Chesapeake Monitoring Cooperative

Prepared by : The Alliance for the Chesapeake Bay and Dickinson College's Alliance for Aquatic Resource Monitoring with assistance from the Izaak Walton League of America, University of Maryland Center for Environmental Science and Chesapeake Bay National Estuarine Research Reserve in Virginia

Quality Assurance Project Plan:
CAPACITY EXPANSION AND INTEGRATING CITIZEN-BASED AND NONTRADITIONAL MONITORING INTO THE CHESAPEAKE BAY PROGRAM PARTNERSHIP : WATER QUALITY MONITORING IN NON-TIDAL WATERS

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Revision History

This table shows changes to this controlled document over time. The most recent version is presented in the top row of the table. Previous versions of the document are maintained by Quality Manager.

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A3. Distribution List

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

Name	Phone Number	E-mail	Organization
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Dave Parrish	540-529-3463	parrishd@vims.edu	CBNERR

Participating Monitoring Groups		Varies	See Appendix F

A4. Project Organization

A4.1 Project Organization

The Capacity Expansion and 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, now known as the Chesapeake Monitoring Cooperative (CMC). The CMC is managed by the Alliance for the Chesapeake Bay (Alliance) 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), Dickinson College's Alliance for Aquatic Resource Monitoring (ALLARM), and the Chesapeake Bay National Estuarine Research Reserve in Virginia (CBNERR-VA). These five organizations together are hereafter referred to as the "Project Team", and each plays a specific role to carry out the three monitoring components: Tidal Water Quality Monitoring, Non-Tidal Water Quality Monitoring, and Benthic Macroinvertebrate Monitoring, and managing the Chesapeake Data Explorer.

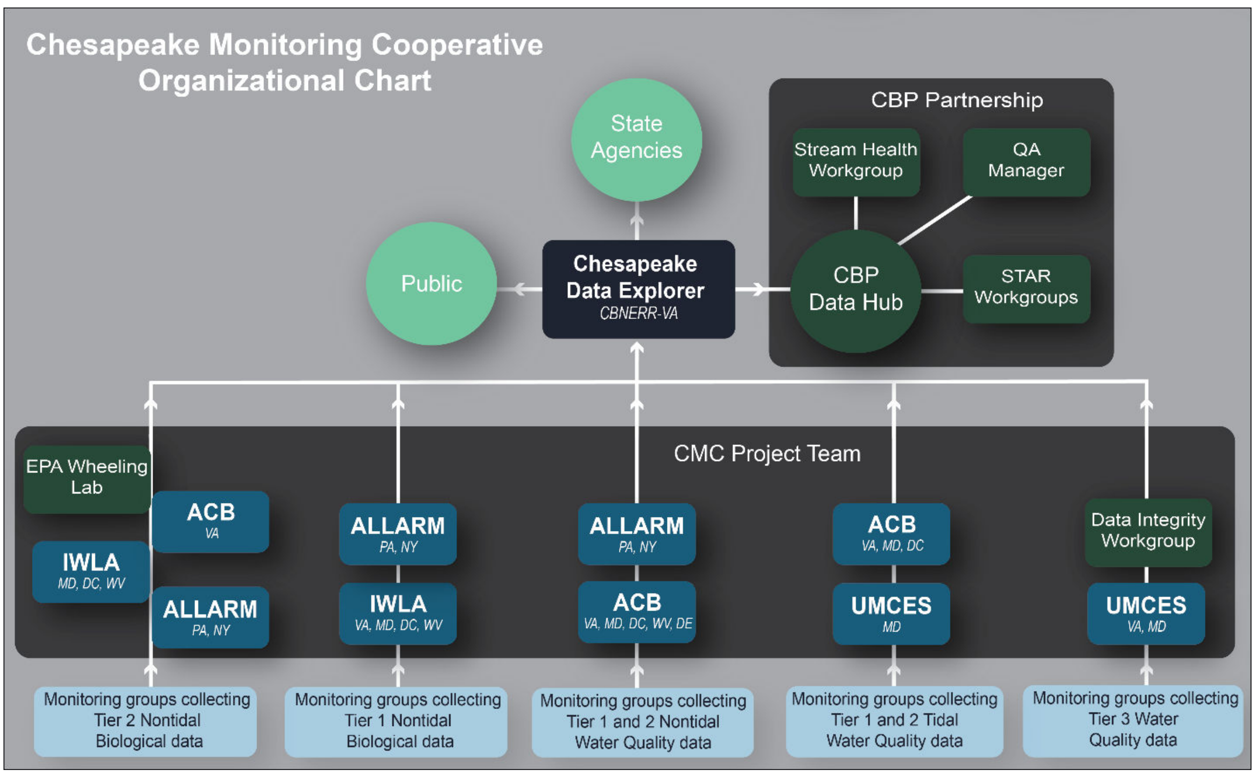

Figure A4-1. Organizational chart for the entire CMC project.

The Alliance and IWLA provide project management and project coordination respectively for all components of the CMC. The Alliance and ALLARM train and support volunteer monitoring groups to collect water quality data following this Water Quality Monitoring in Non-Tidal Stream (Tier I and II) Quality Assurance Project Plan (QAPP), referred to as CMC service providers. The Alliance coordinates the project's Non-Tidal Water Quality Monitoring Program for Tier I and Tier II data collectors in Virginia, Maryland, DC, West Virginia, and Delaware. ALLARM coordinates the Non-Tidal Water Quality Monitoring Program for Tier I and Tier II data collectors in Pennsylvania and New York. CBNERR-VA manages the Chesapeake Data Explorer that houses all of the data collected through the CMC. Table A4-1 lists the personnel involved in tidal water quality monitoring covered in this QAPP and Figure A4-1 reflects the organization chart for the entire Chesapeake Monitoring Cooperative project.

Table A4-1. Organizations, Roles, and Personnel involved in Non-Tidal Water Quality Monitoring.

Organization	Role in Project	Individuals Involved in Project, Title
Alliance for the Chesapeake Bay (Alliance)	Project Manager	Liz Chudoba, Water Quality Monitoring Initiative Director
Izaak Walton League of America (IWLA)	Project Coordinator	Matthew Kierce, Chesapeake Monitoring Outreach Coordinator
Alliance for the Chesapeake Bay (Alliance)	Project Team	Liz Chudoba, Water Quality Monitoring Initiative Director Sophie Stern, Water Quality Monitoring Project Coordinator
Alliance for Aquatic Resource Monitoring (ALLARM)	Project Team	Julie Vastine, Director Stephanie Letourneau, Community Science Specialist
Chesapeake Bay National Estuarine Research Reserve in Virginia (CBNERR-VA)	Project Team	Dave Parrish, Environmental Data Center Manager
Monitoring Groups	Data Collectors	Monitors and Certified Trainers. See Appendix E for current list of participating groups
Chesapeake Bay Program	Data Users/QA Management	Durga Ghosh, QA Coordinator Peter Tango, Chesapeake Bay Watershed Monitoring Coordinator Mike Mallonee

A4.2 Roles and Responsibilities

The roles and responsibilities that pertain to Tier I and II water quality data collection in non-tidal streams are listed below. A full list of roles and responsibilities that pertain to the entire CMC project can be found in the project Quality Management Plan.

Project Manager, Alliance for the Chesapeake Bay

- Manages and provides support for the Project Team to ensure implementation of the Quality Management Plan (QMP), Quality Assurance Project Plans (QAPPs), Standard Operating Procedures (SOPs), and QA policies;
- Annually reviews and updates the approved QMP, QAPP and SOP documents as needed. Small changes will be reported to the Environmental Protection Agency (EPA) in bi-annual reports. When substantial changes that impact the quality system are made to the QMP or QAPPs, the Project Manager will resubmit the QMP or QAPP to EPA for review and approval;
- Schedules, coordinates and facilitates Project Team meetings to build and strengthen partnerships;
- Acts as the liaison between the Project Team and Chesapeake Bay Program Workgroups, including attending workgroup meetings and calls with the STAR Team and the STAR Team's Integrated Monitoring Networks Workgroup and Data Integrity Workgroup (as needed);
- Submit water quality data published in the Chesapeake Data Explorer to the Chesapeake Bay Program's DUET system; and
- Provide CBP with all reporting documentation under the Cooperative Agreement.

Project Coordinator, Izaak Walton League of America

- Assists Project Manager in the coordination and supporting the Project Team to ensure implementation of the Quality Management Plan (QMP), Quality Assurance Project Plans (QAPPs), Standard Operating Procedures (SOPs), and QA policies;
- Assists the Project Manager in annual reviews and updates of the approved QMP, QAPP and SOP documents as needed;
- Schedules, coordinates and facilitates Project Team meetings to build and strengthen partnerships; and
- Acts as the liaison between the Project Team and Chesapeake Bay Program Workgroups, including attending workgroup meetings and calls with the STAR Team and the STAR Team's Integrated Monitoring Networks Workgroup, and the Stream Health Workgroup.

Project Team, Alliance for the Chesapeake Bay

- Develop, review and update EPA approved Water Quality Non-Tidal Quality Assurance Project Plans and the Standard Operating Procedures (SOPs) for monitoring activities;
- Resolve disputes regarding quality system requirements, QA/QC procedures, certifications, or corrective actions.
- Assess data management procedures of the monitoring programs and the Chesapeake Data Explorer to ensure they meet data quality objectives.
- Review and oversee QA policies and SOP's of monitoring groups and document findings for CBP and project records (all Tiers);

- Participates in coordinated annual check ins with CBP's QA team to review QAPP and SOP implementation;
- CMC service provider for Tier I and Tier II data collectors in Non-tidal waters in Virginia, Maryland, West Virginia and the District of Columbia;
    - Provide regular training (Tier I and II) and certification for individual monitors and data collectors;
    - Ensure all water quality monitoring data operations are covered by the appropriate documentation (i.e., SOPs, QAPPs, project plans) for assigned Tier level;
    - Ensure that all data collectors are submitting data to the Chesapeake Data Explorer and adhere to the approved QAPPs and SOPs;
    - Assess and re-certify participants to identify QA compliance or deficiencies. QA deficiencies will be resolved when identified and properly documented;
    - Comply with annual QA reviews or audits with individual Data Collectors.
- CMC service provider for Tier III data collectors (Maryland and Virginia)
    - Screen Tier III candidate QAPPs and/or SOPs;
    - Coordinate with the appropriate State agency to follow state specific processes explained in Appendix H; and
    - Provide technical assistance as needed to achieve Tier III status.

Project Team, Alliance for Aquatic Resource Monitoring

a. Develop, review and update EPA approved Water Quality Non-Tidal Quality Assurance Project Plans and the Standard Operating Procedures (SOPs) for monitoring activities;
b. Review and oversee QA policies and SOP's of monitoring groups and document findings for CBP and project records;
c. Complies with findings and recommendations from QA reviews and audits;
d. Resolves disputes regarding quality system requirements, QA/QC procedures, certifications, or corrective actions;
e. Participates in coordinated annual check ins with CBP's QA team to review QAPP and SOP implementation;
f. Acts as the liaison between the Project Team and Chesapeake Bay Program Workgroups, including attending workgroup meetings and calls with the CBP Diversity Workgroup;
g. CMC service provider for Tier I and Tier II data collectors in non-tidal waters in Pennsylvania and New York:
    - Provide regular training (Tier I and II) and certification for individual monitors and data collectors;
    - Ensure all water quality monitoring data operations are covered by the appropriate documentation (i.e., SOPs, QAPPs, project plans) for assigned Tier level;
    - Ensure that all data collectors are submitting data to the Chesapeake Data Explorer and adhere to the approved QAPPs and SOPs;
    - Assess and re-certify participants to identify QA compliance or deficiencies. QA deficiencies will be resolved when identified and properly documented;
    - Comply with annual QA reviews or audits with individual Data Collectors.

Project Team, University of Maryland Center for Environmental Science

- Support the development, review, and update of the EPA approved Water Quality Tidal Quality Assurance Project Plans (QAPPs) and the Standard Operating Procedures (SOPs) for monitoring activities.

Project Team, Chesapeake Bay National Estuarine Research Reserve in VA

- Continually manage the Chesapeake Data Explorer to ensure functional and data storage of tidal water quality data.
- Assess data management procedures of the monitoring programs and the Chesapeake Data Explorer to ensure they meet data quality objectives.
- Coordinate with QA Management, monitoring groups, project partners, and CBP to ensure incorporation of all required QA measures and documentation into the Chesapeake Data Explorer structure;
- Respond to and implement needed changes in the Chesapeake Data Explorer structure to improve the QA/QC checks and ease of user interface; and
- Coordinate with CBP Data Center to submit data from the Chesapeake Data Explorer to the CBP.

QA Oversight, Chesapeake Bay Program Partnership

- Provides approval of Tier III QAPPs submitted by volunteer and nontraditional monitoring groups participating in this project so that their data may be admitted into the Chesapeake Bay Program monitoring network at the level of attainment;
- Identifies individual(s) to approve the three project Tier I and II QAPPs (macroinvertebrate, non-tidal water quality, and tidal water quality monitoring);
- Annual check ins with CMC Project Team to review QAPP and SOP implementation (3 meetings, one for each QAPP that consists of the relevant project team for each QAPP).
- Reviews CMC project QAPPs and provides guidance to Project Team for effective implementation of QAPPs;
- Follows the communication protocols outlined in Figure A4-1.

Data Collectors (MD, DC, PA, NY, DE, WV, and VA monitoring groups)

- Provide all appropriate monitoring documentation (QAPP, Program Manual, SOP, etc) to the CMC service provider in order to be assigned a tier level;
- Follow all monitoring protocols and QA processes as written in the appropriate monitoring documentation to meet their designated tier level;
- Annual review, quality assurance and oversight of all data uploaded to the Chesapeake Data Explorer;
- Evaluate and report QA issues to designated CMC service provider or QA Management as they occur;
- Maintain annual and biennial certification and re-certification with the designated CMC service provider for Tier II data collection;
- Complies with QA reviews or audits by Project Team and/or QA Officer; and
- At least annually uploads data collected to the Chesapeake Data Explorer.

Participating Labs

- Provide all appropriate lab documentation (SOP, QAPP, certification) for each lab method analyzed by a Data Collector included in this project;
- Follow EPA approved or Standard Methods;
- Report QA issues to the Data Collector and/or CMC service provider;
- Provides data to the Data Collector after analysis.

A5. Project Background

The Project Team members are partnering to provide technical, logistical, and outreach support for the capacity expansion and integration of citizen-based and nontraditional (e.g., non-agency) monitoring data into the Chesapeake Bay Program (CBP) partnership. The project is known as the Chesapeake Monitoring Cooperative, or CMC. 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 collect information that can augment data gathered by the CBP. Both the promotion of data collection as well as 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.

This project started in 2015 through a 6-year cooperative agreement between the Alliance for the Chesapeake Bay and the Chesapeake Bay Program. The first cooperative agreement (2015 – 2021) established the foundation for a consistent and cohesive, watershed-wide, community-based monitoring network. In 2021, the team received a second cooperative agreement (2021 – 2027) in order to maintain this network and increase capacity of community-based monitoring groups to collect data.

A5.1 Goals and Objectives

The CMC project team facilitates data integration from non-traditional and community-based partners throughout the Chesapeake Bay watershed into the Chesapeake Bay Program partnership. To do this, the CMC team works with individual monitoring partners who are currently collecting non-tidal water quality data or wish to develop a new non-tidal monitoring program. Each individual data collector develops their monitoring program around specific goals and data use objectives. These program goals are documented in individual program manuals or standard operating procedures and determine the monitoring frequencies, indicators and equipment used. Program goals typically include the following:

1) Determine long-term trends or changes in water quality indicators;
2) Characterize the present state of a watershed by establishing baseline data, including spatial and seasonal variation, using key water quality indicators;
3) Use data to screen for pollution hot spots or issues that the county or state need to address (e.g. values exceeding state standards;
4) Increase understanding of water quality health in areas with large amounts of recreational activities and to make *E.coli* data directly accessible to the public;
5) Educate community members about local water quality issues and land use impacts.

The CMC is able to use its QAPPs, tiered framework, and data integration rubric to leverage this data beyond the monitoring partners original scope and to help meet the data needs of the Chesapeake Bay Program and State agency partners and answer questions about the Chesapeake Bay. 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”. Additionally, in June 2018, the CBP Principal Staff Committee unanimously signed an historic Memorandum of Understanding (MOU). This MOU acknowledges that water quality monitoring data are necessary to assess these objectives, however, the monitoring needs exceed the capability of individual CBP partners, therefore it is essential that all data sources of known quality be integrated into the CBP monitoring networks.

The CBP has identified a series of goals for which additional non-tidal data are essential. These include, but are not limited to:

a. Understand the status and trends of Chesapeake Bay waters based on watershed inputs;
b. Identify nutrient levels from contributing waters in the watershed to verify effectiveness and progress of management actions;
c. Identify nutrient “hot spots” for better targeted restoration; and
d. Assess the health of the waters at prominent input sites (e.g., headwaters, major tributary inputs, small watersheds).

The CMC project team will work with individual monitoring partners to achieve the following objectives during the 6-year cooperative agreement:

a. To continue to provide technical, logistical, and outreach support to nontraditional data collectors working in tributaries of the Chesapeake Bay Watershed, in order to integrate data into the Chesapeake Data Explorer;
b. To provide support for data collectors 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. Facilitate the use of the data by local, state, and federal entities, including addressing science and information needs identified in the CBP’s SSRF; and
d. Improve the capacity of federally recognized tribes and other underrepresented and environmental justice communities to conduct nontraditional monitoring.

A5.2 Data Classification

All data collected will be categorized into tiers based on equipment sensitivity and quality assurance approaches with suggestions on possible avenues for data use following the 2016 *Tiered Framework for Data Collection and Integration of Nontraditional Monitoring* (*Tiered Framework*, Appendix C). While the tiered framework provides suggested data use options, it is ultimately the decision of a data user to choose the data appropriate for their specific use given the metadata supplied in the Chesapeake Data Explorer. The Project Team categorized these procedures into tiers based on comparability testing, manufacturer’s specifications, experience, and how other water quality monitoring programs have classified procedures. The data categorization process largely depends 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/group per parameter. The protocols established in this QAPP are designed to produce Tier I and Tier II data.

Field data are categorized into the tiers using a standardized classification rubric. Data are categorized based on individual parameters, so each monitoring program can consist of multiple tiers based on parameters monitored and methods used. If data do not meet the requirements for one of the three tiers, they can be classified as provisional, which includes provisional, provisional Tier I or provisional Tier II. Table A5-1 lists tiers, their intended data uses, and a summary of the data requirements, this QAPP only covers Tier I and II data.

Data are classified as Tier III based on Virginia and Maryland regulatory decision-making data use for their Integrated Report. Tier III determination will defer to the individual state requirements where monitoring is occurring (Appendix H). Field parameters considered for Tier III include dissolved oxygen, water temperature, pH, and turbidity.

Table A5-1. All tiers of equipment sensitivity, data quality, intended data use, and data requirements for field data, this QAPP only covers Tier I and Tier II data (highlighted in Green).

Tier	**Intended Data Use**	**Summary of Data Requirements**
Provisional	As a mechanism to move groups into the tiered framework and as users see fit given methodologies.	No quality assurance procedures, methods manuals, program documentation.
Provisional Tier I	Education, environmental health screening	Historic dataset that is categorized as tier 1 or current dataset that is categorized as tier 1 but lacking documented QA practices or necessary metadata.
Tier I	Education, environmental health screening, watershed/county report cards, spot checking problematic sites for further investigation.	• Documented monitoring methodology - study design, methods manual or SOP. • Equipment sensitivity meets Tier 1 requirements according to Table B2-1. • Consistent sampling frequency, equipment and methods. • Annual or biennial water quality training.
Provisional Tier II	Environmental health screening, environmental health report cards, targeting of management actions	Historic dataset that is categorized as tier 2 or current dataset that is categorized as tier 2 but lacking documented QA practices or necessary metadata.

Tier II	Tier I uses plus environmental health report cards and targeting of management actions	• All Tier I Requirements. • State or federal government approved QAPP *or* CMC approved Program Manual/SOP. • Equipment sensitivity meets Tier 2 requirements according to Table B2-1. • Acquires Tier II certification and maintains certification with CMC Project Team or Program Coordinator.
Tier III	Tier I and II uses plus State 303(b)/305(d) Integrated Reports	• Acquire and maintain and EPA/CBP or State agency approved QAPP and field/lab standard operating procedures. • Complete a field audit by either a State agency, CBP, or the CMC every five years.

Lab data are classified as provisional Tier II, Tier II or Tier III, as listed in Table A5-2. In Maryland and Virginia, Bacteria (*E.coli* or *enterococcus)* can be considered Tier III if they meet the state specific requirements in Appendix H.

Table A5-2. All Tiers of equipment sensitivity, data quality, intended data use, and data requirements for laboratory data, this QAPP only covers Tier II data.

Tier	Intended Data Use	Summary of Data Requirements
Provisional Tier II	Environmental health screening, environmental health report cards, targeting of management actions	Historic dataset, or current data not analyzed at a lab that meets Tier II requirements (<10% blanks and duplicates).
Tier II	Environmental health screening, environmental health report cards, targeting of management actions	Certified/CBP approved lab and ≥10% blanks and duplicates analyzed.
Tier III	State 303(b)/305(d) Integrated Reports, public health notifications	• Maintain an EPA/CBP or State approved QAPP. • Acquire a VELAP/NELAP certification, State approval, or annual NSI Laboratory proficiency testing. • Complete a field audit by either a State agency, CBP or the CMC team once every five years.

A5.3 Data Use

All data collected through this project will be archived in the Chesapeake Data Explorer 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. The primary intended data user is the monitoring group collecting the data. Each Data Collector will outline their intended data uses and applicable local, state, or federal standards to define the health of a waterbody in their program documentation. Typical data uses include, but are not limited to:

- Produce a report card for various chemical, physical, and biological parameters to educate the community residents on the local water quality;
- Assess changing conditions in a waterway due to land use changes;
- Assess water quality health for human contact and recreational purposes;
- Target or assess restoration progress.

Secondary data users include the Chesapeake Bay Program partnership. Data collected as Tier I and Tier II from the CMC Non-Tidal Water Quality Monitoring Program are uploaded to the Chesapeake Bay Program annually and are available to fill in data gaps throughout CBP workgroups. For example, water temperature data was included as part of a watershed wide survey of data resources available for the 2021-22 STAC Rising Temperatures Workshop.

Additionally, Data Collectors can opt in to data sharing with state agencies in response to Data Solicitation Notices, in doing so, State agencies access data through the query function of the Homepage. 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.

A6. Project Description

This Quality Assurance Project Plan is designed to ensure that new data collected (data collected after 2017) in non-tidal areas of the Chesapeake Bay (Figure A6-1) will be done in an approved, quality-controlled, and standardized fashion.

Figure A6-1. Areas of coordination by project partner (Alliance and ALLARM).

In order to be included in the CMC as a Tier I or Tier II group, Data Collectors must follow the on-boarding process outlined in Table A6-1 and demonstrate their ability to meet the data quality objectives, quality assurance standards, and Standard Operating Procedures (SOP) established by this QAPP (Appendix A). At a minimum Tier I groups must have documented site locations with latitude and longitude coordinates, a monitoring methods manual and a consistent monitoring frequency. At a minimum Tier II groups must have all the Tier I requirements, plus either a state or federally approved QAPP that has equivalent QA guidelines to this QAPP. A CMC approved Program Manual can substitute for a state or federally approved QAPP in states that do not have a QAPP approval process (Appendix D).

The CMC Project Team will review the monitoring group's documentation, determine the tier designation following a Classification Rubric, and provide any necessary training (see Section A8 for more information on the training provided) in order for the group to be considered integrated into the CMC. After a group has been integrated, they may then begin to collect new water quality data, or continue collecting water quality data under an existing program, and submit it to the Chesapeake Data Explorer. If a group's data does not meet the Tier I or Tier II data requirements, those data can still be submitted to the Chesapeake Data Explorer, 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.

Table A6-1. On-boarding process for Tier I and Tier II data.

Step 1	Connect a monitoring group to the regional CMC service provider.
Step 2	New Groups complete a study design process or decide to connect to an established program (e.g.RiverTrends or Stream Team) Existing groups complete a methods/QA review and evaluation using the Rubric.
Step 3	All monitoring groups complete necessary training. Trainings required are determined by the CMC Service Provider based on monitoring groups individual needs and desired tier level.
Step 4	Upload data to the Chesapeake Data Explorer.

A6.1 Project Timeline

Data collection started in 2017 with the approval of three QAPPs covering the tidal, non-tidal and benthic programs under the first cooperative agreement. Monitoring for this project is planned to continue over the next 6-year project period (May 2021 through April 2027) and beyond. Some CMC Data Collectors have been collecting data for decades, historic data (data collected prior to 2017), will also be included in the project but potentially marked as provisional, provisional Tier I, or provisional Tier II depending on the methodology used. The full project timeline is found in **Table A6-2** including all deliverables and tasks for the 6-year grant period under Cooperative Agreement CB96387101.

Each Data Collector participating in the CMC will have their own project timeline tailored to their specific monitoring program which should include at a minimum the information found in Section B, **Table B1-1**.

Table A6-2. CMC project timeline for individual tasks during the 6-year grant period (May 2021-April 2027).

