QUALITY ASSURANCE PROJECT PLAN

Integrating Citizen-based and Nontraditional Monitoring into the Chesapeake Bay Program Partnership: Water Quality Monitoring in Tidal Waters

Prepared for:

United States Environmental Protection Agency
Chesapeake Bay Program Office
Annapolis, Maryland
Grant #CB96334901

Prepared by:

Alliance for the Chesapeake Bay
Richmond, VA

In Cooperation with:

University of Maryland Center for Environmental Science
Annapolis, MD

Dickinson College's Alliance for Aquatic Resource Monitoring
Carlisle, PA

Izaak Walton League of America
Gaithersburg, MD

March 31, 2017

This page is left blank intentionally

Section A - Program Management Elements

A1. Title and Approval Page

Project Name: Integrating Citizen and Nontraditional Monitoring into the Chesapeake Bay Program Partnership: Water Quality Monitoring in Tidal Waters

Responsibility Agency: Alliance for the Chesapeake Bay
Date:

Liz Chudoba — Date
Project Manager
Alliance for the Chesapeake Bay

Durga Ghosh — Date
Quality Assurance Coordinator
US Geological Survey

Julie Winters — Date
Project Officer
US Environmental Protection Agency

Rich Batiuk — Date
Chesapeake Bay Program Quality Assurance Manager
U.S. Environmental Protection Agency/Chesapeake Bay Program

A2: Table of Contents

A3. Distribution List

Table A3-1. Distribution list for this Quality Assurance Project Plan.

Name	Phone Number	E-mail	Organization
Kate Fritz Nissa Dean Liz Chudoba	443-949-0575 804-775-0951 804-775-0951	kfritz@allianceforthebay.org ndean@allianceforthebay.org lchudoba@allianceforthebay.org	ACB
Dr. William C. Dennison Caroline Donovan	443-496-0196 410-330-3330	dennison@umces.edu cdonovan@umces.edu	UMCES
Danielle Donkersloot Emily Bialowas	301-548-0150 301-548-0150	ddonkersloot@iwla.org ebialowas@iwla.org	IWLA
Julie Vastine Jinnie Monosmith	717-245-1135 717-245-1021	vastine@dickinson.edu monismij@dickinson.edu	ALLARM
Rich Batiuk Terry Simpson Julie Winters	410-267-5731 410-305-2739 410-267-5754	batiuk.richard@epa.gov simpson.terry@epa.gov winters.julie@epa.gov	EPA
Durga Ghosh Peter Tango	410-267-5750 410-267-9875	dghosh@chesapeakebay.net ptango@chesapeakebay.net	USGS
Dave Jasinski	804-832-0630	dave@chesapeakedata.com	CEC
Participating Monitoring Groups			See Appendix E

A4. Project/Task Organization

A4.1 Project Organization

Personnel involved in project implementation are listed in Table A4-1, and shown in the organizational chart in Figure A4-1.

Table A4-1. Organizations, Roles, and Personnel

Organization	Role in Project	Individuals Involved in Project, Title
Alliance for the Chesapeake Bay (Alliance)	Project Manager	Liz Chudoba, Water Quality Program Manager
Alliance for the Chesapeake Bay (Alliance)	Project Partner	Nissa Dean, Virginia Director
University of Maryland Center for Environmental Science Integration and Application Network (UMCES IAN)	Project Partner	Caroline Donovan, Program Manager
Chesapeake Environmental Communications	Database Contractor	Dave Jasinski Dave Parrish
Monitoring Groups	Data Collectors	See Appendix E for current list of participating groups
Chesapeake Bay Program	Data Users	EPA, Virginia DEQ, Maryland DNR, Pennsylvania DEP, etc.
Academic institutions	Data Users	various
Local governments	Data Users	MD, VA, DC

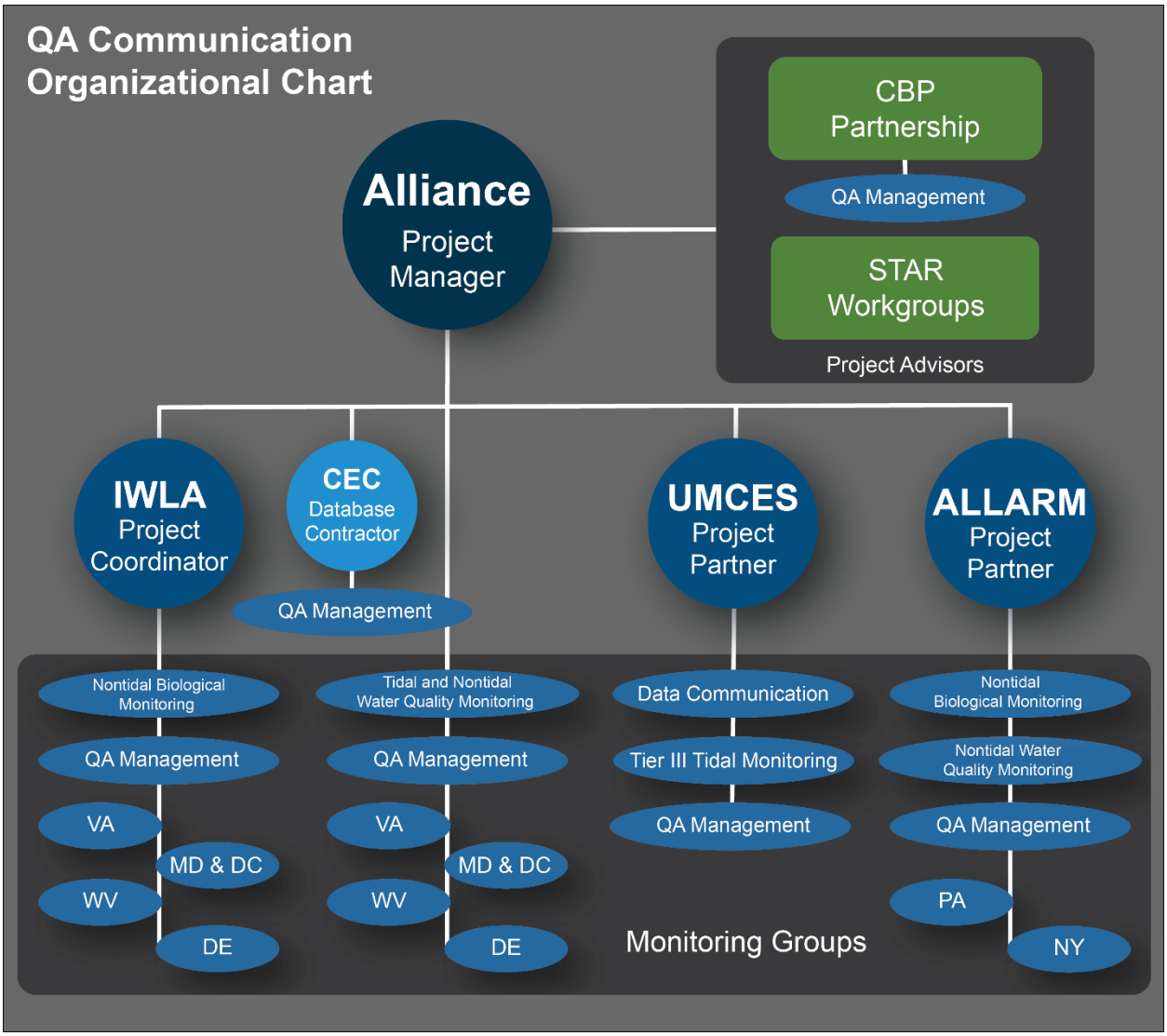

Figure A4-1. Quality Assurance (QA) organizational chart

The Integration of Citizen-based and Nontraditional Monitoring into the Chesapeake Bay Program Partnership project provides support, training and guidance to monitoring groups sampling non-tidal and tidal portions of the Chesapeake Bay Watershed. The project is managed by the Alliance for the Chesapeake Bay (ACB) in partnership with the project coordinator at Izaak Walton League of America (IWLA), and includes project partners at the University of Maryland Center for Environmental Science Integration and Application Network (UMCES) and Dickinson College's Alliance for Aquatic Resource Monitoring (ALLARM). These four organizations together are hereafter referred to as the "Project Team".

A4.2 Roles and Responsibilities

Project Manager: Alliance for the Chesapeake Bay:

- Manages Project Team to ensure implementation of the Quality Management Plan (QMP), QAPPs, and QA policies
- Oversees the effective implementation of the QMP and QAPPs
- Ensures the quality program has adequate resources to accomplish all requirements established by the QMP and QAPPs
- Responsibilities listed under Project Partners for water quality monitoring in VA, MD, and DC.

QA Management: Alliance for the Chesapeake Bay, University of Maryland Center for Environmental Science Integration and Application Network Chesapeake Bay Program, Alliance for Aquatic Resource Monitoring, and Izaak Walton League of America, University of Maryland Center for Environmental Science

- Reviews project QAPPs. Provides guidance to Project Team for effective implementation of QAPPs
- At a minimum, annually review the QA/QC programs, practices, systems, training materials, and performance to ensure practices are in accordance with the QMP, subsequently document and respond to QA/QC needs and issues
- Act as liaison between the Project Team and the Data Integrity Workgroup and attend DIWG meetings
- When needed will assist with QA dispute resolution
- Assess data management procedures of the monitoring programs and the database to ensure they meet data quality objectives

Project Team: Alliance for the Chesapeake Bay

- Ensure that all participants that are involved in water quality data operations adhere to the QMP and approved QAPPs.
- Develop, review, update, and approve Standard Operating Procedures (SOPs) for monitoring activities
- Ensure all water quality monitoring data operations are covered by the appropriate documentation (i.e., SOPs, QAPPs, project plans)
- Provide regular training (Tier I, II, and III) and re-certification for participants
- Assess and re-certify participants to identify QA compliance or deficiencies. QA deficiencies will be resolved when identified and properly documented
- Establish quality assurance measures for project QAPPs and assist monitoring groups in QAPP/SOP implementation
- Review and oversee QA policies and SOP's of monitoring groups and document findings for CBP and project records (all Tiers)
- Comply with QA reviews or audits
- Resolve disputes regarding quality system requirements, QA/QC procedures, certifications, or corrective actions

Project Team: University of Maryland Center for Environmental Science

- Screen Tier III candidate QAPPs and/or SOPs, summarize findings and make recommendations to the CBP for group integration.
- Provide training and guidance to monitoring groups in Tier II and III for sampling protocols, data analysis, and report card generation
- Update the MTAC Tidal Monitoring Protocols to conform to CBP Tidal WQ Methods and QA requirements so that it may be recognized as meeting Tier III requirements.
- Schedule and coordinate on-site audits of Tier III candidates.
- Review Tidal Tier III audit reports and recommendations; provide technical assistance as needed to achieve Tier III status.

Monitoring Groups: MD, DC, VA, participating labs

- Implement QAPPs
- Evaluate and report QA issues to designated project partner, regional liaison, or QA Management as they occur
- Maintain annual and biennial certification and re-certification
- Adhere to SOP guidelines
- Comply with QA reviews or audits by Project Team and/or QA Officer

Database Contractor: Chesapeake Environmental Communications

- Interact with QA Management, monitoring groups, project partners, and CBP to ensure incorporation of all required QA measures and documentation into the database structure
- Respond to and implement needed changes in the database structure to improve the QA/QC checks and ease of user interface
- Interact with CBP Data Center to submit data from the Project database to the CBP.

A5. Problem Definition/Background

The Project Team members are partnering to provide technical, logistical, and outreach support for the integration of citizen-based and nontraditional (e.g., non-agency) monitoring data into the Chesapeake Bay Program (CBP) partnership. While the CBP has immediate access to agency (federal and state) data collected in the watershed, nontraditional data producers are scattered among the watershed and collecting information that can augment data gathered by the CBP. The integration of these data into the CBP monitoring network will provide additional cost-effective data and information that supports shared decision-making and adaptive management by the CBP partners focused on restoration of the Chesapeake Bay and its watershed.

A5.1 Goals and Objectives

The 1985 Chesapeake Bay Restoration and Protection Plan identified the need for restoration activities and a monitoring program to measure the success of these activities. In June 2000, the

Chesapeake Bay Program adopted a new Bay agreement, Chesapeake 2000: A Watershed Partnership to guide the management and restoration of the Bay. In this "C2K"document, Bay Program Partners agreed upon multiple objectives, one of which was "to achieve and maintain the water quality necessary to support the aquatic living resources of the Bay and its tributaries". Water quality monitoring data are necessary to assess these objectives.

The CBP has identified a series of goals for which additional data are essential. For tidal water quality monitoring programs these include (but are not limited to):

a. Assess the habitat conditions for aquatic living resources and determine if these conditions meet tidal water quality criteria and standards designed to protect them from nutrient and sediment impacts;

b. Deduce the likely causes of nutrient and sediment impairments, and determine the best course of action necessary to meet the water quality criteria and standards;

c. Support continued refinement, calibration and validation of Chesapeake Bay Program models such as the Estuarine Water Quality and Sediment Transport Model; and

d. Provide a long-term consistent set of data that is available for public and private research.

In addition, they have identified priority data gaps, such as including data from small watersheds which are typically the foci of nontraditional monitoring organizations. Based on the existing nontraditional monitoring data as well as the potential for additional monitoring by citizens, the CBP is exploring ways to integrate nontraditional partners into the CBP partnership.

The Project Team, using their background, expertise, and knowledge with the nontraditional monitoring community, is working with CBP Scientific, Technical Assessment, and Reporting Team (STAR) to:

a. Establish standardized institutional structures and procedures, such as the Tiered data use framework;

b. Facilitate development of consistent monitoring and training protocols, technical guidance, data gathering tools, quality assurance mechanisms, and data analysis and communication tools;

c. Inventory, prioritize, and recruit monitoring groups; and,

d. Provide training and technical support to monitoring entities.

This comprehensive approach will ensure a consistent submittal of known quality data to the CBP.

The objectives of this project are:

a. To provide technical, logistical, and outreach support to nontraditional data collectors working in tributaries of the Chesapeake Bay Watershed, in order for them to produce data that can be integrated into the CBP. These data will help to fill spatial and temporal data gaps within the CBP dataset and provide additional information to support Chesapeake Bay Watershed management decisions.

b. To provide support for nontraditional monitors to produce and use data to help address concerns they may have about the health of their local waterways and the impacts of their land use practices on tributaries of the Chesapeake Bay.

c. To educate citizens about the Chesapeake Bay Watershed and the relationship between their local watershed health and the issues facing the Bay. Through this program, participants will learn about the scientific process and how water quality can be assessed in a number of ways to understand the general health of a stream. They will also gain an understanding of how data can be collected, managed, and analyzed to then communicate findings to the public and support watershed decisions in their communities and at a broader regional level.

d. Facilitate the use of the data by monitoring groups, local, and state entities.

A5.2 Data Use

A tiered framework for data collection and for integration of nontraditional monitoring has been developed by the Project Team to establish categories of data quality and their associated end uses. All data collected will be categorized into three tiers based on the intended data use. Table A5-1 lists three tiers, their intended data uses, and a summary of the data requirements. The tiered framework provides suggested data use options but uses can extend beyond what is suggested. A goal of the project database is to make sure that there is appropriate metadata to inform potential users of the quality of the data which can result in diverse uses of the data.

The data requirements for tiers largely depend on the methodology used (analysis method and the established accuracy, precision, and sensitivity of the equipment) and the quality assurance requirements (documented internal and external QC procedures - calibration logs, replicates, field blanks, certification, field audits, duplicate analysis of external lab, etc.) implemented by the monitor. The Project Team have categorized these procedures into tiers based on comparability testing, manufacturer's specifications, experience, and how other water quality monitoring programs have classified procedures. Further comparability testing conducted by ALLARM during the summer of 2016 will inform changes that should be made to methodology tier designations. It is ultimately the decision of a data user to choose the data appropriate for their specific use given the metadata supplied in the database.

Table A5-1. The three Tiers of data quality, intended data use, and data requirements.

Tier	Intended Data Use	Summary of Data Requirements
Tier I	Education, environmental health screening	Documentation showing that procedures outlined in this QAPP for collecting and producing Tier I data have been followed. All items must be reviewed and approved by a member of the Project Team: • Written study design • Documented monitoring methodology • Documented site location(s) (with coordinates)
Tier II	Environmental health screening, environmental health report cards, targeting of management actions	State or federal government-approved EPA volunteer monitoring QAPP *or* written agreement to follow the procedures outlined in this QAPP to collect and produce Tier II data. All items must be reviewed and approved by a member of the Project Team: • Written study design • Documented monitoring methodology using field or laboratory standard operating procedures with defined levels of precision and accuracy • Documented site location(s) (with coordinates) • Acquires Tier II certification and maintains certification. For report card generation monitors must sample a minimum of three water quality indicators monthly from March to November.
Tier III	Chesapeake Bay Watershed trends and assessments to help inform policy and management decisions	• Maintain QAPP and field/lab standard operating procedures in line with CBP requirements • Participation in CBP DIWG field and lab audits

The protocols established in this QAPP are designed to produce Tier II and Tier I data. Data collected from the Tidal Water Quality Monitoring Program can be used by the Chesapeake Bay Program for the purpose of environmental health screening, environmental health reports, targeting management actions, and education. Data can also be shared and used at a local level, including local government, community stakeholders, and residents to increase awareness and address environmental concerns at multiple levels. Using the data to inform local practices helps to meet the overall goal of the CBP to improve citizen engagement and the health of the Chesapeake Bay Watershed. The data will also provide a baseline of current watershed conditions to compare to if/when changes in the watershed occur.

Monitoring groups must demonstrate their ability to meet the data quality objectives, quality assurance standards, and Standard Operating Procedures (SOP) established by this QAPP. Once each group has established or demonstrated the appropriate requirements, a Project Team member will review the monitoring group's documentation, determine the tier designation, and accept the group into the program. When a group has been approved, they may then begin to collect water quality data and submit it to the project database. If a groups data do not meet the data requirements of the different tiers, those data will still be submitted to the database, but will be marked as provisional until such a time the methodology is found to be comparable to the SOP established by this QAPP or the quality assurance standards are met.

Groups collecting Tier II and Tier III data will be invited to participate in a data analysis and integration workshop hosted by UMCES. The workshops will teach monitoring groups how to generate report cards using their collected data. Groups that wish to generate a report card will be required to sample at least three water quality indicators and sample at a frequency described in Table A5-2.

Table A5-2. Requirements for Tier II data report card generation

Indicator	Minimum sampling period needed for report card analysis	Minimum sampling resolution
Dissolved oxygen	June - September	Twice monthly
Chlorophyll *a*	March – May; July – September	Twice monthly
Water clarity	April – October; March – November for polyhaline	Twice monthly
Total nitrogen	April-October	Twice monthly
Total phosphorus	April-October	Twice monthly

Tier III groups must demonstrate that they meet the sampling and analytical requirements of the CBP Methods and QA for water quality monitoring, which must be documented in a separate QAPP. The group's documentation must undergo an audit process and be accepted as a Tier III group by the DIWG in order to submit data to the database for use by the CBP.

Process and responsibilities for reviewing Tier III candidates for nontraditional tidal water quality data:

1.) UMCES designee will review QAPPs and Field SOPs for conformance with CBP Tidal and Nontidal Field Methods (as listed in Tidal QAPP, and Appendix B-Prioritization Report).
2.) UMCES designee will identify potential Tier III candidates and:
    1.Notify DIWG of findings (quarterly?)
    2.DIWG confirms and prioritizes candidates
    3.DIWG selects audit team, and then
    4.UMCES notifies candidate and coordinates scheduling
2. Audit Team Preparation will be coordinated and communicated by UMCES:
    1. Select technical leader for the team
    2. Review field SOPs, note additional differences with CBP methods
    3. Schedule audit during routine sample collection
    4. Request and review field blank and duplicate sample results (if any), and
    5. Prepare and send audit itinerary
3. Audit Team evaluates conformance with the Candidate's SOP using appropriate Tidal and/or Nontidal checklists. On the day of the audit:
    1. Conduct entrance interview
    2. Review calibration procedures
    3. Go to stations, observe procedures
    4. Complete a checklist for each station
    5. Note discrepancies w.r.t. CBP protocols, and
    6. Conduct exit interview – convey preliminary findings and impressions
4. Audit Team leader prepares draft report with the following sections:
    1. Summary - Date, participants, station locations, background information, etc.
    2. Observation and findings
    3. Requirements to conform with CBP procedures (if any)
    4. Copy of checklists
5. UMCES or Team leader will send draft report to Tier III candidates to confirm accuracy of report
6. Audit Team will prepare final report with recommendations.
    1. Send to Tier III candidate
    2. Send to DIWG coordinator
7. Audit Team, UMCES and DIWG coordinator are responsible for resolution of deficiencies, technical assistance, and follow-up
    1. Corrective action form
    2. Candidate revises QAPP and/or SOPs
8. EPA QA officer will be responsible for Tier III QAPP approval.

Data collected at the Tier III level will meet the standards and requirements of the Chesapeake Bay Program monitoring program and thus will be used by the CBP. Dependent of the requirements of the data users, Tier III data could potentially be used for regulatory assessments of water and quality standards attainment in addition to the variety data uses of Tier I and Tier II data.

Data will be archived in a new nontraditional monitoring database, accompanied by the appropriate metadata to allow data users (both traditional and nontraditional) to determine appropriate end uses for the data and to use them as they see fit. A project plan will be developed for the creation of the project database. This project plan will establish the framework of the database and all QA/QC guidelines for data submission, checks, flags, processing, and reporting.

A6. Project Description

A6.1 Project Timeline

This Quality Assurance Project Plan is designed to ensure that new data collected for the Tidal Water Quality Monitoring Program will be done in an approved, quality-controlled, and standardized fashion. The Citizen-based and Nontraditional Monitoring Integration Tier I and II Tidal Monitoring Program will start in May 2016. The Program will be composed of a minimum of once monthly water quality sampling encompassing all tidal areas and tidal tributaries of Chesapeake Bay (Figure A6-1). Samples can be collected year round when possible; however, samples need to be collected at a minimum from March to November, with a minimum total number of samples of 9 per site. The entire project period is May 2016 through April 2021 with annual evaluation of this QAPP. If needed, this QAPP Project Description will be updated during the annual evaluation of the overall QAPP.

Table A6-1: Project timeline for 6 year grant period.

