US Army Corps of Engineers®
Baltimore District

Water Quality Program Management Plan

Supporting Documentation for the Baltimore District Water Quality Program

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WQMP Signature Page

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Introduction

The purpose of this document is to ensure the United States Army Corps of Engineers (USACE), Baltimore District's (NAB) compliance with ER 1110-2-8154, which mandates that "Water managers in each district must develop district-specific Water Quality Program Management Plans (WQMPs)." ER 1110-2-8154, Water Quality Management, serves as the primary USACE Engineer Regulation for water quality management and is referenced and summarized throughout NAB's Water Quality Program (WQP), WQMP.

This WQMP outlines the framework for the NAB's WQP to include sampling, monitoring, and associated products and services. The Water Management Section, under the Civil Works Branch of the Engineering Division, is responsible for management of the WQP. Water quality monitoring and management are ongoing annual services, and the management strategies detailed in this document will continue yearly, with updates made as necessary.

USACE Mission

The USACE is mandated by national policy to take a leadership role in achieving the goals and objectives of the Clean Water Act of 1977 (Public Law 95-217, 33 U.S.C. 1251 et seq.), ensuring the protection and maintenance of the nation's water resources under our jurisdiction.

Water quality assessments of USACE reservoirs are conducted to align with the Clean Water Act's water quality objectives and to support the specific authorizations and uses of each reservoir. The Baltimore District's Water Quality Program monitors current conditions and forecasts future trends, providing a reliable, continuous data source. This information supports day-to-day project operations, development of project Water Control Manuals (WCMs) and Master Plans, and ensures compliance with Federal and State water quality standards while safeguarding public health.

Long-term datasets not only support project operations but also inform public inquiries and address concerns from resource agencies and stakeholders regarding water quality conditions at the reservoirs. Additionally, these datasets support planning and construction projects at USACE Civil Works sites by providing information relevant to Sections 22, 206, and 1135 of the Water Resources Development Act, as well as general investigation studies. These efforts often involve environmental compliance and require technical knowledge of the physical, chemical, and biological characteristics of our projects.

Authorities

It is national policy that the Federal government must lead in protecting and enhancing air, water, and land resources through the design, construction, management, operation, and maintenance of its facilities. Federal facilities must comply with all applicable Federal, State, Interstate, and Local requirements in the same manner and extent as non-Federal entities.

Under the Clean Water Act and national antidegradation policy, the following principles guide water quality protection:

1. Existing water quality of waters that constitute an outstanding national resource be maintained and protected
2. Existing water quality of high-quality waters that supports a diverse, productive, and ecologically sound habitat be maintained and protected unless there is compelling evidence that to do so will cause significant national economic and social harm.
3. In all cases, the existing beneficial uses and the water quality necessary to protect them will be maintained.

Existing beneficial uses are defined as those beneficial uses attained in a waterbody on or after 28 November 1975, whether or not they are included in Tribal or State water quality standards (40CFR131.3e).

It is the Corps' policy to take a leadership role in carrying out the goals and objectives of the national policy through managing the nation's water resources that are under its control and ensuring those resources are protected, maintained, and restored. As stewards of these resources, the Corps will not allow the degradation of aquatic resources in accordance with the Federal antidegradation policy. In cases where degradation has occurred, it is the Corps' policy to restore the resource to a biologically productive, diverse, and ecologically robust condition.

The Corps' management responsibilities extend throughout the area influencing and influenced by the water it manages. Because Corps-managed waters are influenced by and impact areas beyond project boundaries, USACE must develop and implement a holistic, environmentally sound water quality management strategy for each project. The strategy must be developed in concert with other authorized project purposes, and be given equal consideration to other project purposes when developing or carrying out management strategies.

At a minimum, the Corps will manage its projects in compliance with all applicable Federal, Tribal, and State environmental laws, criteria, and standards. The Corps is committed to maximizing the environmental potential of its projects through responsible stewardship. This commitment is guided by the four pillars of the Army's environmental strategy: conservation, prevention, restoration, and compliance.

Federal Authorities

The USACE's water control management authority is derived from specific project authorizations and enabling legislation. Its environmental management authority is rooted in the Water Resource Development Acts of 1974, 1986, 1990, 1992, 1996, and 2007, the Water Resources Reform and Development Act of 2014, the River and Harbor Act of 1970, and the Flood Control Act of 1970, as amended. Collectively, these acts emphasize the Federal government's strong commitment to environmental management and ecosystem restoration. Supporting WQP legislation is listed below:

- Executive Order 12088, Federal Compliance with Pollution Control Standards, 1978.
- PL 74-738. Flood Control Act of 1936.
- PL 77-228. Flood Control Act of 1941.
- PL 78-534. Pick-Sloan Flood Control Act of 1944.
- PL 80-845. Federal Water Pollution Act of 1948 and its amendments.
    - PL 95-217. Clean Water Act of 1977.

    - PL 100-4. Water Quality Act of 1987.
- PL 83-780. River and Harbor Act of 1954.
- PL 85-500. Water Supply Act of 1958.
- PL 85-624. Fish and Wildlife Coordination Act of 1958.
- PL 87-874. Flood Control Act of 1962.
- PL 92-500. Federal Water Pollution Control Act Amendments of 1972 (Clean Water Act).
- PL 93-205. Endangered Species Act of 1973.
- PL 100-676. Water Resources Development Act of 1988.
- PL 102-386. Federal Facilities Compliance Act of 1991.
- PL 110-114. Water Resources Development Act of 2007.
- PL 113-121. Water Resources Reform and Development Act of 2014.

USACE Engineer Regulations and Manuals

The operation of water control projects has historically presented significant water quality challenges, which prompted the development of the water quality discipline within USACE. In response, USACE Districts established WQTs to oversee all related water quality activities. In 1974, ER 1130-2-334 mandated annual reports from all Districts and Divisions detailing water quality activities at USACE projects, emphasizing that water quality management must be an integral part of water control management programs. The following year, the USACE Committee on Water Quality was established under ER 15-2-10 to provide further coordination and guidance. Over time, the merger of ERs 1130-2-415, 1110-2-1402, and 1130-2-334 resulted in the creation of USACE's current water quality regulation, ER 1110-2-8154. This regulation mandates the development and implementation of a comprehensive, environmentally responsible water quality management strategy for all projects.

USACE is committed to maximizing environmental compliance in project operations. Engineer and policy documents that guide these efforts include:

- EM 200-1-10. Environmental Quality Guidance for Evaluating Performance-Based Chemical Data.
- EM 1110-2-1201. Reservoir Water Quality Analysis.
- EM 1110-2-3600. Management of Water Control Systems.
- EM 1110-2-4000. Sedimentation Investigations of Rivers and Reservoirs.
- EP 1130-2-540. Environmental Stewardship Operations and Maintenance Guidance and Procedures.
- ER 15-2-10. Committee on Water Quality.
- ER 15-2-14. Committees on Tidal Hydraulics, Channel Stabilization, Water Quality, and Hydrology.
- ER 200-1-5. USACE Environmental Operating Principles.
- ER 200-2-2. Procedures for Implementing NEPA.
- ER 1110-1-12. Quality Management.
- ER 1110-1-261. Quality Assurance of Laboratory Testing Procedures.
- ER 1110-1-1401. Interlaboratory Testing Program for Chemical Analyses.
- ER 1110-2-240. Water Control Management.
- ER 1110-2-1403. Studies by Coastal, Hydraulic, and Hydrologic Facilities and Others.
- ER 1110-2-1941. Drought Contingency Plans.

- ER 1110-2-8154. Water Quality and Environmental Management for Corps Civil Works Projects and Activities.
- ER 1110-2-8156. Preparation of Water Control Manuals.
- ER 1130-2-500. Project Operations Partners and Support (Work Management Policies).
- Authorized and Operating Purposes of NAB Reservoirs.
    - See individual project WCMs.

State Authorities

In addition to federal mandates, USACE must comply with all applicable State environmental regulations and water quality standards. State regulations and standards are detailed below:

- Maryland
    - COMAR Section 26.08.01. Water Pollution—General.
    - COMAR Section 26.08.02. Water Pollution—Water Quality.
- New York
    - 6 NYCRR Part 701. Classifications—Surface Waters and Groundwaters.
    - 6 NYCRR Part 703. Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations.
        - TOGS 1.1.1. Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations.
- Pennsylvania
    - 25 Pa. Code § 93. Water Quality Standards.
    - 25 Pa. Code § 109. Safe Drinking Water.
- West Virginia
    - 47CSR2. Requirements Governing Water Quality Standards.
    - 60CSR5. Antidegradation Implementation Procedures.

Requirements for District Water Quality Programs

In accordance with ER 1110-2-8154, an ongoing water quality monitoring program may be necessary for all USACE projects. Such data is essential to effectively understand and manage the natural resources of USACE water resource projects. Each district must also develop specific water quality management objectives tailored to individual projects which clearly define procedures to be implemented to meet stated objectives. The objectives must be included in project water control manuals, which are reviewed and updated at least once every 10 years. Water quality is an integral part of water control management. General objectives for an effective Water Quality Monitoring Program include:

- Assess compliance with applicable Federal, State, and tribal water quality standards.
- Provide an adequate publicly available database for understanding current water quality conditions, identifying trends, identifying problems and solutions, and facilitating coordination with Federal, State, and tribal agencies regarding watershed activities influencing water quality.
- Investigate special water quality problems (e.g. harmful algal blooms, fish kills, radionuclide contamination, or other acute or chronic conditions) and design/implement modifications to improve water management procedures.