Objective	Deliverable	Deadline
1. Improve capacity of Citizen Science and nontraditional monitoring partner to conduct monitoring.	Provide consistent communication to CMC partners and at least one meeting between the CMC partners and key CBP program staff annually.	Annually, 2021-2027
	Improve capacity of federally recognized tribes and other underrepresented and environmental justice communities to conduct nontraditional monitoring.	2024-2027
2. Develop and improve data analysis, data management, and reporting procedures.	Support and maintenance for the Chesapeake Data Explorer.	Annually, 2021-2027
	Enhance the Chesapeake Data Explorer data visualization components to enable citizen-oriented monitoring and	2024-2025

	nontraditional monitoring programs to support the analysis and visualization of their data.	
	Submit data to the CBP from the Chesapeake Data Explorer	Annually, 2021-2027
3. Strategize data collection efforts by citizen science and nontraditional partners to fill data gaps using regionally standardized approaches.	Update the 2017 Prioritization Report to identify spatial and temporal gaps in the CBP's SSRF and develop strategies to fill those gaps.	2023
	Increase jurisdictional use of nontraditional water quality monitoring data.	Annually, 2021-2027
	Attend relevant CBP workgroup meetings.	Annually, 2021-2027
	Collect 100 benthic macroinvertebrate samples to fill in gaps in the Stream Health Indicator.	Annually, 2021-2027
4. Coordinate and conduct training and support for monitoring program integration.	Provide 30 training sessions annually, including: study design, water quality, biological, train-the-trainer, field audits/QC checks, Data Explorer upload, data interpretation, and recertification.	Annually, 2021-2027
	Revise and update project Quality Management Plan (QMP).	2021 and 2026
	Revise and update three project QAPPs	2022
	Revise and update a scientifically-valid and user-friendly protocol for monitoring and reporting data	2021-2023
	400 individuals participating in citizen-based and nontraditional partner monitoring programs annually.	Annually, 2021-2027
	1,000 individuals reached beyond the CMC network and partners over the six years (170 annually).	Annually, 2021-2027
	Maintain the CMC website that houses all of the recruitment materials, training materials, monitoring protocols, methods manuals, and toolkits.	Annually, 2021-2027

A6.2 Site Selection

This project aims to collect data through the assessment of non-tidal, freshwater streams throughout the Chesapeake Bay Watershed in order to gain a broader understanding of the health of the

Chesapeake Bay and its tributaries. Non-tidal areas are defined as the waters that are not influenced by the tidal cycle.

Monitoring sites are chosen by individual Data Collectors (following the process in Section B) or with the help of the CMC Project Team if needed. All sampling sites will include detailed metadata including a unique site ID, name of sampled waterbody, description of sample site, and latitude/longitude coordinates (in decimal degrees to 4 decimal places) in order to provide the information needed to compare data across all monitoring groups.

When new sampling sites are needed, they will be selected based on the following criteria:

- Individual monitoring groups data needs,
- Local water quality risks and impairments,
- Data gaps identified in the 2017 Prioritization Report,
- Chesapeake Bay Program data requests,
- State agency data requests.

Site selection follows fixed station design, stations should be chosen that give the best representation of the waterway monitored. The number of stations recommended is based on the size and location of the watershed balanced with resources to support data collection (people and equipment). In an ideal situation, a HUC 10 watershed has a site located near the mouth but also central watershed and headwaters as resources allow. Where possible, sites should be located off the stream bank in the free-flowing section of the waterway, representing main channel conditions, which can be collected from a bridge, wading, or sample collection pole. Monitoring sites that cannot be located in the middle of a channel due to safety or resource limitations should ensure samples are collected from areas that represent the characteristics of the waterway, as far out into the main channel as possible, and ideally utilize a sampling pole or bucket to collect the sample. It is important to avoid sample collection near stagnant water, eddies, or areas where debris has accumulated.

Once a sampling site or sites are selected, the monitor/coordinator will:

1. Visit their site to confirm that it is safe and easy to access.
2. Use the Property Owner Permission and Liability Release Agreement form (Appendix E) to obtain written permission allowing them to access the stream, if the sampling site is on private property.
3. Record a description of the site and the latitude and longitude coordinates in decimal degrees using GPS with the North American Datum of 1983 (NAD83).
4. Send the sampling site description and coordinates to the CMC Service Provider for verification using Google Maps and/or the USGS National Hydrography Dataset (NHD) in ESRI ArcMap and for upload on the Data Explorer.

A6.3 Water Quality Parameters

There are many different water quality indicators for the concerns associated with the health of non-tidal tributaries and their impacts on Chesapeake Bay health. The parameters chosen for this project represent many of the water quality indicators currently being monitored by citizen and nontraditional groups in non-tidal streams, and provide an assessment of the predominant water quality concerns in the Chesapeake Bay. The parameters chosen for this project include *in-situ* measurements and lab grab samples. However, this QAPP only covers the field collection methods for lab grab samples, lab analytic methods must also follow the process identified in Section C1.1 in order for data to be included. The full list of parameters that can be analyzed and the equipment that can be used are found in Table B2-1.

This project consists of a diversity of monitoring groups, each with their own goals for what they wish to achieve with their sampling. All projects are not required to monitor all parameters listed, the process for individual monitoring groups to determine their suit of indicators is found in Section B.

A6.4 Data Management

All data collected through this project (All data Tiers and provisional Tiers) are archived in a centralized database, the Chesapeake Data Explorer (Data Explorer), and accompanied by the appropriate metadata to allow data users to determine appropriate uses for the data and to use them as they see fit. Data is uploaded to the Data Explorer by certified monitors, certified program coordinators or the CMC Service Provider. To upload data, an individual will create a personal account that is linked to their specific monitoring group using an active email address. Once an account is created it is activated by a certified program coordinator or a CMC Service Provider and given a specific role listed in **Table A6-3**. Only Members can designate accounts as coordinators for particular monitoring groups if they meet the QA standards.

Table A6-3. Chesapeake Data Explorer Roles and Responsibilities

Role	Personnel	Responsibility
Monitor	Certified Monitors	Have access to upload data to sites registered under their group and to edit and review data points they personally upload into the Data Explorer until it is published by the program coordinator.
Coordinator	Certified Program Coordinator/QA Manager	Have access to upload, edit, review and publish data for all sites and monitors assigned to their monitoring group. Have access to add or remove stations, monitors or parameters from their monitoring program.
Member	CMC Service Provider	Have access to upload, edit, review and publish data for all sites and monitoring groups participating in the CMC. Have access to add or remove stations, monitors or parameters from any monitoring program. Uploads all published data to the Chesapeake Bay Program annually.

All published data in the Chesapeake Data Explorer are publicly accessible for download on the homepage and will be uploaded to the Chesapeake Bay Program's Data Upload and Evaluation Tool (DUET) system annually. Data uploaded to DUET are automatically uploaded to EPA's Water Quality Exchange (WQX).

A7. Measurement Quality Objectives

This project is designed to provide water quality measurements that will be utilized to assess the health of the Chesapeake Bay Watershed. 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 precision, accuracy, measurement range, representativeness, comparability, and completeness.

A7.1 Data Precision

Data precision is defined as the ability of a measurement to consistently be reproduced. Repeated measurements are usually used to determine precision. In the case of repeated measurements, one would typically see how close those measurements agree.

This project meets data precision goals by completing the appropriate field duplicate, replicate, and blank at frequencies found in Section B4.3. The methods for collecting the duplicate, replicate and blank samples can be found in the SOP in Appendix A. Any duplicate, replicate or blank samples that fall outside of the acceptable precision range for a specific parameter will be flagged in the Chesapeake Data Explorer. Additionally, precision ranges for each parameter and equipment type are listed in the Chesapeake Data Explorer (where applicable) and included in the metadata files provided with the data.

A7.2 Data Accuracy

Data accuracy is defined as a degree of confidence in a measurement. The smaller the difference between a measurement of a parameter and its “True” expected value, the more reliable the more accurate the measurement. Also, the more precise or reproducible the result, the more reliable or accurate the result. Accuracy can be determined by comparing an analysis of chemical standard to its actual value.

This project meets data accuracy goals by calibrating, standardizing, and verifying equipment following the frequency and specification criteria outlined in Section B4.2. The methods for performing calibrations, standardizations, and verifications can be found in the SOP in Appendix A. Any calibration samples that fall outside of the acceptable range for a specific equipment will be flagged in the Chesapeake Data Explorer. Additionally, accuracy ranges for each parameter and equipment type are listed in the Chesapeake Data Explorer (where applicable) and included in the metadata files provided with the data.

A7.3 Measurement Range

Measurement range is defined as the range of reliable readings of an instrument or measuring device, or a laboratory method, as specified by the manufacturer or lab.

This project meets measurement range goals by listing the appropriate measurement range for each type of equipment based on manufacturer specifics in the Chesapeake Data Explorer, and included in the metadata files provided with the data. Additionally, upon data upload the data are checked against typical measurement ranges for that particular parameter and flagged if outside of the range. Data can still be accepted if outside the range.

A7.4 Data Representativeness

Data representativeness is defined as how well the collected data depict the true system. This project meets data representativeness goals through the site selection process, sample collection methodology and sampling timelines.

Site locations and the number of sites are chosen with the expectation that they will provide an adequate representation of what is occurring in the water body being sampled. The Project Team will work with individual monitoring groups to select sites based on accessibility, volunteer availability, and budget. More information on the site selection process can be found in Section B4.

Sample collection methodologies should be chosen so that individual samples collected represent the actual conditions or concentrations present in the sampled water body. During sampling, the monitors will utilize reliable QA procedures, follow sample collection and handling methodologies in their methods manual, and follow sample container requirements, preservation, and holding times described in the project SOP (Appendix A).

Water quality samples will be collected following a consistent schedule in order to ensure representativeness. The specific sampling frequency chosen by each monitoring group will depend on the monitoring goals, potential data uses, and resources available, and must be documented in their project QAPP, SOP and/or methods manual. An outline of typical monitoring timelines can be found in Section B1.2.

A7.5 Data Comparability

Data comparability is defined as the extent to which data from one data set can be compared directly to another data set. The data sets should have enough common ground, equivalence or similarity to permit a meaningful analysis.

The Tiered Framework for data collected ensures comparability within and between monitoring groups, by providing the baseline requirements for each Tier Level (see Table A5-1 and A5-2 for requirements for each tier).

Comparability of data within and between monitoring groups is achieved through:

a. Attending training workshops,
b. Following detailed methodology on sample collection, storage, maintenance, and analysis,
c. Using the monitoring equipment supplied or recommended by the CMC 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.

A7.6 Data Completeness

Data completeness is defined by the amount of data that must be collected to achieve the goals and objectives stated for the project. It is typically assessed by comparing the amount of data obtained versus expected given the sampling timeline/frequency set.

For this project, the CMC Project Team works with each individual monitoring group to set their own data completeness goal based on their monitoring frequency and data use goals, which must be documented in the project specific QAPP, SOP or methods manual. Ideally monitoring groups would achieve at least a 90% data completeness percentage within a monitoring year. However, given the nature of volunteer-based monitoring, groups are required to meet a 75% completeness goal from each of the sites during the monitoring time frame. The minimum (75%) data completeness goal for typical monitoring frequencies (weekly and biweekly, year-round, and weekly summer sampling) can be found in Table A7-1.

The actual number of samples collected and analyzed is not known until after the sampling is completed, and should be calculated as part of the data analysis and review.

Table A7-1. Minimum data completeness requirements for a monitoring group sampling monthly or biweekly, year-round or weekly in the summer following a 75% data completeness goal.

Monitoring Frequency	Number of Samples Anticipated	Minimum Samples Achieved
Monthly, Year-round	12	9
Biweekly, Year-round	24	18
Weekly, Summer (May – October)	24	18

A8. Training Requirements and Certification

The CMC Service Providers hold workshops and offer customized assistance to monitoring groups participating in the CMC depending on their specific needs. Specific details of how and when trainings occur for individual data collectors should be documented in their approved program QAPP, methods manuals or CMC Program Manual. Some options for typical training processes include, but are not limited to:

- A monitoring program has a program coordinator that trains volunteers to collect data independently at selected sites: CMC service provider trains the program coordinator annually to be a certified trainer for their specific monitoring group. The certified trainer then trains individual monitors to go out on their own to collect the data associated with their monitoring program. The certified trainer must retain certification documents for all certified monitors. The

CMC service provider additionally trains the program coordinator or an additional staff/volunteer to become the QA manager for their specific monitoring group.

- A monitoring program has a program coordinator and/or staff that collect data at selected sites with the help of volunteers that act as the "crew members": CMC service provider trains a program coordinator and/or staff annually to be a certified monitor for their specific monitoring group. The QA manager can either be the CMC service provider or the program coordinator if they are additionally trained as a QA Manager.
- CMC service provider trains individual volunteers to be certified monitors and collect data independently at their specified monitoring sites: The CMC service provider is the certified trainer and QA manager for the monitoring program. This typically only occurs for the CMC service provider programs (Stream Team, RiverTrends and VASOS).

The CMC service providers conduct five types of training on an annual basis: Study Design Workshops, Water Quality Monitoring Training, Train-the-Trainer Training, Program Coordination/QA Management Training and Data Explorer Training. Finally, the CBP QA officer conducts an annual review of the CMC Project Team/Service Providers.

A8.1 Study Design Workshop

Prior to developing a monitoring program, it is essential to think through the scientific process and the steps necessary to create a program that answers a monitoring question, thinks through intended data uses, and identifies the appropriate indicators and equipment for the assessment goals. The study design process facilitates these important decisions. The Project Team provides Study Design Workshops to monitoring groups who request it (typically monitoring groups who are starting new programs), this process is recommended but not required to collect data under this project. During the study design workshop, the monitoring group will review and determine the following:

- Monitoring goal(s) and question(s)
- Appropriate parameters to monitor and methods to follow
- Number and location of monitoring sites
- When data will be collected
- How they will use and disseminate their data and results locally
- Who will monitor
- Data management, visualization, storage
- Quality control/quality assurance procedures
- Monitoring schedule

The Study Design process is also a tool to ensure that monitoring programs are set up in accordance with the CMC QAPPs.

A8.2 Water Quality Monitoring Training

All monitors are required to attend a Water Quality Monitoring Training before they begin collecting water quality data. These workshops can be held by anyone and monitors can participate in training in many ways, including: attending an in-person workshop, attending a virtual workshop, watching online tutorial videos or recordings of workshops, or side-by-side monitoring tutorials (in the field or in a home/lab setting). The specific training type and topics covered is based on the individual monitoring groups sample collect methods, but should include:

- Goals and objectives of the CMC and individual monitoring project;
- Information on the science of water quality issues in the Chesapeake Bay Watershed;
- Potential uses and applications for their data;
- Information on water quality impacts and the significance of the indicators to be measured, including state criteria, values of concern, etc.;
- Data management process including completing a field datasheet and uploading data to the Chesapeake Data Explorer;
- Equipment maintenance and storage;
- Review of standard operating procedures, QA/QC, etc.; and
- A demonstration using the monitoring equipment and methodologies of their specific program.

It is expected that each certified monitor will be able collect samples, measure concentrations of analytes according to their methods manual, and enter data into the Chesapeake Data Explorer (if applicable). Monitors collecting only Tier I data can start data collection after attending their water quality monitoring training. Monitors who wish to collect any Tier II data must take additional steps to become a Certified Monitor. Certified monitors independently collect field data and/or lab grab samples at designated sites and can be volunteers or paid staff. A certified monitor can start collecting data after attending the training held by a Certified Trainer and completing one of the following certification requirements:

1. Pass a certification test with an 80% or greater within 90 days of training, or
2. Submitting a quality assurance duplicate sample to the Project Team/Certified Trainer and have the results fall within a threshold of acceptance based on the precision of the methodology.

Monitors that are unable to meet the certification requirements will be retrained on their deficiencies and allowed to retake the certification test or resubmit their duplicate sample. 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. Monitors that are still unable to meet the certification standard will remain un-certified and can either assist a certified monitor in the field until they have become comfortable with the procedures and QA/QC protocols or collect Tier I data.

All monitors that have passed the initial certification training, are collecting Tier II data, and wish to maintain their certification must be recertified annually for the first two years, and biennially after that to maintain their certification. The goal of the re-certification is to ensure monitors 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. Replacement equipment, datasheets, information, and chemicals are given if needed. Re-certification typically occurs in two ways:

1. Attend a re-certification workshop (in-person, virtual or one-on-one) and pass a re-certification test with an 80% or greater within 90 days of training, or

2. Submitting a quality assurance duplicate sample to the Project Team/Certified Trainer and have the results fall within a threshold of acceptance based on the precision of the methodology.

All document of both certification and re-certification trainings are retained at the monitoring groups office or regional Project Team office for 7 years.

A8.3 Train-the-Trainer

A Certified Trainer is any person who is certified to lead a Water Quality Monitoring Workshop and certification process for monitors collecting Tier II data. Certified trainers can be volunteers or paid staff at an organization and must attend a Train-the-Trainer workshop held by a CMC Service Provider. These workshops are held on an as-need basis and can be regionally based, where a few trainers are trained together, or one-on-one with the individual trainers. Typically, Certified Trainers are program coordinators and only certify volunteers monitoring under their specific program, however, a Certified Trainer could also be a regional trainer that works with multiple groups. Train-the-Trainer Workshops are tailored to each monitoring group, but typically cover the goals of the project, information on how to conduct Water Quality Monitoring and Certification Workshops, and how to manage the project documentation. If a group does not have a Certified Trainer, a CMC Service Provider can host water quality monitoring workshops for the monitors or their data is considered Tier 1 or Provisional.

In order to become certified, trainers are required to attend a Train-the-Trainer Workshop led by a CMC Service Provider and demonstrate:

1. A thorough understanding of water quality monitoring methods and QA/QC procedures implemented by this project and their individual monitoring project. This can be achieved through prior knowledge and experience (as deemed appropriate by the CMC service provider) or by being a Certified Monitor for at least one year;
2. An ability to conduct a Water Quality Monitoring Workshop or Certification Workshop, by showing their ability to:
    a. Logistically plan and lead a Water Quality Monitoring Workshop, including preparing the equipment and completing all of the necessary documentation,
    b. Explain water quality parameters, water quality science, and the importance of assessing stream health in the Chesapeake Bay Watershed, and
    c. Effectively train workshop participants to collect data following the project's Tidal Water Quality Monitoring Program.

Trainers may be asked to perform a "mock" training or to undergo an observation by a Project Team member in person or by video in order to qualify. Once a trainee qualifies by these means, they become a Certified Trainer and may train and re-certify volunteer monitors under their program.

In order to stay certified as trainers, the Certified Trainers must meet every year with the regional Project Team member in person or by video in order to be re-certified as a Certified Trainer. During this meeting, trainers will:

1. Review the CMC Tidal Water Quality Monitoring Program Manual and update if needed.
2. Demonstrate their ability to perform monitor certification trainings.

3. Provide equipment to check and verification of the Trainer's master thermometer against the Project Team's NIST verified thermometer.
4. Provide all program documentation, including the list of current monitoring sites, certified monitors, and calibration/verification logs.

Certified Trainers must document all of their certification trainings, including a detailed list of active certified monitors. All documentation resulting from the Certified Trainer workshop will be sent to the CMC service provider annually and filed in their office for at least seven years. The CMC service provider may attend and possibly assist with trainings held by the Certified Trainers as time and funding allow.

A8.4 Coordinator/QA Training

A QA Manager is any person who is certified to perform all QA and data management protocols (including data upload and publishing on the Chesapeake Data Explorer) for a monitoring program collecting Tier II data. QA Managers can be the program coordinator/certified trainer, paid staff or a highly engaged volunteer.

The CMC service provider will provide one-on-one workshops on an as-needed basis during the project timeframe (2021-2027), for those interested and qualified to become QA Managers for their monitoring program.

In order to become a QA Manager, the designated person must demonstrate:

1. A thorough understanding of water quality monitoring methods and QA/QC procedures written in the project QAPP or CMC Program Manual;
2. A proficiency in troubleshooting issues with equipment or any other field supplies;
3. A proficiency in data management using Microsoft Excel or some other electronic data mechanism;
4. Annual recertification or passing of prescribed QC practices;
5. A proficiency in data upload to the Chesapeake Data Explorer.

This can be achieved through prior knowledge and experience (as deemed appropriate by the CMC service provider) or by being a Certified Monitor/Trainer for at least one year. Once a QA Manager is designated for a monitoring group, they are responsible for all QA protocols established for their program with support from the CMC service provider as needed, including but not limited to: entering data into an electronic form, spot checking data, performing data QC checks in order to flag questionable data, reviewing calibration records, troubleshooting issues, uploading and publishing data in the Chesapeake Data Explorer. The QA Manager is designated as a Coordinator in the Data Explorer and has full access to upload, edit, publish and delete data associated with their monitoring group.

If a monitoring group does not have a QA Manager either the CMC service provider acts as the QA Manager for that group, or the data is considered Tier I or provisional.

A8.5 Data Explorer Training

These workshops are held as needed and one-on-one between the CMC service provider and individual monitoring groups (typically the Certified Coordinator, but can include other staff as well) to learn how to upload data to the Data Explorer (typically the bulk upload process). Typically held after a group has collected a few months of data and are ready to start uploading to the Data Explorer.

There are no certification requirements because these trainings are held either with monitoring groups who have gone through the monitor and/or coordinator certification workshops, or are not participating in the CMC training workshops and therefore data is marked as provisional. Workshops typically cover:

1. Transfer of data from an excel file (post-QA) to the Data Explorer bulk upload template. This is done using an excel macro tailored to the specific monitoring group.
2. Logging on to the Data Explorer - overview of the stations, monitors and group info that the Coordinator has control to change.
3. Walk through the bulk upload process

A9. Documentation and Records

The CMC Project Team recommends the following documentation and records. Monitoring groups can use their own existing forms if applicable. If a monitoring group does not have a form, the CMC Project Team has developed templates that can be tailored to the monitoring groups needs. Templates for Property Owner Permission Forms, Liability Release Forms, Field Datasheets and Calibration Logs can be found in Appendix E.

A9.1 Property Owner Permission Form

The CMC recommends any monitoring sites located on private property have a property owner release form to give permission to monitor on that site (recommended that these be signed even if the monitor is the property owner). Property owner permission forms are held by individual monitors and/or Project Coordinators for seven years, and archived digitally.

A9.2 Liability Release Form

The CMC is not responsible for any volunteers monitoring under programs working with the CMC. The CMC recommends that all volunteers sign a liability release form prior to starting monitoring activities. Liability release forms are held by the Project Coordinator for seven years, and archived digitally.

A9.3 Field Datasheets

During every sampling occasion, the monitor must fill out and complete a field data sheet. 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 CMC service provider will review and approve the field data sheet for use in the project. Monitoring groups that do not have field data sheets or data sheets that are deemed appropriate by the Project Team may use the CMC Datasheet as a template.

On the data sheet, monitors record essential metadata including their name, date, time, sample site location/station ID and field data including values for replicates as applicable. They may also record weather conditions, whether or not they calibrated their equipment, and time spent monitoring. These data sheets are either entered into the Data Explorer directly upon returning from the field or passed on to the monitoring groups Certified Trainer for data entry.

The Project Team/Certified Trainer maintains original hardcopy or scanned 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 Chesapeake Data Explorer.

A9.4 Calibration Logs

All calibration/standardization information must be recorded before and after monitoring as applicable for Tier II methodologies. Calibration and standardization values are recorded on either field datasheets or separate calibration logs. It is recommended to upload calibration values to the Chesapeake Data Explorer for metadata reporting. However, it is not necessary, as long as data are properly flagged with calibration/standardization QA issues. Calibration and standardization logs must be kept by the CMC Service Provider or the Certified QA Manager for 7 years.

All temperature verifications (including the Alliance's Master Thermometer) must be recorded in Temperature Verification logs annually. All verification logs must be kept by the Certified Trainer or the CMC Service Provider for 7 years.

A9.5 Lab Data Sheets

Each lab will be expected to supply their own lab data sheets to record the results. Labs should submit their lab data sheets to the Project Team or Coordinator for review (No template is included in Appendix E). The lab data sheets are to be held by the lab or the regional Project Team/Certified Coordinator for a period of seven years.

A9.6 Training Documentation

All documentation from trainings, certifications, and re-certifications, including Train-the-Trainer documents, are held at the regional CMC Service Provider or Certified Coordinator office for seven years.

All certified trainers/coordinators must keep a record of and present the following items during annual training/reviews:

- list of certified monitors, certification test results,
- training sign in sheets/registration sheet,
- a copy of their SOP/Methods Manual/QAPP,
- list/map of sites,
- equipment documentation, etc.

All CMC Service Providers must keep a record of all certified monitoring groups working in their jurisdiction and uploading data to the Data Explorer, records should include:

- a list of certified trainers/QA Managers,
- a completed Tiered Rubric (which includes the equipment used, parameters monitored, QA processes in place, site locations and lab info),
- each groups SOP/QAPP,
- partnership agreement and data sharing agreement,
- QC check lists, etc.

SECTION B – DATA COLLECTION METHODS

This section includes detailed information on how individual monitoring groups/data collectors make decisions about sampling design, sampling frequencies, sampling sites, analytical methods used, and quality control requirements. All information must be documented in a monitoring groups state approved QAPP (where applicable), CMC Program Manual or Methods Manual/SOP in order to be considered for inclusion in the tiered framework. Monitoring groups that do not have the proper documentation will be considered *provisional, provisional* Tier 1 or *provisional* Tier 2 until they complete their documentation.

