QUALITY ASSURANCE PROJECT PLAN

Integrating Citizen-based and Nontraditional Monitoring into the Chesapeake Bay Program Partnership: Benthic Macroinvertebrate Monitoring in Wadeable Streams (Tiers I & II)

Prepared for:

United States Environmental Protection Agency
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March 31, 2017

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Section A – Program Management Elements

A1. Title and Approval Page

Project Name: Integrating Citizen-based and Nontraditional Monitoring into the Chesapeake Bay Program Partnership: Benthic Macroinvertebrate Monitoring in Wadeable Streams (Tiers I & II)

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This document has been prepared according to the United States Environmental Protection Agency publications – *The Volunteer Monitor's Guide to Quality Assurance Project Plans,* EPA 841-B-96-003, 1996*,* available at http://water.epa.gov/type/rsl/monitoring/qappcovr.cfm and *EPA Requirements for Quality Assurance Project Plans*, EPA QA/R-5, 2001, available at http://www.epa.gov/quality/qs-docs/r5-final.pdf.

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KEY ACRONYMS

ACB	Alliance for the Chesapeake Bay
ALLARM	Alliance for Aquatic Resource Monitoring (Dickinson College)
CBP	Chesapeake Bay Program
CEC	Chesapeake Environmental Communications, Inc.
CMC	Chesapeake Monitoring Cooperative
DIWG	Data Integrity Workgroup
EPA	Environmental Protection Agency
IAN	Integration and Application Network

INWG	Integrated Monitoring Networks Workgroup
IWLA	Izaak Walton League of America
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
QMP	Quality Management Plan
SOP	Standard Operating Procedure
STAR	Scientific, Technical Assessment and Reporting
UMCES	University of Maryland Center for Environmental Science

A3. Distribution List

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

Name	Phone	E-mail	Organization
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A4. Project/Task Organization

A4.1 Project Organization

The Integration of Citizen-based and Nontraditional Monitoring into the Chesapeake Bay Program (CBP) Partnership project provides support, training, and guidance to volunteer and nontraditional monitoring groups sampling non-tidal and tidal portions of the Chesapeake Bay Watershed. The project is managed by the Alliance for the Chesapeake Bay (ACB) in partnership with the project coordinator at Izaak Walton League of America (IWLA), and includes partners at the University of Maryland Center for Environmental Science Integration and Application Network (UMCES) and Dickinson College's Alliance for Aquatic Resource Monitoring (ALLARM). These four organizations together are hereafter referred to as the "Project Team". The personnel involved in the implementation of this project are listed in Table A4-1, and participating organizations are shown in the organizational chart in Figure A4-1.

Table A4-1. Roles and individuals participating in this project.

Organization	Role in Project	Individuals Involved in Project
Alliance for the Chesapeake Bay (ACB)	Project Manager	Liz Chudoba, Water Quality Program Manager
Izaak Walton League of America (IWLA)	Project Coordinator	Emily Bialowas, Chesapeake Monitoring Outreach Coordinator
Alliance for the Chesapeake Bay (ACB)	Project Partner	Nissa Dean, Virginia Director
Alliance for Aquatic Resource Monitoring (ALLARM) @ Dickinson College	Project Partner	Julie Vastine, Director Jinnie Monismith, Assistant Director Candie Wilderman, Science Advisor
Izaak Walton League of America (IWLA)	Project Partner	Danielle Donkersloot, Clean Water Director
University of Maryland Center for Environmental Science Integration and Application Network (UMCES)	Project Partner	Caroline Donovan, Program Manager
Chesapeake Environmental Communications, Inc. (CEC)	Database Contractor	Dave Jasinski Dave Parrish
Certified Trainers	Trainer	To be determined
Monitoring Groups	Data Collectors	To be determined
Chesapeake Bay Program (CBP)	Data Users	EPA, Virginia DEQ, Maryland DNR, Pennsylvania DEP, etc.

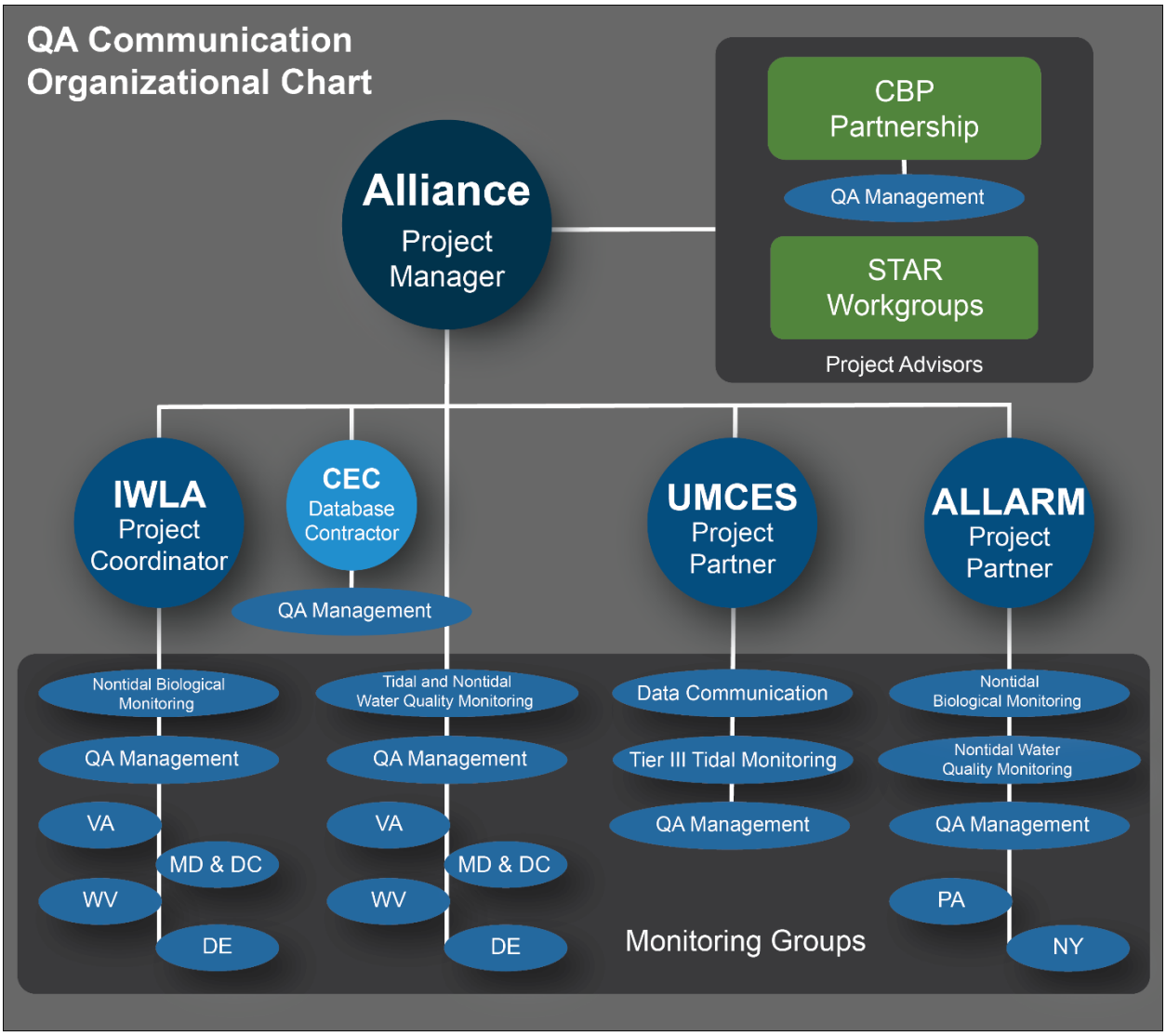

Figure A4-1. Quality assurance (QA) communication organizational chart.

ALLARM and IWLA will train and support volunteer and nontraditional monitoring groups to collect macroinvertebrate data following this Benthic Macroinvertebrate Monitoring in Wadeable Streams (Tiers I & II) Quality Assurance Project Plan (QAPP). ALLARM will coordinate the project's Macroinvertebrate Monitoring Program in the upper Chesapeake Bay Watershed (New York and Pennsylvania) and IWLA will coordinate the program in the lower portion of the watershed (Delaware, DC, Maryland, Virginia, and West Virginia).

The volunteer and nontraditional monitoring groups that will participate in this project will be spread throughout the Chesapeake Bay Watershed, however the number or location of groups cannot be determined at this time. The Project Team surveyed over 100 volunteer and nontraditional monitoring groups in the watershed (Figure A4-2). The groups that participate in the project will likely include a subset of the groups surveyed, groups that already have a relationship with the Project Team, and groups that begin a new monitoring program.

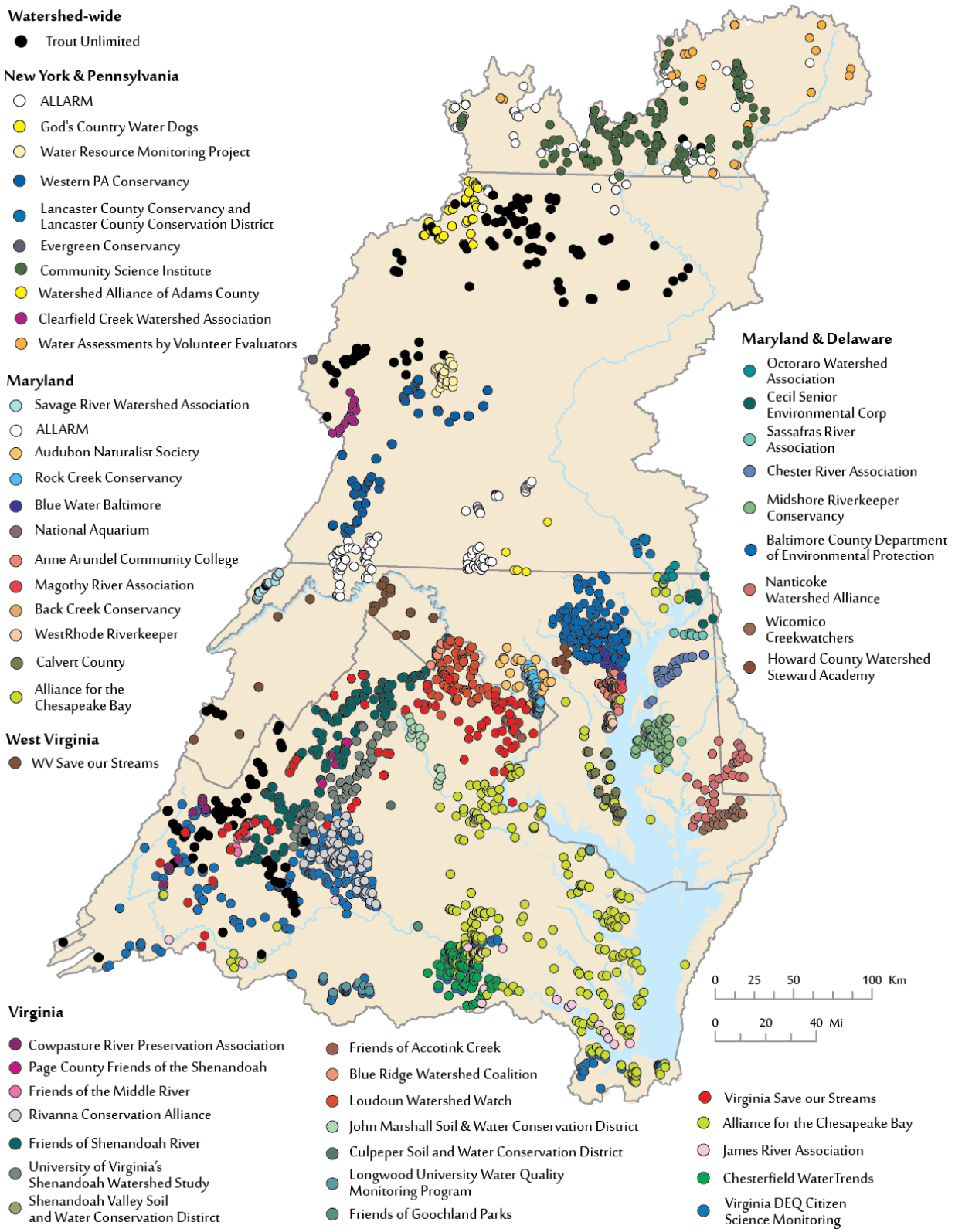

Figure A4-2. Sampling sites of volunteer and nontraditional monitoring groups in the Chesapeake Bay Watershed. *Note: all sites are not accounted for on map.*

A4.2 Roles and Responsibilities

Data collected through this project will be categorized into three tiers based on the quality of the data (see A5.2 Data Use). The roles and responsibilities for the entire project are summarized below, however only those that pertain to Tier I and II macroinvertebrate data collection in wadeable streams are relevant to this Benthic Macroinvertebrate Monitoring in Wadeable Streams (Tiers I & II) QAPP.

Data Users – Chesapeake Bay Program Partnership:

a. 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;
b. Identifies individual(s) to approve the three project Tier I and II QAPPs (macroinvertebrate, non-tidal water quality, and tidal water quality monitoring); and
c. Follows the communication protocols outlined in Figure A4-1.

Project Manager – Alliance for the Chesapeake Bay:

a. Manages the Project Team to ensure the Quality Management Plan (QMP), QAPPs, and Quality Assurance (QA) policies are implemented;
b. Develops the QMP and annual reviews, and updates the 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;
c. Oversees the effective implementation of the QMP and QAPPs;
d. Ensures that the quality program has adequate resources to accomplish all of the requirements established in the QMP and QAPPs; and
e. Is responsible for all items listed under Project Team.

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

a. Reviews the project QAPPs and provides guidance to the Project Team for effective implementation of the QAPPs;
b. Reviews the QA/QC programs, practices, systems, training materials, and performance annually to ensure practices are in accordance with the QMP. Subsequently documents and responds to QA/QC needs and issues;
c. Acts as a liaison between the Project Team and the Data Integrity Workgroup (DIWG) and attends DIWG meetings;
d. Assists with QA dispute resolutions (if/when needed); and
e. Assesses data management procedures for the monitoring programs and the project database to ensure they meet data quality objectives outlined in the QMP and QAPPs.

Project Team – Alliance for Aquatic Resource Monitoring, Izaak Walton League of America, University of Maryland Center for Environmental Science:

a. Ensures that all monitoring groups adhere to the QMP and approved QAPPs;
b. Ensures that all monitoring operations are covered by the appropriate documentation (i.e., SOPs, QAPPs, project plans);
c. Develops, reviews, updates, and approves SOPs for monitoring activities;
d. Conducts workshops and certifies monitors;
e. Continually assesses collected data and monitors performance through data QC, workshops, and re-certifications to identify QA compliance or deficiencies. All QA deficiencies will be properly documented and attempted to be resolved;
f. Establishes quality assurance measures for the three Tier I and II QAPPs and assists monitoring groups in QAPP implementation;
g. Reviews and oversees QA policies and SOP's of monitoring groups and documents findings for CBP and project records;
h. Complies with findings and recommendations from QA reviews and audits; and
i. Resolves disputes regarding quality system requirements, QA/QC procedures, certifications, or corrective actions.

Monitoring Groups – MD, DC, VA, WV, PA, NY, DE, Certified Labs:

a. Adheres to SOPs and complies with QAPP guidelines;
b. Evaluates and reports QA issues to designated Project Team member, regional liaison, or QA Manager as they occur; and
c. Maintains certification as outlined in the project's QAPPs.

Certified Trainer (see A8.4)**:**

a. Conducts workshops and certifies monitors;
b. Adheres to the Certified Trainer requirements;
c. Adheres to SOP guidelines;
d. Maintains annual certification;
e. Reports QA issues to regional Project Partner (ALLARM or IWLA); and
f. Complies with QA reviews or audits.

Data Integrity Workgroup (DIWG), Integrated Monitoring Networks Workgroup (INWG), and Scientific, Technical Assessment and Reporting (STAR) Workgroup:

a. Data Integrity Workgroup (DIWG) will help to identify QA criteria for Tier III data collection and analysis;
b. Integrated Monitoring Networks Workgroup (INWG) will help to identify QA criteria for Tier I and II data collection and analysis; and
c. Scientific, Technical Assessment and Reporting (STAR) will help to review and provide feedback on the Project Team's monitoring and training protocols, quality assurance procedures, and data management, analysis, and communication tools.

A5. Problem Definition/Background

The Project Team is partnering to provide technical, logistical, and outreach support for the integration of citizen-based and nontraditional (e.g., non-agency) monitoring data into the CBP partnership. While the CBP has immediate access to agency (federal and state) data collected in the watershed, volunteer and nontraditional groups that collect stream data are scattered throughout the watershed, and their data are not compiled in one, easily-accessible platform. The macroinvertebrate data these groups collect can be used to help answer many of the diverse questions asked by monitoring groups and the CBP. The integration of data collected by volunteer and nontraditional monitors into the CBP monitoring network will provide additional cost-effective information that supports shared decision-making and adaptive management by the CBP partners focused on restoration of the Chesapeake Bay and its watershed.

A5.1 Goals and Objectives

The CBP has identified a series of goals for which additional 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 nitrogen, phosphorus, and sediment inputs from contributing waters in the watershed to verify effectiveness and progress of management actions;
c. Identify nutrient and sediment "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).

In addition, CBP has identified priority data gaps, including data from small watersheds, which are typically the foci of volunteer and nontraditional monitoring groups. Based on the existing data available, as well as the potential for additional monitoring by these groups, the CBP is exploring ways to integrate nontraditional partners into the CBP partnership.

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

a. Establish institutional structures and procedures, such as the *Tiered Framework for Data Collection and Integration for Nontraditional Monitoring*;
b. Facilitate the development of rigorous and consistent monitoring and training protocols, technical guidance, data gathering tools, quality assurance mechanisms, and data analysis and communication tools;
c. Inventory, prioritize, and recruit monitoring groups; and
d. Provide training and technical support to nontraditional monitoring groups.

This comprehensive approach will ensure a consistent submittal of known quality data to the CBP. The objectives of this project are:

a. Provide technical, logistical, and outreach support to nontraditional data collectors working to monitor benthic macroinvertebrates in wadeable streams of the Chesapeake

Bay Watershed, in order for them to produce data that can be integrated into the CBP partnership. These data will help to fill spatial and temporal gaps within the CBP dataset and provide additional information to support Chesapeake Bay Watershed management decisions;

b. Provide support for monitoring groups to produce and use data to help address concerns they may have about the health of their local waterways;
c. Educate citizens about the Chesapeake Bay Watershed and the relationship between their local watershed health and the issues facing the Bay. Through this program, participants will learn about the scientific process and how macroinvertebrates can be an indicator of stream health. They will also gain an understanding of how data can be collected, managed, and analyzed to then communicate findings to the public and support watershed decisions in their communities and in the broader region; and
d. Facilitate the use of the data by monitoring groups in addition to the key stakeholders.

A5.2 Data Use

A *Tiered Framework for Data Collection and Integration for Nontraditional Monitoring* (*Tiered Framework;* Appendix A) was developed by the Project Team to establish three categories of data based on data quality. The data quality requirements for each tier are largely dependent on the methodology used and the quality assurance procedures implemented by the monitor. The Project Team categorized the methods and QA procedures used by volunteer and nontraditional monitoring groups into three tiers based on comparability testing, manufacturer's specifications, experience, and how they are classified by other water quality monitoring programs. The data collected through this project will be stored in the project database along with the metadata needed to inform the data users of the specific quality of the data. The *Tiered Framework* suggests potential uses of the data, however the uses can extend beyond what is suggested, and it is ultimately the decision of the data users to choose the data which are appropriate for their specific uses given the metadata supplied in the database. Table A5-1 lists the three data tiers along with the potential data uses and requirements.

The protocols established in this QAPP are designed to produce Tier I and Tier II data. Data collected from the CMC Macroinvertebrate Monitoring Program can be used by the CBP and other data users for the purpose of environmental health screening, environmental health report cards, targeting management actions, and education. Data can also be shared and used at the local level by local governments, community stakeholders, and residents to increase awareness and address environmental concerns. Using the data to inform local practices helps to meet the CBP goal of improving citizen engagement and the health of the Chesapeake Bay Watershed. The data will also provide a baseline of current watershed conditions to compare to if/when changes in the watershed occur. Groups collecting Tier III data are not covered by this QAPP. Additional information about Tier III data is included in the project's Quality Management Plan.

Data will be archived in a new project database, accompanied by the appropriate metadata to allow data users (both traditional and nontraditional) to determine appropriate end uses for

the data and to use them as they see fit. Chesapeake Environmental Communications, Inc. (CEC) will develop the database in coordination with the CBP Data Center staff.

Table A5-1. Summary of the three CMC data tiers from the *Tiered Framework*.

Tier	Potential Data Uses	Minimum Data Requirements
Tier I	Education, environmental health screening	Documentation showing that procedures outlined in this QAPP for collecting and producing Tier I data have been followed. All items must be reviewed and approved by a member of the Project Team: a. Written study design b. Documented monitoring methodology c. Documented site location(s) (with coordinates)
Tier II	Tier I uses plus environmental health report cards, targeting of management actions	State or federal government-approved EPA volunteer monitoring QAPP or written agreement to follow the procedures outlined in this QAPP to collect and produce Tier II data. All items must be reviewed and approved by a member of the Project Team: a. Written study design b. Documented monitoring methodology using field or laboratory standard operating procedures with defined levels of precision and accuracy c. Documented site location(s) (with coordinates) d. Acquired and maintained Tier II certification
Tier III	Regulatory assessment of water quality standards attainment	a. EPA or CBP approved QAPP b. EPA or CBP approved field/lab standard operating procedures c. Participation in DIWG field and lab audits

A6 Project/Task Description

A6.1 Project Timeline

This Quality Assurance Project Plan is designed to ensure that new data collected for the CMC Macroinvertebrate Monitoring Program will be done in an approved, quality-controlled, and standardized way. Monitoring groups collecting Tier I data will sample benthic macroinvertebrates in wadeable streams within the Chesapeake Bay Watershed (Figure A6-1) at least one time per year (two times per year is recommended). Monitoring groups collecting Tier II data will sample a minimum of two times per year (four times per year is recommended). The entire project period is May 2016 through April 2021 (Table A6-1). This QAPP will undergo an evaluation annually, and the Project Description will be updated during the annual evaluation if needed.

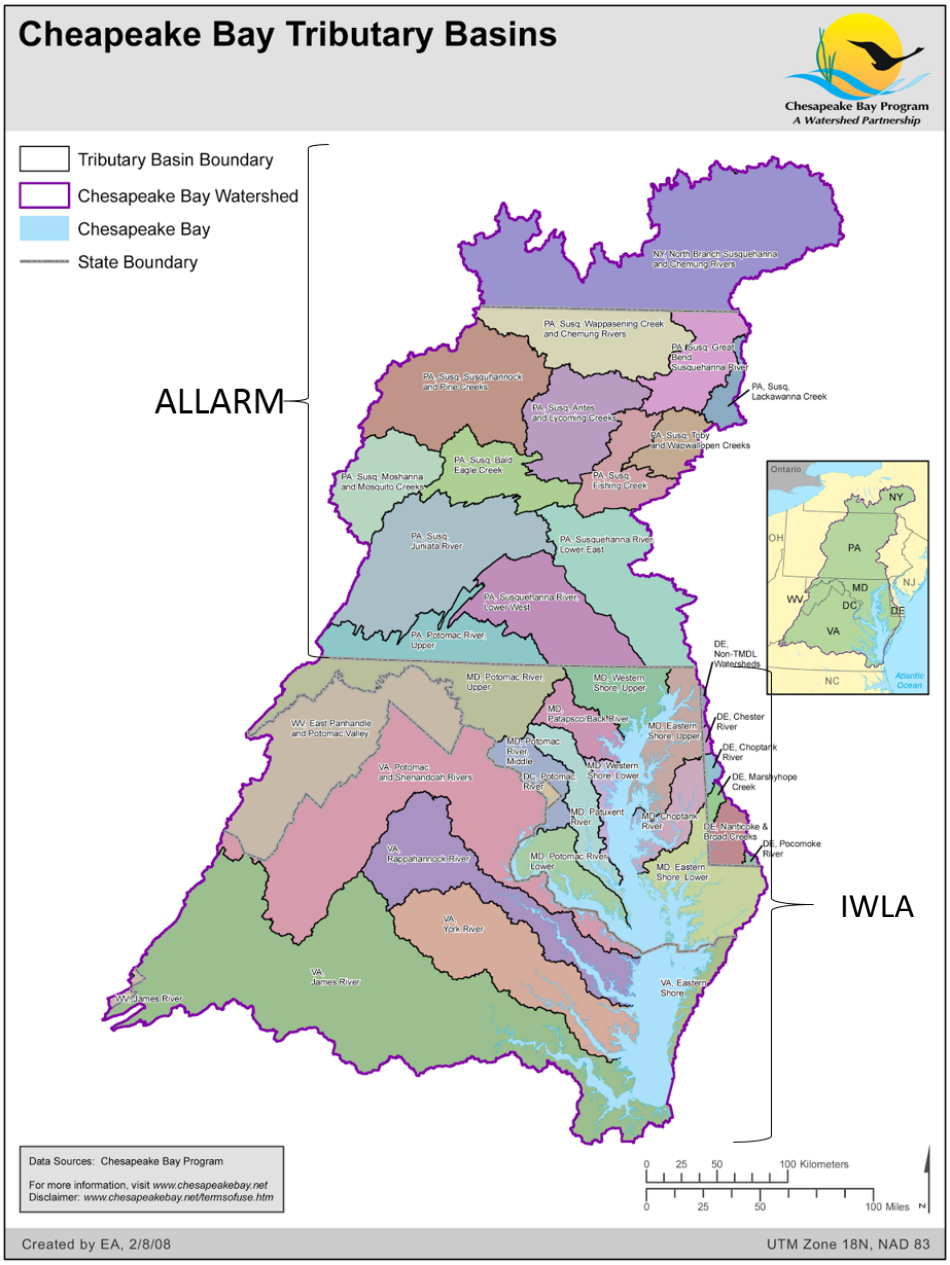

Figure A6-1. Areas of coordination by project partner (ALLARM & IWLA).

Table A6-1. Project timeline for six-year grant period.

Major Tasks	Timeframe
Project Team	
Develop project QMP and QAPPs (3)	2016 – 2017
Develop scientifically-valid and user-friendly protocols for monitoring streams and reporting data	2016 – 2017
Develop workshop training materials	2016 – 2017
Identify spatial and temporal gaps and develop strategies to fill those gaps	2016 – 2017
Develop a user-friendly database	2016 – 2017
Recruit, train, and certify monitors to collect water quality data	2016 – 2020
Train monitors on data analysis, synthesis, and communication	2017 – 2021
Submit data to the CBP (from the project database)	Annually
Recertify Certified Trainers	Annually
Recertify certified monitors	Biennially
Provide data management and quality assurance oversight to monitors	Ongoing
Monitors	
Collect and enter macroinvertebrate data into the project database	2017 – 2021
Submit field data sheets to the Project Team	Biannually

A6.2 Site Selection

This project aims to collect data through the assessment of streams throughout the Chesapeake Bay Watershed in order to gain a broader understanding of the health of the Chesapeake Bay and its tributaries. To achieve the goals of this project, each monitoring group will create a customized monitoring study design, in which sampling sites will be selected in accessible areas where additional information is needed to inform local watershed concerns and fill data gaps by the CBP and other data users. To date, the Project Team has surveyed over 100 volunteer and nontraditional monitoring groups and has collected information about their current sampling sites (Figure A4-2). The Project Team has also met with the CBP, state agencies, and key stakeholders to hear about their data needs. The information gathered by the Project Team from these entities, including a list of priority areas where data gaps exist, is summarized in the *Prioritization Report: How volunteer and nontraditional monitoring can help fill data gaps in the Chesapeake Bay Watershed; Appendix B)*, and will help to inform the location of sampling sites.

