9-2013

The General QAPP for Long Island Sound Volunteer Coastal Monitoring (with Adoption Form)

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The General QAPP for Long Island Sound Volunteer Coastal Monitoring

For Coastal Water Quality Monitoring, Estuarine and Wetland Biomonitoring
and Habitat Assessments, and Marine Introduced Species Monitoring

Version 09.2013

Funded by and Prepared for:

Long Island Sound Study
and
New England Interstate Water Pollution Control Commission

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Project Partners:

The Norwalk Maritime Aquarium, University of Connecticut
Save the Sound, Citizen's Campaign Fund for the Environment

September 2013

Contents

Acknowledgements

This General QAPP was written by Dr. Jamie Vaudrey (Department of Marine Sciences, University of Connecticut) in 2013 as part of a project funded by the Long Island Sound Study and New England Interstate Water Pollution Control Commission. The format and content of the QAPP is based on a 2006 QAPP developed by Jerry Schoen (Massachusetts Water Watch Partnership) and Barbara Warren (Salem Sound Coastwatch) under contract with the Massachusetts Office of Coastal Zone Management: *Massachusetts Volunteer Coastal Monitoring General Quality Assurance Project Plan (QAPP), Version 1.1, For Water Quality Monitoring, Wetland Biological Assessments, and Marine Introduced Species Monitoring*. The format and content have been heavily modified to reflect a focus on coastal monitoring, versus Schoen and Warren's greater focus on freshwater assessments.

i. How to Use This QAPP

"The Quality Assurance Project Plan (QAPP) outlines the procedures a monitoring project will use to ensure that the samples participants collect and analyze, the data they store and manage, and the reports they write are of high enough quality to meet project needs." (*The Volunteer Monitor's Guide to Quality Assurance Project Plans*, US EPA 1996).

Guidance on establishing monitoring goals and methods can be found in *Volunteer Estuary Monitoring. A Methods Manual. 2nd Edition. US EPA and Ocean Conservancy* (http://water.epa.gov/type /rsl/monitoring/index.cfm, or use the internet search terms "EPA volunteer monitoring"). *The General QAPP for Long Island Sound Volunteer Coastal Monitoring* (this document) is designed to streamline the process of writing a QAPP for Monitoring Programs in the Long Island Sound area. This document does not replace guidance on developing a program and is not sufficient as a stand-alone document to guide the initial development and sample design process for a monitoring program.

In general, program planning and development of *The General QAPP Adoption Form* should begin approximately five to six months prior to beginning the actual sampling program.

The General QAPP for Long Island Sound Volunteer Coastal Monitoring (this document) is intended to serve all organizations participating in coastal water quality monitoring in the Long Island Sound area, and may also serve programs working in freshwater and other coastal zones. It contains baseline requirements to be met for data collection projects, as well as common objectives, parameters, methods and approaches for coastal and wetland chemical and biological monitoring. Some references are included for freshwater stream and river monitoring, in recognition of the fact that many coastal monitoring programs also work in the freshwater areas which feed the coastal zone. For freshwater monitoring, additional reference resources should be obtained.

The General QAPP for Long Island Sound Volunteer Coastal Monitoring can be adopted as the project QAPP by any group performing these types of monitoring activities. If not adopted, an individual project QAPP is typically required and *The General QAPP for Long Island Sound Volunteer Coastal Monitoring* may be useful as a template for a project-specific QAPP.

Individual groups adopting this General QAPP must follow these steps:

- Carefully review *The General QAPP for Long Island Sound Volunteer Coastal Monitoring* to ensure that the proposed monitoring program meets the stated requirements.

- Complete *The General QAPP Adoption Form* which was provided as an accompaniment to this document. This adoption form is made up of a series of templates that must be completed by each Monitoring Program. Instructions for completing each element of *The General QAPP Adoption Form* are found in the corresponding numbered chapter of *The General QAPP for Long Island Sound Volunteer Coastal Monitoring*.

  ➔ In this document, important instructions for completing *The General QAPP Adoption Form* are noted by an arrow (as shown here).

- Submit *The General QAPP for Long Island Sound Volunteer Coastal Monitoring* (this document) and *The General QAPP Adoption Form* for review and approval by the funding organization and the EPA.

Note: Groups that submit *The General QAPP Adoption Form* will not be required to develop a stand-alone QAPP for their respective projects.

I.1. SUMMARY OF REQUIREMENTS FOR ADOPTING THE GENERAL QAPP

The following is a summary of the requirements for adopting this QAPP. Each of these requirements is listed again in the appropriate section of *The General QAPP for Long Island Sound Volunteer Coastal Monitoring* (this document) to clearly identify what the Monitoring Program is required to consider when preparing *The General QAPP Adoption Form*.

1. *The General QAPP Adoption Form* must be submitted to the funding organization and the EPA for review and approval. *The General QAPP Adoption Form* has been approved once the signature approval page is completed.

2. *The General QAPP Adoption Form* must include a Table of contents containing the 24 QAPP elements.

3. *The General QAPP for Long Island Sound Volunteer Coastal Monitoring* and *General QAPP Adoption Form* must be distributed to major project participants.

4. The project must have an organized structure for effective communication and completion of tasks.

5. *The General QAPP Adoption Form* must document sufficient background knowledge for the project and methods employed, demonstrated need of the proposed project, and defined objectives for the project.

6. *The General QAPP Adoption Form* must include a brief project summary (i.e., what, when, where, why, and how data collection will occur), including a task calendar.

7. Clear and achievable data quality objectives for each parameter to be measured in the project must be stated in *The General QAPP Adoption Form*.

8. Instruction in all aspects of project data collection and management shall be provided to project participants (as applicable, depending on assigned tasks) and shall be documented, including trainee signatures, trainer(s), dates of training, and subject matter.

9. Documentation and record-keeping for all project activities related to data collection and data quality shall be implemented for the duration of the project.

10. *The General QAPP Adoption Form* must explain the general thought process behind the sampling plan, as well as provide detailed information regarding the "who, what, when, where, why, and how" that was generally referred to in i.1.6 (page 6).

11. *The General QAPP Adoption Form* must discuss measures to be taken to ensure the health and safety of project participants for the duration of the project.

12. *The General QAPP Adoption Form* must provide detailed information regarding how samples will be collected and preserved, as well as copies of standard operating procedures (SOPs).

13. The procedures used to label, transport, store, and track custody of samples must be explained in the project *General QAPP Adoption Form*.

14. All analytical methods used in the project shall be identified in *The General QAPP Adoption Form* and be based on standardized laboratory methods that are specifically referenced or contained in the project-specific *General QAPP Adoption Form*.

15. Project sampling shall include appropriate field and laboratory quality control samples to assess general data quality issues, as well as specific data quality objectives specified in A.7. of the project *General QAPP Adoption Form*.

16. The project shall include a systematic process for consistently checking, testing, and maintaining instruments and equipment for proper functioning.

17. All instruments used in the project shall be calibrated at a pre-determined frequency to ensure instrument accuracy and precision for the duration of the project (with logbook documentation).

18. The procurement, inspection, and acceptance of sampling, analytical, and ancillary project supplies shall occur in a consistent and timely manner.

19. *The General QAPP Adoption Form* shall provide detailed information for any non-project data used in developing and implementing *The General QAPP Adoption Form* or in any other way affecting the project.

20. As detailed in *The General QAPP Adoption Form*, the project shall include a data management system.

21. The project shall have a defined process for identifying and effectively addressing issues that affect data quality, personal safety, and other important project components.

22. The project shall include a reporting mechanism for project data. Reporting shall include raw data, QC data, and important metadata.

23. All project data, metadata, and quality control data shall be critically reviewed to look for problems that may compromise data usability.

24. *The General QAPP Adoption Form* shall explain how all project data and metadata are reviewed and approved as usable data (and as un-usable when the data are questionable for any reason).

25. *The General QAPP Adoption Form* shall describe a process whereby resulting data are compared to the planned DQOs in the project *General QAPP Adoption Form* and the results of this analysis are reported.

A. Project Management

"The elements in this group address the basic area of project management, including the project history and objectives, roles and responsibilities of the participants, etc. These elements ensure that the project has a defined goal, that the participants understand the goal and the approach to be used, and that the planning outputs have been documented."

– quoted from *EPA Requirements for Quality Assurance Project Plans (EPA QA/R-5)*

A.1. Title and Approval Page

General QAPP Adoption, requirement #1 (i.1.1; page 5): Before proceeding with project implementation, *The General QAPP Adoption Form* must be submitted to the funding organization and the EPA for review and approval. *The General QAPP Adoption Form* has been approved once the signature approval page is completed.

➔ See Section A.1. of *The General QAPP Adoption Form* for a Title and Approval Page Template.

A.2. Table of Contents

General QAPP Adoption, requirement #2 (i.1.2; page 5): The General QAPP Adoption Form must include a Table of contents containing the 24 QAPP elements.

➔ The *General QAPP Adoption Form* currently includes a table of contents (TOC). The TOC was created utilizing the "Styles" feature of Microsoft Word. "Styles" such as "Heading 1" and "Heading 2" were applied to the headings of the sections throughout the document. This signals to Word that these lines of text should be included in the TOC. This means that you can update the page numbers automatically, you do not need to renumber the TOC. To update the page numbers in the TOC, follow these steps:

- In Microsoft Word 2007, 2010, and 2013; on a PC: (1) The easiest method to update the TOC is to click press the "**Ctrl**" and "**A**" buttons simultaneously, then release – this will select all text in the document. Then press the "**F9**" key. (2) Alternatively, on the ribbon, select the "**References**" tab. In the "**Table of Contents**" group, you should see a button for "**Update Table**." Select this button and follow the on-screen prompts.

- In Microsoft Word 2003 and earlier; on a PC: Press the "**Ctrl**" and "**A**" buttons simultaneously, then release – this will select all text in the document. Then press the "**F9**" key to update all fields in the document.

- In Microsoft Word 2008 and 2011; on an Apple computer: (1) Hold down "**control**", click in the table of contents, and then select "**Update Field**" from the pop-up list. (2) Pressing "**F9**" will update all fields simultaneously. (3) In the "**Document Elements**" tab of the Ribbon, look in the "**Table of Contents**" group , you should see a button for "**Update Table**." Select this button and follow the on-screen prompts.

A.3. DISTRIBUTION LIST

General QAPP Adoption, requirement #3 (i.1.3; page 6): *The* General QAPP *for Long Island* Sound Volunteer Coastal Monitoring and General QAPP Adoption Form must be distributed to major project participants.

➔ Provide contact information in *The General QAPP Adoption Form*.

Required

- Monitoring Program Project Manager
- Monitoring Program Coordinator
- Monitoring Program Field Coordinator
- Monitoring Program Lab Coordinator
- Monitoring Program Data Management Coordinator
- Monitoring Program Quality Assurance Officer
- Technical Advisory Committee (TAC)
- Funding Agency Project Contact
- Funding Agency Technical Reviewer
- Funding Agency Quality Assurance Officer
- USEPA Quality Assurance Officer

Recommended

- Other project participants, contacts, data users
- Town/City Governance
- Conservation Commission
- Regional/Local Planning Office

A.4. PROJECT / TASK ORGANIZATION

General QAPP Adoption, requirement #4 (i.1.4; page 5): The project must have an organized structure for effective communication and completion of tasks.

➔ Provide names for each role described in Table 1. A table is provided in *The General QAPP Adoption Form*, section A.4.

➔ Review the organizational chart provided in section A.4. of *The General QAPP Adoption Form*.

Table 1: Project Organization (typical).
Key project personnel and their corresponding responsibilities.

Project Title/Responsibility
Monitoring Program Project Manager – Oversees all aspects of project that incorporate the monitoring program including: fiscal management, project objectives, data uses, program changes, etc.
Monitoring Program Coordinator (a.k.a. Monitoring Coordinator) – Volunteer recruitment and training, coordination with TAC. Develops *General QAPP Adoption Form*. Produces monitoring report. Produces or oversees outreach efforts, in coordination with project manager.
Monitoring Program Field Coordinator – Responsible for training and supervising volunteers in field work. Ensures field forms are properly filled out, samples and forms are transported to laboratories as needed; and performs QC checks to make sure procedures are followed or corrected as needed (in collaboration with project QC officer).
Monitoring Program Lab Coordinator – Makes arrangements with any lab(s) used to perform analyses according to QAPP. Ensures correct procedures are used, holding times are met, and adequate documentation is provided.
Monitoring Program Data Management Coordinator – Maintains the data systems for the program. Performs/oversees data entry and checks entries for accuracy against field and lab forms.
Monitoring Program Quality Assurance Officer – Runs Quality Assurance (QA) program. This person cannot be directly involved with field sampling or sample analysis.
Monitoring Program Volunteers – Sample, perform field analyses, assist in laboratory analyses and/or data entry.
Technical Advisory Committee (TAC) – Program oversight and advice.
Funding Agency Project Contact – Oversees grant administration and ensures reporting requirements are met.
Funding Agency Quality Assurance Officer – Reads QA reports, reviews *General QAPP Adoption Form*, confers with program QA officer on quality control issues that arise during the course of a monitoring program.
Funding Agency Technical Reviewer – Reviews General QAPP Adoption Form.
USEPA Quality Assurance Officer – Reviews General QAPP Adoption Form, as applicable.

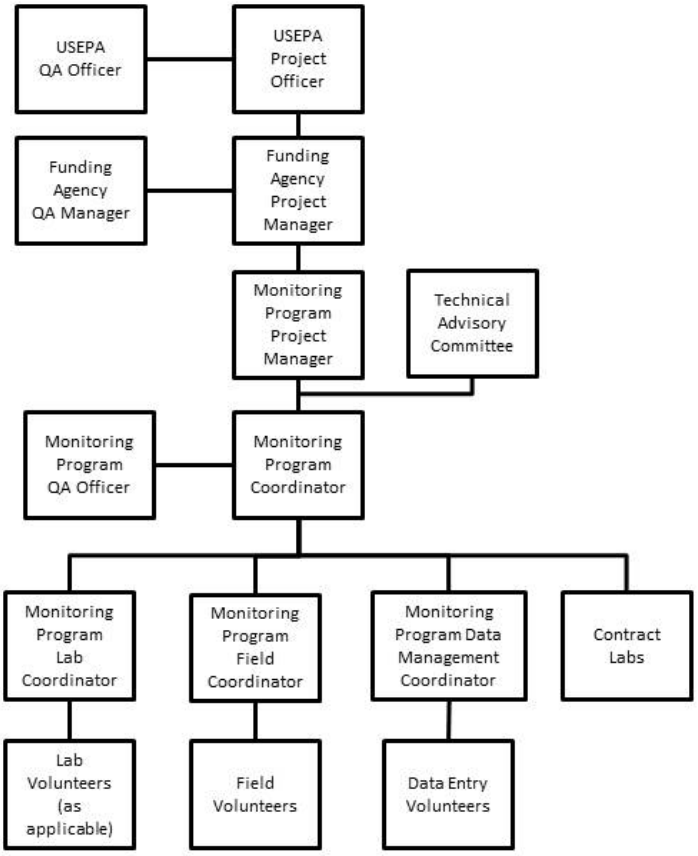

Figure 1: Typical Organizational Chart.
Lines between boxes indicate who communicates directly with whom.

A.5. PROBLEM DEFINITION / BACKGROUND

General QAPP Adoption, requirement #5 (i.1.5; page 6): *The General QAPP Adoption Form* must document sufficient background knowledge for the project and methods employed, demonstrated need of the proposed project, and defined objectives for the project.

➔ In section A.5. of *The General QAPP Adoption Form*, provide text describing the specific problem to be solved, decision to be made, or outcome to be achieved. Include sufficient background information to provide a historical, scientific, and regulatory perspective for this particular project. You may copy and paste text shown below into *The General QAPP Adoption Form*, if it is helpful in formulating your description. Also be sure to review the QAPPs of other monitoring organizations for typical writing style and level of detail (a few examples are in the packet of documents received with this QAPP).

The Long Island Sound Study (LISS) supports organizations that monitor coastal systems; coordinates such efforts with state priority projects; and gathers valuable information to support the protection and restoration of important aquatic habitats and natural resources. "The U.S. Environmental Protection Agency's (EPA) Office of Water encourages all citizens to learn about their water resources and supports volunteer monitoring because of its many benefits. Volunteer monitors build awareness of pollution problems, become trained in pollution prevention, help clean up problem sites, provide data for waters that may otherwise be unassessed, and increase the amount of water quality information available to decision makers at all levels of government. Among the uses of volunteer data are delineating and characterizing watersheds, screening for water quality problems, and measuring baseline conditions and trends." (As stated on EPA's Volunteer Monitoring Program website, http://water.epa.gov/type/rsl/datait/waters/georef/epasvmp.cfm, last accessed 2013.)

Historically, citizen groups active in coastal wetlands and water bodies have conducted monitoring programs including ground and surface water quality monitoring, wetland biological assessments, and monitoring for introduced species to support the protection and restoration of critical natural resources (e.g., beach and marsh habitats, coastal recreational areas, shellfish habitats, eelgrass beds, etc.). Coastal water bodies generally include the embayments and estuaries as well as brooks, streams, rivers, coastal ponds and coastal wetlands (salt and brackish marshes) that discharge into coastal waters.