B1. Sampling Design

This project includes discrete sampling using either *in-situ* sensors, water quality probes, monitoring kits, or lab grab samples that utilize reliable QA procedures. *In-situ* sensors and water quality probes take measurements directly from a waterway, or in some cases a bucket, and include both single parameter sensors and multiprobe sondes. Monitoring kits are used for a variety of parameters, typically using a sample container to collect the sample from a waterway, then samples are analyzed by a monitor either stream-side or at a home, office or lab setting. Lab grab samples are collected directly from a waterway, or in some cases a bucket, and transported to a lab for analysis. Most programs use a combination of techniques to analyze a suite of parameters based on resources available. This project specifically does not include continuous monitoring techniques, air monitoring, drinking water monitoring, groundwater/aquifer monitoring, monitoring for toxic contaminants.

All sampling protocols and equipment will utilize reliable QA procedures in order to meet the data quality objectives of this QAPP. For Tier II field data (*in situ* sensors and monitoring kits), these procedures include calibration/standardization of equipment and field replicates (monitoring kits only) described in the project SOP. For lab analyzed data, these procedures include field blanks and duplicates, sample container requirements, sample preservation, and sample holding times described in the project SOP.

The CMC Project Team will help monitoring groups determine their individual sampling design decisions. Once a project is set up the CMC Project Team will tailor the CMC Non-Tidal Methods Manual (Appendix A) to suit the needs of the monitoring group, based on the decisions made during the Study Design Workshop (A8.1). Monitors will follow the methods and QA procedures in their tailored monitoring manual to collect water quality data (possible parameters listed in Table B2-1) at their sampling site monthly or more frequently for a minimum of one year. They will test all field parameters in-stream or stream-side and will collect water samples to test non-field parameters within the maximum holding time.

B1.1 Sample Collection

Sample data shall be representative of the actual conditions or concentrations present in the sampled water body. Samples should be collected from the thalweg (mid-channel) of the stream when accessible via wading or bridge. Samples that cannot be collected from the thalweg can be collected from a dock or shoreline, following guidelines in Section A6.2. If data are collected using probes it is recommended to use a pole to help extend the probe off the bank and into the free-flowing section of the water body. Nitrile or latex gloves are typically required for bacteria monitoring, but may be used for other monitoring as well.

All equipment, technologies and sampling methods selected for this project are used to monitor baseline surface water conditions following the EPA volunteer monitoring methods for streams. Individual groups may have more specific methods to meet specific objectives, like targeting restorations projects, tracking bacteria levels for human health, etc.

B1.2 Sampling Frequency

Each Data Collector participating in the CMC will have their own sampling schedule and project timeline based on their project design, monitoring goals, and resources available. Program documentation should include at a minimum the information found in **Table B1-1**. In order to be considered Tier 2, groups must monitor the same parameters following a specified sampling frequency (ie. weekly, biweekly, monthly, annual snapshots), with sampling events ideally occurring on a consistent scheduled and at a consistent time of day (ie. The first Thursday of each month at 10am).

Sampling may be canceled 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. If the set sampling day is canceled, the sample should be collected within 2 days (before or after) of the regular sampling day. If sampling within 2 days is not possible, the Program Coordinator will determine if the sample should be taken at some other frequency or skipped.

If sampling multiple sites that cannot be sampled within one sampling day, the monitoring should be broken up into different sampling runs that are completed on a consistent schedule (ie. Run 1 consists of Sites 1-5 and are sampled every Tuesday, Run 2 consists of Sites 6-10 and are sampled every Wednesday, etc.).

Typical sampling frequencies for non-tidal monitoring programs include, but are not limited to:

- Once monthly water quality sampling should be conducted year-round when possible, but can be done at a minimum from March to November.
- Biweekly water quality sampling should be conducted year-round when possible, but can be done at a minimum from March to November.
- Weekly water quality sampling typically occurs during the summer months, May through September/October.
- Combination of timeframes – some monitoring programs perform weekly sample collection in the summer and monthly sample collection the rest of the year.

Monitoring programs that do not follow a standard sampling frequency will be considered for inclusion on a case-by-case basis by a CMC Service Provider and will be marked as *provisional*, *provisional* Tier I or Tier I based on the methodology used.

Sampling timelines should also include schedules for data upload to the Chesapeake Data Explorer and training frequencies. Data should be uploaded at least annually, specific data upload deadlines are determined based on local, state and federal calls for data. Training frequencies should follow guidelines in Section A8 for the monitoring groups designated Tier level.

Table B1-1. Sample project timeline that should be included in program documentation for individual Data Collectors.

Task	Timeline
Program Start Date and End Date (if applicable)	Date the group is considered integrated into the CMC network and an end date for monitoring if there is one.
Sampling frequency (eg. monthly, bimonthly, weekly and year-round or specific months)	Weekly, Biweekly or Monthly
Data upload to the Chesapeake Data Explorer	At least once annually
Audit with CMC service provider	At least once annually
Volunteer monitor recruitment/training	At least once annually
Recertification for Certified Monitors	Annually for Tier II groups
Recertification for Certified Coordinators	Biennially for Tier II groups

B1.3 Site Selection

Sampling sites are chosen by individual Data Collectors (following the process in Section B) or with the help of the CMC Project Team if needed following either probability based or fixed station design outlined in Section A6.2. Where possible, sites 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. All sampling sites will include detailed metadata including a unique site ID, name of sampled waterbody, description of sample site, and latitude/longitude coordinates in order to provide the information needed to compare data across all monitoring groups. Latitude and longitude coordinates must be documented in decimal degrees to 4 decimal places and can be obtained using a handheld GPS unit with the North American 1983 Datum (NAD83) or with online mapping tools, like google maps.

Data Collectors determine sites by 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. Data Collectors also review site characteristics such as accessibility and placement in the watershed in order to choose an appropriate monitoring location that represents the waterway and meets the monitoring goals.

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

a. The number of sites should provide an adequate representation of the water quality of the stream segment being sampled.
b. Monitoring sites should be located in the main channel of a tidal stream or river, when feasible. Monitoring sites that cannot be located in the middle of the channel due to safety or resource

limitations can be located on docks, piers or the shoreline with sample collection occurring as close to mid-channel as possible.

c. Monitoring sites may be co-located at CBP, state monitoring, or nearby group sites to allow for comparison of datasets.
d. Monitoring sites should be located in accessible and safe areas.

B2. Sampling/Analytical Methods for Field Data

All Data Collectors must follow standard methods manual in order to collect data within the Tiered Framework. The full list of approved parameters, sampling procedures, and equipment along with the highest achievable tier and the requirements to meet that tier designation for field data are listed in **Table B2-1**. Each Data Collector selects parameters, equipment and analytical methods used for their program based on their individual monitoring needs and Tier designation. If a monitor or a program does not meet all of the Tier requirements for a given parameter and equipment (ie. Proper calibration is not performed), or proper data documentation/metadata is not maintained the data are downgraded a Tier or considered *provisional, provisional* Tier I or *provisional* Tier 2 based on the requirement missing. See Section B4.2 for calibration, standardization and verification frequencies and standards needed to meet the Tier Requirements in Table B2-1.

A full description of sampling methods available for use by monitors participating is given in the non-tidal standard operating procedures (SOP) 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 if they do not have an SOP of their own.

Table B2-1. Highest achievable Tier and sample method requirements for non-tidal field data.

Parameter	Approved Procedure	Equipment	Highest Achievable Tier	Tier Requirements
Alkalinity	EPA-NEWL: 310.1	Titration Kit (LaMotte 4491-DR-01; LaMotte 4533-DR-01; LaMotte 3467-01)	Tier II	100% field replicates
Alkalinity	Appendix A	Colorimeter (Hanna HI 775)	Tier II	Standardization, >10% field replicates
Bacteria (e.coli)	Appendix A	Coliscan Easygel	Tier I	N/A
Bacteria (e.coli)	Appendix A	R-Card	Tier I	N/A
Bacteria (e.coli)	SM 9223B	IDEXX Colilert	Tier II	>10% blank and duplicates
Conductivity	USEPA Method 120.1	Electronic Probe (LaMotte 1749, Extech, HACH Pocket Tester, Multiprobe Sonde)	Tier II	Calibration, >10% field replicates

Dissolved oxygen	USEPA Method 360.2	Winkler Titration (LaMotte 5860)	Tier II	Standardization, 100% field replicates
Dissolved oxygen	USEPA Method 360.1; As described in probe manual	Electronic Probe (Oakton, Extech, Hanna, Multiprobe Sonde)	Tier II	Calibration, >10% field replicates
Nitrate-nitrogen	Appendix A	Colorimetric Kit (Hach NI-14 1416100, LaMotte 3110, LaMotte 3354)	Tier I	Acid-wash glassware, 100% field replicates
Nitrite-Nitrate	Appendix A	Field Colorimeter or Spectrophotometer (Hanna HI 707 Digital Checker)	Tier I	Acid-wash glassware, 100% field replicates
Nitrate-nitrogen	Appendix A	Field Colorimeter (Hach) or Spectrophotometer	Tier II	Standardization, Acid-wash glassware, >10% field replicates
Orthophosphate	Appendix A	Colorimetric Kit (Hach PO-19 224800, Hanna HI 38061)	Tier I	Acid-wash glassware, 100% field replicates
Orthophosphate	USEPA Method 356.2	Field Colorimeter (Hanna HI 713 Digital Checker)	Tier I	Acid-wash glassware, 100% field replicates
Orthophosphate	USEPA Method 356.2	Field Colorimeter or Spectrophotometer (Hach 9385100)	Tier II	Standardization, Acid-wash glassware, >10% field replicates
pH	Appendix A	ColorpHast pH Strips (2 - 9)	Tier I	N/A
pH	Appendix A	Colorimetric Kit (LaMotte 5858 (Narrow Range), LaMotte 3353 (Wide Range), Hach)	Tier II	Narrow Range, 100% field replicates
pH	USEPA Method 150.1; As described in probe manual	Electronic Probe (Hanna, LaMotte, Oakton, Extech, Multiprobe Sonde)	Tier II	Calibration, >10% field replicates

Total dissolved solids	Appendix A; As described in probe manual	Electronic Probe (LaMotte 1749, Extech)	Tier I	N/A
Water clarity	Appendix A	Turbidity Test Kit (LaMotte 7519)	Tier I	N/A
Water clarity	Appendix A	Transparency Tube (Forestry Suppliers 77107, Ben Meadows 111360)	Tier I	N/A
Water clarity	USEPA Method 180.1	Field colorimeter (ex. Hach DR 900)	Tier II	Standardization, >10% field replicates
Water clarity	USEPA Method 180.1	Turbidimeter (ex. Hach 2100P)	Tier II	Standardization, >10% field replicates
Water temperature	USEPA Method 170.1	Armored Glass Thermometer (LaMotte 1066)	Tier II	Verified, >10% field replicates
Water temperature	USEPA Method 170.1	Digital Thermometer (ex. Hanna 98509)	Tier II	Verified, >10% field replicates
Water temperature	USEPA Method 170.1; As described in probe manual	Multiprobe Sonde Thermistor (Ex. LaMotte 1761)	Tier II	Verified, >10% field replicates

B3. Sampling/Analytical Methods for Lab Data

Some Data Collectors may choose to collect field grab samples that are transported and analyzed in a laboratory setting. The full list of approved parameters and sampling procedures for lab data are listed in **Table B3-1**. Each Data Collector selects parameters and lab used for their program based on their individual monitoring needs.

This QAPP and associated SOP in Appendix A, include field sampling operations for collecting the field grab sample, filling out a standard Chain of Custody form and sample label tags, and preparing the sample for transport to the lab. Sample transport processes must be documented in individual monitoring groups SOPs or Program Manuals. It is recommended that all samples with transport temperature requirements are packed in a cooler with cubed ice and water, samples should be placed in the ice but not fully submerged. A temperature blank can be used if required by the lab or monitoring methods used. Specific requirements for transport temperatures can be found in Appendix B. All laboratory procedures must be documented in a separate lab specific SOP or QAPP.

To be considered Tier 2, groups must:

a. Collect at least 10% field blank and duplicate samples;
b. Prepare and preserve (as applicable) samples according to the procedures in Appendix A;

c. Transport all samples to the lab within the appropriate holding times and at the appropriate temperature referenced in Appendix B; and,
d. The Lab must meet the criteria for Tier 2 data in Section C1.1.

If any of the Tier 2 requirements are not met on a programmatic scale, the data will be marked *provisional* Tier 2 until the criteria are met. If an individual sample is prepared or preserved incorrectly, received at the lab outside of the appropriate holding time or outside of the appropriate temperature the data point will be flagged with the appropriate problem code as described in Section B4.5.3.

Table B3-1. Tier designations and sample method requirements for lab data.

Parameter	Approved Procedure	Equipment	Tier Designation	Hold Time	Transport Temperature
Ammonia-nitrogen	USEPA Method 349.0 (tidal); 4500-NH3D	Specific to individual lab	Tier II	48 hours*	≤ 6° C
Bacteria (e.coli)	SM 9223B	IDEXX Colilert	Tier III	8 hours	≤ 10° C
Nitrate-nitrogen	USEPA Method 352.1	Specific to individual lab	Tier II	48 hours*	≤ 6° C
Nitrite-Nitrate	USEPA Method 353.3 (non-tidal)	Specific to individual lab	Tier II	48 hours*	≤ 6° C
Orthophosphate	USEPA Method 365.1	Specific to individual lab	Tier II	48 hours*	≤ 6° C
Total suspended solids	USEPA Method 160.2	Specific to individual lab	Tier II	7 days	≤ 4° C
Total Nitrogen	USEPA Method 351.2; 4500 N-C	Specific to individual lab	Tier II	48 hours*	≤ 6° C
Total Phosphorus	USEPA Method 365.4	Specific to individual lab	Tier II	48 hours*	≤ 6° C

*Hold times are for unpreserved samples. Hold times may be extended to up to 28 days depending on the preservation method prescribed by the individual lab used. Each monitoring program must specify their individual preservation and hold time requirements (typically adding H_2SO_4 to pH <2 and freeze to -20°C.

B4. 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.

B4.1 Instrument Acquisition, Testing, Inspection and Maintenance

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) before sending to monitors. Expired chemicals should not be used and are collected during re-certification events so they may be disposed of properly in accordance with federal, state, and local environmental control regulations.

Monitors are to inspect their equipment before each monitoring event or as outlined in Appendix A. Monitoring supplies are kept in a secure area, unless otherwise specified. Equipment is stored at room temperature and is 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. All equipment will be maintained according to the manufacturer's instructions.

B4.2 Instrument Calibrations, Standardizations and Verifications

All field probes and some field kits require field quality control samples in order to be considered Tier II data. Field equipment calibrations and standardizations are performed within 24 hours prior to going out on a sample run according to Appendix A or the manufacturer's instructions to ensure it is properly operating and not damaged. If calibrations are performed on a different frequency it is documented in the groups individual QAPP or SOP. Equipment calibration or standardization is done using known references or standards and must fall within limits set in **Table B4-1**. Equipment that fails calibration or verification should not be used until the issue is remedied and the calibration is successful. Data collected using equipment that failed calibration/verification is flagged in the Chesapeake Data Explorer and can be used at a lower or provisional tier based on the nature of the issue encountered.

Post-sample checks are performed for probe measurements and must be performed within 24 hours after a sampling event to identify any instrument drift during sampling. Post-sample checks use the same standard used to calibrate the equipment, but without performing the calibration. The equipment is placed in the standard solution, allowed to stabilize and the reading is recorded on the calibration log or field datasheet. The same calibration ranges apply. If the calibration is successful, but the post-sample check fails, this is an indication that the probe is starting to go bad and it is recommended to replace the sensor and recalibrate the probe. In this case, data can typically still be used as the designated Tier but should be marked with Problem Code F in the Data Explorer.

All calibrations/standardizations events must be documented on a field data sheet or calibration log. See Appendix E for sample data sheets and calibration logs.

Thermometer verifications are performed using a NIST traceable thermometer annually and must fall within the limits set in **Table B4-1**. Thermometer verifications can be performed using the Alliance's master precision thermometer that is verified annually against the Virginia Department of Environmental Quality's NIST-traceable thermometer or another verified thermometer. Thermometer verifications are tracked in Verification Logs and kept by the CMC Service Provider or Certified Trainer for seven years. See Appendix E for sample verification logs.

Table B4-1. Equipment calibration standards and acceptable ranges.

Parameter	Equipment	Calibration standard	Acceptable Calibration Range
Conductivity (TDS/salinity)	Meter or Probe	It is preferred to do a two-point calibration bracketing the average conductivity field value range. A one-point calibration within the typical conductivity field value range is acceptable.	+/- 5% of the standard
Dissolved Oxygen	Meter or Probe	100% saturation	+/- 0.3 mg/L 97% - 103%
Dissolved Oxygen	Winkler Titration	Sodium thiosulfate check – if first check is not within acceptable range, conduct a second check. If the second check is not within range, do not run samples during that sampling event. If the second check is within range, conduct a third check and report the closest two.	9.4 – 10.0 mg/L
Nutrients	Colorimeter	Verified using the verification vial provided by the manufacturer.	+/- 5 mg/L
pH	Meter or Probe	It is preferred to do a two-point calibration bracketing the pH field value, always using pH 7 buffer (either 7 and 10 OR 7 and 4). If the pH field value is outside of the calibration bracket, the post-sample check should be completed with the third buffer solution.	+/-0.20 of standard
Temperature	Armored glass thermometer, digital thermometer	Verification against a standard NIST thermometer in cold (0-4°C), room temp (18-22°C) and warm (30-35°C) water.	Armored thermometer - +/-0.50°C; Digital thermometer - +/-0.20°C
Water Clarity	Colorimeter or Turbidimeter	It is preferred to do a three-point calibration bracketing the typical turbidity field value, using 0 NTU, 10 NTU and 20 or 100 NTU standards.	+/- 0.2 NTU of the 0 NTU standard, +/- 10% of the 10, 20 or 100 NTU standards

B4.3 Field QC Checks

B4.3.1 Field Replicates

Monitors collecting Tier II data using *in situ* probes or electronic meters are required to perform field replicates 10% of the time (ie. 1 out of every 10 samples collected). A field replicate is performed by having the monitor take the instrument to the site and obtain a reading. The instrument is removed and then reinserted into the sample to obtain a second reading.

Monitors will record the replicate values onto their field data sheet, and check to make sure they fall within the acceptable precision range for the parameter being tested and equipment used. If the values are not within the acceptable precision range, additional replicates will be tested until two values are within the acceptable precision range. The acceptable precision range for each parameter is listed in Appendix B, and is based on the precision and sensitivity of the equipment used. Monitors will enter the replicate values into the Chesapeake Data Explorer.

B4.3.2 Field Duplicates

Monitors collecting data using a field kit (Winkler Titration, nutrient colorimetric kits, etc) must perform duplicates (within a range informed by equipment specifications) 100% of the time for every site collected regardless of the Tier. Monitors collecting data using a field colorimeter (nutrients or turbidity) must perform duplicates (within a range informed by equipment specifications) at least 10% of the time for every site collected to be considered Tier II. Duplicates are generated either by testing a single sample twice or by collecting two or more samples from the same site, at the same time, using the same collection method, and then testing them with the equipment to generate two duplicates. Duplicate values must fall within the specified accuracy range for the equipment used. If the duplicate values differ by more than the specified accuracy range, a third analysis may be recommended. Both duplicate values are recorded on the datasheet and monitors will enter both values into the Chesapeake Data Explorer.

If a monitor or group has more than three duplicates 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.

B4.3.3 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 as well as additional training will likely be required. During the audit, monitors must demonstrate proper sample collection, analysis, labeling, 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.

B4.4 Laboratory QC checks

B4.4.1 Field Duplicates

Monitors collecting samples for Tier II laboratory analysis will perform duplicate samples at least 10% of the time (ie. 1 out of every 10 samples collected). Monitors will perform all field procedures including preserving the samples as required and taking them to the lab for analysis using a second sample bottle marked as a duplicate. Results from field duplicates will be recorded and appropriately marked during data entry in the Chesapeake Data Explorer. Field duplicates exceeding >20% deviation for soluble parameters (TN, TP, nitrate, etc) and >30% deviation for solid parameters (TSS and e.coli) will be flagged as questionable data for the associated samples collected.

If a monitor or group has more than three field duplicates 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.

B4.4.2 Field Blanks

Monitors collecting samples for Tier II laboratory analysis will perform field blank samples at least 10% of the time (ie. 1 out of every 10 samples collected). Monitors will perform all field procedures including preserving the samples as required and taking them to the lab for analysis using deionized water supplied by the lab. Results from field blanks will be recorded and appropriately marked during data entry in the Chesapeake Data Explorer. 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.

B4.5 Data Entry QC Checks

All data are checked for data transfer error (spot-checks), out of range results, incomplete data sheets, and written notes by monitors that signal to the Project Team of the possibility of questionable data. These data checks are completed after data upload and before data are published for data uploaded via the data upload form, and prior to data upload for data uploaded via the bulk upload process. Typically, this process includes:

1. Transfer hard copy field datasheets to an electronic version (either directly on the Data Explorer or an excel spreadsheet);
2. Spot-check the data transfer;
3. Check the calibrations and flag questionable data;
4. Check lab data and flag questionable data;
5. Upload/publish data in the Data Explorer.

B4.5.1: Data Transfer Spot Checks

All data are recorded on a paper field datasheet and must be transferred to an electronic version. In order to ensure data are transferred accurately, spot checks must be performed for at least 10% of the datasheets. This transfer process can occur in two ways: via the data upload form on the Chesapeake Data Explorer, or onto a Microsoft Excel spreadsheet that is then bulk uploaded to the Data Explorer.

Data that are uploaded directly on the Data Explorer via the data upload form will be spot checked on the Data Explorer prior to publishing. Monitors upload their data directly on the Data Explorer, then submit the original copies of their field data sheets to their Certified Trainer/QA Manager or CMC Service Provider ideally every three to six months. The Project Team/Certified Trainer will spot check ≥10% of the data sheets and compare the results entered in the Chesapeake Data Explorer for data entry errors or missing data points. For year-round, monthly monitoring, this means checking at least 2 data sheets per monitor or monitoring team per site annually. 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 Project Team/Certified Trainer and a note is put on the data sheet and in the “Comments” field of the Chesapeake Data Explorer indicating that an error was made before data are published. If substantial QC issues are identified the Project Team/Certified Trainer will alert the monitor and work to remedy the issue.

Data that are uploaded to the Data Explorer via the bulk upload process will be spot checked prior to data upload. Data are transferred from the field datasheets to an electronic form (typically a Microsoft Excel spreadsheet) by either a monitor, program coordinator or CMC Project Team member. After data has been entered into the electronic form a spot check will be performed on ≥10% of the data sheets entered and compare the results entered in the Excel spreadsheet for data entry errors or missing data. The spot check ideally is performed by a different person than the person who transferred the data, however, if that is not possible the same person can perform the spot check ≥ 24 hours after the data has been transferred. If a data entry error is found, all of the data sheets transferred at that time are to be checked. Errors will be corrected by the spot-checker before the data are uploaded to the Data Explorer. If substantial QC issues are identified the Project Team/Certified Trainer will work to remedy the issue.

If no errors are found through the spot-check process all data checks outlined in sections B4.5.2 and B5.4.3 should be completed before publishing data.

B4.5.2: Check field data

Once data are transferred to an electronic form (either the Data Explorer or Excel spreadsheet) and the spot-check is complete, additional data checks should be performed to ensure data meet the intended data quality goals. Data checks should include the following, but may include additional checks based on specific equipment or data use goals.

- Check calibrations/standardizations are within acceptable ranges according to **Table B4-1**.
- Check the post-sample check values (when applicable) are within acceptable ranges according to **Table B4-1**.
- Check that the values from calibrated probes are within the calibration standard ranges (ie. pH reading of 7.40 was calibrated with 7 and 10 buffer solution).

- Check that the readings are within “normal” ranges.
- Check that duplicates and replicates are within the acceptable accuracy range for the equipment used.

If data quality issues are found the questionable data points can be removed from the dataset or flagged with the appropriate problem code. Problem codes can be found in **Table B4-2**, see Appendix G for more information about problem codes and how to use them.

Table B4-2. Problem codes used to flag field data in the Chesapeake Data Explorer.

Code	Name	Description
A	Calibration or Standardization failed	Must be used if a sample value is reported, but the calibration or standardization for that equipment failed.
B	Post-sample check failed	Must be used if the sample value is reported, but the post-sample check technique for that equipment failed for specific sampling events. If the issue is chronic, data should be downgraded to a lower Tier or flagged with the “Q” code instead.
C	Field replicate out of range	Must be used if the field replicates or duplicates for kit or probe measurements are out of range. If the issue is chronic, data should be flagged with the “Q” code instead.
V	Other Field QA/QC issue	Must be used if any other quality assurance or quality control measures are not met.
X	No routine sample taken - see comments	Can be used to record that a routine measurement was not taken for a specific sampling date. Should be accompanied by an explanation in the comments section.

B4.5.3: Check Lab Data

Typically, the lab will check data to ensure all laboratory blanks, duplicates, matrix spikes, etc. are within range and the data are good. Additionally, the lab should check the samples to ensure they were sampled and preserved correctly, arrived within the appropriate hold time and at the appropriate temperature. The lab should flag any data that does not meet the lab standards, see Section C.1.1 for more details on lab criteria.

Monitors or Coordinators should check this data to look for any flags that would indicate a laboratory issue, if found the data should be flagged with the appropriate problem code from **Table B4-4**. If none appear, the field duplicate and blank readings should be checked to ensure they are within proper range, found in **Table B4-3**. Additionally, data should be checked to ensure reported values fall above the PQL (or lab reporting limit) and MDL. Any values that fall below the MDL must be flagged with a “<”

detection flag, and any values that fall between the MDL and RL must be flagged with Problem Code "G" found in **Table B4-4**.