The Project Team will work with monitors to select their sampling site(s) during the Study Design Workshop, Macroinvertebrate Monitoring Workshop, or follow-up meeting. The process for choosing sampling sites is outlined below:

1. Access available information about the local watershed

a. location of current and historical sampling sites
b. current and history macroinvertebrate data
c. watershed features – geology, land use, stream designations
d. reports or other documentation regarding macroinvertebrates or stream health

2. Identify specific areas where additional data are needed to help answer the monitoring group's question(s).
3. Identify specific areas that have been prioritized by the CBP or other data users.
4. Review the information gathered and choose sampling sites that are easily accessible and meet the needs of the data users. The number of sites selected will depend on the resources of the monitoring group.

Once a sampling site is selected, the monitor 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 (Appendix C) form 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 using GPS with the North American Datum of 1983 (NAD83).
4. Send the sampling site description and coordinates to ALLARM/IWLA for verification using Google Maps and/or the USGS National Hydrography Dataset (NHD) in ESRI ArcMap.

A6.3 Data Management

Monitors will use field data sheets provided by ALLARM/IWLA to record their observations and benthic macroinvertebrate results, and will enter the information into the project database. The Project Team will assist monitors in interpreting their data throughout the process and will hold data interpretation and communication workshops to help monitors share the information learned from monitoring macroinvertebrates.

The overarching goal of the database is to provide a centralized location where all volunteer and nontraditional data can be housed, accessed, and then used by scientists and managers to better understand the quality of the Chesapeake Bay Watershed. Benthic macroinvertebrate data will be evaluated for different purposes by different stakeholders, and the database will not only provide access to all of the volunteer and nontraditional-collected data throughout the watershed for this project, but will also visualize the data through mapping and graphing applications. A query function will allow database users to search and find data that fit their specific needs, and datasets with corresponding metadata detailing the methods and QA measures followed, can then be downloaded for use. The database is currently being constructed by Chesapeake Environmental Communications, Inc. (CEC), located in Richmond, VA.

A7. Measurement Quality Objectives

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

A7.1 Data Precision, Accuracy and Measurement Range

ALLARM/IWLA/Certified Trainer will train monitors how to properly collect and identify macroinvertebrate community samples. Monitors will process their samples in the field unless their intended data use, as outlined in their study design, requires them to submit their samples to an expert for identification verification. For monitors collecting Tier I data, ALLARM/IWLA/Certified Trainer will verify that they identified the macroinvertebrate sample correctly. Monitors collecting Tier II data will send ≥ 10% of their samples to a taxonomic lab to ensure accuracy of the macroinvertebrate identification. Taxonomists verifying the identification of the benthic macroinvertebrate samples will be responsible for analytical accuracy and precision.

A7.2 Representativeness

A7.2.1 Selection of Sampling Sites

Each monitoring group will create a customized monitoring study design, in which sampling sites will be selected in accessible areas where additional information is needed to inform local watershed concerns and fill data gaps by the CBP and other data users. The information gathered by the Project Team from monitoring groups, the CBP, and other key stakeholders will help to inform the location of sampling sites. The Project Team recommends that monitoring groups consult with local, state, or federal government agencies to identify sampling sites that will best augment and complement the data gathered by those agencies. Final site selection will occur after a discussion between ALLARM/IWLA/Certified Trainer and the monitoring group. Sampling sites will be selected with the expectation that they will provide an adequate representation of the macroinvertebrate community of the stream segment being sampled. Monitors will use GPS to determine the latitude and longitude coordinates of the sampling site. ALLARM/IWLA will verify the site coordinates using Google Maps or the USGS National Hydrography Dataset (NHD) in ESRI ArcMap using the North American Datum of 1983 projection to ensure that the coordinates overlay the stream on the map and that the mapped sampling location matches the physical site description provided by the monitor.

A7.2.2 Sample Collection

Sample data shall be representative of the actual conditions present at the stream site. Sample collection, handling and sampling design, as well as preservation (when applicable), are

interactive factors that directly affect field sample representativeness. Monitors will follow standard operating and QA procedures found in their macroinvertebrate monitoring manual to ensure that representative data are collected. These techniques combined with external validation will ensure that the minimum standards of field representativeness are met.

A.7.2.3 Number of Sites

One goal of the project is to increase the amount stream data collected by volunteer and nontraditional monitoring groups in the Chesapeake Bay Watershed. In order to achieve this goal, ALLARM/IWLA will work with these groups to develop and implement stream monitoring programs that help to answer local and regional questions. The number of sites each group samples will vary by group depending on the group's monitoring question(s) and available resources. While the number of sites sampled through this project cannot be determined at this time, it is expected that additional sites will be monitored each year and the total number of sites will increase over the timeframe of this project.

A.7.2.4 Sampling Timelines

Monitors will sample macroinvertebrates at least one time per year for Tier I designation. Tier II designation requires monitors to sample macroinvertebrates twice a year, once in the spring (March-June) and once in the fall (August-October). Groups will determine their own monitoring schedule and include it in their study design. The Project Team recommends monitors to sample during normal flow conditions when possible and to reschedule sampling events when unsafe conditions such as high water or strong storms occur.

A7.3 Data Comparability

This project is comprised of numerous monitoring groups spread throughout the Chesapeake Bay Watershed, which highlights the need for data comparability. ALLARM/IWLA/Certified Trainer will develop and implement workshops to train monitors to follow comparable methods to collect and identify macroinvertebrates. Monitors will follow the standard operating procedures and QA/QC requirements outlined in their macroinvertebrate monitoring manual, which will help to ensure comparability throughout the region. Monitors will also be required to attend workshops and become and maintain biennial certification (Tier II data collection), or at a minimum, be supervised by a certified monitor during sample collection and identification.

A7.4 Completeness

Groups collecting Tier I data are required to sample each site at least one time per year (twelve-month sampling season), but are encouraged to sample two times per year, once in the spring (March-June) and once in the fall (August-October). Groups collecting Tier II data are required to sample two times a year, once in the spring (March-June) and once in the fall (August-October), but are encouraged to sample up to four times per year (Table A7-1).

Table A7-1. Minimum data completeness requirements for Tier I and Tier II.

Tier	Number of Samples	Sampling Frequency	Sampling Period
Tier I	One sample per site	≥ 1 time/year	Same time each year (spring or fall)
Tier II	One sample per site	≥ 2 times/year	Same time each year (spring and fall)

A8. Training Requirements and Certification

The Project Team will hold workshops and offer customized assistance to monitoring groups who request it, and will check in with monitors on a regular basis. Workshop facilitators will have a thorough understanding of benthic macroinvertebrate sampling methods, identification, and QA protocols implemented by this project. They will also have experience working with volunteer and nontraditional groups and leading training events.

A8.1 Study Design Workshop

ALLARM/IWLA/Certified Trainer will train monitoring groups how to develop a study design, which outlines and describes their monitoring plan. During the Study Design Workshop, the monitoring group will review and determine the following:

- Monitoring goal(s) and question(s)
- Number and location of monitoring sites
- How they will use and disseminate their data and results locally
- Who will monitor
- Monitoring schedule

A8.2 Macroinvertebrate Monitoring Workshop

New monitors will be required to attend a Macroinvertebrate Monitoring Workshop in their region before they begin collecting macroinvertebrate data for this project.
ALLARM/IWLA/Certified Trainer will provide the workshops on an as-needed basis during the project timeframe (2017 – 2020). At the Macroinvertebrate Monitoring Workshop, ALLARM/IWLA/Certified Trainer will present the following information to the participants:

- Goals and objectives of the project
- Science of water quality issues in the Chesapeake Bay Watershed
- Macroinvertebrate biology, identification, and use in assessing stream health
- Required permits and permissions for macroinvertebrate collection
- Macroinvertebrate collection methods
- Importance of safety when monitoring

ALLARM/IWLA/Certified Trainer will train workshop participants how to:

- Clean, use, store, and maintain monitoring equipment
- Collect, sort, and identify macroinvertebrates
- Preserve macroinvertebrate samples for external QC validation as needed
- Accurately fill out and complete field data sheets
- Follow quality assurance and quality control procedures

- Enter monitoring results into the project database

Participant performance will be evaluated at the workshop during the training activities. ALLARM/IWLA/Certified Trainer will work closely with the participants during the hands-on training exercises to be sure that they achieve the goals of the exercises. It is expected that each participant will be able to collect and identify macroinvertebrates and enter the results into the project database after attending the Macroinvertebrate Monitoring Workshop.

Monitors will be given the equipment and supplies (and/or information on how and where to purchase the materials) needed to begin monitoring at the conclusion of the Macroinvertebrate Monitoring Workshop. They will also receive copies of the workshop materials, a taxonomic key, and an ALLARM or IWLA Macroinvertebrate Monitoring Methods Manual (Appendix D and E, respectively). The Methods Manual contains the information they learned at the workshop, standard operating procedures for collecting, recording, and entering their data, field data sheets, external QC forms, and references of how and where to access regional resources to supplement and reinforce what they learned at the workshop.

ALLARM/IWLA/Certified Trainer will distribute a workshop evaluation to all participants at the end of the workshop, and participants will report their perceived level of understanding of the important concepts covered during the workshop. The workshop will be fine-tuned to improve the pedagogy of the workshop, based in part by the results from the evaluation.

A8.3 Certified Monitors

Each person who wishes to collect macroinvertebrate data for this project will be required to become a certified monitor, or at a minimum, be supervised by a certified monitor during sample collection and identification. The two-step Certification Workshop will be administered by ALLARM/IWLA/Certified Trainer and includes:

1. In-stream observation – This portion of the test will be open-book and can be completed as a team with other monitors attempting certification. Each monitor must participate in collecting and processing an entire sample.
2. Macroinvertebrate Identification Test – This written test (Appendix F) will be taken individually. Each monitor must answer at least 90% of the questions correctly in order to become certified. If the monitor does not pass the identification test, they will be retrained on macroinvertebrate verification and allowed to retake the test.

Monitors can maintain their certification by participating in a Certification Workshop biennially.

A8.4 Certified Trainers

A Certified Trainer is any person who is certified to lead a Macroinvertebrate Monitoring Workshop and Certification Workshop for monitors participating in this project. To become a Certified Trainer, a person will be required to:

1. Demonstrate a thorough understanding of benthic macroinvertebrate sampling methods, identification, and QA protocols implemented by this project. This can be

achieved through prior knowledge and experience (as deemed appropriate by ALLARM/IWLA) or by being a Certified Monitor for at least six months and completing two macroinvertebrate sampling events;
2. Complete the Macroinvertebrate Identification Test, the same written test used for the Certification Workshop, answering all questions correctly;
3. Attend a Train-the-Trainer Workshop led by ALLARM/IWLA. The workshop will cover the goals of the project, information on how to conduct Macroinvertebrate Monitoring and Certification Workshops, and how to manage the project documentation; and
4. Conduct a Macroinvertebrate Monitoring Workshop or Certification Workshop while being observed and evaluated by ALLARM/IWLA on their ability to:
    a. Logistically plan and lead a Macroinvertebrate Monitoring Workshop, including preparing the equipment and completing all of the necessary documentation,
    b. Explain macroinvertebrate biology and functions and the importance of assessing stream health in the Chesapeake Bay Watershed, and
    c. Effectively train workshop participants to collect data following the ALLARM/IWLA Macroinvertebrate Monitoring Program procedures.

ALLARM/IWLA will distribute a workshop evaluation to all participants at the end of the workshop, and participants will report their perceived level of understanding of the important concepts covered during the workshop. The workshop will be fine-tuned to improve the pedagogy of the workshop, based in part by the results from the evaluation.

A Certified Trainer may train and recertify monitors in their region in coordination with ALLARM/IWLA. To maintain certification, Certified Trainers must:

1. Lead at least one workshop (Macroinvertebrate Monitoring and/or Certification) per year;
2. Certify at least two monitors per year; and
3. Meet once a year with ALLARM/IWLA in person to review the CMC Macroinvertebrate Monitoring Program and check/verify their training equipment.

If Certified Trainers wish to maintain their certification but have not had the opportunity to lead a workshop, they may conduct a “mock” workshop during their annual meeting with ALLARM/IWLA in lieu of requirements #1 and #2 listed above.

ALLARM/IWLA may attend and/or assist with workshops led by the Certified Trainer as time and funding allow and will observe a workshop conducted by a Certified Trainer in person or by video at least once every two years. All documentation resulting from Train-the-Trainer and Certification Workshops will be managed by ALLARM/IWLA and filed in their office for at least seven years.

A9. Documentation and Records

A9.1 Field Data Sheets

Monitors will fill out and complete field data sheets for every sampling event, as prescribed by ALLARM/IWLA (included in methods manuals). The original data sheets will be submitted to ALLARM/IWLA and archived for at least seven years after the sampling date. The project will also maintain electronic (digital) records of the data within the project database.

A9.2 Spot Check Procedure

ALLARM/IWLA will check in with each new monitor within three months of the Macroinvertebrate Monitoring Workshop to ensure that they are comfortable and confident in macroinvertebrate monitoring methods and that the data they collect are being entered and archived into the project database correctly. It is recommended that monitors submit their data sheets to ALLARM/IWLA/Certified Trainer after every sampling event.
ALLARM/IWLA/Certified Trainer will spot check ≥ 10% of a monitor's total number of data sheets and compare the results entered in the database for data entry errors. If a monitor is found to be at fault of a data entry error, their previous two data sheets will be checked. Errors in the database will be corrected by ALLARM/IWLA/Certified Trainer. If substantial data entry errors are identified by ACB/ALLARM/Certified Trainer, they will alert the monitor and work to remedy the issue.

A9.3 Other Documentation and Records

All documentation from workshops (Macroinvertebrate Monitoring, Certification, and Train-the-Trainer) will be available at the ALLARM/IWLA office for a minimum of seven years as requested.

SECTION B – DATA GENERATION AND ACQUISITION

B1. Sampling Process Design

The specific criteria used to prioritize the location of sampling sites will vary depending on the monitoring group's goal(s) and question(s), but will always take into account the priority areas identified by the CBP and other data users in the *Prioritization Report* (Appendix B). The total number and location of sampling sites will be dependent on the number and location of monitoring groups participating in this project.

Once the sampling site locations are determined, monitors will visit the site(s) to identify the specific stream reaches they will sample and determine which collection method they will follow as outlined in the ALLARM and IWLA Macroinvertebrate Methods Manuals. Monitors will record the GPS coordinates of the stream reach, record a description of the reach, and confirm that it is safe and easy to access. If the stream reach is adjacent to private property, monitors will use the Property Owner Permission and Liability Release Agreement form to obtain permission from the property owner to access the reach prior to sampling. Monitors will also acquire the state-required permits to collect macroinvertebrates prior to sampling.

Monitors will follow the methods and QA procedures in the ALLARM or IWLA Macroinvertebrate Methods Manual to collect macroinvertebrate data at their sampling site 1 – 4 times per year.

B2. Sampling Method Requirements

Each group participating in the project will develop a study design that includes their sampling schedule, site locations, and the monitoring protocol they follow. It is recommended that macroinvertebrate assessments be conducted twice a year, once in the spring (March- June) and once in the fall (August-October), and is required for Tier II classification. Monitors collecting Tier I data must sample their site(s) at least one time per year. Groups adopting this QAPP will submit their study design to ALLARM/IWLA for approval prior to collecting macroinvertebrate data.

Monitors will receive a copy of the ALLARM or IWLA Macroinvertebrate Methods Manual at the Macroinvertebrate Monitoring Workshop. The manual will contain standard operating procedures (SOPs) for sample collection, sample identification, data management, and QA/QC procedures. Method Manuals will also be available online.

ALLARM will coordinate, train, and certify monitors in the Upper Chesapeake Bay Watershed (New York and Pennsylvania) using the ALLARM Macroinvertebrate Monitoring Methods Manual (Appendix D), which is adapted from the EPA Volunteer Stream Monitoring Methods Manual. IWLA will coordinate, train, and certify monitors in the Lower Chesapeake Bay

Watershed (south of Pennsylvania border) using the IWLA Macroinvertebrate Monitoring Methods Manual, which is based on the Virginia Save Our Streams Protocol.

B2.1 Choosing Where to Sample Within the Streams

B2.1.1 IWLA – Rocky Bottom Stream

Volunteers select a riffle typical of the stream, that is, a shallow, fast-moving area with a depth of 3 to 12 inches (8 to 30 cm) and stones, which are cobble-sized (2 – 12 inches). Stone size is important since the macroinvertebrates surveyed prefer these stones for protection and food supply. In addition, the bubbling of water over the rocks provides needed oxygen for healthy growth.

B2.1.2 IWLA – Muddy Bottom Stream

Volunteers identify habitat types within the stream. The habitat areas are: woody snags, banks, submerged aquatic vegetation, and riffle areas (cobble-stone sized rocks). These habitat areas will be sampled in proportion to their abundance in the stream segment sampled.

B2.1.3 ALLARM – Rocky Bottom Stream

Monitors will identify three sites within a 100-foot stream reach to sample. The stream reach should be at least 50 feet upstream from any human-made structure, such as a dam or bridge. The three sites should be in areas of fast-moving water (riffles/runs) and, if possible, have different flow velocities and substrate sizes (gravel to cobble) in order to get a better representation of the in-stream habitat diversity.

B2.1.4 ALLARM – Muddy Bottom Stream

Monitors will identify a 100-foot stream reach to sample. The stream reach should be at least 50 feet upstream from any human-made structure, such as a dam or bridge. The reach should also have multiple habitats present, including vegetated bank margins, snags and logs, aquatic vegetation beds, and decaying organic matter in order to collect a representative sample of the macroinvertebrate population.

B2.2 Rocky Bottom Sampling

Monitors sampling high-gradient streams that have riffles/runs and substrates composed of gravel and/or cobble will follow the ALLARM or IWLA Rocky Bottom Stream Sampling Procedure.

B2.2.1 IWLA

Monitors place a 500 micron mesh kick-seine perpendicular to the flow of water immediately downstream of the 1 ft^2 area in the riffle they have selected to sample. The bottom, weighted edge of the net should fit tightly against the stream bottom. Monitors use cleaned rocks from outside the sampling area to hold the net firmly to the bottom. This prevents insects from escaping under the net. Monitors tilt the net back, so the water flowing through the net covers

a large portion of the net, however, they are careful not to tilt the net so much that water flows over the top, allowing organisms to escape.
A monitor quickly samples the targeted area for 20 seconds, by lifting and rubbing underwater all large rocks in the sample area to dislodge any clinging organisms as well as all exposed surfaces of rocks in the sampling area that are too large to lift. Then the monitor agitates the small rocks and sediments on the streambed in order to dislodge any burrowing macroinvertebrates. The sample should consist of 75% rubbing rocks and 25% agitating sediments.

After sampling for 20 seconds, monitors carefully rub off any rocks used to anchor the net. They then remove the seine with an upstream scooping motion, being careful not to allow water to escape over the top of the net, in order to keep all the macroinvertebrates in the net. Monitors process the sample. If the sample does not contain 200 organisms, further collection is performed and sampling time is adjusted (90 second maximum) in order to collect a minimum of 200 organisms (including first collection). This process is repeated until 200 organisms are collected or a total of four collection attempts are made, whichever is reached first.

B2.2.2 ALLARM

Monitors will follow the procedures in the ALLARM Macroinvertebrate Methods Manual (Appendix D) to collect a representative sample of the macroinvertebrate population.
At least two monitors ("net holder" and "kicker") will enter the stream downstream of the furthest downstream site to avoid disturbing the other two sites and wade to the first 1-meter x 1-meter riffle/run area. The net holder will face upstream and position a 1 m^2, 500 µm kick net in the water, holding it at a 45° angle to the water's surface. The kick net is secured to the streambed using rocks from within the sampling area (which are rubbed first to dislodge any macroinvertebrates clinging to them) or with a chain sewn into the bottom of the net.

The kicker will sample the targeted 1 m^2 area by lifting and rubbing all of large rocks in the sample area underwater to dislodge any clinging organisms. The kicker will then disturb the streambed (≥ two inches in depth) for approximately three minutes to dislodge any burrowing macroinvertebrates.

The kicker will remove any rocks used to anchor the net to the streambed. The kicker and net holder will lift the net out of the water together using a scooping motion, making sure water does not flow over the top or bottom of the net.

Monitors will release any fish, amphibians, or reptiles captured in the net. They will either pick the organisms directly from the net for sorting and identification or flush them into a bucket full of stream water while they sample the other two sites within the 100-foot reach. The organisms collect from all three sites are combined into a single sample to provide a better representation of the stream's overall macroinvertebrate community.

B2.3 Muddy Bottom Sampling

Monitors sampling streams that have muddy, silty, or sandy bottoms and lack riffles will follow the ALLARM or IWLA Muddy Bottom Stream Sampling Procedure.

B2.3.1 IWLA

A single sample of macroinvertebrates consists of collecting 20 jabs in productive habitats using a D-frame net with a mesh size 500 microns. A single sample is what is recorded on the data sheets.

A single jab consists of aggressively thrusting the net into the target habitat for a distance of approximately 1 meter; i.e. the distance the net can be swept while standing in one place. This initial "jab" is followed by 2-3 sweeps of the same area to collect the dislodged organisms. The following techniques are recommended for sampling the three major productive habitats in coastal plain streams:

a. Woody snags – Snags or submerged woody debris, are sampled by jabbing in medium sized snag material (sticks and branches). Large material (e.g., logs) may be sampling by scraping the net along the surface. Woody debris may be picked up, held in the net, and rubbed by hand.
b. Banks – Stream banks with roots and snag material are sampled similar to snags. Vegetated banks are preferred over un-vegetated banks. If the bank is undercut, it is important to jab back under the bank, drawing the net from the stream bottom to the top of the undercut bank.
c. Submerged aquatic vegetation – Submerged macrophytes are sampled in deep water by drawing the net through the vegetation from the bottom to the surface of the water. Macrophytes in shallow water are sampled by bumping the net along the bottom in the macrophyte bed.

If riffle areas are present in the stream segment, they may be sampled by placing the D-frame net firmly along the bottom of the stream and using hand or foot to "rub" around the cobbles in the riffle.

The sample is transferred to the sieve bucket (or other seining device) by banging the net over the bucket opening or by inverting the net into a partially submerged bucket. Contents of the net are transferred into the sieve bucket after each jab.

B2.3.2 ALLARM

Monitors will follow the procedures in the ALLARM Macroinvertebrate Methods Manual (Appendix D) to collect a representative sample of the macroinvertebrate population.

Monitors will identify the types of abundant habitat present in the 100-foot reach and use a 500 µm D-frame net with 500 microns to jab the different habitat areas. The four types of habitat sampled using this method include vegetated bank margins, snags and logs, aquatic vegetation beds, and decaying organic matter. A monitor will jab a habitat area a specific

number of times with the D-net depending on the number and types of habitat present (Table B2-1), using the following procedures for each habitat type:

a. Vegetated bank margin – keep the D-net underwater and jab vigorously with an upward motion, brushing the net against the vegetation and roots along the bank.
b. Snags and logs – hold the net under the submerged wood and rub 1 ft^2 of the snag or log, scooping all dislodged material into the D-net.
c. Aquatic vegetation beds and decaying organic matter – keep the D-net underwater and jab vigorously with an upward motion, brushing the net against or through the plant bed.
d. Silt/sand/gravel substrate – place the flat part of the D-net against the streambed and push it forward one foot upstream to dislodge approximately three inches of the streambed.

Table B2-1. Number of jabs recommended for each habitat category.

<table>
<tr><th></th><th>Vegetated bank margin</th><th>Snags and logs</th><th>Aquatic vegetation beds & decaying organic matter</th><th>Silt/sand/gravel substrate</th></tr>
<tr><td>4 habitats present & abundant</td><td>10 jabs</td><td colspan="3">Combination of 10 jabs</td></tr>
<tr><td>3 habitats present & abundant</td><td colspan="3">Combination of 15 jabs</td><td>5 jabs</td></tr>
<tr><td>2 habitats present & abundant</td><td colspan="3">Combination of 15 jabs</td><td>5 jabs</td></tr>
<tr><td>Some habitats abundant and others sparse OR habitat type unable to be reached due to unsafe conditions</td><td colspan="4">Jab the sparse habitats as much as possible, then jab the remaining abundant habitats. (20 jabs total)</td></tr>
</table>

Monitors will flush the contents from each jab into a bucket full of stream water, to be sorted and identified after all 20 jabs have been completed.

B2.5 Processing the Sample in the Field

Most macroinvertebrate samples will be processed in the field and returned to the stream within a few hours after collection. Some samples will be preserved in the field (see section B3, *Sample Handling and Custody Procedures*, for field preservation procedures) for quality assurance purposes.

B2.5.1 Processing to Order Level

Monitors will place their macroinvertebrate samples on a flat, light-colored surface, such as a white sheet, table, or piece of plastic so the organisms are easy to see. Next, they will sort the macroinvertebrates into groups of organisms that have similar characteristics and appearance. It is important that monitors sort all of the organisms and they will look on both sides of any debris in the sample, since insects often cling to any available litter.

Once the organisms are divided into look-alike groups, using primarily body shape and number of legs and rear protrusions, monitors will use a hand lens or microscope (if needed) and reference materials to identify the organisms to Order level. If an organism cannot be identified or needs to be preserved for quality assurance purposes, monitors will follow the preservation technique listed in section B3. After the samples have been processed and identified and the information has been recorded onto the data sheet, the samples will be returned to the stream and the equipment will be thoroughly rinsed.

B2.5.1.1 Unknown Specimen

Organisms that monitors collect but cannot identify will either be preserved or photographed (Order level only) and sent to ALLARM/IWLA or a certified taxonomist for identification.

Monitors will preserve an unknown organism by placing it in a vial with 70% ethyl alcohol along with a paper label written in pencil with the site ID and sample date. They will also record a physical description of the organism and the suspected taxonomic Order and Family (if applicable) on their field data sheet. Monitors will send or deliver the preserved specimen and a copy of their data sheet to ALLARM/IWLA or a certified taxonomist for identification.

For Tier I level identification, organisms may be photographed instead of preserved. Monitors will take multiple photographs of the organism to document the number of legs/appendages (if any), the head and mouth features, the thorax and abdomen (top and bottom if possible), any tail features, and other distinguishing characteristics. In addition, another object, such as a ruler, should be included in the photograph for scale purposes. Monitors will record a physical description of the organism and the suspected taxonomic Order and Family (if applicable) on their field data sheet, and send a copy of the datasheet and the photographs to ALLARM/IWLA for identification.

B2.6 Processing the Unknown Specimen

Preserved specimens and matched data sheets sent to ALLARM/IWLA or a certified taxonomist for identification, will be processed and identified, and the results will be recorded internally and on the monitor's field data sheet. The identification results will be sent to the monitor (certified taxonomists will also send the identification results to ALLARM/IWLA) and the monitor will enter the information into the project database.

B2.7 Field Data Sheets

Monitors will fill out and complete all sections of their field data sheet (included in Appendix D and E) at each sampling event.

B2.8 Tier I and II Classification

As noted by the *Tiered Framework* in section A5.2, the Project Team will categorize the data collected based on the quality of the data. Monitors participating in the CMC Macroinvertebrate Monitoring Program will follow the procedures outlined in this Benthic Macroinvertebrate Monitoring in Wadeable Stream (Tiers I and II) QAPP. The *Rubric for Tier Determination and Inclusion of Data in the CMC Database* outlines the minimum requirements that must be met for the data to be included in the project database and assigned a designation of tier I or tier II, and include:

1. Program
    a. Approved, written study design
    b. Verified sampling location(s) with coordinates
2. Sampling methods
    a. Sample during normal flow conditions
    b. Collect side by side samples (replicates); 10% of sampling events
    c. Use appropriate sampling method for stream type (rocky vs. muddy bottom) and follow procedures exactly
        i. Choose area with appropriate (if applicable)
            1. hydrology – water depth and flow
            2. substrate type and size
            3. habitat type
        ii. Equipment type and specification
        iii. Collection time
        iv. Number of samples and/or organisms collected
    d. Photograph and/or preserve unknown sample for identification by ALLARM/IWLA/Certified Trainer
3. Equipment maintenance
    a. Inspect equipment and materials each time before use
    b. Clean and store equipment and materials appropriately
4. Monitor
    a. Attend a CMC Macroinvertebrate Monitoring Workshop
    b. Become certified and maintain biennial certification OR collect and identify macroinvertebrates under the supervision of a certified monitor or ALLARM/IWLA/Certified Trainer
    c. Fill out field data sheets completely and accurately

Data collected under this program will be categorized as Tier I or Tier II. In addition to the minimum requirements listed above, specific criteria are used to determine the tier designation (Table B2-2). If a monitor collecting Tier II data does not meet all of the requirements for Tier II, the data will be flagged in the project database, and if appropriate, designated as Tier I.