This General QAPP addresses monitoring activities related to the following three coastal issues:

Coastal Water Quality Monitoring: Data collected from this effort may assist LISS in evaluating water bodies that have not yet been assessed, documenting water quality trends necessary for the designation of strategies to remediate the impairment, and evaluating water quality in areas where these strategies are already being implemented.

Estuarine and Wetland Biomonitoring and Habitat Assessment: Wetland biological assessments are a critical component of the evaluation of coastal development impacts on important aquatic habitats. Evaluation of these impacts requires not only the collection of water quality data, but also an assessment of the biological response of these systems to anthropogenic factors. These assessments may aid in establishing baseline conditions, measuring the scale of the impacts to these systems, and assessing the response of wetlands and estuarine habitats to restoration efforts.

Marine Introduced Species: Introduced (nonindigenous) species also pose a significant threat to coastal waters. As of 2005, Long Island Sound's coastal zone hosts between 50 and 90 identified invasive species (Long Island Sound Invasive Species List, available from Connecticut Sea Grant). While the economic losses associated with introduced species have been estimated at hundreds of millions to billions of dollars nationwide, very little effort has

been dedicated to monitoring for new infestations. Introduced species monitoring efforts allow the LISS to better understand vectors of introduction, analyze population dynamics, and eradicate new introductions before they spread.

Coastal monitoring programs typically include one or more of the following objectives:

1) **Provide quality-controlled data** that support the assessment and restoration of coastal watersheds and critical habitats through the implementation of programs such as:

    i) Under Section 305(b), states are required to periodically report on the quality of all water resources in the state and whether these waters are fully supporting water supply use, recreation activities and aquatic life. Reporting for these waters is submitted to the United States Environmental Protection Agency (US EPA) every two years. Section 303(d) requires states to identify waters of the state where water quality standards are not met and where uses are not supported. The Section 303(d) List includes those waters (and associated pollutants) that do not support uses, and which require development of a Total Maximum Daily Load (TMDL) strategy. Because the Section 303(d) List of Impaired/TMDL Waters is concerned with only impaired waters - and within the universe of impaired waters, only those impaired waters that can be addressed with a TMDL strategy - the Section 305(b) Report provides a more comprehensive assessment of statewide water quality.

    ii) Clean Water Act Section 319 projects - The 1987 amendments to the Clean Water Act (CWA) established the Section 319 Nonpoint Source Management Program. Section 319 addresses the need for greater federal leadership to help focus state and local nonpoint source efforts. Under Section 319, states, territories and tribes receive grant money that supports a wide variety of activities including technical assistance, financial assistance, education, training, technology transfer, demonstration projects and monitoring to assess the success of specific nonpoint source implementation projects.

    iii) Long Island Sound Interstate Aquatic Invasive Species Management Plan

    iv) CT DEEP and NY DEC Watershed Management Plans

    v) Long Island Sound Study's Comprehensive Conservation and Management Plan

    vi) Connecticut's and New York's Nonpoint Source Management Program

    vii) State Beach Monitoring Program

    viii) Coastal Habitat Restoration Programs

2) **Leverage the LISS's funds to increase the collection of quality data.** A primary goal of data collection is to produce data of known and documented quality, in support of state water body health assessments, Total Maximum Daily Load (TMDL) programs, municipal infrastructure improvements, Clean Water Act Section 319 projects, 305(b) water quality reports, other state and regional quality controlled databases, agency program decisions, local-level decisions, and public education on the condition of local waters and coastal habitats.

3) **Watershed/Wetlands health assessment.** The objective is to assess the ecological health and water quality status, relative to the attainment of designated uses as described in the Connecticut or New York Water Quality Standards and Classifications of selected surface waters and watersheds. Information objectives include addressing specific baseline data needs, monitoring for changes in watershed / wetlands health, and evaluating the need for restoration or mitigation efforts. These objectives will be met by collecting multiple samples per year, at fixed stations, for a given number of years.

4) **Pollution source identification and impact assessment.** Impacts may be positive (e.g., installation of a pollution control system) or negative (e.g. pollution). This objective is met in two stages: 1) source tracking: as necessary to locate suspected impacts, and 2) monitoring known/potential impacts with temporal or spatial bracketing of a particular impact on a schedule chosen to capture discharges and, for comparison purposes, periods when or locations where no discharge occurs, as appropriate.

5) **Marine introduced species assessments.** The objective is to monitor existing nonindigenous marine species and provide early detection of newly arrived species by gathering quantitative information on marine introduced species in a variety of coastal habitats. By collecting data on the location of marine introduced species, state agencies may be better able to determine the extent of a particular marine introduced species and possible methods for spread prevention and/or eradication.

6) **Public education and outreach.** The objective is to train and engage volunteers to develop a better understanding of the importance of water resources and to encourage their fellow citizens to take an active role in the preservation and restoration of their local water bodies and watersheds.

7) **Local infrastructure improvements**. The objective is to evaluate the performance of storm water infrastructure, such as settling basins, retention basins, conveyances, outfall pipes, etc.

8) **Other data use objectives**. Specify in *The General QAPP Adoption Form*

A.6. PROJECT / TASK DESCRIPTION

General QAPP Adoption, requirement #6 (i.1.6; page 6): *The General QAPP Adoption Form* must include a brief project summary (i.e., what, when, where, why, and how data collection will occur), including a task calendar.

➔ In section A.6. of *The General QAPP Adoption Form*, provide text describing the project or tasks included in the monitoring program. You may copy and paste text shown below into *The General QAPP Adoption Form*, if it is helpful in formulating your description. Note that section A.6.a. covers the specific types of sampling that will occur, A.6.b includes maps of the study area, and A.6.c includes a task calendar. *This discussion need not be lengthy or overly detailed, but should give an overall picture of how the project will resolve the problem or question described in A.5.*

For coastal water quality monitoring under this QAPP, data can be collected at regular intervals throughout the sampling season, the duration of which is determined by the project team. Some data (particularly macroinvertebrate and plant surveys) can be collected once during the sampling season. Other data can be collected monthly or weekly. April through October are the most common sampling months. In addition, some data may be collected continuously over a brief period of time, either using land-based or in-stream monitoring devices. Sites are selected to reflect representative, average conditions in a water body – at least one site per river reach of interest, lake, wetland, or coastal embayment; two or more for estuarine sampling. In stratified or deep water bodies, data can be collected vertically such that at least one sample is taken in each vertical segment of interest.

Some impact assessment monitoring may depart from this general schedule in order to temporally bracket discharge periods (e.g. during wet and dry events, before and after changes of land use, before and after installation of pollution control systems, etc.). Impact assessment monitoring of sites of interest can also be spatially bracketed (e.g. upstream/downstream of suspected pollution sources in rivers and tidal waters, near/far from sources in bays and wetlands). Where applicable, tidal cycle influence must be taken into account when conducting impact assessments.

Overview of data handling processes: In general, data are typically recorded on field and lab sheets and reviewed for quality control. Final data are transferred to computer spreadsheets and reports, and distributed to the project team (as applicable). The final data may be compared to state water quality criteria or, when no criteria exist, scientific literature, such as ecoregional nutrient criteria or indices provided in methods manuals. The Monitoring Coordinator will develop findings and conclusions, which can be incorporated into a study report for dissemination to the QAPP distribution list, the local press, and other stakeholders via paper or electronic media. Results may also be

disseminated at times throughout the sampling season via web sites, press announcements, or at informational kiosks at public water access locations, etc.

A.6.a. Sampling Types Covered by this General QAPP

➔ In *The General QAPP Adoption Form*, select the types of sampling included in the Monitoring Program.

The type of sample information that can be collected under this General QAPP includes:

- Water depth of the whole water column / sample site; and depth of sample location
- Temperature to determine the suitability of habitat for aquatic life and to determine if stratification occurs (e.g., when collected along depth profiles)
- Salinity to gauge its influence on coastal plant and animal communities and to determine stratification (e.g., when collected along depth profiles)
- Dissolved oxygen concentration and percent saturation to determine the amount of oxygen available for aquatic life and to determine if stratification occurs (e.g., when collected along depth profiles)
- Alkalinity and pH to determine if the waterbody is affected by acid deposition
- Secchi disk measurements for water clarity / transparency
- Light intensity at the location and depth of interest
- Chlorophyll-*a* concentrations as an estimate of algal populations
- Turbidity or total suspended solids (TSS) to evaluate the presence of suspended materials in the water column
- Nitrogen and phosphorus forms to measure nutrient levels
- Bacteria to evaluate health risks associated with recreation or shellfish consumption
- Presence of nonindigenous plants/animals to track the existence, spread, and/or success of removal efforts for invasive species
- Dinoflagellates and their toxic products to evaluate health risks associated with recreation or shellfish consumption (e.g. during Harmful Algal Blooms)
- Detection of optical brighteners / fluorescent whitening agents (FWAs), caffeine, and pharmaceutical and personal care product (PPCP) metabolites to indicate the presence of sewage
- Biological monitoring to determine the nature of plant and animal communities and their response to any changes in water quality or habitat condition.

A.6.b. Maps of Study Area

➔ In *The General QAPP Adoption Form*, provide maps of the study area.

The maps should include sufficient detail to locate the study site within a broader geographical areas. Maps should be include a reference scale. Proposed sampling stations should be indicated.

A.6.c. Annual Task Calendar

➔ In *The General QAPP Adoption Form*, complete the annual task calendar.

This represents a revolving calendar. Some tasks may continue into the following year (e.g. specimen identification, data interpretation and reporting). Specific details are located in the project-specific *General QAPP Adoption Form*.

Table 2: Example of an Annual Task Calendar
Anticipated Schedule (typical; variable, dependent on individual programs).

Activity	J	F	M	A	M	J	J	A	S	O	N	D
Kickoff meeting with project team	X											
Develop draft General QAPP Adoption Form	X	X										
Finalize General QAPP Adoption Form			X									
Meeting with agency representatives		X	X									
Equipment inventory, purchase, inspection, and testing	X	X	X									
Field training and database-related training session(s)			X	X	X	X						
Meeting with analytical laboratory		X	X	X								
Lab training sessions (in-house analyses)		X	X	X	X	X						
Sampling surveys				X	X	X	X	X	X	X		
Data entry					X	X	X	X	X	X	X	
Data review and validation					X	X	X	X	X	X	X	
Field audit(s)					X	X	X	X	X	X		
Lab audit(s)			X	X	X	X	X	X	X			
Draft report									X	X	X	
Final report										X	X	X
Data uploads to website	X	X	X	X	X	X	X	X	X	X	X	X
Other:												
Other:												

A.7. DATA QUALITY OBJECTIVES

General QAPP Adoption, requirement #7 (i.1.7; page 6): Clear and achievable data quality objectives for each parameter to be measured in the project must be stated in *The General QAPP Adoption Form*.

➔ In *The General QAPP Adoption Form*, select all methods that will be used to ensure that data quality objectives are met.

➔ Copy pertinent rows from Table 4 below into the table provided in *The General QAPP Adoption Form*, section A.7.

Taken together, precision, accuracy and bias, representativeness, comparability, completeness, and sensitivity comprise the major data quality indicators used to assess the quality of the program's data. A summary of criteria are provided in Table 3.

Definitions of these data quality indicator terms:

- **Precision** is the degree of agreement among repeated field measurements of the same indicator and gives information about the consistency of your methods. It is typically defined as relative percent difference, or RPD.

- **Accuracy** is a measure of confidence that describes how close a measurement is to its "true" or expected value; it includes a combination of random error (precision) and systematic error (bias) components of both sampling and analytical operations.

- **Bias** is the systematic or persistent distortion of a measurement process that causes errors in one direction.

- **Representativeness** is the extent to which measurements actually represent the true environmental condition. Parameters, site selection (including location of sampling point within the water column), time, and frequency of sample collection can all play a role in determining how representative a sample is.

- **Comparability** is the extent to which data can be compared between sample locations or periods of time within a project, or between different projects.

- **Completeness** is the comparison between the amount of valid or usable data the program originally intended to collect versus how much was actually collected. EPA Region 1 also expects an evaluation of critical samples that may require re-sampling even if the 80% goal has been achieved.

- **Sensitivity** is the capability of a method or instrument to discriminate between measurement responses representing different levels of the variable of interest.

Table 3: Measurement Performance Criteria

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Criteria
Precision – overall	RPD ≤ value indicated in Table 4	field duplicates
Precision – analytical	RPD ≤ value indicated in Table 4	analytical duplicates
Accuracy / Bias	85% ≤ recovery ≤ 115%	certified reference material lab fortified matrix (spikes)
Comparability	standard methods followed	NA
Completeness	data from surface and bottom at each station meet data quality objectives	data completeness check
Sensitivity	value ≥ IDL*	sample value check

* IDL = instrument detection limit. This is a reporting limit based on the lowest standard accurately analyzed in the analysis.

Precision - Typical precision objectives are listed in Table 4 (section A.7., page 20). Precision is often evaluated in the field by participants taking duplicate measurements for at least 5% of samples, where applicable. The frequency of field duplicate measurements for each parameter must be described as in Table 11 (section B.5., page 58).

Relative percent difference (RPD) of duplicate samples is used as one index of precision (Table 4). This is defined as the absolute difference between the duplicates divided by the average of the duplicates. The allowable RPDs for each parameter are provided in Table 9. A difference greater than the designated RPD requires further investigation of the sample run. If the difference is large enough, it indicates failure (unless the average of the two samples is less than 10 times the method detection limit), and results in reanalysis of the entire set of replicates from that station depth, unless there is a reasonable and supported explanation for the inconsistency. Duplicate precision will be analyzed by calculating the RPD using the equation:

$$RPD\ (\%) = |x1 - x2| \ / \ ((x1 + x2)/2) * 100$$

where x1 is the original sample concentration and x2 is the duplicate sample concentration.

The Microsoft Excel formula for calculating the RPD is:

$$= ABS(X1-X2) \ / \ ((X1+X2) \ / \ 2) * 100$$

where X1 is the original sample concentration and X2 is the duplicate sample concentration.

Accuracy and Bias - Typical accuracy objectives are listed in Table 4 (section A.7., page 20). Procedures used to test or ensure accuracy are described in Table 11 (section B.5., page 58). While training and audits help to ensure measurement accuracy and precision, quantitative

measures of accuracy for water quality monitoring are usually estimated using laboratory QC data (blank results, fortified matrix results, known QC samples, etc.). The accuracy of biological sample identifications and assessments can be verified via expert taxonomic review.

Representativeness - Most sampling sites are selected to be representative of the waterbody or in the case of hotspot monitoring, of the pollution source of interest. Sample collection timing and frequency is selected to capture data that are representative of target conditions (e.g. a range of water levels, weather, seasons, etc.).

Comparability - The comparability of the data collected can be assured by using known protocols and documenting methods, analysis, sampling sites, times and dates, sample storage and transfer, as well as laboratories and identification specialists; so that future surveys can produce comparable data by following similar procedures. Examples of typical procedures are available in the collection of Standard Operating Procedures (SOPs) provided as a packet of files accompanying this document.

Completeness - Project monitoring should attempt to maximize the completeness of the dataset. At least 80% of the anticipated number of samples are typically collected, analyzed and determined to meet data quality objectives for the project to be considered fully successful. In the end, however, any quality-controlled data are usually considered useful in some way. A report detailing the number of anticipated samples, number of valid results, and percent completion (number of valid samples/number of anticipated samples) for each parameter is typically produced.

Sensitivity – Typical sensitivity objectives are listed in Table 4 (section A.7., page 20). Sensitivity is the lowest detection limit of the method or instrument for each of the measurement parameters of interest. For analytical methods, these are the method detection limits (MDLs). For instruments (probes, kits, thermometers, GPS units, etc.), these are usually listed in the instrument manual as sensitivity or resolution.

Table 4: Data Quality Objectives for common parameters.

