

Title and Approval Page (A1)

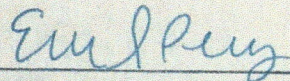
Quality Assurance Project Plan for Cape Cod Ponds Monitoring Program

Revision: 0

EPA Grant #: 00A00370 (RAE Sub-award: SNEPWG18-9-CCC)
RFA 20178

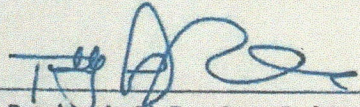
Lead Organization: Cape Cod Commission

Partner Organization(s): Association to Preserve Cape Cod and Center for Coastal Studies, October 1, 2021



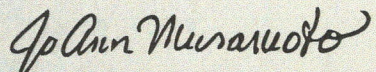
Erin Perry – Cape Cod Commission

10/7/2021
Date



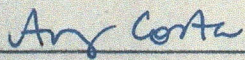
Tim Pasakarnis, Ph.D. – Cape Cod Commission

10/1/2021
Date



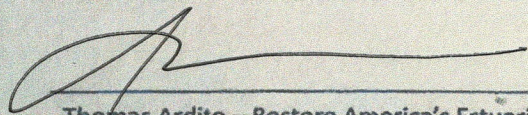
Jo Ann Muramoto, Ph.D. – Association to Preserve Cape Cod

10/12/21
Date



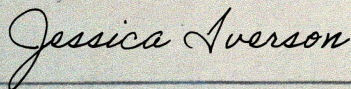
Amy Costa, Ph.D. – Center for Coastal Studies

10-8-2021
Date




Thomas Ardito – Restore America's Estuaries Grant Manager

10/15/21
Date



Jessica Iverson – EPA Quality Assurance Officer

10/25/21
Date



Margherita Pryor – EPA Project Officer

10/15/21
Date

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Amy Costa, Ph.D. – Center for Coastal Studies	Date
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Section A: Project Management

The following section provides information regarding the background of the Cape Cod Pond Monitoring Program, the tasks involved in completing the project, and the names and responsibilities of key project team members.

A4: Project/Task Organization

The Cape Cod Commission (Commission) is the regional planning agency for Cape Cod (Barnstable County), established through the passage of the Cape Cod Commission Act in 1990 (<https://www.capecodcommission.org/about-us/ccc-act/>). The Act identifies the region as possessing unique natural, coastal, scientific, historical, cultural, architectural, archeological, recreational and other values that are threatened and may be irreparably damaged by uncoordinated or inappropriate uses of the region's land and other resources. The Act charges the Commission with protecting, preserving, and enhancing these unique values. The Commission's mission is to protect the unique values and quality of life on Cape Cod by coordinating a balanced relationship between environmental protection and economic progress (<https://www.capecodcommission.org/about-us/ccc-overview/>).

By developing a comprehensive Quality Assurance Project Plan (QAPP) for the Cape Cod Ponds Monitoring Program, the Commission and its partners the Association to Preserve Cape Cod (APCC) and Center for Coastal Studies (CCS) will be able to initiate and maintain a Cape-wide pond water quality monitoring program to collect data that will inform pond management, restoration and protection actions. The data will be incorporated into a regional database developed by the Commission and used to evaluate pond water quality and model nutrients and climate change parameters. The QAPP will strengthen the Commission's pond water quality data collection process and enhance its ability to share and integrate pond data across private and academic institutions, and provide data to state and federal agencies for regulatory listings and other purposes. This increased capacity for standardized data sharing is significant for this project but also for future collaborations. Benefits to Cape Cod as a whole include collection of water quality data of assured quality, comparability of data across the region, acceptance of monitoring data and results by state and federal agencies that require QAPPs in order to fund and support local water quality monitoring programs, and enhanced ability to use water quality data to inform the public and decisionmakers regarding the need for pond protection and restoration.

Cape Cod Commission

The Commission manages the overall project; coordinates with APCC and CCS; disseminates program information to help recruit towns, pond monitoring organizations and volunteers; oversees the data quality assurance / quality control (QA/QC) program; maintains the QAPP; assimilates the Cape Cod Ponds water quality monitoring data into the regional database; maintains and analyzes the data, and manages an online interface so the data are available to the public and end-users including, but not limited to, the Cape Cod Water Protection Collaborative ("Collaborative"), a group with representatives from all fifteen Cape Cod towns and two Barnstable County representatives; APCC; individual towns; pond associations; other organizations; and other end-users such as scientists, restoration consultants, and regulatory agencies.

Association to Preserve Cape Cod

The Association to Preserve Cape Cod assists the Commission in developing the QAPP and distributing it to volunteers, outreach and recruiting of pond monitoring organizations and volunteers to monitor

ponds; provides training and coordination of volunteers who collect water samples; coordinates equipment distribution and calibration; provides preliminary QA/QC of data; and is an end-user of the data generated from the project through APCC's State of the Waters: Cape Cod project.

Center for Coastal Studies

The Center for Coastal Studies provides sampling logistics support and laboratory analyses of water samples collected by volunteers, in accordance with standard operating procedures and this QAPP.

Restore America's Estuaries

Restore America's Estuaries (RAE) has been selected by the Environmental Protection Agency (EPA) to manage the Southeast New England Watershed Grant Program (SNEP) for 2018 and 2019. RAE will oversee fiscal and technical aspects of the grant project.

EPA

The Environmental Protection Agency is the grantor to RAE for the grant funds being used for this project. The EPA will review and approve this QAPP.

See **Figure 1** for organizational chart.

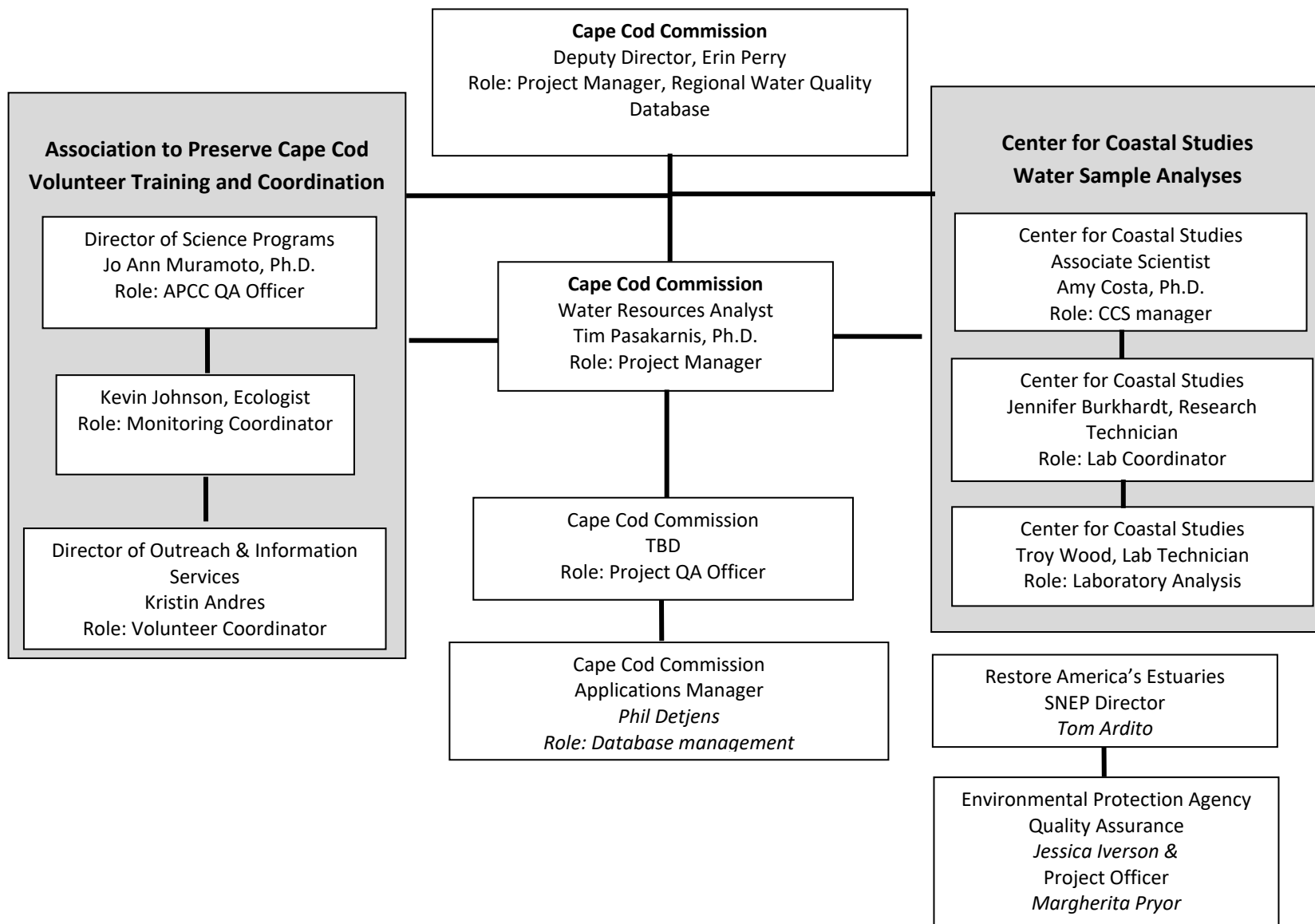


Figure 1: Organizational chart for Cape Cod Pond Monitoring Program Quality Assurance Project Plan.

Table 1: Project Team, Cape Cod Ponds Monitoring Program.