- Provide data to inform reservoir regulation and other civil works activities, enabling effective water quality management, environmental protection, and operational decision-making.
- Supply real-time water quality data to support project operations, including regulatory compliance, environmental flow requirements, and ecosystem sustainability.
- Evaluate water and sediment interactions and their influence on overall water quality.
- Support the understanding, protection, and restoration of aquatic and riparian ecosystems.
- Promote water quality awareness and stewardship through training, Community of Practice lessons learned, and close attention to system response.
- Monitor recreational areas and public water supplies to ensure public safety and resource integrity.
- Ensure stormwater management and erosion/sediment control best management practices (BMPs) are properly designed, constructed, maintained, and compliant with applicable state and local regulations.
- Collect water quality data to support technical studies, evaluations, and water resource modeling efforts.
- Account for spatial and temporal watershed dynamics, including seasonal, annual, and multi-year water quality trends.
- Adapt monitoring protocols to meet evolving management objectives, regulatory requirements, and USACE policies.
- Develop a robust data record to document external impacts to water quality and project resources.
- Provide timely response to incidents that may affect project operations.
- Address additional District-specific objectives as permitted by law.

Baltimore District Water Quality Program

Vision

Deliver a reliable and results-driven Water Quality Program which effectively meets the surface water quality management requirements outlined in District project Water Control Manuals, while providing technical support on water quality issues to ensure the effective planning, execution, and operation of all District water resource projects.

Overview

NAB has a responsibility to preserve, protect, and where necessary, restore that portion of the environment influenced by their reservoirs and other water resource projects. In alignment with USACE policies and authorities, environmental considerations must hold equal weight in all project management and operational decisions. This requires a thorough understanding of watershed interactions and the physical, chemical, and biological processes affecting both aquatic and upland environments. Informed operation and maintenance of projects supports sustainable human use, while protecting and enhancing the environmental value of resources.

The WQP is one of the greatest opportunities for the District to demonstrate its commitment to environmental stewardship, conservation, and restoration. Through responsible water resource

management, the District contributes to the nation's goals for ecologically sustainable development. The Baltimore District has maintained a consistent WQP at its reservoirs since the early 1990s, integrating environmental laws, values, and sound environmental practices into USACE missions.

Each District takes the lead in determining data needs, identifying problems or opportunities, proposing solutions, justifying resources, implementing approved actions, and reporting results. The WQP is essential for collecting status and trend data to support informed decision-making. This information is shared with stakeholders, agencies, and the public. Input from federal, state, and local agencies is considered when designed or revising monitoring efforts. Because data collection is resource-intensive, results are shared to improve efficiency and program effectiveness. Integrating water quality data with hydrologic, climatic, and other environmental data is essential for a comprehensive water management program.

NAB Water Management oversees approximately 42,200 square miles of drainage area within the Susquehanna and Potomac River Basins (*Figure 1*) across Maryland, New York, Pennsylvania, and West Virginia. Water quality sampling and monitoring activities occur at fourteen projects within this area (*Table 1*). Although data exists since the 1970s, standardized physical sampling began in the 1990s, standardized biological data in 2024, and standardized chemical data will begin in 2028. Monitoring methods include *in situ* parameters (e.g. water temperature, dissolved oxygen), Secchi disks transparency, water chemistry sampling via Kemmerer bottles, and benthic macroinvertebrate collection utilizing D-Frame nets. Lab analyses are conducted by contractors, and all data is stored in Data Management and Analysis System for Lakes, Estuaries, and Rivers (DASLER). Quality assurance measures are used during data import, and results are also uploaded to the U.S. Environmental Protection Agency (USEPA) Water Quality Portal and the USACE Access to Water system to allow public access of information. Continuous water quality monitoring data collected from various gages is stored in the Corps Water Management System (CWMS).

To maintain consistency, the WQT follows a structured sampling plan, visiting each reservoir three times a year to collect *in situ* and water chemistry data. Projects where Water Management can make operational changes are sampled for *in situ* parameters two additional times during the year. Benthic macroinvertebrate collection occurs at select projects on a four-year rotational basis.

While the core sampling strategy is consistent, each reservoir requires a customized approach based on watershed characteristics, geology, land and water use, and other influencing factors. Water quality conditions are dynamic, shifting seasonally and annually due to internal and external physical, chemical, and biological inputs, as well as operational changes. These variables directly impact in-lake and downstream water quality, habitat, and aquatic life. As such, monitoring plans are customized to address the specific uses and challenged of each reservoir. The WQP must also remain adaptable to respond to evolving laws, policies, operational needs, site-specific conditions, ecological concerns, and public safety considerations.

Figure 1: Water Quality Program Project Locations

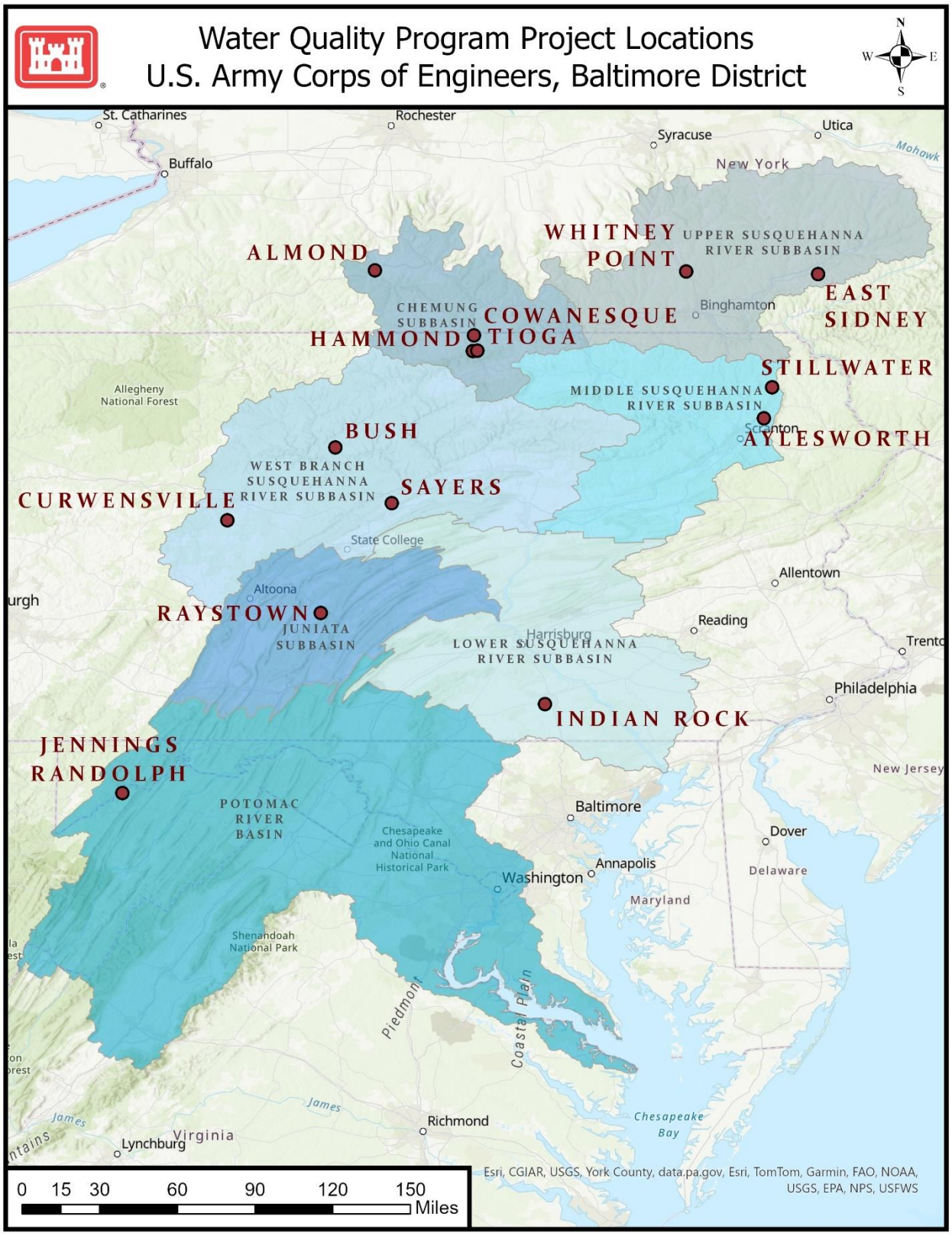


Table 1: Projects and Authorized Purposes

State	Project	Authorized Purposes
Maryland/West Virginia	Jennings Randolph	Flood Control (PL 87-874) Recreation (PL 87-874, 100-676) Water Supply (PL 87-874) Water Quality (PL 87-874)
New York	Almond	Flood Control (PL 74-738) Recreation (PL 78-534)
	East Sidney	Flood Control (PL 74-738) Recreation (PL 78-534)
	Whitney Point	Flood Control (PL 74-738) Recreation (PL 78-534)
Pennsylvania	Aylesworth	Flood Control (PL 87-874) Recreation (PL 78-534)
	Bush	Flood Control (PL 83-780) Recreation (PL 78-534)
	Curwensville	Fish/Wildlife (PL 85-624) Flood Control (PL 83-780) Recreation (PL 78-534) Water Quality (PL 92-500)
	Cowanesque	Flood Control (PL 85-500) Recreation (PL 78-534) Water Supply (PL 85-500) Water Quality (PL 92-500)
	Indian Rock	Flood Control (PL 74-738)
	Raystown	Fish/ Wildlife (PL 87-874) Flood Control (PL 87-874) Hydroelectric Power (PL 87-874) Recreation (PL 87-874)
	Sayers	Flood Control (PL 83-780) Recreation (PL 78-534) Water Quality (PL 92-500)
	Stillwater	Flood Control (PL 77-228) Water Supply (PL 77-228)
	Tioga-Hammond	Flood Control (PL 85-500) Recreation (PL 78-534) Water Quality (PL 92-500)

Objectives

Water quality sampling and monitoring are conducted to achieve four primary objectives that drive NAB's Water Quality Program: 1) Monitor current water quality conditions and identify trends; 2) Support Water Management operations; 3) Assess compliance with Federal and State water quality standards; 4) Evaluate the effectiveness of Water Control Manuals.