* indicates that the sensitivity varies based on the instrument used. Check the manual for the sensitivity (also called the resolution). For MDL of analytical methods, the analytical lab may provide different MDL values which will replace those shown in this table and in Table 9. Table 9 provides the references to standard methods defining MDLs. (MDL = method detection limit; RPD = relative percent difference)

Parameter	Units	Accuracy [a]	Precision [b] (RPD)	Approx. Expected Range	Sensitivity (Resolution or MDL)
Water Quality Parameters					
station depth	meters	+/- 0.1 (in general)	20%	0-15 meters	*

Parameter	Units	Accuracy [a]	Precision [b] (RPD)	Approx. Expected Range	Sensitivity (Resolution or MDL)
location by coordinates (GPS) -use NAD 83 coordinate system or note alternative at each data entry	degrees and decimal minutes (X^{o} X.XX') -or- decimal degrees (X.XXXXX)	+/- 20 feet with Wide Area Augmentation System (WAAS) enabled	Repeated readings to verify coordinates essentially the same	NA	*
temperature (thermometer)	degrees Celsius (^{o}C)	+/- 1	10%	0-35	*
temperature (meter, e.g. YSI, In-Situ, Hach, HydroLab)	degrees Celsius (^{o}C)	+/- 0.20	10%	0-35	*
salinity (refractometer)	ppt	+/- 1	20%	0-32 psu	*
salinity (meter, e.g. YSI, In-Situ, Hach, HydroLab)	psu (= ppt) (psu: practical salinity units)	± 0.1ppt or 1% of reading, whichever is greater	20%	0-32 psu	*
conductivity (meter, e.g. YSI, In-Situ, Hach, HydroLab)	µS/cm (freshwater) mS/cm (salt water) (S: Siemens)	+/- 1% of reading or 0.001 mS/cm, whichever is greater	20%	10–1000 µS/cm in fresh 0.8–55 mS/cm in salt water	*
dissolved oxygen concentration (titration kit)	mg/L O_2 (= ppm = g/m^3)	+/- 0.5	20%	0-14	0.5 mg/L
dissolved oxygen concentration / saturation (meter, e.g. YSI, In-Situ, Hach, HydroLab)	mg/L O_2 (= ppm = g/m^3) % saturation O_2	0 to 20 mg/L: ± 0.2 mg/L or 2% of reading, whichever is greater ± 2% sat or 2% of reading, whichever is greater	20%	0-14 mg/L 0-120%	*
pH	unitless	+/- 0.3	20%	4-10	0.1
alkalinity	mg/L $CaCO_3$ (= ppm = g/m^3)	80% - 120% recovery of lab fortified matrix (LFM)	20%	-5 to 150	2 mg/L
fecal coliform, *E. coli*, enterococci	coliform / 100 mL -or- MPN (MPN: most probable number)	blanks and negatives show no colonies, positives show colonies	30% RPD for log-transformed duplicate data	0-1,000,000	1 MPN/100 mL -or- lower reporting limit <10

Parameter	Units	Accuracy [a]	Precision [b] (RPD)	Approx. Expected Range	Sensitivity (Resolution or MDL)
turbidity	NTUs (NTUs: nephelometric turbidity units)	90-110% recovery of turbidity standard	+/- 0.5 NTU if less than 1 NTU or 20% RPD if more than 1 NTU	0-200	0.2 NTU
chlorophyll *a*	µg/L Chl *a* (= mg/m^3)	75%-125% recovery for lab QC sample (with known Chl *a* content)	+/- 2.0 if $\leq$ 15 µg/L or 20% if > 15 µg/L	0-30	<0.05 ug/L
water clarity (i.e. Secchi disk)	meters	+/- 0.1 meter (in general)	20% between two different readers for same "sample"	0-5	*
light intensity (e.g., Onset HOBO® Light sensor)	lumens m^{-2}	***complete for QAPP Adoption Form – device dependent***	***complete for QAPP Adoption Form***	***complete for Adoption Form***	*
photosynthetically active radiation (PAR)	umol quanta m^{-2} s^{-1}	***complete for QAPP Adoption Form – device dependent***	***complete for QAPP Adoption Form***	0–3000	*
total nitrogen - TN (organic + inorganic, all forms; unfiltered sample)	mg/L TN (= ppm = g/m^3)	80% - 120% recovery of lab fortified matrix (LFM)	30%	0-5	0.03 mg/L
total dissolved nitrogen - TDN (organic + inorganic, all forms; filtered sample)	mg/L TDN (= ppm = g/m^3)	80% - 120% recovery of lab fortified matrix (LFM)	30%	0-4.5	0.03 mg/L
total Kjeldahl nitrogen - TKN (sum of organic N, NH_3, NH_4^+)	mg/L TKN (= ppm = g/m^3)	80% - 120% recovery of lab fortified matrix (LFM)	30%	0-2	0.03 mg/L
ammonia - NH_3 (sum of NH_3, NH_4^+)	mg/L NH_3 (= ppm = g/m^3)	80% - 120% recovery of lab fortified matrix (LFM)	30%	0-1	0.02 mg/L
nitrate-nitrite – NO_X or NO_3^- + NO_2^- (sum of NO_3^-, NO_2^-)	mg/L NO_x (= ppm = g/m^3)	80% - 120% recovery of lab fortified matrix (LFM)	30%	0-2.5	0.02 mg/L
nitrite - NO_2^- (only NO_2^-)	mg/L NO_2 (= ppm = g/m^3)	80% - 120% recovery of lab fortified matrix (LFM)	30%	0-0.7	0.02 mg/L

Parameter	Units	Accuracy [a]	Precision [b] (RPD)	Approx. Expected Range	Sensitivity (Resolution or MDL)
dissolved inorganic nitrogen – DIN (sum of ammonia, nitrate, nitrite)	mg/L DIN (= ppm = g/m^3)	value calculated from multiple N analyses – see above from a filtered water sample	30%	0-4	0.02 mg/L
total inorganic nitrogen – TIN (sum of ammonia, nitrate, nitrite)	mg/L TIN (= ppm = g/m^3)	value calculated from multiple N analyses – see above from an unfiltered water sample	30%	0-4.5	0.02 mg/L
total organic nitrogen – TON (TN - TIN)	mg/L TON (= ppm = g/m^3)	value calculated from multiple N analyses – see above from an unfiltered water sample	30%	0-5	0.03 mg/L
dissolved organic nitrogen - DON (TDN - DIN)	mg/L DON (= ppm = g/m^3)	value calculated from multiple N analyses – see above from a filtered water sample	30%	0-4.5	0.03 mg/L
particulate nitrogen – PN (organic and inorganic N on particles)	mg/L PN (= ppm = g/m^3)	value calculated from multiple N analyses – see above -or- by analyzing the filter pad	30%	0-0.5	0.01 mg/L
total phosphorus – TP (sum of organic P, ortho-P, condensed P; unfiltered sample)	mg/L TP (= ppm = g/m^3)	80% - 120% recovery of lab fortified matrix (LFM)	20%	0-0.5	0.01 mg/L
total dissolved phosphorus – TP (sum of organic P, ortho-P, condensed P; filtered sample)	mg/L TDP (= ppm = g/m^3)	80% - 120% recovery of lab fortified matrix (LFM)	20%	0-0.5	0.01 mg/L
dissolved inorganic phosphate – PO_4^{3-} or DIP (primarily orthophosphate)	mg/L PO_4 mg/L DIP (= ppm = g/m^3)	80% - 120% recovery of lab fortified matrix (LFM)	20%	0-0.3	0.01 mg/L

Parameter	Units	Accuracy [a]	Precision [b] (RPD)	Approx. Expected Range	Sensitivity (Resolution or MDL)
detergents (CHEMets kit; Lamotte kit)	mg/L linear alkylbenzene sulfonate (EW325)	unknown	20%	0-3	
pharmaceuticals and personal care products (PPCPs), including caffeine [c]	ug/L	40-140% recovery for lab fortified matrix (LFM) and lab fortified blank (LFB) (analyte-specific)	20%	highly variable	variable (typically <5 ug/L for most chemicals)
DNA markers for human-specific strains of indicator bacteria [d]	present or absent	consistent meeting of expected results (human waste samples)	duplication of results for 10% of samples	NA	*
optical brighteners/ fluorescent whitening agents [e] (absorbent pad/UV light method)	qualitative: positive, moderately positive, weakly positive, non-detect	weakly positive or non-detect results for blank control pads	duplicate results within one qualitative unit.	non-detect through positive	qualitative
optical brighteners/ fluorescent whitening agents [e] (HPLC Quantitation method)	µg/L	40-140% recovery for Lab Fortified Blank (LFB)	30%	0.22-0.66 for OB 0.03-1.30 µg/l for FWA	variable (<0.5 ug/l preferred for all FWAs)
stream stage (height) measurement [f]	feet or meters, depending on staff gage type	+/- 0.1 foot (in general for staff gage reading)	10% between readings by two different volunteers	NA	*
precipitation	inches or cm, depending on rain gage type	+/- 0.1 inch (= 0.25 cm)	20% between two different gages for the same event	0-3 inches per event	*
tidal hydrology	nearest tenth of foot (nearest 3 cm)	NA	NA	NA	*
Wetland and Estuarine Biomonitoring					
macroinvertebrates	number of individual organisms; taxonomic name	all preserved specimens accurately identified to family or order level; taxonomic confirmation of voucher specimens by experts	standard laboratory procedures; 90% accuracy of identification when invertebrate scientific advisor examines a minimum of 10% of the original samples		undefined
nekton	number of individual organisms; taxonomic name	100% accuracy of identification evaluated by the scientific advisor(s)	undefined	NA	undefined

Parameter	Units	Accuracy [a]	Precision [b] (RPD)	Approx. Expected Range	Sensitivity (Resolution or MDL)
birds	number of individual organisms; taxonomic name	100% accuracy of identification evaluated by the scientific advisor(s)	undefined	NA	undefined
vegetation presence (grasses, sedges, eelgrass, macroalgae, etc.)	present or absent	100% accuracy of identification evaluated by the scientific advisor(s); taxonomic confirmation of voucher specimens by experts	undefined	0 = Absent 1 = Present	undefined
vegetation identification (grasses, sedges, eelgrass, macroalgae, etc.)	taxonomic name	All specimens identified to lowest possible taxonomic unit (e.g. genus, species) with positive taxonomic confirmation of voucher specimens by experts for 100% of samples for first crew survey (% for successive surveys dependent on initial QC)	undefined	0 = Absent 1 = Present	undefined
vegetation abundance (grasses, sedges, eelgrass, macroalgae, etc.)	percent cover (%) / quadrat (0.25 meter^2)	30% agreement among two separate evaluations; evaluate 10% of samples	30%	0-100	undefined
vegetation canopy height (grasses, sedges, eelgrass, macroalgae, etc.)	cm	field based: 30% agreement among two separate evaluations; evaluate 10% of samples lab based: 1 cm	5cm	1-150cm	undefined
vegetation density (grasses, sedges, eelgrass, macroalgae, etc.)	shoots or individuals per quadrat (0.25 meter^2)	undefined	undefined	0-500	undefined
vegetation biomass (grasses, sedges, eelgrass, macroalgae, etc.)	grams dry weight / m^2 (quadrat or grab, convert to m^2)	100% Accuracy of identification evaluated by the Scientific Advisor(s); confirmation of voucher specimens by experts	0.1g	0-1000	undefined

Parameter	Units	Accuracy [a]	Precision [b] (RPD)	Approx. Expected Range	Sensitivity (Resolution or MDL)
eelgrass shoot biomass	grams dry weight / shoot	100% Accuracy of identification evaluated by the Scientific Advisor(s); confirmation of voucher specimens by experts	0.1g	>0.1	undefined
eelgrass shoot morphology (leaf area)	cm^2	100% Accuracy of identification evaluated by the Scientific Advisor(s); confirmation of voucher specimens by experts	0.1cm	1-100	undefined
location and depth of deepwater and shallow water edge (of eelgrass bed)	meters from shore and meters below surface (water depth)	NA	1m	from shore: 0-1000; water depth: 0-15	undefined
presence/absence of eelgrass flowers and seeds	present or absent	100% Accuracy of identification evaluated by the Scientific Advisor(s); confirmation of voucher specimens by experts	undefined	0 = Absent 1 = Present	undefined
presence/absence of wasting disease	present or absent	100% Accuracy of identification evaluated by the Scientific Advisor(s); confirmation of voucher specimens by experts	undefined	0 = Absent 1 = Present	undefined
epiphyte and tunicate abundance on eelgrass blades	present or absent or percent cover (%) / quadrat ($0.25m^{2)}$	100% Accuracy of identification evaluated by the Scientific Advisor(s); confirmation of voucher specimens by experts		0 = Absent 1 = Present; or Trace (0-1), Low (2-30), High (31-100)	undefined
sediment type	qualitative	100% Accuracy of identification evaluated by the Scientific Advisor(s); confirmation of voucher specimens by experts	undefined	mud-fine sand-sand – shell - cobble-boulder/rock	qualitative
sediment grain size	% silt & clay % sand % gravel	50% sediment in the environment can be extremely variable	30% analytical precision of lab replicates	0-100	*

Parameter	Units	Accuracy [a]	Precision [b] (RPD)	Approx. Expected Range	Sensitivity (Resolution or MDL)
sediment organic content (loss-on-ignition method)	% organics	50% sediment in the environment can be extremely variable	30% analytical precision of lab replicates	0-50	*
land use	wetland buffers of 30 meters, 100 meters and 1 kilometer	NA	NA	NA	NA
Marine Introduced Species					
invertebrates - presence/absence	present/absent	100% accuracy to genus or species; taxonomic verification of voucher specimens by Scientific Advisor(s).	undefined	NA	undefined
invertebrates - coverage	percent coverage	100% accuracy to genus or species; taxonomic verification of voucher specimens by Scientific Advisor(s).	undefined	NA	undefined
invertebrates - abundance (count)	count or categories (abundant, common, uncommon, rare)	100% accuracy to genus or species; taxonomic verification of voucher specimens by Scientific Advisor(s).	undefined	NA	undefined
algae – presence/absence	present/absent	100% accuracy to genus or species; taxonomic verification of voucher specimens by Scientific Advisor(s).	undefined	NA	undefined
algae – coverage	percent coverage	100% accuracy to genus or species; taxonomic verification of voucher specimens by Scientific Advisor(s).	undefined	NA	undefined
algae – abundance (count)	count or categories (abundant, common, uncommon, rare)	100% accuracy to genus or species; taxonomic verification of voucher specimens by Scientific Advisor(s).	undefined	NA	undefined

a) "General" accuracy objectives are estimates assuming a true value were known and could be tested; all analytical accuracy objectives (i.e., for samples) include non-detectable concentrations in ambient field blanks.

b) For analytical samples, the objective for overall precision is typically based on the relative percent difference (RPD) of co-located, simultaneous field duplicates

c) PPCPs include such human-sources chemicals as caffeine, acetaminophen, cotinine (nicotine metabolite), codeine, triclosan (antimicrobial), ibuprofen, aspirin, coprostanol, sulfamethoxazole, azithromycin, carbamazepine, cholesterol, etc.
d) Polymerase Chain Reaction (PCR)-type testing for marks of human influence (e.g., septic, wastewater) on water quality can include detection of the Bacteroidetes bacteria human marker in the water sample, detection of the *Enterococcus faecium* esp gene in the water sample, and other published methods.
e) Optical brighteners and fluorescent whitening agents are different terms for chemicals that are added to almost all laundry soaps and detergents, and which are therefore useful indicators of potentially ineffective sewage treatment.A.8. Special Training / Certification
f) Due to the complexities involved in accurately estimating streamflow, streamflow measurements (volumetric, cfs) should only be performed by experts. Staff gage readings (that are incorporated into a site-specific stage-discharge curve) are more appropriate for volunteer groups. Streamflow measurement for educational purposes is appropriate.

A.8. SPECIAL TRAINING / CERTIFICATION

General QAPP Adoption, requirement #8 (i.1.8; page 6): Instruction in all aspects of project data collection and management shall be provided to project participants (as applicable, depending on assigned tasks) and shall be documented, including trainee signatures, trainer(s), dates of training, and subject matter.

The General QAPP Adoption Form includes a table detailing the specific plans for training to be conducted under this QAPP.

➔ The Monitoring Program Coordinator will specify the type of training, frequency, and participants in *The General QAPP Adoption Form*.

All members of the project team are required to attend workshops appropriate to the type of monitoring they will conduct. The Monitoring Program Coordinator shall ensure that volunteers receive appropriate training by organizing and conducting workshops (securing the services of expert trainers as needed) and/or arranging for volunteers to be trained at workshops held by other qualified personnel or organizations. **Volunteers failing to attend required training sessions and/or not meeting expectations shall not participate in data collection under this General QAPP.**

The Monitoring Program Coordinator enters training into the project database and records the following information: subject matter (i.e. what type of monitoring and procedures are covered), training course title, date and agenda, name and qualification of trainers, and names of participants trained.

Field and lab safety will be covered as part of every training. The specific information covered will vary depending on the location of sampling (e.g., from a boat, from a roadway, in a wetland area) and the type of sampling. Issues covered may include, but are not limited to: personal safety, buddy system / informing others of plans to work in the field, situational awareness, safe handling of equipment, chemical safety, and planned response

in the event of an emergency or chemical spill. Safety considerations are covered more fully in section B.1.

Wetland and estuarine biomonitoring requires specific knowledge of species as well as specific sampling protocols for each parameter. Workshops and infield trainings are important resources for volunteers to learn the necessary knowledge to conduct sound data collection. However, supervision by the Field Coordinator of all monitoring activities may be necessary to achieve data quality objectives.

Introduced species monitoring requires that volunteers be trained to identify native species and nonindigenous species for a particular region and nonindigenous species that have the potential to become established in the region. Volunteers shall also be trained in monitoring protocols and be able to document pertinent environmental data for the evaluation site. The Field and Monitoring Program Coordinators may be trained to verify species (or the project team may consist of scientists that are capable of accurate species verification). Contact your local Sea Grant Program for more information if you are interested in this type of monitoring.

A.9. DOCUMENTS AND RECORDS

General QAPP Adoption, requirement #9 (i.1.9; page 6): 9. Documentation and record-keeping for all project activities related to data collection and data quality shall be implemented for the duration of the project.

- ➔ In *The General QAPP Adoption Form*, select the project-specific record keeping techniques.
- ➔ Provide the names of Project-Specific Datasheets, Labels, Laboratory and Voucher Forms. A copy of these forms should be provided in the *General QAPP Adoption Form* appendix.
- ➔ Verify that any scientific collecting permits or certificates of permission necessary for the execution of the Monitoring Program have been obtained.

The specific forms to be used for this project will be developed specifically for your organization as part of the development of standard operating procedures, see section B.2. for details on this process. You will provide an overview of the forms in section A.9. of *The General QAPP Adoption Form*.