Major Tasks	**Timeframe**
Develop project QAPPs and QMP	2016 - 2017
Develop a scientifically-valid and user-friendly protocol for monitoring and reporting data	2016 - 2017
Develop workshop training materials	2016 - 2017
Identify spatial and temporal gaps and develop strategies to fill those gaps	2016 - 2017
Develop a user-friendly database	2016 – 2018
Recruit, train, and certify monitors to collect water quality data	2016 – 2020
Water quality monitoring (monitors)	2016 – 2021
Enter water quality data into project database (monitors)	2017 - 2021
Train monitors on data analysis, synthesis, and communication	2017 – 2021
Submit field data sheets to the Project Team (monitors)	Quarterly
Data is submitted to the CBP from the project database	Annually
Recertify Certified Trainers	Annually
Recertify certified monitors	Biennially
Provide data management and quality assurance oversight	Ongoing

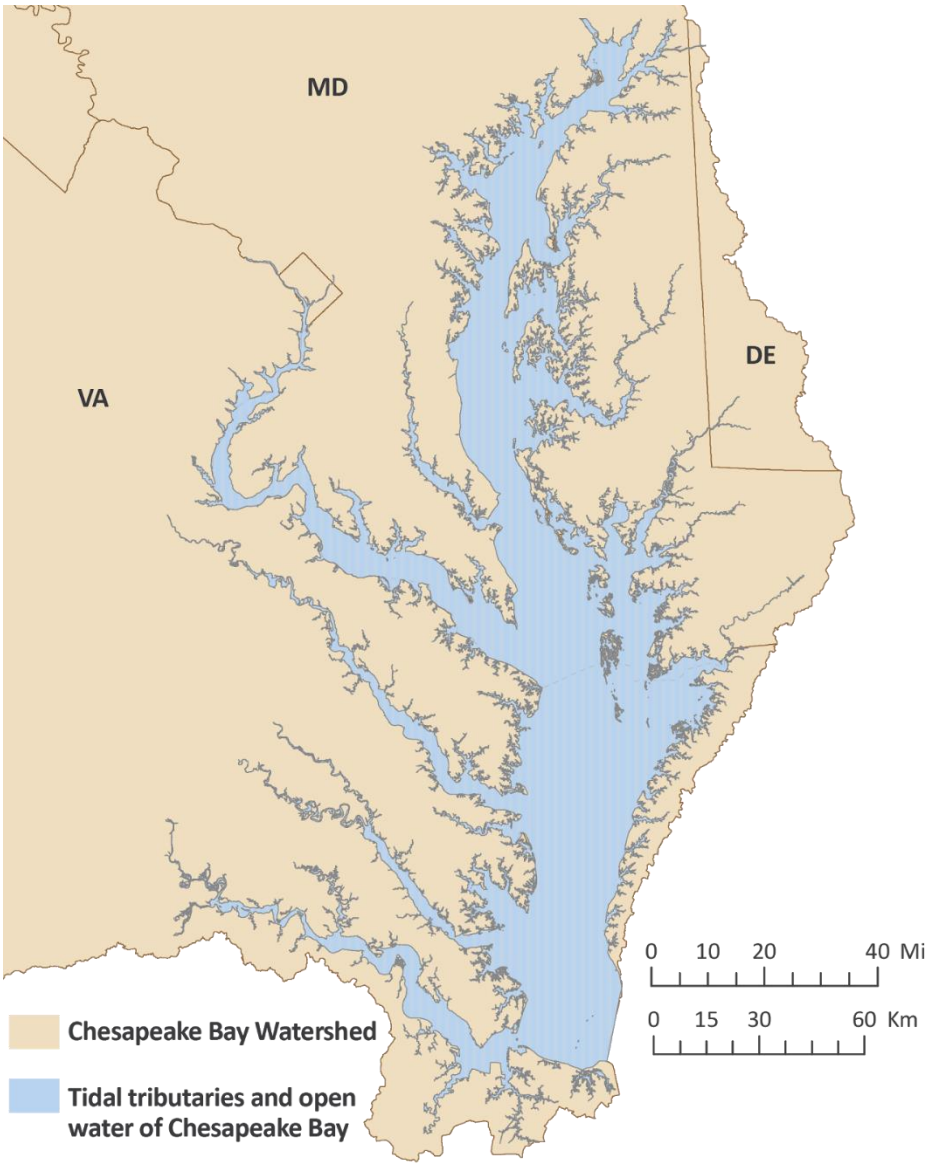

Figure A6-1. Tidal areas and tidal tributaries of Chesapeake Bay Watershed.

A6.2 Site selection

It is recommended that samples are collected in the thalweg representing main channel conditions from a boat, a bridge, or wading upstream. If access is limited samples can be collected from the shore and must be properly documented and designated as collected from the shore. Samples will be collected from tidal freshwater areas of tidal tributaries through the river mouths and open waters of Chesapeake Bay. Tidal areas are defined as the waters that are influenced by the tidal cycle (ebb and flow). Tidal waters include freshwater areas, called tidal fresh regions, which are subjected to the tides pushing water upstream and receding downstream, even if there is no mixing of saline waters with the freshwater.

Sampling runs are organized and conducted by individual monitoring groups. All sampling will be coordinated within each individual monitoring group with detailed metadata including name of sampled waterbody, description of sample site, and latitude/longitude in order to provide the information needed to compare data across all monitoring groups. The Project Team may sometimes work directly with individual monitoring groups on site selection or will rely on monitoring groups to identify their own sites that adhere to requirements in this QAPP. Trainings for all groups will include site selection discussions. Additional trainings will be provided to "Train the Trainers" where the Project Team will train specific groups in each state to work with individual monitoring groups and their site selection.

Monitoring sites can follow a probability based or fixed station design. The process for choosing monitoring sites will include first accessing available information about the local watershed including historical water quality data, land use types, and water quality health concerns in order to see if there are specific data gaps that could be filled or areas that need further monitoring. Next, site characteristics such as accessibility and placement in the watershed will be reviewed in order to choose an appropriate monitoring location. Once site locations are chosen, monitors will document the latitude and longitude coordinates using a handheld GPS unit with the North American 1983 Datum (NAD83). This will then be verified with Google Maps on a mobile device. Monitors sampling from a stable platform (bridge, shore, dock) can document the latitude and longitude coordinates using GPS or mobile device with the North American 1983 Datum (NAD83) to ensure that they are located with 10 meters of the original site location, but it is not required. Monitors sampling from a boat are required to document the latitude and longitude coordinates using GPS or mobile device with the North American 1983 Datum (NAD83) to ensure that they are located with 10 meters of the original site location. For a probability based design, the process of site selection will occur at the beginning of every new sampling season. Repeated measures at each station are encouraged for assessment and reporting (i.e., report card generation). However, if the best way to evaluate a monitoring objective is with probability-based design, then those studies will also be accepted.

A6.3 Water quality parameters

There are many different water quality indicators for the concerns associated with the health of tidal tributaries and their impacts on Chesapeake Bay health. The parameters chosen for this project provide a basic assessment of water quality associated with the key issues of Bay eutrophication as well as secondary parameters that are important to local watershed groups in the watershed. The parameters to be analyzed and the equipment to be used are found in Table B2-1.

The Citizen-based and Nontraditional Monitoring Integration project is comprised of a diversity of monitoring groups, each with their own goals for what they wish to achieve with their sampling. While the project does not require that a monitoring group sample all parameters listed in Table B2-1, all groups must sample at a minimum, temperature and salinity. All groups that monitor dissolved oxygen (DO) are also required to measure total depth. Groups that wish to

generate a report card with their data must sample a minimum of three primary water quality indicators listed in Table A5-2 (i.e., DO, clarity, and chlorophyll or DO, clarity, and nutrients).

A6.4 Data Management

Monitors will use field data sheets provided by the Project Team to record their observations and water quality results. Following data collection, data will be entered into the project database by the monitor. If the monitor is unable to enter the data themselves they may submit their data sheet to their project coordinator for data entry. Following lab analysis lab data sheets or excel files will be submitted to the Certified Trainer or Project Team member for review and data entry. The project database will be a place for data to be housed and visualized. Stakeholders visiting the database will be able to see graphs, maps, and metadata for chosen subsets of data. The Project Team will assist monitors in interpreting their data throughout the process and will hold data interpretation and communication workshops after the first year of data collection for Tier II and Tier III data collectors.

Tier III data collectors will use their project specific field data sheets to record their water quality data. They will upload their data to the monitoring database where it will be identified as Tier III data and then verified by the appropriate project coordinator that it meets the QA criteria.

Water quality data will be evaluated for different purposes by different stakeholders. The database can be queried by the public, scientists, managers, and academics for any purpose. The overarching goal of the database is to provide a centralized location where all nontraditional data can be housed and for that data to be used by scientists and managers to screen sampling sites, target restoration areas, and assess status and trends of Chesapeake Bay and its watershed.

Data will be archived in a new nontraditional monitoring database, accompanied by the appropriate metadata to allow data users (both traditional and nontraditional) to determine appropriate end uses for the data and to use them as they see fit. A project plan will be developed for the creation of the project database. This project plan will establish the framework of the database and all QA/QC guidelines for data submission, checks, flags, processing, and reporting.

A7. Measurement Quality Objectives

The Citizen-based and Nontraditional Monitoring Integration project is designed to provide water quality measurements that will be utilized to assess the health of the Chesapeake Bay Watershed rather than to accept or reject a hypothesis. Therefore, the most effective means of assuring the data quality objectives are met is to establish quality goals for the individual measurements that will be utilized to meet those objectives. Measurement of the quality for the various measurements obtained for the project can be expressed in terms of representativeness, completeness, comparability, accuracy, and precision.

A7.1 Data Precision, Accuracy and Measurement Range

The Project Team trains participating monitoring groups in proper procedure for sampling water quality parameters. Table B2-1 lists the parameters used by participating monitoring groups. Groups may sample a variety of the parameters dependent on their project study design.

Monitoring groups shall be responsible for analyzing samples in the field and at home unless data quality standards require that samples are sent to a certified laboratory for analysis. Laboratories conducting the analyses on the water quality samples are responsible for analytical accuracy and precision. Monitoring groups shall only employ the services of a state, federal, or NELAP certified lab to ensure accuracy and precision in the production of laboratory data. Data reported to the Project Team by a lab must be accompanied by a Method Detection Limit (MDL) for each parameter as established by the laboratory. MDLs represent the minimum concentration of an analyte that the lab can see and qualitatively state that the analyte is present with 95% confidence that the signal is caused by the analyte. Parameters to be analyzed by a lab are referenced in Appendix B.

A7.2 Data Representativeness

A7.2.1 Selection of Sampling Sites

Sites are chosen with the expectation that they will provide an adequate representation of what is occurring in the water body being sampled. In order to fill data gaps the Project Team will survey current locations being monitored by monitoring groups and work with the CBP to identify specific areas where data gaps are to be prioritized. The Project Team will then work with local groups to establish monitoring sites in those prioritized areas. Monitoring groups that wish to establish sites should coordinate with relevant local, state, and federal environmental agencies to identify waterbody segments that will best augment and complement data gathered by state and federal agencies as well as choosing sites that are of interest to the CBP and potential data users.

Final site selection occurs after a discussion between the Project Team and the participant. Because site selection may be based on proximal land use with considerations for spatial and temporal variations, it is important to have the local knowledge provided by the local monitors to help locate sampling sites that will yield data that are of most value to the monitoring group as well as government agencies and the CBP. Monitoring sites must be accessible to monitors (either open to the public or through permission of the private landowner). Often this is resolved by choosing monitoring sites that are actually on the monitor's private property or is on public property, such as a public pier or bridge to ensure that no monitors are trespassing on private property. Site selection also takes into consideration safety of the monitors during access to the site as well are during sampling operations. Once site locations are chosen, monitors will document the latitude and longitude coordinates using GPS.

Participating monitoring groups may have previously determined site locations where historical monitoring has taken place. These sites may be incorporated into the database if the

regional Project Team member agrees that the site selection followed a sound study design, they are public locations or have permission to visit them, and the site is safe for monitoring.

A7.2.2 Sample Collection

Sample data shall be representative of the actual conditions or concentrations present in the sampled water body. Samples will be collected from the thalweg of the channel when accessible via wading, boat, or bridge.

Sample collection, preservation, and handling and sampling design for monitoring are interactive factors that directly affect field sample representativeness. During sampling, the monitors utilize reliable QA procedures (field blanks, field duplicates, and standard operating procedures) to ensure representative data. These techniques combined with sample container requirements, sample preservation, and sample holding times described in project SOPs will assure minimum standards of field representativeness.

A.7.2.3 Number of Sites

The goal of the Citizen-based and Nontraditional Monitoring Integration project is to increase the number of sites monitored by citizen science and nontraditional monitoring groups within the Chesapeake Bay Watershed. Limitations on the growth of monitoring sites within sub-watersheds will be set by the size and capabilities of the participating monitoring groups.

A.7.2.4 Sampling Timelines

Water quality samples will be collected and analyzed by participants at least once a month, annually, and can be more frequent if time and resources allow or is required by a particular study design. For Tier II report card generation, water quality samples will be collected and analyzed by participants at least twice a month or a minimum of 18 number of samples per site. Samples should be collected year round when possible, however, typical monitoring seasons occur from March to November. Monitors are required to note on the data sheet the time and date of each monitoring event. Sampling may be cancelled due to unsafe conditions such as high water, strong storms, or other conditions deemed by the monitors to put them at risk of bodily injury or harm if sampling were to proceed.

A7.3 Data Comparability

The Citizen-based and Nontraditional Monitoring Integration project is comprised of monitoring groups throughout the Chesapeake Bay Watershed, which highlights the need for data comparability. Data collected must be comparable within and between monitoring groups.

Monitors will achieve comparability by:

a. Attending training workshops,

b. Following detailed methodology on sample collection, storage and analysis,

c. Using the monitoring equipment supplied or recommended by the Project Team,

d. Following the standard operating procedures, and

e. Following QA and QC requirements. Details on these items are outlined in their Water Quality Monitoring Methods Manual.

f. Monitors collecting Tier II data will be required to pass a certification test and maintain re-certification annually for the first two years of monitoring and then biennially after that.

When time and resources allow, monitoring groups are encouraged to coordinate samples at the same location and time with other monitoring groups or state monitoring agencies. It is recommended that this occurs at least once a year for each monitoring group. The results from these side by side sampling events will allow the Project Team to assess the comparability of sampling methods and monitoring groups and to identify QA issues that are illuminated at that time.

A comparability analysis of methodologies listed in table Table B2-1 will be performed during the summer of 2016 following CBP comparability study protocols. Results of this study will provide an understanding of the comparability of data from the variety of methodologies utilized in the project.

A7.4 Data Completeness

Completeness is a measure of the amount of valid data obtained compared to the amount that was expected under correct normal conditions. Estimates of completeness for the monitoring parameters of the project should exceed 90%, however it is required that at least 75% of the samples be collected from each of the sites during the monitoring timeframe (9 samples within 12 month period). All groups are required to sample at a minimum of once per month for a twelve-month sampling season and can sample more frequently if their resources allow or it is required by their project plan. It is expected that the sampling will be spread out throughout the calendar year, so that each season is adequately represented, and so that there are data from a minimum of 9 different months in the year (unless extreme weather conditions prevent sampling).
Groups collecting Tier II data and that wish to create a report card assessment are required to monitor at a minimum of twice per month for a nine-month sampling season or a minimum of 18 samples per site.

The actual number of samples collected and analyzed is not known until after the sampling is completed. The percent complete is the percentage of valid samples per parameter that the monitors collected on a schedule set by the particular monitoring group.

Table A7-1. Minimum data completeness requirements for a monitoring group sampling monthly or bi-monthly year round.

Parameter	Valid Monthly Samples Anticipated	Valid Samples for Report Card	Minimum Percent Complete Requirement	Recommended Percent Complete for Report Card
Dissolved Oxygen	12	24	75-100%	90-100%
Nitrogen	12	24	75-100%	90-100%
Phosphate	12	24	75-100%	90-100%
Water Clarity	12	24	75-100%	90-100%
pH	12	24	75-100%	90-100%
Turbidity	12	24	75-100%	90-100%
Water Depth	12	24	75-100%	90-100%
Water Temperature	12	24	75-100%	90-100%
Air Temperature	12	24	75-100%	90-100%
Conductivity	12	24	75-100%	90-100%
TDS	12	24	75-100%	90-100%
Salinity	12	24	75-100%	90-100%
Enterococcus	12	24	75-100%	90-100%
Chlorophyll and Phaeophytin	12	24	75-100%	90-100%
Silicate	12	24	75-100%	90-100%

A8. Training Requirements and Certification

The Project Team will hold workshops and offer customized assistance to monitoring groups who request it. It is recommended that the Project Team check in with monitors on a regular basis at follow-up meetings and through regular communication.

A8.1 Introductory Training

Monitors will be required to attend one or more introductory training workshops in their region before they begin collecting water quality data. Monitors collecting Tier II data will be required to pass an annual re-certification assessment the first two years of monitoring and a biennial re-certification after that. After a year of collecting data, monitors will be invited to participate in a data analysis, synthesis, and communication training workshop. In addition, during the monitoring period, the Project Team will offer customized assistance to monitoring groups who request such.

During an introductory training workshop, the Project Team or Certified Trainer will present the following items to the monitors:

a. Goals and objectives of the Citizen-based and Nontraditional Monitoring Integration Project;

b. Information on the science of water quality issues in the Chesapeake Bay Watershed;

c. Information on water quality impacts and the significance of the indicators to be measured;

d. Information on water quality parameters, including state criteria, values of concern, etc.; and,

e. Importance of safety when monitoring.

f. Intended uses and applications for their data.

Also during the initial training workshop, monitors will learn how to:

a. Develop a monitoring study design;

b. Choose appropriate monitoring site locations;

c. Clean, calibrate, use, store, and maintain monitoring equipment;

d. Collect, store, and transport water samples for water quality analysis;

e. Fill out and complete field data sheets;

f. Test water quality parameters;

g. Follow quality assurance and quality control procedures; and

h. Enter monitoring data into the database.

Monitors will be given the equipment and supplies (and/or information on how and where to purchase) needed to begin monitoring at the conclusion of the initial training workshop. They will also receive copies of the workshop materials, including the Water Quality Methods Manual. The manual contains the information they learned at the workshop, standard operating procedures for collecting, recording, and entering their data, field data sheets, external QC forms, and references of how and where to access regional resources to supplement and reinforce what they have learned at the workshop.

A Project Team Member or Certified Trainer will distribute a workshop evaluation to all participants at the end of the workshop. This evaluation focuses on self-reporting of perceived levels of understanding of the important concepts covered. The workshop will be fine-tuned to improve the pedagogy of the workshop, based in part by the results from the evaluation.

A8.2 Certified Monitors

Monitor performance will be evaluated at the workshop during the training activities. The Project Team members will work very closely with individual monitors during the hands-on training exercises to be sure that they have achieved the goals of the exercises. For example, staff will work with each monitor until they successfully calibrate their equipment and make accurate measurements on the water samples provided. It is expected that each monitor will be able collect samples, measure concentrations of analytes, and enter data into the nontraditional database. Each person who wishes to collect Tier II data for this project will be required to take a certification test to demonstrate their ability to follow standard operating procedures and understand QA/QC procedures. The certification test must be taken by the monitor at least one day after their training event to ensure that they have retained the information. Monitors that are unable to pass the test will be retrained on their deficiencies and allowed to retake the test. Monitors will be allowed to start collecting water quality samples once they have become certified.

After monitors have collected data for one year, they will attend a training workshop on how to analyze, synthesize, and communicate their monitoring results.

The Project Team members hosts re-certification sessions annually and biennially for monitors that have passed the initial training, are collecting Tier II data, and wish to maintain their certification. Re-certification sessions are conducted in a fashion that is similar to a lab practical. Monitors are checked to assure that: they remain proficient in methodology and understanding of basic water quality parameters; their equipment is operational and properly calibrated/verified; and, they have an adequate supply of viable chemicals, procedures, equipment verification/check, and updated information about monitoring.

The re-certification session is set up with a “station” for each water quality parameter. Monitors perform the test and compare their results to a known or controlled result. Project team staff observes the monitors’ methods and ensure that monitors correctly perform the tests and accurately record the data. After completing and “passing” one parameter, the monitor moves through each of the other stations while completing a datasheet that serves as documentation of

re-certification. Replacement equipment, datasheets, information, and chemicals are given if needed. Documentation is retained of re-certification sessions at the regional Project Team office.

A8.3 Certified Trainers

The Project Team conducts Train-the-Trainer workshops for Watershed Coordinators and/or designated certified volunteers to qualify them to perform initial trainings and re-certification sessions of monitors under this QAPP. In order to become certified, trainers must have been an active monitor for at least one year or demonstrate to a Project Team member a thorough understanding of monitoring and QA protocols implemented by this project. Those wishing to become certified as Trainers must then attend a Train-the-Trainer workshop held by the Project Team members. The workshop covers information on how to conduct initial trainings and re-certification sessions; how to manage documentation; checklists for training preparation; and, equipment and chemical management procedures. All documentation from these workshops, including attendance lists, are to be submitted to the regional Project Team member.

Following this Train-the-Trainer workshop, the Project Team invites qualified trainees to become certified. In order to become a Certified Trainer, the Trainer must satisfactorily conduct an initial training or a re-certification session while being observed by a Project Team member. Trainees are evaluated on:

a. Ability to logistically plan a training, including equipment preparation and documentation completion

b. Ability to explain water quality parameters, water quality science, and the importance of water quality monitoring

c. Ability to effectively train volunteer monitors in approved water quality monitoring methods

Once a trainee qualifies by these means, they become a Certified Trainer and may train and re-certify volunteer monitors in their region. The Certified Trainer must complete at least two training session and certify at least five monitors per year in order to remain a trainer. In addition, the trainer must undergo an observation by a Project Team member in person or by video once every two years.

In order to stay certified as trainers, the Certified Trainers must meet every year with the regional Project Team member to be re-certified as a Certified Trainer. At this time, trainers may be asked to perform a “mock” training if deemed necessary. Re-certification of Certified Trainers will also include an equipment check and verification of the Trainer’s master thermometer against the ACB’s verified master thermometer. Trainers will bring a sample monitoring kit that they give to new monitors for verification. This kit must include the correct and verified equipment, viable and correct chemicals, and a sample set of documents that are given to monitors. Project Team

members will attend and possibly assist with trainings held by the Certified Trainers as time and funding allow.

A9. Documentation and Records

A9.1 Field Data Sheets

During every sampling occasion, the monitor will fill out and complete a prescribed and standardized field data sheet. On the data sheet, monitors record essential metadata including their name, date, time, and sample site location/station ID. They also record weather conditions, whether or not they calibrated their equipment, and time spent monitoring. The data fields are entered into a table on the data sheet, including values for replicates. These data sheets are either passed on to the monitoring group leader for data entry or the monitor may enter the data directly into the database upon returning from the field. In either case, the original data sheets are archived with the regional Project Team member. Monitoring groups will submit their data sheets to the Project Team every quarter. It is recommended that a Project Team member or Certified Trainer check in with monitors quarterly to ensure that the data are being archived and entered into the database correctly.