Objective 1: Monitor Current Water Quality Conditions and Identify Trends

The WQT conducts water quality sampling and monitoring of NAB project tailwaters, reservoirs, and major tributaries (inflows); collection includes physical, chemical, and biological data to assess environmental conditions. Parameters collected are included in *Table 2*.

Scheduled and routine surveys allow the WQT to establish baseline conditions, assess current water quality status, and identify significant water quality trends within the Susquehanna and Potomac River Basin. A robust and defensible database is necessary to assess the constantly changing nature of our environment. The WQT uses the following programs for comprehensive water quality database management: DASLER and CWMS.

Table 2: Water Quality Parameters

In situ	**Water Chemistry**	**Biological**
• Dissolved Oxygen • pH • Secchi Disk • Specific Conductance • Water Temperature	• Acidity, Total • Alkalinity, Total and Phenolphthalein • Calcium, Total	• Benthic Macroinvertebrates • Chlorophyll a • Zebra Mussels

Objective 2: Support Water Management Operations

The Corps strives to operate reservoir projects under optimal conditions. Water Management decisions incorporate water quality assessments to guide operational strategies, and often require real-time adjustments in response to changing environmental conditions. The WQT makes recommendations, as necessary, to mitigate issues resulting from reservoir operations.

Partnerships with State regulatory agencies allow the Corps to coordinate operational changes to improve the ecological integrity downstream of our dams.

The WQT provides support to Water Management operations by supplying and maintaining equipment necessary to perform profiles and managing the data that is collected throughout the year. During warmer months, water temperature can exceed State standards while pH and DO in NAB tailwater releases may fall below the standards. At several of the dams, Water Management operations can improve these conditions using selective withdraw by utilizing QC gates, port gates, bypasses, tainter gates, and fish gates.

Objective 3: Assess Compliance with Federal and State Water Quality Standards

The Corps is obligated to adhere to all relevant Federal and State water quality standards at our projects. The NAB WQT monitors the chemical, physical, and biological conditions upstream, downstream, and within fourteen NAB reservoirs, making recommendations, as needed, to address any issues arising from operations. Collaborative partnerships with State and local agencies ensure that NAB stays informed about changes in criteria and newly listed 303(d) impaired streams within NAB's jurisdiction.

Objective 4: Evaluate the Effectiveness of Water Control Manuals

Through continued water quality sampling and monitoring, establishing baselines, identifying trends, and evaluating impairments, NAB's Water Quality Program significantly contributes to evaluating the effectiveness of a project's Water Control Plan. These plans are established within WCMs for each project, and are subject to change due to any water resource needs determined by the Water Management team. Efforts by the WQT directly contribute to updating these plans.

Other sections of the WCMs contain land use and watershed characteristics that are subject to temporal changes. Many water quality constituents are indicators of land use change and analyzing these data may reveal and support any updates necessary to the WCMs. NAB will determine if any project modifications could mitigate impairments to water quality. Any changes to the WCM will be completed following reporting of intensive survey data.

Current and Emerging Water Quality Issues

NAB faces a range of current and emerging water quality and ecological challenges that impact Corps projects, necessitating heightened awareness, focus, and ongoing assessment. Some of these challenges include:

Environmental Flow Management

Environmental flow (e-flow) management involves operating a project in a way that ensures the timing, quantity, and quality of water flows support the sustainability of downstream aquatic ecosystems. Typically, replicating natural conditions—especially those prior to impoundment—proves most effective in maintaining ecological balance. Jennings Randolph is part of the USACE Sustainable Rivers Program (SRP), and, as funding allows, working to assess whether e-flows can be effectively balanced with other authorized objectives, such as water quality management and flood risk reduction.

Harmful Algal Blooms

Cyanobacteria can outcompete other algae under certain conditions, typically driven by high nutrient loading. This can lead to the formation of Harmful Algal Blooms (HABs), which produce and release toxins into the water, posing a significant threat to human and other animal health, as well as drinking water quality. The risk of these toxins being ingested or inhaled makes them a serious health hazard. Historically, HABs have been reported at multiple reservoirs within NAB.

Hypoxia

There are significant decreases in DO concentrations at reservoir projects throughout the summer and fall. The decrease reduces suitable fish habitat and can lead to seasonal fish kills and decreased species richness.

Invasive Species

Invasive species are non-native plants, fish, and animals that, when introduced into an ecosystem, threaten the survival of native species and disrupt native habitat. Typically, invasive species thrive due to the lack of natural competition. Zebra mussels, hydrilla, and HABs are examples of invasive species NAB is currently dealing with.

Nutrient Enrichment

Eutrophication can result in increased algal blooms, reduced water clarity, and low dissolved oxygen concentrations that threaten aquatic life.

Increased nutrients can result in higher turbidity, lower DO concentrations, intensification of algal blooms, and pose a threat to aquatic life. Through a series of biological and chemical processes, eutrophication can also result in more extreme lake stratification, which causes lower DO concentrations at depth and results in the reduction of suitable habitat for fishes. Subsequently, this can cause a decrease in recreational use and drinking water quality issues.

Resource Extraction

The lands with NAB are well-known for their abundance of natural resources such as coal, natural gas, oil, timber, and water. Resource extraction has led to significant water quality issues including acid mine drainage (AMD). AMD occurs when sulfide minerals in exposed rocks react with air and water, forming sulfuric acid, which leaches into nearby waterways. This acidic runoff can lower pH in water making it harmful to aquatic life and disrupting entire ecosystems. Contamination of water with metals, such as iron, aluminum, and manganese furth exacerbates the problem, threatening drinking water supplies and local habitats.

Sedimentation

Sediment is considered the leading pollutant in surface waters across the United States. While sedimentation is a natural process, human activities have significantly accelerated its accumulation, particularly in reservoirs and large rivers. This excess sediment affects water quality by facilitating the transport of nutrients and reducing water clarity, which in turn can jeopardize drinking water quality, harm aquatic ecosystems, and limit recreational opportunities.

Water Contaminants

Contaminants like polychlorinated biphenyls (PCBs), mercury, and other heavy metals are absorbed into fish tissue and bioaccumulate, posing significant risks to both human and other animal health. These harmful substances are carried into reservoirs through disturbed inflow streams, further exacerbating the problem.

Watershed Disturbances

Resource extraction, land development, and farming are examples of watershed disturbances that can adversely affect waterways when not managed properly. Both manmade and natural disturbances are directly correlated with increases in specific conductance, metals, sulfates, and sedimentation that threaten biological communities and habitats.

State Status of Baltimore District Waters

Multiple streams within the District are listed as impaired waters by their respective states. The National Water Quality Inventory Report to Congress (EPA, 2024a) is the primary means of informing Congress and the public about general water quality conditions in the United States. These reports consist of water quality assessments submitted by states, tribes, and others and summarized by the USEPA for Congress.

In addition to designated uses, the report requires listing of impaired waters under Section 303(d) of the Clean Water Act. States are mandated to develop and implement Total Maximum Daily Loads (TMDLs) for water resources listed on their respective 303(d) lists. Within NAB, Corps-managed projects found on the current 303(d) lists are shown in *Table 3*. These designations influence the WQT's annual monitoring site selection and choice of analytes, ensuring that efforts are aligned with known impairments and regulatory priorities.

Table 3: 303(d) Listed Projects

Project	**State**	**303(d) Impairments**
Whitney Point	NY	Total Phosphorus, Algal/Weed Growth
Cowanesque	PA	Mercury, Organic Enrichment
Tioga	PA	Mercury, Siltation
Bush	PA	Mercury
Sayers	PA	Thermal Modifications, Organic Enrichment
Indian Rock	PA	Pathogens

Water Quality Program Implementation Strategy

Water Quality Program Organization and Responsibilities

The Baltimore District Water Quality Team maintains one full-time employee (FTE) and receives assistance from Water Management and/or Operations personnel while conducting fieldwork; occasionally, interns or summer students assist with field activities. The Water Quality Lab and equipment staging and storage area are located at the Fort McHenry field office. Generally, the FTE reports to NAB's Headquarters Office October thru April and operates out of Fort McHenry during the field season, May thru September.

Achieving a successful, sustainable environmental project requires a team approach and a clear understanding of each of the participant's needs and goals. A project that is properly organized with well delineated responsibilities fosters effective coordination and ultimately leads to successful project outcomes. Below is a summary of key functional areas and responsibilities:

- USACE NAB, Water Quality Team – Responsible for designing and maintaining a water quality sampling program to meet the needs of the District. Oversees the scientific execution of the sampling program and manages all associated data. Reviews sampling procedures and ensures compliance with quality control (QC) objectives.
- USACE NAB, Water Management Section – Responsible for operating Civil Works projects in accordance with USACE EOPs. Coordinates with the Water Quality Team in the design and implementation of sampling program.
- USACE NAB, Engineering Division – Provides guidance with policy and procedural oversight related to project operations impacting water quality sampling. Executes project operations directly and ensures alignment with USACE EOPs.
- State Agencies (MD, NY, PA, WV) – Offer technical insight on issues pertaining to the operation of projects within their respective State boundaries. Ultimately responsible for the protection and management of their States' water resources.
- Contracted Laboratory – Responsible for meeting contract requirements, providing rapid data turnaround, maintaining quality control standards, and ensuring appropriate laboratory certifications.