Table B2-2. Specific criteria used to determine tier designation of macroinvertebrate data.

Requirement	Tier I	Tier II
Taxonomic level of identification	Order	Family
Monitor certification	Monitor may be certified or monitor under the supervision of a certified monitor or ALLARM/IWLA/Certified Trainer	Monitor must be certified and maintain biennial certification
Unknown specimen	Monitor photographs and/or preserves specimen for ID by ALLARM/IWLA/Certified Trainer	Monitor preserves and sends specimen to a state or Society for Freshwater Science-certified taxonomist for identification
Identification verification	ALLARM/IWLA/Certified Trainer verifies an entire sample for verification (Order level) ≥ 10% of sampling events – this often coincides with the Certification Workshop	Monitor preserves and sends an entire sample to a state or Society for Freshwater Science-certified taxonomist for verification (Family level) ≥ 10% of sampling events

B3. Sample Handling and Custody Procedures

Monitors are responsible for processing the macroinvertebrate samples in the field and returning them to the stream within a few hours after collection, unless preserving them for quality assurance purposes. To preserve a macroinvertebrate sample, monitors will place the sample and a label written with pencil in a glass or plastic container and fill it with 70% ethyl alcohol until the entire sample is covered. They will deliver the specimen and field data sheet to ALLARM/IWLA or certified taxonomist within three weeks of collection for identification. Once processed and identified, the results will be recorded internally and on the monitor's field data sheet. The identification results will be sent to the monitor (certified taxonomists will also send the identification results to ALLARM/IWLA) and the monitor will enter the information into the project database. Preserved specimens will be used for educational/training purposes or discarded.

B4. Analytical Methods Requirements

Groups using the IWLA protocol use a multimetric index to analyze their macroinvertebrate data. Scientists at Virginia Tech developed this index for monitors using the VA SOS SOPs (Engel 2000). Monitors complete the index by following the steps in four tables found on pages three and four in the field sheet packet (method manual). The results of the multimetric index are calibrated to determine if stream condition is acceptable or not.

Monitoring groups in Pennsylvania and New York will collect macroinvertebrate data following the ALLARM Macroinvertebrate Monitoring Methods Manual (adapted from the EPA Volunteer

Stream Monitoring Methods Manual) to calculate a health score based on the prevalence and sensitivity of organisms (method manual).

B5. Quality Control Requirements

A goal of this project is to collect data that can be used to assist local and regional decisions affecting the Chesapeake Bay and its watershed, so it is essential that a high level of QA/QC be maintained. All members of the project will follow established procedures to ensure data accuracy, precision, representativeness, comparability and completeness necessary for a successful program.

B5.1 Field QC Checks

B5.1.1 Internal Verification

To help ensure macroinvertebrate samples are identified correctly, monitors will work in teams (≥ 2 monitors) to sort and identify the macroinvertebrate samples. The team must agree on the identification before recording the organism on their field data sheet. If the team cannot reach an agreement, even after asking others for help, the team will consider the organism to be an unknown specimen and follow the procedures in B2.5.1.1 to identify it.

B5.1.2 External Verification

Monitors will have an entire macroinvertebrate sample verified externally ≥ 10% of sampling events. Monitors collecting Tier I data will have their sample and final calculated score verified by ALLARM/IWLA/Certified Trainer, which will often occur during the Certification Workshop. Monitors collecting Tier II data will have their sample and final calculated score verified by a state or Society for Freshwater Science-certified taxonomist, and will preserve their sample after processing it in the field using the preservation technique listed in section B3. If the monitors identify > 10% of the sample incorrectly, ALLARM/IWLA/Certified Trainer will retrain the monitors on macroinvertebrate identification and the monitors will be asked to retake and pass the Macroinvertebrate Identification Test (see A8.3; Appendix D) in order to remain certified.

B5.1.3 Certification Workshop

Monitors can maintain their certification by participating in a Certification Workshop biennially. During the workshop, ALLARM/IWLA/Certified Trainer will observe monitors in the field as they collect and process and an entire sample. The Certification Workshop will help to verify the quality of the data collected by this project by validating that monitors are collecting, processing, and identifying macroinvertebrates correctly.

B5.2 Laboratory QC Checks

Certified taxonomists will provide quality control assistance to monitors collecting Tier II data. Laboratory QC procedures are developed by the individual laboratory. When requested, the Project Manager will contact the laboratory to obtain a copy of the procedures.

B5.3 Data Entry QC Checks

Monitors will enter their results into the project database after sampling and will submit their field data sheets to ALLARM/ILWA/Certified Trainer. ALLARM/IWLA/Certified Trainer will spot check ≥ 10% of a monitor's total number of data sheets and compare the results entered in the database for data entry errors. If a monitor is found to be at fault of a data entry error, their previous two data sheets will be checked. Errors in the database will be corrected by ALLARM/IWLA/Certified Trainer. If substantial data entry errors are identified by ACB/ALLARM/Certified Trainer, they will alert the monitor and work to remedy the issue.

B6. Equipment Testing, Inspection, and Maintenance Requirements

Monitors will maintain their equipment and inspect (Table B6-1) it prior to each sampling event to ensure that all materials are clean and working properly. Any problems found during inspection will need to be addressed prior to sampling.

Table B6-1. Equipment inspection requirements for macroinvertebrate sampling.

Equipment Type	Inspection Frequency	Type of Inspection
Net (kick, D-frame)	Before each sampling event	Visual: • Cleanliness – debris, sediment, or dead organisms • Small rips or holes
Light-colored surface used to process samples (sheet, plastic)	Before each sampling event	Visual: • Cleanliness – debris, sediment, or dead organisms • Small rips or holes
Other sampling equipment (buckets, waders, sorting trays and utensils)	Before each sampling event	Visual: • Cleanliness – debris, sediment, or dead organisms • Small rips or holes
Microscope	As per manufacturer recommendation	Cleaned

After sampling, monitors will clean their equipment following the procedures in the ALLARM/IWLA Macroinvertebrate Methods Manual, and will store it in a secure, dry area when not in use.

ALLARM/IWLA/Certified Trainer will provide monitoring groups with the equipment they need to collect, sort, and identify macroinvertebrates or provide them with information on where to purchase the materials.

B7. Instrument Calibration and Frequency

Instruments requiring calibration are not covered by this QAPP.

B8. Inspections/Acceptance Requirements for Supplies

ALLARM/IWLA will obtain and recommend monitoring equipment and supplies from reputable field/laboratory supply companies. ALLARM/IWLA/Certified Trainer will inspect purchased equipment and broken or defective items will be sent back to the supplier. Equipment will be distributed to monitors at the Macroinvertebrate Monitoring Workshop or afterwards as needed. The equipment must meet the specifications outlined in the ALLARM/IWLA Macroinvertebrate Methods Manual and will be inspected and verified by ALLARM/IWLA/Certified Trainer during the Certification Workshop or field audit.

B9. Data Acquisition Requirements

The Integration of Citizen-based and Nontraditional Monitoring into the Chesapeake Bay Program Partnership project will acquire data from monitoring groups which have demonstrated that the data were collected using QA/QC procedures that generate data of known quality. Historic data will be assigned a tier designation based upon the requirements established within this QAPP and outlined in the *Rubric for Tier Determination and Inclusion of Data in the CMC Database*. Historic data will be adequately marked within the database as being of a known quality, but not collected under the requirements of this QAPP.

In Pennsylvania and New York, ALLARM will create a watershed and features map for groups using ESRI ArcMap and data downloaded from federal and state spatial data clearinghouses. Sampling locations will be mapped by ALLARM/IWLA using Google Maps and/or the USGS National Hydrography Dataset (NHD) in ESRI ArcMap. The spatial data used to help select sampling locations will not affect the quality of the data produced through this project.

In some cases, weather conditions and precipitation values will be collected from www.wunderground.com, and stream flow data from nearby USGS stream gages may be used to determine stream flow conditions prior to sampling for safety. Stream flow data will be obtained from the USGS stream gage network at http://waterdata.usgs.gov/nwis/rt. Monitors will consult with ALLARM/IWLA/Certified Trainer to determine which USGS stream gage station to refer to assess stream flow conditions (if applicable).

B10. Data Management

Monitors will record their sampling results onto field data sheets supplied by ALLARM/IWLA/Certified Trainer immediately after identifying each organism. Monitors will complete all sections of their field data sheets and

then send them to ALLARM/IWLA/Certified Trainer after every sampling event to be spot checked (Section A9.2) and then archived for seven years.

The macroinvertebrate results will also be entered into the project database either by the monitor or the monitoring group's data manager (if applicable) via phone, tablet, or computer. Each monitor will have an individual account that is also linked to information specific to their monitoring group, such as methods manuals and contact information. To enter results into the database, a monitor will access the database website and login to their account using a unique login ID and password. Once logged in, they will see their individual profile, which will include information specific to their account, including a list and map of the site(s) they sample. The monitor will click on their site to enter the results into a data input form using drop-down menus and boxes. After entering all of the information from their field data sheet into the data input form, the monitor will review and compare the information between the two for errors before submitting the data record to the database. The data input form will be tailored for each monitor based on the protocol they use to collect the data (ALLARM/IWLA).

It is recommended that ALLARM/IWLA/Certified Trainer contact monitors within three months of the Macroinvertebrate Monitoring Workshop to answer questions and review the sampling and data management methods. At the same time, ALLARM/IWLA/Certified Trainer should review any data the monitor has entered into the project database and assess it for data completeness. Digital data files will be maintained and backed up regularly by Chesapeake Environmental Communications, Inc. Anyone who accesses the project database will be able to download and use the data for analysis.

SECTION C – ASSESSMENT AND OVERSIGHT

C1. Assessment and Response Actions

The Project Team will use four categories of assessment to ensure the integrity of the data:

1. Laboratory
2. Program
3. Field Sampling
4. Validation and Reporting

C1.1 Laboratory Assessments

External verification will be conducted by a state or Society for Freshwater Science-certified taxonomist for Tier II data. It is the responsibility of the taxonomic laboratory to maintain the certification, and the Project Manager may ask the laboratory to supply a copy of the certification if needed.

C1.2 Program Assessments

QA Management will perform an annual assessment of the QA/QC procedures of the CMC Macroinvertebrate Monitoring Program to determine if the data collected meet the program's objectives and are of known quality. If QA Management discovers any QA issues within the program they will work ALLARM/IWLA to resolve the issue(s). It will be the responsibility of ALLARM/IWLA to follow up on any issues. Data submitted to the project database during this time will be flagged until ALLARM/IWLA has verified that the issues have been eliminated.

C1.3 Field Sampling Assessments

ALLARM/IWLA/Certified Trainer is responsible for ensuring that all certified monitors attend a Certification Workshop every two years. The Certification Workshop serves as an audit or proficiency test for the monitors and their equipment. If a monitor demonstrates a faulty sampling technique during the Certification Workshop, ALLARM/IWLA/Certified Trainer will retrain the monitor and will not renew the monitor's certification until the monitor can demonstrate that the sampling technique has been mastered, which is crucial in meeting data quality objectives. Any equipment determined to be faulty during a Certification Workshop will be replaced. Data quality objectives will be reviewed at the Certification Workshop, including:

a. Sample collection method
b. Macroinvertebrate identification
c. Field documentation
d. QA procedures
e. Equipment inspection

C1.4 Validation and Reporting Assessments

The project database will be developed to incorporate a data validation and reporting system that will be supported by ALLARM/IWLA/Certified Trainer. These procedures will be reviewed as a part of the annual assessment conducted by QA Management.

C2. Reports to Management

QA Management will create an annual assessment report of the QA program that will be circulated to the Project Team, CBP, and EPA QA staff. All Project Team members are required to submit a quarterly report to the Project Manager of all project activities, including workshops, 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.

SECTION D – DATA VALIDATION AND USABILITY

D1. Data Review, Validation, and Verification Requirements

The macroinvertebrate results will be entered into the project database and compared to the results on the original field data sheet for data entry errors using the spot check procedure (A9.2). Any errors found will be corrected by ALLARM/IWLA/Certified Trainer. Field data sheets will be retained by ALLARM/IWLA for at least seven years after the sampling date.

D2. Validation and Verification Methods

ALLARM/IWLA/Certified Trainer will work with monitors to ensure that their data are validated and verified by performing a spot check of field data sheets as described in Section A9.2 to ensure proper data entry procedures are upheld. ALLARM/IWLA/Certified Trainer will provide advice and technical assistance to monitors to ensure that they follow the procedures properly and review their data thoroughly before submitting it to the project database.

Monitors will submit their data sheets to ALLARM/IWLA/Certified Trainer after every sampling event. ALLARM/IWLA/Certified Trainer will spot check ≥ 10% of a monitor's total number of data sheets and compare the results entered in the database for data entry errors. If a monitor is found to be at fault of a data entry error, their previous two data sheets will be checked. Errors in the database will be corrected by ALLARM/IWLA/Certified Trainer. If substantial data entry errors are identified by ACB/ALLARM/Certified Trainer, they will alert the monitor and work to remedy the issue.

QC verification samples will be processed externally ≥ 10% of sampling events. These quality control samples will be used to validate and verify identification accuracy.

D3. Reconciliation with Data Quality Objectives

This QAPP is applicable to two data quality objectives defined by Tier I and Tier II criteria. Classifications for data use and quality objectives are summarized in Table A5-2 and further described in Section B2.8. If Tier II data are found to not meet the QA checks when performing family level identification, the data may be recommended for Tier I designation if applicable.

D3.1 Representativeness

The representativeness of the sample will be evaluated during a Certification Workshop. ALLARM/IWLA/Certified Trainer will verify that the site sampled is representative of the conditions in the area. If the site location is not representative or the stream was not sampled in a representative manner, ALLARM/IWLA/Certified Trainer will help the monitor reconcile the issue.

D3.2 Comparability

ALLARM/IWLA/Certified Trainer will evaluate monitors' adherence to the SOPs biennially at a Certification Workshop.

D3.3 Completeness

Monitors collecting Tier I data will sample their site(s) at least one time per year, and monitors collecting Tier II data will sample their sites at least two times a year. This will be considered a complete sample set. ALLARM/IWLA/Certified Trainer will investigate any issues that cause monitors to not meet the data completeness goals and will work with them to remedy the issue.

Appendix A:
Tiered Framework

Tiered Framework for Data Collection and Integration for Nontraditional Monitoring

Tiered Framework for Data Collection and Integration for Nontraditional Monitoring

Introduction

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

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

Purpose of the Framework

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

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

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

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

Monitoring Questions

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

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

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

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

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

Intended Data Use

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

Tier Descriptions and Framework for Determining Tiers

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

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

Tier 1 – Education and Environmental Health Screening:

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

Data Uses:
These data can be used to:

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

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

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

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

Data Uses: These data will:

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

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

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

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

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

Data Uses: These data can be used for:

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

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

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

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

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

Tier 1 - Education:

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

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

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

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

Tier 2 - Screening, Report Cards, Targeting:

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

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

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

Tier 3/Tier 2 - Water Quality Standards Attainment:

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

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

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

Existing Tools

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

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

Areas for Development and Consideration

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

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

Metadata Requirements

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

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

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

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

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

					Plasma Mass Spectrometry

Appendix B:

Prioritization Report:

How volunteer and nontraditional monitoring can help fill data gaps in the Chesapeake Bay Watershed

Prioritization Report:

How volunteer and nontraditional monitoring can help fill data gaps in the Chesapeake Bay Watershed

The Chesapeake Monitoring Cooperative has investigated spatial data gaps and data needs with respect to programs tracking water quality and benthic macroinvertebrates as condition indicators throughout the Chesapeake Bay watershed. This report summarizes the findings of the data needs assessment and identified avenues for nontraditional data to help meet some of the needs.

PRIORITIZATION REPORT

Produced by the Chesapeake Monitoring Cooperative

Working together to understand the health of our waters
March 31, 2017
The development of this report was supported through a cooperative agreement with the EPA Chesapeake Bay Program; ACB CB96334901 – Citizen and Nontraditional Monitoring
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The CMC was formed for the Integration of Citizen-based and Nontraditional Monitoring into the Chesapeake Bay Program partnership.

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Appendix 1: Catalogue of Volunteer Monitoring Groups who Participated in the Chesapeake Monitoring Census
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Executive Summary

The Chesapeake Monitoring Cooperative (CMC) was formed to help integrate water quality and nontidal benthic macroinvertebrate volunteer and nontraditional monitoring data into the Chesapeake Bay Program (CBP) partnership's decision-support system to better manage ecosystem recovery. This project was initiated by a Request for Proposals (RFP) from the U.S. Environmental Protection Agency's CBP Office. CBP is interested in engaging new partners that can augment and enhance the existing CBP partnership's long-term water quality monitoring networks. A priority area as defined for this report is any area with an identified need for more information that could conceivably be filled by volunteer or nontraditional data of known quality. This report showcases priority areas for water quality and benthic macroinvertebrate data as identified by the CBP partnership including federal agencies, interstate commissions, and state agencies. In addition, this report synthesizes results from the Chesapeake Monitoring Census, a survey of over 100 volunteer and nontraditional monitoring groups in the watershed, used to identify common goals and objectives of volunteer and nontraditional monitoring groups. The responses to this Census provided a preliminary assessment of possible partnerships between the diverse monitoring entities in the Chesapeake Bay watershed.

The CMC team facilitated opportunities to listen to diverse water quality stakeholders throughout the Chesapeake Bay watershed. Reoccurring outcomes of these discussions identified that water resource managers throughout the region want access to data of known quality to assist with: measuring long term trends, conducting short term assessments, informing public education, improving assessments to help target limited management resources, and identifying opportunities for research.

Tier designation

The data collected from this project will be categorized into Tiers to help account for the variability of methods, quality assurance procedures, and equipment used to collect water quality data. Classifying each data point will help data users understand how the data were collected. The CMC team developed a Tiered Framework (Table 1) which lists potential ways the data collected by volunteer and nontraditional monitoring groups can be used by the CBP partnership.

Table 1. Intended data use for the different Tier designated data

Tiers	Intended Data Use
Tier 1	Education, environmental health screening
Tier 2	Environmental health report cards, environmental health screening, targeting of management actions
Tier 3	Chesapeake Bay watershed trends and assessments to help inform policy and management decisions

Identified data needs in the Chesapeake Bay watershed

Through meetings with data users in Delaware, District of Columbia, Maryland, New York, Pennsylvania, Virginia, and West Virginia, within the Bay watershed, the goals and objectives of

their water quality and benthic macroinvertebrate monitoring programs were identified and acknowledged. Possible synergies for aligning monitoring approaches across jurisdictional boundaries were evaluated to support watershed-wide consistency in assessments and understanding of regional aquatic resource conditions while retaining support for local information needs. The goals and objectives for data use are, however, often unique to each state. Figure 1 shows the compilation of all priority areas identified for data integration in the Chesapeake Bay watershed by each jurisdiction. Additionally, CBP staff identified the Coastal Plain ecoregion as a priority area, which includes the entire Eastern Shore of Maryland, the Western Shore Uplands and Lowlands of Maryland and the areas east and south of the Piedmont Plateau in Virginia. While the CBP partnership identified the integration of Tier 3 data as a priority, the added value of Tier 1 and 2 data was recognized for the purpose of answering the myriad of watershed management questions and meeting the objectives of the Partnership.

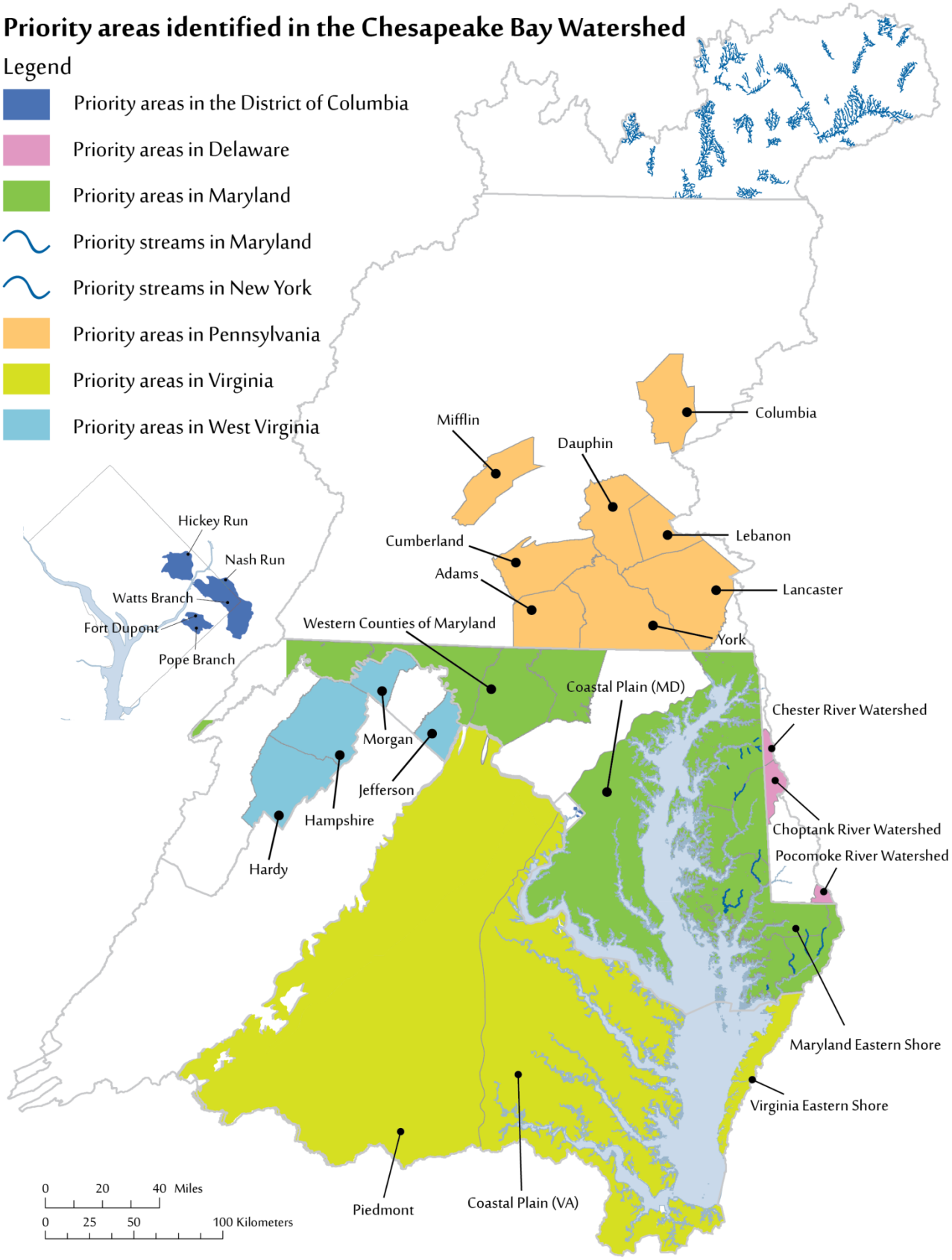
Priority areas identified in the Chesapeake Bay Watershed
Legend
Priority areas in the District of Columbia
Priority areas in Delaware
Priority areas in Maryland
Priority streams in Maryland
Priority streams in New York
Priority areas in Pennsylvania
Priority areas in Virginia
Priority areas in West Virginia
Hickey Run
Nash Run
Watts Branch
Fort Dupont
Pope Branch
Mifflin
Dauphin
Columbia
Cumberland
Lebanon
Adams
Lancaster
York
Western Counties of Maryland
Coastal Plain (MD)
Chester River Watershed
Morgan
Jefferson
Hampshire
Hardy
Choptank River Watershed
Pocomoke River Watershed
Maryland Eastern Shore
Virginia Eastern Shore
Piedmont
Coastal Plain (VA)
0 20 40 Miles
0 25 50 100 Kilometers

Figure 1. Priority areas identified by federal agencies, interstate commisions, and state agencies in the Chesapeake Bay watershed during the investigation for this report. Input was received from state agency staff in every Chesapeake Bay watershes jurisdiction (DC, DE, MD, NY, PA, VA, WV). The priority tidal creeks in Maryland are clearly defined in Figure 9. As are the HUC10 watersheds of the priority streams in New York in Figure 10.

Delaware

The Delaware Department of Natural Resources and Environmental Control (DNREC) is interested in reducing spatial and temporal data gaps for state water quality assessments and reporting. There is specific interest in integrating volunteer and nontraditional data in the Pocomoke, Chester, and Choptank River watersheds. The CMC will investigate groups already monitoring in those watersheds such as the Wicomico Environmental Trust, Chester River Association, and Midshore Riverkeeper Conservancy, as well as engaging other monitoring groups active in Maryland that extend across the Maryland/Delaware state boundary.

District of Columbia

The District of Columbia's Department of Energy and Environment (DOEE) is interested in baseline water quality and living resource data such as dissolved oxygen, water temperature, conductivity, pH, and benthic macroinvertebrates in five select watersheds: the Pope Branch, Nash Run, Hickey Run, Watts Branch, and Ft. Dupont. The CMC will investigate potential partnerships with the Smithsonian Anacostia Community Museum, Potomac Riverkeepers Network, Rock Creek Conservancy, and the Audubon Naturalist Society. Collectively, these groups conduct programs that collect data on chemical, biological, and aesthetic monitoring parameters in both tidal and nontidal waters.

Maryland

Maryland Department of Natural Resources (MDNR) and Maryland Department of the Environment (MDE) identified a need for data to fill spatial and temporal water quality information gaps, assess baseline conditions, support the identification of trends, assess project effectiveness, and help to redirect or target agency monitoring program resources. They have a key interest is in additional conductivity data throughout the state to assess the impacts of winter road salt application. Two broad areas of Maryland were highlighted for the integration of nontidal data such as dissolved oxygen, water temperature, conductivity, and pH for determining baseline conditions. Those areas are the western counties of Maryland and the Eastern Shore. The CMC will target volunteer engagement and outreach in those areas. The CMC identified Blue Water Baltimore and the Nanticoke Watershed Alliance as candidates for Tier 3 status for tidal water quality monitoring (i.e., monitoring program integrity level that supports data uses associated with Clean Water Act water quality standards attainment assessments). Blue Water Baltimore and Nanticoke Watershed Alliance programs were audited in the fall of 2016 and are adapting their protocols in 2017 to the CBP Tier 3 field and laboratory guidance.

New York

The New York State Department of Environmental Conservation (NYSDEC) is interested in detecting changes in water quality over time, identifying threats to streams, and targeting restoration activities. Their Water Assessments by Volunteer Evaluators (WAVE) program keeps track of existing stream conditions. WAVE serves to provide critical information to the state that can red flag sites with potential water quality issues and deserve further investigation at the professional level. The CMC team is having ongoing conversations with NYSDEC and the Upper Susquehanna Coalition to identify how the CMC can support the great work of their WAVE program and increase participation.

Pennsylvania

Pennsylvania Department of Environmental Protection (PADEP) identified a need for data in five select watersheds: Chiques Creek, Octoraro Creek, South Branch Conewago Creek, Fishing Creek, and Kishacoquillas Creek. These are heavy agricultural areas, and PADEP is interested in detecting changes in water quality as a result of implemented land-based best management practices (BMPs) or following planned BMP implementation. PADEP provides direct assistance to volunteers through the Consortium for Scientific Assistance to Watersheds (CSAW) program. The CMC will support the monitoring efforts of CSAW and offer technical support and training to programs located in the select watersheds.