Field data sheets will be completed on site at the time of sampling. They will include the sample collection date and times, the site name, number and/or location, the type of sampler used, the weather, and samplers' names. The data sheets will accompany the

samples to the drop-off point where the Field Coordinator will collect the samples and data sheets.

Sample Labels will be put on all sample containers (and/or in containers, in the case of macroinvertebrate and macrophyte samples). Labels will either include the site name, date, time, location, type of sample, and sampler's name; or label will be unique and this information will be recorded on a data sheet with the unique label code.

Chain of Custody (COC) forms will accompany samples from collection sites to laboratories. CoC forms will be signed by collectors and all individuals who gain custody of the samples until they arrive at a lab. Information will agree with the label information on the sample bottles. Information such as the ID number, date, time, type of sample, and samplers will be included on the Chain of Custody form.

Miscellaneous records for **instrument checks, calibrations, and maintenance** will be kept in a logbook.

In addition to field data sheets, **photographs** (digital preferred) shall be taken of each marine introduced species that is encountered at each evaluation site (i.e. minimum one photo per species per season).

Voucher specimens shall be required for species that are more difficult to identify and/or are newly arrived species. Definition of "difficult to identify" should be determined in consultation with an expert in the particular taxonomic group. In general, voucher specimens of all species should be taken, to allow for training of volunteers and for reference. Vouchers may include herbarium pressings of plants and macroalgae, preserved organisms of all types, and photographs. For invasive species monitoring, contact your local Sea Grant Program for advice on establishing a monitoring program.

Training records for all volunteers involved in the project must be kept.

The electronic project **database** shall be organized and protected from loss and damage through proper back-up of digital data.

The monitoring organization shall obtain all **scientific collecting permits** required by law. In general, you will need a permit for the collection of any animals. Vascular plants that are listed as endangered, threatened, or of special concern will require a permit. Macroalgae, phytoplankton, and zooplankton do not generally require a permit. The Monitoring Program is responsible for checking whether a scientific collection permit is necessary – do not rely on the comments provided here to determine whether a permit is necessary for your organization. For CT and NY, check the website for the most up-to-date information. In CT, use the search terms "CT DEEP scientific collection permit"; in NY, use the search terms "NY DEC scientific collection permit".

The monitoring organization shall obtain all necessary **Certificates of Permission** (CoP). In Connecticut and New York, a CoP is required if you will place a structure in the water or intertidal zone that will be left unattended. Such structures include weighted floats which hold deployed instruments or mark a location. The process of obtaining a CoP may take up to 3 months. Visit the CTDEEP website for the most recent information, use the following search term: "CT DEEP Certificate of Permission". Visit the NYSDEC website for the most recent information, use the following search term: "NYS DEC permits," then look for a floating object permit.

B. Data Generation and Acquisition

"The elements in this group address all aspects of project design and implementation. Implementation of these elements ensure that appropriate methods for sampling, measurement and analysis, data collection or generation, data handling, and QC activities are employed and are properly documented."

– quoted from *EPA Requirements for Quality Assurance Project Plans (EPA QA/R-5)*

B.1. Sampling Process Design (Experimental Design)

General QAPP Adoption, requirement #10 (i.1.10; page 6): *The General QAPP Adoption Form* must explain the general thought process behind the sampling plan, as well as provide detailed information regarding the "who, what, when, where, why, and how" that was generally referred to in i.1.6 (page 6).

General QAPP Adoption, requirement #11 (i.1.11; page 6): *The General QAPP Adoption Form* must discuss measures to be taken to ensure the health and safety of project participants for the duration of the project.

Guidance on establishing monitoring goals and methods can be found in *Volunteer Estuary Monitoring. A Methods Manual. 2nd Edition. US EPA and Ocean Conservancy* (http://water.epa.gov/type /rsl/monitoring/index.cfm, or use the internet search terms "EPA volunteer monitoring"). Guidance on developing standard operating procedures can be found in EPA's *Guidance for Preparing Standard Operating Procedures (SOPs)* (EPA QA/G-6). *The General QAPP for Long Island Sound Volunteer Coastal Monitoring* (this document) is designed to streamline the process of writing a QAPP for Monitoring Programs in the Long Island Sound area. *This document does not replace guidance on developing a program and is not sufficient as a stand-alone document to guide the initial development and sample design process for a monitoring program.*

Parameters, number and location of sampling sites, sampling time of day, frequency, and season are selected to meet the monitoring objectives referred to in i.1.5 (page 6) and

generally described in A.5. (page 11). Typical sampling design components are described below.

➔ In section B.1. of *The General QAPP Adoption Form*, select the appropriate sampling safety measures. In almost all cases, all of these boxes should be checked.

➔ In section B.1. of *The General QAPP Adoption Form*, describe the project-specific sampling design.

Sampling Safety. Personal safety shall be a primary consideration in all activities, including selection of sampling sites and dates, and training programs. No sampling shall occur when personal safety is thought to be compromised. The Monitoring Coordinator and Field Coordinator shall confer before each sampling event to decide whether adverse weather or other conditions pose a threat to safety of field volunteers, and will cancel/postpone sampling when necessary. Sampling shall take place in teams of two or more. Samplers shall wear life vests when sampling from boats or wading in waters under difficult conditions. Samplers shall wear proper clothing to protect against the elements as applicable, especially footwear and raingear. When sampling in rivers, samplers shall estimate flow and avoid sampling when river depth (in feet) times velocity (feet per second) appear to equal 5 or greater, e.g. 1.5 foot depth * 4 feet/second velocity = 6 = unsafe conditions!

Design Considerations. Typical sampling design principles for water quality parameters, estuarine and wetland biomonitoring, and marine introduced species assessments are listed in Table 5. When describing project-specific sampling processes in the program's *General QAPP Adoption Form*, these procedural considerations shall be followed or modified to meet specific monitoring objectives.

Table 5: Typical Sampling Approaches

Indicators	Number of Sample Locations	Site location rationale	Frequency, Duration, Special Conditions	Field Survey QC
Water Quality Parameters				
station depth	each sampling site	NA	each time the site is sampled for any other parameters; note time and tidal stage	repeat readings to verify depth

Indicators	Number of Sample Locations	Site location rationale	Frequency, Duration, Special Conditions	Field Survey QC
GPS: latitude & longitude in decimal degrees; NAD83 coordinate system or record system used	each sampling site	NA	once per year to mark site; each visit to sampling site if site is not easily marked (e.g. center of estuary or longitudinal river profile)	repeat readings to verify coordinates
temperature	at least one each for selected reach or tributary	representative or targeted, define clearly in the SOP; depth(s) of sampling should be consistent with Program goals and defined in SOPs*	at least monthly (April - October), minimum of three "dry" weather surveys	collect a field replicate for ~10% of samples, at least one field duplicate per survey; probe calibration prior to survey (as applicable)
salinity (coastal), conductivity (freshwater, coastal)	at least one each for selected reach or tributary	representative or targeted, define clearly in the SOP; depth(s) of sampling should be consistent with Program goals and defined in SOPs*	at least monthly (April - October), minimum of three "dry" weather surveys	collect a field replicate for ~10% of samples, at least one field duplicate per survey; probe calibration prior to survey (as applicable)
dissolved oxygen	at least one each for selected reach or tributary	representative or targeted, define clearly in the SOP; depth(s) of sampling should be consistent with Program goals and defined in SOPs*	at least monthly (April - October), minimum of three "dry" weather surveys, pre-dawn or early morning DO especially useful	collect a field replicate for ~10% of samples, at least one field duplicate per survey; probe calibration prior to survey (as applicable)
pH, alkalinity	at least one each for selected reach or tributary	representative or targeted, define clearly in the SOP; depth(s) of sampling should be consistent with Program goals and defined in SOPs*	at least monthly (April - October), minimum of three "dry" weather surveys	collect a field replicate for ~10% of samples, at least one field duplicate per survey; probe calibration prior to survey (as applicable)

Indicators	Number of Sample Locations	Site location rationale	Frequency, Duration, Special Conditions	Field Survey QC
bacteria	at least one each for selected reach or tributary	representative or targeted, define clearly in the SOP; depth(s) of sampling should be consistent with Program goals and defined in SOPs*	at least monthly (April - October), minimum of three "dry" weather surveys	collect a field replicate for ~10% of samples, at least one field duplicate per survey; probe calibration prior to survey (as applicable)
turbidity	at least one each for selected reach or tributary	representative or targeted, define clearly in the SOP; depth(s) of sampling should be consistent with Program goals and defined in SOPs*	at least monthly (April - October), minimum of three "dry" weather surveys	collect a field replicate for ~10% of samples, at least one field duplicate per survey; probe calibration prior to survey (as applicable)
TSS	at least one each for selected reach or tributary	representative or targeted, define clearly in the SOP; depth(s) of sampling should be consistent with Program goals and defined in SOPs*	at least monthly (April - October), minimum of three "dry" weather surveys	collect a field replicate for ~10% of samples, at least one field duplicate per survey; probe calibration prior to survey (as applicable)
chlorophyll *a*	at least one each for selected reach or tributary	representative or targeted, define clearly in the SOP; depth(s) of sampling should be consistent with Program goals and defined in SOPs*	at least monthly (April - October), minimum of three "dry" weather surveys	collect a field replicate for ~10% of samples, at least one field duplicate per survey; probe calibration prior to survey (as applicable)
Secchi depth	at least one each for selected reach or tributary	representative or targeted, define clearly in the SOP; depth(s) of sampling should be consistent with Program goals and defined in SOPs*	at least monthly (April - October), minimum of three "dry" weather surveys	collect a field replicate for ~10% of samples, at least one field duplicate per survey; probe calibration prior to survey (as applicable)

Indicators	Number of Sample Locations	Site location rationale	Frequency, Duration, Special Conditions	Field Survey QC
nutrients	at least one each for selected reach or tributary	representative or targeted, define clearly in the SOP; depth(s) of sampling should be consistent with Program goals and defined in SOPs*	at least monthly (April - October), minimum of three "dry" weather surveys	collect a field replicate for ~10% of samples, at least one field duplicate per survey; probe calibration prior to survey (as applicable)
pharmaceuticals and personal care products (PPCPs), including caffeine	at least one each for selected reach or tributary; may only target suspected source areas or may sample along a gradient	representative or targeted, define clearly in the SOP; depth(s) of sampling should be consistent with Program goals and defined in SOPs*	as defined for the Monitoring Program	collect a field replicate for ~10% of samples, at least one field duplicate per survey
DNA markers for human-specific strains of indicator bacteria	at least one each for selected reach or tributary; may only target suspected source areas or may sample along a gradient	representative or targeted, define clearly in the SOP; depth(s) of sampling should be consistent with Program goals and defined in SOPs*	as defined for the Monitoring Program	collect a field replicate for ~10% of samples, at least one field duplicate per survey
optical brighteners/ fluorescent whitening agents (absorbent pad/UV light method)	at least one each for selected reach or tributary; may only target suspected source areas or may sample along a gradient	representative or targeted, define clearly in the SOP; depth(s) of sampling should be consistent with Program goals and defined in SOPs*	as defined for the Monitoring Program	collect a field replicate for ~10% of samples, at least one field duplicate per survey

Indicators	Number of Sample Locations	Site location rationale	Frequency, Duration, Special Conditions	Field Survey QC
precipitation	at least one per watershed, preferably one per sub-watershed or within 10 miles of sampling sites	capture storm events that influence conditions at sampling sites	check for reasonableness (e.g. values consistent with predicted rainfall); duplicate readings by two personnel; compare with other local rain stations	
tidal hydrology: difference in tidal range	two fixed locations: one upstream and one downstream of tidal restriction	representative of tidal flow between study & reference	once, every 15 minutes for 6 hours from low to high spring tide	any combination of qualified supervisor, multiple samplers
Wetland and Estuarine Biomonitoring				
macroinvertebrates - general guidelines	at least one sampling site for each selected reach or tributary	representative or targeted, define clearly in the SOP	once per year, late summer or fall; be consistent with previous studies; evaluate timing based on phenology of target organisms	Voucher specimens for later identification by expert(s)
macroinvertebrates – presence in marsh	3 creek bank sites near 0-150-300 feet	representative of marsh condition at study & reference	once per year, late summer or fall; be consistent with previous studies; evaluate timing based on phenology of target organisms	any combination of qualified supervisor, multiple samplers, voucher specimens, photo documentation
Nekton (fish, shrimp, crabs)– presence, relative abundance	3 equally spaced sampling sites along evaluation area gradient	representative of habitat condition at study & reference	three times June - September; evaluate timing based on phenology of target organisms	any combination of qualified supervisor, multiple samplers, voucher specimens, photo documentation

Indicators	Number of Sample Locations	Site location rationale	Frequency, Duration, Special Conditions	Field Survey QC
birds – point counts of all species seen or heard	single vantage point overlooking evaluation area	representative of marsh condition at study & reference	five times June - September; evaluate dates based on phenology of target organisms; evaluate time of day based on diurnal habits	any combination of qualified supervisor, multiple samplers
vegetation presence, identification, or biomass (grasses, sedges, eelgrass, macroalgae, etc.)	dependent on goals of study and heterogeneity of distribution - more sites are required for heterogeneous distributions	areal density and plant type / species maps	once / year, late summer or fall; be consistent with previous studies; evaluate timing based on phenology of target organisms	voucher plant specimens for later identification by expert(s)
vegetation – presence, identification, abundance, canopy height, density, biomass	6 transects, randomly stratified	representative of condition at study & reference site	once / year, late summer or fall; be consistent with previous studies; evaluate timing based on phenology of target organisms	any combination of qualified supervisor, multiple samplers, voucher specimens, photo documentation
sediment	dependent on goals of study and heterogeneity of distribution - more sites are required for heterogeneous distributions	areal distribution of sediment types, maps	once / year, late summer or fall; be consistent with previous studies; values vary seasonally	any combination of qualified supervisor, multiple samplers
Land Use	map and orthophoto analysis using three concentric buffers	representative of land use effects on habitat conditions	once, unless alterations in land use	any combination: two or more personnel conduct separate mappings of same area, compare results, discuss to resolve differences

Indicators	Number of Sample Locations	Site location rationale	Frequency, Duration, Special Conditions	Field Survey QC
Marine Introduced Species				
algae, Invertebrates - presence	Inventory survey of evaluation area	Representative of evaluation area	Once/year, late summer or fall	Any combination of qualified supervisor, multiple samplers, voucher specimens, photo documentation
algae, invertebrates - coverage, abundance	minimum of four random 1-meter quadrats or line transects within evaluation area	randomly selected to be representative of evaluation area	monthly from April through October	any combination of qualified supervisor, multiple samplers, voucher specimens, photo documentation

* The sampling sites chosen will be representative or targeted. Representative should accurately represent the reach or tributary condition. If looking for areas of interest or impact (species of concern i.e. marsh, eelgrass; source of pollution; problem areas), the sampling site does not need to be representative of the general area. As a general guideline, take one sample per meter in the vertical direction. Sampling depths should be consistent among sites, e.g. 0.5 m below surface, 0.5 m above bottom; define sampling depths in SOPs.

B.2. SAMPLING METHODS

General QAPP Adoption, requirement #12 (i.1.12, page 6): *The General QAPP Adoption Form* must provide detailed information regarding how samples will be collected and preserved, as well as copies of standard operating procedures (SOPs).

It is highly recommended that pre-sampling coordination with a laboratory take place to ensure that proposed sample collection procedures meet the needs of the chosen laboratory.

- ➔ List any labs with which you will confer prior to the start of sampling, to ensure that proposed sample collection procedures meet the needs of the chosen laboratory. A partial list of labs is included in Table 10. Table 10 does not constitute an endorsement of any of these lab, the list was developed utilizing the list published by the Department of Health in Connecticut and New York.

- ➔ In *The General QAPP Adoption Form*, complete the tables detailing the sampling methods. Copy and paste appropriate information from Tables 6 and 7 below into *The General QAPP Adoption Form*.

- ➔ Provide the standard operating procedures (SOPs) used by your organization as an appendix to *The General QAPP Adoption Form*. A folder containing examples of SOPs

should have been provided with this QAPP. Be sure to see section B.3. as procedures for sample labeling and tracking chain of custody must be included in the SOPs.

One of the most time consuming steps in developing a Monitoring Program is the development of Standard Operating Procedures (SOPs). These documents will be unique to each organization, as they include specific, step-by-step instructions on how sampling and sample handling is conducted. As stated in the EPA's *Guidance for Preparing Standard Operating Procedures (SOPs)* (EPA QA/G-6):

> "A Standard Operating Procedure (SOP) is a set of written instructions that document a routine or repetitive activity followed by an organization. The development and use of SOPs are an integral part of a successful quality system as it provides individuals with the information to perform a job properly, and facilitates consistency in the quality and integrity of a product or end-result."

A copy of the EPA's *Guidance for Preparing Standard Operating Procedures (SOPs)* is available online at http://www.epa.gov/quality/qs-docs/g6-final.pdf or by searching for the title of the document. One way to develop SOPs quickly is to modify the documents prepared by other organizations to reflect the specific equipment and techniques employed by your group. A number of sample SOPs were provided with this document. The SOP is the document you would give to the people doing the monitoring. This QAPP is for use by the people overseeing the monitoring program. As such, SOPs are written as "recipes" or "how-to" guides for what to do when sampling and handling samples. If your program is already established, small modifications to your "guides to volunteers" will constitute your SOPs. Check the EPA guidance document listed above (EPA QA/G-6) to see what additional information may be required or advised.