The Project Team member maintains original hardcopy records (data sheets) of water quality data submitted by all participating groups for seven years after submission to the project. In addition, the project maintains electronic (digital) records of the data within the database.

Participating monitoring groups may already have a data sheet in place that fits the individual group's project design and that the group's monitors are already comfortable with. The Project Team will review and approve of field data sheet for the use in the program. Monitoring groups that do not have field data sheets or data sheets that are deemed appropriate by the Project Team may use the standardized field data sheet. Sample data sheet is included as Appendix C.

A9.2 Lab Data Sheets

Each lab will be expected to supply their own lab data sheets. Laboratory results will be reported to the monitoring group that submitted the water samples to the lab. It will be the responsibility of the monitoring group to enter the laboratory results into the project database with accompanying metadata. After data entry the monitoring group will forward the lab data sheets to their regional Project Team member for a data entry check. The lab data sheets are to be held by the lab and the Project regional Project Team member for a period of seven years.

A9.3 Spot check procedure

Monitors will input their data sheets into the database and submit the original copies to their Certified Trainer or regional Project Team member every three months. Monitoring groups with Certified Trainers may have their Certified Trainer supervise a spot check of 10% of the submitted data sheets. If a monitor is found to be at fault of a data entry error, all their recent data sheets from the previous six months are to be checked. Errors will be corrected by the Certified

Trainer. The Project Team will perform a spot check of 10% of the submitted data sheets if a check has not already been done by a monitoring group's Certified Trainer. Again, if a monitor is found to have data entry errors, all their recent data sheets are to be checked. Errors will be corrected by the Project Team. If substantial QC issues are identified the Project Team member will alert the monitor and work to remedy the issue.

A9.4 Other documentation and records

Verification logs for the ACB's master thermometer and thermometers maintained by monitors are stored at the ACB office in Richmond, Virginia for seven years. Project Team staff must copy their verification logs and forward originals to the ACB Richmond office. Verification logs for thermometers are included in Appendix F of this document. Probe calibration information is recorded before and after monitoring. Calibration values are recorded on the field datasheets and the online database for metadata reporting.

All documentation from trainings, certifications, and re-certifications, including Train-the-Trainer documents are held at the regional Project Team members' office for seven years.

Section B - Measurement/Data Acquisition

B1. Sampling Process Design

B1.1 Rationale for Selection for Sampling Sites

While the project strives to maintain monitoring sites that provide an accurate representation of water quality within the Bay and its tributaries, the extent and coverage of sampling locations vary based on the group participating. In addition, some monitoring sites have been added due to individual monitoring interest and are not part of a larger group's monitoring program.

To the degree practical, the following criteria are used when selecting sites or groups of sites for the program:

a. There should be an equal number of monitoring sites in the estuarine, transition, and tidal fresh portions of a tidal river.

b. Monitoring sites should be located in the main channel of a tidal stream or river.

c. Monitoring sites that cannot be located in the middle of the channel due to safety or resource limitations must be located at the end of docks least 30 feet from the shoreline and with low tide depth of at least 5 feet and be as near to the center of channel as possible.

d. Monitoring sites that must be established along shorelines or in shallow water will be designated Tier I on a case-by-case basis.

e. Monitoring sites will be located outside permitted mixing zones, such as wastewater treatment plant outfalls, stormwater drain outflows, or other types of known human or animal discharge UNLESS the monitoring objectives and design are specific to these areas.

f. Monitoring sites may be co-located at CBP, state monitoring, or nearby group site to allow for comparison of datasets.

g. Monitoring sites should be located in accessible and safe areas.

In addition, as discussed in Section A7.2, sites increasingly will be chosen with respect to complementing or augmenting data obtained by state and federal agencies and the CBP as well as to provide data that allows monitoring of changes resulting from best management practices, TMDL implementation plans, and other restoration activities.

Safety is an issue strongly emphasized by Project Team. During training sessions, safety is emphasized and is discussed before training begins. Most sampling locations are on the monitor's property or on public property to prevent safety and trespassing issues resulting from a

lack of landowner permission. The Project Team emphasizes the importance of using "the buddy system" when possible or alerting someone when a monitor will be in the field sampling. Inclement weather, monitor health issues, or environmental hazards are reasons to not conduct monitoring.

B1.2 Sample Design Logistics

Each group participating in the project will have their own unique sampling schedule based on their project design. In addition, each group will measure the parameters that are outlined in their project design. Section B2 provides an all-inclusive list of all potential parameters and methods that are approved to be Tier II or Tier I level data underneath this QAPP.

B2. Sampling Method Requirements

A full description of sampling methods used by monitors participating is given in the tidal standard operating procedures in Appendix A. The SOP is all inclusive of methods that can be used to collect Tier I and Tier II data under this QAPP. Monitoring groups will be provided abridged SOPs that contain only instructions pertinent to their project design. Table B2-1 lists the approved parameters and methodologies for sampling along with their Tier designation.

Samples can be collected from a boat or a bridge as long as the sample is representative of main channel conditions are generally classified as Tier II. Tier I samples are generally taken from shorelines and shallow areas. Samples will be collected from tidal freshwater areas of tributaries through the river mouths and into the open waters of Chesapeake Bay. All sampling will be coordinated within each individual monitoring group with detailed metadata of methodology used, which provides the information needed to compare data across all monitoring groups. Monitoring groups adopting this QAPP will be required to submit their monitoring timeline as well as a list of the approved parameters (with the accompanying methods and equipment) they plan to measure, to be approved by the Project Team.

Table B2-1. Tier designations and sample method requirements.

Parameter	Analytical Method	Equipment	Tier Designation	Tier II Additional Requirements
Ammonia-nitrogen	Spectrophotometry	Specific to individual lab	Tier II	Lab Analysis
Chlorophyll a	Fluorometry	Fluorometry	Tier II	Lab Analysis
Chlorophyll a,b,c	Spectrophotometry	Spectrophotometry	Tier II	Lab Analysis
Chlorophyll a,b,c	HPLC	HPLC	Tier II	Lab Analysis
Conductivity	Electronic probe	LaMotte 1749, Extech	Tier II	Calibration
Dissolved oxygen	Kit using Winkler titration	LaMotte 5860	Tier II	Standardization
Dissolved oxygen	Electronic probe	Multiprobe sonde	Tier II	Calibration
Enterococcus	IDEXX Enterolert	IDEXX Enterolert	Tier II	Lab Analysis
Enterococcus	Membrane Filtration	Membrane Filtration, m-EI prepared Agar Plates	Tier II	Lab Analysis
Nitrate - Nitrogen	Spectrophotometry	Specific to individual lab	Tier II	Lab Analysis
Nitrate-nitrogen	Colorimetric kit using cadmium reduction method	Hach NI-14 1416100	Tier I	
Nitrate-nitrogen	Colorimetric kit using cadmium reduction method	LaMotte 3110	Tier I	
Nitrate-nitrogen	Colorimetric kit using zinc reduction method	LaMotte 3354	Tier I	
Nitrite-Nitrate	Spectrophotometry	Specific to individual lab	Tier II	Lab Analysis
Orthophosphate	Colorimetric kit using ascorbic acid method	Hach PO-19 224800, Hanna HI 38061	Tier I	
Orthophosphate	Digital checker using ascorbic acid method	Hanna HI 713	Tier II	Standardization, Acid-washed glassware
Orthophosphate	Spectrophotometry	Specific to individual lab	Tier II	Lab Analysis

pH	Strips	ColorpHast pH Strips (2 - 9)	Tier I	
pH	pH probe	Hanna, LaMotte, Oakton, Extech	Tier II	Calibration
pH	Colorimetric kit	LaMotte, Hach	Tier II	
Phaeophytin	Fluorometry	Fluorometry	Tier II	Lab Analysis
Salinity	Refractometer	Extech, General	Tier I	
Salinity	Probe	LaMotte 1749, Extech	Tier II	Calibration
Silicate	Spectrophotometry	Specific to individual lab	Tier II	Lab Analysis
Total dissolved solids	Electronic probe	LaMotte 1749, Extech	Tier I	
Total Nitrogen	Spectrophotometry	Specific to individual lab	Tier II	Lab Analysis
Total Phosphorus	Spectrophotometry	Specific to individual lab	Tier II	Lab Analysis
Turbidity	Turbidity kit	LaMotte 7519	Tier I	
Water clarity	Secchi Disk	Ben Meadows 224217	Tier I	
Water clarity	Transparency tube	Forestry Suppliers 77107, Ben Meadows 111360	Tier I	
Water temperature	Armored thermometer	LaMotte 1066	Tier II	Verified
Water temperature	Digital thermometer	Ex. Hanna 98509	Tier II	Verified
Water temperature	Thermistor as part of multi-parameter probe	Ex. LaMotte 1761	Tier II	Verified

As noted by the Tiered Framework in section A5.2, the Project Team categorizes the data collected based on the quality of the data.

Data quality is dependent on the:

a. Analytical method used,

b. Equipment (based on based on accuracy, precision, and sensitivity) used, and

c. Documented quality control procedures used to collect the information.

For this program, data are categorized as Tier I or Tier II. In order for data to qualify for Tier II, monitors must:

a. Meet the data quality requirements for each parameter,

b. Collect samples from the thalweg of the water body,

c. Test samples in replicate and duplicate at required frequencies, and

d. Demonstrate that they are following the SOPs by maintaining certification.

Specific requirements for each Tier II parameter are included in Table B2-1. If a monitor does not meet all of the QA requirements for Tier II data collection, the data will be flagged in the database, and if appropriate demoted to Tier I level.

B3. Sample Handling and Custody Procedures

Sample custody procedures are an integral part of the laboratory and field operations. Since the data generated by Tier I and Tier II groups are not used for legal purposes, formal Chain of Custody (COC) procedures are not required. The most common exception to this is if the contracted laboratory requires a COC procedure. In such a case, the COC procedure is outlined in the affected group's QAPP.

Sample custody procedures are contained in the SOP Manual (see Appendix A) and ensure the integrity of the samples received at the labs. All samples will be properly labeled in the field and will include at minimum location ID, sample number, date, time of collection, sample type, method used to preserve the sample, and the sampler's name.

Field sampling operations include:

a. Procedures for filling out lab scheduling forms, field and lab sheets, and sample label tags;

b. Procedures for preparing samples for shipment; and,

c. Documentation of sample custody in the field.

Upon completion of sampling, the coolers containing samples surrounded by wet ice should be delivered to an approved laboratory as soon as possible within specified holding times (see Appendix B for a list of applicable holding times). Once samples have been received, the laboratory will have sample custody responsibility. Detailed procedures for custody procedures at each lab should be made available upon request from the laboratory.

Sample tags must be attached to every water sample collected and sent to an approved lab for analysis. See Appendix A for the correct procedures for filling out sample tags. The laboratory receiving the samples will reject analysis of any sample under the following conditions:

a. No sample tag attached.

b. No collection information accompanying the samples.

c. Sample tag and collection information does not exactly match and the issue cannot be resolved.

d. Temperature of samples exceeds 4° C.

e. Holding time requirements for water samples have been exceeded (see Appendix B).

Coolers and chlorophyll bottles are returned to the regions by the courier on a regular basis.

B4. Analytical Methods Requirements

Analytical methods utilized will use EPA or CBP recognized methods. A complete list of parameters sampled and their methods are given in Appendix B. Methods are outlined in detail in the SOP in Appendix A. Laboratory analyses will be performed by a state or federally approved lab and pertinent SOPs for analyses are available from each laboratory upon request.

B5. Quality Control Requirements

Because the data generated in this program are going to be used to assist decisions that affect the Chesapeake Bay Watershed, it is essential to maintain a high level of QA/QC. Field, laboratory, and data management personnel will utilize established procedures to ensure data accuracy, precision, representativeness, comparability, and completeness necessary for a successful program.

B5.1 Field QC Checks

B5.1.1 Equipment Calibration

All field and field quality control samples will be collected in accordance with the SOP manual (Appendix A). Generally, field equipment is checked just prior to going out on a sample run to ensure it is properly operating and not damaged. Equipment requiring calibration or verification is done using known references or standards and must fall within limits set in Appendix

B. Equipment that fails calibration or verification is not used and the monitor informs their designated Project Team member of the problem so it can be quickly addressed. Data collected using equipment that failed calibration/verification is flagged and can used at a lower tier based on the nature of the issue encountered.

B5.1.2 Replicates

Duplicates of field parameters generally do not occur as monitors have one set of equipment and field parameters change too quickly for a true duplicate to occur. However, a field replicate can be performed for many field parameters where the monitor takes the instrument to the site and obtains a reading. The instrument is removed or new sample is collected and a second reading is obtained. Valid replicates are if readings are within the accuracy range stated for the equipment used. For Tier II sampling replicate testing must occur at a frequency of 10% of site visits.

B5.1.3 Duplicates

For field parameters, the only true duplicate is performed if monitors are using the Winkler titration method for measuring DO. For Tier II, duplicates are done at every site a Winkler sample is collected. Monitors are instructed to do a third titration if their two initial titrations differ by more than 0.6mg/L. The two closest values are recorded on the datasheet. If the monitor reports values in two consecutive weeks exceeding the quality control requirements, the monitor is contacted by a Project Team member or Certified Trainer to resolve the problem. Monitors collecting samples for Tier II laboratory analysis will perform duplicate samples at least 10% of the time. Duplicates consist of either collecting a larger sample for mixing and splitting it between two containers or immersing sample containers side by side in the water at the same time.

If a monitor or group has more than three duplicates or replicates outside of the accepted range for a particular parameter in a quarter, the Project Team member or trainer is notified and the problem is investigated further by a site audit. If the audit uncovers an underlying problem, refresher training is provided. If the problem continues, data from the monitor/group is flagged depending on the type of problem found.

B5.1.4 Field Blanks

Monitors collecting samples for Tier II laboratory analysis will perform blank samples at least 10% of the time. Monitors will perform all field procedures including preserving the samples as required and taking to the lab for analysis using deionized water supplied by the lab. Results from field blanks will be recorded and appropriately marked during database entry. Field blanks exceeding 20% of the expected concentration range for each sample will be flagged as questionable data for the associated samples collected.

If a monitor or group has more than three field blanks in a three month period outside of the accepted range for a particular parameter, the Project Team member or trainer is notified and the problem is investigated further by a site audit. If the audit uncovers an underlying problem, refresher training is provided. If the problem continues, data from the monitor/group is flagged until a resolution is found.

B5.1.5 Field Audits

Project Team members, the QC management, or Certified Trainers may accompany monitors in the field and observe field collection procedures as part of the re-certification process for monitors. As stated above, if a problem is found with field QA samples or another QA issue is discovered, a field audit will likely be required. During the audit, monitors must demonstrate proper sample collection, analysis, labelling, and preservation in accordance with the SOPs. If deficiencies are found, onsite re-training is provided and the problem noted in a corrective action report for reference by the Project Team. A follow up audit may be required if the problem found was significant and resulted in downgrades to a lower tier.

B5.2 Laboratory QC Checks

Labs should be either NELAP, state, federal certified, or recognized by the CBP. Labs that do not maintain a certification or are not recognized by the CBP will be considered for inclusion on a case by case basis. All labs must adhere to the established standards for precision and accuracy control limits for each parameter, as determined by lab duplicates and spikes, respectively. If any data fail these criteria they are to be flagged as failing QC criteria.

Laboratory QC procedures are developed by the individual laboratory. When requested, the Project Manager will contact the laboratory to obtain a copy of the procedures.

B5.3 Data Entry QC Checks

Monitors will input their data as frequently as collected or as soon as possible into the database. After data entry they will copy the data sheets and then submit the original copy to their Certified Trainer which is bundled with other field sheets and sent to the regional Project Team member every quarter. The database will have algorithms to perform basic data entry checks and flag data and quality samples (blanks and replicates) that are outside the "acceptable" ranges for each parameter. The flags alert the monitor, the Certified Trainer, and/or Project Team member to questionable data and collection practices. If necessary, a process to remedy QC issues will occur. The ranges used to flag data will be those used by the CBP Data Upload and Evaluation Tool (DUET) and are displayed in Appendix B.

Monitoring groups with Certified Trainers may have their Certified Trainer supervise a spot check of 10% of the submitted data sheets. If a monitor is found to be at fault of a data entry error, all their recent data sheets are to be checked. Errors will be corrected by the Certified Trainer. The Project Team will perform a spot check of 10% of the submitted data sheets if a check has not already been done by a monitoring group's Certified Trainer. Again, if a monitor is found to have data entry errors, all their recent data sheets for the previous six months are to be checked. Errors will be corrected by the Project Team. If substantial QC issues are identified, the Project Team member will alert the monitor and work to remedy the issue.

Any inconsistencies in data entry found in the database are corrected and a note is put on the data sheet and in the "Comments" field of the database indicating that an error was made. Repeated entry errors (e.g., recording transposed values in database), out of range results, incomplete data sheets, and written notes by monitors are examples of signals to the Project Team of possibility

of questionable data. Under these circumstances, the monitor is contacted by the Project Team staff, Certified Trainer, or QA Management for a conversation on what, if any, problems the monitor is experiencing, to answer any questions the monitor may have, and to schedule a retraining if necessary.

Questionable data are flagged and downgraded when deemed necessary in the database and field data sheets are marked as such. Examples of questionable data are:

a. Absence of metadata including calibration values for probes and chemical viability checks for sodium thiosulfate;
b. Required samples not taken (e.g., two dissolved oxygen samples are required to be taken at each monitoring event, only one sample taken); and,
c. Out of range results due to:
    1. Equipment issues (e.g., monitor alerting on datasheet that syringe broke during testing;
    2. Monitor not performing test correctly (e.g., determined by monitor comments on data sheet or investigation by Project Team staff, Certified Trainer, or QA Management resulting in retraining of monitor); and,
    3. Chemical expiration or contamination (e.g., determined by monitor comments on datasheet, investigation by Project Team staff, or Certified Trainer, resulting in chemical replacement or recall of reagent)

B6. Instrument/Equipment Testing, Inspection, and Maintenance Requirements

Monitors are to inspect their equipment before each monitoring event or as outlined in Appendix B.

B6.1 Equipment Maintenance

Monitoring supplies are kept in a secure area, unless otherwise specified. Equipment are stored at room temperature and are kept out of reach of animals and children. Unless discolored, failed verification, or other obvious signs of degradation or damage, chemicals are considered valid until the printed date of expiration. Chemicals past the expiration date are collected during re-certification events so they may be disposed of properly in accordance with federal, state, and local environmental control regulations.

The Project Team and Certified Trainers keep and maintain thermometers for use in water quality monitoring. These thermometers are stored upright and if applicable, with batteries removed, and are clearly labeled as either a verified or a non- verified thermometer. Monitors are instructed to keep their non-digital thermometers stored in an upright position or to reduce damage or column separation.

All monitoring probes will be maintained according the manufacturer's instructions.

B7. Instrument Calibration and Frequency

Due to the varied type of equipment used by monitoring groups, Appendix B lists general calibration frequency and standards used. If a monitoring group uses different calibration procedures, it is outlined in the group's specific SOP manual.

The Alliance for the Chesapeake Bay owns a master precision thermometer that is verified annually against the Virginia Department of Environmental Quality's NIST-traceable thermometer. If the ACB master thermometer is not found to be within the acceptable range of within 0.2° C of the NIST reference, the ACB obtains a new thermometer, which is then verified. Project Teams and Certified Trainers are also required to obtain master precision thermometers that are verified to be within 0.2° C against the ACB's verified master thermometer or another NIST traceable thermometer on an annual basis. It is these verified thermometers that are used by the ACB to assure proper verification of the thermometers used by monitoring groups. Verified thermometers are tracked using a unique identification number. Verification logs are retained by the Project Team members and Certified Trainers and forward their original verification logs to the ACB Richmond, Virginia, office to be retained for seven years.

All probes are to be calibrated as specified in the SOP or by the manufacturer's instructions. Calibrations are tracked on the field data sheet itself. See Appendix C for a sample data sheet.

Monitors using Hanna Digital Checkers will verify their checker is reading properly using the verification vial and record their verifications on their data sheet. If orthophosphate is outside +/- 5 mg/L, the monitor must use another verification vial, and if the device is confirmed to be out of range the monitor will replace the Digital Checker.

Monitors should check their probe calibrations upon return from sampling against the standards. If values are outside the ranges of pH +/- 0.2 units, DO +/- 0.3 mg/L (compared to theoretical value), or specific conductance +/- 5% of verification standards, the data must be flagged and the probe must be assessed and fixed or replaced if needed.

B8. Inspections/Acceptance Requirements for Supplies

The Project Team will obtain monitoring equipment and supplies from reputable laboratory supply companies such as LaMotte, Micrology, HACH, Forestry Suppliers, Hanna, AquaPhoenix Scientific, VA Laboratory Supply, and Fisher Scientific. Monitoring equipment for this project will be chosen based on accuracy, precision, ease of use, cost, experience using, and/or recommendations from other monitoring program coordinators.

Upon receipt of equipment, Project Team members and Certified Trainers inspect all supplies as soon as they are received. Items that are broken or appear defective are immediately sent back to the supplier. The Project Team members and Certified Trainers clearly mark the expiration dates

in permanent marker on all chemicals and reagents (based on the lot number or manufacture expiration date).

Supplies are then organized for both training and re-certification sessions. The Project Team members and Certified Trainers ship replacement supplies to monitors as needed. Monitors and Certified Trainers return expired chemicals and defective equipment to a Project Team member.

B9. Data Acquisition Requirements

The Citizen-based and Nontraditional Monitoring Integration project will acquire data from monitoring groups that have demonstrated that data were collected using QA/QC procedures that generate data of known quality. Historic data will be incorporated into the project database along with all available QA/QC supplemental information including any QAPPs, SOPs and other QA documentation. Data users will be able to determine the level of QA rigor of historical datasets based on associated metadata. This historic data will be adequately marked within the database as not collected underneath this project's QAPP and will not be assigned a tier level.

Mapping locations will be attained using USGS 7.5 minute topographic maps or online mapping applications of known accuracy such as Google Maps. Weather conditions will be collected from www.wunderground.com.

In some cases, flow data from nearby USGS stream gauges may be employed to determine stream flow conditions prior to sampling for sampler safety or determine if a representative sample can be collected. Stream flow data is obtained from the USGS stream gauge network at http://waterdata.usgs.gov/nwis/rt. Monitoring groups will consult with the Project Team member, local state environmental monitoring agency, or other resource to determine the best USGS stream gauge to refer to for their sampling needs.