Virginia

Virginia Department of Environmental Quality (VADEQ) is interested in building partnerships and leveraging resources to fill data gaps. A need for more water quality information was identified in two broad areas of Virginia, the Piedmont region in central Virginia and the Chesapeake Bayside of the Virginia Eastern Shore. VADEQ is interested in basic water quality data such as dissolved oxygen, water temperature, and pH for determining baseline conditions. The CMC is researching potential partnerships with Soil and Water Conservation Districts in the Piedmont region, as several are already actively monitoring water quality. The Izaak Walton League's Virginia Save Our Streams program and Alliance for the Chesapeake Bay's RiverTrends program are based in Virginia and are strategically placed for building relationships with other organizations in the region.

West Virginia

The West Virginia Department of Environmental Protection (WVDEP) is interested in assessing water quality status and change in areas with current or future best management practice implementation plans. WVDEP is also interested in additional data to support baseline water quailty condition and habitat health assessments while also identifying areas of high nutrient and sediment loading. WVDEP identified a particular need for water quality data in a few select watersheds: Sleepy Creek and Warm Springs Run in Morgan County, West Virginia's tributaries to the Shenandoah River in Jefferson County, Cacapon River and its tributaries, the Lost River and North River in Hardy, Hampshire, and Morgan Counties, and Elks Run and Elk Branch in Jefferson County. The CMC plans to support the efforts of the WVDEP's West Virginia Save Our Streams program, as well as to help integrate and support active monitoring groups such as the West Virginia Rivers Coalition and the Blue Ridge Watershed Coalition. The

CMC also plans to support a Pipeline Monitoring Program in WV developed by a partnership between Trout Unlimited and the West Virginia Rivers Coalition.

Extensive monitoring of the watershed

The Chesapeake Monitoring Census was used to identify common objectives, basic information (Appendix 1), and potential synergies. The responses to the Census provided an overview of diverse monitoring entities in operation across the Chesapeake Bay watershed. With the preliminary assessment of what, where, and how monitoring activities are distributed, we have learned a lot about the types of opportunities for collaborations that might be pursued. For example, 22% of the respondents watershed-wide are monitoring with the intention of collecting baseline data and 27% are interested in monitoring water quality and habitat change in response to the progress of restoration activities.

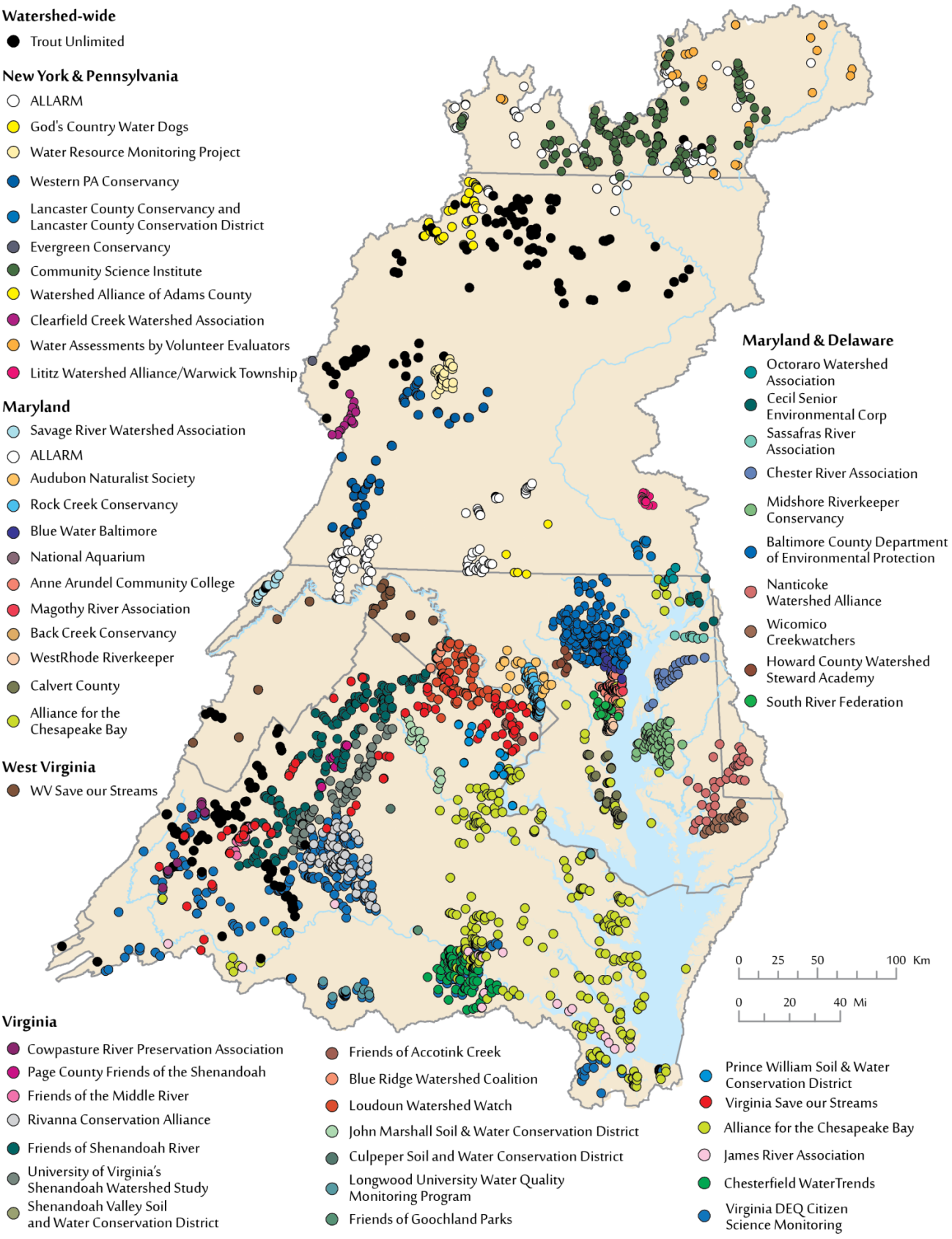
Watershed-wide
Trout Unlimited
New York & Pennsylvania
ALLARM
God's Country Water Dogs
Water Resource Monitoring Project
Western PA Conservancy
Lancaster County Conservancy and Lancaster County Conservation District
Evergreen Conservancy
Community Science Institute
Watershed Alliance of Adams County
Clearfield Creek Watershed Association
Water Assessments by Volunteer Evaluators
Lititz Watershed Alliance/Warwick Township
Maryland
Savage River Watershed Association
ALLARM
Audubon Naturalist Society
Rock Creek Conservancy
Blue Water Baltimore
National Aquarium
Anne Arundel Community College
Magothy River Association
Back Creek Conservancy
WestRhode Riverkeeper
Calvert County
Alliance for the Chesapeake Bay
West Virginia
WV Save our Streams
Maryland & Delaware
Octoraro Watershed Association
Cecil Senior Environmental Corp
Sassafras River Association
Chester River Association
Midshore Riverkeeper Conservancy
Baltimore County Department of Environmental Protection
Nanticoke Watershed Alliance
Wicomico Creekwatchers
Howard County Watershed Steward Academy
South River Federation
0 25 50 100 Km
0 20 40 Mi
Virginia
Cowpasture River Preservation Association
Page County Friends of the Shenandoah
Friends of the Middle River
Rivanna Conservation Alliance
Friends of Shenandoah River
University of Virginia's Shenandoah Watershed Study
Shenandoah Valley Soil and Water Conservation District
Friends of Accotink Creek
Blue Ridge Watershed Coalition
Loudoun Watershed Watch
John Marshall Soil & Water Conservation District
Culpeper Soil and Water Conservation District
Longwood University Water Quality Monitoring Program
Friends of Goochland Parks
Prince William Soil & Water Conservation District
Virginia Save our Streams
Alliance for the Chesapeake Bay
James River Association
Chesterfield WaterTrends
Virginia DEQ Citizen Science Monitoring

Figure 2. Preliminary results from the Chesapeake Monitoring Census show a snapshot of where active volunteer and nontraditional monitoring sites are located. It is important to remember that not all monitoring groups have GPS coordinates for their sites, and some groups have yet to contribute their site locations. Additionally, there are active and historical monitoring sites in Maryland from state-run volunteer monitoring programs not included in this figure due to their extensive spatial coverage of the state (Figure 6).

CMC approach to integrating new partners

The identified groups have diverse needs and incentives for participating in the CMC. Monitoring programs among citizen groups further vary in their investments for quality assurance and quality control of their data collections. The CMC is offering a suite of technical support and services to accommodate the range of needs of these volunteer and nontraditional monitoring groups. The data collected from this project will be categorized into Tiers (Table 1). The CMC also created a rubric to evaluate the diverse monitoring practices of existing groups to help determine the appropriate Tier classification. Tier 3 data for example have data requirements which adhere to the Chesapeake Bay Program's monitoring requirements supporting sufficient integrity that is legally defensible with regulatory water quality standards attainment assessments. The CMC will provide technical support and assistance to help monitoring groups advance to the next Tier when viable.

Chesapeake Environmental Communications is a contractor to the Alliance for the Chesapeake Bay for the purpose of developing the Chesapeake Data Explorer, a database for the integration of all volunteer and nontraditional monitoring groups' water quality data in Chesapeake Bay Watershed states. Clear instructions for interacting with the database will be available online. The CMC will support many of the states' priority objectives within the scope of the project; specifically the integration of water quality and nontidal benthic macroinvertebrate data into the Chesapeake Data Explorer.

The Prioritization Process

The CMC has investigated the data gaps and needs of the CBP partnership by meeting with data users including federal and state agencies, watershed jurisdictions, and inter-state commissions (Appendix 3). Additionally, the CMC team has surveyed nontraditional data producers and has met with monitoring stakeholders to determine what is currently being monitored and what volunteers want to monitor in the watershed. This report summarizes the findings of these two investigations. In addition, the identified priority areas, any area with an identified need for more information that could conceivably be filled by volunteer or nontraditional data of known quality, are guiding the CMC's pathway forward to target integration of new monitoring data. This report outlines opportunities for collaboration in water quality monitoring available to the CBP partnership with new partners in the watershed.

A CMC-organized workshop in October 2016 brought together data users and key players in the volunteer and nontraditional monitoring community to discuss data needs throughout the watershed. This workshop, known as the Prioritization Workshop, served as a key information gathering opportunity and was designed to meet the following objectives:

- Provide an overview of the CMC and the jurisdiction's role in making it a success;
- Discuss the jurisdiction's needs for more data, at a higher frequency, and how the Cooperative intends to help meet agencies' goals for monitoring in the Chesapeake Bay Watershed; and
- Collaborate with jurisdiction's and volunteer monitoring organizations to build a stronger, more robust water quality monitoring networks for the Chesapeake Bay and its watershed.

Participants thought critically about where the CBP partners see opportunities for collaboration and areas where they would like to increase the frequency and availability of monitoring data. The outcomes from the Prioritization Workshop[1] are summarized in this report.

[1] The overview and outcomes of the Prioritization Workshops are summarized and can be found at the following link: https://www.allianceforthebay.org/wp-content/uploads/2016/08/Overview-and-Next-Steps_Prioritization-Workshop_v3.pdf

Identified Data Needs in the Chesapeake Bay Watershed

Overall opportunities for the integration of volunteer and nontraditional water quality monitoring data identified by key stakeholders are listed in Table 2. There are several identified data needs that are shared between jurisdictions. Table 2 identifies the data needs that each state/jurisdiction prioritized, which provides guidance for the CMC team for future outreach and engagement.

Table 2. Priority objectives for volunteer and nontraditional data use identified by environmental agencies in the Chesapeake Bay watershed

Monitoring Data Use/Need	State/Jurisdiction
Fill data gaps for Clean Water Act 305(b)/303(d) assessments	DE, DC, MD, NY, VA
Monitor restoration progress and conservation effectiveness or conduct impact assessment (pre- and post-implementation)	DE, DC, MD, NY, PA, WV
Stormwater MS4 monitoring	PA
Collect longitudinal data and monitor trends over time	MD, NY
Establish baseline water quality data (tidal)	DE, DC, MD, VA
Establish baseline water quality data (nontidal)	DE, DC, MD, PA, VA
Monitor the impacts of road salt (conductivity)	MD
Marcellus Shale natural gas and acid mine drainage mitigation	MD, PA
Determine if a TMDL is needed	MD
Higher frequency monitoring of impaired waters	DC, NY, VA
Promote stewardship and provide opportunities for community outreach and engagement	DE, DC, MD, NY, PA, VA, WV
Identify areas of high nutrient and sediment loading	NY, WV
Monitor areas undergoing change (i.e. development)	DC, WV
Climate change resiliency	NY, PA, VA, WV
Monitor the impacts of pipelines	PA, VA, WV
Monitor areas with high concentrations of agriculture	PA
Monitor presence of aquatic invasive species	MD

The CMC team met with data users in every watershed jurisdiction (DE, DC, MD, NY, PA, VA, and WV) to discuss the goals and objectives and possible synergies for consistent, regional monitoring coverage, spatially and temporally. The process began with identifying basic monitoring objectives in each state. This was followed by exploring the potential for using data that may be collected using differing monitoring protocols from those used by the state agency. Discussions acknowledged that volunteer and nontraditional data use can help reduce the uncertainty in state water quality standards assessments, and/or alert an agency to a harmful practice or nutrient loading hot spot that needs further investigation.

Delaware

The Nanticoke Watershed Alliance has a strong presence in Delaware and was one of the first volunteer monitoring groups to undergo the Tier 3 auditing process as a candidate for Tier 3 data classification. The CMC team met with the DNREC to identify how the CMC can provide support for the current operations and desired growth of the Nanticoke Watershed Alliance.

Additionally, the group brainstormed some gap-filling solutions beyond the Nanticoke Watershed. The most immediate need of DNREC for the integration of volunteer and nontraditional data is data accessibility.
To reiterate, the data needs identified by key stakeholders (Table 2) in Delaware are:

- Fill data gaps for Clean Water Act 305(b)/303(d) assessments
- Monitor restoration progress and conservation effectiveness or conduct impact assessment (pre- and post-implementation)
- Establish baseline water quality data (tidal)
- Establish baseline water quality data (nontidal)
- Promote stewardship and provide opportunities for community outreach and engagement

Priority watersheds and data needs

The Nanticoke Watershed Alliance, with the aim to accumulate long-term, scientifically credible data and to monitor the health of the Nanticoke River and the Fishing Bay headwaters, collects tidal and nontidal water quality data. The Nanticoke Watershed Alliance has worked with a number of CBP partners who have provided a degree of rigor and accountability to the data, including the implementation of the Mid-Atlantic Tributary Assessment Coalition (MTAC) protocols. There is a need for additional tidal and nontidal monitoring data in the Pocomoke, Chester, and Choptank River watersheds (Figure 3). DNREC is interested in identifying volunteer or nontraditional monitoring groups that can contribute to the reduction of spatial and temporal data gaps for state assessments and reporting.

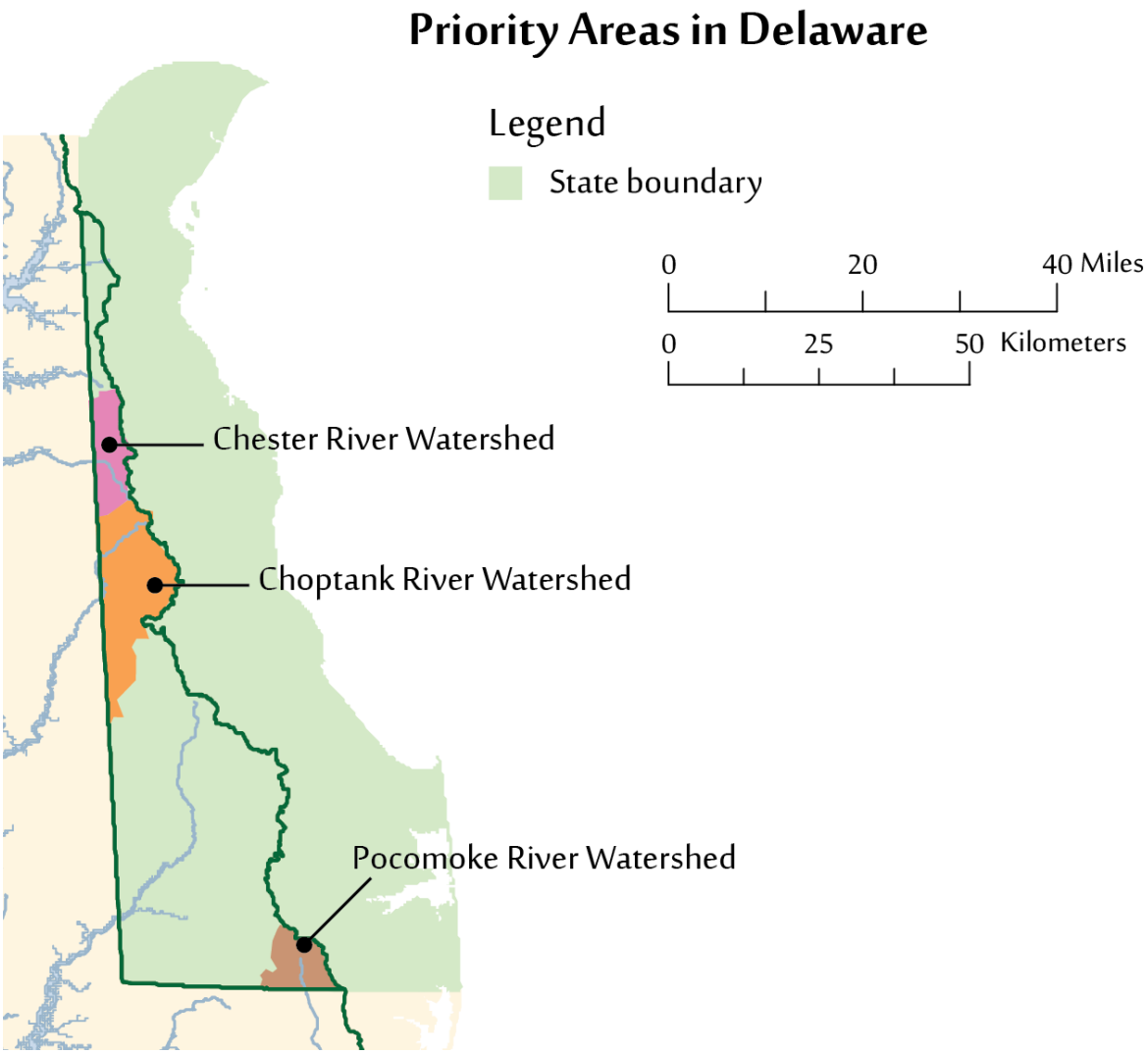

Figure 3. Priority watersheds were identified by Delaware Department of Natural Resources and Environmental Control for targeted CMC outreach and data integration.

CMC Preliminary Plan of Action

The CMC plans to support the needs of DNREC primarily through training and QA/QC protocol review. The CMC will also connect with monitoring groups already monitoring the Pocomoke, Chester, and Choptank Rivers, such as the Wicomico Environmental Trust, the Chester River Association, and Midshore Riverkeeper Conservancy (in Maryland). These monitoring groups may not directly target DNREC's watersheds of interest; however, they either border or overlap as seen in Figure 4. Due to the cross-state nature of the CMC, DNREC would like the CMC team to identify watershed groups that could feasibly expand to monitor across state boundaries. There are no specific Delaware-focused volunteer monitoring groups at this time. However, there are

substantive Maryland-based monitoring programs that may be able to integrate efforts across state borders to gain Delaware coverage.

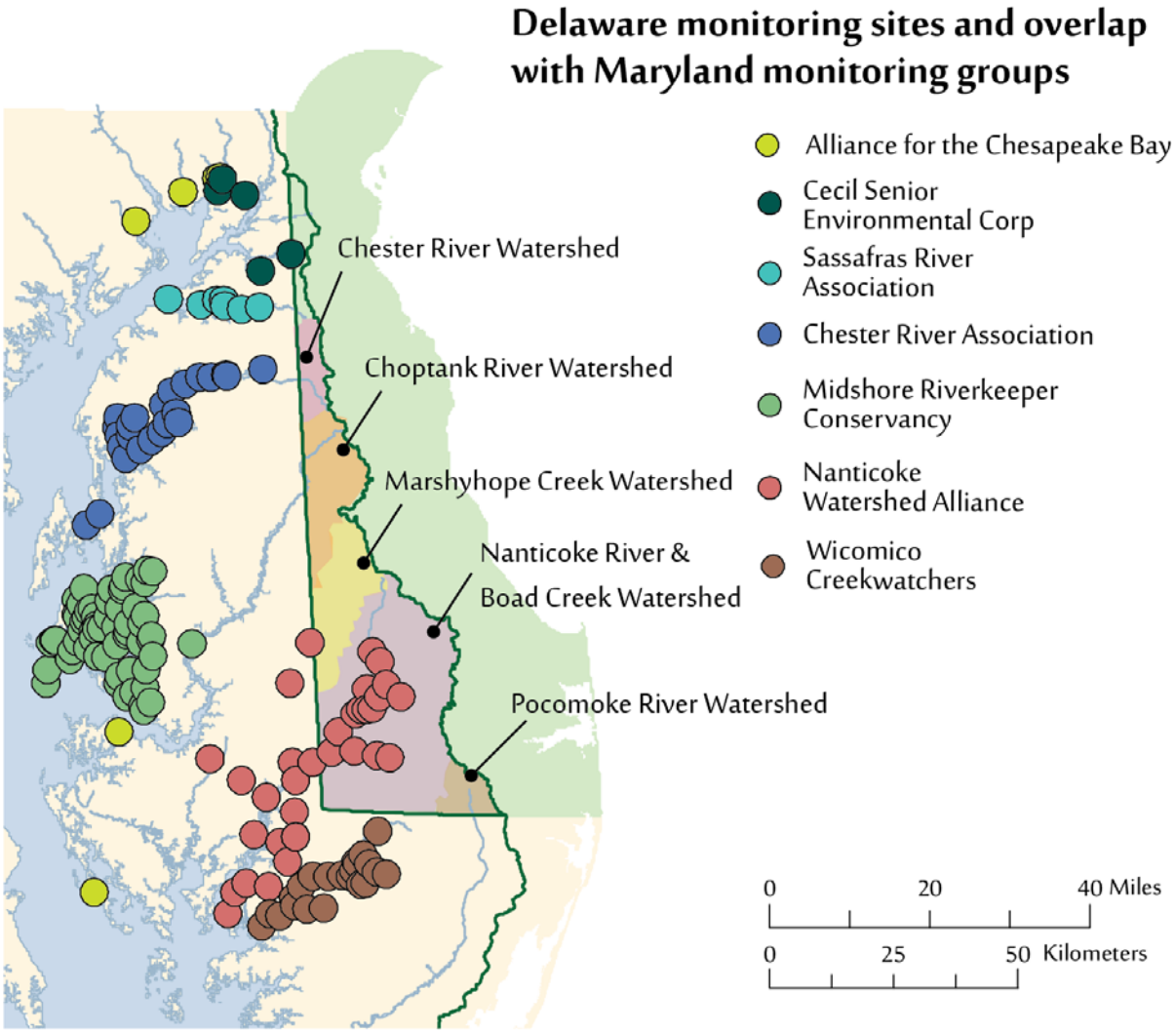

Figure 4. Examples of volunteer monitoring groups that monitor tributaries in or bordering Delaware.

The primary technical support the CMC plans to offer the Nanticoke Watershed Alliance is to review their current nontidal water quality monitoring program and identify the potential for classifying the data into a higher Tier. The CMC may provide financial support to update equipment, and/or provide training for the Nanticoke Watershed Alliance Coordinator on CMC nontidal water quality methods and associated QA/QC protocols.

District of Columbia

The District of Columbia Department of Energy and Environment (DOEE) recently updated their water quality monitoring strategy.

To reiterate, the data needs identified by key stakeholders (Table 2) in the District of Columbia are:

- Fill data gaps for Clean Water Act 305(b)/303(d) assessments
- Monitor restoration progress and conservation effectiveness or conduct impact assessment (pre- and post-implementation)
- Establish baseline water quality data (tidal)
- Establish baseline water quality data (nontidal)
- Higher frequency monitoring of impaired waters
- Promote stewardship and provide opportunities for community outreach and engagement
- Monitor areas undergoing change (i.e. development)

Priority watersheds and data needs

The Department of Energy and Environment (DOEE) identified five small watersheds (Figure 5) for the integration of volunteer and nontraditional water quality and aquatic living resource monitoring data into their water quality assessments:

1. Pope Branch
2. Nash Run
3. Hickey Run
4. Watts Branch
5. Ft. Dupont

DOEE is interested in baseline data such as dissolved oxygen, water temperature, conductivity, pH, and benthic macroinvertebrates.

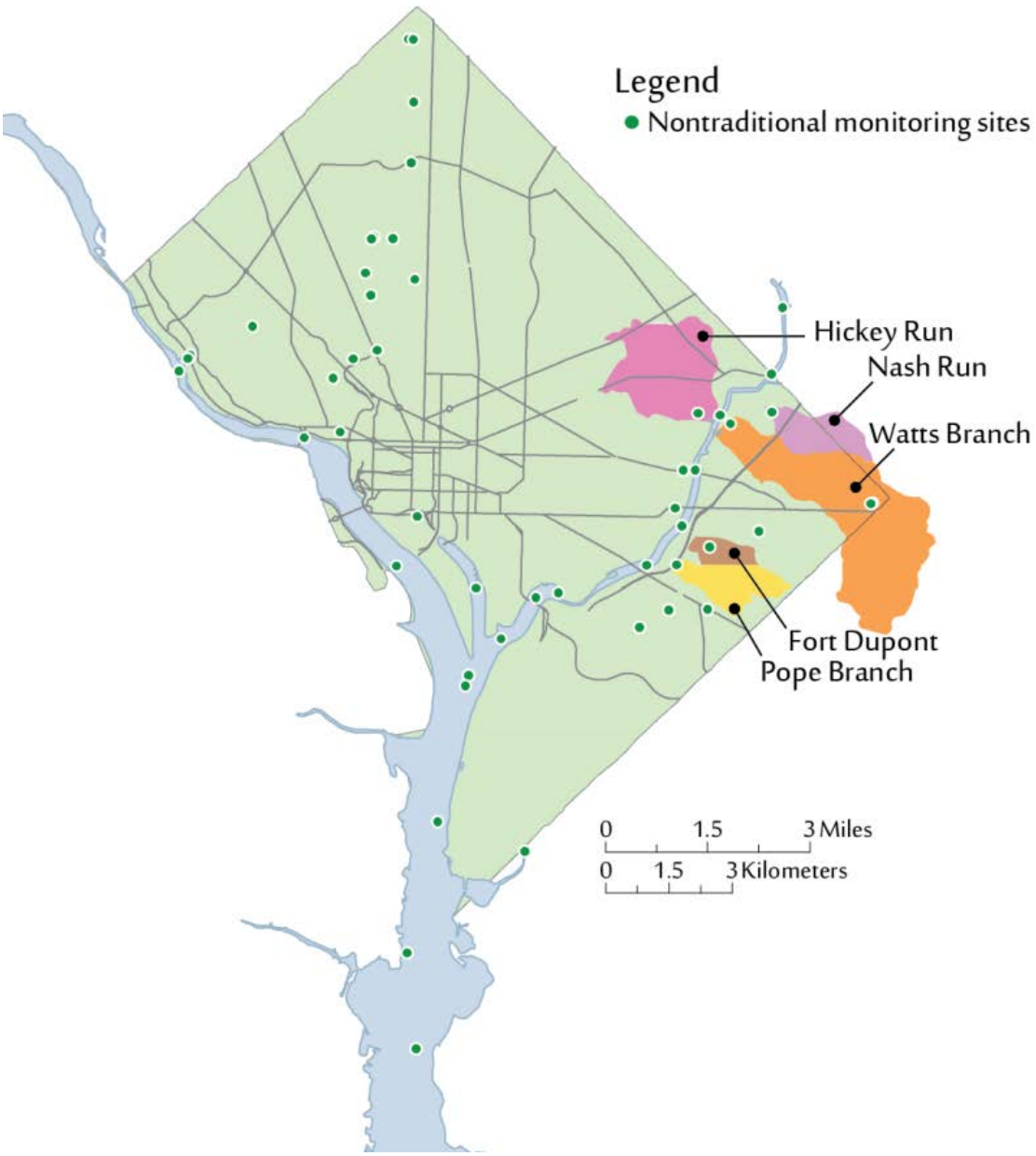

Figure 5. DOEE identified five watersheds in the District of Columbia where DOEE is seeking more water quality and benthic macroinvertebrate monitoring data. The CMC will investigate volunteer and nontraditional monitoring occurring within those five watersheds.