A list of suppliers of sampling equipment is provided in Table 8.

One note on EPA methods for nutrient analyses: Any water collected for nutrient analysis will be stored in a cooler, on ice during the sampling trip. The cooler designated for nutrient samples will not be used for the storage of macrophytes or sediment. *The storage of these samples will be determined by the SOPs of the analytical lab.* The original EPA standard methods require that samples for nutrient analyses be acidified with H_2SO_4 to a pH < 2 and stored at 4^{o}C until analysis[1,2,3]. More recent methods acknowledge that no method for preservation is truly satisfactory. In addition, preservation with H_2SO_4 precludes the analysis of nitrate and nitrite separately, yielding only the sum of these two constituents. Freezing of

[1] Ammonium: Standard Methods 4500-NH3-G [19th ,20th, and 21st Edition] and 4500-NH3-H [18th Edition]
[2] Nitrate and Nitrite: USEPA 353.2. Revision 2.0 (1993)
[3] Phosphorus (Ortho-phosphate): EPA 365.1 Rev. 2.0 (1993)

samples at -20° C is a suggested preservation technique in more recent EPA methods[4] and is widely used as a preservation technique. The storage and preservation techniques detailed here match the techniques presented in other QAPPs approved by the EPA and used as examples for QAPP preparation on the EPA website (http://www.epa.gov/NE/measure/qapp_examples/)[5,6]. If the analytical lab requires freezing versus acidification, samples will be delivered to a freezer within 8 hours of collection and stored at -20°C. Frozen samples will be analyzed within 28 days of collection, but delays in analysis will not affect the validity or usability of results[7].

Table 6: General Sample Collection Methods
The minimum sample quantity will be determined by the analytical lab, examples of typical volumes are included here.

Parameter(s)	Container Type(s) and Preparation	Minimum Sample Quantity	Sample Preservation	Maximum Holding Time
Water Quality Parameters				
Station depth	field data sheets	NA	transfer to digital format; maintain back-up copies of digital data	NA
GPS: latitude & longitude in decimal degrees; NAD83 coordinate system or record system used	field data sheets -or- log to GPS	NA	transfer to digital format; maintain back-up copies of digital data	NA
multi-parameter or single parameter meter (e.g. YSI, In-Situ, Hach) – temperature salinity conductivity dissolved oxygen pH turbidity fluorescence (chl *a*) light	field data sheets -or- log to internal memory	NA	transfer to digital format; maintain back-up copies of digital data	NA

[4] Nitrate and Nitrite: USEPA 353.4. Revision 2.0 (1997)
[5] Leo WS, Prasse J, Delaney MF, Epelman P, Rhode S, Lao Y. 2010. Combined Work/Quality Assurance Project Plan (QAPP) for Nutrient and Chlorophyll Analyses for Outfall Monitoring. Boston: Massachusetts Water Resources Authority. Report 2010-09. 40 p.
[6] Pennock J, Trowbridge P. 2003. UNH Nutrient and Light Extinction Monitoring Program Quality Assurance Project Plan. University of New Hampshire and New Hampshire Department of Environmental Services. 71p.
[7] Avanzino R.J. and V.C. Kennedy, 1993. Long-term frozen storage of stream water samples for dissolved orthophosphate, nitrate plus nitrite, and ammonia analysis. *Water Resources Research*, 29(10) 3357-3362.

Parameter(s)	Container Type(s) and Preparation	Minimum Sample Quantity	Sample Preservation	Maximum Holding Time
temperature (thermometer)	field data sheets	NA	transfer to digital format; maintain back-up copies of digital data	
salinity (refractometer)	field data sheets	NA	transfer to digital format; maintain back-up copies of digital data	
dissolved oxygen concentration (titration kit)	"BOD" Bottle	300 mL, or as defined by kit manufacturer's instructions	fix immediately	8 hours
pH	high density polyethylene (HDPE)	300 mL	in-situ measurement preferred over lab analysis. Alternatively, fill bottle completely, do not leave a head space, refrigerate / chill to <6^{o}C.	Deliver to lab within eight hours of collection, should be analyzed immediately.
alkalinity	high density polyethylene (HDPE)	300 mL	Refrigerate / chill to <6^{o}C; fill bottle completely, do not leave a head space.	14 days
bacteria	Sterilized: HDPE / PP / glass Whirlpak bag	120 mL per analyte	ice or refrigerate water samples at a temperature of <4^{o}C. Do not freeze samples.	transport to lab within 6 hours, begin analysis within 8 hours of collection
turbidity	glass or plastic	300 mL	ice or refrigerate water samples at a temperature of <4^{o}C. Do not freeze samples.	48 hours
TSS	glass or plastic	500 mL minimum, up to 2 L	ice or refrigerate water samples at a temperature of <4^{o}C. Do not freeze samples.	Preferably do not hold samples more than 24 h. In no case hold samples more than 7 d.

Parameter(s)	Container Type(s) and Preparation	Minimum Sample Quantity	Sample Preservation	Maximum Holding Time
chlorophyll *a*	opaque glass or plastic	200 mL per replicate, usually 1 L total (may be in multiple bottles)	filter on boat or shore, wrap filters in foil or otherwise store in dark; if delivering unfiltered to lab, store at <4°C in the dark; once filtered, store at <-20°C	unfiltered sample may be held for 2 hours on ice; filters wrapped in foil may be held on ice for up to 4 hours; filters may be stored at <-20°C for 25 days
Secchi depth	field data sheets	NA	transfer to digital format; maintain back-up copies of digital data	NA
inorganic nutrients	high density polyethylene (HDPE) polypropylene (PP) borosilicate glass (containers pre-acid-washed with 10% hydrochloric acid)	120 mL per analyte	ice or refrigerate water samples at a temperature of <4°C while in the field, store at <-20°C	ideally analyze within 28 d, holding time of ~1 year once frozen
organic nutrients	high density polyethylene (HDPE) polypropylene (PP) borosilicate glass (containers pre-acid-washed with 10% hydrochloric acid)	120 mL per analyte	ice or refrigerate water samples at a temperature of <4°C while in the field, freeze at <-20°C -or- add H_2SO_4 to pH<2 immediately and refrigerate to <4°C	ideally analyze within 28 d, max holding time of 3 months
pharmaceuticals and personal care products (PPCPs), including caffeine	amber glass	500 mL	store at <4°C in the dark	24 hours
DNA markers for human-specific strains of indicator bacteria	Sterilized: HDPE / PP / glass (bottle prep includes bleach wash of PS/HDPE container to remove any DNA/RNA)	120 mL per analyte	ice or refrigerate water samples at a temperature of <4°C. Do not freeze samples.	transport to lab within 6 hours, begin analysis within 8 hours of collection

Parameter(s)	Container Type(s) and Preparation	Minimum Sample Quantity	Sample Preservation	Maximum Holding Time
optical brighteners/ fluorescent whitening agents (absorbent pad/UV light method)	cotton pads	NA	keep pads cool and in dark in separate labeled plastic bags	3 days
precipitation	field data sheets -or- log to internal memory of rain gage	NA	transfer to digital format; maintain back-up copies of digital data	NA
tidal hydrology: difference in tidal range	field data sheets -or- log to internal memory of rain gage	NA	transfer to digital format; maintain back-up copies of digital data	NA
Wetland and Estuarine Biomonitoring / Marine Introduced Species				
macroinvertebrates	plastic bottles or zip-lock bags; camera	dependent on goal; 1 voucher sample of each species, or collect all for counting	preserved in 90% ethyl or isopropyl alcohol; refrigerate until initial sorting to remove debris; vials with 70-90% alcohol until ID; digital storage and back-ups of photos	6 months
nekton	field data sheets, camera	3 samples per site	identified, measured, weighed in situ; retain voucher specimen, if further verification is needed; transfer to digital format; maintain back-up copies of digital data	NA
birds	field data sheets, camera	dependent on Program goals	identified, measured, weighed in situ; retain voucher specimen, if further verification is needed; transfer to digital format; maintain back-up copies of digital data	NA

Parameter(s)	Container Type(s) and Preparation	Minimum Sample Quantity	Sample Preservation	Maximum Holding Time
vegetation, no collection (grasses, sedges, eelgrass, macroalgae, etc.)	labeled reusable zipper baggies or other containers; camera	1 voucher specimen, if needed; photos as needed	identified and measured; herbarium pressing of voucher specimen, if further verification is needed; transfer to digital format; maintain back-up copies of digital data	NA
vegetation, collection (grasses, sedges, eelgrass, macroalgae, etc.)	reusable zipper baggies or other containers; camera	defined by sampling type - e.g., for biomass, collect all within quadrat	dependent on goal - clean of debris, rinse in fresh water, dry at <50^{o}C -or- prepare herbarium pressing; store in desiccator	indefinite once dried
sediment – type, qualitative	NA	3 samples per site	NA	NA
sediment – grain size	Whirlpak baggies, reusable zipper baggies	3 samples per site, may be combined into a composite sample	store at <4^{o}C in the dark while in the field; within 8 hours, store at <-20^{o}C*	ideally analyze within 3 months, max holding time of 1 year
sediment – organic content by loss-on-ignition	Whirlpak baggies, reusable zipper baggies	3 samples per site, may be combined into a composite sample	store at <4^{o}C in the dark while in the field; within 8 hours, store at <-20^{o}C	ideally analyze within 3 months, max holding time of 1 year
land use	digital	NA	transfer to digital format; maintain back-up copies of digital data	NA

* Sediment grain size analysis follows the method of Folk (1974)[8]. Both freezing and refrigeration may potentially affect the results of grain size analysis[9]. As these sediments are relatively rich in organic matter and may contain microflora and fauna, freezing is chosen to reduce biological activity.

[8] Folk, R.L., 1974. Petrology of Sedimentary Rocks, The University of Texas, GEOLOGY 373K, 383L, 383M, Hemphill Publishing Co. Drawer M. University Station. Austin , Texas. 182pgs.

[9] Poppe, L.J., Eliason, A.H., Fredericks, J.J. , Rendigs, R.R., Blackwood D. and Polloni, C.F. 2000. Chapter 1: Grain-size analysis of marine sediments: methodology and data processing. U.S. GEOLOGICAL SURVEY OPEN-FILE REPORT 00-358. http://pubs.usgs.gov/of/2000/of00-358/text/chapter1.htm

Table 7: Typical Field Sampling Considerations

Includes common parameters as may be contained in sampling SOPs. Many of these guidelines follow the standard protocols of established monitoring programs. A monitoring group may choose to alter these methods.

Sample Type	Parameter(s)	Sampling Considerations
in-situ sampling	station depth	Note the tidal stage and time of day. Depth varies greatly over the tidal cycle.
in-situ sampling GPS	GPS: latitude & longitude in decimal degrees; NAD83 coordinate system or record system used	NAD83 coordinate system or record system used; check GPS accuracy relative to a known, fixed location
in-situ sampling meter	temperature salinity conductivity dissolved oxygen pH turbidity fluorescence (chl a) light	Sample at consistent time each day – e.g. 10 AM – 1 PM window; however, dissolved oxygen is best sampled in the very early morning (to capture lowest conditions after darkness) Inspection, maintenance, pre-calibration and post-checking of probes and instruments are critical to achieving accurate and precise measurements, especially for DO.
grab samples - i.e. collection of a water sample	temperature (thermometer)	If collecting from depth (e.g. associated with DO sample), immediately place thermometer in sample water (but not in BOD bottle) upon retrieval from depth. Read within 30 seconds.
grab samples - i.e. collection of a water sample	salinity (refractometer)	Calibrate instrument to zero using distilled water at the start of each sampling day.
grab samples - i.e. collection of a water sample	dissolved oxygen (Winkler titration)	Sample with care to avoid entraining bubbles into the bottle. Sample 0.5m from bottom using Van Dorn or comparable collection device. Samples may also be collected at surface and at other depths to construct DO profile. If bubbles get in, empty and begin again. Sample is fixed immediately on site. Store in dark. Best sampled before sunrise to capture lowest values. Samples are fixed on site. **To qualify as an EPA accepted test, the Sodium Thiosulfate solution must be calibrated daily – these products are not included in the standard kits and must be ordered separately from the kit manufacturer.**
grab samples - i.e. collection of a water sample	pH	Avoid stirring up bottom sediments. Collect sample under water surface. Fill to overflowing. Cap while under water to avoid air in sample.

Sample Type	Parameter(s)	Sampling Considerations
grab samples - i.e. collection of a water sample	alkalinity	Avoid stirring up bottom sediments. Collect sample under water surface. Fill to overflowing. Cap while under water to avoid air in sample.
grab samples - i.e. collection of a water sample	bacteria other "micro" samples	Sterile (new-sealed or autoclaved-sealed) container required. Place upright, capped sample bottle under the surface of the water about six inches. Do not rinse bottle. Slowly uncap and let it fill to capacity under the water. With hands away from the bottle opening, bring the bottle up and out of the water, pour sufficient water to leave approximately 1/2 inch air space in the bottle. Preserve as directed by analytical lab. Cap bottle and tighten. Latex or nitrile gloves should be worn.
grab samples - i.e. collection of a water sample	turbidity	Avoid disturbing bottom sediments. Leave one inch of air in container to allow mixing before analysis.
grab samples - i.e. collection of a water sample	TSS	Avoid disturbing bottom sediments. Leave one inch of air in container to allow mixing before analysis.
grab samples - i.e. collection of a water sample	chlorophyll *a*	Keep careful and accurate track of volume of water passed through each filter pad, quantitation is impossible without this value.
in-situ sampling	water clarity (i.e. Secchi disk)	Take readings between 10 am and 4 pm. Always sample from the shaded side of the boat and note whether a viewscope was used. Always sample without sunglasses. Note if disk hits bottom or is obscured by weeds. Note also when complete surface cover does not allow or complicates a reading. If surface obstruction can be temporarily cleared, take a reading.
grab samples - i.e. collection of a water sample	nutrients	The use of buckets to collect samples is not advised, due to the potential for sample contamination. Direct sample collection (i.e., water into sample bottle) is best. However when sampling from depth, a sampling device will be needed. Triple-rinse container in ambient water immediately prior to sample collection. Care must be taken to avoid contact between fingers and inside surfaces of containers, including bottle caps. New, pre-washed bottles preferred; if not, containers for nutrient samples should be acid-washed and rinsed with deionized water. Field filtration preferred for dissolved fractions. If filtering water, triple-rinse container with *filtered* water immediately prior to sample collection, not ambient water.

Sample Type	Parameter(s)	Sampling Considerations
grab samples - i.e. collection of a water sample	detergents (via kit)	If different analysts will generate data, make sure to perform inter-analyst comparisons using sample duplicates/splits. Using the absorbent pad/UV light method to detect optical brighteners may be more cost-effective, in light of cost of procuring refill reagents.
grab samples - i.e. collection of a water sample	pharmaceuticals and personal care products (PPCPs), including caffeine	Coordinate with lab regarding sample volume requirements and other issues.
grab samples - i.e. collection of a water sample	DNA markers for human-specific strains of indicator bacteria	Special bottle prep for DNA marker analyses
grab samples - i.e. collection of a water sample	optical brighteners/ fluorescent whitening agents (HPLC method & absorbent pad/UV light method)	Avoid exposure to sunlight. Avoid all direct contact with laundry soaps and detergents for at least 24 hours prior to handling any samplers. Wear disposable gloves when handling pads and sampling devices. Upon retrieval, place pads in new zipper locking plastic bags.
in-situ sampling	precipitation	Develop and follow an SOP.
in-situ sampling	tidal hydrology	Take along a timer with an alarm so it can be set to remind monitors every 15-minute interval.
in-situ sampling	macroinvertebrates	When collecting from multiple areas (e.g. fast and slow sections, replicates) sample from furthest downstream location first; then work upstream. When brushing rocks/disturbing sediments, avoid sweeping specimens outside of flow entering net. When sampling streams with high flow fluctuations (e.g. below dams), avoid sites that are usually dry. Disturbed sites take 6-8 weeks to recolonize. Understand the particular conditions of the area being sampled (i.e. tide, thick mud, current) in regards to monitors' safety. Be prepared and careful.
in-situ sampling	nekton	Different equipment types and methods have different advantages and disadvantages (investigate before choosing). Creeks that are deep or have strong currents may be dangerous.
in-situ sampling	birds	Requires careful visual observations and keen auditory skills. Make sure at least one monitor is proficient with identifying birds by sight and birdcalls.

Sample Type	Parameter(s)	Sampling Considerations
in-situ sampling	vegetation	If possible, collect all parts of plant: roots, stems, leaves, flowers. Make sure all collections are labeled well so they are not mixed up. For algae and invertebrates, quadrats are randomly placed at low tide within the evaluation area. Begin in quadrants closest to the low tide line. For eelgrass surveys it may be necessary to start at the shallow water or deep water edge and work with the ebbing or flooding tide, respectively. Line transects on floating docks are not tide dependent. For dock surveys, take something to lie on to conduct search. Do not remove specimens from the transect area.
in-situ sampling	sediment	Sediment quality may vary greatly over small spatial scales, collect independent samples from the general area, versus sub-sampling a single grab.
in-situ sampling remote sensing	land use	Mapping may be done in the office, but it is necessary to field truth assessment.

Table 8: Brief list of suppliers of sampling probes, kits, etc. Other suppliers are available.