Table B4-3. Acceptable field duplicate and blank ranges for lab analyzed parameters.

Parameter	Approved Procedure	Duplicate Range	Blank Range
E.coli	SM 9223B	10x	>1 MPN/100mL
Total Phosphorus	USEPA Method 365.4	20%	20%
Nitrate-Nitrogen	USEPA Method 352.1	20%	20%
Nitrite-Nitrogen	USEPA Method 353.4	20%	20%
Ammonia	USEPA Method 349.0	20%	20%
Total Kjeldahl Nitrogen	USEPA Method 351.1	20%	20%
Total Nitrogen	USEPA Method 351.2	20%	20%
Total suspended solids	USEPA Method 160.2	30%	20%

Table B4-4. Problem codes used to flag lab data in the Chesapeake Data Explorer.

Code	Name	Description
D	Lab sample not preserved properly	Reported by the lab if the sample was received and not preserved (either with acid or on ice) properly.
E	Lab sample received after holding time	Reported by the lab if the sample was received after the appropriate holding time.
F	Lab sample analyzed after holding time	Reported by the lab if the sample was analyzed after the appropriate holding time.
G	Other Lab QA/QC issues	Reported by the lab if there is some issue with the sample (ie. not enough sample was collected, chemical interference, lab analysis issues, etc.).
H	Lab sample field blank failed	May be reported by the lab, but should be checked by the program coordinator when lab data is received.
I	Lab sample field duplicate out of range	May be reported by the lab, but should be checked by the program coordinator when lab data is received.

B4.5.4: Upload/Publish data on the Data Explorer

Once data has passed the spot-check and all additional data checks it can be uploaded and/or published on the Data Explorer and made publicly accessible. For data uploaded via the data upload form, the Coordinator or QA Manager can publish all data that completed the data checks for each site from the edit and review page of the Data Explorer. For data uploaded via the bulk upload process, the data can now be translated into the bulk upload template, see the Data Explorer Manual for more details on that process. This data can be uploaded via the Bulk Upload form and published immediately.

The Data Explorer features a series of automated checks on any data uploaded to the application. First, the application requires basic data formats to be valid. For example, a decimal type number must be uploaded for a sample value. The application also checks data validity, such as confirming that the parameter code associated with a sample exists in the database. Further, the application also ensures that samples are not duplicated in the database based on a unique combination of sample time, sample location, sample depth, parameter, and sample id. The Data Explorer requires that a problem code is associated with any null sample value. The application also provides a warning when the sample values fall outside of an established range for its associated water quality parameter.

B5. Data Acquisition Requirements

The CMC 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 are defined as data collected prior to 2017 and will be incorporated into the Chesapeake Data Explorer along with all available QA/QC supplemental information including any QAPPs, SOPs and other QA documentation. Historic data will be assigned a tier level based on available QA/QC and SOP documentation. If historic data do not have the appropriate documentation or are missing critical QA measures, they will be designated a provisional tier level. Data users will be able to determine the level of QA rigor of historical datasets based on associated metadata and tier designation.

Monitoring site coordinates will be obtained using USGS 7.5 minute topographic maps or online mapping applications of known accuracy such as Google Maps.

Weather conditions are collected along with the benthic data to contextualize the local conditions of the site. Weather conditions are obtained from field observations, or vetted and reliable local sources, some common ones include:

- Weather Underground: www.wunderground.com
- Community Collaborative Rain, Hail and Snow Network (CoCoRaHS): https://www.cocorahs.org/Maps/ViewMap.aspx?state=usa
- National Weather Service: https://www.wrh.noaa.gov/mesowest/getobext.php?wfo=sew&sid=KSEA&num=72&raw=0

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.

B6. Data Management

All Tier I and Tier II field data collected (observational and water quality data) will be recorded on field datasheets, or computers as appropriate for the monitoring equipment used (some multiprobe sondes have data storage abilities). Each Data Collector must have a standard field datasheet or recording mechanisms used. If a group does not have a field datasheet, they can adopt the CMC template (found in Appendix E). Following data collection, data will be entered into the Chesapeake Data Explorer by the monitor, program coordinator, or CMC Project Team either from the field datasheet or via bulk upload (see Table A6-3 for the Data Explorer Roles). The data upload process is a two-step process: 1.) data are uploaded (data does not appear on the publicly accessible Data Explorer homepage) and 2.) data are published (QA checks are performed and data appears on the homepage and is available to query and download).

Data can be uploaded via the data upload form by monitors, coordinators and members (see Section A6.4 for Data Explorer roles). Typically, a monitor uploads the data from the field datasheet through their active Data Explorer account via the data upload form for their designated site. The monitor then sends their field datasheet to their program coordinator or CMC Service Provider. The data are then checked by the program coordinator or CMC Service Provider and published on the Data Explorer according to the quality assurance procedures in Section B4. This process typically occurs on a monthly or quarterly basis. Hard copies of the field data sheets are kept in a secure location for 7 years.

Data can be uploaded via the bulk upload process by coordinators and members, monitors are not able to bulk upload data. Typically, data are transferred from the field datasheet to some type of electronic data recording mechanism (typically a Microsoft Excel spreadsheet) by either the monitor or coordinator. The data is then checked by the program coordinator or CMC Service Provider according to the quality assurance procedures in Section B4. The data file is then converted via a Microsoft Excel Macro developed for this project to the Data Explorer template and uploaded via the bulk upload page. If the data file fails any of the data checks, errors will appear on the bulk upload page detailing the nature of the issue and none of the data is uploaded. If the data file passes all of the data checks, the user will be prompted to publish the data uploaded. This process typically occurs annually.

Lab data sheets or excel files are typically uploaded to the Chesapeake Data Explorer separately than the field data and as it is received. All lab data are uploaded via the bulk upload process as described above.

All data uploaded and/or published in the Chesapeake Data Explorer are stored indefinitely, however members and coordinators have permission to delete data associated with their monitoring group at any point in time. All published data are publicly accessible for download on the homepage and uploaded to the Chesapeake Bay Program's Data Upload and Evaluation Tool (DUET) system annually. Data uploaded to DUET are automatically uploaded to EPA's Water Quality Exchange (WQX).

See **Figure B6-1** for the CMC data management flow chart from data collection, to storage, to use.

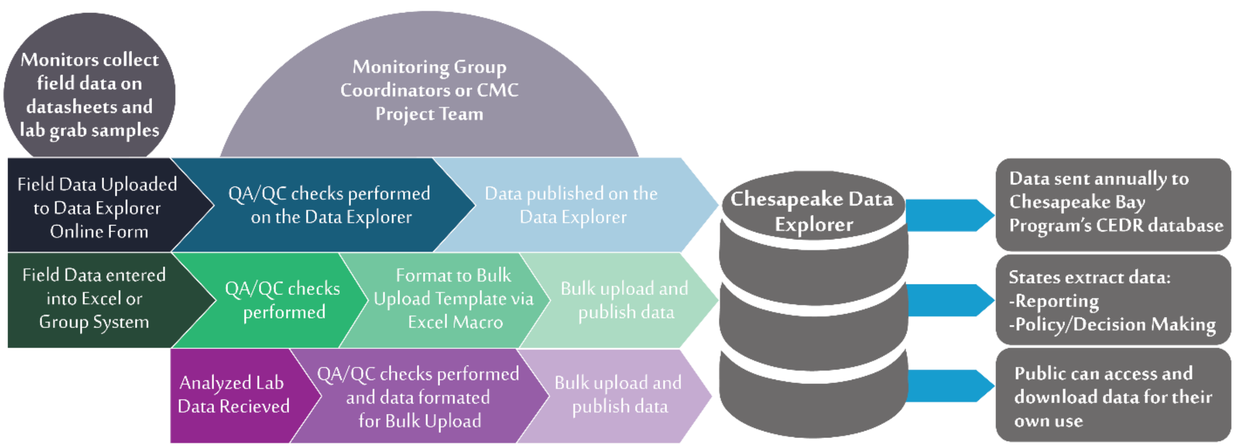

Figure B6-1. Data management flow chart from data collection, to storage, to use.

SECTION C - ASSESSMENT AND OVERSIGHT

Assessments or evaluations are designed to determine whether the QA Project Plan is being implemented as approved (conformance/nonconformance), to increase confidence in the information obtained, and ultimately to determine whether the information may be used for their intended purpose. The elements in this group detail what assessments or evaluations will occur both during and after the project. Data assessments, such as data verification and validation, are discussed in the Group D elements.

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

Each Data Collector will select a laboratory to perform lab analysis that meet their program objectives. In addition to the field sample collection process outlined in Section B4.4, a laboratory will be considered Tier 2 if they meet one of these criteria:

1. Obtain a state or federally approved QAPP for the parameters analyzed for each monitoring group.
2. Must follow an EPA approved or standard method and have documented Laboratory SOPs for each analytical method and equipment used.
3. Perform appropriate lab blanks, duplicates, and matrix spikes and submit that data to the CMC at least annually and/or perform a site visit with the CMC team.

The CMC team will review all relevant SOPS for each analytical method to ensure they meet the EPA or Standard method requirements and review lab blank, duplicate, and matrix spike data annually. All labs must adhere to the established standards for precision and accuracy control limits for each parameter, listed in Table C1.1. If any data fail these criteria they are to be flagged as failing QC criteria. Labs that do not maintain the above criteria will be marked as *provisional* Tier 2 until one of the criteria for Tier 2 are achieved.

In addition to the Tier 2 requirements, labs used to produce Tier 3 bacteria (*E.*coli or *Enterococcus)* data must:

- Obtain a VELAP/NELAP certification, State approval (Virginia DEQ only), or complete NSI laboratory Proficiency Testing.
- Complete a field audit conducted by a State agency and/or the CMC team every five years.

Labs must define and provide the both the MDL and PQL for each parameter being analyzed:

- Method Detection Limit (MDL) is the ability to detect a certain concentration of the analyte with 99% confidence. Thus, values below MDL are not meaningful.
- Practical Quantitation Limit (PQL) is typically defined by the lab, and it may either correspond to the lowest concentration standard analyzed in a sample set, or a value such as 3 times the MDL.

C1.2 Program Assessments

Each of the 5 organizations listed as Project Partners in this QAPP act as CMC Service Providers, the roles and responsibilities for each organization are provided in Section A4.2. Each organization designates paid staff, listed in Table A4-1, to perform CMC Service Provider responsibilities.

Annually, the CBP QA Officer meets with all individuals working as CMC Service Providers under this QAPP to ensure the CMC Service Providers are following QA measures. This meeting typically covers:

a. A review of this Tidal QAPP and SOP to ensure everything is up to date and no changes are needed;
b. A review of all of the monitoring groups the CMC Service Providers are training;
c. An overview of typical training sessions that have occurred with each CMC Service Provider organizations; and,
d. Discuss and resolve any QA issues.

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 as written in Section A8.2. 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 is responsible for ensuring all Coordinators collecting Tier II data attend a recertification session annually as written in Section A8.4. As time and resources allow, the Project Team will conduct field audits with Certified Coordinators to ensure they meet the data quality objectives for their program. If the objectives are not met by the Coordinator, the Project Team will decide on the appropriate corrective action (e.g. downgrade data to Tier I; require more frequent check ins and audits).

C2. Reports to Management

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. EPA Region III then conducts biennial monitoring review with the Project Manager to review the bi-annual report.

SECTION D - DATA VALIDATION AND USABILITY

D1. Data Review, Validation, and Verification Requirements

All data collected through this project are reviewed, validated and verified by the Project Team and/or Certified Coordinator to determine whether the data meet the project objectives listed in Section A7. Specific review, validation and verification frequencies are determined by each individual monitoring group to meet their monitoring objectives (e.g some groups perform all requirements weekly in order to post data for public access immediately and other groups perform all requirements once annually). At a minimum - data review, validation and verification needs to occur once annually prior to data being published on the Data Explorer.

D2. Validation and Verification Methods

Data verification can be performed by monitors, coordinators or the Project Team depending on the structure of the individual monitoring project. If monitors perform any of the verification steps, those steps should be checked by the project coordinator. Specific verification requirements are determined by each monitoring project, but should include at a minimum recording results on a field datasheet, reviewing datasheets to ensure they were fully completed and that all data were collected uniformly, and spot-checking data entry process according to Section C4.5.1. For equipment that require standardization, verification, or calibration, all calibration logs are examined to ensure all standardizations, verifications, and calibrations occurred in accordance with Section B4.2 and to determine how well the measurement instruments performed. If there appears to be significant drift in instrument performance, the data are flagged accordingly before publishing on the Data Explorer. All field replicate and duplicate data should be checked to ensure the frequency requirements for the project was met and all field replicates and duplicates are within the specified range in Section B4.3. If field replicates and duplicates suggest a substantial data quality issue, all data for that monitor should be flagged in the Data Explorer. All datasheets and verification or calibration logs are kept by the Certified Coordinator or Regional Project Team office for seven year.

All lab data should be verified by the Certified Coordinator or Project Team as it is received from the lab by reviewing the field blank and duplicate data to ensure all checks are within the appropriate ranges specified in Section B4.5.3. Additionally, data should be checked to see if the report value is below the Method Detection Limit (MDL) or between the MDL and the Reporting Limit (RL). If the data fall below either of these values they must be flagged appropriately.

Validation methods occur after verification to determine whether the monitoring activities for an individual monitoring project conform to the user needs for the project. This process must occur at least annually and typically occurs at the end of a sampling season, Validation methods should include at a minimum:

- Review sampling locations to ensure coordinates and site descriptions are accurate and up to date;
- All monitors are up to date on their training requirements;
- Calculate completeness metrics for samples collected;

- Review project documentation (methods manuals, SOPs, QAPPs) to ensure the appropriate methods are being used; and,
- Review chain-of-custody, field datasheets and any other documentation to ensure it collects the appropriate information.

All of this information should be used to evaluate the impacts of the monitoring program and if the data collected meets the Data Quality Objectives for the project.

D3. Reconciliation with Data Quality Objectives

All field and laboratory data that do not meet data quality objectives identified in this Tier I and II QAPP will be flagged, downgraded a Tier, be labeled as provisional, or discarded before publishing on the Data Explorer. 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.

If Data Quality Objectives for the project are not being met, the Certified Coordinator should discuss with the Project Team and/or CBP QA Officer to remedy the issue. Updated Program Documentation (such as methods manuals, SOPs, or QAPPs) may be needed in order to meet the Data Quality Objectives for the next sampling season.

Appendix A. Non-Tidal Standard Operating Procedure

Standard Operating Procedures for Non-tidal Monitoring
(Tier I and Tier II)

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

Prepared by:

Alliance for the Chesapeake Bay

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

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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. (2013). Sampling and data analysis protocols for Mid-Atlantic non-tidal stream indicators. Wicks EC, Fries AS, Kelsey RH, (eds). IAN Press, Cambridge, Maryland, USA.

Alliance for Aquatic Resource Monitoring. 2013. Antietam Watershed Association Water Quality Monitoring Manual

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) Safety always comes first. All sampling should be conducted with the proper equipment and least amount of danger to field personnel. Do not sample if the conditions are unsafe.

b) Always perform water-monitoring activities under the guidance of an adult (if under 18).

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

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

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

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

g) 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 other year 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.

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 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.

2.3 Field QC

2.3.1 Duplicates

If monitors are using field kits (ex. Winkler titration method for measuring DO) they will perform the sampling method in duplicate 100% of the time. For the Winkler Titration method, 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

Monitors will perform replicate of field parameters at least 10% of the time. The field replicate is performed by taking the instrument to the site and obtaining a reading. The instrument is removed from the sample or a 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. Field replicates are recorded on the field datasheet and entered into the Data Explorer. 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) Wearing protective gloves at all times while sampling is recommended. 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. Latex or nitrile gloves may be used for common sampling conditions.

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

c) Samples should be collected facing upstream and in the main flow representative of the stream you are monitoring (for small streams, this is usually mid-channel) just below the water surface, about 0.3 meters (1 foot) deep.

d) 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.

3.1.2 Sampling from a Boat

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) and compare to the actual site coordinates to ensure that they are located with 10 meters of the original site location.

The boat captain is responsible for keeping the boat steady as samples are being taken to reduce drift. All field measurements and grab samples should be taken from the upstream side of the boat to reduce sample contamination.

3.1.3 Streambank and Instream Sampling

If wading to the sample site, always wade in to the middle of the channel and then 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.

3.1.4 Dock or Bridge Sampling

If sampling from a dock, sample in the center of main flow or as close as you can get to the center from the dock. Sample from the upstream side of the dock where contamination is least likely to occur.

If sampling from a bridge, sample in the center of the main flow if possible. Sample from the upstream side of the bridge where contamination is least likely to occur. During rainy periods, avoid sampling where storm water runoff from the bridge can affect sample.

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

3.1.5 Bucket Sampling

Whenever possible, collect field measurements directly from the sample site, not from a bucket. If site conditions or equipment limitations do not allow for direct sampling, a bucket may be used to collect a sample and all measurements and grab samples may be taken from the bucket.

To collect the sample, lower the sample bucket into the water, 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. Repeat two more times and on the final time fill ½ to ¾ the way full.

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
2. Nutrients and Chlorophyll
3. All other probe measurements

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

3.2 Air Temperature Measurement

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

Equipment: armored, digital thermistor, or probe

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 Water Clarity - Secchi Disk

Equipment: 8" Secchi disk with attached line

Equipment Checks:
Secchi disks should be checked for general wear and tear prior to each sampling event. The disk should clearly show the black and white sections and the line should not be torn or frayed.

The secchi disk line should be checked against a tape measure to ensure the markings are accurate on an annual basis.

Sampling 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 Water Clarity - 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

Equipment Checks:
Transparency tubes should be check for general wear and tear prior to each sampling events. The measuring tape along the side of the tube should clearly show the measurements, the tube should not be cracked and the crimp should work properly.

Sampling 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 or if the stream is too small to fill the tube, sample water collected in the sampling bucket may be used. 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 and try to avoid debris getting into the tube. To analyze water collected in the bucket, pour sample water from the bucket water directly into the transparency tube.

3. Remove sunglasses and move the tube to the shade, turning your back to the sun if needed, and look down through the opening of the tube.

4. If you can see the black and white pattern at the bottom, record 120cm on your field datasheet and indicate the reading is > (greater than) that depth (ex. >120cm).

5. If you can't see the black and white pattern at the bottom, while looking down through the opening of the tube, partially open drain crimp, slowly draw off sample (Control flow by squeezing the crimp).

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

7. 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

Sampling 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

Thermometer Verification:
Thermometers must be verified against a standardized NIST thermometer annually, in cold (0-4 deg C). room temperature (18-22 deg C) and warm (30-34 deg C) water. Readings must be within 0.2 deg C of the standardized thermometer. If not, the field thermometer needs to be replaced.

Sampling Method:

1. Turn the probe on.

2. Set the probe at the appropriate sample depth for either a surface sample or place in the sample bucket.

3. Record the depth on your data sheet.

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

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

3.6 Water Depth Measurement

Equipment: Secchi disk (for <3 m deep), measuring tape with weighted end, multiprobe sonde with marked lengths (if doing depth profile sampling), or boat depth finder.

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 Winkler Titration Kit (LaMotte 5860)

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.

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.

Sampling 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 0.6mg/L 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:
Individual DO probe (Oakton, Extech, Hanna), or multiprobe sonde (YSI, Hydrolab)

Calibration Method

Calibrate the dissolved oxygen probe within 24 hours prior to each sampling event and record all results on the field datasheet or calibration log.

Perform a post-sample check after each sampling event and record all results on the field datasheet or calibration log.

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).

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.

Sampling Method

1. Turn the probe on.

2. Set the probe at 0.3m or place in the sample bucket.

3. Record the depth on your data sheet.

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

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

Post Sampling Check Method

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: Individual probe (Hanna, LaMotte, Oakton, Extech) or multiprobe sonde (YSI, Hydrolab)

Calibration Method
pH probes must be calibrated within 24 hours of each sampling event. 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.

Sampling Method

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 probe at 0.3m or in your sampling bucket.
3. Once the reading has stabilized (may take 2-3 minutes) record the reading on your datasheet.
4. Turn off the probe and replace the protective cap.

Post Sample Check Method:

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

Verification:
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). Narrow range kits are considered Tier II and wide range kits are considered Tier I data.

Sampling Method:

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 Conductivity and Total Dissolved Solids

Equipment: Individual probes (LaMotte 1749, Extech, HACH Pocket Tester 2686601) or multiprobe sonde (YSI, Hydrolab)

Calibration Method:
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 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 (µS/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.

Sampling Method:

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.

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.

3. Place the probe into the sample water to 0.3m or into your sample bucket.

4. Wait for the reading to stabilize and record the conductivity or TDS

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 Check Method:

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:

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

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 Colorimetric Kits

Equipment:

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

Sampling 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 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 Alkalinity

Equipment: LaMotte 4491-DR-01, LaMotte 3467-01, or LaMotte 4533-DR-01

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 to the 5mL line.
4. Add an indicator tablet.
5. Cap and swirl the vial to mix until the tablet dissolves.
6. Fill the titration syringe with the titration reagent.
7. Insert the titrator syringe into the center hole of the test tube cap.
8. While gently swirling the tube, slowly press the plunger to titrate until the solution color changes from blue-green to purple. Consult the alkalinity endpoint color chart.
9. Read the test result directly from the scale where the large ring on the titrator meets the titrator barrel. Record as ppm on your data sheet.
10. Make sure the sample is well mixed prior to analysis by shaking the sample bottle.
11. 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.
12. Record your results on the data sheet.

Equipment: Hanna HI 775 Digital Checker

Pre Sample Check:

1. 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.
2. Fill the cuvette to the 10 mL line on the cuvette with unreacted sample and replace the cap. Place the cuvette into the meter and close the meter’s cap.
3. Press the button. When the display shows “Add”, “C.2” with “Press” blinking the meter is zeroed.

4. Wipe the standardized cuvette clean with a Kimwipe.

5. Place the standardized cuvette into the meter and close the meter's cap.

6. 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.

7. Record your standard reading on your data sheet.

Method:

1. 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.

2. Fill the cuvette to the 10 mL line on the cuvette with unreacted sample and replace the cap. Place the cuvette into the meter and close the meter's cap.

3. Press the button. When the display shows "Add", "C.2" with "Press" blinking the meter is zeroed. Note: Any chlorine present in the sample will interfere with the reading. To remove the chlorine interference add one drop of HI 93755-53 Chlorine Remover to the unreacted sample.

4. Remove the cuvette, open it and using a 1 mL syringe carefully add exactly 1.00 mL of Alkalinity Reagent to the sample. Replace the cap and gently invert 5 times. Place the cuvette back into the meter. Note: Pay attention not to spill reagent otherwise full color development may be inhibited.

5. Press the button. The instrument directly displays the concentration of alkalinity in ppm of CaCO3. Alkalinity conversion: 1 ppm CaCO3 = 0.02 meq/L = 0.056 dkH The meter automatically turns off after 10 minutes.

3.12 Nitrite-Nitrogen Field Colorimeter

Equipment:

- Hanna HI 707 Nitrite-Nitrogen Low Range Digital Checker
- Clean polypropylene sample bottle or scintillation vial (60 ml)

Sampling 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 707-0 reagent. Replace the cap and shake gently for 15 seconds. 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 15 minutes and press the button. *NOTE: between 15 and 10 mins the timer will be displayed in minutes and under 10 minutes the timer is expressed in minutes and seconds.*

9. The instrument directly displays the concentration of nitrite-nitrogen in ppb. The meter automatically turns off after 10 minutes.

10. Record your results on your datasheet.

3.13 Orthophosphate Field Colorimeter

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

Calibration Method:
Check the Colorimeter with an unreacted sample during each sampling event per instruction and record on your field datasheet.

Sampling 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.

NOTE: If your standard value is outside ±5 mg/L of the expected value, acquire a second standard to check the Digital Checker again. If the second standard is outside ±5 mg/L of the expected value, replace the Digital Checker immediately and do not use for sample analyis.

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.

3.14 Bacteria

Equipment: Coliscan Easygel Kit

Verification Method:
Before going out into the field check that your media has not expired and the sample bottles have remained closed and uncontaminated.

For Tier II data, duplicate samples must be collected at least 10% of the time.

Pre-label your sample bottles with your site ID, date and replicate number as needed.

Sampling Method:
Sample Collection
NOTE: Always sample bacteria **first** and directly from the waterway when possible, use a sample pole if needed. If it is not feasible to collect directly from the waterway, a sample may be taken from a bucket.

1. Remove the media from the freezer. You can either place the media in the fridge the night before or place at room temperature the morning of sampling.

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

3. Un-cap the sterile and pre-labeled bottle, immediately before sampling and without touching the inside of the lid or inside the mouth of the bottle. **NOTE:** DO NOT rinse the bacteria bottle.

4. Holding the bottom of the bottle, use a U motion to dip the bottle into the water (directly from the waterway or in your sample bucket) down to about 0.3m and away from yourself allowing the bottle to fill ¾ full.

5. Return the bottle to the surface of the water, pour out any excess sample, and cap the bottle immediately.

6. 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:

1. Pre-label bottle and secure it to the end of the pole.

2. Un-cap the sterile bottle immediately before sampling and without touching the inside of

the lid or the mouth of the bottle.e **NOTE:** DO NOT rinse the sample bottle before collecting the sample.