CMC Preliminary Plan of Action

The CMC will investigate potential partnerships with the Smithsonian Anacostia Community Museum, Potomac Riverkeepers Network, Rock Creek Conservancy, and the Audubon Naturalist Society. Collectively, these groups monitor in both tidal and nontidal waters, as well as collect chemical, biological, and aesthetic feature monitoring parameters. Working with DOEE, the CMC will identify volunteer and nontraditional monitoring sites within the small watersheds of interest with the hopes of integrating these sites into the next phase of the DOEE monitoring strategy. The CMC will also investigate reinvigorating monitoring efforts of the Anacostia Watershed Society and the Anacostia Riverkeeper.

Maryland

The Maryland Department of Natural Resources (MDNR) operates two widespread biological monitoring programs (Figure 6). The Maryland Biological Stream Survey (MBSS) is managed and run by professional MDNR biologists. The Stream Waders benthic macroinvertebrate sample collection program, also managed by MDNR staff, serves as the volunteer "arm" of the MBSS, with volunteers conducting the field sampling and MDNR biologists conducting the sample analysis.

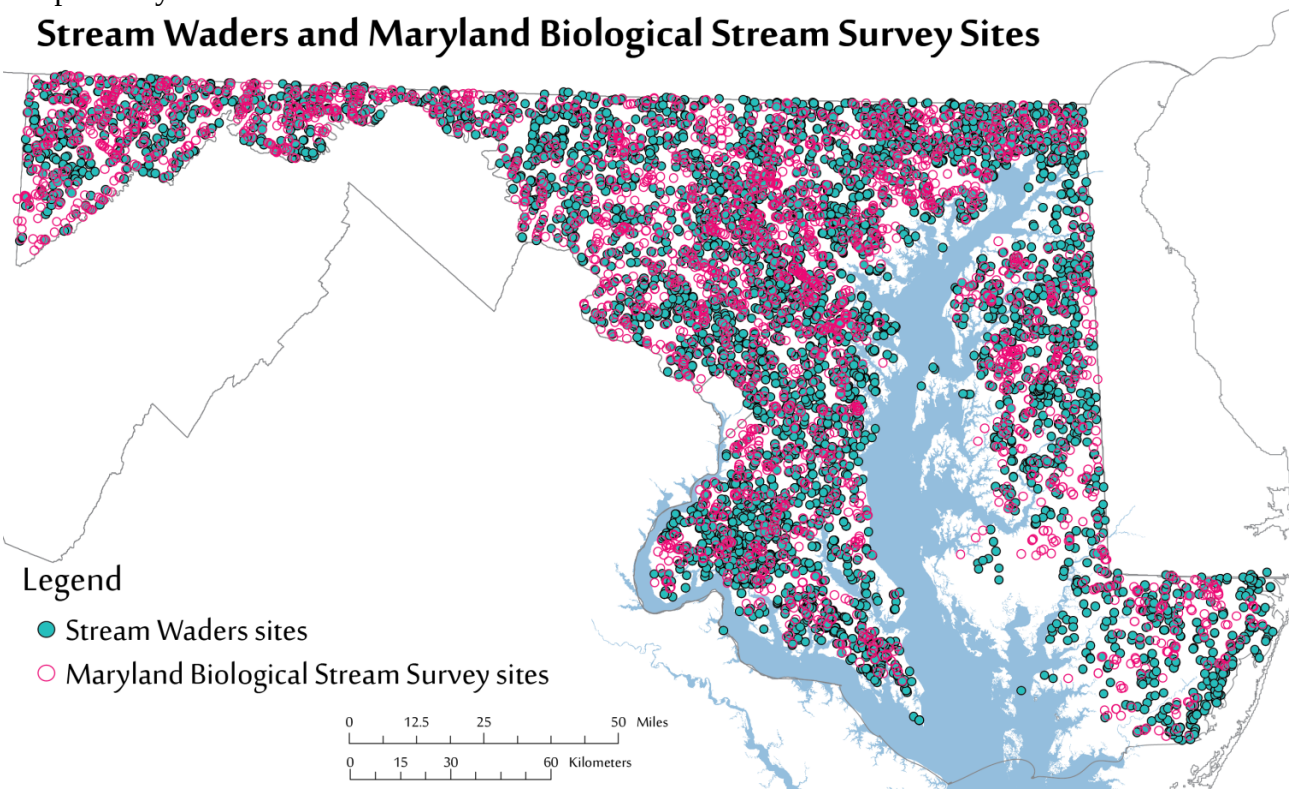

Figure 6. The Maryland Biological Stream Survey was started by the Maryland Department of Natural Resources in 1993. The MBSS was Maryland's first probability-based or random design stream sampling program to monitor stream conditions with known precision at various spatial scales. In 2000, Stream Waders was established. These two programs are used as a cost-effective way to characterize Maryland's 10,000+ miles of freshwater streams.

Maryland state agencies and the CBP identified tidal and non-tidal areas of Maryland that had data gaps as well as areas that are current priorities for the state.
To reiterate, the data needs identified by key stakeholders (Table 2) in Maryland are:

- Fill data gaps for Clean Water Act 305(b)/303(d) assessments
- Monitor restoration progress and conservation effectiveness or conduct impact assessment (pre- and post-implementation)
- Collect longitudinal data and monitor trends over time
- Establish baseline water quality data (tidal)
- Establish baseline water quality data (nontidal)
- Monitor the impacts of road salt (conductivity)
- Marcellus Shale natural gas and acid mine drainage mitigation
- Determine if a TMDL is needed
- Promote stewardship and provide opportunities for community outreach and engagement
- Monitor presence of aquatic invasive species

Priority watersheds and data needs

Data users in Maryland identified a need for data to fill spatial and temporal gaps in water quality and benthic macroinvertebrate assessments, assess baseline conditions, identify trends, assess project effectiveness, and help to redirect or target agency water quality monitoring programs. A high priority for Maryland data users is to collect more conductivity data throughout the state. Based on the results from the Chesapeake Monitoring Census, there are at least 24 volunteer or nontraditional monitoring groups in Maryland collecting conductivity data. As seen in Figure 7, there are volunteer and nontraditional monitoring groups collecting conductivity data in over half of the counties in Maryland.

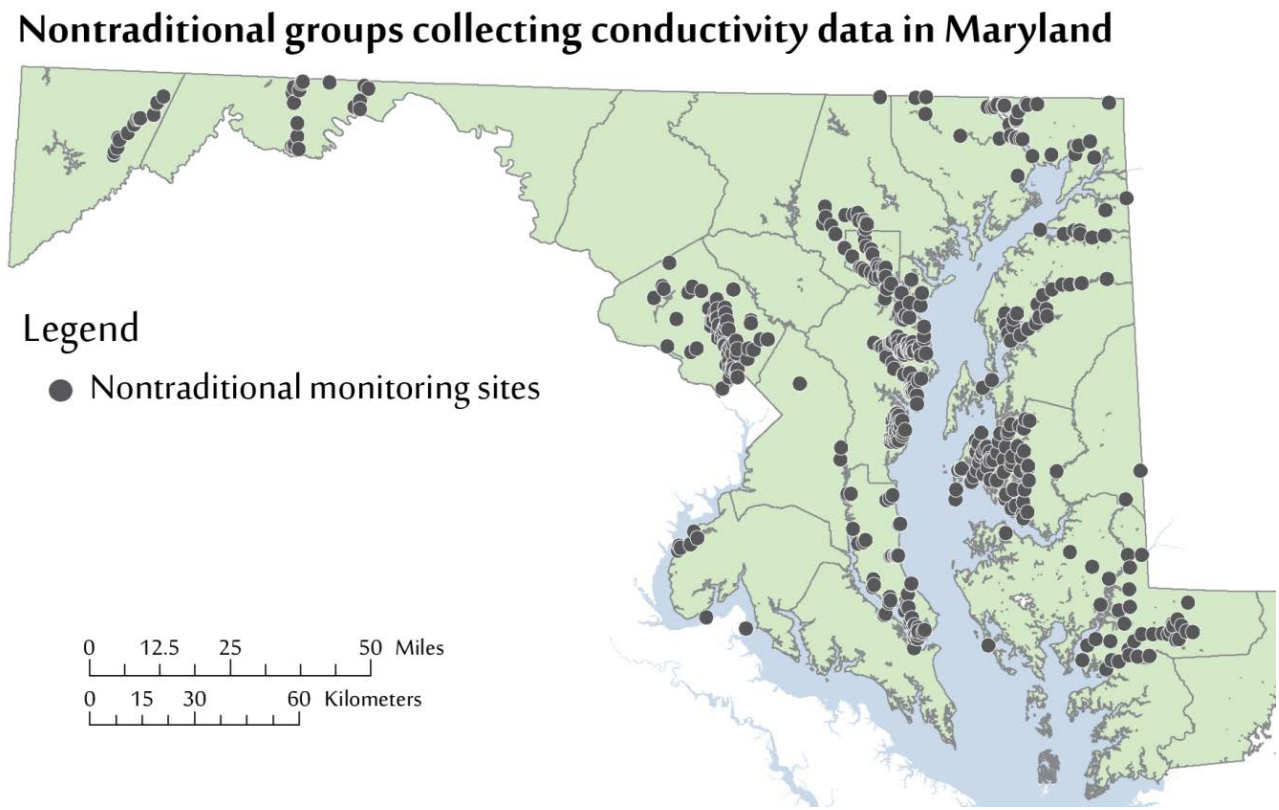

Figure 7. As a priority for Maryland Department of Natural Resources and Maryland Department of the Environment, the CMC evaluated a sample of volunteers and nontraditional monitoring groups to get a spatial picture of where conductivity data are currently collected.

Two broad areas of Maryland were highlighted for their data gaps in nontidal water quality information. Those areas are the western counties (Garrett, Allegheny, Washington, Frederick, and Carroll) and the Eastern Shore (Cecil, Kent, Queen Anne's, Talbot, Caroline, Dorchester, Wicomico, Somerset and Worcester Counties), illustrated in Figure 8.

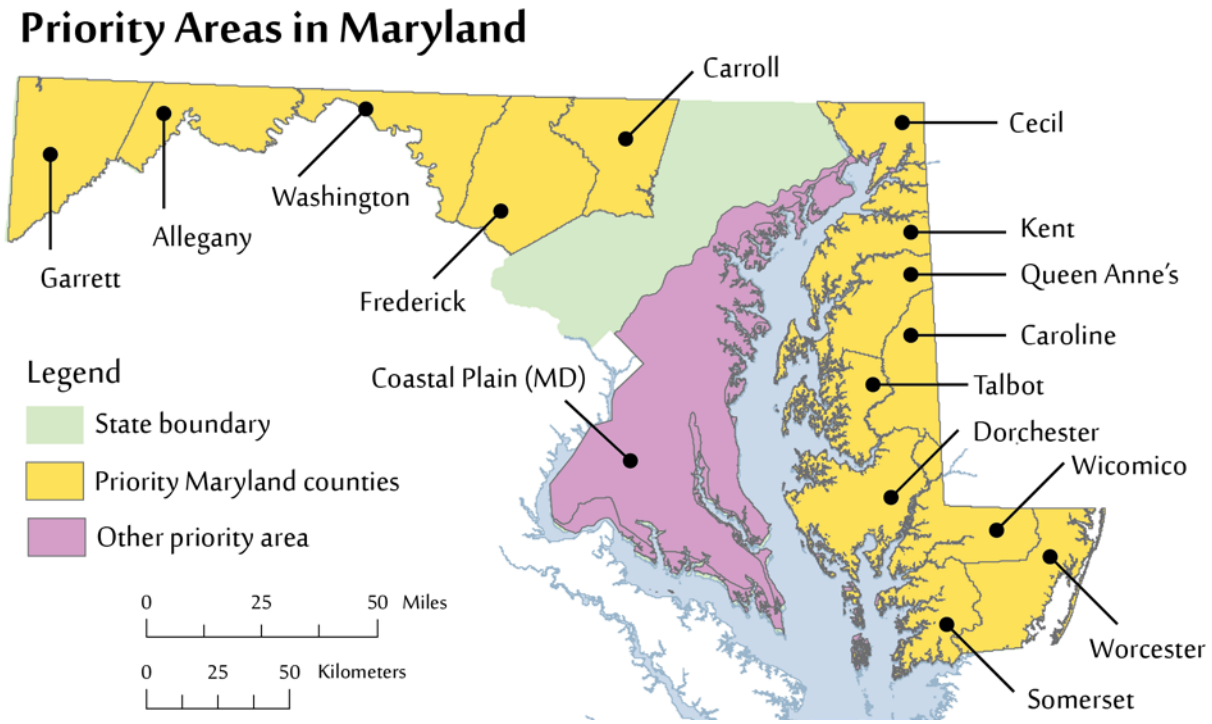

Figure 8. Priority counties were identified by Maryland Department of Natural Resources and Maryland Department of the Environment for targeted CMC outreach and data integration. In addition, CBP staff identified the Coastal Plain ecoregion as a priority area, which includes the entire Eastern Shore and the Western Shore Uplands and Lowlands of Maryland. Several tidal creeks on the Eastern Shore were also identified as priority areas, which are clearly defined in Figure 9.

In the western counties, water quality data such as dissolved oxygen, water temperature, conductivity, and pH are needed to establish baseline conditions. Additionally, Marcellus Shale natural gas well impact monitoring and acid mine drainage mitigation monitoring of water quality were identified as needs in specific areas within the western counties.

On the Eastern Shore, basic water quality data such as dissolved oxygen, water temperature, conductivity, and pH are needed to determine baseline conditions. The Coastal Plain ecoregion, which includes the entire Eastern Shore of Maryland, was identified as needing more data. Specific areas identified as priority areas in Maryland included Marshyhope Creek, the Little Choptank River, Harris Creek, the Pocomoke River, the creeks along the northern shore of the Potomac River, and the area around southern St. Mary's County. Additionally, the Coastal Plain, which includes many small tidal creeks, is another priority for additional data. There are gaps in information about these small tidal creeks because they are difficult to access by motorized boats used by agencies for monitoring. These small tidal creeks are in the tidal fresh and oligohaline areas of most tributaries in Maryland, and would benefit from additional environmental health information from on-the-ground volunteer monitors.

Areas where more data would be helpful to better understand nutrient exporting from certain watersheds are shown in Figure 9. Parameters that Maryland Department of the Environment is

interested in are dissolved oxygen, Biological Oxygen Demand, chlorophyll *a*, pH, Total Suspended Solids, turbidity, water temperature, nitrogen, and phosphorus.

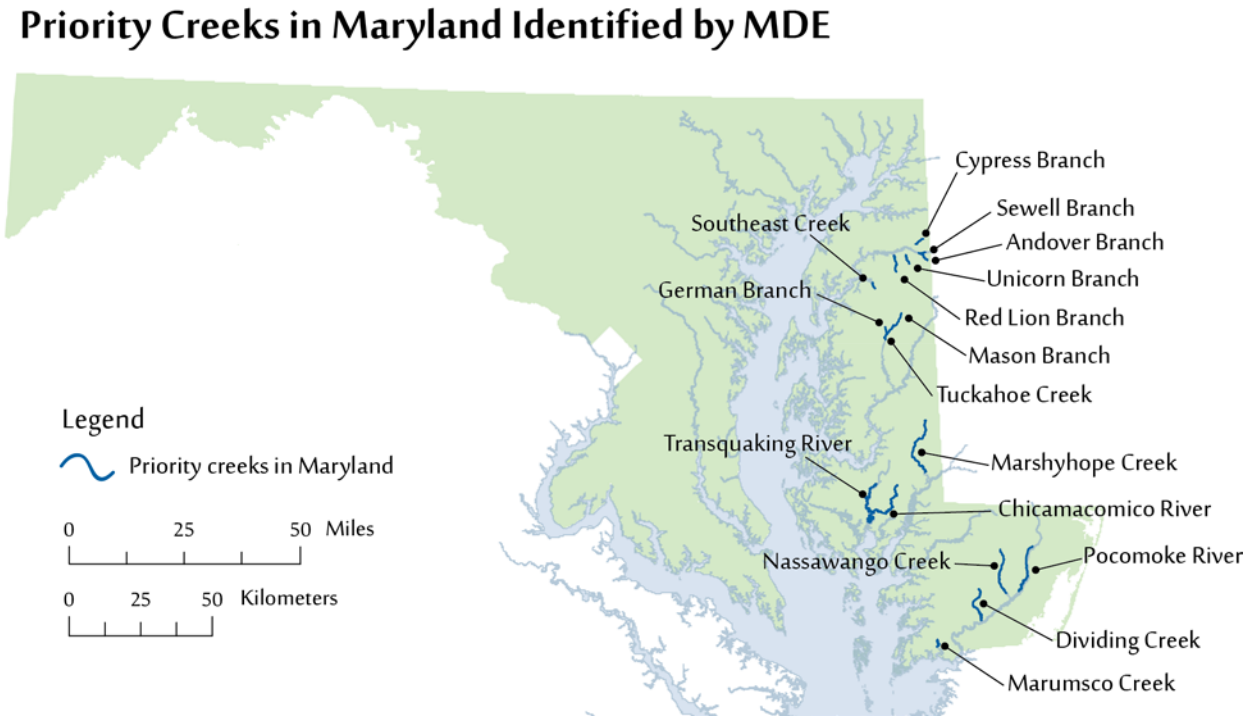

Figure 9. Tidal Creeks highlighted by Maryland Department of the Environment as specific watersheds of interest, seeking additional water quality data to better understand nutrient exporting.

Priority areas for Maryland state agencies cover a variety of targeted monitoring goals. For example, monitoring water quality both before and after best management practice implementation in order to measure and evaluate the effect of management actions is a priority for several agencies. Maryland's Chesapeake & Atlantic Coastal Bays Trust Fund leverages funds and resources to accelerate restoration of the Chesapeake and Coastal Bays. However, monitoring the effectiveness of those restoration projects is limited. There is a need for pre- and post-restoration monitoring at such sites.

Other priority areas for Maryland state agencies are Maryland's 8-digit scale watersheds that are impaired for water temperature standards. These watersheds could be monitored by volunteer or nontraditional groups using Maryland Department of the Environment's (MDE) protocol which would contribute greatly to understanding temperature trends and could potentially delist some of these watersheds.

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The CMC has contacted multiple tidal water quality monitoring groups to encourage their participation in the Cooperative. Blue Water Baltimore and the Nanticoke Watershed Alliance were identified as candidates for Tier 3 (for use in Clean Water Act water quality standards attainment assessments) data collection. These two groups were audited in the fall of 2016 to evaluate how their programs meet or need to be adapted in order to meet the Tier 3 assessment protocols for select water quality parameters (e.g., dissolved oxygen). See Appendix 2 for more information. Furthermore, the CMC partnered with the Maryland Water Monitoring Council (MWMC), MDE, and others to provide a *Data to Decisions Workshop* that targeted Maryland watershed organizations for better inclusion in Maryland state water quality assessments and reporting. These reports are traditionally funneled to the CBP partnership. The CMC has also participated in the MWMC annual meeting and will continue to participate in many networking events with the agency and volunteer monitoring communities in Maryland. Additionally, the CMC has connected several monitoring groups directly with Maryland state agencies based on identified priority areas such as the Nanticoke Watershed Alliance and MDE.

The Chesapeake Monitoring Census identified volunteer and nontraditional groups collecting data of interest in the identified priority areas (Appendix 1). Several of these groups have also identified interest in using the new Chesapeake Data Explorer (i.e. the database being developed for the CMC) for storing and visualizing their data and adapting to the CMC standardized protocols and quality assurance project plans. The CMC will target outreach and training to the groups accordingly. In a later section, Table 4 lists the number of monitoring groups in Maryland who responded to the census, and are collecting priority biological, physiochemical, and visual monitoring parameters, providing some insight into the vast under-utilized data available in the state.

New York

The New York State Department of Environmental Conservation (NYSDEC) developed a citizen-based program, the Water Assessments by Volunteer Evaluators (WAVE), in 2012 to collect benthic macroinvertebrate data to assess water quality of wadable streams. NYSDEC through the WAVE program offers training to volunteers for sample collection, and the WAVE coordinator identifies all the benthic macroinvertebrates to the family level. NYSDEC is interested in detecting change in water quality over time, identifying threats to streams, and targeting restoration activities. The WAVE program keeps track of existing stream conditions and flags sites for the NYSDEC that show potential water quality issues which may deserve further investigation at the professional level. WAVE data is also used for:

- State and Federal Reporting - No Known Impact sites are included in the NYS Waterbody Inventory and EPA's Clean Water Act Section 305(b) reporting.
- Monitoring Reports - WAVE data are included in the Trend Monitoring and basin reports.
- Rotating Integrated Basin Studies - WAVE data are considered when sites are selected for DEC's monitoring program.

- Non-point Source Discharges Issues - WAVE data provide basic background information on water quality conditions for NYSDEC staff working on non-point discharge sources.

There are a number of monitoring stakeholders in the Upper Susquehanna including the New York Water Sentinels (organized by the Mid-Atlantic chapter of the Sierra Club), Trout Unlimited, and the Upper Susquehanna Coalition, which works with the Soil and Water Conservation Districts and watershed organizations on stream assessments and restoration projects.

To reiterate, the data needs identified by key stakeholders (Table 2) in New York are:

- Fill data gaps for Clean Water Act 305(b)/303(d) assessments
- Monitor restoration progress and conservation effectiveness or conduct impact assessment (pre- and post-implementation)
- Collect longitudinal data and monitor trends over time
- Higher frequency monitoring of impaired waters
- Promote stewardship and provide opportunities for community outreach and engagement
- Identify areas of high nutrient and sediment loading
- Climate change resiliency

CMC Preliminary Plan of Action

The CMC team is having ongoing conversations with NYSDEC (including WAVE), the Upper Susquehanna Coalition (USC), and the Community Science Institute, a nonprofit state-certified water quality testing lab which partners with volunteers to monitor water quality in New York's Finger Lakes and Southern Tier regions. NYSDEC would like to see additional participation in their WAVE program and USC would like to see additional community monitoring efforts in the upper Susquehanna River watershed. NYSDEC prepares a map each year of the monitored and unmonitored streams (Figure 10), which will serve as the starting point for outreach and engagement. A strong desired outcome from NYSDEC of the CMC is the expanded community engagement that volunteers monitoring their local waterways can provide. The CMC intends to support that objective in all outreach and engagement in New York.

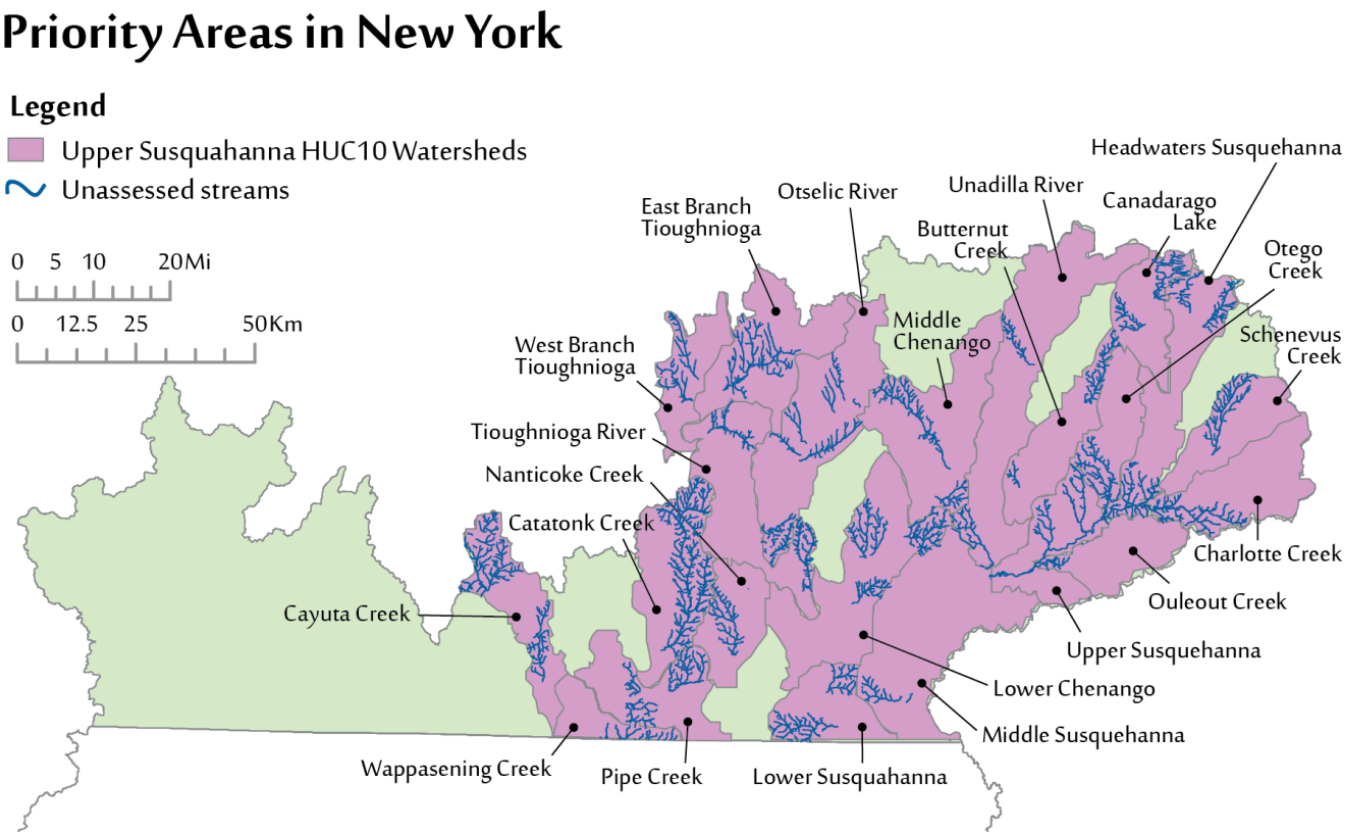

Figure 10. Depicted in this figure are the New York State Department of Environmental Conservation identified unassessed stream segments as of spring 2016. To provide some spatial context for the unassessed streams, smaller watershed (10-digit Hydrologic Unit Code, or HUC10 Watersheds) boundaries are labeled.

Pennsylvania

Pennsylvania has a rich history of watershed group engagement and volunteer monitoring. To help ensure that communities were conducting question-driven programs and matching the appropriate equipment with the intended data use, the Pennsylvania Department of Environmental Protection (PADEP) provided direct assistance through its Citizen Volunteer Monitoring Program (CVMP) established in 1996 and through the Consortium for Scientific Assistance to Watersheds (CSAW) established in 2001. In July 2009, due to budget constraints, PADEP eliminated its CVMP, which coordinated volunteer monitoring activities and data use at the agency. It continued to fund technical support to volunteer monitors by renewing grant funding for the CSAW at a reduced level. As a result, volunteer monitoring efforts dwindled. Today, PADEP would like to use volunteer monitoring data to screen streams for water quality issues to highlight in their integrated reports as well as assess potential progress from stream restoration projects, best management practices, and abandoned mine land remediation projects. PADEP recruits volunteers from across the state for bacteria monitoring for the purpose of Recreational Use assessments. Volunteers are trained by PADEP in adherence to sampling protocol and quality assurance plans. All fecal coliform laboratory analysis is completed by

PADEP certified laboratories. The bacteria data collected by various citizen volunteer groups in 2014 and 2015 resulted in the assessment of approximately 250 stream miles for Recreational Use.