Water Quality Monitoring and Assessment

Collecting surface water quality data is essential for the successful development, implementation, and evaluation of water quality management activities. A well-designed water quality program ensures that critical information is effectively delivered to water quality analysts, water managers, and/or stakeholders. Without proper planning, the program may result in the expenditure of significant time and resources, and generate data that offers limited value to decisionmakers.

An effective program is supported by a thorough Quality Control Plan, detailed Standard Operating Procedures, and other essential documentation. These should clearly outline data requirements, monitoring objectives, quality standards, and the methodologies for both data collection and analysis.

When designing water quality studies or setting water quality management objectives, the District will fully consider the views of other Federal, Tribal, State, and Local agencies regarding data requirements, as applicable. Given the high cost and labor intensity of data collection, collaboration and data-sharing opportunities will be prioritized. Moreover, integrating water quality data with hydrologic and other environmental information is crucial for a more complete understanding and effective management plan.

Monitoring Strategy

A site-specific monitoring program has been implemented to monitor the status and trends in water quality constituents. The types of surveys, sampling, analyses, and frequency of sampling are altered in response to environmental events, weather, staffing levels, and budget constraints. General sampling events are shown in *Table 4*, and additional project information and reservoir station maps are located in *Appendix A: Baltimore District Water Management Project Authorizations, Appendix B: Reservoir Project Information, Appendix C: Project Water Quality Stations*, and *Appendix D: Parameter Justifications*. The intent is to maintain a Water Quality Program that is adaptive and responsive to changing conditions, rather than rigidly fixed or solely budget driven.

Table 4: Sampling Rotations

Sampling Type	Trips/Year	Number of Projects	Frequency
Full (Profile, Phytoplankton, Chemical)	3	14	Yearly
Reservoir Profile Only	2	7	Yearly
Benthic Macroinvertebrates	1	2-4	4 Year Rotation

Full Surveys are designed to fully assess water quality parameters within a watershed. Such surveys are conducted three times a year between May and September. Parameters collected include profiles (temperature, DO, specific conductance, pH and chlorophyll a) taken every five feet from near surface to just above the bottom of the reservoir, Secchi disk readings, phytoplankton samples, and water chemistry samples (nutrients and metals).

Reservoir Profile Only Surveys are designed to monitor the progression of thermal and chemical stratification throughout the year. These types of surveys utilize physiochemical data profiles and occur at seven reservoirs; these are Cowanesque, Tioga-Hammond, Bush, Sayers, Raystown, and Jennings Randolph. Data is used for operational adjustments during critical water quality periods.

Benthic Macroinvertebrate Surveys are typically conducted once a year at two to four projects on a four-year rotation. Benthic macroinvertebrates are a useful indicator of stream health and can provide a snapshot of long-term conditions of waterways due to different species sensitivity to pollutants. Prior to benthic macroinvertebrate surveys, the WQT must obtain a yearly scientific collection permit from the State(s) in which collection will occur. It is the permit holder's responsibility to ensure all requirements of the permit are fulfilled.

Zebra Mussel Surveys are conducted at targeted projects to monitor and manage environmental impacts and protect critical infrastructure. Sampling includes visual assessments, veliger collection, and targeted surveys for adult zebra mussels. Prior to surveys, the WQT must obtain a

yearly scientific collection permit from the State(s) collection will occur. It is the permit holder's responsibility to ensure all requirements of the permit are fulfilled.

Situational Surveys are conducted as needed and are typically in response to an environmental event such as a fish kill or algal blooms. While these surveys are generally not long in duration the data collected are still valuable for tracking long term trends.

Special Studies are conducted as needs arise, where budget and staffing levels permit. The WQT is sometimes tasked to develop or participate in long-term monitoring studies that are designed to answer a question or improve a project's operation. These studies are often conducted in cooperation with another agency or office.

Harmful Algal Bloom Response occurs when there are suspected algal blooms at any NAB project. The WQT, as well as District Operations Coordinators, are responsible for notifying the States of potential HABs. Notification to the States fulfills the NAB's official responsibilities; however, when requested, personnel may assist the States in collection of potential HAB samples.

Sample Analysis

Chemical analyses of samples are completed by the Water Quality Team. Benthic macroinvertebrate samples are contracted to BSA Environmental Services, Inc. through USACE's Engineer Research and Development Center Environmental Lab (ERDC EL) for analysis.

In FY24, USACE had an interagency agreement with the U.S. Geological Survey (USGS) regarding a zebra mussel study at Cowanesque. Through this agreement and partnerships with the Susquehanna River Basin Commission (SRBC) and Mansfield University (MU), study specific chemical and biological samples are being collected and analyzed by each entity, as well as BSA.

Sampling plans and cost analysis estimates are included in Appendix E.

Data Management and Assessment

All field collected chemical, physical, and biological water quality data is in DASLER. Continuous water quality data is in CWMS.

DASLER and RStudio are used to conduct graphical and statistical analyses; these methods enable the WQT to interpret trends, assess limnologic conditions, evaluate compliance with Federal and State WQ standards, and identify potential issues such as low dissolved oxygen, water temperature exceedances, and algal blooms. Once all data is reviewed, the results are compiled into the Water Quality Annual Report, which includes data assessment and recommendations for the following year. Following each water quality sampling trip, field data reports and plots are distributed to stakeholders throughout the Susquehanna and Potomac River Basins.

In 2007, the Water Resources Development Act (WRDA) directed USACE to make water quality data accessible to the public via the internet. The Committee on Water Quality submitted a Water Quality Data Implementation Plan (2009) to meet this requirement. NAB is in the beginning stages of satisfying the WRDA requirement by making water quality data publicly available via our Water Management Section website (https://water.usace.army.mil/office/nab/), on USACE Access to

Water (http://water.usace.army.mil/), and through the EPA Water Quality Exchange (WQX) (https://www.epa.gov/waterdata/water-quality-data-wqx).

Reporting and Planning

In addition to this document, the following documents are created and/or reviewed and updated as needed, on an annual basis:

- Annual Water Quality Report
- Annual Water Management Report
- NAB WQ Yearly Sampling Status and Analysis Cost
- Standard Operating Procedures
- Water Quality—Quality Control Plan
- Safety Data Sheet Binder

Water Quality Management Planning

Water quality management is an integral component of the Water Quality Program. In accordance with ER 1110-2-8154, specific water quality management objectives must be incorporated into all District projects. Detailed WQMPs are documented in project specific Water Control Manual, Water Control Plans. The plans are to be reviewed and modified, as needed, at least once every 10 years. The scope should include all areas influencing and influenced by the project. While water is restricted bank-to-bank, the environment is not. All must be considered as they are impacted by water.

Program Development and Evaluation

The WQMP should be reviewed and updated as required to serve as the Water Quality Program driver. The WQMP is used to establish program goals, objectives, and priorities for surface water quality issues within the District.

Planning and Reporting Schedule

Table 5 describes the Water Quality Program planning and reporting schedule by month. All dates are approximate, and completion of tasks by the target dates is subject to change due to weather, staff availability, and budget or contract complications. Although every effort is taken to adhere to a schedule to satisfy NAB stakeholders and partners, unforeseen events may limit success.

Table 5: WQ Planning and Reporting Schedule

Target Date Range	Activity
January to March	Revise WQMP, as needed Revise Water Quality—Quality Control Plan, as needed Update Water Control Manuals, as needed Continued development of draft WQ Annual Report Assess and order supplies for field season Attend USACE and PA WQ conferences Distribute WQ sampling dates to projects
April to May	Calibrate equipment First round full sampling Zebra mussel plate deployment QA/QC and upload benthic macroinvertebrate data Submit Scientific Collection Permit applications
June	Profile-only sampling Finalize WQ Annual Report
July	Second round full sampling Benthic macroinvertebrate sampling
August	Profile-only sampling
September	Third round full sampling
October	Zebra mussel plate retrieval
November-December	Data processing, QA/QC Draft WQ Annual Report preparation Water Management Annual Report Revise SOPs, as needed Update Water Control Manuals, as needed Yearly Sampling Status and Analysis Cost

Annual Planning and Reporting Documents

A NAB WQ Yearly Sampling Status and Analysis Cost Excel file outlines Water Quality Program priorities and needs within a specific year. The document operates on a calendar-year basis and will be finalized by December of the previous year. Fiscal budget summaries, Program priorities, and target sampling dates are listed within the file.

The Water Quality Annual Report will be developed and routed through the chain of command to the NAD Division water quality component and uploaded to the national USACE WQ SharePoint. It provides a detailed review and assessment of water quality activities over the previous calendar year. Findings and recommendations from the report are used to prioritize future budget requests and monitoring needs. Copies of the report will be distributed as needed.

Quality Control Plan

The Quality Control Plan (QCP) is vital to ensuring data validity and programmatic success. Modifications or deviations of techniques need to be thoroughly documented. This will ensure that all reports, recommendations, and shared data are of the highest quality.

Risk Management Assessment

There is a high potential for risk involved with the execution of the Water Quality Program. Risks can be separated into four categories – Internal, External, Natural, and Personnel. Specific risks and impacts of each type are described below:

Internal risks include funding constraints, contracting issues, staffing limitations, and scheduling conflicts. A loss of funding, staff, or contracting authority will ultimately result in a decreased ability to meet Program objectives and maintain compliance with laws and regulations. The Program serves as the only long-term, continuous monitoring effort within NAB. Data collection is vital for determining long- term trends relative to State water quality standards, watershed conditions, recreational conditions, and drinking water quality.