Name	Title	Organization	Project Role and Primary Responsibility
Erin Perry	Deputy Director	Cape Cod Commission	<u>Project Manager for Regional Water Quality Database</u> : Project lead for the Southeast New England Program Watershed Grant and Regional Water Quality Database. Oversees Ponds Monitoring project and coordination with partners; takes any corrective actions necessary to meet QAPP objectives.
Tim Pasakarnis	Water Resources Analyst	Cape Cod Commission	<u>Project Manager</u> : General program oversight and development, including sampling design, data collection procedures, data management, and coordination with analytical lab (CCS). Coordinates data distribution with partner organizations and maintains QAPP document.
TBD	TBD	Cape Cod Commission	<u>Project QA Officer</u> : Oversees all aspects of data QA/QC, including coordination of QA/QC with APCC and CCS; oversees all database QA/QC procedures; identifies issues; and recommends corrective actions.
Jo Ann Muramoto, Ph.D.	Director of Science Programs	Association to Preserve Cape Cod	<u>APCC QA Officer</u> : Develops the QAPP and provides updates or revisions as needed; reviews staff and volunteer operations to ensure QAPP is followed; provides QA/QC training to staff and volunteers; conducts initial QA/QC review of field data and relays results to Project QA Officer; verifies chain-of-custody protocols are followed.
Kevin Johnson	Ecologist	Association to Preserve Cape Cod	<u>APCC Monitoring Coordinator</u> : Oversees all field operations and ensures QAPP is followed; trains and coordinates volunteers; calibrates and maintains equipment; coordinates bottles and sample transfer from/to lab (CCS); and conducts monitoring as needed.
Kristin Andres	Associate Director for Education and Information Services	Association to Preserve Cape Cod	<u>APCC Volunteer Coordinator</u> : Assists the APCC Monitoring Coordinator and QA Officer with coordination and organization of volunteers; organizes annual training

			event; prepares training and outreach materials for volunteers.
Amy Costa, Ph.D.	Associate Scientist	Center for Coastal Studies	<u>CCS Manager</u> : Oversees Water Quality Monitoring lab; reviews staff operations to ensure QAPP is followed; leads/supervises lab analyses; maintains chain of custody documentation; provides QA/QC check of lab data in accordance with standard operating procedures.
Jennifer Burkhardt	Lab Coordinator	Center for Coastal Studies	<u>CCS Lab Coordinator</u> : Coordinates bottles and data transfer; maintains chain of custody documentation; conducts initial QA/QC check; performs lab analyses.
Troy Wood	Lab Technician	Center for Coastal Studies	<u>Performs lab analyses, conducts QA/QC checks</u>
Volunteers	Cape Cod Ponds Monitoring Volunteers	Association to Preserve Cape Cod	Collect field data and water samples.
Phil Detjens	Applications Manager	Cape Cod Commission	<u>Applications Manager</u> : Assimilates data into regional database; manages online access.
Tom Ardito	Director	Restore America's Estuaries	<u>EPA Southeast New England Program Watershed Grant Manager</u> .
Jessica Iverson	Quality Assurance	EPA	Reviews and approves QAPP
Margherita Pryor	Project Officer	EPA	Reviews and approves QAPP

A5: Problem Definition/Background

Background

Cape Cod (Barnstable County) is a peninsula located in Southeastern Massachusetts which is connected to mainland Massachusetts via three bridges. There are 15 towns (Barnstable, Bourne, Brewster, Chatham, Dennis, Eastham, Falmouth, Harwich, Mashpee, Orleans, Provincetown, Sandwich, Truro, Wellfleet and Yarmouth). The year-round population is approximately 222,230 residents of various ages and income levels, but the seasonal population increases greatly during the summer to more than twice this number. Shore areas, both coastal and fresh, attract residents and visitors alike due to their scenic value and recreational opportunities for swimming, boating and fishing.

The Cape has 996 freshwater ponds and lakes that cover nearly 11,000 acres and range in size from less than one acre to 735 acres, including 166 freshwater ponds of greater than 10 acres ("Great Ponds"

under MGL, Chapter 91). Locally freshwater ponds and lakes are often called ponds regardless of size, and that terminology is used here. Freshwater ponds are found in all 15 towns. Most ponds are hydrologically connected to groundwater and are groundwater-fed, though many ponds also connect directly to estuaries via streams or rivers.

Cape Cod's freshwater ponds are ecologically rich and extremely fragile. Ponds provide important spawning and nursery habitat for migratory fish such as river herring and American eels, and there are at least 41 active herring runs extending from such ponds to the sea. A number of ponds provide critical habitat for state-listed species and sensitive natural community types such as coastal plain pond shores and Atlantic white cedar swamps. These community types are relatively unique, and the majority of their global distribution is within Barnstable County and Southeastern Massachusetts. Ponds are also important resources for recreational and homeowner uses. While only one pond is used as a public drinking water source, most ponds on the Cape are hydrologically connected to the Cape Cod aquifer which serves as the region's sole source for drinking water.

In 2001, the Commission and a number of regional and local partners began monitoring pond water quality as part of the Cape Cod Ponds and Lakes Stewardship (PALS) program. Data generated by early PALS program sampling was used to publish the 2003 Cape Cod Ponds and Lakes Atlas (Pond Atlas), and the PALS program has continued to collect annual snapshots from a changing roster of individual ponds. Monitoring results were provided to towns, organizations and the public via reports and workshops. Pond and watershed associations and individual towns have assisted by collecting PALS data with their available resources. The Commission and partners frequently receive inquiries from residents regarding the water quality and existence of monitoring data for individual ponds, and often refer to the rather outdated Ponds Atlas and subsequent PALS data to answer many of these questions.

Many concerns relate to eutrophication of ponds. In 2018 the Commission received EPA SNEP funding to initiate an effort called the "Regional Collection and Analysis of Cape Cod Water Resources Data to Inform Local Decision-Making" (aka "Cape Cod Regional Water Quality Monitoring Program") to collect water quality data from Cape Cod, organize and evaluate old and new data, and provide feedback to citizens and town decision-makers about water resource status and management concerns. This has been a successful program to date and the addition of the freshwater pond monitoring program will add valuable data on pond water quality to this database making it accessible to towns, pond and watershed associations, resource managers, decisionmakers, the State and EPA.

Problem Definition

Based on historical data and ongoing monitoring, freshwater pond water quality throughout the Cape has become significantly degraded by human activities and land use. The 2016 Massachusetts 303d list of impaired waters lists twenty ponds in nine towns as Category 5 water bodies requiring Total Maximum Daily Loads (TMDL) due to excess nutrients, harmful algal blooms, dissolved oxygen deficiencies, or chlorophyll. In 2019 and 2020 APCC reviewed historical snapshot pond water quality data collected by the Commission, consisting mainly of PALS Program monitoring, for the purpose of grading water quality through APCC's State of the Waters: Cape Cod project (www.capecodwaters.org). The results showed that only 174 ponds or 17% of the Cape's 996 ponds have ever been monitored, and less than three dozen have consistent data from 2015 on. Thus, the vast majority of the Cape's freshwater ponds have not been monitored or have not been monitored recently. Of the ponds that have been monitored, many show signs of eutrophication including excess nutrients, harmful algal blooms, low dissolved oxygen, poor water clarity, and/or high chlorophyll concentrations. The main

cause of nutrient pollution of ponds is discharge from nearby septic systems, but stormwater runoff and fertilizer can also be significant sources of nutrient pollution to ponds. Other causes of impairment include mercury contamination which is outside the scope of this QAPP.

The lack of comprehensive pond water quality data from ponds across the Cape hampers restoration and management of ponds even as pond associations and residents call for improvement of water quality in their ponds. Establishing a consistent monitoring program based on past monitoring that includes a regular review and reassessment will provide the Commission and local, regional and state resource managers with a consistent and reliable basis for management of pond and lake water quality.

Towns are ultimately responsible for implementing nutrient reduction strategies to preserve and restore the health of these degraded water bodies. In many areas across the region however, development density is not adequate to support cost-effective traditional collection and treatment of wastewater via sewerage. In response, the Area Wide Water Quality Management Plan for Cape Cod (208 Plan) was updated in 2015 to provide a framework of traditional and non-traditional strategies for estuarine and freshwater quality improvement available to assist towns with water quality improvement. Although the 208 Plan focuses on nitrogen as the major target for improving water quality in estuaries, nutrient loading (both nitrogen and phosphorus) is similarly impacting freshwater ponds and streams and should also be addressed in a strategic manner. Having high-quality pond data guided by a QAPP is important for helping communities to develop effective, environmentally safe and defensible pond protection and restoration methods.

The 208 Plan's efficacy as a framework for local water quality management depends on the ability to ground truth and record if strategies are effective in improving water quality. Towns must revisit implementation plans periodically for consistency with the 208 Plan and municipal separate storm sewer system (MS4) permits and to maintain compliance with Watershed Permits issued by the Massachusetts Department of Environmental Protection (DEP). In most cases, towns must revisit plans at least every five years, and adjust their approaches through adaptive management actions as necessary. Reliable high-quality data are needed to evaluate and determine the success – or failure – of selected approaches. Moreover, a body of regional pond water quality data would enable local, regional, state and federal managers to determine the efficacy of water quality improvement and restoration efforts at a variety of scales.

Although there are several local research institutions and non-governmental organizations that provide pond water quality monitoring services, frequently the data are not readily available, easily accessible or understandable for town officials and the public. Current pond monitoring efforts are being conducted by individual towns and organizations working on their own. Furthermore, there is no approved QAPP for pond monitoring which governs QA/QC for sample collection, analysis and reporting. Having an approved QAPP for monitoring will help to provide quality data which can be used to compare water quality throughout the region and provide a basis for determining additional water bodies to include on the State Integrated List of Waters. State and federal agencies are also increasingly requiring a QAPP as a condition for awarding grants for water quality monitoring, and the lack of an approved pond monitoring QAPP creates additional burden for towns and organizations seeking to obtain funding for monitoring.

Addressing Needs

To address these needs, the Commission proposes a new Cape Cod Ponds Monitoring Program (CCPMP) as a component of the Cape Cod Water Quality Monitoring Program. The CCPMP will begin as a snapshot monitoring program that is designed to provide initial and continuing long-term data about the status of selected ponds. Sampling will occur initially during August-September of each calendar year to reflect what are likely to be worst water quality conditions in the selected ponds. Pending availability of funding and samplers, additional sampling events may be scheduled to assess baseline conditions in the spring or to examine specific events or conditions during the summer. This QAPP will be amended as needed to accommodate additional planned sampling events.

Once snapshot data has been gathered, reporting and public feedback will focus on the production of a new edition of the Cape Cod Ponds Atlas. The Atlas will build upon the previous edition to update characteristic information about the listed ponds, their physical data, provide a synthesis of past sampling data, and make assessments of the status of individual ponds where appropriate. It is anticipated that these efforts will initiate an on-going effort that will include regular public feedback and updates.

Goals

Goals for the CCPMP are to:

- Establish a standard and consistent strategy to collect water quality data from the Cape's ponds;
- Collect new data;
- Enter data into the Commission's Regional Water Quality Database;
- Organize and evaluate old and new data;
- Engage municipal and citizen monitoring groups; and
- Provide data and analysis in an easily understood format and transparent manner to citizens and local, regional, state and federal decision-makers about pond status and management concerns.

The Cape Cod Pond Monitoring Program will gather water quality data on selected ponds, incorporate new data and existing historical data into the Regional Water Quality Database, share updated data and analysis through a new edition of the Cape Cod Pond and Lake Atlas, and build a sustainable sampling model to continue pond monitoring beyond the timeframe funded by EPA SNEP funding. Monitoring results will be made publicly available through the Commission's website for the Cape Cod Regional Water Quality Database and will be updated on a regular basis as new information becomes available. The Commission will work with project partners such as towns and pond associations, to share project findings in multiple settings and through various media outlets.