Local tide tables will be referred to by the monitoring group to determine the correct tide phase to collect samples or notate it in their field sheet. There are a number of online resources as well as publications a monitor or group can refer to based on their location. As a general reference, groups can refer to the US Harbors Chesapeake Tide Charts at http://usharbors.com/chesapeake-tide-charts to find general tide information. However, groups are encouraged to use other tide charts that apply to their specific area or are familiar with. In such cases, the Project Team member or trainer can evaluate the reference the group will use to see if it is well suited to the needs of the project.

B10. Data Management

All data will be collected using an approved field data sheet. Not all data sheets will be exactly the same due to the diverse nature of the many monitoring groups participating. All field sheets will be required to have a site ID, date, collection time, monitor's name(s), calibration logs, and

parameters measured. An example field sheet is located in Appendix C. All field data, regardless of Tier designation, will be entered by monitors into the database after collection. Original copies of field data sheets, regardless of Tier designation, are to be maintained by the regional Project Team member for seven years. Participating labs will maintain their documentation pertaining to this project for seven years.

Water quality data are reviewed for errors using two methods. Data entry will be reviewed using a spot check procedure defined in section B5.3. Within the database, data will be reviewed on a rolling basis as defined within the database project plan. Summary statistics are calculated and data are plotted in order to identify anomalies within the data. When anomalies occur the regional Project Team member or Certified Trainer will review the field and lab data sheets and make corrections if necessary.

Digital data files will be maintained and backed up as described in the database project plan. All participating monitoring groups, Certified Trainers, the Project Team, and the CBP will have access to approved data for analysis.

Section C - Assessment and Oversight

C1. Assessment and Response Actions

The Citizen-based and Nontraditional Monitoring Integration project utilizes several levels of assessment to ensure the integrity of the reported data. The assessments are divided into 4 areas:

a. Laboratory
b. Programmatic
c. Field Sampling
d. Validation and Reporting

C1.1 Laboratory Assessments

Labs utilized for this project should be either NELAP, state, federal certified, or recognized by the CBP. Labs that do not maintain a certification or are not recognized by the CBP will be considered for inclusion on a case by case basis. Assessments by a certifying body or by the CBP will be reviewed by the project team to assess the conditions of the laboratory in the following areas:

a. Sample blanks
b. Procedures
c. Quality assurance
d. Data reduction and reporting

C1.2 Program Assessments

The QA Management will perform an annual assessment of the QA/QC procedures of the program to determine that data produced meet program objectives and are of known quality. This includes an assessment of a monitoring groups' ability to maintain certification and a high level of QA. If the QA Management discovers any QA issues within the program or with a monitoring group they will work with the appropriate regional Project Team member to resolve the issue. Once an issue has been resolved it is the responsibility of the Project Team member to follow up on the issue to ensure that QA issues have not reoccurred. Data submitted to the database during this time will be flagged as "questionable data" until the Project Team member has verified that the issue is eliminated.

C1.3 Field Sampling Assessments

The Project Team and Certified Trainers are responsible for ensuring that all monitors collecting Tier II data attend a re-certification session every year for the first two years of data collection and once every two years after that. These sessions serve as an audits or proficiency test for the monitors and their equipment. The Project Team retrains any monitor who demonstrates a faulty sampling technique and will not renew a monitor's certification until they can adequately

demonstrate that they have mastered the sampling technique. The Project Team and Certified Trainers use re-certification sessions to identify faulty equipment so that it can be immediately replaced.

Monitors can be re-certified at one of three meetings: a scheduled re-certification session; during a site visit by a Project Team member, Certified Trainer, or QA Management; or during a visit to any Project Team office for individual re-certification. The Project Team analyzes the data sheets from re-certification sessions to determine if the data quality objectives (e.g., correct values for parameters compared to controls) are met and if the monitor had any questions about the procedures. These objectives include:

a. Sampling methodology and handling procedures
b. Field documentation procedures
c. QA procedures
d. Problem identification
e. Equipment inspected, verified, calibrated, and replaced if damaged

If the objectives are not met by the monitor, the Project Team will decide on appropriate corrective action (e.g., training monitors to use an alternate method of sampling; requiring that equipment be more frequently verified; or the monitor ceases measuring the parameter in question.)

C1.4 Validation and Reporting Assessments

The database will be developed to incorporate a data validation and reporting system that will be supported by Project Team members and Certified Trainers. These procedures will be reviewed as a part of the annual assessment conducted by the QA Management.

C2. Reports to Management

The QA Management will create an annual assessment report of the QA program that will be circulated to all Project Team members, CBP, and EPA QA staff. All Project Team members are required to submit a quarterly report to the Project Manager of all project activities. QA matters will be included in these reports including trainings, certifications, re-certifications, and QA problem resolution. In addition, the Project Manager is required to submit bi-annual reports to EPA Region III of all project activities and will include any significant QA issues that have been addressed by EPA or CBP staff.

UMCES will provide trainings on data interpretation and reporting to monitoring groups collecting Tier II data. These trainings will provide monitoring groups with the tools they need to create a water quality monitoring report card using the data they have collected. All monitoring group reports generated within the project will be shared throughout the project, with local and state officials, as well as with the CBP and EPA.

Section D - Data Validation and Usability

D1. Data Review, Validation, and Verification Requirements

All field data sheets and information are thoroughly reviewed by the Project Team and Certified Trainers prior to data analysis to assure that all data were collected uniformly. Any data that are not collected according to standard operating procedures are examined to determine whether they are representative. All calibration logs are examined to determine how well the measurement instruments performed. If there appears to be significant drift in instrument performance, the data are flagged accordingly. Field data are entered into the database and compared against the original field data sheet for errors using the recommended 10% spot check procedure in section B5.3. These errors will be corrected by Project Team members. Field data sheets are retained by the regional Project Team member.

D2. Validation and Verification Methods

The Project Team works with monitoring groups to ensure that all data are validated and verified before acceptance in the database. The Project Team recommends that Certified Trainers and monitoring groups perform a spot check of data sheets as described in section B5.3 to ensure proper data entry procedures are upheld. The Project Team provides advice and technical assistance to ensure that procedures are properly followed and that submitted data have been checked thoroughly.

The monitoring group forwards the original datasheet to the regional Project Team member. If during spot-checking of raw data sheets and within the database data are found to be out of known ranges, erroneous, or questionable, it will be flagged by the database, Certified Trainers, or by a Project Team member during data review. When errors are identified the Project Team during the spot check process, previous data sheets from that monitor are checked back to the previous submission date. If more errors are found, the Project Team contacts the monitoring group for more information and to thoroughly investigate the error. If errors are easily identifiable, the monitor is informed of errors and is retrained on the applicable protocol to ensure proper data collection. If the error is unable to be resolved the data from that monitor for that period and onward is flagged until a resolution is found.

Through annual recertification for the first two years of a monitor's participation and biennial re-certification sessions after that, the Project Team works with monitors to ensure that equipment and reagents are still in good condition and monitors are performing the testing methods correctly. Monitors who use probes log their calibrations on the datasheet and in the project database. The Project Team and Certified Trainers log verifications of thermometers, probes, and other applicable equipment.

The Project Team keeps verification log sheets at the ACB Richmond, Virginia, office and are checked and referenced if any questionable data arise to confirm proper equipment verification. Calibration of probes occurs before, and after each use or as specified by manufacturer's instructions. Verification of master thermometers occurs yearly. Thermometers for new monitors are verified as needed. Monitor thermometers are checked yearly at re-certification sessions or are mailed in to the ACB office and are replaced if needed with new verified equipment.

Field replicates and blanks are collected and processed at a minimum of 10% of the samples collected. These quality control samples will be used to validate and verify field and lab procedures. A review of samples that are flagged by the database as failing QC checks (defined in the database project plan) will be conducted by the Project Team using field documentation. Results from the quality control and documentation review will be used to accept, qualify, or reject data for inclusion in the database.

D3. Reconciliation with Data Quality Objectives

This QAPP is applicable to two data quality objectives defined by Tier I and Tier II criteria. Classifications for data use and quality objectives are defined in Table A5-1 and data completeness goals are defined in Table A7-1. If Tier II data is found to not meet completeness goals required for report card analysis but maintains QA/QC rigor, the data can still be used and submitted underneath Tier II designation but will not be used for report card generation.

The results of all re-certification sessions are immediately analyzed to determine if monitors have met quality assurance requirements for each parameter re-certified. If an individual monitor does not meet these requirements, their equipment will be re-verified, checked, and replaced if it is determined to be faulty. If a monitor's technique is incorrect, they are re-trained and re-assessed until they can demonstrate the correct technique. If the monitor continues to use incorrect technique, their data are flagged by the Project Team or certified monitor and not entered into the database nor used in reporting.

Field and laboratory data that does not meet data quality objectives will be flagged. Data corrections will be reported to the monitoring group as well as the EPA, CBP, or other report requiring body by a Project Team member or the QA Management.

Appendix A:

Standard Operating Procedures for Tidal Monitoring

Standard Operating Procedures for Tidal Monitoring

Integration of Citizen-based and Nontraditional Monitoring into the Chesapeake Bay Program Partnership

Prepared by:

Alliance for the Chesapeake Bay

In cooperation with
Maryland Department of Environmental Science, Alliance for Aquatic Resource Monitoring, and the Izaak Walton League of America

May 2017

This document was created for the Integration of Citizen-based and Nontraditional monitoring into the Chesapeake Bay Program partnership through a cooperative agreement with EPA. (CB-96334901)

Acknowledged Works

Much of the information in this manual has been adapted from the following methods manuals:

Alliance for the Chesapeake Bay. 2012. Citizen Monitoring Program Manual

EcoCheck. (2011). Sampling and data analysis protocols for Mid-Atlantic tidal tributary indicators. Wicks EC, Andreychek ML, Kelsey RH, Powell SL (eds). IAN Press, Cambridge, Maryland, USA.

Virginia Citizen Water Quality Monitoring Program. 2007. Virginia Citizen Water Quality Monitoring Program Methods Manual

Center for Marine Conservation & U. S. EPA. Volunteer Estuary Monitoring: A Methods Manual, Second Edition.

U.S. EPA. 1997. Volunteer Stream Monitoring: A Methods Manual. EPA 841-B-97-003.

U.S. EPA. 1996. Recommended Guidelines for Sampling and Analyses in the Chesapeake Bay Monitoring Program. EPA 903-R-96-006.

Table of Contents

1 Before You Begin

1.1 Safety, Equipment List, and Volunteer Responsibilities

1.1.1 Safety – General Precautions

a) Always perform water-monitoring activities under the guidance of an adult.

b) Read all instructions to familiarize yourself with the test procedure before you begin. Note any precautions in the instructions.

c) Keep all equipment and chemicals out of the reach of young children and pets.

d) Avoid contact between chemicals and skin, eyes, nose and mouth.

e) Read the label on each reagent container prior to use. Some containers include precautionary notices or antidote information on the back of the container.

f) In the event of an accident or suspected poisoning, immediately call the Poison Control Center phone number in the front of your local telephone directory or call your physician. Be prepared to give the name of the reagent in question and its code number. Most kit reagents are registered with POISINDEX, a computerized poison control information system available to all local poison control centers.

1.1.2 Protect Yourself & Your Equipment: Use Proper Technique

a) Wear safety goggles or glasses when handling reagent chemicals.

b) Use the test tube caps or stoppers, not your fingers, to cover test tubes during shaking or mixing.

c) When dispensing a reagent from a plastic squeeze bottle, hold the bottle vertically upside-down (not at an angle) and gently squeeze it (if a gentle squeeze does not suffice, the dispensing cap or plug may be clogged).

d) Wipe up any reagent spills, liquid or powder, as soon as they occur. Rinse area with a wet sponge, and then dry.

e) Thoroughly rinse test tubes before and after each test. Dry your hands and the outside of the tubes.

f) Tightly close all reagent containers immediately after use. Do not interchange caps from different containers.

g) Avoid prolonged exposure of equipment and reagents to direct sunlight. Protect them from extremely high temperatures. Protect them from freezing.

1.2 Monitor Responsibilities

Choose a regular sampling day: Choose a convenient day of the week for sampling. Samples should be taken at regular weekly or monthly intervals. If it is not possible to sample on the same day each week, try to sample within 2 days (either side) of your regular day spacing the sampling dates, 5 to 9 days apart. Sample at the same time of day each week; if you are sampling multiple locations, be sure to always sample your sites in the same order each monitoring run to achieve similar sample timing.

Record your test results: Record data on a data collection form provided. Always record the test results as you go along. Keep a copy of the data collected for your records and to provide a backup copy should the original be lost.

Provide comments as necessary: The "Comments" section can be used to record general observations about the site especially changes due to erosion, recent notable weather, and any problems you had with the sampling procedures.

Submit data to database: If you have access to the internet, submit your data to the project's online database.

Send datasheets once every three months. Mail the data sheets to the Alliance or your Watershed Coordinator every three months so that we can maintain a current database.

Stay certified: Attend a recertification session every year for the first two years of monitoring and then every other year after that to maintain your skills and learn new information and techniques. You can also attend any training session to refresh yourself of the concepts and procedures between re-certifications.

2 QA/QC Procedures

2.1 Certification and Re-certification

2.1.1 Certification

All monitors that wish to submit Tier II data must gain monitor certification. Monitors can become certified at their initial training session by demonstrating a mastery of the sampling procedures and complete understanding of the quality assurance protocols used during data collection to be assessed by a Project Team member or Certified Trainer. Monitors must also pass a test that assesses the monitor's understanding of QA/QC procedures outlined in this SOP and the project QAPP with a 90% score. The certification test must be taken by the monitor at least one day after their training event to ensure that they have retained the information.

Monitors that attend an initial training and are unable to pass the requirements to become certified at the end of the training will be encouraged to continue practicing their monitoring procedures. Un-certified monitors are encouraged assist a certified monitors in the field until they have become comfortable with the procedures and QA/QC protocols. Un-certified monitors are allowed to retake the certification test, and demonstrate proper sampling and analysis technique up to three times in order to become a certified monitor.

When a monitor achieves certification, they may be assigned a site and begin to collect Tier II data and submit it to the project database.

2.1.2 Re-certification

The Project Team and Certified Monitors will host recertification sessions annually and biennially for monitors that have passed the initial training and wish to maintain their certification. Recertification sessions are conducted in a fashion that is similar to a lab practical. Monitors are checked to assure that: they remain proficient in methodology and understanding of basic water quality parameters; their equipment is operational and properly calibrated / verified; and they have an adequate supply of viable chemicals, procedures, equipment verification/check, and updated information about monitoring.

The recertification session is set up with a "station" for each water quality parameter. Monitors perform the test and compare their results to a known or controlled result. Project staff observe the monitors' methods and ensure that monitors correctly perform the tests and accurately record the data. After completing and "passing" one parameter, the monitor moves through each of the other stations while completing a datasheet that serves as documentation of re-certification. Replacement equipment, datasheets, information, and chemicals are given if needed. Alliance for the Chesapeake Bay retains documentation of recertification sessions.

2.1.3 Field Audits

Project Team members, the QC manager, or Certified Trainers may accompany monitors in the field and observe field collection procedures as part of the recertification process for monitors. Monitors will demonstrate proper sample collection, analysis, labelling, and preservation in accordance with this SOP.

2.2 Pre-monitoring checks

2.2.1 Equipment Check

Prior to going out into the field, monitors should check their equipment for cleanliness, breakage, probe function and battery life, and chemical expiration dates. If a monitor finds that their equipment is damaged and will affect the quality of the data they collect they will not collect data that day and mark the reason on their data sheet. The monitor should contact their Project Team member to get the equipment repaired or replaced prior to the next scheduled sample.

Monitors measuring dissolved oxygen using the Winkler titration will check the viability of their sodium thiosulfate solution prior to each monitoring event and record the results on their field datasheet. Sodium thiosulfate is used for monitoring dissolved oxygen. By using a standard solution of iodate-iodide, with 10 mg/L dissolved oxygen value, the monitor must record a value of 9.4 – 10 mg/L with their sodium thiosulfate measurement.

If results of the first check are above or below these intended values, a second check is performed. If the second check yields unacceptable values or if the two checks are greater than 0.4 mg/L apart from each other, the monitor is instructed to abandon the dissolved oxygen test because the sodium thiosulfate is no longer viable. The monitor must replace all expired chemicals prior to sampling again.

2.2.2 Calibration

Monitors will calibrate any equipment that requires calibration prior to being used (within 24 hours of use), using standard solutions and following the manufacturer's instructions. Monitors will note on their data sheet that they calibrated their equipment.

After sampling, it is recommended that monitors check their probes against the standard solutions used for calibration to identify instrument drift. If pH is outside of +/- 0.20 units, DO is +/- 0.3 mg/L, or specific conductance is +/- 5% of verification standards, the data must be flagged and the probe must be assessed and fixed or replaced if needed.

Monitors record these calibration and verification values on their datasheet and values are entered into the online database.

Thermometers that are verified should be re-verified every year. Thermometers must be verified against the Alliance master precision thermometer that is annually verified against an NIST-traceable thermometer to 0.2° C. If the Alliance thermometer is found to be reading beyond 0.2° C of a NIST-traceable thermometer it will be discarded and replaced and the new thermometer will be verified. Temperature data collected from thermometers confirmed by the Alliance thermometer found to be out of compliance will be flagged as not verified and downgraded a tier back dated to the last calibration check.

2.3 Field QC

2.3.1 Duplicates

If monitors are using the Winkler titration method for measuring DO they will perform the dissolved oxygen test on the actual water sample in duplicate. Monitors are instructed to do a third titration if their two initial titrations differ by more than 0.6mg/L. The two closest values are recorded on the datasheet.

Monitors collecting samples for Tier II laboratory analysis will perform duplicate samples at least 10% of the time. Duplicates consist of either collecting a larger sample for mixing and splitting it between two containers or immersing sample containers side by side in the water at the same time.

2.3.2 Replicates

Duplicates of field parameters generally do not occur as monitors have one set of equipment and field parameters change too quickly for a true duplicate to occur. However, a field replicate can be performed for many field parameters where the monitor takes the instrument to the site and obtains a reading. The instrument is removed or a new sample is collected and a second reading is obtained from the exact location and depth of the first sample. Monitors will perform replicate samples of all other parameters (DO using Winkler titration method must be done in duplicate each sample) 10% of the time. The quality control samples are prepared and analyzed for all parameters of interest. The field replicate data are used to determine the overall precision of the field and laboratory procedures.

2.3.3 Field Blanks

A field blank is sample of analyte-free deionized water supplied by a laboratory and processed in the field as a regular sample and then returned to the lab for analysis. Monitors will perform blank samples 10% of the time for samples to be sent to a lab for analysis. Monitors will perform all field procedures including preserving the samples as required and taking to the lab for analysis using deionized water provided by the laboratory. Results from field blanks will be recorded and appropriately marked during database entry.

3 Field Monitoring Procedures

3.1 Field Sampling Procedures

3.1.1 Best Practices

a) Use of protective gloves. Gloves serve a dual purpose: 1) protecting the sample collector from potential exposure to sample constituents and 2) minimizing accidental contamination of samples by the collector. Wearing protective gloves at all times while sampling is recommended. Latex or nitrile gloves may be used for common sampling conditions.

b) Safety always comes first. All sampling should be conducted with the proper equipment and least amount of danger to field personnel.

c) Permission must be obtained from landowners before entering private property.

d) Care should be taken not to disturb the bottom when sampling. When entering a stream, always walk in an upstream direction.

e) Surface water should always be collected facing upstream and in the center of main area of flow. Therefore, unless safety is an issue, samples should be obtained from a bridge or instream.

f) Samples should be collected in the main flow representative of the stream you are monitoring (for small streams, this is usually mid-channel).

   i. If you are sampling from a boat in Virginia, and have appropriate equipment, surface samples should be taken at a depth of 1 m.
   ii. If you are sampling from a boat in Maryland, and have appropriate equipment, surface samples should be taken at a depth of 0.5 m.
   iii. If you are unable to collect at these depths, due to equipment limitations, surface samples can be taken at 0.3 meters depth. All sample depths must be recorded on your data sheet.

g) Whenever possible, collect field measurements directly from the sample site, not from bucket. If the field parameters need to be measured in the bucket, collect water quality samples (nutrients, etc.) first before placing the multi probe instrument in the bucket.

h) When there are obvious standing pools of water during low or no flow conditions, do not collect samples or field measurements. Make a note of this on the data sheet.

i) When collecting bacterial samples:

   i. DO NOT rinse the bacteria sample bottle before collecting the sample.
   ii. If sample bottles contain a dechlorinating tablet (usually small white tablet) and

you are collecting an unchlorinated sample, dump out the tablet before collecting the sample.

iii. Be careful not to insert fingers into the mouth of the container or on the interior of the cap.

3.1.2 Sampling from a Boat

Using a probe

If you are measuring with a multi probe and have a long enough cord, you are encouraged to do depth profiles. If the depth is ≤3 m deep take a surface measurement 1 m below the surface in Virginia and 0.5 m below the surface in Maryland and a bottom measurement at 1 m above the bottom. If the depth is >3 m measure 1.0 m above the bottom, then 1 meter intervals up to 1 m below the surface in Virginia and take an additional measurement at 0.5 m below the surface in Maryland (Example: At a 3.4 m deep site, measure at 2.4, 2.0, 1.0 m and take an additional measurement at 0.5 m if in Maryland). At each iteration allow the probe to stabilize before recording your reading at the corresponding depth.

If you only are taking surface measurements, place your probe 0.5 m beneath the surface if sampling in Maryland and 1 m beneath the surface if you are sampling in Virginia, wait for the probe to stabilize, and then record your reading. If you are unable to measure at these depths due to equipment limitations you may sample at 0.3 m beneath the surface. All sampling depths must be recorded on your field sheet.

If the meter is not equipped with a pressure gauge for depth estimation and the current is strong enough to pull the meter so that the cable is at an angle noticeably different than vertical, estimation of depth will have to be corrected. Weighted probe guards may help prevent displacement by current.

Using sample bottles

For chlorophyll and nutrient grab samples, rinse the sample bottles three times with sample water. If sampling for chlorophyll, rinse your syringes three times with sample water as well. Drain the bottle until it is empty, put the cap on, lower it one forearm's length under water (about 0.3 meters) then remove the cap. Wait for the bottle to fill, then cap it and return it to the surface.

3.1.3 Streambank and Instream Sampling

If possible, wade into the stream to collect the sample. If wading to the sample site, always proceed upstream to allow the flow of the water to push any disturbed sediment downstream of where you will be collecting the sample.