External risks include laboratory QA/QC issues, laboratory closure, and sample equipment malfunctions and repair delays. In conjunction with the Water Management Section Chief, the WQT Program Manager is responsible for deciding how to address such issues and determining both short and long-term program impacts.

Natural risks include weather (short-term) and climate (long-term) impacts. Weather can influence scheduled sampling events and poses the most risk to events that are coordinated between multiple agencies. Prolonged drought conditions have the potential to reduce inflow and in-lake sample locations. Conversely, expansive floods can alter inflow sample locations and monthly sample schedules. In conjunction with the Water Management Section Chief, the WQT Program Manager is responsible for determining alterations or modifications to annual sampling schedules related to such natural risks.

Personnel risks include safety and occupational health hazards encountered during office and field activities, motor vehicle operations, and marine operations; these can be detrimental to the Water Quality Program due to injury or loss of life and damage or loss of property (vehicles, boats, trailers). Details and controls for these hazards can be found in individual personnel Position Hazard Analyses and USACE EM 385-1-1.

Scientific Collection Permitting and Reporting

The WQT is required to acquire scientific collection permits from states that benthic macroinvertebrate samples will be collected in during a given year. The process of obtaining and maintaining a permit involves a permit application, approval, and submission of annual reports. Table 6 outlines the requirements for obtaining a scientific collection permit by state.

Table 6: Scientific Collection Permit Information

State	Permit Renewal Date	Annual Report Date	Application Fee	Other Fee(s)
New York	Annually	Prior to permit expiration	$0	None
Pennsylvania	Annually	Within 45 days of permit expiration	$0	Up to $210 Permit terms and conditions require permit holder and assistants to possess a PA fishing license; prices vary based on in-state and out-of-state residence.
Maryland	Annually	31 December	$10	None
West Virginia	Annually	Within 45 days of permit expiration	$0	None

Technical Assistance

The District's Water Quality Program will provide technical support on water quality issues to all District activities, as requested. The degree of support is dependent upon staff and resource availability.

Management Plan Changes

Any programmatic changes will be addressed by the Water Management Section and implemented by the Water Quality Team; these changes include those to budget, personnel, weather, or project operations. Immediate impacts to stakeholders will be communicated in the most efficient manner depending upon the situation at hand. Changes and resulting impacts will be noted and discussed in the WQ Annual Report.

Communication Plan

Water Quality Program data and results are shared with other agencies and the public by the Water Management Section through a variety of forms—raw data, annual reports, electronic media, print media, and presentations. Raw data is available to Federal and State agencies upon the completion of data entry, proofing, and analyses. Annual reports are available upon completion to all interested parties electronically via the District's Water Management website. The District's website will be utilized to include individual lake conditions reflected by profile data. Printed media is utilized when opportunities arise; the Public Affairs Office (PAO) will be notified of such events. Presentations are provided upon request, as well as for national, regional, state, and local conferences related to project water quality and watershed issues.

Appendices

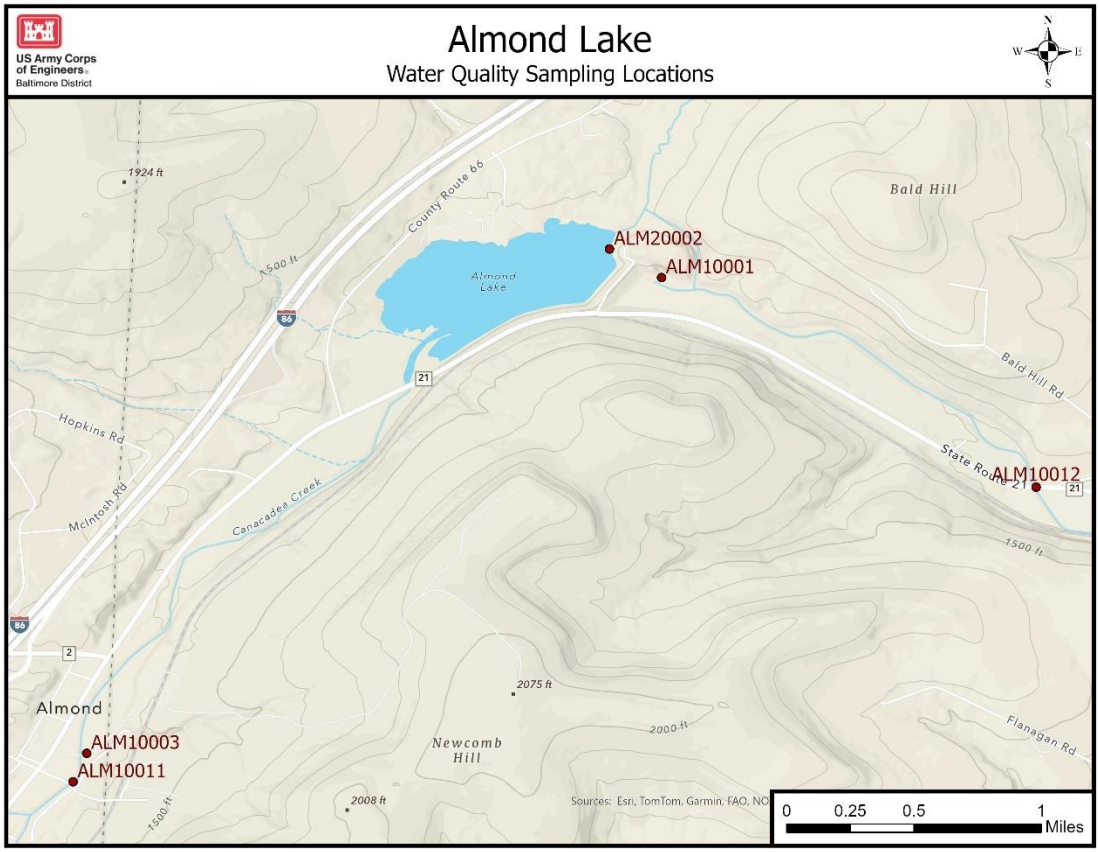
Appendix A: Baltimore District Water Management Project Authorizations

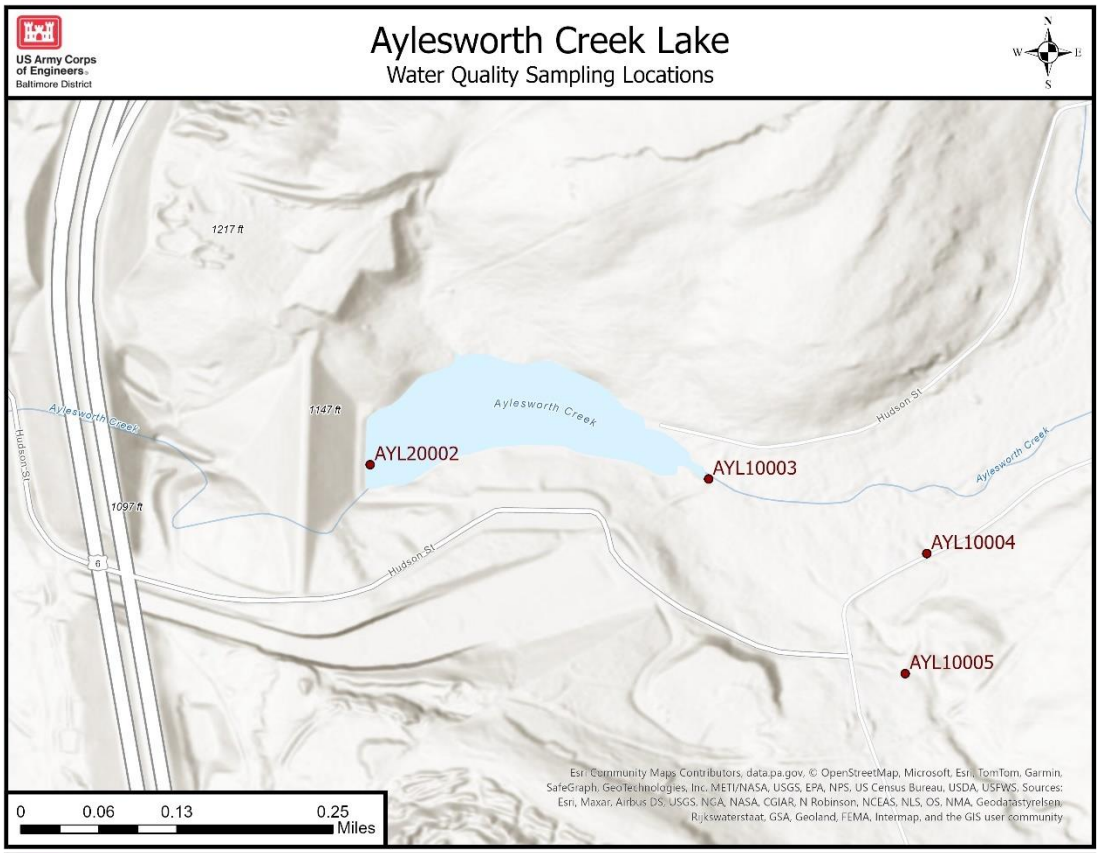
Project	Location	Operating Purposes	Authorized Purposes
Almond Lake	Steuben County, New York	Recreation Flood Control	Recreation Flood Control
Alvin R. Bush Dam	Clinton County, Pennsylvania	Recreation Flood Control	Recreation Flood Control
Aylesworth Creek	Lackawanna County, Pennsylvania	Recreation Flood Control	Recreation Flood Control
Cowanesque Lake	Tioga County, Pennsylvania	Water Supply Water Quality Recreation Flood Control	Water Supply Water Quality Recreation Flood Control
Curwensville Lake	Clearfield County, Pennsylvania	Fish/ Wildlife Water Quality Recreation Flood Control	Fish/ Wildlife Water Quality Recreation Flood Control
East Sidney Lake	Delaware County, New York	Recreation Flood Control	Recreation Flood Control
Foster Joseph Sayers Dam	Centre County, Pennsylvania	Water Quality Recreation Flood Control	Water Quality Recreation Flood Control
Jennings Randolph Lake	Garrett County, Maryland	Water Supply Water Quality Recreation Flood Control	Water Supply Water Quality Recreation Flood Control
Raystown Lake	Huntingdon County, Pennsylvania	Flood Control Fish/Wildlife Recreation	Flood Control Fish/Wildlife Recreation Hydroelectric Power
Stillwater Lake	Susquehanna County, Pennsylvania	Water Supply Flood Control	Water Supply Flood Control
Tioga-Hammond Lakes	Tioga County, Pennsylvania	Water Quality Recreation Flood Control	Water Quality Recreation Flood Control
Whitney Point Lake	Broome County, New York	Recreation Flood Control	Recreation Flood Control
York Indian Rock Dam	York County, Pennsylvania	Flood Control	Flood Control