3. Extend the pole outward and dip at approximately 0.3 m below the surface.

4. Bring the sample to the surface and pour out any excess sample (bottle should be about ¾ full).

5. Immediately 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.

Sample Plating

Write the site designation, sample #, date, and time on the bottom of the Petri dish with a permanent marker. It is best to use small lettering on the outer rim of the dish.

1. Gently mix the water sample in the bottle.

2. Use proper technique to keep pipette sterile: open pipette packet bulb-side first, and only touch the bulb, so that you do not contaminate the tip. Pipette the desired volume (1.0 – 5.0 milliliters) of sample water directly into Coliscan media bottle. Be careful not to let the bottle lid touch anything, and not to touch the pipette tip to the media, to prevent sample contamination.

3. Record the number of mL added to the media on your field datasheet.

4. Gently mix (do not shake) bottle of Coliscan media containing the sample water, and then pour the entire contents into a Petri dish. Only open the Petri dish long enough to pour in the sample.

5. Replace the Petri dish lid. Gently swirl Petri dish so the Coliscan media covers the entire bottom. For safety purposes, you can tape the Petri dish shut at this point.

6. Allow the media to solidify for approximately 60 minutes prior to incubation. (Amount of time will vary based on room temperature.)

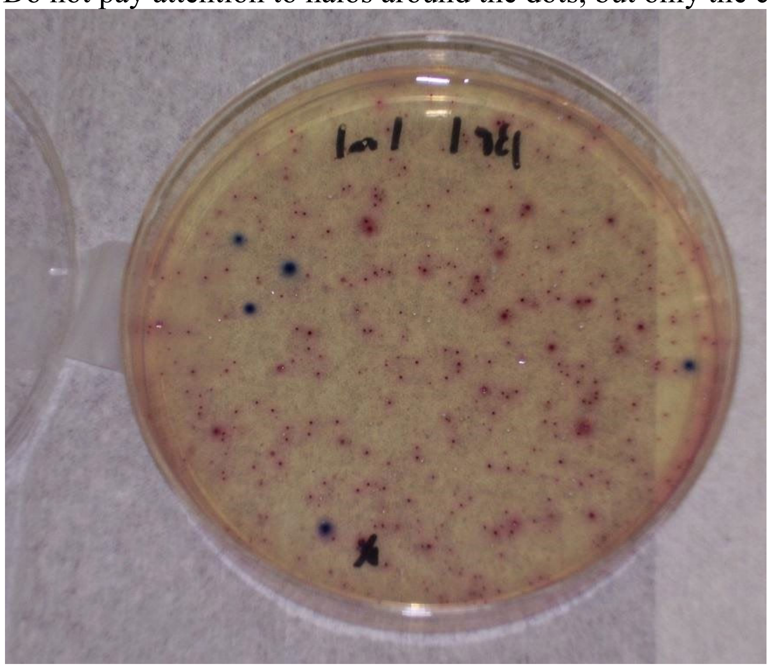
7. Put plates in incubator and try to maintain at 37ºC (= 98.6ºF) for 24 hours. If no incubator is available, place the dish in a safe warm place out of direct sunlight, such as on top of a fridge or a water heater. Depending on temperature, the plates may need to be incubated for 48 to 72 hours.

8. Record the average incubator temperature on the datasheet as well as the # of hours that the plates were in the incubator.

NOTE: As soon as plates are removed from incubator, they must be scored.

Sample Scoring

1. Place the Petri dishes on a white background or in natural sunlight. Count the number of dark blue (NOT TEAL) to purple (NOT PINK) colored colonies larger than pinprick size on each plate. Do not pay attention to halos around the dots, but only the center color.



2. Record this number on the datasheet.

3. Calculate the number of E. coli per 100 milliliters of water by dividing 100 by the amount of sample added to the media (mL) and multiplying that by the number of colonies recorded. ([100/mL sample added]*# of colonies counted)

4. Record the calculated value on the datasheet. **NOTE:** This is the value you will report in the online database.

Sample Cleanup and Disposal

1. Throw used pipettes in the trash.

2. Rinse empty Coliscan bottles 2-3 times with tap water and dispose of in the trash can. (If media bottles are not rinsed, pathogens could grow in the remaining media.)

3. Add bleach or rubbing alcohol to each Petri dish to completely cover the solid media. Allow dishes to stand for at least 10 minutes to ensure all bacteria have been killed.

4. Place the plates in a zip-lock bag and dispose of in the trash.

3.15 Bacteria

Equipment: R-Card

Verification Method:
Before going out into the field check that your R-cards have not expired and the cards have remained uncontaminated.

For Tier II data, duplicate samples must be collected at least 10% of the time.

Pre-label your cards with your site ID, date and replicate number as needed.

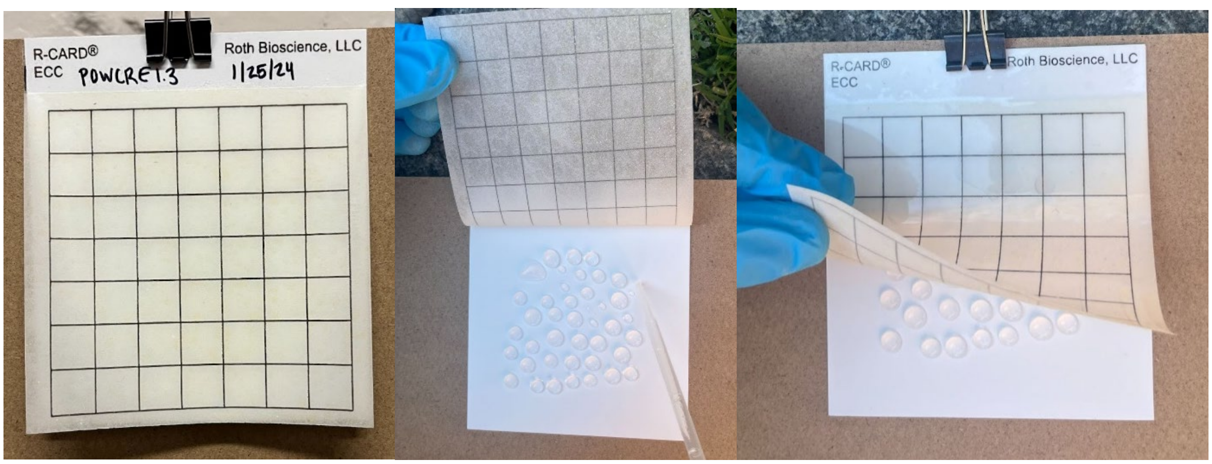
Storage:
- Store R-cards in freezer when not using.
- R-cards may be stored in the freezer for up to 1 year in a sealed container to avoid frost.
- Mark card containers with expiration dates.

Sampling Method:
Before Sampling
1. Check expiration date on R-card and confirm cards are within the expiration date.
2. Remove the required number of cards from the package (1 per site, or two if collecting a replicate sample) and label each card at the top using a pen or sharpie with your Site ID and date. If sampling more than one site, transport cards in separate containers by site.
3. Turn on the incubator before leaving to collect your samples. Your incubator should be set at 38°C. These temperatures simulate those of human and animal body temperatures and favor growth of E. coli. Temperatures above 44 °C may kill the bacteria; temperatures below 32°C may not allow for growth of colonies and could skew results.
4. Gather 1 sterile pipette per site. The same pipette may not be used at different sites.

In the Field
1. Place the R-card for the site on the clipboard, securing in place with your binder clip with one sheet of paper to cover the cards.
2. Confirm that the labeling information on the card matches your monitoring site and place the clipboard on a level surface, or have a partner hold the clipboard steady.
3. Collect samples upstream from where you are standing, or on the upstream side of the dock/boat 12-18 inches away from your body. When possible, **it is recommended to collect samples directly from the waterway.** If you are unable to do this, collect from your bucket only after rinsing the bucket thoroughly three times and before collecting other field samples.
4. Unwrap a sterile pipette from the bulb end and avoid touching the tip of the pipette with anything except sample water.
    a. Never use a previously unwrapped pipette.

   b. If collecting a duplicate sample, you may use the same sterile pipette if it has not come in contact with anything else except the sample water. Use a new pipette if it has been contaminated.

5. Squeeze the bulb of the pipette to remove air before submerging in the water. Insert the tip 2-3 inches below the water surface. Slowly release the bulb and expel excess water to the desired 1mL sample volume. A small raised line near the bulb of the pipette denotes the 1mL measurement.
   a. Be careful to not collect sediment from the bottom of the stream. Do not insert your hand into the water.
6. Using a gloved hand, grab the bottom corner of the top layer to separate the film from the card. Continue to hold the film up and slowly squeeze the pipette bulb to dispense the water sample in small droplets onto the card, focusing on the top two thirds. Attempt to disperse the sample following the grid pattern on the film.
   a. Continue to hold the film up and repeat this process two more times to dispense 3 mL of sample water total on your card. **Avoid placing droplets near the edges of the card.**



7. **Very slowly,** roll the top film down onto the sample to prevent air bubbles. Allow the sample to spread between the top and bottom pieces. Do **not** use your hands to spread the sample.
8. The sample will solidify in 1-2 minutes.

CALLOUT BOX: If you frequently experience overflow of your sample to the edge of the card, or the amount of dark blue colonies growing are frequently too numerous to count, reduce sample amount to 2mL.

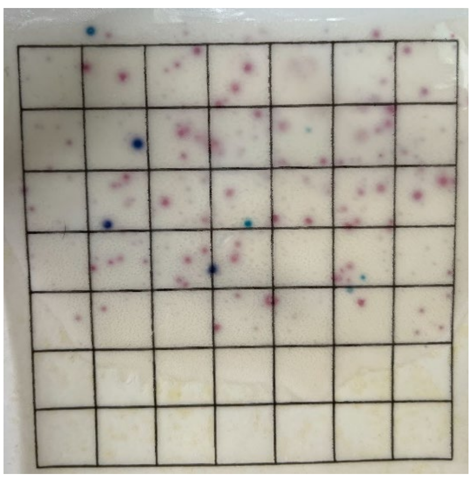
9. Place labeled, inoculated cards under an opaque sheet of paper or into a small opaque container while transporting them to your indoor setting. Cards do not have to be transported on ice, just kept out of direct sunlight. After cards are solidified, they may be stacked on top of eachother.

In the Lab

1. Place cards right-side up directly in your pre-heated incubator, maintaining its temperature at 38°C.
2. Incubate cards for 22-24 hours before counting colonies. **Do not exceed 24 hrs of incubation time.** This may cause additional colonies to grow that are not E. coli.
3. Colonies will start appearing a few hours after inoculation.

COUNTING COLONIES

1. Record all additional necessary data on your datasheet, including sample amount, incubation time, incubation temperature. (removed “e.coli” here)
2. Count all dark blue-to-purple colonies on each card as E-coli. Do not count very small or “pinpoint” colonies smaller than the period at the end of this sentence.
3. Record the number of colonies in the column labeled “Total # of purple or dark blue colonies” on the datasheet.
4. Calculate the number of E. coli per 100 milliliters of water by following the instructions on the datasheet and record on your datasheet.



Clean up and Storage

1. Throw used pipettes in the trash or recycling bin.
2. Use bleach or dish soap to kill bacteria by lifting up the film and adding a few drops to the sample.
3. Dispose of R-Card in the trash.

4 Lab sample collection preparation and handling

4.1 Bacteria (E.coli)

Lab Method: IDEXX Colilert (SM9223B) (can be analyzed in office or in a lab)

Equipment:

- Sealed, sterile clear bottle (with or without dechlorinating tablet). 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.

Sampling Method:
Note the amount of rainfall within 48 hours prior to sampling and record in the bacteria section of the datasheet. It is recommended to use latex or nitrile gloves for all bacteria monitoring.

NOTE: Always collect bacteria samples first before any other lab or field samples!

Collecting directly from waterway or bucket

1. Pre-label the bottle with the sample site ID, date, time and sample collector.

2. Un-cap the sterile bottle, be careful not to insert fingers into the mouth of the container or on the interior of the cap. **NOTE:** DO NOT rinse sample bottle before collecting the sample.

3. Holding the bottom of the bottle, use a U motion to dip the bottle into the water down to approximately 0.3 m (or into the bucket) and away from yourself allowing the bottle to fill to designated mark on the bottle.

4. Bring bottle to the surface of the water, pour out any excess sample, and cap immediately.

5. 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

1. Pre-label bottle with the sample site ID, date, time and sample collector, and secure it to the end of the pole.

2. Un-cap the sterile bottle, be careful not to insert fingers into the mouth of the container or on the interior of the cap. **NOTE:** DO NOT rinse sample bottle before collecting the sample

3. 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.

4. Bring bottle to the surface and pour out any excess sample.

5. Immediately 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 Nutrient and Grab Samples

Lab Methods:
- Nitrate – Nitrogen (USEPA Method 352.1)
- Nitrite – Nitrogen (USEPA Method 353.3 (non-tidal))
- Ammonia – Nitrogen (USEPA Method 350.1 (non-tidal))
- Total Kjeldahl Nitrogen (USEPA Method 351.1, 351.2, 351.4; SM4500-Norg-C; SM4500-Norg-B)
- Total Nitrogen (USEPA Method 351.2; 4500 N-C)
- Orthophosphare (USEPA Method 365.5)
- Total Phosphorus (USEPA Method 365.4)
- Total Suspended Solids (SM 2540 D-11; USEPA Method 160.1)

Equipment: Unpreserved sample bottle.

Sampling Methods:

Collecting directly from waterway

1. Pre-label the sample bottle with the sample site ID, date, time and sample collector.

2. Rinse the bottle out three times, be sure to pour water downstream of sampling site.

3. 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.

4. 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.

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

Collecting with a sampling pole

1. Pre-label the sample bottle with the sample site ID, date, time and sample collector.
2. Attach the sample bottle to the sampling pole, making sure that the clamp is tight.
3. The sampling point in the stream or river should have a low to medium flow and not be in eddies or stagnant water.
4. Facing upstream, extend the pole and bottle, rinse the bottle out three times, pouring out water downstream of the sample location.
5. 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. Fill the bottle up to the shoulders and immediately cap.
6. Place the samples 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.
7. On the field data sheet, record the sample depth, time, date and any other information about the water sampling event.

4.3 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.

4.4 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.

4.5 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)

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.

4.6 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

Lab work will be performed by a NELAP, federal, or state approved lab. 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
Silicate	US EPA method 366.0	Appendix III
Nitrate - Nitrogen	USEPA Method 352.1	Appendix IV
Nitrite - Nitrate	USEPA Method 353.3	Appendix V
Ammonia - Nitrogen	USEPA Method 350.1	Appendix VI
Total Nitrogen	USEPA Method 351.2	Appendix VII
Total Phosphorus	USEPA Method 365.4	Appendix VIII

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 sampling 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 °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 (1013-1008)	**1**	**735-731 (980-975)**	**0.967**	**710-706 (947-941)**	**0.934**	**685-681 (914-908)**	**0.9**
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 – Silicate – US EPA 366.0

Appendix IV

Laboratory Method – Nitrate – Nitrogen – US EPA 352.1

Appendix V

Laboratory Method – Nitrite - Nitrate – US EPA 353.3

Appendix VI

Laboratory Method – Ammonia - Nitrogen – US EPA 350.1

Appendix VII
Laboratory Method – Total Nitrogen – US EPA 351.2

Appendix VIII

Laboratory Method – Total Phosphorus– US EPA 365.4

Appendix F:
ALLARM Specific Program Requirements

ALLARM Specific Program Requirements

A8.3 Certified Monitors

ALLARM monitors will be required to go through a recertification process once a year. The recertification process will include one of two options:

1. Certification Workshop: ALLARM will hold a Certification Workshop to recertify monitors. At the workshop, monitors will test known samples or external field duplicates will be tested by monitors and an ALLARM staff member.
2. Lab Analysis of Duplicate Samples: Monitors will send a duplicate sample to the ALLARM Community Aquatic Research Laboratory for comparison of results between the monitor and the ALLARM lab for each applicable parameter (alkalinity, conductivity, nitrate-nitrogen, orthophosphate, pH, total dissolved solids, and turbidity).

Each monitor will maintain their certification after completing and passing the recertification process above successfully. Passing criteria are met if the relative percent difference (RPD) between the results obtained by the monitor and the ALLARM staff/lab is ≤ 20%, or if the results fall within the accuracy range of the equipment.

A9.3 Other Documentation and Records

Monitors who send duplicate samples to the ALLARM Community Aquatic Research Laboratory for quality control/recertification will fill out an ALLARM Quality Control Form (Figure A9-1) and send it along with their water sample(s). Before a sample is analyzed in the lab, the monitor and sample information will be entered into the laboratory Quality Control binder (the monitor's results are not entered so there is no bias when recording the lab results). The same information, as well as the monitor's results will also be entered into a QC Excel spreadsheet that is maintained by ALLARM. The original Quality Control Forms will then be filed in the ALLARM office.

Figure A9-1. Example of a Quality Control Form used by monitors when submitting a duplicate water sample to the ALLARM Laboratory for analysis.

SHALE GAS VOLUNTEER MONITORING PROGRAM
Quality Assurance/Quality Control Form

1. Fill out the label on your QA/QC bottle.

2. Enter the stream and face upstream. Fill your QA/QC bottle and pour the rinse water out downstream. Rinse your bottle and cap three times. Fill your QA/QC bottle completely with stream water and close it tightly with the cap.

ALLARM Shale Gas Volunteer Monitoring Program
Quality Assurance/Quality Control Bottle

Monitor Name	
Stream Name	
Collection Date	
Bottle #:	

3. Record your results in the boxes below.

Parameter	Units	Replicate #1	Replicate #2	Average Result
Conductivity	µS/cm			
Total Dissolved Solids	mg/L			
Stage	feet			

4. Fill out the information in the boxes below.

Monitor Information		Sample Information	
Monitor's Name		Stream Name	
Mailing Address		Latitude Coordinate	
		Longitude Coordinate	
Email Address		Collection Date	
County Monitored		Collection Time	
Affiliation (if applicable)		Equipment Used (i.e. LaMotte meter)	

5. Pack a small box with your QA/QC bottle and this QA/QC form. Secure the bottle so it cannot move around during shipment. Mail the box to ALLARM for QA/QC processing at: ALLARM
Dickinson College
5 N Orange Street
Carlisle, PA 17013

Alliance for Aquatic Resource Monitoring (ALLARM) June 2013

B3.2 Samples collected for Quality Control

Samples that are collected for duplicate testing by the ALLARM Lab will be collected in 500 mL polyethylene bottles (provided by ALLARM), and labeled in the field with the monitor's name, stream name, site name, and collection date and time. Monitors will collect samples following sample collection procedures in the CMC Non-Tidal Methods Manual (Appendix C). In the field, the samples are the responsibility of the monitor. The monitor will send the sample(s) along with their completed Quality Control Form to ALLARM (Figure A9-1) via mail or by dropping the sample(s) off at the ALLARM office. Most parameters will require refrigeration during the holding time, therefore monitors will place the sample(s) in an insulated box with frozen ice packs before shipping/delivering them to ALLARM. The Quality Control Form, Quality Control sample collection bottle, and shipping materials will be provided by ALLARM.

B4.1 ALLARM Analysis Methods of Duplicate Samples

Similar to the monitors, the ALLARM Lab will have a manual that contains detailed information on all of the sample handling, sample analysis, and data reporting protocols used for the analysis of duplicate samples sent by ALLARM monitors for quality control and recertification purposes. Table B4-1 summarizes a portion of this information.

Table B4-1. Summary of analytical methods used by the ALLARM Laboratory for analyzing duplicate samples.

WQ Parameter	Analysis Method #1 (Monitor Equipment)	Analysis Method #2 (Lab Equipment)
Alkalinity	Same as monitor (LaMotte 4491-DR-01, LaMotte 4533-DR-01, LaMotte 3467-01, Hanna HI 775)	Hach Spectrophotometer DR5000
Conductivity	LaMotte Tracer 1749	Fisher Scientific accumet XL200
Nitrate-nitrogen	Same as monitor (Hach NI-14 1416100, LaMotte 3110, LaMotte 3354)	Hach Spectrophotometer DR5000
Orthophosphate	Same as monitor (Hach PO-19 224800, Hanna HI 38061, Hanna HI 713)	Hach Spectrophotometer DR5000
pH	LaMotte Tracer 1749	Fisher Scientific accumet XL200
Total dissolved solids	LaMotte Tracer 1749	Fisher Scientific accumet XL200
Turbidity	LaMotte 7519	Hach Turbidimeter 2100P

B5.1.3 Replicates

ALLARM monitors will test each parameter twice (two replicates) and each value will be recorded onto their field data sheet. If the first two replicates fall within the acceptable range, the values will be averaged for the final result. If the values are not within the acceptable range, additional replicates will be tested until two values are within the acceptable range. Only those two values will be averaged for the final result. The other values will be crossed out by one line going through the middle of the number horizontally. The acceptable range for each parameter is based on the precision and sensitivity of the equipment used. Table B5-1 provides a summary of the parameters measured, testing order, equipment used, and the acceptable range.

Table B5-1. Summary of parameter testing order and acceptable range of field replicates for ALLARM monitors.

Testing Order	Parameter	Field/Home	Equipment	Acceptable Precision Range
1	Water temperature	Field	LaMotte armored Thermometer	± 1° C
1	Water temperature	Field	Hanna digital thermometer	± 0.5° C
1	Water temperature	Field	LaMotte DO meter w/thermometer	± 0.5° C
2	Water clarity	Field	Transparency tube	TBD
2	Water clarity	Field	Secchi disk	± 20 cm
3	pH	Field	Meter(s) (models TBD)	± 0.5 pH unit
3	pH	Field	Colorimetric kits (models TBD)	± 1 pH unit
3	pH	Field	ColorpHast pH Strips	± 1 pH unit
4	Conductivity	Field/Home	LaMotte Tracer PockeTester	± 10% or 10 µS/cm, whichever is greater
5	Total dissolved solids	Field/Home	LaMotte Tracer PockeTester	± 10 mg/L
6	Dissolved oxygen	Field/Home	LaMotte DO kit	± 0.6 mg/L

6	Dissolved oxygen	Field/Home	LaMotte DO meter	± 0.5 mg/L
7	Nitrate-nitrogen	Home	Hach nitrate kit	0 – 1 mg/L: ± 0.1 mg/L 1 – 10 mg/L: ± 1 mg/L
7	Nitrate-nitrogen	Home	LaMotte nitrate kits	Within 1 sensitivity unit of colorimetric scale
7	Nitrate-nitrogen	Home	Colorimeter; Spectrophotometer	0 – 1 mg/L: ± 0.1 mg/L 1 – 10 mg/L: ± 0.5 mg/L
8	Orthophosphate	Home	Hach orthophosphate kit	± 0.04 mg/L
8	Orthophosphate	Home	Hanna orthophosphate kit	± 0.04 mg/L
8	Orthophosphate	Home	Hanna digital orthophosphate checker	± 0.04 mg/L
8	Orthophosphate	Home	Colorimeter; Spectrophotometer	± 0.04 mg/L
9	Alkalinity	Home	LaMotte alkalinity kits	± 8 mg/L
9	Alkalinity	Home	Hanna digital alkalinity checker	± 5 mg/L
10	Turbidity	Home	LaMotte turbidity kit	± 5 JTU

B5.2.1 Analysis of Duplicate Samples by ALLARM Laboratory

The first time a monitor visits their site, they will collect a duplicate sample to send to the ALLARM Lab for analysis. At the lab, the sample will be tested for the same parameters the monitor measured (except for water temperature, water clarity, and dissolved oxygen), using the same brand and model equipment as the monitor. In addition, the ALLARM lab will test the samples using at least one alternative piece of equipment to document comparability between methods. The monitor's results will be compared to the results obtained by the ALLARM lab. In order to "pass" the QC check, the results must be within a 20% relative percent difference (RPD) of each other, or the monitor's results must fall within the acceptable precision range of the individual piece of equipment. The latter is used most often with values that are very low. Monitors will send in samples to the ALLARM Lab or participate in a Certification Workshop annually.

B6.1 Cleaning Requirements for ALLARM Monitors

ALLARM monitors are required to clean their monitoring equipment after each use, since used glassware can affect the monitoring results significantly. A summary of the cleaning procedures used for each parameter are included in Table B6-1, and the complete procedures are listed in the CMC Non-Tidal Methods Manual (Appendix C).

Table B6-1. Summary of equipment cleaning and maintenance requirements for ALLARM monitors.