Having an approved Ponds Monitoring QAPP in place would provide the following benefits to all Cape Cod towns and organizations that participate:

- Readily accessible and easily understood data;
- Systematically collected monitoring data of high quality to inform development of pond protection and restoration efforts, to track restoration progress, and enable comparison of water quality between ponds and throughout Cape Cod;
- Documented baseline level of data quality that supports its use for regulatory listing purposes;
- Reconnaissance-level or preliminary assessment of pond water quality to inform whether more in-depth or detailed pond monitoring studies are needed;

- Increased adoption of town sponsored pond monitoring programs, secure in the knowledge that their data will be accepted by state and federal agencies for use in pond protection and restoration programs;
- Facilitation in obtaining grants for pond monitoring from state and federal agencies which require QAPPs for monitoring programs; and
- Increased level of citizen stewardship to foster pond protection and restoration efforts, and a sustainable long-term network of volunteers.

A6: Project Task Descriptions

There are six main tasks associated with the CCPMP. See Table 2 for a list of tasks and general timeframe associated with each task.

Table 2: Project Tasks and Schedule. *Note that Tasks 2 – 6 will repeat each year of pond monitoring into the foreseeable future.*

Task	Deliverable	Timeline
1. QAPP Development	Pond Monitoring Program QAPP	September 2020 –September 2021
2. Field Season Preparation and Training	Annual in-person or virtual volunteer training workshop	April – July, Annually
3. Pond Sampling, Data Collection & Analysis	Preliminary data set of field and lab measurements	August – September, Annually
4. Routine QA / QC Checks		August – September, Annually
5. Final Data Review	Reviewed and finalized data set	September – December, Annually
6. Final Reporting	Update to Ponds Atlas	January – April, Annually

Task 1: QAPP Development

The first step for the CCPMP involves preparing the QAPP to guide field season preparation and training (Task 2), data collection including sample collection and sample analyses (Task 3), quarterly QA checks (Task 4), final data review (Task 5), and reporting (Task 6).

This QAPP describes the management system and procedures, as well as the roles and responsibilities of the Project Team. The QAPP provides an overview of the project and quality assurance procedures related to data used for the project. Commission staff will be responsible for maintenance and distribution of the approved QAPP, which will be provided electronically as needed.

Task 2: Field Season Preparation and Training

Following QAPP development, at the beginning of each year (January – March) APCC will conduct an inventory of field sampling equipment and verify equipment calibrations and maintenance are conducted as needed. The Center for Coastal Studies will also prepare for lab analysis of samples. Annual training of volunteers from towns and pond monitoring groups will be conducted from April through July, and any necessary equipment replacement or upgrades will be arranged in advance of the start of the sampling season in August. APCC staff assisted by Commission staff will conduct training for all sampling personnel and volunteers. Training will review sampling protocols, equipment use, sample handling procedures, sampling safety, and pre-sampling checklists; with an emphasis on consistency of sampling techniques. See Section A8 for more details regarding training events. This task will occur annually.

Task 3: Data Collection: Pond Sampling and Analyses

Data collection (water sample collection and analyses) will be conducted in accordance with sampling and analysis procedures detailed in Section B from August 1 to September 30. Equipment calibrations will occur as needed throughout the sampling season – see Section B for more information regarding calibrations and other equipment protocols. This task will occur annually.

A list of ponds to be monitored is still in the process of being developed. Criteria such as pond access and history of monitoring will be used to help select ponds for monitoring. Additional detail regarding the criteria for pond selection is contained in Section B1. Once the ponds are selected Appendix A will be populated. Prior to each year's sampling season, and if funds and resources allow, additional ponds will be added to the list. To keep track of pond monitoring tasks as they are completed, a task tracking sheet will be maintained by the APCC Monitoring Coordinator to enable the Project Manager to track monitoring activities as they are completed (Appendix B, Tracksheet for Cape Cod Ponds Monitoring Activities).

Pond sampling and analyses

Pond water quality will be monitored for the following parameters:

- 1) Temperature (field measurement)
- 2) pH (field measurement)
- 3) Conductivity / salinity (field measurement)
- 4) Dissolved oxygen (field measurement)

- 5) Water clarity (field measurement)
- 6) Alkalinity (lab analysis)
- 7) Total Phosphorus (lab analysis)
- 8) Total Nitrogen (lab analysis)
- 9) Nitrate / nitrite (lab analysis)
- 10) Orthophosphate (lab analysis)
- 11) Ammonium (lab analysis)
- 12) Chlorophyll-a (lab analysis)
- 13) Phaeophytin (lab analysis).

The Association to Preserve Cape Cod Monitoring Coordinator and/or volunteer monitoring groups and individuals will collect field measurements and water samples for lab analyses.

The Center for Coastal Studies will conduct laboratory analyses of water samples. Laboratory procedures are described in the *CCS QAPP for Water Quality Monitoring in Cape Cod Bay* (Appendix G). Laboratory procedures for analysis of freshwater pond samples will be identical to those described in the CCS QAPP.

Data quality objectives for field and laboratory data are described in Section A7 and Tables 3 and 4.

Task 4: Routine QA/QC Checks

Throughout the data collection period, several layers of QA/QC checks will be performed by project partners as follow. APCC will review field data sheets and perform initial QA/QC to verify that errors have not occurred in the field or during electronic data entry before transmitting field measurement data to the Commission. Following receipt of field or lab data records and upon data import, basic and extended validation is performed by Commission staff as described in Section B5 and further detailed in the *Quality Assurance Project Plan for Regional Collection and Analysis of Cape Cod Water Resources* (Appendix I). CCS will perform QA/QC checks on laboratory analyses and sample results as described in Section B5. If problems are identified at any of these steps, the required response actions will be initiated to resolve the issue. This task will be ongoing throughout the year.

Task 5: Final Data Review

The final review of each year's data will be completed following the conclusion of sampling and within 60 days of all field and lab sampling data having been received and imported into the database. Each season's data will be examined graphically and/or through standard statistical methods, including automated outlier flagging. This task will be ongoing on an annual cycle.

Task 6: Sharing and Distribution of Monitoring Data

This task will be ongoing on an annual cycle. Reporting for the CCPMP will occur through the Commission's Regional Water Quality Database, which will provide users access to the data in near real-time once it is received, with accompanying release status information and applicable metadata. Data that passes basic and extended validation during import will be immediately available via the water quality portal as provisional data. As described in Task 5, provisional data will undergo final review at the end of each sampling season and will be designated as final data once that review is complete. To take advantage of all available long-term monitoring data, while also establishing quality control standards,

any historic data generated before or without an approved QAPP will be flagged accordingly in the database as part of the QA/QC process. The database includes sample metadata as well as an explanation of the appropriate uses and use limitations of non-QAPP approved data.

A7: Quality Objectives and Criteria

Quality Objectives

In order for the data to be useable (i.e., for inclusion in a regional water quality monitoring database, which is intended for local decision makers to track changes in aquatic ecosystem health), data must meet certain data quality objectives. These data quality objectives are listed below:

- 1) Samples collected are representative of the study area;
- 2) Data collected in the field and in the lab are accurate and unbiased;
- 3) Data sensitivity and precision fall within acceptable resolutions specified by regulatory agencies and equipment manufacturers;
- 4) Data collection is complete – missing or erroneous data does not exceed 20% of intended collection; and
- 5) Data are comparable across sites and across water quality programs.

To achieve these data quality objectives, the CCPMP will employ and satisfy the data quality objectives outlined in this section. Quality control measures to achieve these objectives are described in Section B5. The data collected will be used in making decisions regarding pond protection and management activities as described in the Program Description and Goals section. This section outlines measures to ensure samples are collected and analyzed properly, thereby meeting quality standards.

Field Measurements

Data quality objectives for water quality parameters to be measured in the field are described below and summarized in Table 3.

Representativeness

Data representativeness will be met by the following requirements:

- All sampling sites are selected to be representative of “average” late summer conditions for the water body or pollution source, when water quality is expected to be at its worst on an annual basis.
- Any abnormal or episodic conditions that may affect the representativeness of sample data are noted and maintained as metadata.
- Field blanks will be collected every sampling day and subject to all analysis procedures, including reporting, to ensure sampling and lab procedures are not adding bias to results.

Precision and Accuracy

Accuracy refers to how close a measurement is to the true or accepted value of an item. Precision refers to how close measurements of the same item are to each other. Precision can be broken down into two

components: repeatability and reproducibility. Repeatability is the variation observed when the same operator measures the same part repeatedly with the same device. Reproducibility is the variation observed when different operators measure the same part repeatedly using the same device (<https://blog.minitab.com/blog/real-world-quality-improvement/accuracy-vs-precision-whats-the-difference>).

Accuracy is ensured by utilizing standardized sampling procedures and analytical equipment that has been calibrated using standards. By following standardized procedures during maintenance and calibration, inaccurate measurements or bias is avoided. See Table 3 for the field measurement data quality criteria. These criteria are based on the equipment specifications provided by the manufacturer and are dependent on calibration accuracy. See Section B for more information regarding standard operating procedures for equipment calibrations.

Sampling precision is ensured by obtaining duplicate water samples for analyses:

- Duplicate field samples are required for approximately 10% of samples for each sampling run. A unique identifier will be assigned to the duplicate and noted in the Field Monitoring and Chain-of-Custody Form (Appendix F).
- Duplicate samples are collected from the same sample collection. Duplicate samples are obtained by filling two 1-liter (L) bottles from the same collection samplers.
- Upon receipt of field duplicate results, the CCS Lab Manager will review to ensure samples are within an acceptable range, normally $\pm 10\%$.

Comparability

The comparability of project data to previously collected pond data will be ensured by using the same protocols and by following these established protocols. This will ensure that all new samples are collected following the same procedure and approach and are assayed by the same methods as in the prior surveys:

- Documenting sampling sites, times and dates and sample transport using the Field Monitoring and Chain-of-Custody Forms (Appendix F). No samples will be accepted at the CCS Laboratory without completed chain-of-custody documentation. Detailed and complete sample records including the Field Monitoring and Chain-of-Custody Forms (Appendix F) will be maintained.
- Results can be compared to historical data from that station collected during the same season of previous years.
- Final reports detailing data and conclusions may be published and posted by the Commission.

Completeness

The Cape Cod Ponds Monitoring Program data are considered complete when at least 80% of the planned sampling events occur successfully. Missing data occurs primarily when poor weather conditions (e.g., high winds, storms, lightning, extreme heat) prevent sampling activities. Every effort is made to find a substitute when staff or volunteers are unavailable. The Pond Monitoring Tracksheet (Appendix B) will enable the Monitoring Coordinator, Project Manager and Project Team to keep track of monitoring activities as they are completed.