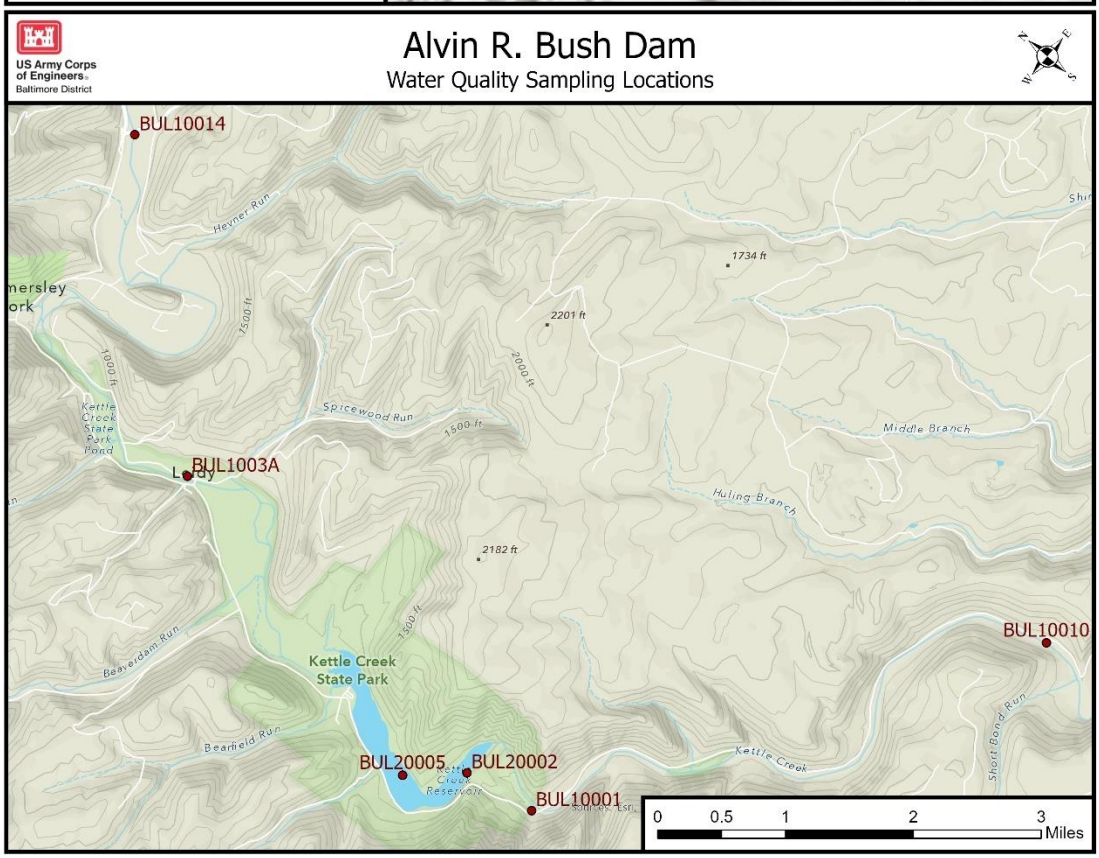
Appendix B: Reservoir Project Information

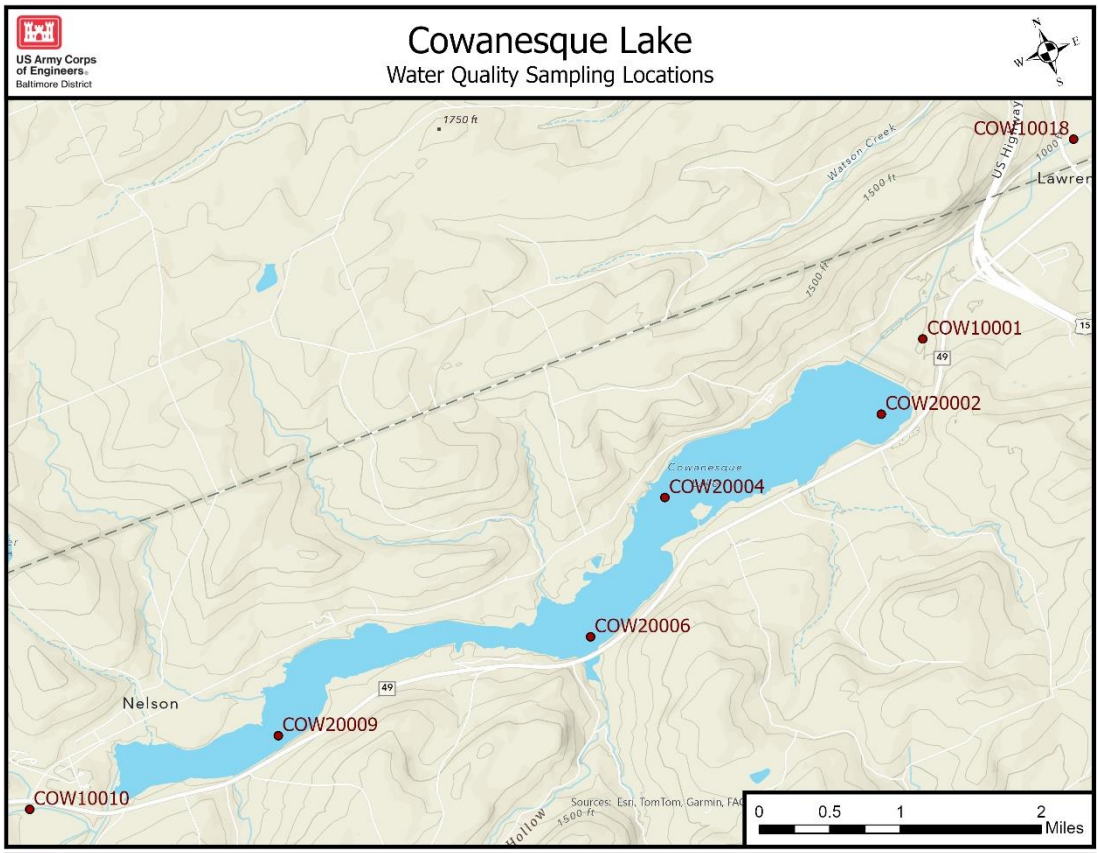
Reservoir	Spillway Crest Elev (ft)	Conservation Pool Information				Water Quality Information		
		Elev (ft)	Season	Storage Used (ac-ft)	Flood Storage Remaining (ac-ft)	Stream WQ Stations	Reservoir WQ Stations	Continuous WQ Monitors
North Branch Potomac River Subbasin								
Jennings Randolph Lake	1468	1466	Year-Round	94700	36200	2	5	1
Upper Susquehanna River Subbasin								
East Sidney Lake	1203	1140	Winter	1700	31850	6	3	0
		1150	Summer	3350	30200			
Whitney Point Lake	1010	973	Year-Round	11688	72545	4	3	0
Chemung Subbasin								
Almond Lake	1300	1260	Year-Round	840	12557	4	1	0
Tioga Lake	1131	1081	Year-Round	9945	52362	8	6	1
Hammond Lake	1131	1086	Year-Round	8625	54886	3	3	
Cowanesque Lake	1117	1080	Year-Round	29876	54871	3	9	1
West Branch Susquehanna Subbasin								
Curwensville Lake	1228	1162	Year-Round	7483	111984	3	3	0
Alvin R. Bush Dam	937	841	Year-Round	1740	73260	4	2	0
Foster Joseph Sayers Dam	657	610	Late-Winter	6300	92700	6	4	1
		625	Early-Winter	21060	77940			
		630	Summer	28800	70200			
Juniata Subbasin								
Raystown Lake	812	786	Year-Round	514000	248000	6	8	0
Middle Susquehanna River Subbasin								
Stillwater Lake	1621	1572	Year-Round	343	11657	2	1	0
Aylesworth Creek Lake	1150	1108	Year-Round	64	1700	3	1	0
Lower Susquehanna River Subbasin								
York Indian Rock Dam	435	370	Year-Round	0	27657	5	0	0