Parameter	Equipment	Cleaning Methods Between Use
Water temperature	Thermometer	Rinse w/DI water
pH	ColorpHast pH Strips	Rinse vial w/DI water
Water clarity	Transparency tube	Rinse tubes w/DI water
Conductivity	LaMotte Tracer PockeTester	Rinse vial w/DI water
Total dissolved solids	LaMotte Tracer PockeTester	Rinse vial w/DI water
Dissolved oxygen	LaMotte DO Kit	5% Alconox soap, 10% HCl, rinse w/DI water
Nitrate-nitrogen	Hach Nitrate Kit	5% Alconox soap, 10% HCl, rinse w/DI water
Orthophosphate	Hach Orthophosphate Kit	5% Alconox soap, 10% HCl, rinse w/DI water
Alkalinity	LaMotte Alkalinity Kit	5% Alconox soap, 10% HCl, rinse w/DI water
Turbidity	LaMotte Turbidity Kit	5% Alconox soap, 10% HCl, rinse w/DI water

Appendix G:
Field Data Sheet

Chesapeake Monitoring Cooperative

Non-tidal Field Data Sheet

Site Name & # ______________________________ Stream Name ______________________

Date _____/_____/_____ Time (military time) ______________ Rainfall (mm last 48 hrs)______

Monitors: ____

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		
Stream Flow				Low / Med / High / NA		
Water Color				Clear / Milky / Muddy Oil slick / Other		
Air Temperature (°C)	Armored Classic / Digital / Probe	Verified? Y / N				
Water Temperature (°C)	Armored Classic / Digital / Probe	Verified? Y / N				
Dissolved Oxygen (mg/L)	Winkler Titration / Probe					
pH	Kit / Probe / ColorpHast Strips					
Conductivity (μS/cm)	Probe					
TDS (mg/L)	Probe					
Turbidity (JTU)	LaMotte 7519					
Water Clarity (cm)	Secchi Disk / Turbidity Tube					
Alkalinity (mg/L)	Hanna Digital Checker	Pre only:				
Alkalinity (mg/L)	LaMotte 4491-DR-01 / LaMotte 3467-01 LaMotte 4533-DR-01					
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				

Comments:____
____
____
____

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	+/- 1 pH unit
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
Alkalinity	< 100 mg/L = +/- 10 mg/L > 100 mg/L = +/- 20 mg/L
Turbidity	+/- 5 JTU

E. coli Bacteria Measurement (using Coliscan Easygel plates)
Incubation time: _______ hours (to nearest hour)

Incubation temp: ______.____ o C (to nearest half degree)

Media expiration date: ________ Plate expiration date: _____________

Amount of water sample added to media bottle (max 5 ml per Rep):

Rep1:______(A1)Rep2:_____(A2)

Total # of purple or dark blue colonies on plate: Rep1:________(B1) Rep2:________(B2)

Note: disregard any pink, blue-green or white colonies- these are not E. coli bacteria

To calculate the Total Colonies of E. coli bacteria per 100 ml of water:

1. Divide 100 by the ml of water used. 2. Multiply this quotient by the number of purple colonies counted

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):

Name: ____________________________ Hours: __________ (Round to nearest 15 min.)

Name: ____________________________ Hours: __________ (Round to nearest 15 min.)

Name: ____________________________ Hours: __________ (Round to nearest 15 min.)

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

Or

ALLARM
Dickinson College-Environmental Studies Dept.
P.O. Box 1773-College & Louther Streets
Carlisle , PA 17013

Appendix B. Water Quality Monitoring Parameters Table

Appendix D:
Parameters and Equipment

Water Quality Parameters

Table ID #	Matrix	Parameter	Analytical Method	Approved Procedure	Equipment	In Situ or Lab Analysis	Holding Time
NT-A-1	Water	Alkalinity	Kit using titration	EPA-NERL: 310.1	LaMotte 4491-DR-01, LaMotte 3467-01, LaMotte 4533-DR-01	Field or Home	24 hours
NT-A-2	Water	Alkalinity	Digital checker (colorimetric method)	See Appendix A	Hanna HI 775	Field or Home	24 hours
NT-AT-1	Air	Air temperature	Armored thermometer	USEPA Method 170.1	LaMotte 1066	Field	N/A
NT-AT-2	Air	Air temperature	Digital thermometer	USEPA Method 170.1	Ex. Hanna 98509	Field	N/A
NT-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
NT-B-1	Water	Bacteria (E. Coli)	E. coli	See Appendix A	Coliscan Easy Gel	Home	24 hours
NT-C-1	Water	Conductivity	Electronic probe	USEPA Method 120.1	LaMotte 1749, Extech	Field or Home	28 days
NT-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
NT-DO-2	Water	Dissolved oxygen	Electronic probe	USEPA Method 360.1; As described in probe manual	Multiprobe sonde	Field	N/A
NT-N-1	Water	Nitrate-nitrogen	Colorimetric kit using cadmium reduction method	See Appendix A	Hach NI-14 1416100	Field or Home	48 hours
NT-N-2	Water	Nitrate-nitrogen	Colorimetric kit using cadmium reduction method	See Appendix A	LaMotte 3110	Field or Home	48 hours
NT-N-3	Water	Nitrate-nitrogen	Colorimetric kit using zinc reduction method	See Appendix A	LaMotte 3354	Field or Home	48 hours
NT-N-4	Water	Nitrite-Nitrate	Lab Analysis	USEPA Method 353.2	Specific to individual lab	Lab	Dependendent on preservation method - 28 days maximum
NT-N-5	Water	Nitrate - Nitrogen	Lab Analysis	USEPA Method 353.2	Specific to individual lab	Lab	Dependendent on preservation method - 28 days maximum
NT-N-6	Water	Ammonia-nitrogen	Lab Analysis	USEPA Method 350.1	Specific to individual lab	Lab	Dependendent on preservation method - 28 days maximum
NT-N-7	Water	Total Nitrogen	Lab Analysis	SM 4500-N C-2011 or 4500-P J-2011	Specific to individual lab	Lab	28 days
NT-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
NT-P-2	Water	Orthophosphate	Digital checker using ascorbic acid method	See Appendix A	Hanna HI 713	Field or Home	48 hours
NT-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

Table ID #	Matrix	Parameter	Analytical Method	Approved Procedure	Equipment	In Situ or Lab Analysis	Holding Time
NT-P-4	Water	Total Phosphorus	Lab Analysis	SM 4500-N C-2011 or 4500-P J-2011	Specific to individual lab	Lab	Dependendent on preservation method - 28 days maximum
NT-PH-1	Water	pH	pH probe	USEPA Method 150.1; As described in probe manual	Hanna, LaMotte, Oakton, Extech	Field or Home	24 hours
NT-PH-2	Water	pH	Colorimetric kit	See Appendix A	LaMotte, Hach	Field or Home	24 hours
NT-PH-3	Water	pH	Strips		ColorpHast pH Strips (2 - 9)	Field or Home	24 hours
NT-TDS-1	Water	Total dissolved solids	Electronic probe	See Appendix A	LaMotte 1749, Extech	Field or Home	28 days*
NT-TURB-1	Water	Turbidity	Turbidity kit	See Appendix A	LaMotte 7519	Field or Home	24 hours
NT-WC-1	Water	Water clarity	Secchi Disk	See Appendix A	Ben Meadows 224217	Field	N/A
NT-WC-2	Water	Water clarity	Transparency tube	See Appendix A	Forestry Suppliers 77107, Ben Meadows 111360	Field	N/A
NT-WT-1	Water	Water temperature	Armored thermometer	USEPA Method 170.1	LaMotte 1066	Field	N/A
NT-WT-2	Water	Water temperature	Digital thermometer	USEPA Method 170.1	Ex. Hanna 98509	Field	N/A
NT-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
NT-A-1	4 mg/L	Unknown - testing needed	0-200+ mg/L	Tier II	All samples in replicate	Cool, ≤ 6° C	< 0 mg/L; > 400 mg/L
NT-A-2	1 mg/L	± 5%, 5 mg/L	0 - 500 mg/L	Tier II	Standardization	Cool, ≤ 6° C	< 0 mg/L; > 400 mg/L
NT-AT-1	0.5 °C	1 °C	-5 – 45 °C	Tier II	Verified	N/A	<-20 °C; >40 °C
NT-AT-2	0.1 °C	± 0.2 °C	-50 – 150 °C	Tier II	Verified	N/A	<-20 °C; >40 °C
NT-AT-3	0.1 °C	± 1.0 °C	0 – 50 °C	Tier II	Verified	N/A	<-20 °C; >40 °C
NT-B-1	20 CFU/100mL	log(0.6)	<20 CFU/100mL to	Tier I	All samples in replicate	Cool to < 10° C	NA
NT-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
NT-DO-1	0.2 mg/L	0.6 mg/L	0 – 10+ mg/L	Tier II	Standardization	Immediate acidification	<0 mg/L; >20 mg/L
NT-DO-2	0.01 mg/L	± 2% FS	0 – 20 mg/L	Tier II	Calibration	N/A	<0 mg/L; >20 mg/L
NT-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
NT-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
NT-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
NT-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
NT-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
NT-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
NT-N-7	≤ 15% RPD	Varies depending on lab equipment	Varies depending on lab equipment	Tier II	Lab Analysis	Freeze to -20 C	<NO23+NH4
NT-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
NT-P-2	0.01 mg/L	± 4%, 0.04 mg/L	0 – 2.5 mg/L	Tier II	Standardization, 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	QC Criteria
NT-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
NT-P-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)	<PO4
NT-PH-1	0.01 pH	± .01 pH	- 1.00 – 15.00 pH	Tier II	Calibration	Cool, ≤ 6° C	<4.0 pH; >9.5 pH
NT-PH-2	0.2 SU; 0.5 SU	± 0.4, + 1 SU	3.0 - 10.5 SU; 4 to 10 SU	Tier II	All samples in replicate	Cool, ≤ 6° C	<4.0 SU; >9.5 SU
NT-PH-3	0.5 pH units	Unknown - testing needed	2 - 9 pH units	Tier I	N/A	Cool, ≤ 6° C	< 4.0 pH units; > 9.5 pH units
NT-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
NT-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
NT-WC-1	10 cm	20 cm	0 - 300 cm	Tier I	N/A	N/A	<0 cm; >300 cm
NT-WC-2	2 cm	Unknown - testing needed	0 – 60 cm; 0 - 120 cm	Tier I	N/A	N/A	<0 cm; >300 cm
NT-WT-1	0.5 °C	1 °C	-5 – 45 °C	Tier II	Verified	N/A	<-1 °C; >35 °C
NT-WT-2	0.1 °C	± 0.5 °C	-50 – 150 °C	Tier II	Verified	N/A	<-1 °C; >35 °C
NT-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
NT-A-1	Before each use	Glassware is clean and intact, reagents have not expired	N/A	N/A
NT-A-2	Before each use	Glassware is clean and intact, reagents have not expired, checker functions properly, no sign of low battery	Before each use	HI775-11 Alkalinity Checker HC® Calibration Check Set
NT-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
NT-AT-2	Before each use	Thermometer functions properly and reads approximate air temperature. Metal stem is undamaged.	Annually if needed	NIST Verified thermometer
NT-AT-3	Before each use	Thermometer functions properly and reads approximate air temperature	Annually if needed	NIST Verified thermometer
NT-B-1	Before each use	Collection bottles and plates remain sterile, media and plates have not expired	N/A	N/A
NT-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
NT-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
NT-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.
NT-N-1	Before each use	Glassware is clean and intact, reagents have not expired	N/A	N/A
NT-N-2	Before each use	Glassware is clean and intact, reagents have not expired	N/A	N/A
NT-N-3	Before each use	Glassware is clean and intact, reagents have not expired	N/A	N/A
NT-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
NT-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
NT-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
NT-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

Table ID #	Inspection Frequency	Type of Inspection	Calibration Frequency	Standard or Calibration Instrument Used
NT-P-1	Before each use	Glassware is clean and intact, reagents have not expired	N/A	N/A
NT-P-2	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
NT-P-3	Before each use	All equipment is intact and operational	Daily or more frequently	Calibrate using known standards covering entire range of expected values
NT-P-4	Before each use	All equipment is intact and operational	Daily or more frequently	Calibrate using known standards covering entire range of expected values
NT-PH-1	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.
NT-PH-2	Before each use	Glassware is clean and intact, reagents have not expired	N/A	N/A
NT-PH-3	Before each use	Strips are not discolored or wet	N/A	N/A
NT-TDS-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
NT-TURB-1	Before each use	Turbidity columns are clean, reagents have not expired	N/A	N/A
NT-WC-1	Before each use / Annual	Marks are still attched/visible and rope is not knotted / Check against tape measure for stretch	Annually	Tape measurer
NT-WC-2	Before each use	Transparency tube is clean	N/A	N/A
NT-WT-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
NT-WT-2	Before each use	Thermometer functions properly and reads approximate air temperature. Metal stem is undamaged.	Annual verification	NIST Verified thermometer
NT-WT-3	Before each use	Thermometer functions properly and reads approximate air temperature	Annual verification	NIST Verified thermometer

Appendix C. 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 ofncorresponding 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	Regulatory Assessments of Water Quality Standards Attainment

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 - Attainment:

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

Data Uses: These data will 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 D. CMC Program Manual

Chesapeake Monitoring Cooperative
Program Manual

[GROUP NAME]
[Date]

Title and Approval Page

Program Name:
Monitoring Group:
Date:

[name] Date
Certified Trainer/QA Officer
[Group Name]

Liz Chudoba Date
CMC Service Provider
Alliance for the Chesapeake Bay

Stephanie Letourneau Date
CMC Service Provider
Alliance for Aquatic Resource Monitoring

Section A: Roles and Responsibilities

[***INSERT Org Chart/Flow Chart and details about personnel at the organization involved in the monitoring program and their roles. Can include more positions than what is listed in Table 1, but at a minimum needs to include someone in charge of ensuring data is collected properly (either by volunteers or paid staff), someone in charge of managing the data and quality assurance measures to ensure data quality, and a certified monitor/trainer. Those roles can be filled by one person or multiple people. Additional roles can be included as needed for specific programs, for example, boat captains, laboratory analyses, etc.]***

Table A1: Personnel involved in the monitoring program and their designated roles.

Role	Description	Individuals Involved
Program Coordinator	Manages and administers the monitoring program to ensure all volunteer monitors follow proper sampling procedures.	
QA Officer	Performs all quality assurance measures outlined in this manual, including calibration checks, replicate/duplicate checks, spot checks and QA on data. Uploads and publishes data in the Chesapeake Data Explorer.	
Certified Trainer	Performs new and recertification trainings for monitors within the associated monitoring group.	
Certified Monitor	Performs all of the measurements or collects lab analyzed samples at the designated sites.	
CMC Service Provider	Conducts the initial certification training with the program coordinator and annual recertification trainings. Conducts annual thermometer checks. Assists with data integration into the Data Explorer.	Liz Chudoba (ACB) Caroline Donovan (UMCES) Stephanie Letourneau (ALLARM)

Section B: Program Summary

Background

[Add in background info as needed for specific monitoring program. Can include watershed context, TMDL's or watershed impairments, past monitoring that has occurred or current monitoring that is occurring by other organizations, etc.]

Goals and Objectives

[Identify the goals and objectives of the monitoring program. What are the questions you are trying to answer? Examples include but are not limited to:

- **Determine the status and trends for water quality conditions on and around Blackwater NWR, capturing spatial and temporal variability, and sufficient to guide habitat management, enhancement and restoration activities. (Credit: Blackwater National Wildlife Refuge)**

- **Characterize the present state of the Nanticoke River by establishing baseline data, including spatial and seasonal variation, using key water quality indicators. (Credit: Nanticoke Watershed Alliance)**
- **Determine long-term trends or changes in key water quality indicators in relation to pollution control programs. (Credit: Nanticoke Watershed Alliance)**
- **Identify areas for management and restoration efforts. (Credit: Nanticoke Watershed Alliance)]**

Data Use (Tier Level)

[Identify specific data uses and audiences for the data collected through this program. Examples include but are not limited to:

- ***SRA uses the water quality data to explain changing conditions in our river, such as the permanent dead zone, why we've lost habitat for Yellow Perch, what caused the decline of underwater grasses, what killed off our oyster reefs, why there were no pickerel in the river last winter, and what can we do to save habitat for what remains: turtles, beaver, river otters, waterfowl, horseshoe crabs, rockfish, blue crabs etc. (Credit: Severn River Association)***
- ***We'll use GIS story maps, press releases, social media campaigns, monthly educational meetings, e-mail campaigns, report cards, annual reports, SRA's monthly newsletter, brochures and websites. (Credit: Severn River Association)***
- ***Produce a report card for the Antietam Creek watershed's health by subwatersheds for various chemical, physical, and biological parameters which could be distributed to County residents. (Credit: Antietam-Conococheague Watershed Alliance)]***

Data collected through this project are classified as Tier X, Tier X and Tier X in the CMC's Chesapeake Data Explorer, based on equipment used and QA procedures established in this Program Manual. See Table B1 for the intended data uses for those tier levels.

For use in the Integrated Report of Surface Water Quality, Maryland Department of the Environment (MDE) solicits data from the Data Explorer biannually. Each Integrated Report cycle typically includes a five-year data window and all data published by February 1st of the odd numbered calendar year will be used in the next even numbered calendar year's Integrated Report. For example, for the 2024 IR, all data from 2018-2022 should be published by February 1, 2023 to be included in the 2024 Integrated Report. Any data published after February 1, 2023 will be used for the next cycle (2026) of the Integrated Report. Specific data used are determined based on MDE's Tiered Framework.

The purpose of the Integrated Report is to identify and list waters not meeting water quality standards. The most frequently assessed non-tidal parameters for the Integrated Report include pH, dissolved oxygen (DO), turbidity (in NTU), biology, and bacteria. Maryland does not have water quality criteria for some commonly monitored nontidal parameters such as nutrients, suspended solids, or water clarity (Secchi depth) for nontidal waters. All tidal data should go through the Chesapeake Data Explorer to be included in the Chesapeake Bay Program's Interpolator Assessments that are used in the Integrated Report.

For use by the Chesapeake Bay Program partnership, data is also uploaded to the Chesapeake Bay Program's DUET/CEDR database annually by the CMC team.

Table B1: The CMC's Tiered Framework and intended data uses. Tiers are determined for individual parameters not entire programs and are based off of monitoring protocols, sampling frequency, equipment and quality assurance protocols.

Tier	**Intended Data Use**	**Summary of Data Requirements**
Provisional	Track groups collecting water quality monitoring data across the watershed.	Program does not meet minimum requirements for Tier 1.
Provisional Tier 1	Education, environmental health screening	• Historic dataset that is categorized as Tier 1 • Current dataset that is categorized as Tier 1 but the group does not attend a CMC certification training workshop.
Tier 1	Education, environmental health screening, targeting of management actions, baseline stream health assessment.	• Written study design (preferred) • Documented monitoring methodology and field data sheet • Documented site location(s) (with coordinates) • Collect samples at a specified sampling rate with an 80% completion rate.
Provisional Tier 2	Environmental health screening, environmental health report cards, targeting of management actions	• Historic dataset that is categorized as Tier 2 • Current dataset that is categorized as Tier 2 but the group does not attend a CMC certification training workshop.
Tier 2	Education, environmental health screening, targeting of management actions, baseline stream health assessment, and CMC Report Cards.	• Same at Tier 1 • Meets the Tier 2 quality assurance standards for specific equipment and parameters. • Acquires and maintains CMC Tier II certification.
Tier 3	Tier 1 and 2 uses and Chesapeake Bay Watershed trends and assessments to help inform policy and management decisions.	• Maintain QAPP and field/lab standard operating procedures approved by CBP. • Participation in CBP DIWG field and lab audits.

Timeline

[Specify the program sampling timeline, frequency, and schedule. Additional information to include if possible are contingencies if the sampling cannot occur on the same schedule.

Examples:
Alliance for the Chesapeake Bay:
Samples are collected once a month, year-round. Individual monitors/monitoring groups select a sampling day that works for them, but is consistent each month (ie. The first Tuesday of each month).

If there is a conflict with the regularly scheduled sampling day (due to inclement weather, etc), the sample is collected on a different day within 2 days of the original sampling day.

Severn River Association:
Samples are collected weekly from May-October, weather permitting, and monthly from November – April. There are three vessels in the SRA fleet, 4 volunteer boat captains who rotate their services on the WQ tours. SRA recruits volunteers to help out with the Wednesday and Thursday WQ Tours. SRA's Tom Guay and the CCC Intern lead these tours.

To cover the entire river, SRA monitors the Anne Arundel County portions of the Severn River. We are also working with partners, Operation Clearwater and the Spa Creek Conservancy who monitor Spa and Back Creeks in the city of Annapolis.

The breakdown is as follows:

1. ***Upper River (Clements Creek To Indian Landing). Weekly monitoring on Wednesdays by SRA.***
2. ***Mid-River (Asquith Creek To USNA Bridge). Weekly monitoring on Thursdays by SRA.***
3. ***Lower River (Lake Ogleton To Whitehall Creeks). Weekly monitoring on Thursdays or Fridays by SRA.***
4. ***Spa Creek (Wednesday): Weekly monitoring by Spa Creek Conservancy in conjunction with Operation Clearwater, and***
5. ***Back Creek (Thursday): Weekly monitoring Back Creek Conservancy in conjunction with Operation Clearwater.***

Blackwater National Wildlife Refuge:
Trained volunteers collect data once per month, year around. Testing is intended to be conducted on the second Tuesday of each month, between 8 am and noon. Occasionally, severe ice conditions may prevent sampling at some locations. If weather conditions or volunteer availability require rescheduling to a different day, it should be rescheduled to be as close to the original day as possible.]

Table B2: Project Timeline

Task	Timeline
Program Start Date	
Sampling frequency (eq. monthly, bimonthly, weekly)	
Sampling timeframe (eg. Year round, months)	
Data upload to the Chesapeake Data Explorer	
Volunteer monitor recruitment/training	
Recertification for Monitors	Annually
Recertification for Coordinators	Annually

Site Selection

[Document site location selection process/how the sites were selected and how many sites. Fill in Table B3 with the actual site locations, using the latitude and longitude coordinates in decimal degrees (4 decimal places) with the North American 1983 Datum (NAD83). 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.

Blackwater National Wildlife Refuge Example:
Sampling locations were selected to adequately capture spatial variability across the project area and characterize key hydrologic units. The exact locations were selected for convenience purposes (bridges for sites F, G, and H, allowing midstream sampling; a boat launch with bulkhead for site I). Site F characterizes the upper Blackwater River and the Buttons Creek tributary as it flows downstream towards Fishing Bay. Site G characterizes the water quality at the mouth of the Little Blackwater River as it flows into the Blackwater River, approximately seven miles downstream from the Nanticoke Watershed Alliance's Little Blackwater 4 sampling point. Site H characterizes water quality as the Blackwater River narrows and eventually flows into Fishing Bay. Site I characterizes the quality of the Transquaking River, approximately 11.2 miles downstream from Nanticoke Watershed Alliance's TRAN2 station on Drawbridge Road, as it approaches Fishing Bay. A final advantage of using these sites is that they were used in the past, allowing a direct comparison with historical data.]

Figure 1: Sampling site locations for this project.
[INSERT site map]

Table B3: List of Monitoring Sites for the project.

Site ID	Sample Method	Description	Latitude	Longitude
EX. ACB1	***Wade in mid-channel with a bucket.***	***Located in Richmond, VA on Reedy Creek off of the hiking trail through the park.***	***38.9876***	***-76.8976***

*Latitude and Longitude coordinates must be in decimal degrees with 4 decimal places.

Water Quality Parameters
This program will use ***[insert specific equipment (ex. YSI Pro DSS)]*** to measure ***[insert specific parameters with units (ex. Dissolved oxygen (mg/L and % saturation), water temperature (degrees Celsius)]*** *in situ*. The parameters to be analyzed in the field and the equipment to be used are found in Table B4. All samples will be collected following the detailed methodology found in Appendix A.

The program will collect samples from a ***[insert how the samples are taken – boat, dock, bridge, wade-in. Specify whether surface samples or depth profiles will be measured and if samples are taken with a bucket.]***

[Standard language to include if doing depth profile samples] Depth profile readings must be taken mid-channel by boat. Channel depth should be measured with the depth finder on the boat or by using the Secchi line/measuring tape. In the main stem of the river (or if the depth is >3 m deep) take a bottom measurement at 1.0 m above the bottom, go to the next whole number and take a reading, then proceed in 1.0 m increments until you reach 0.5 m below the surface (Example: At a 3.4 m deep site, measure at 2.4, 2.0, 1.0 m and 0.5 m). In the creeks (or if the depth is ≤3 m) measure 1.0 m above the bottom and then again at 0.5 m below the surface. At each iteration allow the probe to stabilize before recording your reading at the corresponding depth.

Table B4: Field Parameters Monitored

Parameter	Analytical Method	Equipment	Units	Tier Designation
Air and Water Temperature	USEPA 170.1	***[insert specific probe/meter]***	Celsius	Tier 2
Dissolved Oxygen	USEPA 360.1	***[insert specific probe/meter]***	mg/L and % sat	Tier 2
pH	USEPA 150.1	***[insert specific probe/meter]***	SU	Tier 2
Water Clarity	Secchi Depth	Secchi Disk	Meters	Tier 1
Total Depth	N/A	***[insert specific equipment]***	Meters	Tier 1

This program will use ***[insert specific lab with address and any contact info (ex. Horn Point Laboratories, address, point of contact)]*** to analyze ***[insert specific parameters with units (ex. Total Nitrogen (mg/L)]***.

Table B5: Lab Parameters Monitored

Lab	Parameter and Units	Analytical Method	MDL (Detection Limit)	Holding Time and Condition
EX. Horn Point	***Total Nitrogen (mg/L as N)***	***EPA Method 353.2***	***0.006 mg/L***	***28 days in -20 ^{o}C freezer***

Data Management

All data collected (observations and water quality results) will be recorded on field data sheets provided by the program coordinator. [**Update this language based on your data flow process: Following data collection, data will be entered into the Chesapeake Data Explorer by the monitor or program coordinator either from the field datasheet or via bulk upload. The data is then checked by the QA Officer and published on the Chesapeake Data Explorer according to the quality assurance procedures in Section C. Lab data sheets or excel files will be uploaded to the Chesapeake Data Explorer as received.]**

All data published on the Chesapeake Data Explorer are publicly available for federal, state, and other entities to use. A subset of this data are uploaded to the Chesapeake Bay Program's DUET system and EPA's Water Quality Exchange (WQX) by the CMC team on an annual basis. Refer to the Chesapeake Data Explorer User Manual for more detailed information.