Table 3: Data quality objectives for field parameters measured using YSI water quality meter.
Information provided by YSI, Inc. at <https://www.ysi.com/proplus>

Parameter	Method	Units	Range	Accuracy	Resolution (Sensitivity)	Calibration
Temperature	YSI Professional Plus	°C	-5 – 70	± 0.2 for cable < 45 m	0.1	Manufacturer’s calibration procedure
pH	YSI Professional Plus	pH units	0-14	± 0.2 units within +/- 10° of calibration temperature;	0.01	Same as above
Conductivity	YSI Professional Plus	µS/cm	0 - 200	For a 20-m cable, ± 1% of reading or 0.001 (whichever is greater)	0.001 to 0.01 (range dependent)	Same as above
Salinity	YSI Professional Plus	ppt	0 to 70	± 1% of reading or 0.1 ppt (whichever is greater)	0.01	Same as above
Dissolved Oxygen	YSI Professional Plus	%	0 - 500	0-200%: ± 2% of the reading or 2% air saturation (whichever is greater)	0.1	Same as above
				200-500%: ± 6% of reading		
Dissolved Oxygen	YSI Professional Plus	mg/L	0-50	0-20: ± 0.2 mg/L or 2% of reading (whichever is greater)	0.01	Same as above
				20 - 50: ± 6% of reading		
Depth (non-vented)	Depth sounder	m	0-20	0.004	0.1	NA
Water clarity	Secchi disk disappearance	m	1-10 cm	NA	1 cm	NA – line is measuring tape

Laboratory Measurements

Precision and Accuracy

Precision and accuracy of laboratory procedures are ensured by the analysis of quality control (QC) samples including procedural/filter blanks, prepared standards, standard reference samples, where available, laboratory control samples, laboratory replicates and field replicates, as applicable. Table 4 lists the data quality objectives for each parameter. QC samples and procedures to assess precision and accuracy are described in Section B and Tables 5, 6 and 7 (CCS QAPP Tables 2-3, 2-4 and 2-5). Method procedural blanks for parameters that use blank correction are the batch-average uncorrected method procedural blanks.

Comparability

The Center for Coastal Studies follows strict precision, accuracy, and storage procedures and generates results using comparable methods. Data will be directly comparable to results obtained previously at the same or similar sites in other Cape Cod ponds monitored by CCS because field program design and analytical procedures are similar or identical. In addition, use of written standardized procedures ensures that sample preparation and analyses will be comparable throughout the project and with other projects. The CCS lab routinely performs water quality analyses and provides data to towns and regulatory agencies under EPA- and MassDEP approved QAPPs for other monitoring programs.

Representativeness

Representativeness is addressed in sampling design. The sampling practices and laboratory measurements that will be performed during the water quality monitoring have already been used in many systems to characterize eutrophication and/or microbiological effects on the water column and are, therefore, expected to yield data representative of the study area. Representativeness will also be ensured by proper handling, storage (including appropriate preservation, holding times and temperatures), and analysis of samples so that the material analyzed reflects the material collected as accurately as possible. Deviations from the analytical scheme described in this QAPP will be noted in the laboratory records associated with analytical batches in the QA statements.

Sensitivity

Sensitivity is the capability of methodology or instrumentation to discriminate among measurement responses for quantitative differences of a parameter of interest. The method detection limits (MDLs) provide the sensitivity goals for the procedures as outlined in Table 4. Data users should be aware that precision and accuracy generally degrade as analyte concentrations decrease. While numerical results are being reported down to the MDL, results below the lowest calibration standard will often have precision and accuracy that do not meet the data quality objectives for the project.

Completeness

The lab is expected to successfully analyze 100% of the samples provided. However, a loss of <10% of the samples will not compromise the objectives of the monitoring programs. Contamination or loss of the particulate filters is the most common form of lost data. The Tracksheet for Cape Cod Ponds

Monitoring Activities (Appendix B) will enable the Project Manager, Monitoring Coordinator, and Project Team to track lab tasks as they are completed.

Table 4. Data quality objectives for laboratory analyses. From CCS QAPP, Table 2-3, Data quality objectives.

Parameter	Units	MDL	Expected Range	Accuracy (+/-)	Precision
Alkalinity	mg/L	0.5	0 – 200	80-120 % recovery for QC std. and lab fortified matrix	<u>20% RPD</u>
Ammonia	µM	0.1	0 – 5	80-120 % recovery for QC std. and lab fortified matrix	± 0.1 µM if less than 0.5 µM or 20% RPD if more than 0.5 µM
Nitrite/Nitrate	µM	0.05	0 – 10	80-120 % recovery for QC std. and lab fortified matrix	± 0.1 µM if less than 0.5 µM or 20% RPD if more than 0.5 µM
Ortho-Phosphate	µM	0.02	0 – 3	80-120 % recovery for QC std. and lab fortified matrix	± 0.05 µM if less than 0.1 µM or 20% RPD if more than 0.1µM
Total Nitrogen	µM	0.5	0 – 30	80-120 % recovery for QC std. and lab fortified matrix	20% RPD
Total Phosphorous	µM	0.1	0 – 6	80-120 % recovery for QC std. and lab fortified matrix	20% RPD
Chlorophyll <i>a</i>	µg/L	0.02	0 – 50	75-125% recovery for QC std.	± 2.0 µM if less than 15 µg/L or 25% RPD if more than 15 µg/L

A8: Special Trainings/Certification

Training of volunteers for pond monitoring and sampling.

Pond monitoring and sampling requires the use of routine field sampling techniques and analyses that do not require specialized training. Field personnel from the Commission and APCC are experienced in using the equipment identified within this QAPP.

Trained volunteers will collect water samples and conduct water quality monitoring, under the guidance of the APCC Monitoring Coordinator and Commission staff. Pond associations with experience in water quality monitoring will be recruited to provide volunteers for the program. Further volunteer recruitment will be conducted through APCC, Commission and CCS contacts including pond associations, neighborhood associations, and town water quality committees.

Volunteers will participate in mandatory training before assisting in the program. Each spring prior to the start of training, staff from the Commission and APCC will meet to coordinate and plan for training of staff and volunteers (i.e., review standard procedures for monitoring, training volunteers, lessons learned from the previous year’s sampling program, and QA procedures). Following the initial planning session, Commission and APCC staff (Monitoring Coordinator, Volunteer Coordinator) will organize an annual meeting for volunteers each spring (e.g., May), to share findings from previous monitoring data,

review protocols, and announce any updates to the procedures. This will include review of sampling protocols, proper equipment use, sample handling procedures, sampling safety, pre-sampling checklists, and corrective actions. Additionally, any updates or improvements to the protocols will be finalized. Completion of training will be documented in the Tracksheet for Cape Cod Ponds Monitoring Activities (Appendix B).

The information covered in the trainings will be made available to each sampling team and laminated copies will be available in the lab and with the sampling equipment (see Field Checklist and Field Instructions, Appendix C and Appendix D, respectively). Presentations, meeting, and training materials will be stored on the Commission's cloud server (continuously backed-up). Additionally, all attendees are provided with copies of information, e.g., presentations, QA/QC templates and checklists, and all other relevant resources. Training information and handouts will also be made available electronically via a CCPMP website and/or Regional Water Quality Database. In addition to the annual program-wide training meeting, regional training sessions may be provided depending on location of ponds to be monitored and monitoring groups availability.

Laboratory Analyses

The lab analyses specified in Section A6, task 3 conducted by CCS are standard procedures for their lab and thus do not require any specialized training to complete the lab analytical tasks. Lab personnel are experienced in these standard protocols specified in CCS's QAPP for handling, storing, and preparing samples for analysis. If any changes to personnel occur during the project period, CCS will ensure that new employees are trained to meet the standard performance requirements.

A9: Documentation and Records

The Association to Preserve Cape Cod QA Officer will ensure that all appropriate project personnel have the most current approved version of the QAPP. The APCC QA Officer will develop updates as needed and distribute the updated QAPP via email to the Project QA Officer and project team members and volunteers.

The Association to Preserve Cape Cod's Monitoring Coordinator and Volunteer Coordinator will ensure that all volunteers and staff collecting field samples use standard data forms. Completed hard copy data forms will be collected from volunteers and will be scanned into electronic copies. Hard copy data forms and electronic data records will be maintained in both the APCC office and at the Commission.

Association to Preserve Cape Cod staff will enter field data into electronic form using Microsoft Excel. The entered data are stored locally on APCC's Share server. During the sampling season, electronic field data will be emailed or uploaded directly as .csv or Microsoft Excel (.xlsx) documents to the Commission regularly (weekly / monthly). All field datasheets will be filed and archived by year in filing cabinets located in the APCC Office. These files will be maintained in either hardcopy or electronic form for the foreseeable future (at least ten years). The Commission will also maintain electronic forms for the foreseeable future (at least ten years).

The Center for Coastal Studies will provide all lab analyses results to the Commission via email or direct upload as .csv or Microsoft Excel (.xlsx) documents. Raw data submissions and compiled files are maintained on Commission Microsoft Azure servers which are continuously backed up. Sample metadata are developed upon import and are stored with data in the water quality database.

The primary output of this project is the collection, storage, organization and dissemination of collected data. All sampling records and accompanying metadata will be made available in near real-time via the Cape Cod Regional Water Quality Database to project partners and other end-users. The Regional Water Quality Database and other associated websites will be maintained into the foreseeable future (at least ten years).

Information on data QA/QC processes is provided in Section B10.

Requested citation format:

Cape Cod Ponds Monitoring Program (CCPMP). Data accessed from the Cape Cod Commission's Cape Cod Regional Water Quality website: waterquality.capecodcommission.org; *accessed* 12 October 2012.

Section B: Data Generation and Acquisition

B1: Sampling Process Design (Experimental Design)

The Cape Cod Ponds Monitoring Program consists of a snapshot reconnaissance-level approach to monitoring pond water quality to identify potential issues that may require remediation or further in-depth monitoring or studies. Monitoring activities will include field monitoring of water quality conditions and collection of water samples for lab analyses. The field monitoring and water quality sampling tasks will be led and managed by APCC and Commission staff who will work with trained volunteers to obtain water samples. Since this is a snapshot sampling, each pond will be visited once during the August 1 to September 30 sampling period. Samples will be collected between 7 a.m. and 3 p.m. to maximize phytoplankton activity. The sampling period was selected to sample what is likely to be the worst nutrient related water quality conditions in the ponds. Individual sampling dates within the sampling period will be arranged by the monitoring coordinator based on sampler availability, lab schedule, and weather forecasts to maintain representative sampling conditions. See Table 2 for the sampling duration and frequency of the monitoring program.

Ponds will be initially selected for monitoring based on the following criteria:

- Ponds must have a public access point
- Ponds with an active monitoring presence, or a history of monitoring (but not necessarily an active group) will be prioritized
- Ponds with demand for sampling will also be prioritized. Demand could be based on interest from residents, recreational or restoration/conservation significance to the town, or other factors
- In the future, other data sets may be used to aid in the selection of additional ponds for monitoring. As specific data sets and criteria are identified, the QAPP will be updated appropriately to include those details.