Volunteers can sample from a streambank if they are unable to collect a mid-channel sample by wading, from a boat, or from a bridge or if conditions are unsafe. When sampling from the streambank, care should be taken to sample from an area that will most closely represent the entire stream. Typically, this will be the area of the greatest flow in the stream and away from stagnant pools or eddies.

Step	Bacteria Samples	Nutrient and Chlorophyll Samples
1.	Walk upstream to the sample location. Be sure any sediment or debris disturbed from your movement in the streambed is not present where you will collect the sample.	Walk upstream to the sample location. Be sure any sediment or debris disturbed from your movement in the streambed is not present where you will collect the sample.
2.	Submerge the container; neck first into the water. The mouth of the bottle should be completely below the water surface approximately 0.3 m or 1 foot.	Lower the capped sample bottle 0.3 m or 1 foot beneath the surface and up-cap the bottle to fill.
3.	Invert the bottle so the neck is upright and pointing into the water flow.	Allow the bottle to fill to the neck of the bottle.
4.	Move the bottle forward away from the body for at least six inches.	Lift the filled container. Do not pour out any excess water.
5.	Return the filled container quickly to the surface. Pour any excess water and cap.	

3.1.4 Dock or Bridge Sampling

1. Sample in the center of main flow from or as close as you can get on the dock. If sampling from a bridge sample from the safest side of the bridge and where contamination is least likely to occur. Typically, sampling on the upstream side of the bridge or dock is less likely to be contaminated.

2. During rainy periods, avoid sampling where storm water runoff from the bridge can affect sample.

3. Obtain field parameters (DO, pH, temperature) first before lowering a sample bucket.

4. When lowering the sample bucket, allow it to fill ¼ the way full and retrieve. Swirl the contents and dump the rinse away from the sample location to avoid kicking up sediment.

5. Repeat step 4 two more times and on the final time fill ½ to ¾ the way full.

6. Retrieve the bucket and collect the samples in the following order. Be sure to gently stir the

water with a clean tool before taking samples or measurements (do not introduce air bubbles).

1. Bacteria
    - Open the bottle without touching the inner wall of the bottle or lid.
    - Invert the bottle by holding to the main body of the bottle and lower into the bucket 3-6 inches.
    - Fill the bottle in a 'U' from the side of the bucket closest to you to the opposite end.
    - At the end, bottle opening should be facing up and remove from the bucket.
    - Pour off any excess water and cap with the lid.
    - If collecting a replicate sample, hold two bottles in one hand to fill both bottles at the same time.

2. Nutrients and Chlorophyll
    - Open the bottle and tilt so that one side of the bottle will be below the waterline of the bucket.
    - Allow the bottle to fill to the neck of the bottle.
    - Remove the bottle and cap. Do not pour off any excess sample.
    - If collecting a replicate sample, collect using two bottles simultaneously and fill both bottles at the same time.

7. In situations where field parameters must be obtained from the bucket, all water samples must be collected prior to inserting the probe in the bucket.

8. When performing a replicate sample using a probe, take your first measurement, remove the probe, take a second measurement, and record both measurements on your data sheet.

9. If you sampled using a bucket, mark your data sheet to indicate your sampling technique.

3.2 Air Temperature Measurement

Equipment: armored, digital thermistor, or probe

Temperature is reported in degrees Celsius (ºC). Always measure air temperature before water temperature.

Method:

1. Locate a place near your site and hang the thermometer out of the direct sun.

2. Wait 3-5 minutes to allow the thermometer to equilibrate.

3. Record air temperature to the nearest 0.5 ºC for the armored thermometer or to the nearest tenth of a degree for the digital thermistor or probe on Page 2 of the datasheet.

3.3 Recording General Observations

Record weather and general observations on the datasheet.

3.4 Water Clarity & Turbidity Measurement

3.4.1 Secchi Disk

Equipment: 8" Secchi disk with attached line

Method:

1. Remove sunglasses if you are wearing them and stand with the sun to your back. Try to lower the disk into a shaded area.

2. Lower the disk into the water until the disk barely disappears from sight. Note the depth reading, in meters, based on the length of line submerged. Each mark is one-tenth (or 0.1) meter.

3. Slowly raise the disk and record the depth at which it reappears (i.e. is barely perceptible).

4. Average the two depth readings obtained above. The average of the two readings is considered to be the limit of visibility, or index of transparency. Record this average to the nearest tenth of a meter on your data form.

3.4.2 Transparency Tube

Transparency tubes are a type of equipment used for measuring transparency of water in streams and rivers. They are helpful for measuring transparency in situations where the stream is too shallow for the Secchi disk to be practical and for running waters where flow is too fast that the Secchi disk cannot remain vertical. Sample water collected either directly from the stream or from the sampling bucket is analyzed.

Equipment: Transparency tube

Method:

1. Close the drain tube by squeezing the crimp.

2. Fill the transparency tube with your sample water. Water may be collected directly from the stream in the vicinity of the sampling location if the stream is too small to fill the bucket, or sample water collected in the sampling bucket may be used (See 5.4, "Collecting the Water Sample"). To collect water directly from the stream, point the top of the tube in the upstream direction and collect surface water, being careful not to disturb the stream bed. To analyze water collected in the bucket, pour sample water from the bucket water directly into the transparency tube.

3. While looking down through the opening of the tube, partially open drain crimp, slowly draw off sample (Control flow by squeezing the crimp).

4. When the black and white pattern begins to appear, immediately tighten the crimp.

5. Record the level of water remaining via the centimeter ruler on the side of tube.

3.4.3 Turbidity Kit

This test is performed by comparing the turbidity of a measured amount of the sample with an identical amount of turbidity-free water containing a measured amount of standardized turbidity reagent. The readings are made by looking down through the column of liquid at a black dot. If turbidity is present, it will interfere with the passage of light through the column of liquid. Small amounts of turbidity will cause a "blurring" of the black dot in the bottom of the tube. Large amounts of turbidity may provide sufficient "cloudiness" so that it is not possible to see the black dot when looking down through the column. Any color that may be present in the sample should be disregarded. This determination is concerned only with the haziness or cloudy nature of the sample.

Equipment: Turbidity kit – LaMotte 7519-01

Method:

1. Fill one Turbidity Column to the 50 mL line with the sample water. If the black dot on the bottom of the tube is not visible when looking down through the column of liquid, pour out a sufficient amount of the test sample so that the tube is filled to the 25 mL line.

2. Fill the second Turbidity Column with an amount of turbidity-free water that is equal to the amount of sample being measured. Distilled water is preferred; however, clear tap water may be used. This is the "clear water" tube.

3. Place the two tubes side by side and note the difference in clarity. If the black dot is equally clear in both tubes, the turbidity is zero. If the black dot in the sample tube is less clear, proceed to Step 4.

4. Shake the Standard Turbidity Reagent vigorously. Add 0.5 mL to the "clear water" tube. Use the stirring rod to stir contents of both tubes to equally distribute turbid particles. Check for amount of turbidity by looking down through the solution at the black dot. If the turbidity of the sample water is greater than that of the "clear water", continue to add Standard Turbidity Reagent in 0.5 mL increments to the "clear water" tube, mixing after each addition until the turbidity equals that of the sample. Record total amount of Standard Turbidity Reagent added.

5. Each 0.5 mL addition to the 50 mL size sample is equal to 5 Jackson Turbidity Units (JTUs). If a 25 mL sample size is used, each 0.5 mL addition of the Standard Turbidity Reagent is equal to 10 Jackson Turbidity Units (JTUs). See Table 3.4-1 below. Rinse both tubes carefully after each determination.

Table 3.4-1-1. Turbidity Test Results – from LaMotte 7519-01 instructions

TURBITITY TEST RESULTS

Number of Measured Additions	Amount in mL	50 mL Graduation	25 mL Graduation
1	0.5	5 JTU	10 JTU
2	1.0	10 JTU	20 JTU
3	1.5	15 JTU	30 JTU
4	2.0	20 JTU	40 JTU
5	2.5	25 JTU	50 JTU
6	3.0	30 JTU	60 JTU
7	3.5	35 JTU	70 JTU
8	4.0	40 JTU	80 JTU
9	4.5	45 JTU	90 JTU
10	5.0	50 JTU	100 JTU
15	7.5	75 JTU	150 JTU
20	10.0	100 JTU	200 JTU

3.5 Water Temperature Measurement

Equipment: armored, digital thermistor, or probe

Method:

Depth Profile Sampling (>3m):
If you are measuring with a multi probe and have a long enough cord, you are encouraged to do depth profiles.

1. Measure 1.0 m above the bottom, then move your sensor up to the next whole integer depth, then proceed at 1 meter intervals up through the water column until you reach 1 m below the surface if sampling in Virginia, take an additional measurement at 0.5 m below the surface if sampling in Maryland. (Example: At a 3.4 m deep site, measure at 2.4, 2.0, 1.0 m and take an additional measurement at 0.5 m if in Maryland)

2. At each iteration allow the probe to stabilize before recording your temperature reading at the corresponding depth

3. Measure salinity and DO at each depth as well

4. Record depth, DO, temperature, and salinity on your data sheet for each depth

Depth Profile Sampling (≤3 m):

1. Measure 1.0 m above the bottom, allow the probe to stabilize and record your result

2. Measure 0.5 m below the surface if sampling in Maryland and 1 m below the surface if sampling in Virginia, allow the probe to stabilize and record your result

Surface Sampling with Probe:

1. Place your probe 0.5 m beneath the surface of the water if sampling in Maryland and 1 m beneath the surface if sampling in Virginia.

2. Wait for the probe or thermometer to stabilize

3. Record your reading

Surface Sampling with Individual Thermometer:

1. Place your thermometer 0.5 m beneath the surface of the water if sampling in Maryland and 1 m beneath the surface if sampling in Virginia.

2. Wait for the thermometer to stabilize

3. Record your reading

Sample with bucket:

1. Hang thermometer in the bucket
2. Wait for the probe or thermometer to stabilize
3. Record your reading. Mark on your data sheet that the measurement was taken from a bucket.

3.6 Water Depth Measurement

Equipment: Secchi disk (for <3 m deep), measuring tape with weighted end, or DO probe with marked lengths (if doing depth profile sampling)

Method:

1. At your sampling site, lower the measuring device into the water until it is resting on the bottom and the line is slack.

2. Record the depth reading, to the nearest tenth, based on the length of line submerged.

3.7 Dissolved Oxygen

3.7.1 **Winkler Titration Method**

Equipment: LaMotte Dissolved Oxygen Test Kit

Sodium Thiosulfate Check:
Prior to each sampling event (either the night before or the day of), you must run a test to make sure your Sodium Thiosulfate is still fresh and functional. Sodium Thiosulfate is fairly unstable and can degrade very suddenly, making it necessary to check it before each DO sampling. Perform this check at home before you go out. It is important to perform this check in a room temperature environment at 20°C. Here is how you do the check…

1. Rinse the titrating tube (small glass vial with plastic lid with hole in it) with a small amount of Iodate-Iodide Standard Solution (in large amber bottle).

2. Pour into waste container.

3. Repeat step 1 and 2 two more times

4. Pour 20 ml of the Iodate-Iodide Standard Solution into the rinsed titrating tube.

5. Add 8 drops of Sulfuric Acid (hold the bottle vertical to ensure equal drop size) to the 20 ml of solution and mix by swirling. Then place plastic cap (with hole in it) onto titrating tube.

6. Fill titrating syringe to the "0" mark with Sodium Thiosulfate.

7. Titrate using the Sodium Thiosulfate.

8. When solution turns a pale yellow color, but not clear:
   a) Remove cap, leaving syringe in cap.
   b) Add 8 drops Starch Solution (white bottle). Swirl titration sample gently to mix to a uniform blue color. Recap glass tube and continue titration process.

9. Continue adding Sodium Thiosulfate until solution turns from blue to clear.

10. Read results on syringe - Record your results under the Dissolved Oxygen portion on your field datasheet.

11. If results are less than 9.4 mg/L or greater than 10.0 mg/L, perform a 2nd test and record in the space on datasheet marked "2nd check".

12. Dispose of solution in titrating tube and syringe by pouring down sink and flushing with additional tap water.

13. Keep the amber bottle solution at home- you don't need to take into the field.

DO Analysis Method:

NOTE: Duplicate tests are run simultaneously on each sample to guard against error. If the amount of DO in the second test is more than 0.6 ppm different than the first test, you should do a third test. Record the average of the two closest results.

Since you will be doing two tests at the same time, thoroughly rinse both water sampling bottles with the sample water, filling and dumping the waste water downstream three times before collecting your sample.

1. Using the first sample bottle, submerge about 1/2 of the bottle opening allowing the water to gently flow into the bottle. Try to fill the bottle without causing a lot of bubbles. Submerge the filled bottle.

2. Turn the submerged bottle upright and tap the sides of the bottle to dislodge any air bubbles clinging to the inside of the bottle. Cap the bottle while it is still submerged.

3. Retrieve the bottle and turn it upside down to make sure that no air bubbles are trapped inside. If any air bubbles are present, empty the sample bottle downstream and refill. Fill the second sample bottle. Once two satisfactory samples have been collected, proceed immediately with Steps 4 & 5.

4. Place both sample bottles on a flat surface and uncap. While holding the bottle vertical, add 8 drops of Manganese Sulfate Solution followed by 8 drops of Alkaline Potassium Iodide Solution to each sample bottle. Always add the Manganese Sulfate first. Cap each sample bottle and mix by inverting gently several times. A precipitate will form. Allow the precipitate to settle to the shoulder of the bottle. Mix both bottles again and allow the precipitate to settle to the shoulder again.

5. Add 8 drops of the Sulfuric Acid both sample bottles. Cap the bottles and gently shake to mix, until both the reagent and the precipitate have dissolved. A clear-yellow to brown-orange color will develop. If brown flecks are present, keep mixing the samples until the flecks will not dissolve any further.

NOTE: Following the completion of Step 5, the samples have been "fixed," which means that dissolved oxygen cannot be added to the sample bottles. The titration procedure described in Steps 6-13 may be performed at a later time (but must be performed within 8 hours of sample collection). This means that several samples can be collected and "fixed" in the field and then carried back to a testing station for the remaining steps.

6. Pour 20 ml of the solution from one of the sample bottles into one of the glass tubes with a hole in its cap. Fill to white line so that the bottom of the meniscus (the curved surface of the liquid in the tube) rests on the top of the white line. The amount is critical so be

sure to use the glass dropper to add or remove the sample solution from the tube. Place cap on the tube.

7. Fill syringe (titrator) to the 0 mark with Sodium Thiosulfate solution. Be sure that there are no air bubbles in the syringe. Refer to kit manual for instructions on how to properly fill syringe.

8. To titrate the solution in the tube, insert the syringe into the cap of tube. Add 1 drop of Sodium Thiosulfate to test tube and gently swirl the glass tube to mix. Add another drop of the Sodium Thiosulfate and swirl the tube. Continue this process one drop at a time until the yellow-brown solution in the glass tube turns a pale yellow (lighter than the original yellow-brown solution but not clear). Once you reach this point, take the cap off while leaving the syringe in the cap.

9. Add 8 drops of Starch Solution to the glass tube. Swirl the tube gently to mix. The solution should turn from light yellow to dark blue.

10. Recap the glass tube and continue the titration process with the Sodium Thiosulfate remaining in the syringe (adding one drop at a time and swirling as described in Step 9), until the test tube solution turns from blue to clear. This is the endpoint. If the solution turns blue again, ignore it. Do not add any more Sodium Thiosulfate than is necessary to produce this first color change. Be sure to gently swirl the test tube after each drop.

NOTE: When the dissolved oxygen level is above 10 ppm, the solution in the tube will still be blue when the plunger tip of the titrator reaches 10 units. If it reaches this 10 unit line, do not go beyond that line. Usually, this will only happen when the water temperature is cold. In this case, refill the syringe to the 0 line from the Sodium Thiosulfate bottle and continue adding a drop at a time and swirling until reaching the endpoint.

11. Using the scale on the side of the syringe, read the total number of units of Sodium Thiosulfate used. Each line is 0.2 units. This number equals the number of parts per million (ppm) or milligrams per liter (mg/L) of dissolved oxygen in the water sample.

12. Carry out Steps 7-12 on second sample bottle and second glass tube.

13. Record the results of the two tests on the data sheet. If the difference between Test 1 and Test 2 is more than 0.6 ppm, you should do a third test and record the two results which are within 0.6 ppm.

NOTE: If using transparency tube to measure turbidity, perform this measurement now.

3.7.2 Electronic Probe Method

Equipment: Various models of dissolved oxygen probes and meters

Calibrating Dissolved Oxygen Probes and Meters

With practice and proper care for the DO probe, users can complete the entire DO probe calibration process within 5-10 minutes.

NOTE: Some probes may differ in displaying values. For DO probes, parts per million (ppm), and milligrams per liter (mg/L) are the same value. In addition, barometric pressure may be displayed in millibars (mBar) or in millimeters of mercury (mmHg).

Method:

1. Record the date of calibration. Calibration must be done each day you collect DO samples.

2. Record the temperature of the probe just before you calibrate the probe.

3. Set the barometric pressure (BP) mmHg or mBar- Most probes allow the user to adjust the barometric pressure readout of the probe for calibrating DO. The standard unit for barometric pressure is millimeters of mercury (mmHg) or millibars (mBar). You can get local barometric pressure readings from www.weatherunderground.com or www.noaa.gov. If using weather station data, it is important to adjust the reading by the altitude of the weather station. Appendix II explains how to calculate the correct reading.

4. Calculate the Theoretical DO Value mg/L- Prior to calibrating your probe, you should determine the theoretical DO value to confirm your probes readout. To determine the theoretical value, please follow the instructions found in Appendix II.

5. Record the mg/L reading of the calibrated DO level. If everything is working properly, the probe should display the correct DO level based on the altitude and temperature that you are calibrating at. The theoretical DO value and the probes calibrated readout should be within 0.2 mg/L. If not, try to recalibrate the probe or perform maintenance on the probe based on manufacturer instructions.

6. Turn off the probe if the manufacturer says so. If not, keep the probe on at all times while you are taking it out to the field and performing your field samples.

Measure DO

Depth Profile Sampling (>3m)
If you are measuring with a multi probe and have a long enough cord, you are encouraged to do depth profiles.

1. Measure 1.0 m above the bottom, then move your sensor up to the next whole integer depth, then proceed at 1 meter intervals up through the water column until you reach 1 m below the surface if sampling in Virginia, take an additional measurement at 0.5 m below the surface if sampling in Maryland. (Example: At a 3.4 m deep site, measure at 2.4, 2.0, 1.0 m and take an additional measurement at 0.5 m if in Maryland)

2. At each iteration allow the probe to stabilize before recording your DO reading at the corresponding depth

3. Measure salinity and temperature at each depth as well

4. Record depth, DO, temperature, and salinity on your data sheet for each depth

Depth Profile Sampling (≤3 m)

1. Measure 1.0 m above the bottom, allow the probe to stabilize and record your result

2. Measure 0.5 m below the surface if sampling in Maryland and 1 m below the surface if measuring in Virginia, allow the probe to stabilize and record your result

Surface Sampling

1. Place your probe 0.5 m beneath the surface of the water if sampling in Maryland and 1 m beneath the surface if sampling in Virginia.

2. Wait for the probe to stabilize, and then record your reading

Post Sampling Calibration Check

After the sample run is complete, return the probe to the calibration station to perform a quick post check. The post check consists of placing the probe in the DO calibration chamber and letting it equalize. This may take between 2 to 10 minutes depending on the condition of the probe.

1. Measure and record the temperature. If you did the morning calibration indoors, the probe temperature should be roughly close to the same as the morning calibration. If you are calibrating the probe outside, the temperature may be different from the earlier reading. This should not affect the post check.

2. Record the barometric pressure reading of the probe. This may have changed from the morning reading due to weather changes. You can get current local barometric pressure readings from the Internet. Remember to adjust any weather station data based on the instructions found in Appendix II.

3. As in the morning calibration, use Appendix II to determine your theoretical DO level.

4. Record the DO reading of the probe (ppm or mg/L). DO NOT recalibrate the probe. The purpose of this check is to see if the probe has drifted out of acceptable limits during the day.

5. Calculate the difference between the probe reported value and the theoretical DO value. If the probe is functioning properly there should be a difference of less than 0.50 mg/L from the afternoon theoretical DO level and the probe readout. If the calibration

difference is greater than 0.50 mg/L the probe needs service and you must flag the data because the probe did not hold onto the calibration. If the calibration difference is 0.16 to 0.50 mg/L. The calibration of the probe is approaching the limits of accuracy and preventative maintenance may be required. It may be wise to clean the probe or replace the probe membrane when this occurs.

3.8 pH

3.8.1 Electronic probe method

Equipment: Various models of pH probes and meters

Calibration

The pH probe calibration procedure a similar protocol used in calibrating the DO probe. Most meters allow calibrating the pH probe using two different buffers. In most cases the use the 7.00 and 4.00 pH buffer solutions is suitable. If you are experiencing pH values above 7.00, calibrate using 7.00 and 10.00 buffer.

Use fresh buffer solution when you calibrate the probe and check the readings at the end of the day. If the probe is capable in doing so, please record the probe readings to the nearest hundredth unit place (Ex. 7.01) when performing the calibration.

1. Record the date of calibration. Calibration must be done each day you perform samples.

2. Record the temperature of the probe during calibration.

3. Record the probe reading as you place the probe in the 7.00 buffer solution. Gently swirl the buffer or the probe to obtain an accurate reading.

4. Calibrate the probe, the probe should now read a value close to 7.00 pH units. Most manufacturers of buffers provide a table showing the pH result that probes should display based on temperature. Check against this value displayed on the probe is close to this value.

5. Clean the probe with distilled or deionized water and blot dry

6. Immerse the probe in the 4.00 (or 10.00) buffer solution, record the stabilized value.

7. Calibrate the probe and it should now read a value close to 4 (or 10) pH units. Again, consult the buffer solution table to ensure accuracy.

After calibration, you may turn off the probe if the manufacturer says so. If not, the probe should be kept on at all times while going out into the field and prior to the post check. Follow manufacturer instructions regarding transporting of the probe into the field to prevent damage and drying out of the pH probe.

Field Sampling with Multiprobe

IMPORTANT NOTE- When traveling to a sample station, keep the probe tip stored in the protective cap. This will keep the glass sensor hydrated.

1. Turn the probe on.

2. Set the probe 0.5 m beneath the surface is sampling in Maryland and 1 m beneath the surface in Virginia. Let the reading stabilize. This may take a little longer than the other probes.

3. Once the reading has stabilized record the reading on your datasheet.

4. Mark the depth that you took your sample on your data sheet.

5. Turn off the probe and replace the protective cap.

Field Sampling with Individual pH probe

IMPORTANT NOTE- When traveling to a sample station, keep the probe tip stored in the protective cap. This will keep the glass sensor hydrated.