In addition to CSAW, there are other organizations who work with volunteer monitors such as: Nature Abounds, Pennsylvania Senior Environment Corps, Trout Unlimited (with 53 chapters in the state), and Penn State Extension (recently developed a Master Watershed program).

The CMC will help identify the quality and potential use of water quality and benthic macroinvertebrate data collected throughout the state of Pennsylvania. With input from data users, the CMC has identified the priority objectives where CMC can provide assistance.

To reiterate, the data needs identified by key stakeholders (Table 2) in Pennsylvania are:

- Monitor restoration progress and conservation effectiveness or conduct impact assessment (pre- and post-implementation)
- Stormwater MS4 monitoring
- Establish baseline water quality data (nontidal)
- Marcellus Shale natural gas and acid mine drainage mitigation
- Promote stewardship and provide opportunities for community outreach and engagement
- Climate change resiliency
- Monitor the impacts of pipelines
- Monitor areas with high concentrations of agriculture

Priority watersheds and data needs

At the Prioritization Workshop, a number of watersheds were identified as high priority areas for more data collection. These watersheds include:

1. Chiques Creek
2. Octoraro Creek
3. South Branch Conewago Creek
4. Fishing Creek
5. Kishacoquillas Creek

These watersheds are within the counties of Lancaster, York, Lebanon, Dauphin, Adams, Cumberland, Mifflin, and Columbia (Figure 11). They are mostly heavy agricultural areas; however, agencies do not have the resources to monitor with enough frequency to support effective water quality change detection from implementation of current BMPs or planned BMP implementation.

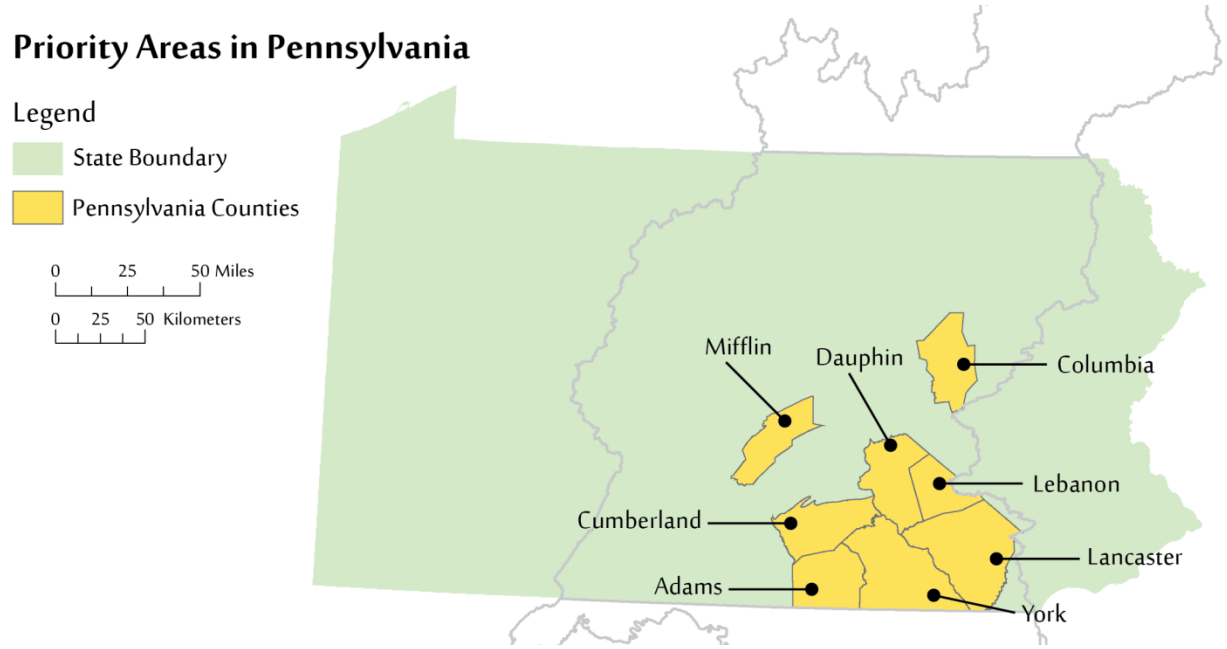

Figure 11. Priority watersheds were identified by Pennsylvania Department of Environmental Protection and the Susquehanna River Basin Commission within eight counties with high levels of agricultural land use.

Data users are also interested in monitoring coal mining legacy areas to determine the effectiveness of remediation actions on water quality.

CMC Preliminary Plan of Action

The CMC will review programs and offer technical support and training to water quality monitoring programs located in the target watersheds. Additionally, there is the potential for volunteers to collect and report aesthetic feature/visual integrity assessments of BMP maintenance. The CMC will explore recommending tools or providing support for this need.

Virginia

In 2002, the Virginia General Assembly codified a law that Virginia Department of Environmental Quality (VADEQ) had to establish a citizen water quality monitoring program and provide technical assistance and grant funding to support citizen water quality monitoring groups. Currently, VADEQ has a Quality Assurance Coordinator to review submitted data and a Water Quality Data Liaison to support the integration of volunteer monitoring data, and also provides funding to groups which allows them to purchase more sensitive equipment and therefore provide more accurate data. The CMC team has learned a great deal from the successes with volunteer monitoring in Virginia, and seeks to provide ongoing support for VADEQ's continued efforts.

To reiterate, the data needs identified by key stakeholders (Table 2) in Virginia are:

- Fill data gaps for Clean Water Act 305(b)/303(d) assessments
- Establish baseline water quality data (tidal)

- Establish baseline water quality data (nontidal)
- Higher frequency monitoring of impaired waters
- Promote stewardship and provide opportunities for community outreach and engagement
- Climate change resiliency
- Monitor the impacts of pipelines

Priority watersheds and data needs

VADEQ is interested in connecting with more organizations that can help increase the amount of water quality and benthic macroinvertebrate data collected and fill some of the current data gaps. Two broad areas of Virginia were highlighted that have data gaps in water quality information, the Piedmont region in central Virginia and the Bay side of the Virginia Eastern Shore (Figure 12). In the Piedmont region, Soil and Water Conservation Districts (SWCD), such as Monacan, Piedmont, Tri County/City, Henricopolis and Peter Francisco were identified as excellent potential partners for the VADEQ. In addition, the Tri-county/City SWCD has a volunteer monitoring program called the Fredericksburg Area Monitoring for the Environment (FAME), which includes a Bacteria monitoring QAPP with VADEQ. Also with a VADEQ approved volunteer water quality monitoring QAPP, is the Henricopolis SWCD program, called the Henrico Area Water Quality Samplers (HAWQS). These are examples of a partnership opportunity where the CMC can leverage already existing relationships.

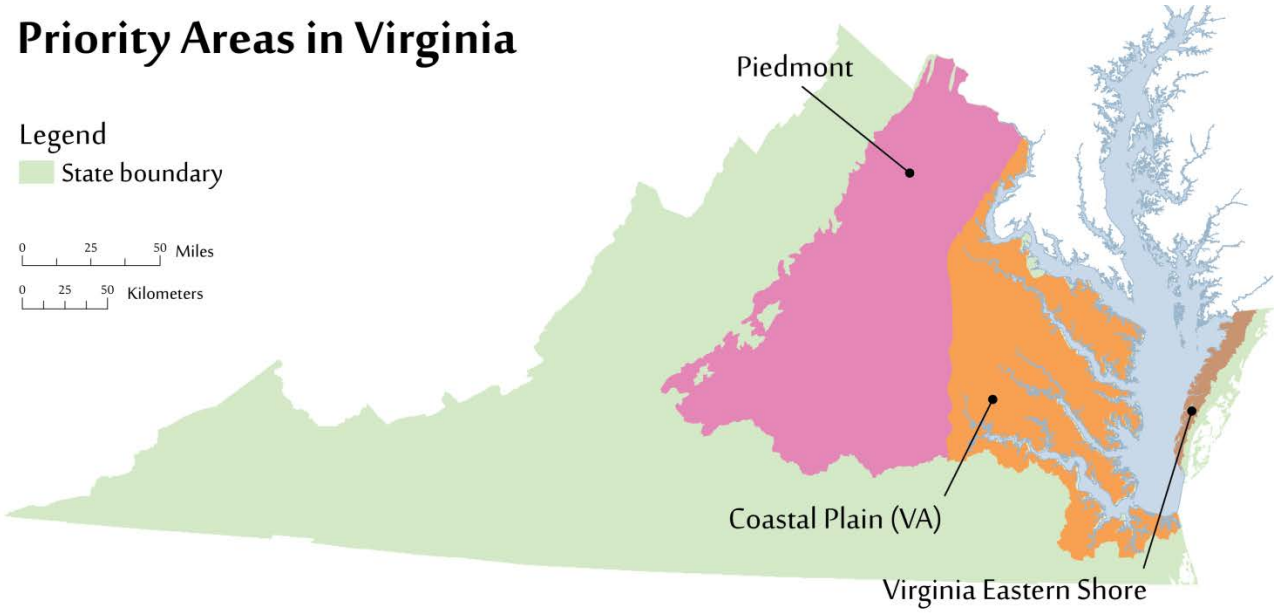

Figure 12. The Piedmont region in central Virginia and the Chesapeake Bay side of the Virginia Eastern Shore were identified as having significant water quality data gaps by Virginia Department of Environmental Quality. Per their recommendation, the CMC is researching potential partnerships with Soil and Water Conservation Districts in the Piedmont region, as they are already actively monitoring water quality. In addition, CBP staff identified the Coastal

Plain ecoregion as a priority area, which includes the area east and south of the Piedmont Plateau in Virginia. The unassessed creeks in VA were also identified as a priority, which are clearly defined in Figure 13.

VADEQ is interested in basic water quality data (dissolved oxygen, water temperature, and pH) needed to determine baseline conditions specifically of second order streams and under-monitored impaired waters. These waters are represented as priority creeks in Virginia in Figure 13. As shown in Figure 13, a number of priority creeks in Virginia are currently being monitored by volunteers. In addition to the aforementioned priorities, VADEQ is open to any water quality data submitted by volunteers, such as benthic macroinvertebrates, fecal indicator bacteria, and others.

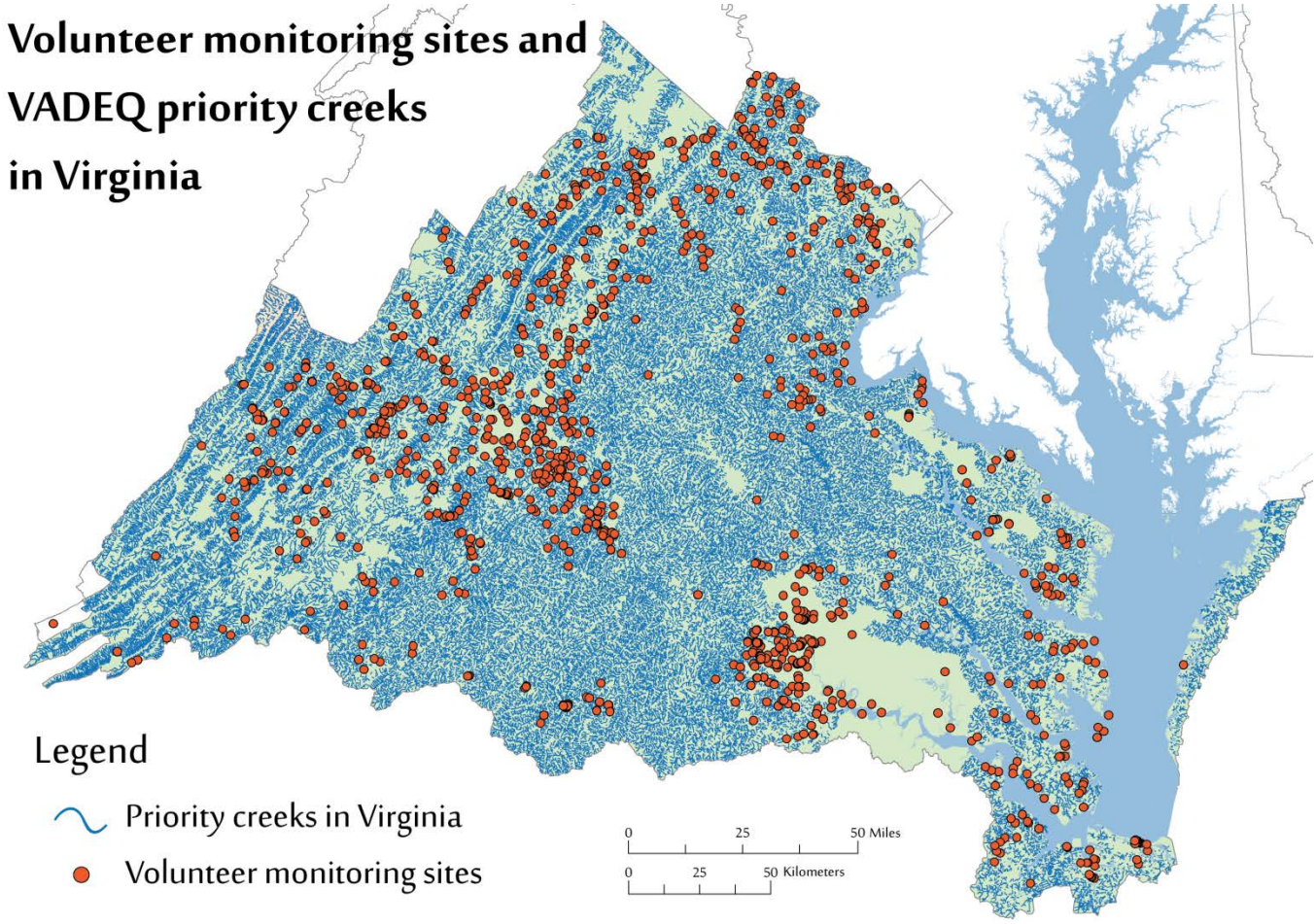

Figure 13. Virginia Department of Environmental Quality provided the location of priority creeks in Virginia. The volunteer monitoring sites are a sample of where volunteer or nontraditional monitoring groups are actively monitoring in Virginia based on the response to the Chesapeake Monitoring Census. Engaging and partnering with SWCDs in Virginia may help address the spatial gap in the Piedmont region seen in this figure.

VADEQ also identified the lower Rappahannock and York Rivers as priority areas for increased outreach and engagement for the CMC, and the need for increased reliability (data quality) in water temperature, dissolved oxygen, pH, and chlorophyll *a* (only in lakes/large rivers) data watershed-wide.

CMC Preliminary Plan of Action

The CMC connected with VADEQ to organize the Virginia Citizens for Water Quality summit that targeted Virginia watershed organizations for better inclusion in Virginia state water quality reporting. VADEQ identified interest in working with the Waterman's Museum, James River Watch, the U.S. Coast Guard Auxiliary, Lynnhaven River NOW, Elizabeth River Project, Friends of the Appomattox (historical group with potential to reinvigorate), Virginia Aquarium, Virginia Master Naturalist Chapters, the Nansemond River Preservation Alliance, and Trout Unlimited. VADEQ also encouraged the CMC team to research potential partnerships with waste water treatment plants and universities that have certified laboratories with the potential to process volunteer collected water samples at a reasonable rate.

Based on VADEQ's suggestions, the Alliance's RiverTrends program is currently working on building a relationship with the Waterman's Museum. The Izaak Walton League of America is currently working with the James River Watch to develop a benthic macroinvertebrate monitoring program. The CMC opened discussions with Trout Unlimited for expanding their pipeline monitoring program in Virginia to support the monitoring of local cold-water streams for impacts from shale gas and pipeline development, specifically using the CMC benthic macroinvertebrate monitoring protocols. Furthermore, the CMC has begun researching potential models for partnerships between volunteers and certified laboratories (i.e. The Community Science Institute in Albany, NY).

West Virginia

West Virginia Save Our Streams (WVSOS) provides the state with enhanced ability to monitor and protect surface waters through increased volunteer-collected water quality data. This program is run by WVDEP with the support of a WVDEP hired coordinator. WVSOS aims to collect information on watersheds where the state is unable to discern current impacts from nonpoint source pollution or to determine areas that may improve after installation of BMPs.

The CMC team received input from West Virginia Department of Environmental Protection (WVDEP), WVSOS, Trout Unlimited, West Virginia Rivers Coalition, and the Blue Ridge Watershed Coalition, outside of the Prioritization Workshop. Additional spatial and temporal coverage needs were identified based on the objectives of the WVDEP that cannot be met with the existing state monitoring networks.

To reiterate, the data needs identified by key stakeholders (Table 2) in West Virginia are:

- Monitor restoration progress and conservation effectiveness or conduct impact assessment (pre- and post-implementation)
- Promote stewardship and provide opportunities for community outreach and engagement
- Identify areas of high nutrient and sediment loading

- Monitor areas undergoing change (i.e. development)
- Climate change resiliency
- Monitor the impacts of pipelines

Priority watersheds and data needs

WVDEP identified five priority watersheds for volunteer and nontraditional data integration: Sleepy Creek and Warm Springs Run in Morgan County, West Virginia's tributaries to the Shenandoah River in Jefferson County, Cacapon River and its tributaries, the Lost River and North River in Hardy, Hampshire, and Morgan Counties, and Elks Run and Elk Branch in Jefferson County (Figure 14).

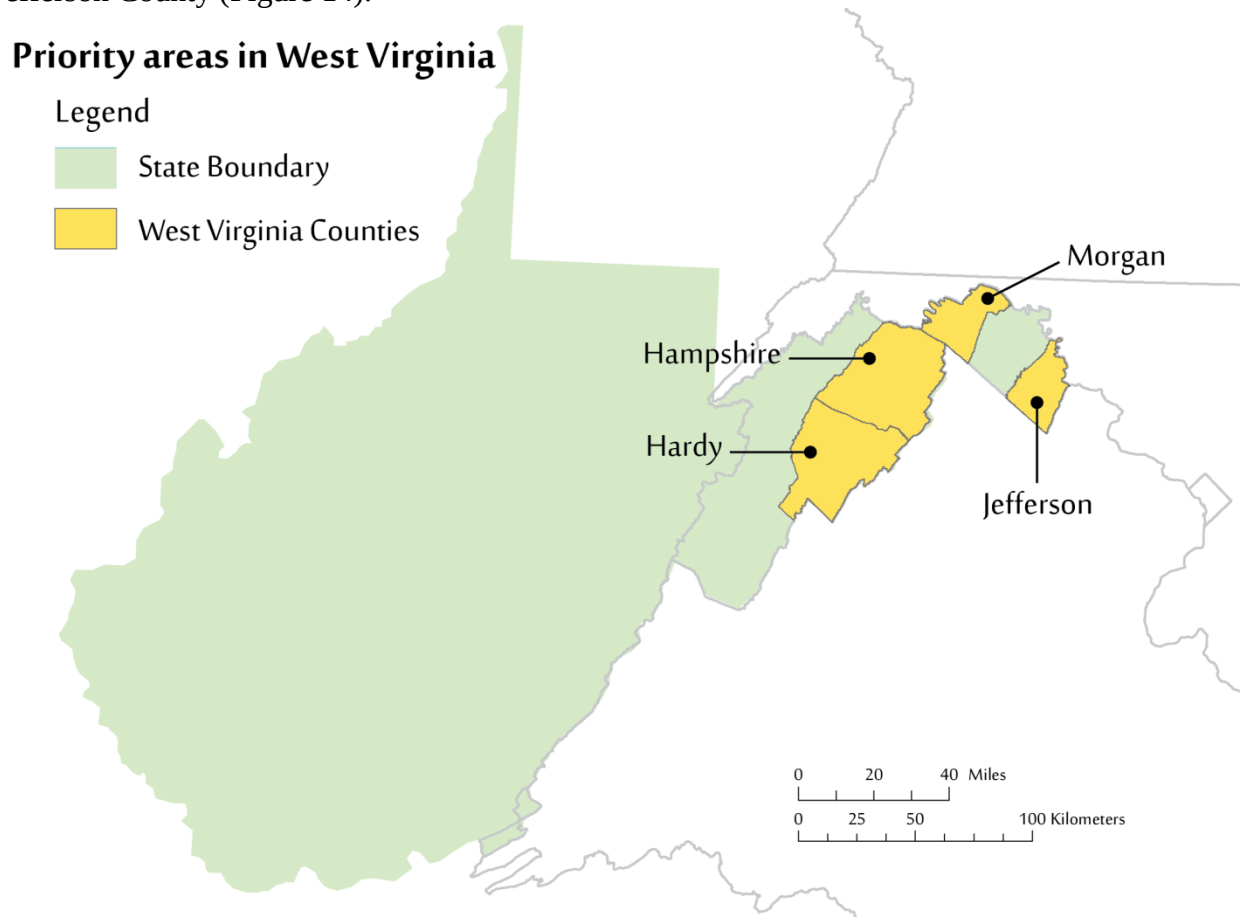

Figure 14. West Virginia Department of Environmental Protection identified watersheds for volunteer and nontraditional data integration within the four WV counties of Jefferson, Morgan, Hampshire, and Hardy.

Trout Unlimited identified a need for more water and air temperature monitoring data to support the community's understanding of climate change impacts and trout habitat assessments, as well as more support for their (in cooperation with West Virginia Rivers Coalition) pipeline monitoring program. WVDEP acknowledged the need for technical support to integrate data

from active volunteer monitoring groups into their networks. One example is the Blue Ridge Watershed Coalition. WVDEP is seeking support in evaluating their quality assurance procedures in comparison with current WVDEP guidelines.

CMC Preliminary Plan of Action

The CMC team plans to support the valuable work already underway such as the Potomac River headwaters initiative of the WVSOS, as well as to help integrate active groups such as the West Virginia Rivers Coalition and Blue Ridge Watershed Coalition. Additionally, the expansion of the Trout Unlimited and West Virginia Rivers Coalition pipeline monitoring program (including water quality and benthic macroinvertebrate monitoring), by helping to establish reference sites and sites downstream, along the Potomac, from established pipelines, will be a focus of the CMC in West Virginia.

Trout Unlimited and West Virginia Rivers Coalition surveyed West Virginia residents and identified volunteer monitoring interest areas. The CMC team can leverage that information to help support the expansion of active programs in West Virginia based on the objectives and interest of potential volunteers.

Extensive Monitoring of the Watershed

The Chesapeake Monitoring Census was used to identify common goals and objectives of volunteer and nontraditional monitoring groups. The responses to this Census provided an assessment of the potential for collaboration between the diverse monitoring entities in the Chesapeake Bay watershed. The Census received 93 responses to the question "why do you monitor?" from April 1 – November 23, 2016.

The responses varied widely in specificity and content, but nine major goals emerged and responses were sorted into these categories. If responses listed several goals, they were broken into segments and sorted appropriately. If responses applied to two categories, they were listed within each appropriate category. The 93 responses from Census respondents were broken into 173 sub-responses, which were sorted into the nine goal categories. Goal categories ranged in popularity among respondents—For example, 22% of the 93 respondents expressed a desire to establish baseline data, which was a commonly cited response with 20 mentions and a common objective of state agencies within the Chesapeake Bay watershed.

Each of the nine goals listed in Table 3 is accompanied by a list of relevant monitoring parameters and/or style of data collection that can be compared to volunteer and nontraditional monitoring groups in Appendix 1.

Table 3. Nine major goals identified by volunteer and nontraditional monitoring groups:

Major Goals	Associated monitoring parameters	Percentage of respondents who mentioned goal
1. Learn about the environment, educate and communicate environmental issues to community members	Parameters that are easy to collect and data that are easy to interpret that give a picture of the environment's total health	30%
2. Monitor restoration progress and conservation effectiveness or conduct impact assessment	Nutrients and sediments, benthic macroinvertebrates, fish population/community	27%
3. Address general concern for habitat and water quality	Parameters that measure community biodiversity or habitat suitability of environment, such as benthic macroinvertebrates, water clarity, and SAV	25%
4. Establish baseline water quality data	Water quality, nutrients, water clarity, chlorophyll *a*, dissolved oxygen	22%
5. Identify impaired waters to advocate for or assess compliance and influence policy	Nutrients, ammonia, trash, sediment, bacteria, benthic macroinvertebrates	20%
6. Collect longitudinal data and monitor trends over time	pH and nutrients	18%

7. Discover if public health and human recreation are safe (drinking, swimming, fishing)	E. coli, bacteria, enterococcus, fish tissue toxicity, fish community	16%
8. Promote stewardship and provide opportunities for community outreach and engagement	Parameters that are easy to measure and interpret data, inexpensive to promote maximum involvement, such as macroinvertebrates and water clarity	16%
9. Provide scientists and agencies with credible data for their work	All parameters, but with higher quality assurance/quality control, more expensive sample processing and more frequent sampling	12%

In order to identify the potential for collaboration beyond observable shared goals and objectives, Table 4 provides a preliminary assessment of the number of volunteer and nontraditional monitoring groups measuring diverse parameters by jurisdiction. Each of these groups may be collecting data at anywhere between 1-1,000 locations within the jurisdiction.

Table 4. Number of volunteer or nontraditional monitoring groups measuring biological, physiochemical, and visual assessment/aesthetic feature parameters by jurisdiction.

Monitoring Parameter	DC	MD	DE	NY	PA	VA	WV
Biological Parameters							
Algae	1	13			3	5	2
Bacteria		16	1	1	2	15	1
Benthic macroinvertebrates	2	17		1	13	13	3
Birds		5			1	2	
Fish		12			3	2	
Salamanders		3				1	1
SAV		8			2	3	
Biological: Other	2	9	1	1	3	2	
Physiochemical Parameters							
% Saturation		12	1	1	2	3	2
Alkalinity		6		1	7	2	2
Ammonium		9		1	3	5	2
Biological oxygen demand		4			2		
Chlorophyll *a*		14	1	1	2	3	
Conductivity		24		1	14	7	3
Dissolved oxygen		29	1	1	14	13	3
Nitrates		15		1	14	9	3
Nitrites		9		1	3	5	3
Orthophosphate		9		1	12	7	1

pH		29		1	16	15	4
Salinity		21	1			8	1
Stream flow		13		1	12	15	4
Temperature		34	1	1	17	21	4
Total dissolved solids		7		1	8	2	2
Total nitrogen		16	1	1	5	3	1
Total phosphorus		17	1	1	6	4	1
Total suspended solids		12		1	4	2	1
Turbidity		15		1	10	13	4
Water clarity		24	1	1	4	5	2
Physicochemical: Other		8			6	4	
Visual Assessment Parameters							
Direct measurements of stream bed and bank		6			4	4	3
Trash	1	12			4	11	1
Visual habitat assessment	1	13		1	9	10	2
Visual observations of stream bed and bank	1	17		1	11	15	4
Physical/visual: Other	1	8			4	6	

How the CMC Will Approach the Integration of Monitoring Partners

CMC will engage with a variety of volunteer and nontraditional groups that are interested in monitoring surface water within the Chesapeake Bay Watershed. These groups will fall into one of two categories, depending on the monitoring methods and Quality Assurance procedures they choose to follow:

1. New Monitoring Groups – a group starting a new monitoring program that adopts the CMC Monitoring Program (i.e. non-tidal water quality, tidal water quality, and/or benthic macroinvertebrate quality assurance project plan(s) (QAPPs) and method(s)). All CMC Monitoring Programs follow an EPA-approved Quality Assurance Project Plan and Methods Manual to collect monitoring data. In addition, input from state agency staff was incorporated into the development of all monitoring methods and Quality Assurance procedures.
2. Existing Groups – an existing group can either update their methods to adopt the standardized CMC monitoring program or use their existing methodology that does not follow the standardized CMC monitoring protocols and quality assurance procedures. Data collected through a method not approved in the CMC Standard Operating procedures will be flagged as provisional, until such a time that it is found to be equivalent to the accepted procedures and included in the Standard Operating Procedures or the group updates their methodology to an approved method.