The goal will be to establish a representative sample of ponds across the Cape that provide insight into regional freshwater pond water quality and how it is impacted by factors including pond size, surrounding land use, land cover, and watershed characteristics. As part of its *Comprehensive Planning for Pond and Lake Health on Cape Cod* effort, the Cape Cod Commission has developed the following draft Scope of Work for GIS analysis of Cape Cod freshwater resources.

Volunteer pond monitoring to-date has focused on ponds where there is a local or municipal interest or established pond association. Ponds monitored have been selected due to factors such as ease of access, level of interest, usage, popularity, or available funding. To help prioritize which ponds to monitor in the future in a more scientific manner than has been done in the past, the Commission will conduct a GIS analysis of Cape Cod ponds based on factors that may contribute to changes in water quality, including an assessment of potential internal and external drivers of pollution.

The Commission maintains an extensive database of information to perform this task. Ponds within defined watersheds and / or recharge areas will be assessed in relation to their built and natural surroundings to characterize potential stressors to pond water quality. Surrounding features will include sewerage areas, stormwater systems, impervious coverage, and surrounding development patterns. Based on this assessment, ponds exposed to multiple or high-level stressors that have not been monitored in the past could be prioritized for future monitoring. Similarly, seemingly unstressed ponds could be prioritized to compare with those ponds identified as stressed. Healthy ponds could serve as baseline or “controls,” to show how ponds are responding to climate change independent of other land use stressors.

As the monitoring program is expanded, information from the GIS analysis and other appropriate sources will be used to select ponds that fill gaps and allow for more representative sampling of different watershed characteristics will be prioritized. Details for that prioritization will be included in subsequent revisions to this QAPP.

B2: Sampling Methods

The field monitoring protocol requires that the deepest area of the pond be located first using a depth sounder. Sampling typically requires a small boat or kayak for access, unless a bridge or boardwalk facilitates safe collection of samples from the designated location. If a sampling location is newly established, GPS coordinates will be established and recorded prior to sampling. For existing sampling locations past coordinates will be used. At each location a pre-calibrated YSI water quality meter is used to measure temperature, pH, dissolved oxygen, and conductivity/salinity profiles at regular depth intervals (see Table 5), and a Secchi disk to measure Secchi disk transparency. Water quality samples will be collected at standardized depths through the water column using Niskin samplers or similar sample collection devices according to the following protocol shown in Table 5. All field monitoring is conducted according to the Standard Operating Procedures (SOP) for Field Sampling in Appendix E.

Table 5. Sampling depths based on total pond depth

Pond Depth	<1 m	1-9 m	9-11 m	>11 m
0.5 m	2 samples	1 sample	1 sample	1 sample
3 m			1 sample	1 sample
9 m				1 sample
1 m above bottom		1 sample	1 sample	1 sample

Samples will be collected for lab analyses of alkalinity, total phosphorus, total nitrogen, dissolved inorganic nutrients (nitrate+nitrite, ortho-phosphate, ammonium), chlorophyll *a* and phaeophytin at each pond at the water depths specified in Table 5. As detailed in Table 6, a one-liter sample is collected, and divided into three subsamples: one for Total Nitrogen and Total Phosphorus; one for Nitrate/Nitrite, Ammonia, and Ortho-phosphate; and one for Chlorophyll *a* and Phaeophytin. A separate 250 ml sample is collected for Alkalinity. A minimum of two sets of samples for lab analyses will be collected at each pond. Electronic data will be stored in the YSI memory and downloaded at the APCC office. This

sampling protocol has been used for citizen-based, volunteer pond water quality monitoring snapshots for 13 years on Cape Cod and the consistency of this approach provides a valuable comparison between the ponds in the present study and other southeastern Massachusetts ponds that are in the same ecoregion.

Table 6. Sample collection and storage for lab analysis samples. From CCS QAPP, Table 2-1 Sample collection and storage.

Parameter	Sample Container	Analytical Sample Volume per analyte	Sample Processing	Maximum Holding Time to Analysis
Total Nitrogen Total Phosphorus	1-L wide-mouth Amber HDPE bottle	125 ml	Decant into 125 ml polypropylene bottle and freeze until analysis.	28 days
Nitrate/Nitrite Ammonia Ortho-phosphate		80 ml	Pass through Nucleopore filter, freeze filtrate in 100 ml whirl pak until analysis	28 days
Chlorophyll <i>a</i> Phaeophytin		100 – 500 ml	Pass sample through Whatman GF/F. Wrap filter in foil and freeze until analysis.	28 days
Alkalinity	250 ml wide-mouth HDPE bottle	250 ml	N/A	24 hours

Total Nutrients (Nitrogen and Phosphorus)

Water from a transfer jar will be decanted into a cleaned, pre-labeled 125 ml polypropylene container. This container will receive a triple rinse with pond water from that site before being filled with sample water. The container will be stored in a cooler until it can be transferred to the lab where it will be analyzed or frozen within 8 hours. Samples will be processed according to CCS SOP for total nitrogen and phosphorus.

Dissolved Inorganic Nutrients (Ammonia, Nitrate/Nitrite, Orthophosphate)

Water will be drawn up from a transfer bottle (1 L polypropylene container) using a 60-ml syringe. The syringe will then be used to push the sample water through an in-line filter (0.4-µm-membrane filter) and into a 100-ml pre-labeled Whirl Pak. At the start of each survey day the 60-ml syringe is rinsed with 10% HCl solution then with ultrapure de-ionized water (Milli-Q). Additionally, the syringe is rinsed with

Milli-Q between each station. The sample processing begins with the syringe receiving a triple rinse with site water. The sample will be stored in a cooler until it is transferred to the lab and frozen within 8 hours.

Chlorophyll *a* and Phaeophytin

Samples for chlorophyll *a*/phaeophytin determination will be collected in dark HDPE pre-cleaned 1-liter bottles and transferred to the lab in a cooler with ice packs (4°C) within 8 hours. Samples will be processed according to CCS SOP for chlorophyll *a*/phaeophytin. Sample water will be filtered through Whatman 4.7-cm-diameter GF/F using a vacuum pump at a vacuum no greater than 6 inches Hg. The final volume, typically between 100 to 500 ml for most ponds, will result in a light green/brown residue on the filter. Using forceps, the filter will be removed from the filter holder, folded in half, and blotted on acid-free blotting paper to remove excess moisture.

Field and lab notes

All field notes and in-situ data are recorded on field datasheets (Appendix F). Data recorded in the field are entered into an electronic spreadsheet (Microsoft Excel 2007) by APCC's Monitoring Coordinator within one week of the sampling event. Lab filtration notes including staff names, sampling and filtration dates, volumes filtered, and any other pertinent information are recorded on lab datasheets and filed for future reference. Electronic field data are stored and backed up on APCC's share server.

B3: Sampling Handling and Custody

Samples will be divided, filtered as applicable, and frozen; or transferred to dark HDPE acid-washed 1-liter bottles and transported by the volunteers and or APCC's Monitoring Coordinator in coolers with ice packs (4°C) from the sampling site to the CCS lab. Duplicate quality assurance (QA) samples will be collected and analyzed for 10% of samples collected during the sampling period. All samples will be processed and frozen or delivered to the lab within six (6) hours of collection. See Appendix F for Field Monitoring and Chain-of-Custody Forms.

Sample Bottles: The Center for Coastal Studies provides pre-cleaned polyethylene bottles to APCC's Monitoring Coordinator prior to sampling. The top and side of all bottles are labeled by APCC, including the organization's name, date sample was collected, and site ID.

Chain of Custody: The Field Monitoring and Chain-of-Custody Forms are included in Appendix F. The Chain of Custody form is included with the samples upon delivery to CCS and a copy is filed with APCC's records. It includes relevant information including the date and time of delivery, the pond name and location, who retrieved the samples at the delivery site, the number of samples, and a list of the sample ID's included in the delivery. See Table 6 for holding times. If samples surpass recommended holding times, the respective data are flagged as suspect (for this and additional sample handling information, see the CCS QAPP (Appendix G).

Field and lab notes: All field notes and in-situ data are recorded in the Field Monitoring and Chain-of-Custody Form (Appendix F). The completed form is photographed in the field before enclosing a copy with the samples to be sent to the lab. Data recorded in the field are entered into an electronic spreadsheet (Microsoft Excel 2007) within one week of the sampling event. CCS lab notes including staff names, sampling and analysis dates, sample IDs and any other pertinent information are recorded on lab

datasheets and filed for future reference. Both APCC and CCS network servers are automatically backed up weekly.

B4: Analytical Methods

Laboratory analyses for dissolved inorganic nutrients, total nitrogen, total phosphorus, alkalinity, chlorophyll *a* and phaeophytin in collected pond water samples are conducted at the CCS laboratory. All lab analyses are conducted according to the CCS QAPP (Appendix G).

A brief description of the analytical methods is provided below. Table 6 summarizes the methods used for sample analysis. The analyses will be conducted as described in the SOPs listed, with are based on literature references or EPA methods. For more information regarding waste disposal, corrective actions, etc., refer to the CCS QAPP. When an analytical system failure occurs, the CCS Program Manager or Laboratory Manager contacts the data recipient (Commission) immediately. Corrections are made to the data and equipment as necessary. Personnel involved in multiple errors or equipment failures are re-trained and must re-qualify for that assay.

Table 7. Methods for analysis of total nitrogen, total phosphorus, chlorophyll *a*, phaeophytin, and alkalinity. From CCS QAPP Table 2-2 Methods of detection for analytes.

Parameter	Units	Instrument	SOP/Analysis Method
Total nitrogen	μmol/L	Astoria 2 Autoanalyzer	SOP 006/USGS 03-4174
Total phosphorus			SOP 006/USGS 03-4174
Nitrate/Nitrite	μmol/L	Astoria 2 Autoanalyzer	SOP 003/EPA 353.4
Ammonium			SOP 005/EPA 350.1
Ortho-phosphate			SOP 004/EPA 365.5
Chlorophyll <i>a</i> Phaeophytin	μg/L	Turner Trilogy	SOP 007/Modified EPA 445.0
Alkalinity	mg/L	Metrohm 855 Titrando	SOP 013/EPA 310.1

Dissolved and Total Inorganic Nutrients

(from CCS QAPP 2.4.2.1, Dissolved and Total Inorganic Nutrients)

The analyses of dissolved inorganic nutrients are based on the cited EPA methods. Dissolved inorganic nutrient concentrations are determined for samples that have been passed through a 0.4- μm pore size membrane filter in the field. The concentrations of nitrate/nitrite, ortho-phosphate, ammonia, silicate, total nitrogen and total phosphorus are measured colorimetrically on an Astoria 2 Autoanalyzer. This instrument automates standard manual techniques for analysis of nutrients.