1. Turn the probe on.

2. Set the probe 0.5 m beneath the surface of the water if sampling in Maryland and 1 m beneath the surface if sampling in Virginia. Let the reading stabilize. This may take a little longer than the other probes.

3. If measuring in a bucket, gently swirl the water with the probe and measure just beneath the surface.

4. Once the reading has stabilized record the reading on your datasheet.

5. Mark the depth that you took your sample on your data sheet.

6. Turn off the probe and replace the protective cap.

End of Day Calibration Check

To ensure the probe has maintained proper calibration, it is important to verify no significant probe drift has occurred. The procedures listed below will verify the probe did not drift outside QA/QC specifications. DO NOT CALIBRATE the probe during this check. Doing so will invalidate the data collected during the sample run.

1. Rinse off the probe and probe tip with distilled water and wipe dry using a soft cloth. Washing the probe will remove any material that may reduce probe life.

2. Place the probe into a container of pH 7.00 buffer. You may use the same buffer used during the morning calibration as long as the buffer was covered and appears clean.

3. Allow the probe to stabilize and record the temperature and pH reading in the "End of Day Temp C" and the "End of Day pH 7 Check" columns on the "pH Probe Calibration Form."

4. Rinse the probe and repeat the end of day check process using the 4.00 or 10.00 buffer.

If both buffer checks are within 0.20 units from the calibration values, the probe is within specifications. If the readings are greater than 0.20 units, flag all pH data collected during the sample run by typing "pH probe flag" in the "Additional comments" section when entering data into the online database. Also note "pH probe flag" at the top of the hard copy datasheet. This is because sometime during the sample run, the probe exceeded QA/QC specifications.

3.8.2 Colorimetric Kit

Equipment: LaMotte or Hach pH kits

Method:
Look on the front of black box to determine whether you have a wide range pH kit or a narrow range pH kit (i.e. cresol red, phenol red, bromthymol blue, thymol blue).

1. Rinse one sample test tube and cap twice with water from the stream or bucket.

2. Fill the sample test tube to the black line with water from the stream or bucket. The bottom of the meniscus should be even with the line. Use plastic dropper to add or remove water from test tube.

3. For wide range pH kit, add ten drops of the wide range indicator while holding the reagent bottle completely upside down. For narrow range kits, add 8 drops of the indicator while holding the reagent bottle completely upside down.

4. Cap the test tube and mix the sample thoroughly.

5. Slide the tube in the comparator slot, hold it up to the sunlight, and record the pH value from the color in the comparator that most closely matches the sample tube color. When the color observed is between 2 colors on the comparator, the value is reported to the nearest 0.5 unit (for wide range kit) or 0.1 unit for other pH kits.

3.9 Salinity, Conductivity, and Total Dissolved Solids

3.9.1 Salinity Measurement with a Refractometer

Equipment: Salinity refractometer

The refractometer must be calibrated before taking salinity measurement.

Calibration:

1. Check the refractometer with distilled water. If it does not read 0 o/oo, you must calibrate the instrument. DO NOT PERFORM CALIBRATION IN THE FIELD. Calibration must take place in controlled environment at approximately 20 oC (room temperature) using distilled water of the same temperature.

2. Lift the cleat plate and add 1-2 drops of distilled water to the oval blue prism. Hold the prism at an angle close to parallel so the water drops will not run off.

3. Close the plate gently. The water drops should spread and cover the entire prism. Repeat the process if there are any gaps or if the sample is only on one portion of the prism.

4. Look through the eyepiece. If the scale is not in focus, adjust it by turning the eyepiece either clockwise or counterclockwise.

5. The reading is taken at the point where the boundary line of the blue and white fields crosses the scale.

6. If the reading is not at "0" turn the calibration screw with the included screwdriver while looking through the eyepiece until the boundary line falls on "0."

7. When the measurement is complete, the sample must be cleaned using tissue paper and distilled water.

NOTE: The refractometer needs to be at the same approximate temperature as the sample water. If the refractometer has been sitting in an air-conditioned environment prior to sampling, allow it to warm to the outside air temperature.

Method:

1. Rinse the refractometer with water sample.

2. Then apply drops of your water sample onto the refractometer and hold up to light to read salinity (right side of circle).

3. Record as parts per thousand (o/oo) using the scale located on the right hand side of

refractometer view scope.

3.9.2 Salinity, Conductivity, and TDS Probe

Equipment: Various models of conductivity probes and meters

Calibration
Most probes that test for conductivity and TDS use a pre-made calibration solution with a specific conductivity value. The probe is immersed in the solution and calibrated to the value of the solution. It is good to use a calibration solution concentration similar to what you may find in the field to ensure accuracy.

1. Record the date of calibration. Calibration must be done each day you perform samples.

2. Record the temperature of the water read by the probe while you are calibrating the probe.

3. Write down the conductivity listed on the probe when you immerse the probe into the conductivity solution and record the value prior to calibration.

4. Record the conductivity solution that you will use to calibrate the probe. The standard unit for these solutions is in microsiemens per centimeter (mS/cm) but probes may use different units.

5. Write down the conductivity reading after you have calibrated the probe in the solution. The probe should be very close to the calibrated buffer solution but may be off by a couple of units.

Measure salinity, conductivity & TDS

Depth Profile Sampling (>3m)
If you are measuring with a multi probe and have a long enough cord, you are encouraged to do depth profiles.

1. Measure 0.5 m above the bottom, then move your sensor up to the next whole integer depth, then proceed at 1 meter intervals up through the water column until you reach 1 m below the surface if sampling in Virginia, take an additional measurement at 0.5 m below the surface if sampling in Maryland. (Example: At a 3.4 m deep site, measure at 2.4, 2.0, 1.0 m and take an additional measurement at 0.5 m if in Maryland)

2. At each iteration allow the probe to stabilize before recording your salinity reading at the corresponding depth.

3. Measure DO and temperature at each depth as well.

4. Record depth, DO, temperature, and salinity on your data sheet for each depth.

Depth Profile Sampling (≤3 m)

1. Measure 1.0 m above the bottom, allow the probe to stabilize and record your result.

2. Measure 0.5 m below the surface if sampling in Maryland and 1.0 m below the surface if sampling in Virginia, allow the probe to stabilize and record your result.

Surface Sampling with Multiprobe

1. Prior to sampling, rinse the probe with deionized or distilled water.

2. Select the appropriate mode and range on the meter, beginning with the highest range and working down. Some probes will auto select the correct range.

3. Place the probe 0.5 m beneath the surface if sampling in Maryland and 1 m beneath the surface if sampling in Virginia, and read the salinity, conductivity or TDS of the water sample on the meter's scale.

4. Record the depth at which you took your sample on your data sheet.

NOTE: If your probe does not automatically select the appropriate measurement range, and the reading is in the lower 10 percent of the range that you selected, switch to the next lower range. If the reading is above 10 percent on the scale, then record this number on your data sheet.

5. Rinse the probe with distilled or deionized water between each sample and before post sampling calibration check. Replace the cap for storage and transport.

Surface Sampling with individual Salinity/TDS probe

1. Prior to sampling, rinse the probe with deionized or distilled water.

2. Select the appropriate mode and range on the meter, beginning with the highest range and working down. Some probes will auto select the correct range.

3. Place the probe 0.5 m beneath the surface if sampling in Maryland and 1 m beneath the surface if sampling in Virginia and read the salinity, conductivity or TDS of the water sample on the meter's scale.

4. Record the depth at which you took your sample on your data sheet.

NOTE: If your probe does not automatically select the appropriate measurement range, and the reading is in the lower 10 percent of the range that you selected, switch to the next lower range. If the reading is above 10 percent on the scale, then record this number on your data sheet.

5. Rinse the probe with distilled or deionized water between each sample and before post sampling calibration check. Replace the cap for storage and transport.

Post sampling calibration check

1. Record the temperature of the probe at the end of the day when you are performing the calibration check.

2. Write down the conductivity listed on the probe when you immerse the probe into the conductivity solution and record the value.

3. Calculate the difference between the pre and post sampling calibration values.

4. Standard rule of thumb is if the probe difference is less than 10.00%, you should be confident of the probe values. To calculate the relative percent difference use the formula:

$$RPD\% = \frac{AbsoluteValue(Sample1 - Sample2)}{Average(Sample1 + Sample2)} \times 100\%$$

5. Initial the person calibrating and using the probe for your records. This is good to know in case something happens to the probe that you may not be aware of due to someone else is using it.

3.10 Nitrate – Nitrogen and Orthophosphate Kits

Equipment:

- Nitrate – Nitrogen kit w/ all chemicals and clean glassware (Hach NI-14 14161000, LaMotte, 3110, LaMotte 3354)
- Orthophosphate kit w/ all chemicals and clean glassware (Hach PO-19 224800, Hanna HI 38061, Hanna HI 713)
- Clean polypropylene sample bottle or scintillation vial (60 ml)

Method:

1. Rinse the sample bottle with sample water and dispose of downstream.

2. Repeat step 1 three times.

3. Fill the bottle with sample water from about 0.3 m beneath the surface and cap. Process the sample as soon as possible.

4. Make sure the sample is well mixed prior to analysis by shaking the sample bottle.

5. Follow the protocol for each nutrient type as outlined in the instructions accompanying the kit. Reagents should be maintained at about 20° C to yield best results.

6. Record your results on the data sheet.

3.11 Phosphate

Equipment:

- Hanna HI 713 Phosphate Low Range Checker
- Clean polypropylene sample bottle or scintillation vial (60 ml)

Method:

1. Rinse the sample bottle with sample water and dispose of downstream three times.

2. Fill the bottle with sample water from about 0.3 m beneath the surface and cap. Process the sample as soon as possible.

3. Make sure the sample is well mixed prior to analysis by shaking the sample bottle.

4. Turn the meter on by pressing the button. All segments will be displayed. When the display shows “Add”, “C.1” with “Press” blinking, the meter is ready.

5. Fill the cuvette with 10 mL of unreacted sample and replace the cap. Place the cuvette into the meter and close the meter’s cap.

6. Press the button. When the display shows “Add”, “C.2” with “Press” blinking the meter is zeroed.

7. Remove the cuvette from the meter and unscrew the cap. Add the content of one packet of HI 713-25 reagent. Replace the cap and shake gently for 2 minutes until the powder is completely dissolved. Place the cuvette back into the meter.

8. Press and hold the button until the timer is displayed on the LCD (the display will show the countdown prior to the measurement) or, alternatively, wait for 3 minutes and press the button.

9. The instrument directly displays the concentration of phosphate in ppm. The meter automatically turns off after 2 minutes.

10. Record your results on your datasheet.

4 Lab sample collection preparation and handling

4.1 Bacteria

Sample collection:

Note the amount of rainfall within 48 hours prior to sampling and record in the bacteria section of the datasheet.

Collecting by wading:

1. Wade into the main flow of the stream.
2. Take a few steps upstream with minimal disturbance;
3. Un-cap the sterile and pre-labeled bottle without touching the inside of the lid.
4. Using a U motion dip the bottle into the water down to approximately 0.3 m down and away from yourself allowing the bottle to fill ¾ full.
5. Cap the bottle and place sample on ice in cooler immediately (cooler temperature should be 1°C to 4°C). NOTE: Do not freeze your sample.

Collecting using a bucket:

1. Make sure not to touch inside of bucket with your hands.
2. If sampling from a dock or pier, go as far as possible to the end of the pier to collect your sample.
3. Throw the bucket out as far as possible in the main channel, and try not to disturb the bottom.
4. Rinse the bucket three times with stream water collected downstream of your sampling location.
5. Fill the bucket with the sample water to 1/3 full.
6. Un-cap the sterile and pre-labeled bottle without touching the inside of the lid.
7. Using a U motion dip the bottle into the water down and away from yourself allowing the bottle to fill ¾ full.
8. Cap the bottle and place sample on ice in cooler immediately (cooler temperature should be 1°C to 4°C). NOTE: Do not freeze your sample.

Collecting using a sampling pole (from boat or dock):

If sampling from a boat make sure that the boat motor has not stirred up the water. If the water is shallow, sampling should be done through wading.

1. Un-cap your sterile and pre-labeled bottle and secure it to the end of the pole.

2. Extend the pole outward and dip at approximately 0.5 m below the surface if sampling in Maryland and 1.0 m below the surface if sampling in Virginia.

3. Cap the bottle and place sample on ice in cooler immediately (cooler temperature should be 1°C to 4°C). NOTE: Do not freeze your sample.

After sampling bacteria wash your skin that came in contact with the water with disinfectant or soap to reduce your chances of becoming sick.

4.2 Chlorophyll A

Example field supplies:

- 500-mL polypropylene (PP) sample bottles
- 50-mL syringes
- filter bodies with filter caps
- 25-mm 0.7-µm porosity GF/F filter membranes
- Handheld vacuum pump
- Opaque towels
- Aluminum foil
- Filter forceps

Before going out to collect samples, prepare equipment and supplies according to the recommended sampling procedure of the laboratory where the samples will be analyzed. This can include syringe filtering or a handheld vacuum pump and filters.

Method:

1. Using the sampling pole, rinse the 500-mL labeled site specific bottle and syringe three times.

2. Drain the bottle until it is empty, put the cap on, lower it one forearm's length under water (about 0.3 meters) then remove the cap. Wait for the bottle to fill, then cap it and return it to the surface.

3. Follow the recommended filtering procedure by the analytical laboratory where the samples will be analyzed. Color on the filter generally indicates a sufficient sample for analysis.

4. Record the volume of water pushed through the filter on the data collection sheet.

5. Store samples in cooler. Samples must be kept cool and out of sunlight for the duration of field sampling.

6. Cap 500-mL bottle retaining sampled water and store in dark location to bring back to lab. This sample will serve as a back-up sample should there be a filter problem.

Laboratory preparation:
Following the procedures laid out by the analytical lab that will process the samples is important. Here are a few general steps:

1. Prepare pieces of aluminum foil.

2. Fold in half again, then unfold, creating a crease.

3. Create labels using labeling tape noting site number, date, and volume pressed through

filter.

4. Place filter in aluminum foil with the center of the filter centered on the crease, with side containing the intercept chlorophyll up (should have slight color to it). Folding foil and gently assisting with forceps if necessary by pressing on filter fold the filter in half.

5. Double over edges of fold, displacing air and create a little pocket in which the folded filter is located.

6. Repeat for all samples.

7. Label foil packets.

8. Place foil packets in locking plastic bag and then double bag with another locking plastic bag.

9. Place in freezer to await shipment to the analytical laboratory.

10. Rinse all filter holders and 500-mL bottles with tap water and allow to air dry.

NOTE: It is critical that the chlorophyll water samples and foil packets remain dry. The samples in foil should be double bagged and packed with ice in portable Styrofoam transport coolers with surrounding cardboard box. Samples should be mailed overnight to arrive at the analytical laboratory as soon as possible. If properly packaged and frozen (sampled filters should be stored frozen, at least -20˚C, in the dark), chlorophyll a samples can be stored for up to three and a half weeks. The package should also be marked to indicate “chlorophyll samples” as contents.

4.3 Nutrient and Grab Samples

Collecting from a boat:

1. Facing upstream, extend the pole and bottle, rinse the bottle out three times, and take the sample the fourth time from a depth of 0.3 m beneath the surface.

2. After samples are taken, immediately place the sample on ice up to the shoulders of the bottle. The lid should not be immersed under the ice, in case ice water leaks into the sample bottle, diluting the concentration of the sample.

3. On the field data sheet, record the time, date, and any other information about the water sampling event.

Collecting by wading:

1. Wade into the main flow of the stream.

2. Take a few steps upstream with care not to disturb the sediment;

3. Un-cap the pre-labeled bottle.

4. Using a U motion dip the bottle into the water approximately 0.3 m down and away from yourself allowing the bottle to fill to the shoulder.

5. After samples are taken, immediately place the sample on ice up to the shoulders of the bottle. The lid should not be immersed under the ice, in case ice water leaks into the sample bottle, diluting the concentration of the sample.

Collecting with a sampling pole from the shore or a dock:

1. Attach the sample bottle to the sampling pole, making sure that the clamp is tight.

2. The sampling point in the stream or river should have a low to medium flow and not be in eddies or stagnant water.

3. Facing upstream, extend the pole and bottle, rinse the bottle out three times, and take the sample the fourth time from approximately 0. 5 m beneath the surface if sampling in Maryland and 1.0 m beneath the surface if sampling in Virginia.

4. Fill the bottle up to the shoulders and immediately cap and place on ice. The lid should not be immersed under the ice, in case ice water leaks into the sample bottle, diluting the concentration of the sample.

4.4 Chemical preservatives and reagents

The nutrient sample bottles contain a small amount of sulfuric acid as a preservative. When sampling it is important to fill the bottle to the needed level and not pour out the preservative or excess sample from the bottle.

The bacteria sample bottle contains a dechlorinating tablet. When collecting non-chlorinated water, discard the tablet. Samplers should discard the tablet just prior to collecting a bacteria sample at the site. Discard the tablet by dumping out of the bottle without touching the lip or inner wall of the sample bottle. The tablets are harmless to the environment and may be left at the site.

4.5 Sample container handling and preservation

Proper sample containers and sample preservation are essential to sample integrity. Samples not preserved properly may be rejected by the laboratory.

a) Sample containers should be inspected and any torn, punctured or cracked sample containers discarded.

b) After collecting the sample, make sure the lids are secured tightly to prevent contamination from water seepage in or out of the container.

c) Sample containers and coolers should be stored with the tops securely fastened. Containers with loose fasteners should be replaced or taped to prevent loss of sample containers during transport.

d) In the field, unless specified otherwise, all samples should be placed in an ice filled cooler immediately after collection. To ensure samples do not exceed the 4°C holding temperature, sample containers shall be placed upright and if possible, covered with ice in such a manner that the container openings are above the level of ice. Bacteria sample bottles should be stored in bags, placed in coolers and surrounded with wet ice.

e) Glass sample containers should be packed in bubble wrap or other waterproof protective materials to minimize accidental breakage.

f) The laboratory will provide temperature bottles that they use to determine sample temperature upon arrival at the lab. Make sure that every cooler used to ship samples to the lab contains one of these bottles.

g) Store sample containers in a clean area away from fumes, smoke, gasoline containers, etc. A trunk of car or a garage may not be appropriate.

4.6 Sample Bottle Identification

Each sample container must include a label with the following information:

a) Station ID or description

b) Date and time of sample collection

c) Collector's initials

d) Sample depth in meters (surface samples are reported as 0.3 m)

e) Parameter name and/or group code

f) Container number

g) Preservative used and volume filtered, if applicable.

Samples will not be analyzed if this information is missing. If more than one container is needed for a parameter (such as a duplicate sample), each container collected for that parameter must have a label with identical information in addition to an indication of 1 of 3, 2 of 3, 3 of 3, etc., as required. Split samples should be designated as S1 and S2.

Please remember to fill out the labels on the bottle with a waterproof pen before taking the samples.

It is essential that the actual sampling site match the labeling information. Always check the labeling information against the actual site. Samples not labeled properly may be rejected by the laboratory.

4.7 Transport of Samples

After collecting the samples at the site:

1. Place the bottles in the cooler filled with ice. Coolers should have enough ice to come up to the necks of the sample bottles.

2. Place any chain of custody forms in the Ziploc bag taped to the inner lid of the cooler.

3. Transport the cooler with samples to the designated drop off point or laboratory by the specified time.

5 Lab Procedures

Labs should be either NELAP, state, federal certified, or recognized by the CBP. Labs that do not maintain a certification or are not recognized by the CBP will be considered for inclusion on a case by case basis. The following are the approved methods and their corresponding SOPs for reference for laboratories. It is expected that laboratories will be in compliance with these methods and will already be in possession of the procedural documentation for these methods.

Parameter	Method	Appendix
Bacteria - Enterococcus	US EPA method 1600	Appendix III
Bacteria - Enterococcus	ASTM Method #D6503-99	See manufacturer's manual
Chlorophyll & Pheophytin	CBP IV-12.0	Appendix IV
Chlorophyll & Pheophytin	US EPA method 446.0	Appendix V
Chlorophyll & Pheophytin	US EPA method 445.0	Appendix VI
Silicate	US EPA method 366.0	Appendix VII
Nitrate - Nitrogen	US EPA Method 353.2	Appendix VIII
Nitrite - Nitrate	US EPA Method 353.2	Appendix VIII
Ammonia - Nitrogen	US EPA Method 350.1	Appendix IX
Orthophosphate	US EPA Method 365.5 or 365.1	Appendix X
Total Nitrogen	Standard Methods 4500-N C-2011 or 4500-P J-2011	Appendix XI
Total Phosphorus	EPA Method 365.1 or Standard Methods 4500-P J-2011	Appendix XII

Laboratories will perform QA/QC measures including: method blanks, matrix spikes, replicates, check standard.

6 Cleanup and Storage of Water Monitoring Equipment

a) Rinse the thermometer in tap water and store upright.

b) Pour contents of DO sampling bottles and chemical kits into the sink. Rinse all the bottles and containers thoroughly with tap water. Put all equipment away until next sampling time.

c) Store all chemical reagents in a dark, cool place and out of the reach of children and pets!

d) Save expired chemicals and give them to your monitoring coordinator or trainer at the next recertification event for proper disposal.

NOTE: If you conduct the analytical procedures away from home or on a boat, you need a special container for safe disposal of the test samples. A plastic milk jug or jar works well and is easy to obtain. Fill this container about ½ to ¾ full with kitty litter to absorb the moisture. When the litter is saturated, place the closed jar in double plastic garbage bags and dispose of in the trash.

6.1 Maintenance for pH meter

Follow maintenance and care guidelines as specified by the manufacturer manual. Below are some general day to day care tips.

1. Ensure the probe is cleaned and well maintained. After each sample run, rinse off the probe with distilled water. Use a soft cloth and gently dry the probe and glass sensor.

2. Store the probe tip in the cap provided by the manufacturer. Inside this cap, place a small cotton ball or piece of paper towel soaked with pH 4.00 buffer (or probe storage solution). This will keep the probe in working condition until the next field sampling event.

3. If you see any biological growth (mold, algae, etc.), use mild soap or warm (~30o C) pH 4.00 buffer to clean. Rinse with distilled water and dry.

4. If the calibration or end of day check indicates there is a problem with the probe, and standard cleaning does not produce acceptable results, replacement of the sensor cap may be necessary. Contact a Project Team Member to get a replacement sensor cap.