CMC will work with both new and existing CMC Groups, but in different capacities.

New Monitoring Groups

Groups looking to begin a water quality or benthic macroinvertebrate monitoring program will work with a CMC Partner to develop a study design that best meets the group's goals and answers their monitoring question(s), while fitting in with CMC goals. The customization will include selecting appropriate monitoring sites, parameters, and equipment, as described in the CMC Monitoring QAPPs. Following the study design process (Appendix 2), the CMC Partner will provide the following assistance:

- Water quality and/or benthic macroinvertebrate monitoring training workshops
- Monitoring equipment support – maintenance, troubleshooting, loaned/reduced cost supplies
- Quality assurance and quality control support
- Data management – Chesapeake Data Explorer
- Data interpretation and report card development

CMC Partners will mentor new monitoring groups to ensure they implement a CMC Monitoring Program successfully.

Existing Monitoring Groups

When the CMC engages with a group that has an existing monitoring program in place, a CMC Partner will evaluate the program (methods, Quality Assurance procedures, and equipment) and identify changes that need to be made to align their program with the CMC Monitoring Program. Input from state agency staff and the CBP was incorporated into the development of CMC evaluation tools. If the group makes the changes necessary to follow the CMC Monitoring Program, they will become a CMC Group. If they choose to continue their program without incorporating the suggested changes, they will become a CMC Group, but any data collected using a non-CMC approved method will be labeled provisional. Groups following the CMC monitoring program will have access to the support offered to new monitoring groups; Groups not following the CMC monitoring program will have access to support using the Chesapeake Data Explorer.

CMC technical support and services are dependent on the types of services requested and geographical location (Figure 15).

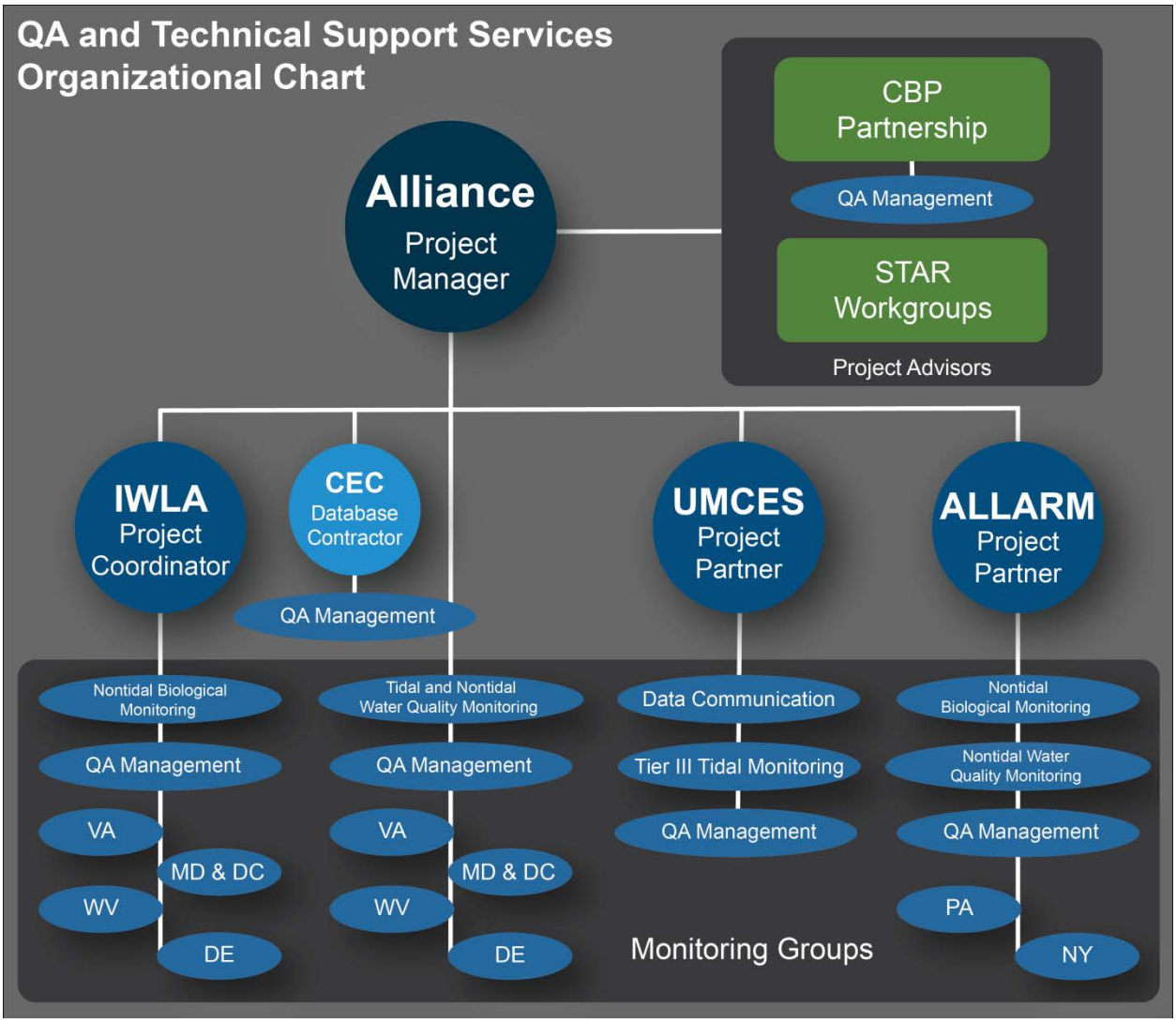

Figure 15. Organizational chart for data quality assurance and technical support services for CMC partners and interested parties. Volunteer and nontraditional monitoring groups will engage with the CMC through the application for assistance that will be available online (chesapeakemonitoringcoop.org) and submitted to the Alliance for the Chesapeake Bay. The Alliance for the Chesapeake Bay will connect the monitoring group with the appropriate CMC lead based on the above organizational chart. If a group is monitoring: water quality parameters in DC, DE, MD, VA, and/or WV, the CMC lead and point of contact is the Alliance for the Chesapeake Bay (ACB), monitoring benthic macroinvertebrates in DC, DE, MD, VA, and/or WV, the CMC lead and point of contact is the Izaak Walton League of America (IWLA), and monitoring water quality and/or benthic macroinvertebrates in NY and/or PA, the CMC lead and point of contact is the Alliance for Aquatic Resource Monitoring (ALLARM). For Tier 3 tidal verification auditing and data interpretation workshops the point of contact is the University of Maryland Center for Environmental Science (UMCES), Integration and Application Network. ACB oversees all aspects of the project and is the main point of contact for all CMC project

leads, the CBP partnership, and Chesapeake Environmental Communications (CEC) the developer of the Chesapeake Data Explorer.

Tier designation

The data collected from this project will be categorized into Tiers to help account for the variability of methods, quality assurance procedures, and equipment used to collect stream data. Classifying each data point will help data users understand how the data were collected. The CMC developed a Tiered Framework (Table 1) which lists potential ways the data collected by volunteer and nontraditional monitoring groups can be used by the CBP partnership. Tier 3 data have data requirements which adhere to the Chesapeake Bay Program's monitoring requirements for trends and assessments (Table 5).

Table 5. Required Methods and QA Protocols for CMC Groups by Tier

Tiers	Monitoring Methods and QA Procedures for CMC Groups
Tier 1 & 2	CMC developed QAPPs and methods manuals for tidal water quality monitoring, nontidal water quality monitoring, and/or benthic macroinvertebrate monitoring in nontidal streams
Tier 3	Chesapeake Bay Program's tidal water quality field and laboratory procedures

The CMC also created a rubric to help determine the appropriate Tier classification for Tier 1 and Tier 2 data. There are diverse monitoring practices used throughout the Chesapeake Bay watershed. As a result, the rubric is a data classification tool to help CMC review the monitoring techniques, quality assurance measures, and metadata of the volunteer and nontraditional data that will be integrated in the Chesapeake Data Explorer. Thus the rubric focuses on Tier 1 and Tier 2 data. The rubric, and corresponding tools such as checklists, will help to inform conversations that CMC will have with potential data contributors about data requirements. Finally, the rubric will facilitate a process that CMC will use to ensure that there is enough information corresponding with CMC datasets for users of the Chesapeake Data Explorer to make informed choices.

The rubric serves two needs:

- Determine if the data collected are suitable to be included in the Chesapeake Data (minimum requirements)
- Classify the data into Tiers (specific requirements)

A CMC Partner will use the rubric to determine the Tier for data collected in their region for both CMC and Conditional-CMC Groups. For more information about the resources and technical support the CMC is offering to data contributors, see Appendix 2.

Prioritizing the Cooperative in States' Actions

Resources permitting, the CMC will support as many of the aforementioned priority objectives outlined by data users. The following recommendations reflect ideas discussed regarding how CBP partners and key stakeholders of the CMC can support the success of this project.

Further exploration into Virginia's codified law on volunteer monitoring

Prior to 2003, VADEQ had limited opportunities to use submitted volunteer and nontraditional data. This led to frustration by all parties due to seeing valuable data being underutilized. VADEQ was able to increase the standards for volunteer monitors in Virginia when the Virginia General Assembly approved the following law: § 62.1-44.19:11. In 2007, Part B of the law was added, which stimulated the development of a tracking tool to determine the specific geographic contributions volunteers provide to the agency. The CMC and key stakeholders are interested in exploring lessons learned from VADEQ's success with a codified law.

§ 62.1-44.19:11

A. The Department of Environmental Quality shall establish a citizen water quality monitoring program to provide technical assistance and may provide grants to support citizen water quality monitoring groups if (i) the monitoring is done pursuant to a memorandum of agreement with the Department, (ii) the project or activity is consistent with the Department of Environmental Quality's water quality monitoring program, (iii) the monitoring is conducted in a manner consistent with the Virginia Citizens Monitoring Methods Manual, and (iv) the location of the water quality monitoring activity is part of the water quality control plan required under § 62.1-44.19:5. The results of such citizen monitoring shall not be used as evidence in any enforcement action.

B. It shall be the goal of the Department to encourage citizen water quality monitoring so that 3,000 stream miles are monitored by volunteer citizens by 2010.

Adopt nontraditional data integration into regional monitoring strategies

State and regional government agencies who develop monitoring strategies should consider adopting a section on volunteer and nontraditional data integration, if applicable. This section could define a system for evaluation and permitted use of solicited volunteer and nontraditional data. The CMC has developed a suggested Tiered framework for data use and a data quality rubric for evaluation; however, the CMC team suggests that each jurisdiction modify and adopt a system based on their specific data needs. Additionally, the CMC team recommends a transparent system.

Identify the point of contact

The CMC team encourages each data user of the Chesapeake Data Explorer to identify a point of contact for the CMC team for ongoing conversations about metadata needs and potential for new partnerships.

Share our success stories

As the Chesapeake monitoring community, we need to identify success stories to share to bring more awareness to the great work of volunteers in our region and the benefits of collaboration between volunteer and nontraditional groups and government agencies. These success stories can be shared through a variety of outreach mechanisms such as the CMC quarterly e-newsletter, social media, and those used by CBP partnership communications team using a host of approachable multimedia applications.

Conclusion

The CBP partnership leads and directs Chesapeake Bay watershed restoration and protection, and there is an abundance of underutilized volunteer and nontraditional water quality data collected throughout the watershed available to aid in better understanding of Bay watershed health. However, the existing framework for integrating citizen science data into the CBP to help inform policy management decisions was previously limited. Therefore, the CMC developed a framework to categorize volunteer and nontraditional data into three tiers to identify the variability of methods, quality assurance procedures that help define program integrity, and equipment used to collect water quality monitoring data. The CMC recommends potential ways the water quality data collected by volunteer and nontraditional monitoring groups can be used by the CBP partner jurisdictions based on the tier classification, generated by input from the diverse partners of the CBP.

Investigating the priorities of the Chesapeake Bay watershed jurisdictions as summarized in this report provides basis and direction for the CMC's outreach and engagement. Moving forward, the water quality data that will be available to Chesapeake Bay watershed data users will undoubtedly lead to additional capabilities in assessment and management. This timely initiative has the potential to further enhance watershed implementation plans/objectives outlined in the 2014 Chesapeake Bay Watershed Agreement.

Glossary

Acid mine drainage – the result of water flowing over or through rocks containing sulfur-bearing minerals. The resulting chemical reaction is highly acidic waters. Typically occurs in connection with mining activity
Alkalinity – the ability of water to absorb acid (buffer capacity), the higher the pH (7-14 on the pH scale) the more alkaline the water is.
Ammonium – a form of nitrogen which aquatic plants and algae can absorb for growth
Baseline – initial collection of data that serves as a basis for comparisons of future data
Benthic Macroinvertebrate – organisms that live underwater in streams and rivers that do not have a backbone and can be seen by the naked eye. The diversity of organisms found are indicators of stream/river health.
Best Management Practice (BMP) – practice(s) that have been determined to be an effective and practical means of preventing or reducing pollution
Biological Oxygen Demand – the amount of oxygen consumed by microorganisms during oxidation of organic matter such as the decomposition of plant matter.
Chlorophyll *a* – the predominant green pigment found in microscopic algae in fresh and saltwater ecosystems, and used as a measure of microalgae abundance.
Coastal Plain – the level land downstream of the Piedmont and fall line, where soils are generally finer and fertile and rivers are influenced by the tide.
Conductivity – ability of water to conduct an electrical current due to the presence of charged particles,
Dissolved Oxygen – the amount of oxygen gas that is present in the water.
Impaired waters – waterways that do not meet water quality standards set by jurisdictions and/or the Clean Water Act.
Marcellus Shale – sedimentary rock formation thousands of feet below the surface stretching from upstate New York through Pennsylvania to West Virginia and parts of Ohio containing natural gas.
Nitrate – a form (ion) of nitrogen used by plants and animals
Nitrite – a form (ion) of nitrogen used by plants and animals
Nitrogen – an essential nutrient for all life, can be a limiting factor
Non-point source – sources of pollution that come from many diffused sources and cannot be traced to a single source. For example: runoff from lawns, farmland or streets.
Nontraditional monitoring – for the sake of this project, nontraditional monitoring refers to efforts by monitoring groups who do not traditionally submit their data to the Chesapeake Bay Program.
Nutrient – any substance that provides for essential growth and life
Orthophosphate – a form of phosphorous that can be absorbed by living organisms, used to provide an estimation of the amount of phosphorus available for plant growth.
pH – a measure of how acidic or basic water is. The pH scale ranges from 0-14, with 7 being neutral. pH less than 7 indicates acidity, and a pH greater than 7 indicates a base.
Phosphorus – an essential nutrient for all growth and reproduction.
Phycoerythrin – photosynthetic pigment found in certain algaes

Piedmont – uplands or hill country located above the fall line. Rivers and streams in the Piedmont region are not influenced by the tide.
Priority area – any area with an identified need for more information that could conceivably be filled by volunteer or nontraditional data of known quality.
QAPP – Quality Assurance Project Plan – documentation that provides the framework and procedures used to meet quality assurance standards
Salinity – a measure of the salt content of water, the weight of salt per volume of water measured in parts per thousand (ppt)
Submerged aquatic vegetation (SAV) – technical term for underwater bay grasses. SAV help improve water quality and provide important food and habitat for fish, shellfish, invertebrates, and waterfowl.
Shale gas – natural gas that either resides or has been extracted from a shale formation such as the Marcellus Shale
Spatial – relating to space or geographic spread of sampling
Stormwater MS4 – Stormwater Municipal Separate Storm Sewer System permitting
Study Design – The process of making choices and decisions about your monitoring program, such as: What are your primary watershed concerns? What parameters and/or methods are appropriate to answer your monitoring question? Where to monitor?
Temporal – relating to time or frequency of sampling
Total Maximum Daily Load (TMDL) – the total maximum amount of pollutant allowed in a water body in order to meet water quality standards
Total suspended solids (TSS) – solids within a water column that can be trapped by filtration
Turbidity – a measure of the clarity of a water body; the cloudiness of the water

Appendix 1: Catalogue of Volunteer Monitoring Groups who Participated in the Chesapeake Monitoring Census

This includes the basic information for groups who participated in the Census. There are still more groups throughout the Watershed that need focused attention.

Table A-1. Catalogue of Volunteer and Nontraditional monitoring groups

Name of Organization	Physicochemical parameters	Biological Parameters	State	County/City/Township/ Ecoregion
Potomac Riverkeeper Network	Metals	Algae	DC	Potomac River
Rock Creek Conservancy	None	Benthic macroinvertebrates	DC	Rock Creek Watershed
Smithsonian Anacostia Community Museum	DO, Nitrates, Nitrites, pH, TP, Cond, Turb	Benthic macroinvertebrates	DC	Anacostia Watershed
Anne Arundel Community College	DO, Temp, pH, TSS, Cond, Salinity	Benthic macroinvertebrates, Bacteria	MD	Dividing Creek, Anne Arundel County
Anne Arundel Community College Environmental Center	DO, Temp, pH, TN, TP, TSS, Cond, Water Clarity, Salinity, Chla	Bacteria	MD	Spa Creek on the Severn Mill River and Dividing Creek on the Magothy River
Audubon Naturalist Society	Temp, pH	Benthic macroinvertebrates	MD and DC	Montgomery County, MD, and Washington, DC
Back Creek Conservancy	DO, Temp, % Sat, pH, TSS, BOD, Cond, Turb, Water Clarity, Salinity	Benthic macroinvertebrates, Bacteria, Fish, Algae, SAV, Birds, Turtles, Rays, Snakes	MD	Back Creek, Annapolis, Anne Arundel County
Baltimore County Dept of Environmental Protection & Sustainability	DO, Temp, % Sat, pH, Ammonium, Nitrates, Nitrites, TN, Ortho-P, TP, TSS, BOD, Cond, Salinity	Benthic macroinvertebrates, Bacteria, Fish, SAV, Salamanders	MD	Baltimore County
Bird River Restoration Campaign		Bacteria	MD	Bird River, Windlass Run, Honeygo Run, Whitemarsh Run, Gunpowder River

Blue Water Baltimore	DO, Temp, % Sat, pH, Nitrates, Nitrites, TN, TP, Cond, Turb, Water Clarity, Salinity, Chla, Phycoerythrin	Bacteria	MD	Jones Falls and Gwynns Falls, Patapsco River
Calvert County	DO, Temp, pH, Ammonium, Nitrates, Nitrites, Ortho-P, TDS, TSS, Cond, Water Clarity, Salinity, Chla	Algae	MD	Streams and creeks in Calvert County
CAT-N	DO, Temp, % Sat, pH, Alkalinity, Ammonium, Nitrates, Nitrites, TN, Ortho-P, TP, TDS, TSS, Cond, Turb, Water Clarity, Salinity, Chla, CDOM, Oil, Optical Brighteners	Benthic macroinvertebrates, Bacteria, Fish, SAV, Birds	MD	Severn River and South River Tidal and Watershed
Cecil Senior Environment Corps	DO, Temp, pH, Alkalinity, Nitrates, Ortho-P, Cond, SO4	Benthic macroinvertebrates	MD	Cecil County
Chesapeake Bay Foundation	DO, Temp, pH, Nitrates, Ortho-P, Water Clarity, Salinity, Cond	Fish	MD	Chesapeake Bay in and around Tangier Sound and near Bishop's Head (Accomack Co., VA, Somerset/Dorchester Cos., MD), Anacostia River (Washington DC), Potomac River (Washington DC), Susquehanna River (Cecil Co., MD, Lancaster Co., PA), Patapsco River/Baltimore Inner Harbor, Creeks and streams in Southern PA (Mountain Creek,

				Hammer Creek, Swatara Creek, Long Pine Run), James River (Charles City, VA), Lynnhaven River/Chesapeake Bay (Virginia Beach)
Chesapeake Bay National Estuarine Research Reserve (MD Dept of Natural Resources)	DO, Temp, pH, Nitrates, TN, Ortho-P, TP, TSS, Cond, Turb, Salinity, Chla	Fish, Algae, SAV, Birds	MD	Bush River (Harford County), Patuxent River (Anne Arundel and Prince George's counties) Little Monie Creek (Somerset County)
City of Baltimore	DO, Temp, % Sat, pH, Alkalinity, Ammonium, Nitrates, Nitrites, TN, Ortho-P, TP, TDS, TSS, Cond, Turb, Water Clarity, Chla	Bacteria, Algae	MD	City of Baltimore
Fox Haven Organic Farm & Learning Center	Water Clarity	Benthic macroinvertebrates, Algae	MD	Lewis Creek and Catoctin Creek (Frederick County, MD)
Friends of the Bohemia	DO, Temp, pH, TN, TP, Cond, Turb, Water Clarity, Salinity, Chla, (For Tidal, different for Nontidal)	Benthic macroinvertebrates, SAV	MD	Bohemia River Watershed
Gunpowder Riverkeeper	DO, Temp, pH, TSS, Cond, Turb, Water Clarity, Salinity	Benthic macroinvertebrates, Bacteria, Fish, Algae	MD	Carroll, Baltimore and Harford Counties

Hood College Center for Coastal & Watershed Studies	DO, Temp, % Sat, pH, Ammonium, Nitrates, TN, Ortho-P, TP, TSS, Cond, Water Clarity, Chla, Phycocyanin Fluorescence, occasional algal toxins	Bacteria, Algae	MD	Frederick, Montgomery, and Howard Counties
Howard County Conservancy		Benthic macroinvertebrates	MD	Howard County, Lower Patapsco River, Middle Patuxent River, and Little Patuxent River
Howard County Watershed Steward Academy	DO, Temp, pH, Nitrates, Cond	Benthic macroinvertebrates	MD	Little Patuxent, Middle Patuxent, and Patapsco (Howard County)
IWLA-WAC	DO, Temp, pH, Alkalinity, Ammonium, Nitrates, Nitrites, TP, Turb, Water Clarity	Fish, Algae, SAV, Salamanders, Birds	MD	Monocacy River at Michael's Mill by Buckeystown
Koolhof Earth/Restore Rock Creek	DO, Temp, % Sat, pH, BOD, Cond, Water Clarity, Salinity	Bacteria	MD	Rock Creek on the tidal Patapsco River in Pasadena
Little Falls Watershed Alliance	Temp, pH	Benthic macroinvertebrates, Fish	MD	Little Falls Branch in Montgomery County
Living Classrooms Foundation	DO, Temp, pH, Nitrites, TP, Turb, Salinity	Fish	MD	Patapsco River Watershed in Baltimore City
Magothy River Association	DO, Temp, % Sat, pH, Cond, Water Clarity, Salinity	Bacteria, SAV, Oysters	MD	Magothy River and tributaries
Maryland Department of Natural Resources (Stream Waders and MBSS)	pH, Alkalinity, Ammonium, Nitrates, Nitrites, TN, Ortho-P, TP, TDS, Cond, Turb, Acid Neutralizing Capacity	Benthic macroinvertebrates, Fish, Salamanders, and other organisms, Exotic plants	MD	State of Maryland

Maryland Department of the Environment	DO, Temp, pH, Ammonium, TN, TP, Cond, Turb, Water Clarity, Salinity, Chla	Benthic macroinvertebrates, Bacteria, Fish, Algae	MD	State of Maryland
Mattawoman Watershed Society	DO, Temp, Cond, Salinity	Benthic macroinvertebrates, Fish eggs and larvae	MD	Mattawoman Creek, Charles and Prince George's Counties
Midshore River Conservancy	DO, Temp, % Sat, pH, Water Clarity, Salinity	Bacteria	MD	Wye River, Queen Anne's County
Nanticoke Watershed Alliance (CreekWatchers)	DO, Temp, % Sat, TN, TP, Water Clarity, Salinity, Chla	Bacteria, will be starting MusselWatchers program in DE in 2016, separate from CreekWatchers	MD and DE	Nanticoke River in MD and DE (Sussex, Dorchester, and Wicomico Counties)
National Aquarium	DO, Temp, TN, TP, BOD, Cond, Turb, Water Clarity, Salinity, Chla	Bacteria	MD	Patapsco River
Octoraro Watershed Association	Temp, Nitrates, Cond, Water Clarity	Benthic macroinvertebrates	MD	Octoraro Mainstem in PA and in Cecil County MD
Osborn Cove	DO, Temp, pH, Water Clarity, Salinity		MD	St. Leonard Creek and Osborn Cove on the Patuxent River (Calvert County)
Phillips Wharf Environmental Center	DO, Temp, pH, Ammonium, Nitrates, Nitrites	Benthic macroinvertebrates, Fish, Algae	MD	Talbot County
Sassafras River Association	DO, Temp, pH, TN, TP, Cond, Turb, Salinity, Chla	Algae, SAV	MD	Sassafras River and tributaries
Savage River Watershed Association	Temp, TDS, Cond, Turb, Water Clarity	Benthic macroinvertebrates	MD	Savage River and tributaries
Spa Creek Conservancy	DO, Temp, % Sat, pH, Alkalinity, Nitrates, TN,	Bacteria	MD	Spa Creek

	TDS, TSS, Water Clarity			
USGS-Patuxent Wildlife Restoration Center	None	Birds	MD	Chesapeake Bay and many tributaries
Watershed Protection and Restoration Program - Anne Arundel County Public Works	Water quality monitoring for regulatory compliance		MD	Anne Arundel County
Wicomico Creekwatchers	Temp, TN, TP, Water Clarity, Chla	Algae	MD	Wicomico River system
The Community Science Institute, Inc.	DO, Temp, % Sat, pH, Alkalinity, Ammonium, Nitrates, Nitrites, TN, Ortho-P, TP, TDS, TSS, Cond, Turb, Water Clarity, Chla	Benthic macroinvertebrates, Bacteria	NY	Upstate NY, near Albany (more info on their database: *database.communityscience.org*)
Water Assessments by Volunteer Evaluators (WAVE)		Benthic macroinvertebrates	NY	State of New York
Alliance for Aquatic Resource Monitoring (ALLARM)	DO, pH, Nitrates, TP, Cond	Algae, SAV	PA	LeTort Spring Run, Carlisle, Cumberland County
Bradford County Monitors	TDS, Cond, Ba and Sr (via a certified lab)	None	PA	Bradford County
Clearfield Creek Watershed Association	Temp, pH, Alkalinity, Nitrates, TDS, TSS, Cond, Fe, Mn, Al, SO4, and others	Special studies	PA	Cambria and Clearfield County, in Clearfield Creek Watershed
Conococheague Watershed Alliance	DO, Temp, pH, Nitrates, Ortho-P, Turb	Benthic macroinvertebrates	PA	Mainstem Conococheague River in Chambersburg
Dauphin County Conservation District	Baseline water chemistry parameters, Turb	Benthic macroinvertebrates	PA	Dauphin County
Evergreen Conservancy	Temp, Cond, Water level	Benthic macroinvertebrates	PA	Susquehanna and Allegheny River

				watersheds in Indiana County
Friends of Tom's Creek	Water Clarity	Benthic macroinvertebrates	PA	Tom's Creek (Adams County)
God's Country Water Dogs (Potter County PA)	TDS, Cond, Ba and Sr (via a certified lab)	None	PA	Potter County
Lake Carey Welfare Association	DO, Temp, pH, Ammonium, Nitrates, Nitrites. TN, Ortho-P, TP, TDS, TSS, BOD, Turb, Water Clarity, Chla	Benthic Macroinvertebrates, Algae, SAV	PA	Lake Carey and Flow Pond (Wyoming County)
Lower Penns Creek Watershed Association	Temp, pH, Nitrates, Ortho-P, Cond, Turb		PA	Synder and Union Counties
Luzerne Conservation District	water quality monitoring for acid deposition impacts and mitigation measures on naturally reproducing brook trout		PA	Bowmans Creek headwaters
Middle Spring Watershed Association	DO, Temp, pH, Nitrates, Ortho-P, Cond, Water Clarity	Benthic macroinvertebrates	PA	Mainstem Middle Spring Stream
Mifflin County Conservation District	DO, Temp, % Sat, pH, Alkalinity, Nitrates, Nitrites, TN, TP, TDS, TSS, Cond, Turb	Benthic macroinvertebrates, Fish	PA	Kishacoquillas Creek and Hungry Run
Nature Abounds (Senior Environment Corps Program)	DO, Temp, pH, Alkalinity, Nitrates, Ortho-P, TP, Cond, SO4, Fe, Mn	Benthic macroinvertebrates	PA	Mostly throughout the state of Pennsylvania but also in Maryland
Renfrew Institute for Cultural & Environmental Studies	DO, Temp, pH, Alkalinity, Nitrates, Ortho-P, Turb	Benthic macroinvertebrates	PA	Various streams throughout the state of Pennsylvania