- For analysis of total nitrogen and total phosphorus, an alkaline persulfate digestion oxidizes all forms of inorganic and organic nitrogen to nitrate and hydrolyzes all forms of inorganic and organic phosphorous to ortho-phosphate. After digestion, sample analysis for total nitrogen and total phosphorus proceeds as described below for nitrate/nitrite and ortho-phosphate respectively.
- For nitrate/nitrite analysis, nitrate in the sample is reduced quantitatively to nitrite by cadmium metal in the form of an open tubular cadmium reactor. The nitrite thus formed plus any originally present in the sample is determined as an azo dye at 540 nm following its diazotization with sulfanilamide and subsequent coupling with N-1-naphthylethylenediamine. These reactions take place in acidic solution.
- For analysis of ortho-phosphate, the ortho-phosphate in the sample reacts with molybdenum (VI) and antimony (III) in an acidic medium to form a phosphoantimonylmolybdenum complex. This complex is subsequently reduced by ascorbic acid to a heteropolyblue with an absorbance maximum at 880 nm.

Chlorophyll a and Phaeophytin

(From CCS QAPP 2.4.2.2, Chlorophyll)

Samples for chlorophyll a /phaeophytin are processed according to EPA Method 445.0 using a Turner Trilogy Fluorometer. Samples are filtered in the field as soon as possible after collection and the filters stored at -10°C . All handling steps are performed in subdued light. The chlorophyll a /phaeophytin is extracted from the cells retained on the GF/F filter by a 16-24-hour steep in 90% acetone at 4°C . The extract is analyzed using a fluorometer. 150 μL of 0.1 N HCl is added to the extract and the extract is remeasured after 90 seconds to determine phaeophytin concentrations.

Alkalinity

(From CCS SOP 13, Alkalinity)

Samples for alkalinity are processed according to EPA Method 310.1 using a Metrohm Titrando 855 auto-titrator. Samples must be stored at 4°C in the dark and analyzed with 24 hours of collection, or preserved with a saturated mercuric chloride solution and stored in a narrow mouth borosilicate glass necked bottle sealed with a ground borosilicate glass stopper coated with Apiezon high vacuum grease. Samples are then titrated to an electrometrically determined end point of pH 4.5 using H_2SO_4 .

Finalized data are received from CCS on an annual basis according to the Schedule. Please refer to the CCS QAPP for their analysis procedures and quality control steps (Appendix G).

B5: Quality Control

Data quality objectives for the CCPMP are described above in Section A7. Analytical methods for lab analyses are described above in Section B4. The Commission, APCC, and CCS will follow the procedures and data quality objectives outlined above in order to ensure quality data are collected.

Field measurements

Representativeness

To ensure representativeness, field blanks will be collected every sampling day and subject to all analysis procedures, including reporting, to ensure sampling and lab procedures are not adding bias to results. Any abnormal or episodic conditions that may affect the representativeness of sample data are noted on the field datasheet and maintained as metadata in the Excel spreadsheet containing data.

Precision and Accuracy

To ensure accuracy of the YSI water quality meter, each year the YSI meters are sent to the manufacturer for calibration. Each week during the monitoring season the YSI Proplus water quality meter is calibrated using standard solutions according to manufacturer instructions. See Table 3 in Section A7 for data quality objectives for YSI parameters (pH, temperature, conductivity/salinity, and dissolved oxygen). See Section B for more information regarding standard operating procedures for equipment calibrations.

Sampling precision is ensured by obtaining duplicate water samples for analyses:

- Duplicate field samples are required for approximately 10% of samples for each sampling run at a pond. A unique identifier will be assigned to the duplicate and noted in the Field Monitoring and Chain-of-Custody Form (Appendix F).
- Duplicate samples for lab analyses are collected from the same sample collection. Duplicate samples are obtained by filling two 1-liter (L) bottles from the same collection samplers.
- Upon receipt of field duplicate results, the QA Officer will review to ensure samples are within an acceptable range, normally $\pm 10\%$.

Comparability

The comparability of project data to previously collected pond data will be ensured by using the same protocols and by following these established protocols. This will ensure that all new samples are collected following the same procedure and approach and are assayed by the same methods as in the prior surveys:

- Documenting sampling sites, times and dates and sample transfer to the lab on the Field Monitoring and Chain-of-Custody Forms (Appendix F). No samples will be accepted at the CCS lab without a chain-of-custody form.
- Results can be compared to historical data from that station collected during the same season.
- Detailed and complete sample records including the Field Monitoring and Chain-of-Custody Forms (Appendix F) will be maintained.
- Final reports detailing data and conclusions may be published and posted by the Commission.

Completeness

The Cape Cod Ponds Monitoring Program data are considered complete when at least 80% of the planned sampling events occur successfully. Missing data occurs primarily when poor weather conditions (e.g., high winds, storms, lightning, extreme heat) prevent sampling activities. Every effort is made to find a substitute when staff or volunteers are unavailable. Tracking of planned and executed sampling events will be carried out by the APCC Monitoring Coordinator, assisted by Commission staff, using a CCPMP Pond Monitoring Excel spreadsheet for that year. Calculation of percentage of executed sampling events will be done by dividing the actual number of executed sampling events by the planned number of sampling events for that year and multiplying by 100. The Tracksheet for Cape Cod Ponds Monitoring Activities (Appendix B) will be maintained and utilized to evaluate completeness of sampling.

Laboratory analyses quality control

As further detailed in the CCS QAPP (Appendix G), both the Laboratory Manager and the QA Officer will review data to determine if it meets the quality assurance objectives. Decisions to qualify or reject the data will be made by the Laboratory Manager and the QA Officer and if required, corrective actions will be implemented as outlined in the QAPP. Table 8 and Table 9 provide the lab quality control measures and response actions to ensure that lab analyses meet data quality objectives specified earlier in Section A7 and Table 4.

Table 8. Laboratory Analytical QC for Total Nitrogen and Total Phosphorus. From CCS QAPP Table 2-4. Laboratory Analytical QC: Nutrients (Nitrate+Nitrite, Ortho-Phosphate, Ammonia, TN, and TP).

QC	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person Responsible for Corrective Action	Measurement Performance Criteria
Method Blank	1 per set of 20	< MDL	Re-run	Lab Manager	< MDL
Reagent Blank	1 per set of 20	< MDL	Re-run	Lab Manager	< MDL
Laboratory Duplicate	10% of samples	<20%RPD	Re-run	Lab Manager	<20%RPD
Internal Standards*	1 per set of 20	90-110% recovery	Re-run	Lab Manager	90-110% recovery
External Standards**	1 per set of 20	90-110% recovery	Re-run	Lab Manager	90-110% recovery

***Internal standard:** a known amount of a standard added to a test portion of a sample and carried through the entire determination procedure as a reference for calibrating and controlling the precision and bias of the applied analytical method.

****External standard:** USGS Standard Reference Nutrient Samples

**Table 9. Laboratory Analytical QC for Chlorophyll *a* and Phaeophytin. From CCS QAPP Table 2-5.
Laboratory Analytical QC: Chlorophyll *a*.**

QC	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person Responsible for Corrective Action	Measurement Performance Criteria
Method Blank	1 per set of 20	< MDL	Re-clean, re- run	Lab Manager	< MDL
Instrument Blank	1 per set of 20	< MDL	Re-clean, re- run	Lab Manager	< MDL
Laboratory Duplicate	10% of samples	<20%RPD	Qualify	Lab Manager	<20%RPD
External Standards**	1 per set of 20	90-110% recovery	Qualify	Lab Manager	90-110% recovery

***Internal standard:** a known amount of a standard added to a test portion of a sample and carried through the entire determination procedure as a reference for calibrating and controlling the precision and bias of the applied analytical method.

****External standard:** either a liquid primary chlorophyll *a* standard provided by Turner Designs or a solid secondary standard.

Data validation, reporting and verification

As detailed in the following excerpt from the *Quality Assurance Project Plan for Regional Collection and Analysis of Cape Cod Water Resources*, basic and extended data validation is performed when data is imported into the regional water quality database.

Basic data validation is performed upon import to verify that incoming data matches the WISKI database hierarchy. The WISKI software will produce error messages and restrict import for any entries that are not formatted correctly (i.e. text in a numeric field, invalid characters, impossible parameter values, etc.), for sample locations that are not established in the system or associated with the monitoring program being imported, and for parameters that are not measured by the current program. Extended data validation additionally flags any values that are accepted for import where a value already exists in the database and require the database administrator to specify for each value whether to accept or reject the proposed change.

Basic and extended data validation prevents unintended changes to database values due to incorrect sample labeling, typographic errors, value transposition, and other common data issues. Values that fail

import are logged, and the database administrator will be responsible for checking the source data and conferring with the appropriate project partner(s) to determine the source of the errors.

Analytical Methods

Data Evaluation: Both the Laboratory Manager and the Project QA Officer will review data to determine if it meets the quality assurance objectives (Tables 4, 7, 8) Decisions to qualify or reject the data will be made by the Laboratory Manager and the QA Officer and if required, corrective actions will be implemented as outlined in Tables 7 and 8.

B6: Instrument/Equipment Testing, Inspection and Maintenance

The YSI ProPlus water quality meter is used for in-situ readings during pond sampling events. It is maintained by the APCC Monitoring Coordinator following YSI manual instructions. The unit, including temperature, specific conductivity/salinity, pH, and dissolved oxygen sensors, is calibrated at least monthly and the calibration logs are saved on the lab computer hard drive. Batteries and probes are replaced as necessary. Ordering parts is the responsibility of the Monitoring Coordinator.

If there are errors or unacceptable readings during the calibration process, the sensor is removed from its port, checked for damage, cleaned, and reinserted. In the case of pH, probes are “reconditioned” (soaked in 1:1 bleach and tap water for half an hour and then soaked in tap water for one hour) quarterly (i.e., every three months). The electrode is also replaced as needed to maintain readings within data quality objectives (DQOs). If the cleaning or other maintenance does not resolve the problem, the probe and calibration solution are replaced and the calibration for that parameter starts over. The failed probe is sent to YSI technical support for inspection and repair. If the handheld display fails, a backup YSI model is used while the unit is sent in for repair.

Pond sampling kits are comprised of one calibrated handheld YSI device, clipboard with datasheet, sampling pole, and cooler containing sample bottles. The APCC Monitoring Coordinator maintains these kits, repairing and replacing broken or missing parts as necessary. The batteries and dissolved oxygen membrane are replaced as needed or at least annually. There is one additional backup YSI device, which is also calibrated and maintained on a monthly basis, in case problems arise. The APCC Monitoring Coordinator is responsible for ordering calibration solutions and replacement parts as needed.