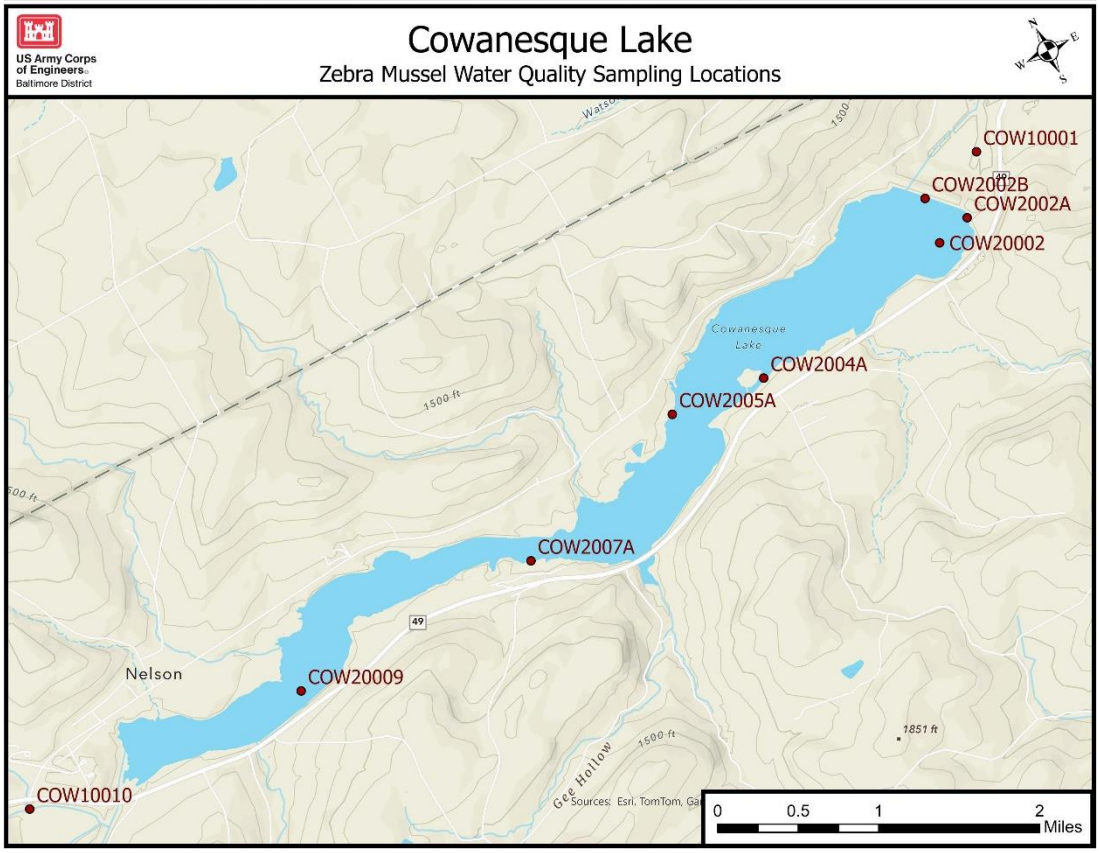
Appendix C: Project Water Quality Stations

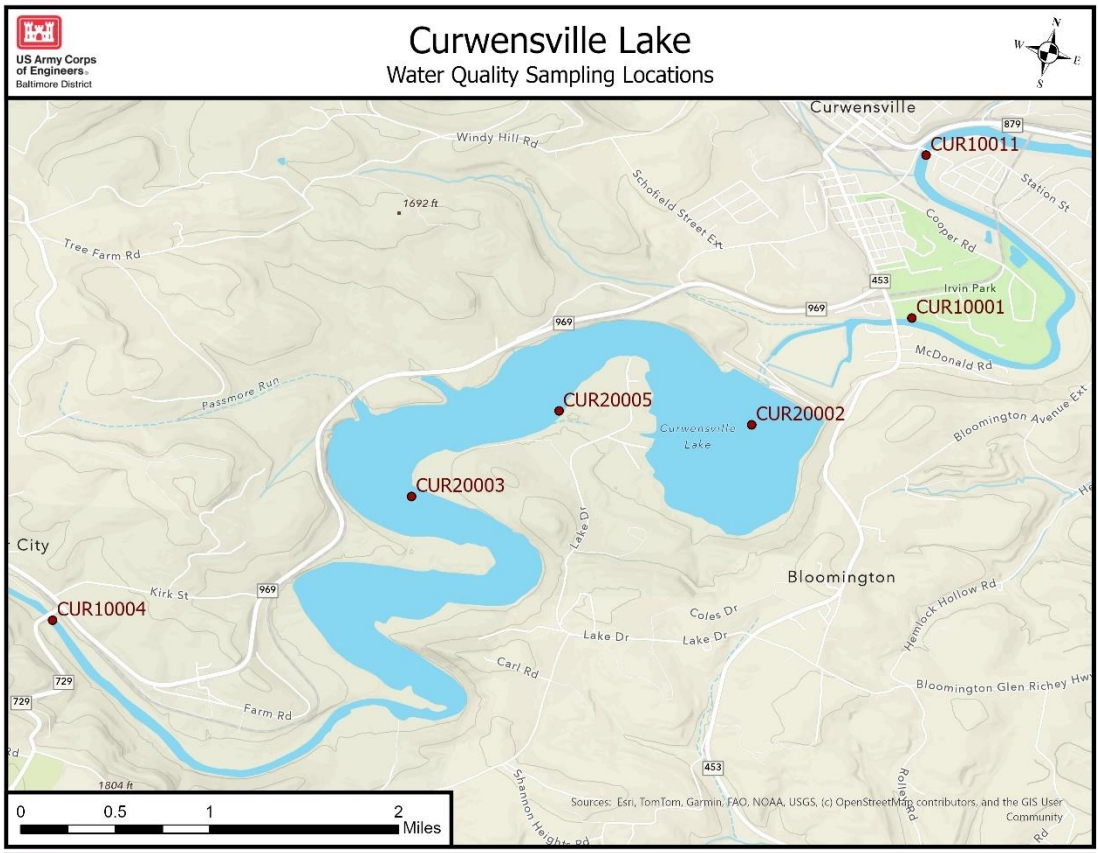


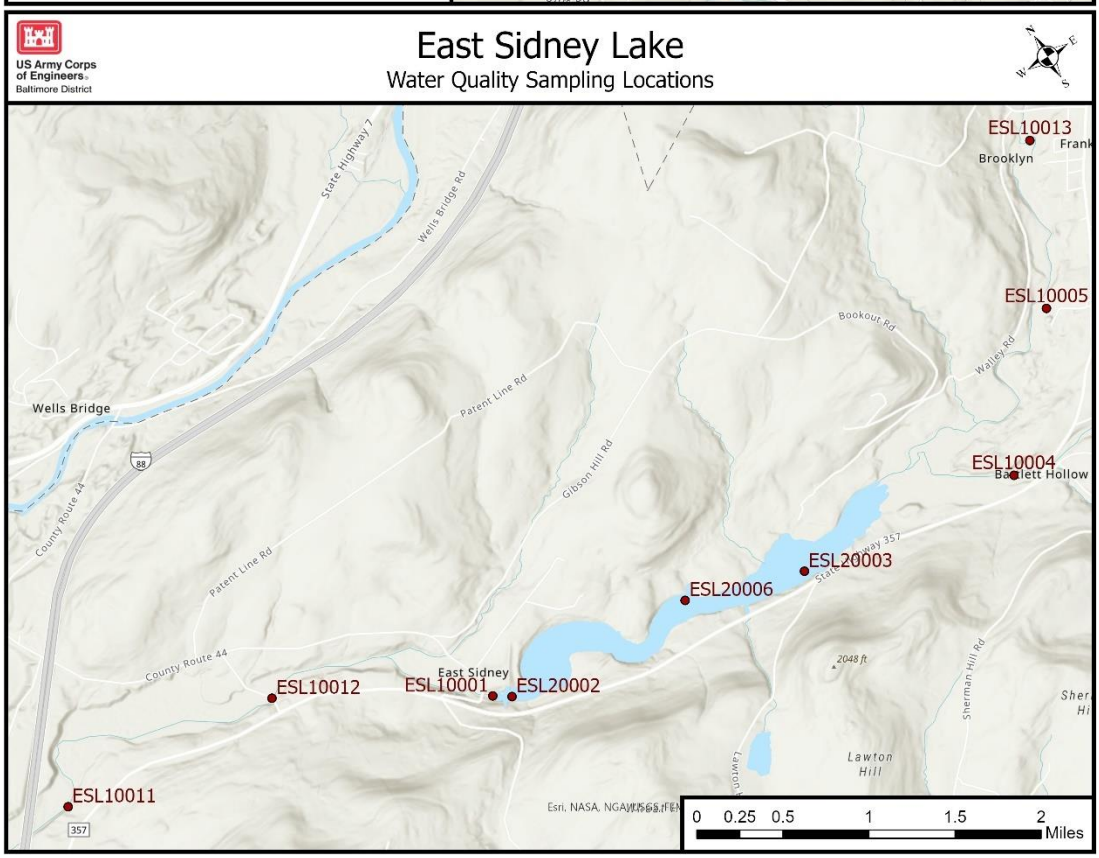

US Army Corps of Engineers
Baltimore District
Aylesworth Creek Lake
Water Quality Sampling Locations
1217 ft
1147 ft
1097 ft
Aylesworth Creek
Hudson St
AYL20002
AYL10003
AYL10004
AYL10005
6
0 0.06 0.13 0.25 Miles
Esri Community Maps Contributors, data.pa.gov, © OpenStreetMap, Microsoft, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, USFWS, Sources: Esri, Maxar, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap, and the GIS user community