Acorn Naturalists Science and environmental education resources, including field kits for schools 155 El Camino Real Tustin, CA 92780 1-800-422-8886 www.acornnaturalists.com	Hydrolab Sampling instruments Hach Environmental Headquarters P.O. Box 389 Loveland, CO 80539 1-800-949-3766 ext 1 http://www.hydrolab.com/
Ben Meadows Company Equipment and supplies for a variety of outdoor work, including water sampling P.O. Box 5277 Janesville, WI 53547-5277 1-800-241-6401 www.benmeadows.com	In-Situ, Inc. Sampling instruments 221 East Lincoln Ave. Fort Collins, CO 80524 1-800-446-7488 http://www.in-situ.com/
Carolina Biological Supply Curriculum supplements and monitoring equipment for schools 2700 York Court Burlington, NC 27215 1-800-334-5551 www.carolina.com	LaMotte Water quality testing equipment 802 Washington Ave. P.O. Box 329 Chestertown, Maryland 21620 1-800-344-3100 www.lamotte.com
Eureka Environmental Engineering Sampling instruments, software 2113 Wells Branch Parkway Suite 4400 Austin, TX 78728 1-512-302-4333 http://www.eurekaenvironmental.com/	Rite in the Rain All weather writing supplies, logbooks JL DARLING LLC 2614 Pacific Highway E Tacoma, Washington 98424 USA 1-253-922-5000 http://www.riteintherain.com/

Fisher Scientific Full range of monitoring instruments ands supplies 2000 Park Lane Pittsburgh PS 15275 1-800-766-7000 http://www.fisherscientific.com/	Water Monitoring Equipment and Supply (Lawrence Enterprises of Maine) Lake, stream, and pond/vernal pool monitoring equipment P.O. Box 344 Seal Harbor, Maine 04675 1-207-276-5746 www.watermonitoringequip.com
HACH Company Analyzers, instruments, and chemistries for water analysis P.O. Box 389 Loveland, Colorado 80539 1-800-227-4224 www.hach.com	Wildlife Supply Wildco Aquatic sampling instruments and equipment 301 Cass St. Saginaw, MI 48602-2097 1-800-799-8301 www.wildco.com
Healthy Water Healthy People Manuals, curriculum and field kits available 201 Culbertson Hall PO Box 170575 Montana State University Bozeman, MT 59717-0575 www.HealthyWater.org	YSI Environmental Equipment, supplies and instruments for environmental monitoring 1700/1725 Brannum Land Yellow Springs, OH 45387 1-800 897-4151 www.ysi.com

B.3. SAMPLE HANDLING AND CUSTODY

General QAPP Adoption, requirement #13 (i.1.13; page 6): The procedures used to label, transport, store, and track custody of samples must be explained in the project *General QAPP Adoption Form*.

➔ Sample handling and custody procedures shall be in compliance with project Standard Operating Procedures (SOPs). Development of SOPs was addressed in section B.2. The actual labeling of samples will be determined by the SOPs of the organization.

➔ Specific steps shall be taken to avoid sample mislabeling. These steps must be detailed in the project-specific *General QAPP Adoption Form*.

LABELS ON SAMPLES – All samples must be labeled with a unique identification. This includes physical samples (e.g. water, sediment, chlorophyll pads), data written on field sheets (e.g. secchi depth, temperature), and digitally logged data (e.g. YSI/Hach/HydroLab/InSitu meters which store data, deployed temperature sensors).

In all cases, you must record:

- Site ID number or name
- sample type
- date and time

- preservation (if any)
- name of sampler
- name of organization conducting sample

Additional information may include, but is not limited to:

- volume sampled (for TSS, chlorophyll, etc.)
- GPS coordinates
- weather conditions
- tidal stage
- depth of station
- depth of sampling (necessary if depth varies based on location or sample type)

Each site sampled should have a standard identifier determined by the *Monitoring Program Field Coordinator*; this identifier should be unique for all years. In other words, an identifier such as "station 1" is likely to be applied to different locations over multiple years. The GPS coordinates or a specific name such as "Avila Brook Rt. 2 culvert" provide unique identifiers. Identifiers may be abbreviated, if the same abbreviation is always used, "AB_R2c" could refer to "Avila Brook Rt. 2 culvert." This unique identifier and the date and time should be included on all data sheets and/or labels associated with sampling at that site.

Bottles, vials, bags, and other solid containers may have labels which are stickers or the label may be written on the container. In general, there are two labeling schemes – (1) all information on each sample, (2) information summarized on a field data sheet with unique labels on samples:

(1) **all information on each sample** - Sample container labels can be attached to dry bottles, with the following information: Site ID, sample type, date and time, preservation (if any), name of sampler, name of organization conducting sample.

(2) **information summarized on a field data sheet** - Each sample has a completely unique ID affixed to the container. The labeling of these containers (or labels) is done by the analytical lab or the *Monitoring Program Field Coordinator* to ensure there is no repetition in labels. When used in the field, a data sheet is completed with the required information listed above and the unique identifier of the container.

Macroinvertebrate and macrophyte samples may be labeled in pencil on paper placed in sample container or the samples may be placed in resealable zipper storage bags and labeled on the outside with permanent ink markers.

Note that paper labels must be kept dry or they will disintegrate. Plastic labels with information printed in permanent ink or on a laser printer are generally water resistant. Labels written directly on containers (bottles, vials, baggies, foil) with permanent ink are

generally waterproof, but the permanent ink may rub off with rough handling; covering permanent ink labels with clear tape essentially eliminates the risk of rubbing off the label. Pencil or permanent ink are the best writing tools for the field and lab, use of pens may result in bleeding of marks on the paper if it gets wet.

CHAIN OF CUSTODY - All samples shall be handled and transported in accordance with SOPs for each indicator. A summary of these steps is included in Table 6 (page 40) of this document. Chain of custody forms shall be prepared and completed in all cases. The whereabouts of all samples shall be known at all times.

B.4. Analytical Methods

General QAPP Adoption requirement #14 (i.1.14, page 6): All analytical methods used in the project shall be identified in *The General QAPP Adoption Form* and be based on standardized laboratory methods that are specifically referenced or contained in the project-specific *General QAPP Adoption Form*.

Samples may require analytical analysis before data may be interpreted. This typically refers to a laboratory based procedure such as analysis of water for nutrient concentration or bacteria concentration. Data such as temperature, salinity, or water current speed may also require further analysis to determine such things as density (requires temperature and salinity) or extrapolating flow measurements to a volume flux across a channel. In these cases, a description of the equations used to transform the data are required.

Information required in the QAPP for typical analytical methods are provided in Table 9.

Lists of certified analytical labs are listed in Table 10. When choosing a lab, check which analyses an individual lab is certified for. Lab certification is not required, but is recommended where possible. Other labs not shown here may also be certified. Check the Department of Public Health (DPH) websites for labs you might not see listed.

See the EPA's *Guidance for Preparing Standard Operating Procedures (SOPs)* (EPA QA/G-6) for more information on what to include in the SOPs (http://www.epa.gov/quality/qs-docs/g6-final.pdf).

- ➔ For analytical methods conducted by the Monitoring Program, the description of these methods may be included in the SOPs which address sampling procedures. Alternatively, the analytical methods may go in a stand-alone SOP which focuses solely on the analysis. These SOPs may reference a published method (e.g. SM 4500 P), but citing a method alone is not sufficient.

➔ For analytical methods conducted by an external laboratory, a copy of that organization's QAPP and SOPs is required in Appendix C of *The General QAPP Adoption Form*.

➔ In *The General QAPP Adoption Form*, complete the table in section B.4. which provides an overview of the lab-based analytical methods employed in the Monitoring Program, using Table 9 for guidance. These refer to the physical analysis of samples, versus transformation of data. The table should include analyses conducted by the Monitoring Program and by any external contract laboratories or consultants. Information in the table does not replace inclusion of the SOPs in Appendix A and/or C of *The General QAPP Adoption Form*.

Table 9: Typical Analytical Methods (applicable for fresh and salt water, unless otherwise stated)

Parameter	Method #	Source of Method	Typical MDL	Alternative Applications Special Provisions "Kit" availability
total Kjeldahl nitrogen (TKN)	EPA 351.1, 351.2, 351.3, 351.4	EPA	0.05 mg/L	
total Kjeldahl nitrogen (TKN)	SM 4500-N_{org} B SM 4500-N_{org} C	Standard Methods, 21st	0.05 mg/L	
total nitrogen (TN)	SM 4500-N B SM 4500-N C	Standard Methods, 21st	0.03 mg/L	
total nitrogen (TN)	WRIR 03-4174	USGS	0.03 mg/L	
ammonia (NH_3)	EPA 350.1, 350.2, 350.3	EPA	0.02 mg/L	When the samples to be analyzed are saline waters, Synthetic Ocean Water (SOW) should be used for preparing the standards; otherwise, distilled water is used.
ammonia (NH_3)	SM 4500-NH_3	Standard Methods, 21st	0.02 mg/L	When the samples to be analyzed are saline waters, Synthetic Ocean Water (SOW) should be used for preparing the standards; otherwise, distilled water is used.
nitrate-nitrite (NO_3-NO_2)	SM 4500-NO_3	Standard Methods, 21st	0.02 mg/L	
nitrate-nitrite (NO_3-NO_2)	EPA 353.1, 353.2, 353.3	EPA	0.02 mg/L	When the samples to be analyzed are saline waters, Synthetic Ocean Water (SOW) should be used for preparing the standards; otherwise, distilled water is used.

Parameter	Method #	Source of Method	Typical MDL	Alternative Applications Special Provisions "Kit" availability
total phosphorus (TP)	SM 4500-P	Standard Methods, 21st	0.01 mg/L	field filtration preferred for dissolved fractions
total phosphorus (TP)	EPA 365.1, 365.2, 365.3	EPA	0.01 mg/L	field filtration preferred for dissolved fractions
orthophosphate (PO_4^{3-})	SM 4500-P	Standard Methods, 21st	0.01 mg/L	field filtration preferred for dissolved fractions
orthophosphate (PO_4^{3-})	EPA 365.1, 365.2, 365.3	EPA	0.01 mg/L	field filtration preferred for dissolved fractions
fecal coliform	SM 9222-D	Standard Methods, 21st	* lower reporting limit <10	
fecal coliform	SM 9221 (C, E)	Standard Methods, 21st	* lower reporting limit <10	
E. coli	EPA 1603 (modified mTEC)	EPA	* lower reporting limit <10	preferred bacteria indicator for fresh waters
E. coli	SM 9213-D (MTEC)	Standard Methods, 21st	* lower reporting limit <10	preferred bacteria indicator for fresh waters
E. coli	SM 9223-B (enzyme substrate)	Standard Methods, 21st	1 MPN/100 mL	preferred bacteria indicator for fresh waters
enterococci bacteria	EPA 1600 (MF)	EPA	* lower reporting limit <10	preferred bacteria indicator for marine waters
enterococci bacteria	SM 9230	Standard Methods, 21st	* lower reporting limit <10	preferred bacteria indicator for marine waters
enterococci bacteria	ASTM D6503-99 (enzyme substrate)	ASTM	1 MPN/100 mL.	preferred bacteria indicator for marine waters
Chlorophyll *a*	SM 10200 H	Standard Methods, 21st	NA	
Chlorophyll *a*	EPA 445.0	EPA	<0.05 ug/L	
turbidity	EPA 180.1 or SM 2130-B	EPA or SM, 21st	0.2 NTU	
TSS	SM 2540D or EPA 160.2	EPA or SM, 21st	1 mg/L	
pH	SM-4500-H	SM, 21st	0.1	in-situ measurement preferred over lab analysis; if lab, fill bottle to top with no headspace
alkalinity	SM 2320-B	SM, 21st	2 mg/L	

Parameter	Method #	Source of Method	Typical MDL	Alternative Applications Special Provisions "Kit" availability
hardness	SM 2340-B	SM, 21st	2 mg/L	
chloride	SM-4500-Cl-(B)	SM, 21st	1 mg/L	
conductivity	SM-2510-B	SM, 21st	1 mS/cm	
dissolved oxygen	SM 4500-O	Standard Methods, 21st	0.5 mg/L	**To qualify as an EPA accepted test, the Sodium Thiosulfate solution must be calibrated daily – these products are not included in the standard kits and must be ordered separately from the kit manufacturer.** Ensure reagents are fresh and thiosulfate titrant is standardized prior to beginning titration. Beware of over-running colorimetric end-point.
optical brighteners/ fluorescent whitening agents	*	*	qualitative	
optical brighteners/ fluorescent whitening agents	* (solid phase extraction & HPLC)	*	variable (<0.5 ug/l preferred for all FWAs)	
caffeine	* (solid phase extraction & GC/MS)	*	variable (<20 ng/l preferred)	
pharmaceuticals and personal care products (PPCPs)	* (usually solid phase extraction & LC/MS)	*	variable (typically <5 ug/L for most chemicals)	
DNA markers for human-specific strains of indicator bacteria	* §	* §	*	

***** Lab-specific and/or research-based.

§ Library-based microbial source tracking (MST) methods have been intentionally left out of this general QAPP in favor of library-independent methods to determine likely source organisms for bacterial/pathogen pollution.

Table 10: Laboratories that may provide services for volunteer monitoring groups in coastal areas, by State. This listing is current as of 05-27-2013. When choosing a lab, check which analyses an individual lab is certified for. Lab certification is not required, but is recommended where possible. Other labs not shown here may also be certified. Check the Department of Public Health (DPH) websites for labs you might not see listed. The labs below are a partial listing showing labs geographically close to Long Island Sound. Inclusion in this table does not constitute an endorsement of any of particular lab, the list was developed utilizing the list published by the Department of Health in Connecticut and New York.

CT Lab ID	Lab Name	City	Phone
PH-0404	Northeast Laboratories, Inc.	Berlin	860-828-9787
PH-0514	Columbia Environmental Laboratory	Columbia	860-228-0329
PH-0465	Premier Laboratory, INC.	Dayville	860-774-6814
PH-0703	Greenwich Health Dept. Laboratory	Greenwich	860-622-7843
PH-0409	Groton Utilities Water Treatment Plant Lab	Groton	860-446-4080
PH-0535	Environmental Consulting Lab	Madison	203-245-0568
PH-0618	Phoenix Environmental Laboratories, Inc.	Manchester	860-645-1102
PH-0547	Connecticut Testing Laboratories	Meriden	203-634-3731
PH-0440	Baron Consulting Company	Milford	203-874-5678
PH-0411	Regional Water Authority	New Haven	203-401-2700
PH-0627	Hydro-Technologies	New Milford	860-355-8773
PH-0787	Aqua Environmental Lab	Newtown	203-270-9973
PH-0454	Aqualogic	North Haven	203-248-8959
PH-0295	KB Analytical	Oakdale	860-442-4080
PH-0448	Eastern Analytical Laboratory	Old Saybrook	860-388-2378
PH-0513	Averill Environmental Lab	Plainville	860-747-0676
PH-0710	Stamford Health Dept. Lab Gov't Center	Stamford	203-977-4378
PH-0723	York Analytical Laboratories, Inc.	Stratford	203-325-1371
PH-0116	Complete Environmental Testing	Stratford	203-377-9984
PH-0525	Fallon Water Analysis	Tolland	860-871-2529
PH-0509	Environmental Monitoring Lab	Wallingford	203-284-0555
PH-0322	EMSL Analytical, Inc.	Wallingford	203-284-5948
PH-0537	Northwest Environmental Water Labs	Waterbury	203-437-4110
PH-0518	Analytical Consulting Technology	Waterbury	203-757-3960
PH-0202	MAX Water Lab	Watertown	860-945-3566
PH-0461	South Norwalk Electric and Water Laboratory	Wilton	203-762-7884
PH-0464	Envirotech Laboratory	Windsor	860-688-7249
PH-0466	Aquatek Lab	Woodbridge	203-389-1824
NY Lab ID	**Lab Name**	**City**	**Phone**
11469	EMSL Analytical, Inc.	Carle Place	516-997-7251
11418	American Analytical Laboratories LLC	Farmingdale	631-454-6100
10950	Analytical Chemists laboratory, LLC	Farmingdale	631-414-7685
10969	Environmental Quality Services, Inc.	Farmingdale	631-249-1456
11516	Cascade Water Services	Hicksville	800-247-3973
11693	Long Island Analytical Laboratories, Inc.	Holbrook	631-472-3400
10924	Smith Laboratory	Hyde Park	845-229-6536
11273	KAM Consultants	Long Island City	718-729-1997
10328	Henningson Durham & Richardson Architecture and Engineering PC	Nanuet	845-680-0031
10478	H2M Labs Inc.	Melville	631-694-3040

CT Lab ID	Lab Name	City	Phone
11480	America Science Team New York Inc.	New York	212-679-8600
11999	Atlas Environmental Labs	New York	212-563-0400
10879	Cardno ATC	New York	212-353-8280
11506	EMSL Analytical, Inc.	New York	212-290-0051
11972	Green Planet Labs, LLC	New York	718-858-7020
11713	Advanced Analytical technologies	Orangeburg	201-484-7461
11765	pCi/LABS	Orangeburg	845-680-0031
11921	Environmental Assessment and Remediations	Patchogue	631-249-1456
10338	Certified Laboratories Inc.	Plainview	516-576-1400
11510	NY Environmental and Analytical Labs, Inc.	Port Washington	516-944-9500
11681	Enviroscience Consultants, Inc.	Ronkonkoma	631-580-3191
10667	Shapiro Engineering	Valley Stream	516-358-2955

B.5. QUALITY CONTROL

General QAPP Adoption requirement #15 (i.1.15, page 11): Project sampling shall include appropriate field and laboratory quality control samples to assess general data quality issues, as well as specific data quality objectives specified in A.7. of the project *General QAPP Adoption Form*.