If there is an error or unacceptable reading during calibration, the probes are removed, cleaned, and reinserted. Calibration resumes in new uncontaminated solution. If dissolved oxygen shows errors or has drifted substantially since the previous month (more than 25%), the membrane is replaced. If cleaning and maintenance do not solve the problem, the probe is replaced and the faulty one is sent to YSI technical support for inspection and repair. If the handheld display has failed, a backup is used while the other is sent in for repair.

Pond monitoring volunteers are trained how to use the devices in the field and are shown how to store and protect the YSI probe in the field. Volunteers attend an annual training meeting held in spring before the late summer sampling season (e.g., May, see Schedule) for reminders and training on

protocol updates. Volunteers who cannot attend the meeting are met with individually; alternatively, videoconferencing (e.g., Zoom) and recorded training sessions may be used as needed.

B7: Instrument/Equipment Calibration and Frequency

Field monitoring

The YSI water quality meter is maintained regularly and the probes on the instrument are calibrated following manufacturer's specifications prior to taking the equipment into the field for measurements (at least 1 time per week). If personnel calibrating the equipment notice sensors are not calibrating properly or are otherwise functioning outside specified manufacturer guidelines, the sensors will be sent to the manufacturer for recalibration.

All water sampling equipment should be visually inspected prior to use to ensure it has been properly cleaned and decontaminated with deionized water and/or kept clean prior to use. Sample bottles from the lab should remain closed and clean of debris.

Laboratory analyses -- see CCS QAPP for instrument calibration procedures (Appendix G). These are copied here.

Instrument calibration for lab analyses of Nutrients (nitrate+nitrite, ammonium, ortho-phosphate, total nitrogen (TN), and total phosphorus (TP))

At least 6 working calibrants for each chemistry will be prepared from certified standards to cover the concentration range of the samples to be analyzed. The calibrants are run at the beginning of the analyses, and a calibration curve is fitted. If the correlation <0.995 , new calibrants will be prepared, and calibration will be re-done. See SOPs for more detail. Standards are supplied from Astoria Pacific. Each standard is labeled with concentration and expiration date. Standards are stored at room temperature. Working calibrants of concentrations $>100 \mu\text{M}$ are prepared weekly and stored at 4°C . Working calibrants of concentrations $<100 \mu\text{M}$ are prepared daily.

Instrument calibration for lab analyses of Chlorophyll *a* and Phaeophytin

The laboratory fluorometer is calibrated at the beginning of each monitoring season with 2 liquid pure chlorophyll *a* standards and reagent. At the time of calibration, a solid secondary standard is also analyzed and the formula for calculating chlorophyll *a* in samples is determined. The solid secondary standard is analyzed with each batch of samples. Blanks of 90% acetone, and an unused filter extracted with 90% acetone are set up with each rack of samples.

B8: Inspection/Acceptance of Supplies and Consumables

Field monitoring supplies

The APCC Monitoring Coordinator will ensure that necessary supplies and calibration standards are maintained at the APCC monitoring center. Supplies must be ordered and received ahead of when the items will need to be consumed. The quantity and timing of procurement is managed to ensure that expiration dates are not exceeded, and all supplies meet high quality standards. Upon receipt of materials, the APCC Monitoring Coordinator or designated APCC staff signs the packing slip with the

date of receipt. The signed packing slip is scanned for an electronic copy. One hard copy of the signed packing slip is filed in the APCC Monitoring Coordinator's file cabinet and a scanned copy is saved to the project files on the APCC server. A second hard copy is filed in the APCC grant manager's office, and a scanned copy is stored in the grant manager's files on the APCC server, which is backed up weekly.

Supplies are inspected upon receipt and the date of receipt is labeled on the bottle or box. Any obviously damaged or contaminated supplies are rejected and returned. The date the bottle or individual package is opened for use is also marked on the bottle or box. All calibration certificates are filed in labeled folders in the lab office. All standards, chemicals, and materials are handled and stored properly according to the respective Material Safety Data Sheets (MSDS).

APCC will provide coolers, ice, deionized water and sampling gloves for volunteers as needed.

Sample bottles and labels will be provided by CCS and conform with their QAPP and standards.

B9: Non-Direct Measurements (i.e. secondary data)

Data collected before the approved QAPP may not meet the same stringent standards as the current design. However, all data included in the regional database will undergo another phase of QA as part of the data transfer process. Any suspect data will be removed from the final regional database. In regard to outputs, any analyses which include data collected before the EPA QAPP approval will be labeled accordingly and any online or paper reports will include a disclaimer describing the use of historical data and any potential biases therein. Additionally, all data collected before the QAPP approval will be highlighted in such a way that the user understands where there may be variability in data quality. As detailed in section B1, the presence or absence of historical monitoring data (which is considered secondary data) may be used as a criterion for selecting which ponds will initially be monitored. At this time however, the secondary measurements themselves are not anticipated to play a role in the selection of ponds for monitoring.

Future expansion of the pond monitoring program may rely on other secondary data sources, e.g., analysis of remote sensing imagery. When applicable, the QAPP will be updated to appropriately detail those data sources and analysis methods, and how they will be used to determine additional ponds for monitoring.

B10: Data Management

Water quality field data collected by APCC and volunteers will be documented on the field datasheet. Field datasheets will be photographed in the field prior to being sent to the lab with the water samples. APCC staff will upload the photographs of the field datasheets to the APCC server after returning from the field. These will serve as the electronic versions of the field datasheets. APCC's Monitoring Coordinator will enter field data into an excel spreadsheet while providing an initial QA/QC review. A secondary review will be performed by the APCC QA Officer by graphing the data and looking for outliers. Following corrections or comments, QA/QC checked field data will be sent to the Commission in electronic form (xlsx, csv) or uploaded directly into the water quality portal.

At the CCS lab, nutrient data are reviewed for primary QA/QC. Once the reviewed data is considered acceptable by the lab, it is transmitted to the Commission and imported into the Regional Water Quality Database.

All field and lab data will be retained in electronic copy on the Commission's Regional Water Quality Database. Pond field monitoring data will be imported into the Microsoft SQL database using automated procedures. The staff provides another QA/QC by identifying data which are missing, incomplete, or outside normal ranges. Errors are removed from the final dataset and metadata notes are entered into the excel spreadsheet containing data. Additionally, automated QA/QC will flag any data point that is outside a ten-year standard deviation as suspect.

Section C: Assessment and Oversight

This section addresses the activities for assessing the effectiveness of the implementation of the quality assurance and quality control activities. The purpose of the assessment is to ensure that QAPP is implemented as described.

C1: Assessments and Response Actions

Field monitoring

The APCC Monitoring Coordinator is responsible for ensuring that YSI water quality meter calibrations and rotations meet the expectations described in the QAPP. The data quality downloaded from the YSI meter is also evaluated by the APCC QA Officer on an annual basis. The APCC QA Officer is responsible for noting degraded data quality and relaying those observations to the Project Manager and APCC Monitoring Coordinator. In a case of reduced data quality or completeness, the Project Manager and APCC Monitoring Coordinator must take action to resolve the issue (e.g., retraining staff, volunteers, allocating funds to replace failing equipment, maintaining or repairing equipment, etc.). All questionable data will be flagged as necessary in the database and any equipment issues will be reported in the metadata.

The APCC Monitoring Coordinator and Volunteer Coordinator, with assistance from the Commission, supervise and train all volunteer pond monitoring groups, volunteer leaders, and individuals. Depending on the number of volunteers and groups involved, pond volunteer leaders may be designated to lead sub-groups of volunteers. The Monitoring Coordinator will work with pond volunteer leaders to review field monitoring data and to recognize issues as they arise after each monitoring event. The APCC QA Officer reviews the progress and data quality of the volunteers to ensure completeness and accuracy after each sampling event. The Monitoring Coordinator will communicate issues to and work with the APCC QA Officer to determine whether the issues or problems are due to equipment, human error, or natural processes (e.g., storms) and decide on response actions. The Monitoring Coordinator will address corrective actions involving equipment and volunteers. If errors, missing data or other issues are due to human error, the Monitoring Coordinator contacts the volunteer leader and volunteer whose work is in question to address the problem. If the volunteer is not available for the next sampling event or if there is an issue with a volunteer not being able to implement corrective action, a new volunteer must be recruited and trained. When field data does not pass QA/QC checks, efforts will be made to collect a replacement sample at the location in question.

Lab analyses

Water samples collected for lab analyses will be reviewed by the CCS lab. If a problem is identified, the CCS Associate Scientist, who oversees the water quality analytical lab, will take the necessary steps towards resolving the issue. All questionable data will be flagged or removed in the database as necessary and all actions taken will be reported in the metadata.

The CCS Associate Scientist oversees the CCS task of analyzing pond samples. The CCS Lab Coordinator is responsible for processing the samples as dictated by the SOPs and QAPP. Data generated by the CCS is under constant review through regular QA/QC checks.

Corrective actions identified in the CCS QAPP Section 2.7. are as follows: If results from any analyses of QC checks are unacceptable, corrective actions will be taken as described for lab SOPs. Whenever possible, analyses will be re-run with new QC checks. If results are still unacceptable, the instrument will be re-calibrated according to manufacturer's instructions. The Lab manager is responsible for all corrective actions. The Project QA Officer must also be consulted. All corrective actions will be documented in the lab notebook. See Tables 7 and 8 for lab corrective actions.

If corrective actions do not resolve the issue, the CCS Lab Director documents this and notifies the CCS Associate Scientist who will relay the finding along with the data. The data are reviewed by the CCC QA Officer at least once a month. If the data do not meet data quality objectives in this QAPP through no fault of the lab, the CCC QA Officer will notify the Project Manager who will notify Project Team members (i.e., Commission, APCC and CCS) as needed to remedy the issue or be made aware of the issue. All questionable data will be flagged as necessary in the database and all actions taken will be reported in the metadata.

C2: Reports to Management

Data collection and assimilation will be ongoing while the CCPMP is active. Updates regarding the project's progress, performance evaluation, and data quality assessments will be prepared annually and posted to the Commission's website and linked from the Regional Water Quality Database. Any applicable changes to the scope and frequency of pond monitoring in the future, as well as corresponding changes to the frequency of reporting actions will be reported detailed in subsequent revisions to the QAPP.

Section D: Data Validation and Usability

This section addresses the QA activities that occur after the data collection of the project has been completed. Implementation of these elements ensures that the data conform to the specified criteria and achieve the project objectives.

D1: Data Review, Verification, and Validation

QA/QC of the Cape Cod Ponds Monitoring data occurs in four phases: 1) field data review by the volunteer who enters the data followed by review by the APCC Monitoring Coordinator; 2) field data review by the APCC QA Officer; 3) lab data review by the CCS Lab Coordinator and Associate Scientist, 4) all data review by the Commission Project QA Officer and Project Manager.

