1.7)
DO hi/lo transmission test	pass / fail	
pH MV Buffer 7	_____	(range 0 to ± 40 MV)
pH MV Buffer 10	_____	(range -180 MV ± 40MV)

Notes:_____

II: Programming:

Format flash disk or deleted files (circle one): YES NO Disk Free Space:_____(K)

Parameters: date, time, temp (C), SpCond (mS/cm), Sal (ppt), DOSAT%, DO (mg/L), Depth (m), pH, Turb (NTU), Batt (V)

Datalogger filename (ssmmddyy) or (_____):_____

Sampling interval: 30 min. Other:_____

Sampling duration: _____ days

Start Date (mm/dd/yy):__ __/__ __/__ __ | End Date (mm/dd/yy): __ __/__ __/__ __

Start Time (HH:MM):__ __:__ __ | End Time (HH:MM):__ __ :__ __

III: Deployment:

Site: _____

Date (mm/dd/yy): __ __/__ __/ __ __ Time (HH:MM, LST):__ __ :__ __

Weather:_____ Tide: Flood, Ebb, Slack_High, Slack_Low

Notes:_____

IV: Datalogger Retrieval:

Date (mm/dd/yy): __ __/__ __/__ __ Time (HH:MM, LST):__ __ :__ __

Weather:_____ Tide: Flood, Ebb, Slack_High, Slack_Low

Notes:_____

V: Post Deployment File Retrieval:

PC6000 format file retrieved to 610-DM or PC; **Filename:**_____**.dat** (if use 610-DM)

PC6000 format file uploaded to PC, exported as *.csv file to hard drive and floppy.

Filename:_____**.csv**

Print out PC6000/EcoWatch Graph of Data: Y N If no, why:_____
Notes:_____
___
_____
___

VI: Post Deployment Calibration Check: List new standards used:_____
DO% (100.0):_____ pH(7.0):_____ Depth (0.0m):_____
Turbidity. (0.0NTU):_____ SpecCond (_____mS/cm):_____ **or** Salin. (_____ppt):_____
Batt(V):_____
Probes need to be serviced or replaced by YSI:_____
_____
_____
Notes:_____
___
_____
___
_____
___

VII: ATTACH TRACKING SHEET TO PC6000/ECOWatch GRAPH AND SUBMIT TO SWMP MANAGER FOR REVIEW

SWMP YSI 6-Series LAB CALIBRATION, DEPLOYMENT, and RETRIEVAL LOG

I: Calibration:

Date (MM/DD/YY):_____ **Datalogger ID**:_____ **Conductivity ID**:_____
Check Time (LST) (circle one): YES NO **Turb. Probe ID:**_____ **DO Probe ID:**_____
Battery Volts:_____ (change if below 10.0 volts) Changed Batteries: Y N
Calibration: (enter standard) DO%:_____ error message:_____
pH (7 and 10):_____ error message:_____
Spec. Cond :_____ error message:_____
Turbidity (1 or 2 pt.):_____ error message:_____
Depth (remove from cup):_____ error message:_____
DO Membrane Changed: Y N ; Turbidity Wiper Changed: Y N ; Wiper parks ~180° from optics: Y N
Record the following diagnostic numbers after calibration:
Conductivity Cell Constant _____ (range 4.6 to 5.45)
DO Charge _____ (range 25 to 75)
DO Gain _____ (range 0.8 to 1.7)
DO hi/lo transmission test pass / fail
pH MV Buffer 7 _____ (range 0 to ± 40 MV)
pH MV Buffer 10 _____ (range -180 MV ± 40MV)
Notes:_____
_____
_____

II: Programming:

Format flash disk (circle one): YES NO Disk Free Space:_____(K)
Parameters: date, time, temp (C), SpCond (mS/cm), Sal (ppt), DOSAT%, DO (mg/L), Depth (m), pH, Turb (NTU), Batt (V)
Datalogger filename (ssmmddyy) or (_____):_____
Sampling interval: 30 min. Other:_____
Sampling duration: _____ days
Start Date (mm/dd/yy):__ __/__ __/__ __ | End Date (mm/dd/yy): __ __/__ __/__
Start Time (HH:MM):__ __:__ __ | End Time (HH:MM):__ __ :__ __

III: Deployment:

Site: _____
Date (mm/dd/yy): __ __/__ __/ __ __ Time (HH:MM, LST):__ __ :__ __
Weather:_____ Tide: Flood, Ebb, Slack_High, Slack_Low
Notes:_____
_____

IV: Datalogger Retrieval:

Date (mm/dd/yy): __ __/__ __/__ __ Time (HH:MM, LST):__ __ :__ __
Weather:_____ Tide: Flood, Ebb, Slack_High, Slack_Low
Notes:_____
_____

Field Calibration Check (complete if performed)

	Deploy	Retrieve
DO (mg/L)		

V: Post Deployment File Retrieval:

PC6000 format file retrieved to 610-DM or PC; **Filename:_____.dat** (if use 610-DM)
PC6000 format file uploaded to PC, exported as *.csv file to hard drive and floppy.
Filename:_____.csv
Print out PC6000/EcoWatch Graph of Data: Y N If no, why:_____
Notes:_____
___
_____
___

VI: Post Deployment Calibration Check: List new standards

used:_____
DO% (100.0):_____ pH(7.0):_____ Depth (0.0m):_____
Turbidity. (0.0NTU):_____ SpCond(_____mS/cm):_____ **or** Salin. (_____ppt):_____ Batt (V):_____
Probes need to be serviced or replaced by
YSI:_____
_____
___
Notes:_____
___
_____
___
_____
___

VII: ATTACH TRACKING SHEET TO PC6000/ECOWatch GRAPH AND SUBMIT TO SWMP MANAGER FOR REVIEW

Appendix B

GREAT BAY SWMP STATION LOG SHEET

Station: _____ ***Lat Deg:Lat Min***: _____:_____

Date: _____ ***Lon Deg:Lon Min***: _____:_____

Time:_____

Tide: ***Low*** ***High*** ***(Circle One)***

CTD / YSI

	Depth	*Temp*	*Salinity*	*%SAT*	*DO*
Surface YSI-85					
Surface YSI-6600					

Environmental Conditions

Cloud Cover	**Precipitation**	**Tide Stage**	**Wave Height**	**Wind Direction**	**Wind Speed**

Bottle Cast Data

	Nutrient/TSS Bottle ID	*DON/PON Bottle ID*	*(Additional Sample)*	*(Additional Sample)*
Surface				

LiCor PAR Measurements *(Cross off Depths Where Measurements are Taken/Stored; Make a Minimum of 6 Measurements)*

Depth (cm): 10 25 50 75 100 125 150 175 200

250 300 350 400 450 500 550 600 650

700 750 800 850 900 950 1000 1050 1100

1200 1300 1400 1500

Bottom Depth:

Comments