Table 11 in this document summarizes the quality control measures used for a number of field and lab procedures.

- ➔ Copy and paste the appropriate entries from Table 11 found in this document in to the appropriate table in section B.5. of *The General QAPP Adoption Form*
- ➔ If an external lab facility or contractor will be analyzing samples, lab Quality Control (QC) protocols shall be discussed with the lab prior to sampling to ensure acceptability.
- ➔ Quality control shall also be discussed and defined prior to sampling (e.g., during training).

Quality control in field sampling efforts refers to the need to ensure that samples are not contaminated or altered by the sampling method (handling, state of containers, etc.). To verify that collected samples are accurate, any error associated with the act of sampling is accounted for through the use of blanks and replicates. The types of blanks and replicates have been divided into two categories addressed in the following sections: Coastal Water Quality (section B.5.a) and Biological Monitoring (section B.5.b).

- ➔ Identify the type of blanks and replicates used in the Monitoring Program by selecting the appropriate check boxes in sections B.5.a. and B.5.b. of *The General*

QAPP Adoption Form. See sections B.5.a. and B.5.b. for more details on blanks and replicates.

➔ Provide details on the Quality Control (QC) steps employed by the Monitoring Program in sections B.5.a. and B.5.b. of *The General QAPP Adoption Form*. Instructions on what to include are provided in this document, sections B.5.a. and B.5.b. ***NOTE*** – Table 11 in this document includes details on QC protocol. *The General QAPP Adoption Form* will include excerpts from this table. You may refer to the table when completing the text portion of this section, to avoid redundancy.

When working with instruments or test kits, the monitoring crews should conduct periodic inter-group comparisons. In other words, everyone should sample the same body of water at the same time and compare their results. The purpose of this inter-comparison is to find any instruments or kits which are not functioning properly or to identify individuals who are not following the required methods. These intercomparisons can be conducted during training sessions, as a proof of ability. At a minimum, they should also be conducted midway through the sampling season to check in with volunteers.

While intercomparison ideally occurs with all volunteers present, it is acceptable to compare subsets of sampling groups, provided one person is present and sampling at all such events. As an example, the Field Coordinator may schedule three mid-season reviews on June 4, 5, and 6 in order to accommodate everyone's schedule. The Field Coordinator should be present at all three events and conduct the sampling alongside the volunteers. The volunteer's results can then be compared to the Field Coordinator's results.

An intercomparison of instruments or field kits can be conducted by a single person or a few people. This is essentially a test of the instruments or kits, to ensure they are yielding accurate results. While this is an intercomparison, it is instrument or equipment specific and should thus be covered in section B.6. of *The General QAPP Adoption Form*, not in this section.

➔ Provide details on how intercomparisons will be conducted by the Monitoring Program in sections B.5.a. and B.5.b. of *The General QAPP Adoption Form*.

B.5.a. Coastal Water Quality

As a general rule, field quality control samples will be taken for 5% of all water quality samples taken.

Example numbers of QC samples required to meet an approximately 5% rate are as follows:

- 1-20 samples taken, 1 QC sample is processed.
- 21-40 samples taken, 2 QC samples are processed.
- 41-60 samples taken, 3 QC samples are processed.

Specific procedures for taking ambient field blank QC samples and field duplicate QC samples shall be stated in *The General QAPP Adoption Form*. The following information provides examples of options.

DUPLICATES - Field duplicates can be 1) side-by-side and simultaneous, 2) sequential, or 3) split from a large volume sample.

BLANKS - For most analyses, **field blanks** (transferred from one container to another in the field) are generally preferred over **trip blanks** (blank samples simply taken on the survey trip and returned unopened).

B.5.b. Biological Monitoring

As a general rule, field quality control samples should be conducted for 10% of all samples taken.

Specific procedures for taking ambient field blank QC samples and field duplicate QC samples shall be stated in *The General QAPP Adoption Form*. The following information provides examples of options.

DUPLICATES – The description of what constitutes a duplicate will be specific to the type of biological sampling. For example, field duplicates may involve field measurements by two different samplers. When the biological sampling involves identification of an organism, duplicate peer-review or expert-review of voucher specimens or photo documentation is appropriate. If photos are analyzed (e.g. percent cover of an organism, presence or absence, etc.), duplicate reviewers may analyze the same photos. A list of options is included in section B.5.b. of *The General QAPP Adoption Form*. Additional methods for collecting duplicates should be added as appropriate.

BLANKS – The concept of blanks does not usually apply to biological monitoring. Methods for collecting blanks should be added to section B.5.b. of *The General QAPP Adoption Form* as appropriate.

Table 11: Typical Quality Control Measures

Sample Type	Instrument/ Parameter	Accuracy Checks	Precision Checks	% Field QC Samples (blanks and field duplicates)
Multiprobe instruments	salinity, conductivity, temperature, oxygen, pH, turbidity, chlorophyll, light	Pre-survey calibration and post-survey checks, including "zero" DO standard check	field duplicates -or- 3-5 minutes of stable readings recorded	verify repeatability in the field

Sample Type	Instrument/ Parameter	Accuracy Checks	Precision Checks	% Field QC Samples (blanks and field duplicates)
Single probe instruments	Thermometer	Compare with certified thermometer	field duplicates -or- 3-5 minutes of stable readings recorded	5%
Single probe instruments	Conductivity & Salinity	Field blanks, QC standard	field duplicates -or- 3-5 minutes of stable readings recorded	5%
Single probe instruments	Dissolved Oxygen	Compare with audit samples or Winkler titration method	field duplicates -or- 3-5 minutes of stable readings recorded	5%
Single probe instruments	Fluorescence (Chlorophyll)	Field or lab blanks, Compare with audit samples (filter water sample for chlorophyll analysis)	field duplicates -or- 3-5 minutes of stable readings recorded	5%
Single probe instruments	Turbidity	Field or lab blanks, QC standards	field duplicates -or- 3-5 minutes of stable readings recorded	5%
Water samples – grab	Salinity - Refractometer Hydrometer	External standards, freshwater – 0 salinity	Field duplicates	5%
Water samples – grab	Dissolved Oxygen	Compare with blind QC standards (preferred) or known QC or calibration standards	Field Duplicates	5%
Water samples – grab	pH, alkalinity	Blind audit samples	Field duplicates	5%
Water samples – grab	Chlorophyll	Commercial audit samples	Field Duplicates	5%
Water samples – grab	TSS Turbidity	External audit/QC standard, distilled water lab blank.	Field duplicates Lab duplicates	5%
Water samples – grab	TP, P fractions TN TKN NH3 NO3-NO2	Field: blanks Lab: analysis of lab-fortified matrix (spiked samples) and/or lab QC standard	Field duplicates Lab duplicates	5%
Water samples – grab	fecal coliform *E. coli* enterococci	Negative and positive plates	Field duplicates Lab duplicates	5%
Water samples – grab	PPCPs (including caffeine)	Field: blanks Lab: analysis of lab-fortified matrix (spiked samples) and/or lab QC standard	Field duplicates Lab duplicates	5%
Water samples – grab	DNA markers for human-specific strains of indicator bacteria	Blind audit samples from different animals	blind audit samples from different animals	min. once per project

Sample Type	Instrument/ Parameter	Accuracy Checks	Precision Checks	% Field QC Samples (blanks and field duplicates)
Physical/visual etc.	Secchi disk Transparency tube	Annual calibration check of calibrated line	Field replicates (1-2 analysts)	5%
Physical/visual	Optical Brighteners/ Fluorescent Whitening Agents	Blank pads	Field replicates	5%
Physical/visual	Habitat assessments	NA	Different personnel conduct side-by-side assessments, compare	5%
Physical/visual	Aquatic plants	2 personnel conduct separate mappings of same area, compare results, discuss to resolve differences. 2 personnel ID plants separately. Discrepancies/unknowns taken to expert for ID confirmation.		5%
Physical/visual	Benthic Macroinvertebrates	IDs verified by external expert. 90% Accuracy of identification when Invertebrate Scientific Advisor examines a minimum of 10% of the original samples		5%
Physical/visual	Nekton	100% Accuracy of identification evaluated by the Scientific Advisor(s)		
Physical/visual	Birds	100% Accuracy of identification evaluated by the Scientific Advisor(s)		
Physical/visual	Vegetation	100% Accuracy of identification evaluated by the Scientific Advisor(s)		
Physical/visual	Tidal Hydrology		Different personnel conduct side-by-side measurement readings, compare	
Physical/visual	Land Use		Different personnel conduct side-by-side assessment, compare	
Inventory, quadrat and line transects	Algae, Eelgrass, Invertebrates	100% Accuracy to genus or species; taxonomic verification of voucher specimens by Scientific Advisor(s).		

B.6. INSTRUMENT / EQUIPMENT TESTING, INSPECTION AND MAINTENANCE

General QAPP Adoption requirement #16 (i.1.16, page 7): The project shall include a systematic process for consistently checking, testing, and maintaining instruments and equipment for proper functioning.

Maintenance of instruments and equipment shall occur as needed and as specified by the manufacturer.

Records of equipment inspection, maintenance, repair and replacement shall be kept in a logbook. A backup of the logbook will be kept in a separate location. If the logbook is digital, appropriate backups of the computer files will be maintained.

Manufacturer's recommendations and group-specific instrument maintenance procedures shall be included in the SOPs for the appropriate methods or as stand-alone SOPs.

➔ Copy and paste the appropriate entries from Table 12 found in this document in to the appropriate table in section B.6. of *The General QAPP Adoption Form*.

Table 12: Typical Instrument / Equipment Inspection and Testing Procedures

Equipment Type	Inspection Frequency	Type Inspection	Maintenance, Corrective Action
water quality meters	before each sampling date	battery life, electrical connections, membrane condition	spare membranes, batteries
pH meter	before each sampling date	battery life, level of electrolyte, integrity of probe	spare batteries, electrolyte
conductivity meter	before each sampling date	battery life	spare batteries
turbidity meter	before each sampling date	battery life	spare batteries
thermometer	before each sampling date	visual, breakage/ integrity of column	keep spares on hand
refractometer	before each use	visually for integrity	keep clean, replace as necessary
flow meter	before each use	spin test	clean after each
Secchi disk	before each use	visual for integrity, cleanliness	spare disk, spare line
calibrated line for Secchi disk	annually, or when a potential problem is noted	check the calibrated line against a meter tape	wipe tape after each use, if line has stretched or is damaged, replace immediately and note recent data as questionable

Equipment Type	Inspection Frequency	Type Inspection	Maintenance, Corrective Action
collection rake, rope	before each collection	visually for integrity	repair, replace keep spares on hand
macroinvertebrate kick nets, buckets, sieves	before each collection	visually for integrity	repair, replace keep spares on hand
Van Dorn, other sampling device	before each sampling run	visual for integrity	repair, replace as necessary
nutrient sample bottles	before each use	visual for integrity, cleanliness.	acid washed prior to delivery to volunteers
filtering apparatus (nutrients, esp. P)	before each use	proper functioning, clean storage	spare syringe, spare filters
filtering apparatus (chlorophyll, TSS)	before each use	proper functioning, clean storage	spare filters
sample prep equipment (e.g., sealer for Collier® bacteria method)	prior to each sampling	visual inspection, clean, and maintain according to manufacturer's recommendations	identify options for borrowing a sampler
incubator (bacteria analysis)	prior to each sampling	check temperature with max/min electronic thermometer (traceable to NIST)	spare batteries
autoclave (bacteria analysis)	weekly	spore check is run with a batch to ensure the autoclave is reaching proper temperature and pressure	
electronic balance (solids)	before each sampling run	visual - integrity of balance solid weight standards	return to manufacturer for calibraiton
digital titrator	before each sampling date	proper installation of cartridge, zero reset	spare cartridges, dispensing tubes

B.7. INSTRUMENT / EQUIPMENT CALIBRATION AND FREQUENCY

General QAPP Adoption requirement #17 (i.1.17, page 7): All instruments used in the project shall be calibrated at a pre-determined frequency to ensure instrument accuracy and precision for the duration of the project (with logbook documentation).

Calibration of instruments and equipment shall occur as required by the manufacturer.

Records of calibration shall be kept in a logbook. A copy of the logbook will be maintained in a separate location. If the logbook is digital, appropriate backups of the computer files will be maintained.

In addition to following manufacturer's recommendations, instrument calibration procedures specific to your organization shall be included in the SOPs for the appropriate methods or as stand-alone SOPs.

➔ Copy and paste the appropriate entries from Table 13 found in this document in to the appropriate table in section B.7. of *The General QAPP Adoption Form*.

Table 13: Typical Instrumentation Calibration Procedures
External standards refer to standards of reliable quality obtained from reputable commercial or other supplier. Known standards refer to those where the value is known before calibration

Instrument	Inspection and Calibration Frequency	Standard of Calibration Instrument Used	Corrective Action
calibrated line	annually	tape measure	recalibrate or replace with calibrated line
multi-probe meter	before each sampling run	standard solutions, according to manufacturer's recommendations	according to manufacturer's instruction
DO / other water quality meter	before each sampling run	follow manufacturer's instruction, compare against Winkler titration	replace membrane or correct instrument
conductivity meter	before each sampling run	known standards	adjust according to manufacturer's recommendations
turbidity meter	before each sampling run	external standards	adjust instrument
pH meter	before each sampling run	pH buffers 7 and 10 or external standards (pH 4 is also recommended)	adjust instrument, clean electrodes, replace electrodes
flow meter	before each sampling run	NA	according to manufacturer's instruction
thermometer	annually	NIST certified thermometer	replace or provide correction factor
refractometer	before each sampling run	fresh water, 0 salinity	recalibrate, replace, repair as needed
electronic balance (solids)	every 3 months	use of certified inspection standards	adjust and recalibrate

B.8. INSPECTION / ACCEPTANCE OF SUPPLIES AND CONSUMABLES

General QAPP Adoption requirement #18 (i.1.18, page 7): The procurement, inspection, and acceptance of sampling, analytical, and ancillary project supplies shall occur in a consistent and timely manner.

➔ Copy and paste the appropriate entries from Table 14 found in this document in to the appropriate table in section B.8. of *The General QAPP Adoption Form*.

Table 14: Typical Supplies Inspection and Acceptance Procedures

Supplies	Inspection Frequency	Type of Inspection	Available Parts	Maintenance
reagents	before each sampling date	visual inspection of quantity and expiration date	spare, fresh reagents/cartridges	storage according to manufacturer's recommendations, replacement if past expiration date
calibration standards	before each sampling date	visual inspection of quantity and expiration date	spare, fresh solutions	storage according to manufacturer's recommendations, annual replacement at beginning of sampling season
membranes, filters, bags (e.g. Whirlpak, Ziplock)	before each sampling date	visual inspection of quantity, integrity	spares	storage according to manufacturer's recommendations
field and lab sample sheets	before each sampling date	visual	additional copies	
waders or life preservers	before each sampling date	visual inspection for damage	patch kit	as needed
sample bottles	before each sampling date	integrity, cleanness and seal for nutrient bottles, verified sterility of bacterial sample bottles	one set of spare bottles	clean after use (note that nutrient bottles require acid washing before reuse)
cooler	before each sampling date	cleanness, ice packs		annually or as needed

B.9. NON-DIRECT MEASUREMENTS

General QAPP Adoption requirement #19 (i.1.19, page 7): *The General QAPP Adoption Form* shall provide detailed information for any non-project data used in developing and implementing *The General QAPP Adoption Form* or in any other way affecting the project.

To provide high-quality data to enhance the interpretation of data collected as part of this Monitoring Program, data may be acquired from a variety of qualified sources, including peer-reviewed literature, federal and state agencies, university researchers, and watershed groups.

Data may include but are not limited to: water chemistry, hypsography and bathymetry, land cover and other watershed characteristics, pollutant loads, temperature, light, salinity, suspended solids, turbidity, submerged aquatic vegetation and other biological data.

Primary data sources for this project may include but are not limited to:

- Published literature and reports
- Results and data from unpublished research
- Third party data including agency monitoring and compliance data
- Publicly available databases, e.g., USGS stream monitoring data
- Output from models
- Maps, GIS data and similar media from prior studies

Examples of these sources are summarized in Table 15.

The Monitoring Program Coordinators will ensure that all data conforms to the state government level quality assurance standards and will review DQIs established for this project to make data acceptability determinations (as listed in Table 4 of this document). The DQIs in Table 4 identify the categories of acceptance criteria that will be reviewed for this project. In addition, for chemical and physical parameters, data quality objectives and QA sample protocols established in the CTDEP LIS Monitoring Program QAPP[10] may be used as supplemental evaluation criteria to check project specific QA data (tables 16 and 17).

Table 15. Examples of Data Types and Sources.