Table B6: Chesapeake Data Explorer Roles and Responsibilities:

Role	Personnel	Responsibility
Monitor	Certified Monitors	Have access to upload data to sites registered under their group and to edit and review data points they upload into the Data Explorer until it is published by the program coordinator.
Coordinator	Program Coordinator/ QA Officer	Have access to edit, review and publish data for all sites and monitors assigned to their monitoring group.

		Have access to add or remove stations, monitors or parameters from their monitoring program.
Member	CMC Service Provider	Upload all published data to the Chesapeake Bay Program annually.

Section C: Quality Assurance

Training

[Insert overall details of how trainings will occur annually. Some options include:

- ***CMC service provider trains the program coordinator annually to be a certified trainer, who then trains the monitors to go out on their own to collect the data.***
- ***CMC service provider trains the program coordinator annually to be a certified monitor, who collects the data with or without the help of volunteers.***
- ***CMC service provider trains the program coordinator and volunteers to be certified monitors.***

Fill out the Certified Monitor/Certified Coordinator sections as needed based on the set up of the program.]

Certified Monitor

[This section can be edited to fit the nature of your program and training, but at a minimum should have these elements…]

Each person who wishes to collect Tier II data for this project will be required to attend a certification workshop hosted by either the CMC Service Provider or Certified Trainer and take a certification test to demonstrate their ability to follow standard operating procedures and understand QA/QC procedures. The certification workshop covers the following items:

1. Goals and objectives of the monitoring program and the CMC
2. Information about the Chesapeake Bay Watershed health and water quality impacts
3. Water quality parameters measured
4. Safety when monitoring
5. Data upload to the Data Explorer (if applicable)
6. Sampling methods:
    a. Clean, calibrate, use, store and maintain all equipment used
    b. Collect, store and transport water samples for analysis (if applicable)
    c. Analyze water samples (if applicable)

The certification test must be taken by the monitor at least one day after their training event and within 90 days to ensure that they have retained the information. Monitors must pass the certification test with an 80% or greater. 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.

Certified Monitors that are collecting Tier 2 data and wish to maintain their certification must attend a re-certification session hosted by the CMC Service Provider or Certified Trainer annually. During the re-certification 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.

Each sampling event/monitoring group collecting Tier 2 data must have at least one certified monitor responsible for data collection.

Certified Coordinator

[This section can be edited to fit the nature of your program and training, but at a minimum should have these elements…]

The CMC Service Provider will host a Certified Coordinator workshop with the program coordinator. The workshop will cover the goals of the project, information on how to conduct Water Quality Monitoring and Certification Workshops, how to manage the project documentation, how to perform QA/QC checks appropriately, and upload data to the Data Explorer. In order to become certified, trainers must demonstrate a thorough understanding of water quality monitoring methods and QA/QC procedures implemented by the program. This can be achieved through prior knowledge and experience (as deemed appropriate by the CMC Service Provider) or by being a Certified Monitor for at least one year. Once a trainer becomes certified they may train and re-certify volunteer monitors under their program, quality assure data, and publish data in the Chesapeake Data Explorer.

In order to stay certified, trainers will need to attend annual recertification workshops either one on one or regionally with the CMC project team member in person or by video to retain their certification. Trainers may be asked to perform a “mock” training if deemed necessary.

Field Parameters

Spot-checking data sheets

[Choose from the three basic options below, should also be tailored based on your specific program and how your data is transferred so long as 10% of the datasheets are checked for accuracy…]

For programs that allow monitors to upload data to the Data Explorer and send in their field datasheets to the regional Coordinator for review.

- Check all datasheets have an entry in the database and all data entries have datasheets.
    - If a datasheet is not entered, enter the data and wait one day to conduct the spot check or have someone else complete the following tasks.
    - If datasheets are missing, contact the monitor.
- Complete a 10% spot check of data sheets per site.
    - Spot check every datasheet for new monitors for the first year of monitoring to ensure they are following directions and entering data properly.
    - Spot check every datasheet for certain monitors that have frequent issues.
    - If an error is found that is the fault of the monitor, all their recent data sheets from the previous 6 months are to be checked.
    - Errors will be corrected by the project coordinator.
    - See the CMC QAPP for more specific instructions on spot-checking.
- Scan and file datasheets, keep hard copies for 7 years.

For programs that send the datasheets to a centralized coordinator or QA officer for data upload via the data upload form.

- Enter data from the field datasheets into the Chesapeake Data Explorer online form or onto an excel spreadsheet. Either have a second person or wait one day to complete a 10% spot check of

data sheets (ex. Pick one datasheet per sampling day at random). Check to ensure the data was transferred accurately.
  - If an error is found in data entry, check all of the other datasheets for that day or month.

For programs that collect the data on an excel spreadsheet (or some other database) and upload data via the bulk upload process:

Equipment maintenance
All equipment is maintained according to the manufacturer's instructions, full details are included in the SOP found in Appendix A. The basic maintenance activities include:

- Thermometers:
  - Verified annually against a NIST master thermometer.
  - Check for signs of damage before each sampling event.
  - Properly clean after each sampling event.
- Probes:
  - Calibrated to manufacturer's instructions within 24 hours before sampling and post-sample checks completed within 24 hours after sampling. Calibrations and post-sample checks are tracked on the field data sheets or calibration logs.
  - Stored in a cool dry place according to manufacturer's instructions.
  - Check for damage before each sampling event.
  - Properly clean after each sampling event.
- Kits:
  - Standardized using the appropriate standard solution within 24 hours before sampling.
  - Store in a cool dry place according to the manufacturer's instructions.
  - Check chemical expiration dates and glassware before each sampling event.
  - Properly clean all glassware after each sampling event.

Calibration and Standardizations
All probes must be calibrated within 24 hours of sampling and post-sample checked within 24 hours after sampling using standard solutions following the manufacturer's instructions and Table C1. All calibrations must be recorded on the field datasheet or a calibration log.

If any of the calibrations or standardizations fail (ie. Do not fall within the acceptable range in Table C1), measurements for that parameter should not be taken until the issue is resolved and the calibration is successful.

If any of the post-sample checks fail, flag data with the appropriate problem code listed in Table C4.

Table C1: Quality Control requirements for Tier 2 field equipment.

Parameter	Equipment	Calibration standard	Acceptable Calibration Range
Conductivity (TDS/salinity)	Meter or Probe	It is preferred to do a two-point calibration bracketing the average conductivity field value range.	+/- 5% of the standard

Dissolved Oxygen	Meter or Probe	100% saturation	+/- 0.3 mg/L 95% - 105%
Dissolved Oxygen	Winkler Titration	Sodium thiosulfate check – if first check is not within acceptable range, conduct a second check. If the second check is not within range, do not run samples during that sampling event. If the second check is within range, conduct a third check and report the closest two.	9.4 – 10.0 mg/L
pH	Meter or Probe	It is preferred to do a two-point calibration bracketing the pH field value, always using pH 7 buffer (either 7 and 10 OR 7 and 4). If the pH field value is outside of the calibration bracket, the post-sample check should be completed with the third buffer solution.	+/-0.20 of standard

Other field measurements are checked annually to verify accuracy of the reading as identified in Table C2.

Table C2: Annual verification requirements for Tier 2 field equipment.

Parameter	Equipment	Verification	Acceptable Calibration Range
Air and Water Temperature	Armored glass thermometer, digital thermometer or thermistor	Checked annually against a NIST traceable thermometer in cold (0-4^{o}C), room temperature (18-22^{o}C) and hot (30-35^{o}C) water.	+/- 0.2^{o}C
Secchi Depth	Secchi Disk	Line measured annually to verify accurate readings.	None, markings adjusted as needed

Field Replicates and Duplicates

In Situ probe measurements in tidal waters are recommended but not required to do ≥10% field replicates due to changing conditions.

In Situ probe measurements in non-tidal waters are required to do ≥10% field replicates in order for data to be classified as Tier 2 (i.e. 1 out of every 10 sites). This includes placing the probe into the sample water and recording the sample value. Then removing the probe and replacing it in the sample water to take a second reading.

All Kit measurements (ie. The Winkler Titration for dissolved oxygen) in tidal or non-tidal waters are required to do 100% field replicates for data to be classified as Tier 2. This includes collecting the sample water in two separate bottles or containers for analysis. All field replicates and duplicate readings should fall within the acceptable ranges identified in Table C3.

Table C3: Acceptable replicate and duplicate ranges for field parameters.

Parameter	**Equipment**	**Field Replicate/Duplicate Acceptable Range**
Conductivity (TDS/salinity)	Meter or Probe	2% FS
Dissolved Oxygen	Meter or Probe	+/- 0.3 mg/L
Dissolved Oxygen	Winkler Titration	+/- 0.6 mg/L
pH	Meter or Probe	+/- 0.2 SU
pH	Colorimetric Kits	+/- 0.5 SU
pH	Test Strips	+/- 1 SU
Water Clarity	Turbidimeter	+/- 5 JTU
Air and Water Temperature	Armored glass thermometer	+/- 1.0^{o}C
Air and Water Temperature	Digital thermometer or thermistor	+/- 0.5^{o}C
Nitrate	Colorimetric Kit	Low range (0–1 mg/L) = +/- 0.1 mg/L Mid range (1–10 mg/L) = +/- 1 mg/L
Phosphate	Colorimetric Kit	+/- 0.04 mg/L

If any of the QA checks fail the data should be flagged by marking the specific data point with the problem code in Table C4 in the Chesapeake Data Explorer.

Table C4: Problem codes used to flag field data in the Chesapeake Data Explorer.

CBP Problem Code	QA Issue
(C) Instrument Failure (during sampling that may have effected results)	pH/DO/conductivity post-sample check failure, if values appear inaccurate
(F) post-calibration failure (likely due to equipment damage after sampling; data appear normal)	pH/DO/conductivity post-sample check failure, if values appear accurate
(V) Sample results rejected due to QC Criteria	pH/DO/conductivity calibration failed – data is questionable
(HI)	Duplicates are not within accepted range

Lab Analysis

This program will use the follow lab/s for data analysis:

- Lab Name:
- Address:
- Contact Information:
- Parameters Analyzed:
- Link to lab website/methodologies:
- State, Federal or NELAP Certification – Y/N
- CBP Data Integrity Workgroup Approval – Y/N

Labs that do not maintain a certification or are not approved by the CBP will be considered for inclusion on a case by case basis, and all data will be marked as provisional Tier II until recognized by the CBP or CMC team.

Table C5: Parameters analyzed and holding times for lab analyzed samples.

Parameter	Approved Procedure	Equipment	Holding Time
Chlorophyll a	USEPA Method 445.0	Flourometry	30 days
Chlorophyll a, b, c	CBP IV-12.0	Spectrophotometry	30 days
Enterococcus	ASTM Method (#D6503-99)	IDEXX Enterolert	6 hours
E.coli	SM 9223B	IDEXX Colilert	6 hours
Total Phosphorus	USEPA Method 365.4	Specific to Individual Lab	28 days
Nitrate-Nitrogen	USEPA Method 352.1	Specific to Individual Lab	28 days
Nitrite-Nitrogen	USEPA Method 353.4	Specific to Individual Lab	28 days
Ammonia	USEPA Method 349.0	Specific to Individual Lab	28 days
Total Kjeldahl Nitrogen	USEPA Method 351.1	Specific to Individual Lab	28 days
Total Nitrogen	USEPA Method 351.2	Specific to Individual Lab	28 days

Table C6: Problem codes used to flag lab data in the Chesapeake Data Explorer.

CBP Problem Code	QA Issue
(E) Sample received after holding time	The sample was delivered to the lab after the holding time.
(GG) Sample analyzed after holding time	The sample was delivered to the lab within the proper holding time, but the lab analyzed the sample after the holding time.
(V) Sample results rejected due to QC Criteria	Data is questionable

Blanks/Duplicates

Duplicate and blank samples will be collected at least 10% of the time (i.e. 1 out of every 10 sites). To collect duplicate samples, monitors will collect a sample in a second bottle and perform all field procedures. This bottle should be labelled as a duplicate, and sent to the lab for analysis with the first sample. To collect blank samples, monitors will perform all field procedures including preserving the samples as required using deionized water supplied by the lab instead of sample water. Results from field blanks will be recorded and appropriately marked during data entry in the Chesapeake Data Explorer.

Table C7: Acceptable replicate and duplicate ranges for lab parameters.

Parameter	Approved Procedure	Duplicate Range	Blank Range
Chlorophyll a	USEPA Method 445.0		
Chlorophyll a, b, c	CBP IV-12.0		
Enterococcus	ASTM Method (#D6503-99)		
E.coli	SM 9223B		>1 MPN/100mL
Total Phosphorus	USEPA Method 365.4		
Nitrate-Nitrogen	USEPA Method 352.1		
Nitrite-Nitrogen	USEPA Method 353.4		
Ammonia	USEPA Method 349.0		
Total Kjeldahl Nitrogen	USEPA Method 351.1		
Total Nitrogen	USEPA Method 351.2		

Documentation and Records

This project uses the following documentation and records. A copy of the field datasheets and calibration logs can be found in Appendix B. A copy of the Chain of Custody form can be found in Appendix D.

Property Owner Permission Form
All monitoring sites located on private property have a property owner release form to give permission to monitor on that site. This form is recommended even if the monitor is the property owner.

Liability Release Form
All volunteers should sign a volunteer release form prior to starting monitoring activities.

Field Datasheets
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 may also record weather conditions, whether they calibrated their equipment, and time spent monitoring. The data values are entered into the appropriate place on the data sheet, including values for replicates. A hard copy of all data sheets are archived with the Certified Trainer or regional Project Team member for seven years after submission to the project. In addition, the project maintains electronic (digital) records of the data within the database.

Calibration Logs
All probe calibrations and colorimeter standardizations will be recorded before and after monitoring on an equipment calibration sheet. On the calibration sheet, the calibration values and post-sample check values are recorded, along with notes about passing or failing calibration. A hard copy of all data sheets are archived with the Certified Trainer or regional Project Team member for seven years after submission to the project.

All thermometer checks are recorded on Thermometer Verification Logs. A copy of the thermometer verification log is kept by the Certified Trainer and sent to the CMC Service Provider annually.

Chain of Custody Forms
All lab samples will have a Chain of Custody to track when samples were collected and dropped off at the laboratory to ensure samples arrive within the proper holding times.

Training Documentation
All documentation from trainings, certifications and re-certifications sessions are held by the Certified Trainer and reported annually to the CMC service provider. Certified trainers must keep a record of the following items:

- List of certified monitors and certification test results,
- Training sign in sheets/registration sheets, and
- Equipment QA documentation.

These items will be stored with the Certified trainer along with the Monitoring Program Manual, monitoring manuals or SOPs.

Table C8: Document and record holding times.

Document	Storage Location	Storage Time

Monitoring Manual/SOP	XXXX	Permanently, updated as needed
Monitoring Field Datasheets and Calibration records	XXXX	Hard copy 7 years, electronic copy permanently
Thermometer Verification Logs	Alliance for the Chesapeake Bay's Richmond Office	Permanently, updated at least annually
Training Documentation	XXXXX	Physical copy 7 years, electronic copy permanently. Updated and submitted to the CMC Service Provider at least annually.
List of active certified monitors	XXXX	Physical copy 7 years, electronic copy permanently. Updated and submitted to the CMC Service Provider at least annually.

Appendix A: Sampling Methods
Appendix B: Field Datasheet
Appendix C: Lab Analytical Methods
Appendix D: Lab Chain of Custody

Appendix E. Program Documentation Templates

CMC Chesapeake Monitoring Cooperative

[INSERT YOUR LOGO]

PROPERTY OWNER PERMISSION

As part of the **[Insert your program name**, trained local volunteers collect water quality samples on a **[weekly, biweekly, or monthly]** basis at consistent specific sites. This agreement is intended to grant permission to volunteers to access private property for site-specific data collection, as well as to release and hold harmless the property owner from liability arising from that access.

Property Address: ____

Access granted starting(Date):_______________ Until (Date): ________________

Site ID and Access Instructions: ____

____

SITE ACCESS PERMISSION (CHOOSE ONE OPTION)

____I grant permission to water quality monitoring volunteers with the **[Insert your organization name]** to access my property for the sole purpose of conducting water quality monitoring activities at the above-mentioned site following the site access instructions.

____I grant permission to the **[Insert your organization name]** to access my property for the sole purpose of conducting water quality monitoring activities at the above-mentioned site following the site access instructions, with myself as the primary monitor and only as long as I continue to monitor.

LIABILITY RELEASE

____ I agree to hold the **[Insert your organization name]**, it's volunteers, and necessary project partners harmless from and forever discharge them from any and all liability for damages, injury, or loss which may be sustained as a result of their entry onto my property.

____ I acknowledge that the **[Insert your organization name]** holds harmless and forever discharges me, the property owner, from any and all liability for any damage, injury, or loss which may be sustained as a result of entry onto my property.

CHESAPEAKE DATA EXPLORER PERMISSION

____I grant my permission for the water quality monitoring site established on my property to be shown on the publicly accessible homepage of the Chesapeake Data Explorer. This includes latitude and longitude coordinates and a pin on the homepage map indicating where the site is located. Specific address information or personal identifiers are not included.

Name (Printed): _______________________________ **Signature:** ___________________________________

Date: _________________________

CMC
Chesapeake Monitoring Cooperative

[INSERT YOUR LOGO]

VOLUNTEER WAIVER

CODE OF CONDUCT

____ I hereby agree to perform **[Insert your program name]** volunteer responsibilities willingly and courteously to the best of my abilities.

____ I will show respect to everyone involved in **[Insert your program name]** (volunteers, organizational partners and staff) and strive to create a safe environment for everyone. I understand that failure to uphold these community values will result in my dismissal from **[Insert your program name]**.

LIABILITY RELEASE

____ I acknowledge that there are risks and hazards associated with water quality monitoring through **[Insert your program name]** and I agree to assume all such risks and the possibility of hazards to me, my child (children), and all real or personal property, and do not hold the **[Your Organization]**, property owners, or other associated organizing group(s) responsible.

____ I recognize that by signing this document I am waiving certain rights, including the right to sue.

EQUIPMENT AGREEMENT

____ I acknowledge that all monitoring equipment is given to me as a loan and I assume responsibility for the safety and care of all equipment. I agree to transport and store the equipment according to the **[Insert your program name]** Manual and to use the equipment in a prudent and reasonable manner in order to reduce the possibility of damage. In the event that I discontinue monitoring, or at the request of the **[Your Organization]**, I will return said equipment within a reasonable timeframe to: **Enter Address**.

PHOTO RELEASE

____ I give permission for photos of myself and/or children taken during this event to be used for future project promotion and/or reporting.

- Check here if you do not give permission for your photos to be used.

Name (Printed): ____________________________________ **Signature:** __________________________________

Date: ______________________

Chesapeake Monitoring Cooperative

Non-tidal Field Data Sheet

Site ID ______________________________ Stream Name ______________________________

Date ______/______/______ Time (military time) ______________ Rainfall (mm last 48 hrs) _________________

Monitor Name(s): ____

Calibrations				
Dissolved Oxygen (Winkler Titration)		**Check 1**	**Check 2**	**Check 3**
If check 1 is between 9.4 and 10.0, proceed with sampling. If out of range, perform check 2. If check 2 fails, do not proceed with field sampling and contact your coordinator for new chemicals. If check 2 passes, completed check 3 to confirm checks are within 0.4 of each other.		_________ mg/L	_________ mg/L	_________ mg/L
Dissolved Oxygen (Probe)	**Calibration Reading and Temperature**		**Post-Sample Check and Temperature**	
100% Saturation Acceptable range: +/- 3%	__________ %	__________ °C	__________ %	__________ °C
Conductivity	**Calibration Reading and Temperature**		**Post-Sample Check and Temperature**	
Standard Used: _______ Acceptable range: +/- 10%	_________ µS/cm	__________ °C	_________ µS/cm	__________ °C
pH	**Calibration and Temp**		**Post-Sample Check and Temp**	
Conduct a two-point calibration using either 7.00 and 4.01 or 10.01 buffer solutions. Acceptable Range: +/- 0.20	7.00 _________ 4.01 _________ 10.01 ________	__________ °C	7.00 _________ 4.01 _________ 10.01 ________	__________ °C

Bacteria (E.coli) Measurements (Coliscan)				
Disregard any pink, red, green-blue, or white colonies. Only count purple and blue-purple colonies.	Incubation Time	Incubation Temperature	Sample water used (1-5mL)	Total colonies counted on plate
	________ hours	_____._____ °C	Sample 1: ______mL Sample 2: ______mL	Sample 1: ______ Sample 2: ______

To calculate the Total Colonies per 100mL of water:

1. Divide 100 by the mL of water used. 2. Multiply this quotient by the number of purple colonies counted.

Sample 1: ([100/mL of water used]*colonies counted) = _______CFU/100mL

Sample 2: ([100/mL of water used]*colonies counted) = _______CFU/100mL

Observations			
Water Surface	Calm / Ripple / Waves / White Caps	**Water Odor**	Sewage / Earthy / Fishy / Rotten Eggs / None / Other_____________
Stream Flow	Dry (negligible) / Low / Normal / High	**Water Color**	Normal / Abnormal Abnormal description: ______________
Weather Conditions	Sunny / Partly Cloudy / Overcast / Fog/haze / Drizzle / Rain / Intermittent Rain / Snow		
Other Conditions	Sea Nettles / Dead Fish / Dead Crabs / SAV / Oil Slick / Ice / Debris / Erosion / Foam / Bubbles / Odor		
Comments:			

Parameter	Field Reading	Field Replicate	Acceptable Replicate Range
Air Temperature (ºC)			Armored (+/- 1° C) Digital (+/- 0.5° C)
Alkalinity (mg/L)			< 100 mg/L = +/- 10 mg/L > 100 mg/L = +/- 20 mg/L
Conductivity (µS/cm)			+/- 2% FS
Dissolved Oxygen (mg/L)			+/- 0.6 mg/L
Nitrate (mg/L)			Low range (0–1 mg/L) = +/- 0.1 mg/L Mid range (1–10 mg/L) = +/- 1 mg/L
Orthophosphate (mg/L)			N/A
Phosphate (mg/L)			+/- 0.04 mg/L
pH			+/- 1 pH unit
TDS (mg/L)			+/- 2% FS
Turbidity (NTU)			+/- 5 JTU
Water Clarity (cm)			N/A
Water Temperature (°C)			Armored (+/- 1° C) Digital (+/- 0.5° C)

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):

Name: ________________________________ Hours: ___________ (Round to nearest 15 min.)

Name: ________________________________ Hours: ___________ (Round to nearest 15 min.)

Name: ________________________________ Hours: ___________ (Round to nearest 15 min.)