Shermans Creek Conservation Association		Benthic macroinvertebrates	PA	Shermans Creek
Susquehanna River Basin Commission	DO, Temp, pH, Alkalinity, Ammonium, Nitrates, Nitrites, TN, Ortho-P, TP, TDS, TSS, BOD, Cond, Turb, Chla	Benthic macroinvertebrates, Fish, Algae	PA	Susquehanna River Watershed
Trout Unlimited	Temp, pH, Cond, Turb	Benthic macroinvertebrates	PA VA and WV	various streams in the Chesapeake Bay Watershed
Warwick Township	DO, Temp, Nitrates, TP, Turb	Benthic macroinvertebrates, Bacteria, Fish, Birds	PA	Lancaster County
Water Resource Monitoring Project	DO, Temp, pH, Ammonium, Nitrates, Ortho-P, TDS, Cond, Turb	None	PA	Spring Creek Watershed, Centre County
Watershed Alliance of Adams County	DO, Temp, pH, Alkalinity, Nitrates, Ortho-P, Cond, Water Clarity	None	PA	Rock Creek, Marsh Creek, Little Marsh Creek, and Alloway Creek (Adams County)
Watershed Alliance of York	DO, Temp, pH, TN, Ortho-P	Benthic macroinvertebrates	PA	Codorus Creek and Muddy Creek
Western Pennsylvania Conservancy	DO, Temp, pH, Nitrates, Ortho-P, TDS, Cond, Turb	Benthic macroinvertebrates	PA	
WQVC : Lancaster County Conservancy and Lancaster County Conservation District	DO, Temp, pH, Alkalinity, Ammonium, Nitrates, Ortho-P, TDS, Cond, Salinity	Benthic macroinvertebrates	PA	Lancaster County
York County Conservation District	DO, Temp, % Sat, pH, Alkalinity, TN, Ortho-P	Benthic macroinvertebrates	PA	Codorus and Muddy Creeks

Alliance for the Chesapeake Bay	DO, Temp, pH, Ammonium, Nitrates, Nitrites, TN, Ortho-P, TP, TDS, TSS, Turb, Water Clarity, Salinity	None	VA	Chesapeake Bay watershed of VA
Chesterfield WaterTrends	DO, Temp, pH, Turb, Water Clarity, Salinity	Bacteria	VA	Chesterfield County
Cowpasture River Preservation Association	DO, Temp, % Sat, pH, Nitrates, Ortho-P, TP, Cond, Water Clarity, Salinity, Chloride	Benthic macroinvertebrates, Bacteria	VA	Bullpasture River (Highland County) and Cowpasture River (Highland, Bath, Alleghany, and Botetourt Counties)
Culpeper SWCD	Temp	Benthic macroinvertebrates	VA	Various streams in Culpeper, Greene, Madison, Orange and Rappahannock
Fairfax County Stormwater Planning Division	Water quality monitoring for regulatory compliance		VA	Fairfax County
Friends of Accotink Creek	None	Benthic macroinvertebrates	VA	Fairfax County
Friends of Goochland Parks	Temp, Turb	Bacteria	VA	James River (Goochland County)
Friends of Shenandoah	Temp, Nitrate, Ortho-P, Ammonia, DO, pH, Turb		VA	Augusta, VA
Friends of the Middle River	None	Benthic macroinvertebrates, Bacteria	VA	Middle River watershed
Friends of the Rappahannock, Tri-County Soil & Water District		Bacteria	VA	Fredericksburg area with Fredericksburg Area Monitors for the Environment (FAME) volunteers, and Claiborne Run, located in Stafford County
G2 Associates	Temp, pH, Ammonium, Nitrates, Ortho-P, Salinity, Chla	Algae	VA	Antipoison Creek (Lancaster County) and Potomac River in Great Falls

GMU's Potomac Environmental Research & Education Center	basic water chemistry parameters for middle school education	Benthic macroinvertebrates	VA	
Henricopolis Soil & Water Conservation District	Temp, Nitrites, TP, Turb	Bacteria	VA	Middle James River watershed
James River Association	Temp, Cond, Turb	Bacteria	VA	James River and tributaries
John Marshall Soil & Water Conservation District	DO, Temp, pH, Nitrates, Ortho-P	Benthic macroinvertebrates, Bacteria	VA	Fauquier County
Longwood University Water Quality Monitoring Program	DO, Temp, % Sat, pH, TN, Cond, Salinity, Chla, DOC	Bacteria	VA	
Lord Fairfax Soil & Water Conservation District	Unknown	Unknown	VA	Frederick, Clarke, Warren, and Shenandoah Counties, and the City of Winchester
Loudoun Watershed Watch	Temp, Turb	Benthic macroinvertebrates, Bacteria	VA	Loudoun County
Master Naturalist	DO, Temp, pH, TN, TP, Turb, Water Clarity, Salinity	Bacteria, Algae, SAV, Birds	VA	Tributaries to the James River, cities of Poquoson and Hampton
McClure River Restoration Project	DO, Temp, pH	Bacteria	VA	Dickenson and Wise County
New River Conservancy	Temp, Water Clarity, Water Depth, DO, pH		VA	New River Watershed
Northern Virginia Soil and Water Conservation District	None	Benthic macroinvertebrates	VA	Fairfax County
ODU OEAS	DO, Temp, % Sat, pH, Ammonium, Nitrates, Nitrites, Ortho-P, Cond, Turb, Salinity, Chla	Algae	VA	Lafayette River
Page County Monitors	DO, Temp, pH, Ammonium,	None	VA	Page County

	Nitrates, Nitrites, Ortho-P, Turb			
Peninsula Master Naturalist	DO, Temp, pH, Turb, Salinity	Bacteria, Fish, Algae, SAV, Birds	VA	James River, Warwick River, Hampton Roads, Back River in the cities/counties of Newport News, Hampton, Poquoson, and York. Expanding to Gloucester.
Peter Francisco SWCD	DO, Temp, pH, Alkalinity, Nitrates, Ortho-P, Cond, Turb	Benthic macroinvertebrates, Bacteria	VA	Horsepen Creek in the city of Buckingham
Prince William Soil and Water Conservation District	DO, Temp, pH, Nitrates, Nitrites, Turb	Benthic macroinvertebrates	VA	Potomac River Watershed (Prince William County)
Reston Association	None	Benthic macroinvertebrates	VA	City of Reston
Rivanna Conservation Alliance	Temp, Turb	Benthic macroinvertebrates, Bacteria	VA	Rivanna River Watershed
Shenandoah Valley Soil and Water Conservation District	DO, Temp, pH, TDS, TSS, Cond, Turb, Water Clarity	Benthic macroinvertebrates, Bacteria	VA	Linville Creek Watershed
Shenandoah Watershed Study-Virginia Trout Stream Sensitivity Study	Temp, pH, Alkalinity, Ammonium, Nitrates, Cond, Acid Neutralizing Capacity, Ca, Chloride, Mg, K, Silica, Na, SO4, Total Monomeric Al	None	VA	Shenandoah River Watershed
VA Save Our Streams	Turb, pH	Benthic macroinvertebrates	VA	Mostly in the state of Virginia but some in Maryland
Virginia DEQ	DO, pH, Temp, Cond, TN, TP, Turb, Chla, and other nutrients at certain sites	Benthic macroinvertebrates, Bacteria, Fish, Algae, SAV	VA	State of Virginia

Virginia Master Naturalist - Historic Southside Chapter	None	Benthic macroinvertebrates, Salamanders	VA	Vernal pools
Blue Ridge Watershed Coalition	DO, Temp, pH, Ammonium, Nitrates, Nitrites, Ortho-P, TP, TDS, Cond, Turb	Bacteria	WV	Shenandoah River
Sleepy Creek Watershed Association	DO, Temp, % Sat, pH, Alkalinity, Ammonium, Nitrates, Nitrites, TN, TDS, TSS, Cond, Turb, Water Clarity, Salinity	Benthic macroinvertebrates, Algae	WV	Sleepy Creek (Morgan County)
The Mountain Institute		Benthic Macroinvertebrates (Partnership with WV Save Our Streams)	WV	School groups awarded mini-grants for various stream monitoring projects
Warm Springs Watershed Association	DO, Temp, % Sat, pH, Alkalinity, Nitrates, Nitrites, Turb, Water Clarity	Benthic macroinvertebrates, Algae, Salamanders	WV	Morgan County
West Virginia Rivers Coalition (Trout Unlimited)	Temp, pH, Cond, Turb	Benthic macroinvertebrates	WV	State of West Virginia
WVDEP Nonpoint Source Program	Water quality monitoring for regulatory compliance	Benthic macroinvertebrates (Oversees the WV Save Our Streams Program)	WV	State of West Virginia

Glossary of Abbreviations:

Abbreviation	Parameter
% Sat	Percent Saturation
Al	Aluminum
Ba	Barium
BOD	Biological oxygen demand
Ca	Calcium
DO	Dissolved oxygen

DOC	Dissolved organic carbon
Fe	Iron
K	Potassium
Mg	Magnesium
Mn	Manganese
Na	Sodium
Ortho-P	Orthophosphate
pH	Potential of hydrogen
SO4	Sulfate
Sr	Strontium
TDS	Total dissolved solids
Temp	Water temperature
TN	Total nitrogen
Total Monomeric Al	Total monomeric aluminum
TP	Total phosphorus
TSS	Total suspended solids
Turb	Turbidity

Appendix 2: Resources and Technical Support Offered by the CMC

Tier 3 Data Audit

Tier 3 groups are those that are following the CBP Monitoring and Field Procedures, have an audit of their program completed by CBP's Data Integrity Workgroup, and have made recommended changes to their program based on the audit. Based on monitoring groups' field methods, the CMC team identifies candidates for Tier 3 status. Candidates are referred to the Data Integrity Workgroup for an audit. The Data Integrity Workgroup created an auditing checklist that is used to thoroughly question and examine potential candidates' field and lab practices and methods. This checklist includes review of the monitoring group's Quality Assurance Project Plan, field equipment list, and lab equipment list (if applicable) before the audit. The auditors will prepare a report following the audit with recommendations for the monitoring group. Once the group shows that they've incorporated the auditors' recommendations, their data will be classified as Tier 3 in the Chesapeake Data Explorer.

Provide Quality Assurance Project Plan for groups to use

Volunteer monitoring groups who are using a monitoring procedure that fit the Tier 1 or Tier 2 criteria, but do not have the technical documentation, will be incorporated into the CMC Quality Assurance Project Plans (QAPPs) developed for benthic macroinvertebrate, non-tidal, and tidal monitoring. When a group decides to adopt a CMC QAPP, they will need to participate in training by one of the CMC partners, and become certified under the QAPP. CMC participants who fall under the QAPPs will receive training to incorporate quality control measures into their monitoring approaches. If a participant is unable to meet the quality control requirements their data will be classified as a lower Tier.

Host trainings

If a volunteer or nontraditional monitoring group wants to join the CMC and follow the methods and QA/QC protocols they will be invited to a training workshop. If there are individuals interested in participating in volunteer monitoring, the CMC will help connect them with a local group and encourage them to participate in a CMC training workshop. There are several types of trainings that the CMC is offering, including:

- Supporting development of study designs
- Teaching monitoring methods
- Facilitating database use, and
- Conducting data interpretation workshops

Support development of study designs

The first step for an organization or individual interested in starting a monitoring group is to develop a study design, which is a ten-step process that outlines the key steps in developing a monitoring program. Study designs (originally developed by River Network) are standard monitoring tools for service providers to use with communities interested in monitoring. By developing a study design, CMC will be able to insure that data of known value are collected by

partners and that community goals are in line with the spirit of the project. Questions answered in the study design include:

Step 1: What are your organizations major objectives?
Step 2: Why are you monitoring?
Step 3: How will you use the data that you collect?
Step 4: What will you monitor?
Step 5: How will you monitor?
Step 6: Where will you monitor?
Step 7: When will you monitor?
Step 8: What are your Quality Assurance/ Quality Control
Step 9: How will you manage and present the data?
Step 10: What are the tasks and who will do them?

Expertise within the CMC partnership will support the development of study designs that support the objectives of the volunteer and design a plan for monitoring, data management, and assessment.

Teach monitoring methods

The CMC prepared standardized methods for the most popular water quality and biological monitoring parameters monitored by volunteer groups in the Chesapeake Bay watershed in accordance with the QAPPs. ALLARM and the League will be offering training sessions for benthic macroinvertebrate monitoring and identification to order level. The Alliance and ALLARM will offer training sessions on collecting water quality parameters.

Facilitate database use

Chesapeake Environmental Communications is developing the Chesapeake Data Explorer, a database for all volunteer and nontraditional monitoring groups in Chesapeake Bay Watershed states. Monitoring groups that have connected with the CMC, and are ready to submit data, will have the option of taking a workshop on how to use the Chesapeake Data Explorer. Clear instructions for interacting with the Chesapeake Data Explorer will also be available.

Conduct data interpretation workshops

The data interpretation workshops will focus on communicating a monitoring group's data to a wide variety of audiences through print and digital products and includes both principles and practical application of science communication, data visualization, and synthesis. Groups that have Tier 2 data can generate geographically specific ecosystem assessments (e.g., a report card) for their data. Report card generation includes a specific set of analyses that will be determined by each group. The training will help each group determine the framework for their analyses. Groups that have Tier 1 data can use that data to produce education materials for their constituents and to tell stories using the data they collect. Synthesizing data is important for key messaging and outreach.

Help acquire equipment

If a volunteer group is close to meeting the criteria for Tier 1 or Tier 2 monitoring and is within a priority area, but needs upgraded equipment, the CMC team will evaluate the availability of

resources to see if an equipment upgrade is possible to integrate the new volunteer or nontraditional monitoring group.

Survey monitoring groups

Based on the identified needs of the CBP partnership, if there is a volunteer or nontraditional group monitoring in a priority region, the CMC team will identify the group's needs and potential for collaboration with the CMC, and encourage that group to fill out the Chesapeake Monitoring Census (i.e. survey) to share key information about their program for evaluation.

Appendix 3: Contributors

Below is a list of the many contributors to this research through participation in workshops, meetings, or participation in the Chesapeake Monitoring Census.

Name	Affiliation	State
Cathy Wiss	Audubon Naturalist Society	DC and MD
Lucretia Brown	District of Columbia Department of Energy and Environment	DC
Jeff Kelble	Potomac Riverkeeper Network	DC
Tony Thomas	Smithsonian Anacostia Community Museum	DC
Ben Pressley	Delaware Dept. of Natural Resources and Environmental Control	DE
Chris Remaine	Delaware Dept. of Natural Resources and Environmental Control	DE
Ellen Dickey	Delaware Dept. of Natural Resources and Environmental Control	DE
Hassan Mirsajadi	Delaware Dept. of Natural Resources and Environmental Control	DE
Kathy Knowls	Delaware Dept. of Natural Resources and Environmental Control	DE
Robyn Tyler	Delaware Dept. of Natural Resources and Environmental Control	DE
Greg Barranco	U.S. EPA Chesapeake Bay Program Office	Federal
Rich Batiuk	U.S. EPA Chesapeake Bay Program Office	Federal
Tammy Zimmerman	U.S. Geological Survey	Federal
Peter Tango	U.S. Geological Survey at the Chesapeake Bay Program Office	Federal
Tammy Domanski	AACC Environmental Center	MD
Al Todd	Alliance for the Chesapeake Bay	MD
Lou Etigen	Alliance for the Chesapeake Bay	MD
Susan Lamont	Anne Arundel Community College	MD
Gregg Trilling	Audubon Naturalist Society	MD
David Read Barker	Back Creek Conservancy	MD
Kevin Brittingham	Baltimore County Dept. of Environmental Protection & Sustainability	MD
Peter Terry	Bird River Restoration Campaign	MD
Alice Volpitta	Blue Water Baltimore	MD
David Brownlee	Calvert County	MD
Kevin Haigis	Capital SUP/Spa Creek Conservancy	MD
Diana Muller	CAT-N	MD
Kordell Wilen	Cecil Senior Environment Corps	MD
Sam Woolford	Chesapeake Bay Foundation	MD
Amanda Garzio-Hadzick	Chesapeake Bay National Estuarine Research Reserve (Maryland Dept. of Natural Resources)	MD

Clark Howells	City of Baltimore	MD
Maddie Price	Fox Haven Organic Farm & Learning Center	MD
Rebecca Wright	Friends of the Bohemia	MD
Theaux Le Gardeur	Gunpowder RIVERKEEPER	MD
Drew Ferrier	Hood College Center for Coastal & Watershed Studies	MD
Alan Pflugrad	Howard County Watershed Steward Academy	MD
Claire Buchanan	Interstate Commission on the Potomac River Basin at the Chesapeake Bay Program	MD
Mike Mallonee	Interstate Commission on the Potomac River Basin at the Chesapeake Bay Program	MD
Rodger Moran	Izaak Walton League of America Wildlife Achievement Chapter	MD
Danielle Donkersloot*	Izaak Walton League of America	MD
Lea Rubin*	Izaak Walton League of America	MD
Allan Straughan	Koolhof Earth/Restore Rock Creek	MD
Sara Robinson	Little Falls Watershed Alliance	MD
Sarah Morse	Little Falls Watershed Alliance	MD
Lisa Jones	Living Classrooms Foundation	MD
Sally Hornor	Magothy River Association	MD
Amanda Sullivan	Maryland Department of Natural Resources	MD
Becky Lang	Maryland Department of the Environment	MD
Matt Stover	Maryland Department of the Environment	MD
Tim Fox	Maryland Department of the Environment	MD
Brian Smith	Maryland Dept. of Natural Resources	MD
Dan Boward	Maryland Dept. of Natural Resources	MD
Kristen Hyer	Maryland Dept. of Natural Resources	MD
Mark Trice	Maryland Dept. of Natural Resources	MD
Scott Stranco	Maryland Dept. of Natural Resources	MD
Sherm Garrison	Maryland Dept. of Natural Resources	MD
Tom Parham	Maryland Dept. of Natural Resources	MD
Matthew Tomitz	Maryland Environmental Service	MD
Jim Long	Mattawoman Watershed Society	MD
Joseph Jelich	Midshore River Conservancy	MD
Beth Wasden	Nanticoke Watershed Alliance	MD
Charmaine Dahlenburg	National Aquarium	MD
Rupert Rossetti	Octoraro Watershed Association	MD
Kent Mountford, PhD	Osborn Cove	MD
Kayla Fairfield	Phillips Wharf Environmental Center	MD
Erica Carlsson	Rock Creek Conservancy	MD
Emmett Duke	Sassafras River Association	MD
Ann Bristow	Savage River Watershed Association	MD
Donna Jefferson	Spa Creek Conservancy	MD

Alexandra Fries*	University of Maryland Center for Environmental Science	MD
Caroline Donovan*	University of Maryland Center for Environmental Science	MD
Barnett Rattner	USGS-Patuxent Wildl Res Ctr	MD
Peter Bozick	Wicomico Creekwatchers	MD
Daniel Dickerson	East Carolina University	NC
Steve Penningroth	Community Science Institute, Inc.	NY
Sara Latessa	New York Department of Environmental Conservation	NY
Alene Onion	New York Department of Environmental Conservation/ WAVE	NY
Maribeth Rubenstein	The Community Science Institute, Inc.	NY
Mike Lovegreen	Upper Susquehanna Coalition	NY
Wendy Walsh	Upper Susquehanna Coalition	NY
Candie Wilderman	Alliance for Aquatic Resource Monitoring	PA
Holden Sparacino	Alliance for Aquatic Resource Monitoring	PA
Jinnie Monismith*	Alliance for Aquatic Resource Monitoring	PA
Julie Vastine*	Alliance for Aquatic Resource Monitoring	PA
Arthur Rose	Clearfield Creek Watershed Association	PA
Chris Mayer	Conococheague Watershed Alliance	PA
Cindy Rogers	Evergreen Conservancy	PA
Ed Hetzel	Lake Carey Welfare Association	PA
Blyden Potts	Middle Spring Watershed Association	PA
Justin Kozak	Mifflin County Conservation District	PA
Melinda Hughes	Nature Abounds	PA
Josh Lockenbill	Pennsylvania Dept. of Environmental Protection	PA
Melodie Anderson-Smith	Renfrew Institute for Cultural & Environmental Studies	PA
Ellyn Campbell	Susquehanna River Basin Commission	PA
Jamie Shallenberger	Susquehanna River Basin Commission	PA
Jake Lemon	Trout Unlimited	PA
Dan Zimmerman	Warwick Township	PA
Adrienne Gemberling	Water Resource Monitoring Project	PA
Adam McClain	Watershed Alliance of Adams County	PA
Jim Gockowski	Watershed Alliance of Adams County	PA
Jennifer Farabasugh	Western Pennsylvania Conservancy	PA
Gary Peacock	York County Conservation District	PA
Anne Dunckel*	Alliance for the Chesapeake Bay	VA
Nissa Dean*	Alliance for the Chesapeake Bay	VA
Jim McCord	Chesterfield Water Trends	VA
Lorne Field	Chesterfield WaterTrends	VA
Mike Hayslett	Cowpasture River Preservation Association	VA
Roger Baroody	Cowpasture River Preservation Association	VA
Stephanie DeNicola	Culpeper SWCD	VA
Philip Latasa	Friends of Accotink Creek	VA

Mark Williams	Friends of Goochland Parks	VA
Ginny Hoffman	Friends of Shenandoah	VA
Joe McCue	Friends of the Middle River	VA
Kathleen Daley	G2 Associates	VA
Stacey Heflin	Henricopolis Soil & Water Conservation District	VA
Pat Calvert	James River Association	VA
Michael Trop	John Marshall Soil & Water Conservation District	VA
Dina Leech, PhD	Longwood University Water Quality Monitoring Program	VA
David Singletary	Master Naturalist	VA
Noreen Fleming	McClure River Restoration Project	VA
Dan Schwartz	Northern Virginia Soil and Water Conservation District	VA
Katherine Filippino	ODU OEAS	VA
Charles Newton	Page County Monitors	VA
Daina Henry	Peninsula Master Naturalist	VA
Elise Corbin	Peter Francisco SWCD	VA
Veronica Tangiri	Prince William Soil and Water Conservation District	VA
William Peterson	Reston Association	VA
Kevin Geiger	Rivanna Conservation Alliance	VA
Megen Dalton	Shenandoah Valley Soil and Water Conservation District	VA
Ami Riscassi	Shenandoah Watershed Study-Virginia Trout Stream Sensitivity Study	VA
James Beckley	Virginia Dept. of Environmental Quality	VA
Geoffrey Payne	Virginia Master Naturalist - Historic Southside Chapter	VA
Natalie Smirnoff	Virginia Save Our Streams	VA
John Maxey	Blue Ridge Watershed Coalition	WV
Norman Dean	Sleepy Creek Watershed	WV
Robert Meadows	sleepy creek watershed association	WV
Kate Lehman	Warm Springs Watershed Association	WV
Alana Hartman	West Virginia Dept. of Environmental Protection	WV
John Wirts	West Virginia Dept. of Environmental Protection	WV
Teresa Koon	West Virginia Dept. of Environmental Protection	WV
Tim Craddock	West Virginia Dept. of Environmental Protection	WV
Kathleen Tyner	West Virginia Rivers Coalition	WV
Angie Rosser	West Virginia Rivers Coalition	WV

***** *Chesapeake Monitoring Cooperative Development Team Member*

Appendix C:
Landowner Permission Form

Property Owner Permission and
Liability Release Agreement

PROPERTY OWNER PERMISSION AND LIABILITY RELEASE AGREEMENT

_____ is participating in a program to collect baseline data to
(organization/volunteer name)

monitor the condition of local streams and ensure that water quality and stream habitat are properly maintained. As part of the program, trained local volunteers collect macroinvertebrate samples 1 – 4 times per year at specific sites. Volunteers will be at the site for approximately 30 minutes, collecting and processing the sample. This agreement is intended to grant permission to volunteers to access private property for data collection, as well as to release and hold harmless the property owner from liability arising from that access.

I,_____, hereby grant permission to
_____,
(property owner name) *(organization/volunteer name)*

its volunteers, and necessary program partners, to enter my property located at

_____
,

beginning_____until_____, for the sole purpose of
(start date) *(end date or program completion)*

site-access and sample collection that takes place on or near my property to gather baseline data on the adjacent stream. I agree that my permission is granted on a voluntary basis and I have neither received or expect to receive any form of compensation in exchange for my permission. I agree to hold the organization listed above, its 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 into the private property described in this agreement. In addition, the organization listed above 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 their entry into the private property described in this agreement.

Property Owner_____Date: _____

Organization_____ Date:_____

Appendix D:
Macroinvertebrate ID Test

Macroinvertebrate Identification Test

March 2004

Virginia Save Our Streams Program
Eastern Method Macroinvertebrate Identification
Quality Assurance Procedure

Name:_____ **Date:**_____
Address:_____
_____
Phone:_____ E-mail:_____

Using the macroinvertebrate groupings found on your tally sheet and bug identification card, identify the organisms in the lettered test vials. You may use whatever written resources you wish; however you may not discuss the organisms with a friend during this procedure. You must get at least 17 correct to pass.

A. _____
B. _____
C. _____
D. _____
E. _____
F. _____
G. _____
H. _____
I. _____
J. _____
K. _____
L. _____
M. _____
N. _____
O. _____
P. _____
Q. _____
R. _____
S. _____

Please answer the following questions:

1. How many habitat areas are you looking for? _____
2. What is the minimum number of organisms you need in your sample? _____

3. What is the number of jabs you will collect at each site? _____
4. It is ok to discard a jab if there is too much sediment or debris in the jab
   T F
5. Fish and Salamanders should be counted in your sample T F
6. How many times a year should you sample your site? _____

VA Save Our Streams Program
VA Division of the Izaak Walton League of America
P.O. Box 8297 Richmond, VA 23226 (804)
615-5036 www.vasos.org

Virginia Save Our Streams Program

Eastern Muddy Bottom Method Field Collection Quality Assurance Procedure

Name(s):

_____

_____

_____

Date: _____

This form has been designed for reviewing the field collection skills of monitors in the Virginia Save Our Streams Program. This form is only to be filled out by official Virginia Save Our Streams Program trainers. A minimum score of eleven must be received in order to pass.

1. Monitor selected a representative section of the stream to monitor? Y N
2. Monitored accurately identified 3 habitat areas? Y N
3. Monitor adequately assigned percentages to each habitat area? Y N
4. Monitor disturbed sample area prior to monitoring? Y N
5. Monitor correctly sampled woody debris habitat? Y N
6. Monitor correctly sampled submerged aquatic vegetation habitat? Y N
7. Monitor correctly sampled undercut/vegetated banks? Y N
8. Monitor correctly emptied each jab into the sieve bucket? Y N
9. Monitor discarded any jab that was had too much sediment or debris? Y N
10. Monitor correctly placed sample on the table and divided sample? Y N
11. Monitor quickly picked all organisms from the net and sheet? Y N
12. Monitor showed adequate field identification skills? Y N
13. Monitor correctly filled out field sheets? Y N

Test administered by:

_____