During the first phase, the volunteer will highlight missing or suspect data for the APCC Monitoring Coordinator to investigate further. Suspect data includes nonsensical readings (e.g., decimal place error or data entered in the wrong column on the datasheet) and readings outside the normal range. If the mistake is obvious and the error can be corrected, the Monitoring Coordinator will correct the data point in the electronic database and make a note on the datasheet. If the error cannot be corrected, the Monitoring Coordinator will make a note on the datasheet and communicate it to the APCC QA Officer.

During the second phase, the APCC QA Officer will review all field data to check for data quality objectives relating to representativeness, accuracy, precision, and completeness. Missing or suspect data will be flagged, and corrective actions will be implemented as needed to address issues that can be addressed (with the exception of natural events or events outside the control of APCC and volunteers). Field sampling and chain-of-custody forms (Appendix F) will be reviewed, any errors or omissions noted, and corrective actions identified. A summary of field data QA activities and findings will be provided in electronic form (Word and/or Excel format), to be sent to the Project QA Officer.

During the third phase, the CCS Associate Scientist and Lab Coordinator will conduct a review of all lab QA/QC checks including lab blanks, duplicates, spikes, and recoveries. If the data does not meet the QA standards as described in the QAPP, the data affected are rejected. The CCS Lab Coordinator and Associate Scientist will identify data that do not meet QA/QC checks when sending the final electronic files to the Commission.

During the fourth and final phase, the Project QA Officer will review all electronically entered data provided by APCC and CCS by visually scanning the datasets, graphing, and/or automated statistical outlier procedures used as part of the Regional Water Quality Database. Each parameter is analyzed against previous years' data to locate outliers or unusual trends. Data that do not pass the quality criteria and assurance standards as described in the QAPP, are flagged as suspect or removed from the final database. These omitted data may be a result of a data recording error, inaccurate equipment calibration, contaminated sample, failed laboratory instrument, or events outside the control of the project (e.g., storm, pandemic-related shutdown, etc.). In these rare cases, the removed data is acknowledged and explained in the accompanying metadata.

D2: Verification and Validation of Methods

As part of the verification and validation process, the field sampling and lab analytical methods are also under review to ensure that the results meet QAPP standard requirements. Chain-of-custody records must be on file to document the exchange of samples between sampling staff, APCC project staff, and the CCS lab before payment is approved by the Project Manager. These chain-of-custody records are managed by the APCC Monitoring Coordinator and APCC QA Officer and are reviewed by the Project Manager. If samples are missing, the chain-of-custody records also document who is responsible for the missing samples, and the supervising authorities of the responsible party will seek the necessary corrective measures.

Additionally, during periodic QA/QC checks, all calibration logs for the field YSI meter are reviewed by the APCC Monitoring Coordinator and APCC QA Officer, and all calibration logs for CCS lab analytical instruments are reviewed by the CCS Lab Coordinator. Calibration logs are also reviewed by the Project QA Officer. By regularly checking the calibration logs, any drift or problematic symptoms associated with the equipment can be detected and resolved early. It is the responsibility of APCC and CCS to detect and resolve any equipment issues. If equipment needs to be replaced or repaired, the Project Manager is notified to approve funds.

The end users of the data will have access to metadata through the Regional Water Quality Database, which outlines any problems associated with data points and the measures taken to remedy those issues. Data which may have been impacted by poor sample handling or equipment calibrations are handled in accordance with the QAPP. Thus, the end user receives data which meet all performance standards and can be applied as intended for research and local decision-making.

D3: Reconciliation with User Requirements

The Ponds data will be reviewed for precision, accuracy, completeness, representativeness, sensitivity, and comparability by the Commission, APCC and CCS through the QA/QC methods described above. If the data meet the quality criteria as described in Section A, then the Commission will incorporate the data into the Cape Cod Regional Water Quality Database, which is the main objective of this project. Additional detail regarding the data, analysis, and users of the database can be found in Appendix I, *Quality Assurance Project Plan for Regional Collection and Analysis of Cape Cod Water Resources*.

If some of the data do not meet these standards, those measurements will be flagged as questionable data, which is not viewable in the online portal but can be downloaded from the database with corresponding metadata. If the pond water quality results are found to be insufficient to meet data use needs, the sampling design and/or methods will be revised for the following season. Any proposed QAPP revisions will be submitted to EPA for approval.

Additionally, for historical data collected before the approval of the QAPP, the use of those data will be more limited and in cases where they are used for analysis or interpretative tools, the reduced confidence of those findings will be acknowledged online and in written reports.

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Appendix C. Field Checklist, Cape Cod Ponds Monitoring Program

Pond Monitoring Program Checklist

Needed prior to sampling date:

- o Ensure adequate bottle supply for all anticipated samples, including field duplicates
- o Ensure all sampling equipment is working properly.
- o Gather all ancillary field materials, including GPS, sampling sheets, coolers, ice packs, labeling pen, etc.

For sampling day:

- o Field monitoring/sampling chain-of-custody sheets for each pond
- o Map(s) or queued digital map images of access points
- o Phone numbers of access contacts for private access points
- o Sufficient sample bottles for each pond plus field duplicates
- o Cooler and ice packs (each cooler is assigned a unique number)
- o Sampling equipment, including DO/Temperature meter, sampling device, and Secchi disk

Return of samples to lab:

- o Ensure samples remain cold until returned.
- o Samples should be sent to CCS lab within 6 hours of collection to maintain holding times.
- o Field monitoring/sampling chain-of-custody sheets should be signed by samplers, transfer personnel, and all Lab staff that control/transport the samples/data sheets, including time and location.
- o Photograph field monitoring/sampling chain-of-custody sheet
- o Ensure field monitoring/sampling chain-of-custody sheets (see Appendix F) are collected and stored for later review and input of field data into spreadsheets.

Appendix D. Field Instructions, Cape Cod Ponds Monitoring Program

Cape Cod Ponds Sampling Procedures

1. Record all applicable information on the Cape Cod Ponds field datasheet/ chain-of-custody sheets, including name of sampler, date, weather conditions, and sampling depths.
2. Collect Secchi reading and total station depth; record readings on field datasheet.
3. Collect dissolved oxygen and temperature profile readings as detailed in Table 5; record readings on field datasheet.
4. If not already labeled, enter pond name, date and sample depth on sample bottles.
5. Collect water samples at depths specific to the total station depth. A minimum of two samples per pond with samples at 0.5 m and 1 m off the bottom. If the pond is 1 m or less in depth, collect two 0.5 m samples. In ponds of ~9 m deep, collect one additional sample at 3 m depth. In ponds with a total station depth greater than 11 m, collect one additional sample at 9 m depth. Record sampled depths on field datasheet.
6. Samples should be transferred to 1-L dark, acid-washed Nalgene bottles. Care should be taken to avoid contact with the interior portion of the bottle or with the water stream between the sampling device and the sample bottles.
7. Sample bottles should be stored in the cooler as they are collected.
8. Duplicate sample for each sampling run should be randomly collected and recorded on appropriate sampling sheet.
9. Photograph field monitoring/chain-of-custody form
10. Samples should be returned to the CCS Lab within 6 hours of sampling to ensure holding times are met.

Appendix E. Standard Operating Procedures for Field Sampling

SOP 1 – Secchi depth / total depth measurements

Equipment needed: secchi disk, measuring tape


Procedure:


1. Using bathymetric maps or GPS coordinates, samplers should first confirm their field sampling location.
2. Begin Secchi reading collection by lowering the Secchi disk into the water on the shaded side of the boat.
3. Continue to lower the Secchi disk until the black and white quadrants can no longer be distinguished, and the disk disappears. Be sure to remove sunglasses when taking the Secchi reading. Record the depth at which the disk disappears.
4. After the disk has disappeared from view, slowly raise the disk until it becomes visible again. Record the depth at which the disk reappears.
5. The Secchi depth is determined by averaging the disappearance and reappearance depths.
6. A reference video for this procedure can also be viewed at (<https://youtu.be/xiRT2j54Y2U>)
7. The Secchi disk can also be used to measure total depth, by lowering the disk vertically into the water until it hits the bottom surface. Record the depth at which the line begins to go slack.

SOP 2 – YSI ProPlus (Dissolved oxygen, Temperature, pH, conductivity)

Equipment needed: YSI ProPlus meter or equivalent

Procedure:

1. Press the Power key  to turn the instrument on. The main display should be in run mode which shows temperature, barometric pressure, dissolved oxygen (% and concentration), conductivity, and pH. Allow at least 5 minutes for the instrument to warm up and stabilize before taking measurements. If any of the parameters are not displayed on the run screen, contact the Monitoring Coordinator or consult the user manual (<https://www.ysi.com/file%20library/documents/manuals/605596-ysi-proplus-user-manual-revd.pdf>)
2. Lower the probe into the water on the opposite side of the boat from where Secchi measurements were collected. This minimizes the potential for interference from any sediment disturbed by the Secchi disk.
3. At the first sample depth, keep the probe in place until the temperature reading has stabilized.

When the dissolved oxygen reading has also stabilized, log the sample by pressing Enter,  and record the temperature, pH, conductivity, and dissolved oxygen readings on the field sheet.
4. Repeat step 3 at each subsequent sampling depth, following the sampling guidance in Table 5 based on total pond depth.

Appendix F. Field Monitoring and Chain-of-Custody Form, Cape Cod Ponds Monitoring Program

Town:

Pond name:

Pond ID:

Date:

Time (beginning and end of sampling):

Sampling staff and volunteers:

Weather conditions:

Notes / Observations:

Field Monitoring Data

Depth (m)	Temperature (°C)	pH (pH unit)	Conductivity (µS/cm)	Salinity (ppt)	Dissolved oxygen (mg/L)	Dissolved oxygen (%)	Secchi disk (m)	No. of samples for lab analyses	Duplicates taken

Sample Custody Information:

For Sender to fill out:

Sample ID:

Pond name, town:

Date and time samples placed in cooler:

Number of samples sent:

Name of person packing cooler with samples:

Notes or instructions for lab:

For Receiving Lab (CCS) to fill out:

Cooler ID:

Pond name, town:

Date and time cooler received:

Number of samples received:

Condition of samples received (i.e., temperature):

Initials of person receiving cooler and unpacking samples:

Notes or instructions for analytical lab staff:

Example Sample Label

Sample ID: _____	Sample #: _____
Pond Name: _____	Sample Depth _____
Pond ID: _____	Town: _____
Sampler Initials: _____	Organization: _____
Date: _____	Time: _____

**Appendix G. Center for Coastal Studies Standard Operating Procedures -
Excerpted from *Quality Assurance Project Plan for Water Quality Monitoring in
Cape Cod Bay***

Appendix H. EPA Methods for Calculating Minimum Detection Limits

Appendix I. Quality Assurance Project Plan for Regional Collection and Analysis of Cape Cod Water Resources