Appendix I

Field Data Sheet

Appendix II

Theoretical DO Calculation

How to Calculate Theoretical Dissolved Oxygen Values

From: Virginia Citizen Water Quality Monitoring Program Methods Manual - October 2007

Proper calibration of Dissolved Oxygen (DO) probes is important to collect accurate data. An easy way to see if a probe is calibrated correctly is to compare the probe's results against a theoretical DO value. This value is what the DO level should be based on temperature and barometric pressure.

DO Level based on temperature

The top table on the attached chart allows users to find the DO level based on temperature. The top and side axis of the table corresponds to the temperature that the probe is reporting. The intersection of the two axes displays the DO reading. Write this number down to start calculating the theoretical DO level.

Correction factor for barometric pressure

Barometric pressure is a way to tell how much atmosphere is pressing down on a surface. Weather systems and elevation above (or below) sea level can change this value. The bottom table of the attached chart will help compensate for these changes in pressure. Dissolved oxygen probes normally show pressure in millimeters of mercury (**mmHg**) or millibars (**mBar**).

Having a barometer on hand is a good way to get pressure data. A weather station can also provide pressure data. Websites such as www.weatherunderground.com are useful to find local weather stations. Please note that most barometers and weather stations report pressure in inches of mercury (**inHg**).

Note about using weather station pressure readings

Weather stations compensate pressure readings to make it appear as if the station is at sea level. To account for this, subtract the barometric pressure by 1.01 inHg per 1,000 feet in elevation of the weather station. This final value is known as absolute barometric pressure.

Example: Find the absolute barometric pressure of a station located 222 feet above sea level that reported 30.12 inHg.

$$30.12 \text{ inHg} - \frac{1.01 \text{ inHg}}{1000/ 222 \text{ feet}} \rightarrow 30.12 - \frac{1.01}{4.50} \rightarrow 30.12 - 0.22 == 29.90 \text{ inHg absolute barometric pressure}$$

Once finding the absolute pressure, use the bottom table found on the attached chart to find the proper correction factor to use. The formulas at the bottom of the chart will help in converting inHg barometric pressure readings into **millibars** (mBar) or **millimeters of mercury** (mmHg) that are commonly used to calibrate a dissolved oxygen probe. Use this value to find the correction factor to use in the final calculation.

Example: A barometric pressure of 970 millibars you would use a correction factor of 0.96 (second column, bottom row).

Theoretical DO Calculation

To find the theoretical DO value, use the following formula.

Theoretical DO = (DO level based on temperature) x (barometric pressure correction factor)

Example: If a probe had a temperature of 18.4 C and the barometric pressure was 970 mBar, the theoretical DO value would be 9.00 mg/L (9.37mg/L x 0.96 correction factor).

Dissolved Oxygen Saturation

Directions- To determine theoretical DO saturation, multiply the O2 concentration value (found in the top chart) by the barometric pressure correction factor (bottom chart).

Example: Find the DO saturation for at a temperature of **18.4 C** at **730 mmHg** pressure: 9.37 x 0.96= **9.00 mg/L**

Temp in ^{O}C	O_2 concentrations in mg/l									
	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
5	12.75	12.71	12.68	12.65	12.61	12.58	12.55	12.52	12.48	12.45
6	12.42	12.39	12.36	12.32	12.29	12.26	12.23	12.2	12.17	12.14
7	12.11	12.08	12.05	12.02	11.99	11.96	11.93	11.9	11.87	11.84
8	11.81	11.78	11.758	11.72	11.69	11.67	11.64	11.61	11.58	11.55
9	11.53	11.5	11.47	11.44	11.42	11.39	11.36	11.33	11.31	11.28
10	11.25	11.23	11.2	11.18	11.15	11.12	11.1	11.07	11.05	11.02
11	10.99	10.97	10.94	10.92	10.89	10.87	10.84	10.82	10.79	10.77
12	10.75	10.72	10.7	10.67	10.65	10.63	10.6	10.58	10.55	10.53
13	10.51	10.48	10.46	10.44	10.41	10.39	10.37	10.35	10.32	10.3
14	10.28	10.26	10.23	10.21	10.19	10.17	10.15	10.12	10.1	10.08
15	10.06	10.04	10.02	9.99	9.97	9.95	9.93	9.91	9.89	9.87
16	9.85	9.83	9.81	9.79	9.76	9.74	9.72	9.7	9.68	9.66
17	9.64	9.62	9.6	9.58	9.56	9.54	9.53	9.51	9.49	9.47
18	9.45	9.43	9.41	9.39	9.37	9.35	9.33	9.31	9.3	9.28
19	9.26	9.24	9.22	9.2	9.19	9.17	9.15	9.13	9.11	9.09
20	9.08	9.06	9.04	9.02	9.01	8.99	8.97	8.95	8.94	8.92
21	8.9	8.88	8.87	8.85	8.83	8.82	8.8	8.78	8.76	8.75
22	8.73	8.71	8.7	8.68	8.66	8.65	8.63	8.62	8.6	8.58
23	8.57	8.55	8.53	8.52	8.5	8.49	8.47	8.46	8.44	8.42
24	8.41	8.39	8.38	8.36	8.35	8.33	8.32	8.3	8.28	8.27
25	8.25	8.24	8.22	8.21	8.19	8.18	8.16	8.15	8.14	8.12
26	8.11	8.09	8.08	8.06	8.05	8.03	8.02	8	7.99	7.98
27	7.96	7.95	7.93	7.92	7.9	7.89	7.88	7.86	7.85	7.83
28	7.82	7.81	7.79	7.78	7.77	7.75	7.74	7.73	7.71	7.7
29	7.69	7.67	7.66	7.65	7.63	7.62	7.61	7.59	7.58	7.57
30	7.55	7.54	7.53	7.51	7.5	7.49	7.48	7.46	7.45	7.44

Barometric Pressure Correction factor:

mmHg (mBar)	Corr. Factor	mmHg (mBar)	Corr. Factor	mmHg (mBar)	Corr. Factor	mmHg (mBar)	Corr. Factor
775-771 (1033-1028)	1.02	750-746 (1000-995)	0.987	725-721 (967-961)	0.953	700-696 (934-928)	0.92
770-766 (1027-1021)	1.014	745-741 (994-988)	0.98	720-716 (960-955)	0.947	695-691 (927-921)	0.914
765-761 (1020-1014)	1.007	740-736 (987-981)	0.973	715-711 (954-948)	0.94	690-686 (920-915)	0.907
760-756	1	735-731	0.967	710-706	0.934	685-681	0.9

(1013-1008)		(980-975)		(947-941)		(914-908)	
755-751 (1007-1001)	0.993	730-726 (974-968)	0.96	705-701 (940-935)	0.927	680-676 (907-901)	0.893

Appendix III

Laboratory Method – Bacteria – Enterococcus

Appendix IV

Laboratory Method – Chlorophyll & Pheophytin CBP IV-12.0

Appendix V

Laboratory Method – Chlorophyll & Pheophytin – US EPA 446.0

Appendix VI

Laboratory Method – Chlorophyll & Pheophytin – US EPA 445.0

Appendix VII

Laboratory Method – Silicate – US EPA 366.0

Appendix VIII

Laboratory Method – Nitrate - Nitrite - Nitrogen – US EPA 353.2

Appendix IX

Laboratory Method – Ammonia – Nitrogen US EPA 350.1

Appendix X
Laboratory Method – Orthophosphate
US EPA 365.5 and US EPA 365.1

Appendix XI

Laboratory Method – Total Nitrogen –
Standard Methods 4500-N C-2011 and 4500-P J-2011

Appendix XII

Laboratory Method – Total Phosphorus

EPA Method 365.1 and Standard Methods 4500-P J-2011

Appendix B

Water Quality Monitoring Parameters

Table ID #	Matrix	Parameter	Analytical Method	Approved Procedure	Equipment	In Situ or Lab Analysis	Holding Time
T-AT-1	Air	Air temperature	Armored thermometer	USEPA Method 170.1	LaMotte 1066	Field	N/A
T-AT-2	Air	Air temperature	Digital thermometer	USEPA Method 170.1	Ex. Hanna 98509	Field	N/A
T-AT-3	Air	Air temperature	Thermometer and/or thermistor as part of multiparameter probe	USEPA Method 170.1; As described in probe manual	Ex. LaMotte 1761	Field	N/A
T-B-1	Water	Enterococcus	IDEXX Enterolert	ASTM Method (#D6503-99)	IDEXX Enterolert	Home or Lab	6 hours
T-B-2	Water	Enterococcus	Membrane Filtration	USEPA Method 1600	Membrane Filtration, m-EI prepared Agar Plates	Lab	6 hours
T-B-3	Water	Bacteria (E. Coli)	Coliscan Easy Gel	Coliscan Easy Gel	Coliscan Easy Gel	Home or Lab	24 hours
T-C-1	Water	Conductivity	Electronic probe	USEPA Method 120.1	LaMotte 1749, Extech	Field or Home	28 days
T-CA-1	Water	Chlorophyll a,b,c	Spectrophotometry	CBP IV-12.0	Spectrophotometry	Lab	30 days
T-CA-2	Water	Chlorophyll a,b,c	Spectroscopy	USEPA Method 446.0	Spectroscopy	Lab	30 days
T-CA-3	Water	Chlorophyll a	Fluorometry	USEPA Method 445.0	Fluorometry	Lab	30 days
T-DO-1	Water	Dissolved oxygen	Kit using Winkler titration	USEPA Method 360.2	LaMotte 5860	Field acidificationfixing, titration in field or home	8 hours after acidiciation
T-DO-2	Water	Dissolved oxygen	Electronic probe	USEPA Method 360.1; As described in probe manual	Multiprobe sonde	Field	N/A
T-N-1	Water	Nitrate-nitrogen	Colorimetric kit using cadmium reduction method	See Appendix A	Hach NI-14 1416100	Field or Home	48 hours
T-N-2	Water	Nitrate-nitrogen	Colorimetric kit using cadmium reduction method	See Appendix A	LaMotte 3110	Field or Home	48 hours
T-N-3	Water	Nitrate-nitrogen	Colorimetric kit using zinc reduction method	See Appendix A	LaMotte 3354	Field or Home	48 hours
T-N-4	Water	Nitrite-Nitrate	Lab Analysis	USEPA Method 353.2	Specific to individual lab	Lab	Dependendent on preservation method - 28 days maximum
T-N-5	Water	Nitrate - Nitrogen	Lab Analysis	USEPA Method 353.2	Specific to individual lab	Lab	Dependendent on preservation method - 28 days maximum

T-N-6	Water	Ammonia-nitrogen	Lab Analysis	USEPA Method 350.1	Specific to individual lab	Lab	Dependendent on preservation method - 28 days maximum

Table ID #	Matrix	Parameter	Analytical Method	Approved Procedure	Equipment	In Situ or Lab Analysis	Holding Time
T-N-7	Water	Total Nitrogen	Lab Analysis	SM 4500-N C-2011 or 4500-P J-2011	Specific to individual lab	Lab	28 days
T-P-1	Water	Orthophosphate	Colorimetric kit using ascorbic acid method	See Appendix A	Hach PO-19 224800, Hanna HI 38061	Field or Home	48 hours
T-P-2	Water	Orthophosphate	Digital checker using ascorbic acid method	See Appendix A	Hanna HI 713	Field or Home	48 hours
T-P-3	Water	Orthophosphate	Lab Analysis	USEPA Method 365.5 or 365.1	Specific to individual lab	Lab	Dependendent on preservation method - 28 days maximum
T-P-3	Water	Total Phosphorus	Lab Analysis	USEPA Method 365.1 or SM 4500-P J-2011	Specific to individual lab	Lab	Dependendent on preservation method - 28 days maximum
T-PH-1	Water	pH	pH probe	USEPA Method 150.1; As described in probe manual	Hanna, LaMotte, Oakton, Extech	Field or Home	24 hours
T-PH-2	Water	pH	Colorimetric kit	See Appendix A	LaMotte, Hach	Field or Home	24 hours
T-PHAE-1	Water	Phaeophytin	Fluorometry	USEPA Method 445.0	Fluorometry	Lab	30 days
T-S-1	Water	Salinity	Refractometer	See Appendix A	Extech, General	Field	N/A
T-S-1	Water	Silicate	Lab Analysis	USEPA Method 366.0	Specific to individual lab	Lab	28 days
T-S-2	Water	Salinity	Probe	USEPA Method 120.1; As described in probe manual	LaMotte 1749, Extech	Field or Home	24 hours
T-TDS-1	Water	Total dissolved solids	Electronic probe	See Appendix A	LaMotte 1749, Extech	Field or Home	28 days*
T-Turb-1	Water	Turbidity	Turbidity kit	See Appendix A	LaMotte 7519	Field or Home	24 hours
T-WC-1	Water	Water clarity	Secchi Disk	See Appendix A	Ben Meadows 224217	Field	N/A
T-WC-2	Water	Water clarity	Transparency tube	See Appendix A	Forestry Suppliers 77107, Ben Meadows 111360	Field	N/A
T-WT-1	Water	Water temperature	Armored thermometer	USEPA Method 170.1	LaMotte 1066	Field	N/A
T-WT-2	Water	Water temperature	Digital thermometer	USEPA Method 170.1	Ex. Hanna 98509	Field	N/A
T-WT-3	Water	Water temperature	Thermistor as part of multiparameter probe	USEPA Method 170.1; As described in probe manual	Ex. LaMotte 1761	Field	N/A

Table ID #	Precision	Accuracy	Range	Tier Designation	Tier II Additional Requirements	Sample Preservation	Data Entry QC Criteria
T-AT-1	0.5 °C	1 °C	-5 – 45 °C	Tier II	Verified	N/A	<-20 °C; >40 °C
T-AT-2	0.1 °C	± 0.2 °C	-50 – 150 °C	Tier II	Verified	N/A	<-20 °C; >40 °C
T-AT-3	0.1 °C	± 1.0 °C	0 – 50 °C	Tier II	Verified	N/A	<-20 °C; >40 °C
T-B-1	1 enterococci/100 mL	N/A	1-2,419 enterococci/100 mL	Tier II	Lab Analysis	Cool <10° C	<0 E/100 mL; >2,500 E/100mL
T-B-2	Dependent on dilution	N/A	Dependent on dilution	Tier II	Lab Analysis	Cool <10° C	<0 E/100 mL; >2,500 E/100mL
T-B-3	20 CFU/100mL	log(0.6)	<20 CFU/100mL to	Tier I	N/A	Cool <10° C	NA
T-C-1	0.1 µS/cm (0 – 199.9 µS/cm); 1.0 µS/cm (200 – 1999 µS/cm); 0.01 mS/cm (2.00 – 19.99 mS/cm)	± 2% FS	0 – 19.99 mS	Tier II	Calibration	Cool, ≤ 6° C	<0 mS; >20mS
T-CA-1	≤ 20% RPD	N/A	Varies depending on lab equipment	Tier II	Lab Analysis	Freeze to -20 C	<0; >200
T-CA-2	≤ 20% RPD	N/A	Varies depending on lab equipment	Tier II	Lab Analysis	Freeze to -20 C	<0; >200
T-CA-3	≤ 20% RPD	N/A	Varies depending on lab equipment	Tier II	Lab Analysis	Freeze to -20 C	<0; >200
T-DO-1	0.2 mg/L	0.6 mg/L	0 – 10+ mg/L	Tier II	Standardized	Immediate acidification	<0 mg/L; >20 mg/L
T-DO-2	0.01 mg/L	± 2% FS	0 – 20 mg/L	Tier II	Calibration	N/A	<0 mg/L; >20 mg/L
T-N-1	0.01 mg/L (0 – 1 mg/L); 0.1 mg/L (1 – 10 mg/L)	Unknown - testing needed	0 – 1 mg/L; 1 – 10 mg/L	Tier I	N/A	Cool, ≤ 6° C	<0 mg/L; >10 mg/L
T-N-2	0.25, 0.5, 1, 2, 4, 6, 8, 10 mg/L	Unknown - testing needed	0 – 10 mg/L	Tier I	N/A	Cool, ≤ 6° C	<0 mg/L; >10 mg/L
T-N-3	0, 1, 2, 4, 6, 8, 10, 15 mg/L	Unknown - testing needed	0 – 15 mg/L	Tier I	N/A	Cool, ≤ 6° C	<0 mg/L; > 15 mg/L
T-N-4	≤ 15% RPD	Varies depending on lab equipment	Varies depending on lab equipment	Tier II	Lab Analysis	Cool, ≤ 6° C (48 hours); Add H2SO4 to pH < 2 and freeze to -20° C (28 days)	>TN
T-N-5	≤ 15% RPD	Varies depending on lab equipment	Varies depending on lab equipment	Tier II	Lab Analysis	Cool, ≤ 6° C (48 hours); Add H2SO4 to pH < 2 and freeze to -20° C (28 days)	>TN
T-N-6	≤ 20% RPD	Varies depending on lab equipment	Varies depending on lab equipment	Tier II	Lab Analysis	Cool, ≤ 6° C (48 hours); Add H2SO4 to pH < 2 and Cool, ≤ 6° C (7 days); Add H2SO4 to pH < 2 and freeze to -20° C (28 days)	>TN
T-N-7	≤ 15% RPD	Varies depending on lab equipment	Varies depending on lab equipment	Tier II	Lab Analysis	Freeze to -20 C	<NO23+NH4
T-P-1	0.02 mg/L (0 – 1 mg/L)	Unknown - testing needed	0 – 1 mg/L; 0 – 5 mg/L	Tier I	N/A	Cool, ≤ 6° C	<0 mg/L; > 5 mg/L

T-P-2	0.01 mg/L	± 4%, 0.04 mg/L	0 – 2.5 mg/L	Tier II	Standardized, Acid-washed glassware	Cool, ≤ 6° C	<0 mg/L; > 2.5 mg/L

Table ID #	Precision	Accuracy	Range	Tier Designation	Tier II Additional Requirements	Sample Preservation	Data Entry QC Criteria
T-P-3	≤ 20% RPD	Varies depending on lab equipment	Varies depending on lab equipment	Tier II	Lab Analysis	Cool, ≤ 6° C (48 hours); Add H2SO4 to pH < 2 and freeze to -20° C (28 days)	>TDP
T-P-3	≤ 15% RPD	Varies depending on lab equipment	Varies depending on lab equipment	Tier II	Lab Analysis	Cool, ≤ 6° C (48 hours); Add H2SO4 to pH < 2 and freeze to -20° C (28 days)	<PO4
T-PH-1	0.01 pH	± .01 pH	- 1.00 – 15.00 pH	Tier II	Calibration	Cool, ≤ 6° C	<4.0 pH; >9.5 pH
T-PH-2	0.2 SU; 0.5 SU	± 0.4, + 1 SU	3.0 - 10.5 SU; 4 to 10 SU	Tier II	Replicate 10% of samples	Cool, ≤ 6° C	<4.0 SU; >9.5 SU
T-PHAE-1	≤ 15% RPD			Tier II	Lab Analysis	Freeze to -20 C	<0; >200
T-S-1	1 ppt	±0.1%	0 to 100 ppt	Tier I	N/A	N/A	<0 mg/L; >100 ppt
T-S-1	≤ 15% RPD			Tier II	Lab Analysis	Chill on ice to <4° C	
T-S-2	0.1ppm; 1ppm; 0.01ppt	±2%	0 to 99.9ppm; 100 to 999ppm; 1.00 to 9.99ppt	Tier II	Calibration	Chill on ice to <4° C	<0 mg/L; >100 ppt
T-TDS-1	10 mg/L	± 2% FS	0 – 9.99 g/L	Tier I	N/A	Cool, ≤ 6° C	<0 g/L; >10 g/L
T-Turb-1	5 JTU; 10 JTU	± 5 JTU	0 – 100 JTU; 0 – 200 JTU	Tier I	N/A	Cool, ≤ 6° C; store in dark	< 0 JTU; > 300 JTU
T-WC-1	10 cm	20 cm	0 - 300 cm	Tier I	N/A	N/A	<0 cm; >300 cm
T-WC-2	2 cm	Unknown - testing needed	0 – 60 cm; 0 - 120 cm	Tier I	N/A	N/A	<0 cm; >300 cm
T-WT-1	0.5 °C	1 °C	-5 – 45 °C	Tier II	Verified	N/A	<-1 °C; >35 °C
T-WT-2	0.1 °C	± 0.5 °C	-50 – 150 °C	Tier II	Verified	N/A	<-1 °C; >35 °C
T-WT-3	0.1 °C	± 0.5 °C	0 – 50 °C	Tier II	Verified	N/A	<-1 °C; >35 °C

Table ID #	Inspection Frequency	Type of Inspection	Calibration Frequency	Standard or Calibration Instrument Used
T-AT-1	Before each use	Thermometer reads approximate air temperature, armored case is intact, no gaps in liquid column	Annual verification	Verified against NIST verified thermometer
T-AT-2	Before each use	Thermometer functions properly and reads approximate air temperature. Metal stem is undamaged.	Annually if needed	NIST Verified thermometer
T-AT-3	Before each use	Thermometer functions properly and reads approximate air temperature	Annually if needed	NIST Verified thermometer
T-B-1	Before each use	Sample collection bottles and Quanti-Tray are sterile and intact	Each batch of media	Blank and Postive/negative controls using known quantiy of organisms (e.g. QuantiCult™)
T-B-2	Before each use	All equipment is intact and operational	N/A	N/A
T-B-3	Before each use	Collection bottles and plates remain sterile, media and plates have not expired	N/A	N/A
T-C-1	Before each use	Meter functions properly, no sign of low battery, reading stabilizes, calibration solution has not expired	Before each use	84, 1,413, 12,880 µS/cm
T-CA-1	Before each use	All equipment is intact and operational	Daily or more frequently	N/A
T-CA-2	Before each use	All equipment is intact and operational	Daily or more frequently	N/A
T-CA-3	Before each use	All equipment is intact and operational	Daily or more frequently	Calibrate using known standards covering entire range of expected values
T-DO-1	Before each use	Glassware is clean and intact, reagents have not expired	Standardize sodium thiosulfate solution before each sample run (EPA compliance)	Iodide-Iodate standard 0.00125 N (equivalent to 10 mg/L as DO
T-DO-2	Before each use	Meter functions properly, no sign of low battery, reading stabilizes, DO membrane clean and intact	Before each sample run	100% air saturated water or water saturated air.
T-N-1	Before each use	Glassware is clean and intact, reagents have not expired	N/A	N/A
T-N-2	Before each use	Glassware is clean and intact, reagents have not expired	N/A	N/A
T-N-3	Before each use	Glassware is clean and intact, reagents have not expired	N/A	N/A
T-N-4	Before each use	All equipment is intact and operational	Daily or more frequently	Calibrate using known standards covering entire range of expected values
T-N-5	Before each use	All equipment is intact and operational	Daily or more frequently	Calibrate using known standards covering entire range of expected values
T-N-6	Before each use	All equipment is intact and operational	Daily or more frequently	Calibrate using known standards covering entire range of expected values
T-N-7	Before each use	All equipment is intact and operational	Daily or more frequently	Calibrate using known standards covering entire range of expected values