Data	Source	Links
Water Chemistry	USGS, EPA, CTDEP, RIDEM	USGS: http://ct.water.usgs.gov/ CTDEP: http://www.ct.gov/deep/site/default.asp EPA – LIS Office: http://www.longislandsoundstudy.net/
Land Use/Land Cover	CTDEP, CLEAR	CTDEP: http://www.ct.gov/deep/site/default.asp CLEAR: http://clear.uconn.edu/
Flow	USGS	USGS: http://ct.water.usgs.gov/
Septic System Usage	US Census, CTDEP	US Census: http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml CTDEP: http://www.ct.gov/deep/site/default.asp
Point Sources	CTDEP	CTDEP: http://www.ct.gov/deep/site/default.asp
SAV	CTDEP, USFWS, EPA-Narragansett	CTDEP: http://www.ct.gov/deep/site/default.asp

Table 16. Physical variable precision goals and QA requirements from CTDEP[10].

Variable	Precision Goal	QA Sample Type	Frequency of QA	Data Generated
Depth	0.5 m	Performance verification at certified calibration facility	Annually	CTD response vs. calibration standards; annual drift
Depth	0.5 m	QC check against vessel's depth finder	Every cast	Difference between CTD station depth and on-board depth finder

[10] CTDEP, 2002. Quality Assurance Project Plan, Long Island Sound ambient water quality monitoring program. CTDEP, Bureau of Water Management, Hartford, CT. 31 p.

Variable	Precision Goal	QA Sample Type	Frequency of QA	Data Generated
Temperature	0.5 ^{o}C	Performance verification at certified calibration facility	Annually	CTD response vs. calibration standards; annual drift
Temperature	0.5 ^{o}C	QC check against secondary thermistor in DO sensor module	Every cast	CTD temperature vs. oxygen sensor temp
Salinity	0.5 psu	Performance verification at certified calibration facility	Annually	CTD response vs. calibration standards; annual drift
Dissolved Oxygen	0.5 mg/L	New membrane installation and calibration at laboratory	At least monthly; always prior to cruise	CTD response at zero and 100% saturated water; new coefficient values
D.O.	0.5 mg/L	Comparison to discrete water sample (Winkler titration)	Daily during cruise	Difference between CTD DO and chemical determination
D.O.	0.5 mg/L	Winkler Replicates: 2 when CTD DO $\leq$5mg/L; 3 when DO $\leq$3 mg/L	Daily when CTD DO $\leq$5 mg/L	precision
PAR	NA	Performance verification at certified calibration facility	At least every other year	Sensor response vs. calibration standard; drift
pH	0.3 units	QC check with standard buffers	Daily during cruise	Difference between probe and standard
Secchi depth	0.3 m	Three replicate observations and check by second crew member	At each site	precision and comparison with second crew member observation

Table 17. Chemical variable precision goals and QA requirements from CTDEP[10].

Variable	Accuracy Goal	Precision Goal	QA Sample Type	Frequency of QA	Data Generated
Ammonia (**NH_3**)	85-115%	15%	Standards, spikes, lab and field duplicates	Per batch; one cruise	Relative accuracy and precision
Nitrate + Nitrite (**NO_3^- +NO_2**)	85-115%	15%	Standards, spikes, lab and field duplicates; QC check against Day 0 wholewater BOD sample, 11 stations	Per batch; one cruise	Relative accuracy and precision; secondary NOx measurement on fresh sample
Total Dissolved Nitrogen (**TDN**)	85-115%	15%	Standards, spikes, lab and field duplicates	Per batch; one cruise	Relative accuracy and precision
Particulate Nitrogen (**PN**)	85-115%	15%	Field blanks and field duplicates	Per batch; one cruise	Precision; estimate of field contamination
Orthophosphate (**PO_4^{3-}**) or (**DIP**)	85-115%	15%	Standards, spikes, lab and field duplicates	Per batch; one cruise	Relative accuracy and precision
Total Dissolved Phosphorus (**TDP**)	85-115%	15%	Standards, spikes, lab and field duplicates	Per batch; one cruise	Relative accuracy and precision
Particulate Phosphorus (**PP**)	85-115%	15%	Standards, spikes, field blanks, lab and field duplicates	Per batch; one cruise	Relative accuracy and precision; estimate of field contamination
Dissolved Org.Carbon (**DOC**)	85-115%	15%	Standards, spikes, lab and field duplicates	Per batch; one cruise	Relative accuracy and precision

Variable	Accuracy Goal	Precision Goal	QA Sample Type	Frequency of QA	Data Generated
Particulate Carbon (**PC**)	85-115%	15%	Field blanks and field duplicates	Per batch; one cruise	Precision; estimate of field contamination
Dissolved Silica (**SiO_2**)	85-115%	15%	Standards, spikes, lab and field duplicates	Per batch; one cruise	Relative accuracy and precision
Biogenic Silica (**BioSi**)	85-115%	15%	Standards, spikes, field blanks, lab and field duplicates	Per batch; one cruise	Relative accuracy and precision; estimate of field contamination
Chlorophyll *a* (**Chl a**)	85-115%	15%	Standards, spikes, field blanks, field duplicates	Per batch; one cruise	Relative accuracy and precision; estimate of field contamination
Total Suspended Solids (**TSS**)	NA	15%	Standards, field blanks and duplicates; replicates averaged	Per batch; one cruise	Precision; estimate of field contamination
Biological Oxygen Demand (**BOD**)	NA	15%	Field duplicate	Per batch; one cruise	Precision
Hydrogen Sulfide (**H_2S)**	85-115%	15%	Standards, spikes, lab and field dups.	Per batch; one cruise	Relative accuracy and precision

To verify that any data used by this project but not collected by project personnel are of known and documented quality and are consistent with project data quality objectives, the following "metadata" will be provided for each data source ("metadata" are defined as the important information associated with sample data; examples include sampling location, date, time, type of sample, etc.):

- Title of document or descriptive name of the information.
- Source of information.
- Notes on quality of data, including whether it was collected under an EPA approved QAPP or there is some other means of demonstrating quality of the data.
- As applicable, a statement on planned restrictions in use of the data because of questions about data quality.

Specific information regarding non-project data shall be provided in the project *General QAPP Adoption Form*.

B.10. DATA MANAGEMENT

General QAPP Adoption requirement #20 (i.1.20, page 7): As detailed in *The General QAPP Adoption Form*, the project shall include a data management system.

➔ In *The General QAPP Adoption Form*, select statements to indicate agreement and provide data as needed.

Field samplers shall record data on field sheets, review them, sign, and turn them over to the Field Coordinator. The Field Coordinator will review the sheets and confer with samplers on any needed corrective action. The chain-of-custody form will be completed by the person or people designated as the responsible party in the SOPs for the Monitoring Program before forwarding the processed samples to the laboratory. Each person who handles or transports samples will also sign the custody form upon receipt of the samples. Chain of custody forms will follow samples to the lab and back to the Monitoring Coordinator by mail or pickup after each analysis run is completed.

Once laboratory analyses are complete, the laboratory personnel will mail lab results to the Monitoring Coordinator or arrange for pickup. The Monitoring Coordinator and/or Data Entry Coordinator will enter raw field and lab data into the project computer system. Computer-entered data are then compared with field sheets for accuracy. The original data sheets will be stored in the organization's office or held by the designee for the organization. Digital back-ups of entered data will be made and stored in a *separate location* designated by the Monitoring Coordinator. Any maps or other data that are not typically stored in a digital format will be copied and those copies will be stored in a *separate location* designated by the Monitoring Coordinator. One solution to dealing with the back-up of non-digitized data is to scan the material into a .pdf file or image file (.jpg, .gif, .png).

Data quality control steps will be taken at several stages, as outlined in Table 18 of this document. Documentation of data recording and handling, including all problems and corrective actions, shall be included in all preliminary and final reports.

The project *General QAPP Adoption Form* shall describe program-specific data management systems - e.g. spreadsheets, databases (preferably compatible with Microsoft Excel and Access), statistical or graphical software packages, location of data records (paper and electronic), and examples of forms and checklists.

Table 18: Data Management, Review, Validation, Verification Process

Activity	By whom	Corrective action, if needed
Check labels just prior to sampling, to ensure correct labeling of container.	Field sampler	Correct label or change container.
At time of sampling, record data, sign field sheets.	Field sampler	Remind samplers of proper procedures; retrain if needed.
Fill out, sign chain of custody (CoC) forms for any samples going to lab.	Field sampler or designated person	Remind person of proper procedures; retrain if needed.
Before turning field sheets over to field/monitoring coordinator, check for reasonableness to expected range, completeness.	Field sampler	Resample if feasible; otherwise, flag suspect data.

Activity	By whom	Corrective action, if needed
Upon receipt of field sheets, recheck for reasonableness to expected range, completeness, accuracy, and legibility. Sign CoC form.	Field Coordinator or Monitoring Coordinator	Confer with field sampler(s) immediately or within 24 hours. Resample if feasible; otherwise, flag suspect data.
Upon receipt of samples, field sheets and CoC forms, check to see that sheets and forms correspond to number of samples, condition of samples as stated on CoC forms. Sign CoC forms. Copies of field sheets and CoC forms are made, given to field/monitoring coordinator.	Lab Coordinator or Field Coordinator or Monitoring Coordinator	Confer with field/monitoring coordinator. Contact field samplers as needed to locate missing samples, data records. In case of missing/spoiled samples or data records, authorize resampling as needed and feasible. If resampling is not feasible, flag all suspect data.
Upon completion of laboratory analyses, fill out lab sheets, including data on QC tests. Review for reasonableness to expected range, completeness. Make copies of lab sheets.	Lab Coordinator	Re-analyze if possible. If not, confer with monitoring coordinator. Flag all suspect data and note these in the final quality control report. If flagged data are likely to result in erroneous conclusions, do not include.
Upon receipt of lab sheets, review for completeness and legibility.	Monitoring Coordinator or Data Entry Coordinator	Confer with Lab Coordinator.
Upon completion of data entry, print out raw data. Compare with field/lab sheets for accuracy.	Data Entry Coordinator or other volunteer. Data entry personnel may review their own work, but a different person than data entry person shall perform the final accuracy comparison.	Re-enter data.
Translate raw data printouts into preliminary data reports: run statistical analyses and/or prepare graphical summaries of data. Check for agreement with QC objectives stated in Tables 4 and 11 for completeness.	Monitoring Coordinator or Data Entry Coordinator	Confer with QA Officer. Flag or discard suspect data.
In-season (at least once) and end of season review of collected data sets (individual sample runs and season-total compilations); review for completeness and agreement with QC objectives and DQOs.	Monitoring Coordinator TAC if applicable Share with QA Officer	Flag or discard suspect data. Decide upon any restrictions in use of data with respect to original data use goals.

C. Assessment and Oversight

"The elements in this group address the activities for assessing the effectiveness of the implementation of the project and associated QA and QC activities. The purpose of assessment is to ensure that the QA Project Plan is implemented as prescribed."

– quoted from *EPA Requirements for Quality Assurance Project Plans (EPA QA/R-5)*

C.1. Assessment and Response Actions

General QAPP Adoption requirement #21 (i.1.21, page 7): The project shall have a defined process for identifying and effectively addressing issues that affect data quality, personal safety, and other important project components.

➔ In *The General QAPP Adoption Form*, select statements to indicate agreement.

The progress and quality of the monitoring program shall be assessed to ensure that the objectives are being accomplished. The Monitoring Coordinator will periodically check to see the following:

a. Monitoring is occurring as planned;
b. Sufficient written commentary and supporting photographs exist;
c. Sufficient volunteers are available;
d. Volunteers have been observed as they sample their sites;
e. Samplers are collecting in accordance with project schedules;
f. Data sheets and custody control sheets are being properly completed and signed;
g. Data are properly interpreted;
h. Plans for dealing with adverse weather are in place;
i. Retraining or other corrective action is implemented at the first hint of non-compliance with the QAPP or SOPs;
j. Labs are adhering to the requirements of their QAPP, in terms of work performed, accuracy, acceptable holding times, timely and understandable results and delivery process;
k. Data management is being handled properly, i.e. data are entered on a timely basis, is properly backed up, is easily accessed, and raw data are properly stored in a safe place;
l. Procedure for developing and reporting the results exists.

The Monitoring Coordinator shall confer with the QA Officer as necessary to discuss any problems that occur and what corrective actions are needed to maintain program integrity. In addition, the Monitoring Coordinator and QA Officer shall meet at the end of the sampling season, to review the draft report and discuss all aspects of the program and identify necessary program modifications for future sampling activities. If the program

includes a technical advisory committee, the TAC shall be included in these discussions. All problems discovered and program modifications made shall be documented in the final version of the project report. If modifications require changes in the Quality Assurance Project Plan, these changes shall be submitted to the QAPP distribution list for review.

If data are found to be consistently outside the Data Quality Objectives as defined in section A.7. of this document and detailed in section A.7. of *The General QAPP Adoption Form*, the Monitoring Coordinator and the TAC (as applicable) shall review the program and correct problems as needed. Corrections may include retraining volunteers; rewriting sampling instructions; replacement of volunteers; alteration of sampling schedules, sites or methods; or other actions deemed necessary.

C.2. REPORTS TO MANAGEMENT

General QAPP Adoption requirement #22 (i.1.22, page 7): The project shall include a reporting mechanism for project data. Reporting shall include raw data, QC data, and important metadata.

- ➔ In *The General QAPP Adoption Form*, select statements to indicate agreement.
- ➔ Complete the table in section C.2. of *The General QAPP Adoption Form*.

Data that have passed preliminary QC analysis as described in Table 18 may be posted on the organization's web site, shared with the local media or at other venues (e.g. kiosks at recreation access sites), and submitted to the LISS, NEIWPCC, IEC, NYS DEC, and/or CT DEEP. A caveat will accompany these or any data released on a preliminary basis, explaining that they are for review purposes only and subject to correction after completion of a full data review occurring at the end of the sampling season.

The Monitoring Coordinator will write a final report, with assistance from the QA Officer. This will be sent to the distribution list (as defined in section A.3. of *The General QAPP Adoption Form*). The final report will include (updated as necessary) any tables and graphs that were developed for initial data distribution efforts (i.e. the web site and media), and it will describe the program's goals, methods, quality control results, data interpretation, and recommendations. This report may also be used in public presentations.

All reports, preliminary or final, will include discussion of steps taken to assure data quality, findings on data quality, and decisions made on use, censor, or flagging of questionable data. Any data that are censored in reports will be either referred to in this discussion, or presented but noted as censored.

D. Data Validation and Usability

"The elements in this group address the QA activities that occur after the data collection or generation phase of the project is completed. Implementation of these elements ensures that the data conform to the specified criteria, thus achieving the project objectives."

– quoted from *EPA Requirements for Quality Assurance Project Plans (EPA QA/R-5)*

D.1. Data Review, Verification, and Validation

General QAPP Adoption requirement #23 (i.1.23, page 7): All project data, metadata, and quality control data shall be critically reviewed to look for problems that may compromise data usability.

➔ Describe the plan for reviewing, verifying, and validating the data.

The following is the suggested plan for achieving the review, verification, and validation of the data. In The General QAPP Adoption Form, modify this plant to fit your organization.

The Monitoring Coordinator will review field and laboratory data after each sampling run and take corrective actions as described in Table 18 of this document. At least once during the season, at the end of the season and if questions arise, the Monitoring Coordinator will share the data with the QA Officer to determine if the data appear to meet the objectives of the QAPP. Together, they will decide on any actions to take if problems are found.

D.2. Verification and Validation Methods

General QAPP Adoption requirement #24 (i.1.24, page 7): *The General QAPP Adoption Form* shall explain how all project data and metadata are reviewed and approved as usable data (and as un-usable when the data are questionable for any reason).

➔ In *The General QAPP Adoption Form*, select statements to indicate agreement.

Data verification and validation will occur as described in Table 18, and will include checks on:

- Completion of all fields on data sheets; missing data sheets
- Completeness of sampling runs (e.g. number of sites visited / samples taken vs. number proposed, were all parameters sampled / analyzed)
- Completeness of QC checks (e.g. number and type of QC checks performed vs. number / type proposed)
- Number of samples exceeding QC limits for accuracy and precision and how far limits were exceeded.

D.3. RECONCILIATION WITH USER REQUIREMENTS

General QAPP Adoption requirement #25 (i.1.25, page 7): *The General QAPP Adoption Form* shall describe a process whereby resulting data are compared to the planned DQOs in the project *General QAPP Adoption Form* and the results of this analysis are reported.

➔ In *The General QAPP Adoption Form*, select statements to indicate agreement.

➔ Describe how project data are compared to the program's data quality objectives (DQOs) and the mechanisms used to accomplish the reconciliation.

At the conclusion of the sampling season, after all in-season quality control checks, assessment actions, validation and verification checks and corrective actions have been taken, the resulting data set will be compared with the program's data quality objectives (DQOs) as defined in section A.7. of *The General QAPP Adoption Form*. This review will include, for each parameter, calculation of the following:

- Completeness goals: overall % of samples passing QC tests vs. number proposed.
- Percent of samples exceeding accuracy and precision limits.
- Average departure from accuracy and precision targets.

After reviewing these calculations, and taking into consideration such factors as clusters of unacceptable data (e.g. whether certain parameters, sites, dates, volunteer teams, etc. produced poor results), the Monitoring Coordinator, QA Officer, and TAC members (as applicable) will evaluate overall program attainment of DQOs and determine what limitations to place on the use of the data, or if a revision of the DQOs is allowable.