Lead Monitor Signature: ______________________________________ Date: _________

Appendix F. Participating Monitoring Groups

Code	Name	BenthicMethod	ContactName	ContactEmail	Description	Url	AddressFirst	AddressSecond	City	State	Zip
ACB	Alliance for the Chesapeake Bay		Sophie Stern	sstern@allianceforthebay.org	RiverTrends VA - monthly sampling for air and water temp, dissolved oxygen, pH,	https://www.allianceforthebay.org	612 Hull Street	Suite 101C	Richmond	VA	23224
ARK	Anacostia Riverkeeper		Robbie O'Donnell	robbie@anacostiariverkeeper.org	Weekly summer bacteria monitoring using the IDEXX system in DC, Virginia and	https://www.anacostiariverkeeper.org	515 M St. SE	Suite 218	Washington	DC	20003
AACC	Anne Arundel Community College		Tammy Domanski	tldomanski@aacc.edu			101 College Parkway		Arnold	MD	21409
AWA	Antietam Watershed Association	allarm		letourns@dickinson.edu	ALLARM partner group in Waynesboro, PA.	www.antietamws.org	PO Box 331	32 West Main St	Waynesboro	PA	17268
ACWA	Antietam-Conococheague Watershed Alliance		Susan Simonson	crickhollowmd@gmail.com	Started monitoring in 2019 with CMC approved methods manuals and QAPP					MD	
ARF	Arundel Rivers Federation		Sarah Giordano	sarahg@southriverfederation.net	2017/2018 data is Tier 2, Tier 3 approved March 2019 and beyond.	https://www.arundelrivers.org	2822 Solomons Island Road	Suite 202	Edgewater	MD	21037
ABWS	Atlantic Blue Water Services		Brianna Griffin	brianna@atlanticblue.net	2022 RiverTrends MD group				Westminster	MD	
ANS	Audubon Naturalist Society		Cathy Wiss		Benthic Tier 2 - stream side identification to family level	www.anshome.org			Chevy Chase	MD	
BRVMN	Beagle River Virginia Master Naturalists	iwl									
BSWA	Big Spring Watershed Association	allarm		letourns@dickinson.edu	ALLARM partner group in Newville, PA.	http://bigspringwatershed.blogspot.com	P.O. Box 52		Newville	PA	17241
BNWR	Blackwater National Wildlife Refuge		Ron Ketter	rgketter@gmail.com	CMC approved Program Manual, trained in 2021. Taking surface and bottom					MD	
BWB	Blue Water Baltimore		Alice Volpitta	avolpitta@bluewaterbaltimore.org	Tier III approved 2018	https://www.bluewaterbaltimore.org	2631 Sisson Street		Baltimore	MD	21211
BSU	Bowie State University		Alan Anderson	ajanderson@bowiestate.edu	RiverTrends MD					MD	
BCVM	Bradford County Volunteer Monitors			letourns@dickinson.edu	ALLARM partner group in Bradford County, PA and Tioga County, NY.		28 N College St PO Box 1773		Carlisle	PA	17013
BCWA	Buffalo Creek Watershed Alliance	allarm	Dave Staebler	dlstaebler@att.net	Buffalo Creek Watershed Association, Union County PA.	http://www.buffalocreekwatershed.org	P.O. Box 501		Lewisburg	PA	17837
CSP	Caledon State Park		Callie Morgan	callie.morgan@dcr.virginia.gov	RiverTrends VA		11617 Caledon Road		King George	VA	22485
CCPSEC	Centre County Pennsylvania Senior Environmental Corps	allarm	Joyce McKay	mckayjm@yahoo.com	The mission of the Centre County Pennsylvania Senior Environmental Corps (CCPaSEC)	www.ccpasec.org				PA	
CBF	Chesapeake Bay Foundation		Sam Woolford	swoolford@cbf.org							
CBGS	Chesapeake Bay Governor's School		Kim Olsen	kolsen@cbgs.k12.va.us	RiverTrends VA		52 Campus Dr.	Rappahannock Community College	Warsaw	VA	22572
CWT	Chesterfield WaterTrends		Lorne Field	FieldL@chesterfield.gov	DEQ Volunteer Program		9800 Government Center Parkway		Chesterfield	VA	23832
CS	City of Suffolk		Heather Baggett	hbaggett@suffolkva.us	DEQ Program		442 W. Washington Street		Suffolk	VA	23434
CCST	Columbia County Stream Team/ALLARM	allarm	Stephanie Letourneau	letourns@dickinson.edu	ALLARM Stream Team group in Columbia County, PA.				Bloomsburg	PA	
CSI	Community Science Institute		Nathaniel Launer	nathaniel.launer@communityscience.org	Non-profit organization and certified water quality testing lab in Ithaca, NY.	www.communityscience.org				NY	
CCWA	Conodoguinet Creek Watershed Association	allarm		letourns@dickinson.edu	ALLARM partner group in Carlisle, PA.		28 N College St PO Box 1773		Carlisle	PA	17013
CRPA	Cowpasture River Preservation Association	iwl									
CSAWCD	Culpeper Soil and Water Coservation District	iwl	Greg Wichelns	gregw@culpeperswcd.org	VA DEQ 319 Bacteria TMDL monitoring and VA SOS					VA	
CCCD	Cumberland County Conservation District			letourns@dickinson.edu	ALLARM partner group for the Conodoguinet Watershed Snapshot, in Cumberland		310 Allen Road, Suite 301		Carlisle	PA	17013
CCSTA	Cumberland County Stream Team/ALLARM	allarm	Stephanie Letourneau	letourns@dickinson.edu	ALLARM Stream Team group in Cumberland County, PA.					PA	
CVTU	Cumberland Valley Trout Unlimited			letourns@dickinson.edu	ALLARM partner group in Cumberland County, PA.		28 N College St PO Box 1773		Carlisle	PA	17013
DRBA	Dan River Basin Association	iwl									
DCSTA	Dauphin County Stream Team/ALLARM	allarm	Stephanie Letourneau	letourns@dickinson.edu	ALLARM Stream Team in Dauphin County, PA.					PA	
DCWA	Deer Creek Watershed Association		Tami Imbierowicz	timbierowicz@harford.edu	CMC 2019, part of the Head of the Bay Alliance					MD	
E2	EcoCrew 2831		Tom McKee	asr.tom.mckee@gmail.com	RiverTrends VA - High School Scout Troop				Chesterfield	VA	
ENERWA	Elk and North East River Watershed Association		George Kaplan	gkaplan@zoominternet.net	CMC monitoring group 2018					MD	
FC	Ferrum College	iwl									
FMRO	Four Mile Run Conservancy		Kurt Moser	kmoser@fourmilerun.org	VA DEQ mini grant 2020					VA	
FAC	Friends of Accotink Creek	iwl									
FDR	Friends of Dragon Run		Meo Curtis	meosotis58@verizon.net	RiverTrends VA - started in December 2020.	www.dragonrun.org				VA	
FB	Friends of the Bohemia	iwl	Chuck Foster	friendsofthebohemia@gmail.com	CMC tidal monitoring - 2018 data is provisional tier 2 and 2019 and beyond is Tier 2.	www.friendsofthebohemia.org	PO Box 506	40 Two Rivers Lane	Chesapeake City	MD	21915
FMR	Friends of the Middle River	iwl		fomr.mccue@gmail.com	VA DEQ WQ program and IWLA benthic						
FOR	Friends of the Rappahannock		Adam Lynch	adam.lynch@riverfriends.org	RiverTrends VA	https://www.riverfriends.org	3219 Fall Hill Ave		Fredericksburg	VA	22401
GCWD	Gods Country Water Dogs			letourns@dickinson.edu	ALLARM partner group in Potter and Tioga County, PA.		28 N College St PO Box 1773		Carlisle	PA	
GCA	Goose Creek Association	iwl									
GA	Green Aquia		Deborah Caldwell	debora.caldwell@gmail.com	RiverTrends VA						
GVC	Gunpowder Valley Conservancy		Darcy Herman	dherman@gunpowdervc.org	RiverTrends MD					MD	
HAWQS	Henrico Area Water Quality Samplers	iwl	Stacey Heflin	hef001@henrico.us	VA DEQ Volunteer Program		8600 Dixon Powers Dr		Henrico	VA	23228
HRMN	Historic Rivers Master Naturalists		Trevor Long	Trevor.Long@jamescitycountyva.gov	RiverTrends VA - James City County manage HRMN group members who reside in		2008 Governors Square		Williamsburg	VA	23188
HC	Hoffler Creek		Ashley Morgan	ashley.morgan@hofflercreek.org	VA DEQ Tier 1 group starting in 2021					VA	
JCC	James City County		Trevor Long	Trevor.Long@jamescitycountyva.gov	RiverTrends VA - also works with Historic Rivers Master Naturalists		101 E Mounts Bay Road	PO Box 8784	Williamsburg	VA	23187
JRA	James River Association	iwl		jbrunkow@jrava.org	VA DEQ volunteer program	www.jrava.org				VA	
JRMN	James River Master Naturalists		Elena Henderson	pray4elena@gmail.com	RiverTrends VA					VA	
JMSAWCD	John Marshall Soil and Water Conservation District	iwl	Michael Trop	Michael.Trop@fauquiercounty.gov	VA DEQ 319 bacteria TMDL monitoring and VA SOS					VA	
JRRC	Johnston Run Revitalization Council	allarm		letourns@dickinson.edu	ALLARM partner group in Mercersburg, PA.				Mercersburg	PA	17236
LCSTA	Lackawanna County Stream Team/ALLARM	allarm	Stephanie Letourneau	letourns@dickinson.edu	ALLARM Stream Team in Lackawanna County, PA.					PA	
LACA	Lake Anna Civic Association		Kenneth Remmers	remmerskd@verizon.net	VA DEQ volunteer program					VA	
LWQVC	Lancaster Water Quality Volunteer Coalition	allarm	Matt Kofroth	MattKofroth@lancasterconservation.org						PA	
LCSTA.2	Lebanon County Stream Team/ALLARM	allarm	Stephanie Letourneau	letourns@dickinson.edu	ALLARM Stream Team in Lebanon County, PA.					PA	
LRA	LeTort Regional Authority	allarm		letourns@dickinson.edu	Data collected by Alliance for Aquatic Resource Monitoring (ALLARM).		415 Franklin Street		Carlisle	PA	17013
LGBG	Lewis Ginter Botanical Garden		Karin Stretchko	KStretchko@reynolds.edu	VA DEQ QAPP					VA	
LWC	Loudon Wildlife Conservancy	iwl									
LSRA	Lower Susquehanna Riverkeeper Association	allarm		letourns@dickinson.edu	ALLARM Stream Team partner in York, PA.	www.lowersusquehannariverkeeper.org			Wrightsville	PA	17368
LCSTA.1	Luzerne County Stream Team/ALLARM	allarm	Stephanie Letourneau	letourns@dickinson.edu	ALLARM Stream Team in Luzerne County, PA.					PA	
MDE	Maryland Department of the Environment		Billy Evans	wevans@maryland.gov	Tier 3					MD	
MRM	Maury River Monitors	iwl									
MSW	MBSS Stream Waders		Katherine Hanna	Katherine.hanna@maryland.gov	Maryland Biological Stream Survey Stream Waders program data					MD	
MPMN	Middle Peninsula Master Naturalists		Susan Crocket		RiverTrends VA starting in November, 2019. Data uploaded for WH, WL, and RR					VA	
MSWA	Middle Spring Watershed Association			letourns@dickinson.edu	ALLARM partner group in Shippensburg, PA.		28 N College St PO Box 1773		Carlisle	PA	17013
NRPA	Nansemond River Preservation Alliance		Elizabeth Taraski	taraski.nrpa@gmail.com	VA DEQ approved QAPP					VA	
NWA	Nanticoke Watershed Alliance		Beth Wasden	bethwasden@nanticokeriver.org	Formed in 2007, the Nanticoke Creekwatchers Program collects data in the entire	www.nanticokeriver.org	P.O. Box 111	113 Old Ocean Gateway	Vienna	MD	21869
NRVVMN	New River Valley Virginia Master Naturalists	iwl									
NYWS	New York Water Sentinels	allarm	Stephanie Letourneau	letourns@dickinson.edu	ALLARM partner shale gas groups.					NY	
NRCA	North Ridge Citizens Association		Bill Gillespie	bgillespie70@hotmail.com	RiverTrends VA				Alexandria	VA	
NNMN	Northern Neck Master Naturalists		Audrey Vaughn	virginiariverbreeze@gmail.com	RiverTrends VA					VA	
NVSWCD	Northern Virginia Soil and Water Conservation District			Daniel.Schwartz@fairfaxcounty.gov	NVSWCD submits their data to IWLA VA SOS. ACB updated their thermometers and pH						
NVTU	Northern Virginia Trout Unlimited	iwl									
OWA	Octoraro Watershed Association		Rupert Rossetti	rupertrossetti@gmail.com	Monitoring under the Lancaster Water Quality Volunteer Coalition.						
OCCA	Otsego County Conservation Association	allarm		letourns@dickinson.edu	ALLARM partner group in Otsego County, NY.		7207 State Highway 80, PO Box 931		Cooperstown	NY	13326
PHG	Patapsco Heritage Greenway		Abri Segal	phgintern@patapsco.org	2020 RiverTrends MD group					MD	
PVMN	Peninsula Chapter Virginia Master Naturalists		David Singletary	david.singletary@gmail.com	Falls under VA DEQ volunteer program.		312 Parkway Drive		Newport News	VA	23606
PCST	Perry County Stream Team/ALLARM	allarm	Stephanie Letourneau	letourns@dickinson.edu	Stream Team in Perry County, PA.					PA	
PEC	Piedmont Environmental Council		Claire Catlett	ccatlett@pecva.org	Claire works with volunteers to regularly monitor one site each month, with						
PRK	Potomac Riverkeeper		Dean Naujoks	dean@potomacriverkeeper.org	CMC 2019	https://www.potomacriverkeepernetwork.org	3070 M Street NW		Washington	DC	20007
PWSWCD	Prince William Soil and Water Conservation District	iwl	Veronica Tangiri	waterquality@pwswcd.org	PWSWCD submits their benthic data to IWLA VA SOS. Has a VA DEQ approved QAPP	www.pwswcd.org	8850 Rixlew Lane		Manassas	VA	20109
RCC	Reedy Creek Coalition		Bill Shanabruch	billanddi@verizon.net	RiverTrends VA - Started monitoring in 2011 under the Alliance's QAPP with DEQ but					VA	
RA	Reston Association	iwl	Garrett Stewart	gstewart@reston.org	Lakes and Streams program conducted by Reston Staff					VA	
RV	Reston Volunteers	iwl	Garret Stewart	gStewart@reston.org	RiverTrends VA and VASOS					VA	
RVS	Ridge Valley Streamkeepers		Jinnie Monismith	monismij@dickinson.edu	ALLARM partner group		P.O. Box 1773		Carlisle	PA	17013
RCA	Rivanna Conservation Alliance		Rachel Pence	rachelpence@rivannariver.org	VA DEQ program for both benthic and water quality data.	www.rivannariver.org	1150 River Road	Suite One	Charlottesville	VA	22901
RMN	Riverine Master Naturalists		Diane Dean	ddean.mg@gmail.com	RiverTrends VA					VA	
RCIWLA	Roanoke Chapter- Izaak Walton League of America	iwl									
RWM	Rockbridge Water Monitors		Sandra Stuart		RiverTrends VA					VA	
RRM	Rush River Monitors		Claire Catlett	ccatlett@pecva.org	RiverTrends VA ONLY bacteria - This group will do bacteria monitoring every other					VA	22747
SRA	Severn River Association		Tom Guay	ecalert@gmail.com	CMC Tier 2 starting in 2019	https://severnriver.org	7076 Bembe Beach Road, Suite 203	PO Box 146	Annapolis	MD	21404
SUES	Shenandoah University Environmental Studies	iwl									
SVSAWCD	Shenandoah Valley Soil and Water Conservation District	iwl									
SCC	Spa Creek Conservancy		Tammy Domanski	tldomanski@aacc.edu	Working under Anne Arundel Community College					MD	

TUCCC	Trout Unlimited Coldwater Conservation Corps		Jake Lemon	jacob.lemon@tu.org	TU Coldwater Conservation Corps partners with ALLARM in PA.		
TUPMP	Trout Unlimited Pipeline Monitoring Program		Jake Lemon	Jacob.Lemon@tu.org	Pipeline monitoring program of Trout Unlimited, partner group with ALLARM in VA		
USNADC	United States National Arboretum D.C.			mpeters@fona.org	RiverTrends MD - Set up through a NFWF Grant with ACB to monitor Spring House		DC
VSOS	Virginia Save Our Streams	iwl		ebialowas@iwla.org			
VSU	Virginia State University				RiverTrends VA		
WET	Wicomico Environmental Trust		Deborah Finkbeiner	dmf.wet@gmail.com	CMC group as of February 2020		MD
YCST	York County Stream Team/ALLARM	allarm	Ted Evgeniadis	lowsusriver@hotmail.com	ALLARM Stream Team group in York County, PA.	York	PA
YMNA	York MWS Nature Abounds		Jodi Sulpizio	jrb143@psu.edu	York Master Watershed Stewards Nature Abounds monitors.		PA

Appendix G: List of Data Explorer Problem and Qualifier codes

QUALIFIER AND PROBLEM CODE FACTSHEET

Qualifier Codes

Table 1: Qualifier codes available in the CMC Data Explorer. Only codes labeled "Field" will be available on the data upload form, all codes are available for bulk upload.

Field/Lab	Code	Description
Field/Lab	<	Value reported is **less than** the method detection limit (MDL) for the equipment used to analyze the sample. Used for lab grab samples if the lab reports a value lower than the MDL or field samples like bacteria (Coliscan or R-Card) analyses.
Field	>	Value reported equals the upper range limit for the equipment used, but the actual reading or measurement is **greater than** this value. Used for secchi depth, turbidity tube, and bacteria (Coliscan or R-Card) readings.

When to use qualifier codes

Qualifier codes are used to describe cases where the value reported for a sample is less than or greater than the detection limit for the equipment used to analyze the sample.

- Less than (<) - is used for lab data, or in some cases field data (like bacteria Coliscan or R-Card samples), when the value reported is less than the method detection limit (MDL) for the associated lab and/or equipment. All labs are required to report their MDL for each parameter analyzed and this information is stored within the Data Explorer.
- Greater than (>) - is used for water clarity data (secchi depth or turbidity tube) when the reading is actually greater than the highest achievable value (ie. the secchi disk is visible on the stream bed or when the turbidity tube is filled to the top and the disk is still visible) and bacteria data when the plate is "too numerous to count" or above the upper range limit for the method (typically 2419 CFU/100mL or MPN).

How to use qualifier codes

Qualifier codes should be associated with the water quality **value** reported for an individual parameter or data point.

- The less than (<) symbol will be automatically attached to the data if the value reported is less than the MDL recorded for that parameter and lab. The less than symbol can also be attached to the data manually during the bulk upload process or via the data upload form/edit and review process.

- The greater than (>) symbol is attached to the data manually during the bulk upload process or via the data upload form/edit and review process.
    - If the secchi disk is visible while sitting on the stream bed, the total depth should be recorded as the value with the > symbol as the qualifier code.
    - If the secchi disk is visible at the bottom of the Turbidity Tube while the tube is completely full, the highest value achievable (could be 55cm, 60cm, 115cm, or 120cm) should be recorded with the > symbol as the qualifier code.

Who should use qualifier codes

Qualifier codes should be assigned by project coordinators during the quality assurance checks in place for their specific programs. In some cases individual monitors may include a code on the data upload form, but that code should be checked by the appropriate coordinator.

What happens to the data after a qualifier code is used?

All qualifier codes are attached to the value reported when these data are downloaded from the Query page of the Data Explorer or submitted to the Chesapeake Bay Program and the Water Quality Exchange (WQX). There are multiple methods for handling below MDL values and each system may handle them differently.

Problem Codes

Table 2: Problem codes available in the CMC Data Explorer. Only codes labeled "Field" will be available on the data upload form, all codes are available for bulk upload.

Field/Lab	Code	Name	Description
Field	A	Calibration or Standardization failed	Must be used if a sample value is reported, but the calibration or standardization for that equipment failed.
Field	B	Post-sample check failed	Must be used if the sample value is reported, but the post-sample check technique for that equipment failed for specific sampling events. If the issue is chronic, data should be downgraded to a lower Tier or flagged with the "Q" code instead.
Field	C	Field replicate out of range	Must be used if the field replicates or duplicates for kit or probe measurements are out of range. If the issue is chronic, data should be flagged with the "Q" code instead.
Field	V	Other Field QA/QC issue	Must be used if any other quality assurance or quality control measures are not met.
Field	X	No routine sample taken - see comments	Can be used to record that a routine measurement was not taken for a specific sampling date. Should be accompanied by an explanation in the comments section.
Lab	D	Lab sample not preserved properly	Reported by the lab if the sample was received and not preserved (either with acid or on ice) properly.
Lab	E	Lab sample received after holding time	Reported by the lab if the sample was received after the appropriate holding time.
Lab	F	Lab sample analyzed after holding time	Reported by the lab if the sample was analyzed after the appropriate holding time.
Lab	G	Other Lab QA/QC issues	Reported by the lab if there is some issue with the sample (ie. not enough sample was collected, chemical interference, lab analysis issues, etc.).
Lab	H	Lab sample field blank failed	May be reported by the lab, but should be checked by the program coordinator when lab data is received.
Lab	I	Lab sample field duplicate out of range	May be reported by the lab, but should be checked by the program coordinator when lab data is received.

When to use problem codes

Problem codes are used to signify a quality assurance or quality control issue or concern with a specific data point so a data user can make a decision whether or not to use that data. Problem codes should be used in the following ways:

- By groups who have volunteer monitors upload their data on the data upload form and a coordinator performs the quality assurance checks at a later date to flag data that failed QA checks.
- By groups who take grab samples to a lab for analysis if the lab flags data.

Monitoring groups who bulk upload field data most likely remove questionable data prior to upload. Problem codes can be included in the bulk upload process if questionable data are included.

How to use problem codes

Problem codes should be associated with the water quality **value** reported for an individual parameter or data point.

- The problem codes labeled “Field” can be attached to a data point via the data upload form or on the edit and review page by clicking the red circle next to the parameter and selecting the appropriate code from the drop down list.
- All problem codes can be attached to a data point via the bulk upload form by including the code in Column K “Problem” on the data upload template.

Who should use problem codes

Problem codes should be assigned by project coordinators during the quality assurance checks in place for their specific programs. In some cases individual monitors may select a code on the data upload form, but that code should be checked by the appropriate coordinator.

What happens to the data after a problem code is used?

Problem codes are used to alert a potential data user to a quality assurance or quality control issue with a particular data point. All problem codes are attached to the value reported when data are downloaded from the Query page of the Data Explorer or submitted to CBP and WQX. There are multiple methods for handling problem codes and each system may handle them differently.

Appendix H: Non-Tidal Tier 3 Process

CMC Non-Tidal Tier 3 Process

The CMC Non-Tidal Tier 3 Process is based on Virginia and Maryland regulatory decision making data used in their respective 303(d)/305(b) Integrated Reports. The CMC requirements are a summary of the individual state requirements to lay the foundation for the process and ensure data are compatible across jurisdictions, but Tier 3 determinations will defer to the individual state standards and requirements where monitoring is occurring. The CMC Non-tidal Tier 3 parameters are included in Table 1, additional parameters may be considered on a case by case basis if included with a Tier 3 program.

Data Use:

- Virginia Department of Environmental Quality 303(d)/305(b) Integrated Report
- Maryland Department of the Environment 303(d)/305(b) Integrated Report

Monitoring Program Requirements:

- EPA/CBP or State approved program QAPP (approved every 5 years, updated annually as needed)
- Field Audit conducted by the State and/or CMC (every 5 years along with QAPP approval)
- Bacteria Lab Requirements - VELAP/NELAP certification, State approval, or annual NSI laboratory proficiency testing.
- Sampling Frequency (varies based on parameter and state) - Ideally sampling occurs at least monthly, year-round for all parameters, except for Bacteria which is weekly May-September. Ultimately, the quality assurance procedures and monitoring methods determine the quality of the data produced and not the specific sampling schedule.

Review and update QAPP annually:

- If no changes the group maintains Tier 3 under the current QAPP.
- If there are minor changes, update the Program QAPP and resubmit the approval authority. Minor changes include: adding or removing a few stations, equipment changes with similar equipment, personnel changes as long as there is an existing staff member to train the new staff, or lab changes.
- If there are major changes that significantly impact the structure of the program or monitoring protocols, a new QAPP must be submitted for a full review and a new field audit may be requested. Major changes include: updated program structure, changed monitoring protocols or methods, major staff turnover without overlap or training of new staff.

Table 1: Parameters included in the CMC Non-Tidal Tier 3 process.

Parameter	Other Requirements
Bacteria (e.coli and enterococcus)	● Method: IDEXX enterolert and Colilert, membrane filtration. ● Certified Lab (NELAP/VELAP), State approved lab, or NSI proficiency testing (depending on jurisdiction) ● 10% field and lab blanks/duplicates
Dissolved Oxygen	● Equipment: individual probe or multiprobe sonde ● 1 point calibration (100% saturation) prior to each sampling event. ● Post-sample checks after each sampling event. ● Equipment: Winkler titration kit ● Sodium Thiosulfate standardization prior to each sampling event. ● 100% field replicates
Water Temperature	● Equipment: digital thermometer or multiprobe sonde ● Annual Thermometer checks with a NIST traceable thermometer in cold, room temperature and warm water.
pH	● Equipment: Individual probe or multiprobe sonde ● 2 point calibration bracketing the expected reading prior to each sampling event. ● Post-sample checks after each sampling event.
Turbidity	● Equipment: Field colorimeter or multiprobe sonde ● 1 point calibration within the typical field reading range.

Virginia

VA DEQ will consider CMC Tier 2 and Tier 3 for inclusion in the Water Quality Assessment 303(d)/305(b) Integrate Report at DEQ Level 2 and Level 3 respectively, but individual data points may be downgraded during analysis based on specific QA requirements. See the VA DEQ Citizen Monitoring Website for specific requirements.

Program Requirements:

- VA DEQ approved Program QAPP - annually approved
    - Any group that received CitMon funding annually must have a VA DEQ approved program QAPP for Level 2 and 3 data collection.
    - Any group that does not receive CitMon funding can also submit a QAPP for VA DEQ approved to have their data used as Level 3.
- VA DEQ Field Audit - annual
- VELAP/NELAP certified lab or VA DEQ approved Lab (lab audit conducted)
- Sampling frequency - Level 3 requirements are based on the methodology used not on sampling frequency. Can combine data with other datasets to complete the data set needed for analysis.

Parameter	**Other Requirements**
Bacteria (e.coli)	• Method: IDEXX Colilert • VELAP/NELAP certification or VA DEQ approved Lab
Dissolved Oxygen	• Calibrated probe • Standardized Winkler titration
Water Temperature	• Annual thermometer checks
pH	• Calibrated probe

Maryland

MDE will assess Tier 3 data to list or delist waters (Category 2 or 5) in the Integrated Report (IF), support attainment purposes, and contribute to the State data for Total Maximum Daily Load (TMDL) development. See the MDE Data Solicitation page for more information on MDE Tier 3 criteria.

Program Requirements:

- EPA approved Program QAPP- approved every 5 years.
    - Maintain Tier 3 annually - CMC checks in with each group to identify any programmatic updates. If minor changes (include: adding or removing stations, equipment updates with similar equipment used, minor personnel turnover) occur, document in the QAPP. If major changes occur (including: updated program structure, changing monitoring protocols, major personnel changes, etc.) the group must submit a new QAPP for approval and complete a new field audit.

- CMC/MDE Field Audit is completed in the first year after the QAPP is approved (can be done anytime during the first season).
    - The Field Audit is good for the entirety of the QAPP performance period (5 years), unless a major change occurs.
- Lab - NSI proficiency testing for bacteria (both IDEXX and membrane filtration) completed annually prior to sampling beginning.
    - Must do PT testing for any analyte they want to be Tier 3 (ecoli and/or enterococcus).

Parameter	**Other Requirements**
Bacteria (e.coli and enterococcus)	• Weekly samples May-September • Annual NSI Lab proficiency testing
Dissolved Oxygen	• Calibrated probe
pH	• Calibrated probe
Turbidity	• Turbidity (colorimeter) in NTU