Appendix B. Water Quality Monitoring Parameters

Inspection Frequency	Type of Inspection	Calibration Frequency	Standard or Calibration Instrument Used
Before each use	Glassware is clean and intact, reagents have not expired	N/A	N/A
Before each use	Glassware is clean and intact, reagents have not expired, checker functions properly, no sign of low battery	Before each use	sealed vials of 0 & 1 mg/L standards
Before each use	All equipment is intact and operational	Daily or more frequently	Calibrate using known standards covering entire range of expected values
Before each use	All equipment is intact and operational	Daily or more frequently	Calibrate using known standards covering entire range of expected values
Before each use	Meter functions properly, no sign of low battery, reading stabilizes, calibration solution has not expired	Before each use	pH 4.00, 7.00, 10.00 buffer.
Before each use	Glassware is clean and intact, reagents have not expired	N/A	N/A
Before each use	All equipment is intact and operational	Daily or more frequently	Calibrate using known standards covering entire range of expected values
Before each use	Prism plate is clean and instrument is intact	Before each use	2-3 drops of distilled water to zero instrument
Before each use	All equipment is intact and operational	Daily or more frequently	Calibrate using known standards covering entire range of expected values
Before each use	Meter functions properly, no sign of low battery, reading stabilizes, calibration solution has not expired	Before each use	84, 1,413, 12,880 µS/cm
Before each use	Meter functions properly, no sign of low battery, reading stabilizes, calibration solution has not expired	Before each use	84, 1,413, 12,880 µS/cm
Before each use	Turbidity columns are clean, reagents have not expired	N/A	N/A
Before each use / Annual	Marks are still attched/visible and rope is not knotted / Check against tape measure for stretch	Annually	Tape measurer
Before each use	Transparency tube is clean	N/A	N/A
Before each use	Thermometer reads approximate air temperature, armored case is intact, no gaps in liquid column	Annual verification	Verified against NIST verified thermometer
Before each use	Thermometer functions properly and reads approximate air temperature. Metal stem is undamaged.	Annual verification	NIST Verified thermometer
Before each use	Thermometer functions properly and reads approximate air temperature	Annual verification	NIST Verified thermometer

Appendix C

Sample Field Data Sheet

Chesapeake Monitoring Cooperative

Tidal Field Data Sheet

Site Name & # _____ **Lat**_____ **Long** _____

Date _____/_____/_____ **Start Time** (military time) _____ **Rainfall** (mm last 48 hrs) _____

Monitors & Group Name: _____

Parameter	**Method Used** (Circle Applicable)	**Calibration** Pre / Post Sampling		**Measurement** 1st / 2nd / 3rd Replicate or Circle observation		
Weather Conditions (cloud cover)				Clear / Partly Cloudy Cloudy / Fog or Haze		
Tide Condition				High / Outgoing (Ebb) Low / Incoming (Flood)		
Water Color				Clear / Milky / Muddy Oil slick / Other		
Air Temperature (°C)	Armored Classic / Digital / Probe	Verified? Y / N				
pH	Kit / Probe / ColorpHast Strips					
Conductivity (µS/cm)	Probe					
TDS (mg/L)	Probe					
Turbidity (JTU)	LaMotte 7519					
Water Clarity (cm)	Secchi Disk / Turbidity Tube					
Phosphate (mg/L)	Hanna Digital Checker	Pre only:				
Orthophosphate (mg/L)	Hach PO-19 224800 Hanna HI 38061					
Nitrate (mg/L)	Hach NI-14 1416100 / LaMotte 3110 LaMotte 3354					

Use this chart to determine if your two replicates are within range of each other. If not, perform a third test.

Parameter	Acceptable Range
Temperature	Armored (+/- 1° C) | Digital (+/- 0.5° C)
Dissolved Oxygen Sodium Thiosulfate Check	Only perform 1 test. If <9.4 or >10 mg/L, do a second test. If both tests are not within 0.4 mg/L of each other, do not measure DO.
Dissolved Oxygen	+/- 0.6 mg/L
pH	+/- 0.5 SU for kits | +/- 0.2 SU for probes | +/- 1 SU for strips
Salinity / TDS / Conductivity	± 2% FS
Nitrate	Low range (0–1 mg/L) = +/- 0.1 mg/L Mid range (1–10 mg/L) = +/- 1 mg/L
Phosphate	+/- 0.04 mg/L
Turbidity	+/- 5 JTU

Water Column Profile Data	**Water Temperature (°C)**			**Salinity (ppt)**			**Dissolved Oxygen (mg/L)**		
Type of device (circle one)	Armored / Digital / Probe			Refractometer / Probe			Winkler Titration / Probe		
Calibration Check Pre/Post	Verified? Y / N								
Sample Depth (m)	**Rep 1**	**Rep 2**	**Rep 3**	**Rep 1**	**Rep 2**	**Rep 3**	**Rep 1**	**Rep 2**	**Rep 3**
Surface sample depth _____									

Total depth ____			
Sample was collected using a bucket (check one): [ ] Yes [ ] No			
Sample was collected from: [ ] bridge [ ] boat [ ] dock [ ] shoreline [ ] wade in			

Notes:_____
_____
_____

Total Time Spent Monitoring:(Includes travel to and from monitoring site; equipment preparation; sample collection; water's edge time; and time spent filling out data sheets. Round to the nearest 15 min):

Name: _____ Hours: _____ Name: _____ Hours: _____

Name: _____ Hours: _____ Name: _____ Hours: _____

Lead Monitor Signature: _____ **Date:** _____

Once datasheets have been entered in the database, send original forms to your coordinator or:

Alliance for the Chesapeake Bay
Attn: Chesapeake Monitoring Coop
612 Hull St. Suite 101C
Richmond, VA 23225

Appendix D

Tiered Framework

Tiered Framework for Data Collection and Integration for Nontraditional Monitoring

Introduction

The Alliance for the Chesapeake Bay (Alliance), Izaak Walton League of America (League), Dickinson College's Alliance for Aquatic Resource Monitoring (ALLARM), and the University of Maryland Center for Environmental Science Integration and Application Network (UMCES IAN) (referred to as the "Project Team" in this document) are partnering to provide technical, logistical, and outreach support for the integration of citizen-based and non-traditional (i.e., non-agency) monitoring data into the Chesapeake Bay Program (CBP) partnership. The integration of these data into the CBP monitoring networks will provide additional cost-effective data and information that supports shared decision-making and adaptive management by the CBP partners focused on restoration of the Chesapeake Bay and its watershed.

The Project Team, using their background, expertise, and knowledge with the nontraditional monitoring community, are working with CBP STAR (Scientific, Technical Assessment and Reporting Team) to: 1) establish institutional structures and procedures, such as the tiered data use framework; 2) facilitate development of consistent monitoring and training protocols, technical guidance, data gathering tools, quality assurance mechanisms, and data analysis and communication tools; 3) inventory, prioritize and recruit monitoring groups; and 4) provide training and technical support to monitoring entities. This comprehensive approach will ensure a consistent submittal of known quality data to the CBP.

Purpose of the Framework

The Tiered Framework for Data Collection and Integration for Nontraditional Monitoring identifies recommended categories of data quality and their associated end uses. Broad data quality requirements for each category are identified. This framework also provides recommendations of existing resources to inform data production protocols.

For the development of this framework and associated data collection and management protocols, the Project Team is working with experienced nontraditional monitoring programs, state agency programs, and the STAR Data Integrity workgroup to incorporate best practices and lessons learned. Additionally, the Project Team has examined thirteen states' volunteer monitoring programs, and identified five states to best inform the development of this tiered framework. The Project Team will seek adoption of the tiered data use framework, monitoring protocols, and Quality Assurance Project Plans (QAPPs) by the CBP.

The framework is meant to be a guiding document that will be subject to change and refinement once the Project Team receives data from a watershed monitoring census (to document the most commonly used monitoring techniques in the Bay Watershed) which will inform equipment testing and the development of corresponding monitoring method manuals and QAPPs. Once those key monitoring

tools are established, the framework document will be updated (Fall 2016) to reflect the monitoring that is and will be taking place in the watershed.

Monitoring Questions

Non-traditional monitoring entities typically develop study designs, in part to identify their research questions and objectives. Most non-traditional monitoring entities have been monitoring for water quality status and trends using three lines of evidence:

- Water quality/chemistry
- Biological – macroinvertebrates and submerged aquatic vegetation
- Physical – habitat and stream bank assessments

Although the issues addressed are almost always locally-based, the data collected can also be utilized, along with other Bay-wide data, to address the status and trends of waterway health in the Chesapeake Bay watershed. Some examples of Bay-wide priority research questions that local non-traditional monitoring data can inform include:

- What is the effectiveness of management actions?
- What are the relationships in space and time between watershed health and bay health?
- What are the effects of emerging contaminants and climate change on the status and recovery of bay and watershed health?
- Where should natural resource managers prioritize restoration efforts?
- How does the inclusion of citizen science data change individual behaviors and increase environmental stewardship?

Once the data are organized and entered into a database, CBP may use the non-traditional data to help answer these and additional questions.

Intended Data Use

TIERS	Intended Data Use
TIER 1	Education, Environmental Health Screening
TIER 2	Environmental Health Report Cards, Environmental Health Screening, Targeting of Management Actions
TIER 3	Chesapeake Bay Watershed trends and assessments to help inform policy and management decisions

Tier Descriptions and Framework for Determining Tiers

There are diverse motivations for monitoring and diverse projects where non-traditional data are collected. In the aquatic citizen science field/volunteer monitoring, most organizations developing monitoring programs answer the question “how do they intend to use their data” prior to identifying parameters, appropriate techniques, and corresponding quality assurance measures. This process is done with the goal to match the data quality with the intended use. For the integration of non-

traditional data into the Bay program, the Project Team has identified Tiers for data use. If data do not meet the data requirements of the different tiers, those data will not be included in this project.

Tier 1 – Education and Environmental Health Screening:

Definition: Tier 1 data include programs whose data do not meet the requirements of Tier 2 and Tier 3 but are of known quality, have written study designs, documented quality assurance/quality control measures, and as a result still contribute to understanding of the health of the Bay watershed.

Data Uses:
These data can be used to:

- Provide location information on where monitoring is taking place;
- Provide on-the ground information for future site development;
- Indicate potential pollution hot spots;
- Prioritize sites for follow-up monitoring;
- Target restoration projects;
- Inform sub watershed report cards; and
- Highlight local, community projects that are implemented to improve the health of the Bay watershed.

Data Requirements: Clearly documented monitoring methodology, site locations, and written study designs.

Tier 2 - Environmental Health Report Cards, Environmental Health Screening, Targeting of Management Actions:

Definition: Tier 2 data are data with clearly defined and approved methodology (using the volunteer monitoring EPA QAPP guidelines) but do not meet Tier 3 data requirements.

Data Uses: These data will:

- Be used for Bay Program report cards;
- Be used to help target stream segments for water quality standards attainment assessments and Clean Water Act 305(b) reports;
- Be used for screening for Clean Water Act 303(d) stream segments;
- Target new priority agency sites;
- Track the performance of Total Maximum Daily Load (TMDL) implementation projects; and
- Be used for all uses identified in Tier 1.

Data Requirements: Program, at minimum, has an approved volunteer monitoring Quality Assurance Project Plan (http://www.epa.gov/sites/production/files/2015-06/documents/vol_qapp.pdf). Data collected, uses approved field or laboratory standard operating procedures with defined levels of precision and accuracy for the measurements, or

program can be participating in an umbrella monitoring initiative that has an approved QAPP or field/lab standard operating procedures.

Tier 3 - Chesapeake Bay Watershed trends and assessments to help inform policy and management decisions:

Definition: Tier 3 data are regulatory, decision-making, legally defensible data.

Data Uses: These data can be used for:

- Attainment purposes, Clean Water Act 305 (b) reports, Clean Water Act 303 (d) listing and delisting; and
- All uses identified in Tier 1 and Tier 2.

Data Requirements: United States Environmental Protection Agency (EPA) or CBP approved QAPP and field/lab standard operating procedures.

The Project team will be refining data requirements (Fall 2016) criteria after monitoring method manuals and QAPPs are developed to add additional information on types of monitoring techniques, their precision, accuracy, and sensitivity as well as quality assurance measures.

Examples of Non-traditional Data Contributor Success Stories within Each Tier

There a number of existing success stories that highlight the diverse ways that nontraditional data can be used to inform education, screening of pollution problems, long-term trend analysis, and water quality standards attainment.

Tier 1 - Education:

Data collection is inherently educational for participants. Beyond the educational development of the data collector/analyzer, a typical goal for watershed organizations and programs is to use the data collected to educate municipal officials, community members, and other stakeholders about water quality in their community. Most data-collecting entities use the stories found in their data for local education.

One successful case study in Pennsylvania is the work accomplished by the Antietam Watershed Association (AWA). When AWA developed their study design with technical support from ALLARM, they were primarily concerned with the effect of non-point source runoff in the watershed; agricultural runoff was the primary issue in the West Branch of the Antietam and stormwater runoff was the primary issue in the East Branch of the Antietam. Three years into their baseline data collection, there were three large farms that were sold in the West Branch for housing subdivisions. Using the data they collected, AWA was able to illustrate the impact of agricultural runoff on the West Branch as well as the impacts of stormwater runoff in the East Branch. As a result, AWA was able to work with the local municipality, Washington Township, to develop a buffer ordinance for the new housing subdivision.

The South Anna Monitoring Project is a citizen water quality monitoring volunteer group that operates under a VA DEQ-approved QAPP to monitor water quality parameters at designated sites along the

South Anna Creek and its tributaries in Louisa County, Virginia. Volunteers have been collecting data and noting land use changes in the upper portion of the watershed for the past 10 years. With this data, an educational report was developed to illustrate land use change impacts.

Tier 2 - Screening, Report Cards, Targeting:

A common product of watershed monitoring activities are reports and report cards that outline findings as well as recommendations on data use, sites for further investigation, and additional questions to answer in the watershed.

The Shermans Creek Conservation Association (SCCA) was a watershed group located in Perry County, Pennsylvania (one of Pennsylvania's more rural counties). SCCA formed in 1998 and conducted baseline chemical, biological, and physical stream monitoring from 1999 – 2008 with technical support and mentoring from ALLARM. Throughout their nine years of water quality data collection they went through three rounds of data interpretation and data use. The first watershed report on Shermans Creek was published in 2004 and it was the impetus and primary content used for the development of a Rivers Conservation Plan. As a primarily agricultural county, the watershed data were particularly useful in identifying locations for best management practices to be installed to address a variety of issues from faulty manure storage facilities to lack of riparian buffers. Another result of the 2004 report was a petition to the Pennsylvania Department of Environmental Protection (PADEP) to upgrade the stream designation of a portion of the main stem of Shermans Creek, based on the citizen-collected data. The SCCA data which were submitted to the state helped the state target their own monitoring to inform the designated use upgrade process.

The Reedy Creek Coalition (RCC), a watershed group in Richmond, Virginia, with training and technical assistance from the Alliance, has been collecting water quality data to help identify pollution hotspots and potential sources. Through regularly monthly monitoring along the creek and streamwalks, the Coalition has identified several illicit discharges over the span of the monitoring program. In 2011, during a streamwalk, a dry weather discharge was detected at a large stormwater pipe, along with a strong sanitary sewer odor and bacterial growth. This, along with follow-up testing from Randolph Macon College students which showed very high levels of *E. coli*, prompted the City of Richmond to investigate. They discovered a damaged sanity sewer line nearby and repaired it. Also, in 2012, the water quality monitors identified foul odors and elevated *E. coli* counts at a monitoring site on Crooked Branch, a tributary of Reedy Creek. The RCC notified the City of Richmond's Department of Public Utilities (DPU) regarding their observations and the DPU Pretreatment Program began an investigation. Their monitoring confirmed the volunteers' findings and they traced the contamination to a blocked sanitary sewer line. This was fixed, and follow up sampling showed much lower concentrations of *E. coli.*

Tier 3/Tier 2 - Water Quality Standards Attainment:

Typically for monitoring programs interested in attainment, there is a strong reliance upon state-approved protocols and certified laboratories for data analysis. However, there are success stories of nontraditional data being used to inform Clean Water Act violations as well as the listing and delisting of streams.

The Codorus Creek Watershed Association was formed in 1998 to implement watershed assessments. One of the group's concerns centered on the Glatfelter Paper Plant, whose discharge led to the community nickname of the Codorus as the "inky stinky." Upstream of the plant's effluent the Codorus is classified as a High Quality Cold Water Fishery (the second highest designated use in PA). As a result

of the temperature and color of the plant's discharge the creek downstream only met criteria for a Warm Water Fishery. Using two parameters, temperature and color, the group produced data that illustrated the plant was in violation of the Clean Water Act and the Pennsylvania Chapter 93 code. The Pennsylvania Department of Environmental Protection then sued the plant, which resulted in $2.5 million in penalties and required the plant to install $32 million worth of new equipment to improve the clarity and temperature of the discharge.

Existing Tools

There are a number of existing tools to help identify appropriate chemical water quality monitoring procedures that will be helpful for this project:

- To inform non-tidal monitoring procedures, the Project Team will use the VA DEQs Virginia Citizen Water Quality Monitoring Program's Methods Manual and the Mid Atlantic Tributary Assessment Coalition Nontidal Protocols http://www.deq.state.va.us/Portals/0/DEQ/Water/WaterQualityMonitoring/CitizenMonitoring/Citmon_Manual.pdf;
- To inform tidal monitoring procedures, the Project Team will use the Mid Atlantic Tributary Assessment Coalition Tidal Protocols; and
- To inform attainment data use, the Project Team will use the Chesapeake Bay Program's Recommended Guidelines for Sampling and Analysis as well as the 2015 Technical Addendum for Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity, and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries.

Areas for Development and Consideration

For chemical data, the VA DEQ methods will have to be examined and the Project Team will have to confirm that those tiers fit in appropriately with this project.

The questions that nontraditional data will help answer are expansive and will require integrative data. One consideration here is how the program will diversify the information inputs into the tiered framework to better integrate additional parameters such as benthic macroinvertebrates, physical habitat, and submerged aquatic vegetation.

Metadata Requirements

As a part of the tiered approach, data producers will need to submit accompanying metadata alongside their monitoring data. All data of known quality are valuable as long as the end use matches the data quality; metadata are crucial to ascertain the quality of data.. The metadata provide additional information as to how the measurements were obtained and the level of precision and accuracy. Typically metadata includes, but is not limited to: equipment and materials used, storage methods, holding times, and analysis methods.

There are a number of approaches to determining what metadata is needed, including relying on existing tools and frameworks, such as:

- EPA Volunteer Monitoring QAPP Development guidelines http://www.epa.gov/sites/production/files/2015-06/documents/vol_qapp.pdf;
- VA DEQ established metadata protocols for their databases; and
- Conversations with the Chesapeake Bay Program teams that are discussing required metadata for different data uses.

Below is an example of metadata from a Pennsylvania Watershed Group's Study Design:

Parameter	**Equipment**	**Holding Container**	**Storage**	**Maximum Holding Time**	**Method**
Temperature	LaMotte Hg-Free Thermometer	Measured at stream	N/A	Immediate	Field Thermometer
Conductivity	LaMotte Tracer PocketTester	500 ml Nalgene	N/A	Immediate	Field meter
pH	EMD Millipore ColorpHast pH strips	Measured at stream	Refrigerate	2 hours	pH strips
Dissolved Oxygen	LaMotte Kit #5860	60 ml glass container	N/A	Fixed at streamside, titrate within 8 hours	Winkler Titration
Water Clarity	LaMotte Transparency Tube			Immediate	Visual
Ortho-Phosphates	Hach Kit #PO-19	500 ml Nalgene	Refrigerate	Within 48 hours	Ascorbic Acid
Nitrate- Nitrogen	Hach Kit #NI-14	500 ml Nalgene	Refrigerate	Within 48 hours	Cadmium Reduction
Benthic Macro-invertebrates	Kick net or D-net with 500-micron mesh	Identify at stream side; OR Preserve in wide mouth 1 liter plastic screw cap container	Preserved in at least 70% ethanol	Indefinite	EASI or VA SOS protocol
Streamwalk	Field data sheet, camera	N/A	N/A	N/A	Adaptation of Tier I of USDA Visual Assessment Protocol
Stream Reach Survey	Field data sheet, camera	N/A	N/A	N/A	Adaptation of EPA Volunteer Stream Monitoring Protocol
Heavy Metals	Professional lab	500 ml container	Preserve with nitric acid to a pH < 2		Atomic Absorption Spectroscopy or Inductively Coupled

					Plasma Mass Spectrometry

Appendix E

Participating Monitoring Groups

Group Name	State	Tier
Alliance for the Chesapeake Bay	VA	Tier II

Appendix F

Chesapeake Monitoring Cooperative Site Documentation

Office Use Only
Monitoring Coordinator: _____
WSO: _____
Tributary: _____
HUC: _____
FIPS: _____
Date Site Information entered into database: _____

Chesapeake Monitoring Cooperative Site Documentation

Instructions: Please fill in this form as fully and accurately as possible. The information you provide will be used to document monitoring site locations. Be as descriptive as you can. **We need to have precise site documentation to enable the location of your site in the future. In each of the Sections, circle the option that applies.**

SITE DESCRIPTION: _____

_____

PRIMARY MONITOR'S NAME: _____

BACK-UP MONITOR'S NAME: _____

DATA COLLECTION START DATE: _____

I. Location Description: (Please Circle)

Tidal Nontidal

Water body (What Creek, Stream, River, Lake the site is on)

_____

Other Location Details: _____

_____

II. Collection Description: (Please Circle)

Shoreline Pier/Dock Bridge Crossing Boat Wading to Stream Center

III. Coordinates:

A GPS Unit are the recommended methods for determining site coordinates.

There are also several web applications to determine coordinates.

- http://www.getlatlon.com/ Using hybrid view, zoom to your location and pan the map until your site is under the crosshairs.
- http://gisweb.deq.virginia.gov

Please Put in Units in Decimal Degrees (DD.DDDD)

LATITUDE:_____LONGITUDE:_____

(Example: 37.1234) (Example: -77.1234)

☐ MAP- Please attach a map of your site to this form, with the site labeled.

 PHOTO DOCUMENTATION- It is recommended that you visually document your site with photographs of the monitoring location looking upstream and downstream. Label the photos accordingly, and attach copies to this form.