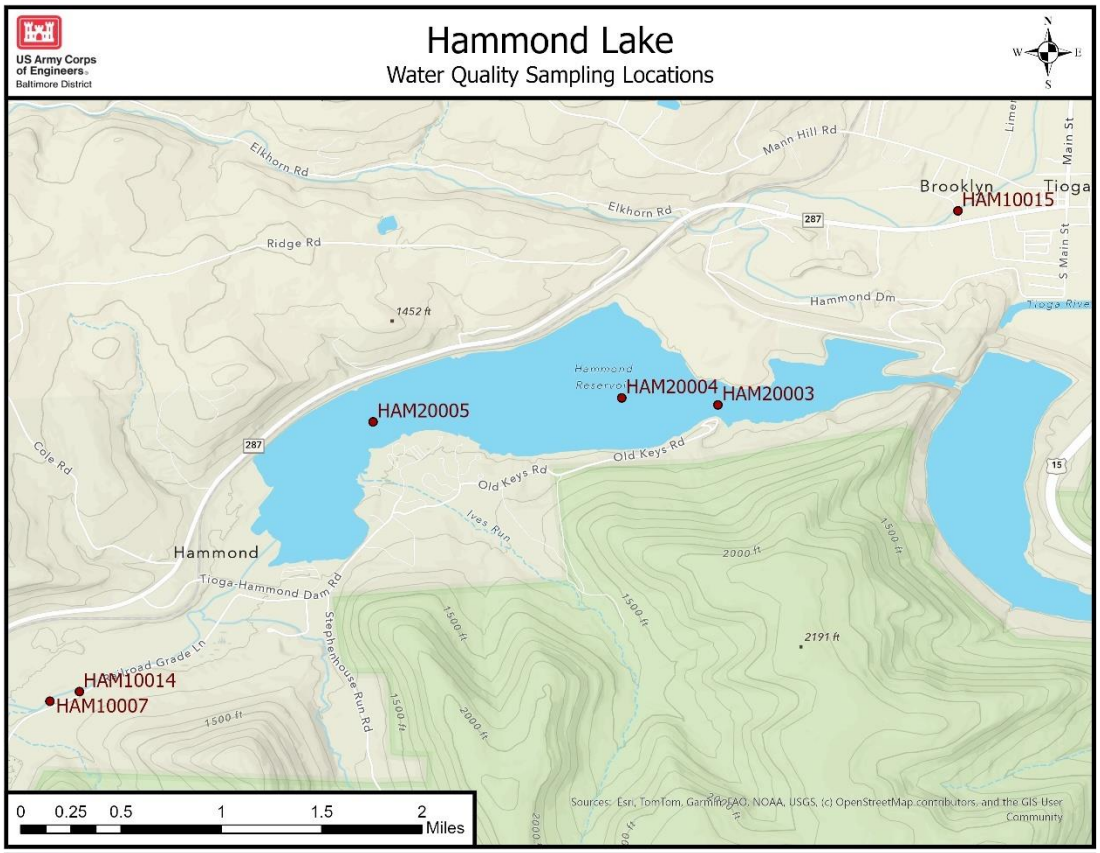

US Army Corps of Engineers
Baltimore District
Alvin R. Bush Dam
Water Quality Sampling Locations
BUL10014
Heyner Run
1734 ft
2201 ft
1500 ft
2000 ft
1900 ft
Kettle Creek State Park Pond
Spicewood Run
Middle Branch
BUL1003A
Huling Branch
2182 ft
BUL10010
Beaverdam Run
Kettle Creek State Park
Bearfield Run
BUL20005
BUL20002
BUL10001
Kettle Creek
Short Bond Run
0 0.5 1 2 3 Miles

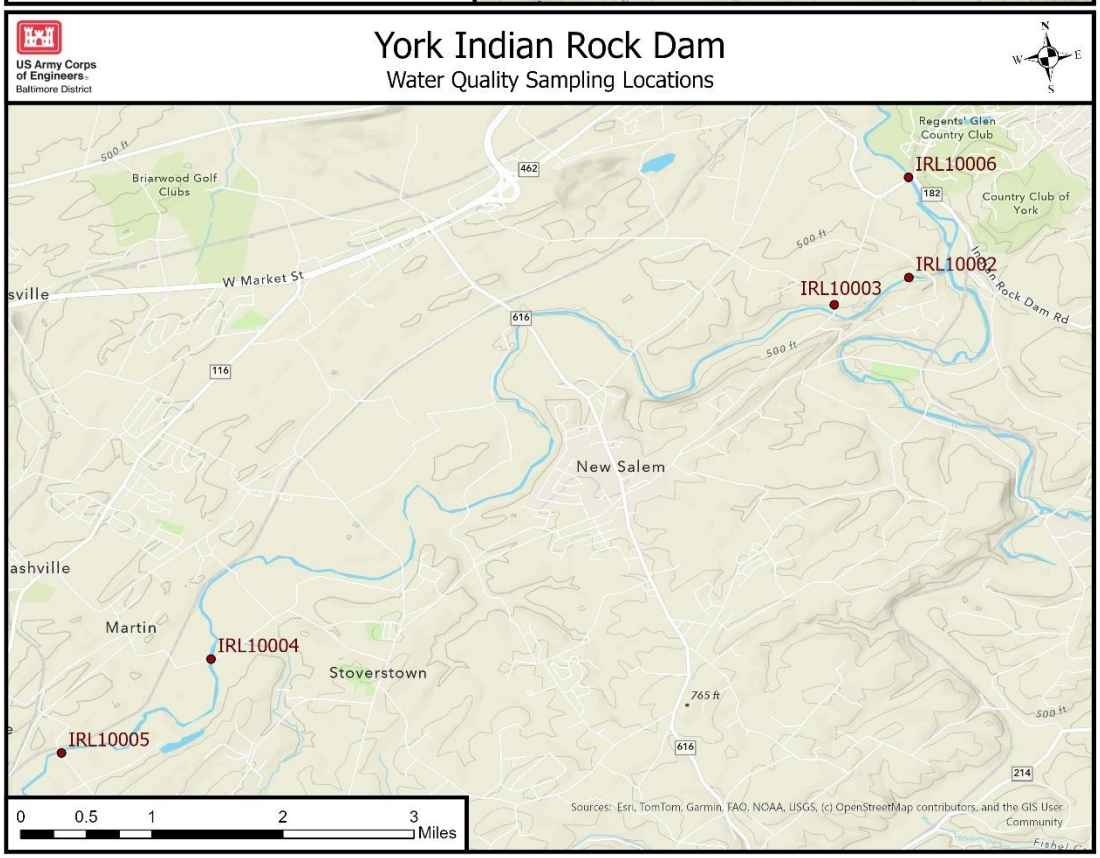

US Army Corps of Engineers
Baltimore District
Cowanesque Lake
Water Quality Sampling Locations
COW10018
COW10001
COW20002
COW20004
COW20006
COW20009
COW10010
Nelson
Watson Creek
Cowanesque
Gee Hollow
1750 ft
1500 ft
49
0 0.5 1 2
Miles


US Army Corps of Engineers
Baltimore District
Cowanesque Lake
Zebra Mussel Water Quality Sampling Locations
COW10001
COW2002B
COW2002A
COW20002
COW2004A
COW2005A
COW2007A
COW20009
COW10010
Nelson
Cowanesque Lake
Gee Hollow
1851 ft
1500 ft
49
0 0.5 1 2
Miles


US Army Corps of Engineers
Baltimore District
Curwensville Lake
Water Quality Sampling Locations
Curwensville
CUR10011
CUR10001
CUR20005
CUR20002
CUR20003
CUR10004
Windy Hill Rd
Schofield Street Ext
Tree Farm Rd
Cooper Rd
Irvin Park
McDonald Rd
Passmore Run
Bloomington Avenue Ext
Curwensville Lake
Lake Dr
City
Kirk St
Bloomington
Hemlock Hollow Rd
Coles Dr
Carl Rd
Bloomington Glen Richey Hwy
Farm Rd
Shannon Heights Rd
Rolling Rd
0 0.5 1 2 Miles
Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community


US Army Corps of Engineers
Baltimore District
East Sidney Lake
Water Quality Sampling Locations
ESL10013
Brooklyn
ESL10005
Bookout Rd
Wells Bridge
Parent Line Rd
Gibson Hill Rd
ESL10004
Bartlett Hollow
ESL20003
ESL20006
County Route 44
East Sidney
ESL10012
ESL10001
ESL20002
Sherman Hill Rd
Lawton Hill
ESL10011
0 0.25 0.5 1 1.5 2 Miles


US Army Corps of Engineers
Baltimore District
Hammond Lake
Water Quality Sampling Locations
N
W
E
S
Elkhorn Rd
Main Hill Rd
Brooklyn
Tioga
HAM10015
Ridge Rd
287
S Main St
Hammond Dm
1452 ft
Hammond Reservoir
HAM20004
HAM20003
HAM20005
Old Keys Rd
Cole Rd
Ives Run
15
Hammond
Tioga-Hammond Dam Rd
2000 ft
1500 ft
Stephenhouse Run Rd
2191 ft
HAM10014
HAM10007
0 0.25 0.5 1 1.5 2 Miles
Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community


US Army Corps of Engineers
Baltimore District
York Indian Rock Dam
Water Quality Sampling Locations
N
W
E
S
Regents' Glen Country Club
IRL10006
Briarwood Golf Clubs
462
182
Country Club of York
500 ft
W Market St
IRL10002
IRL10003
Indian Rock Dam Rd
616
116
New Salem
Martin
IRL10004
Stoverstown
765 ft
IRL10005
214
0 0.5 1 2 3 Miles
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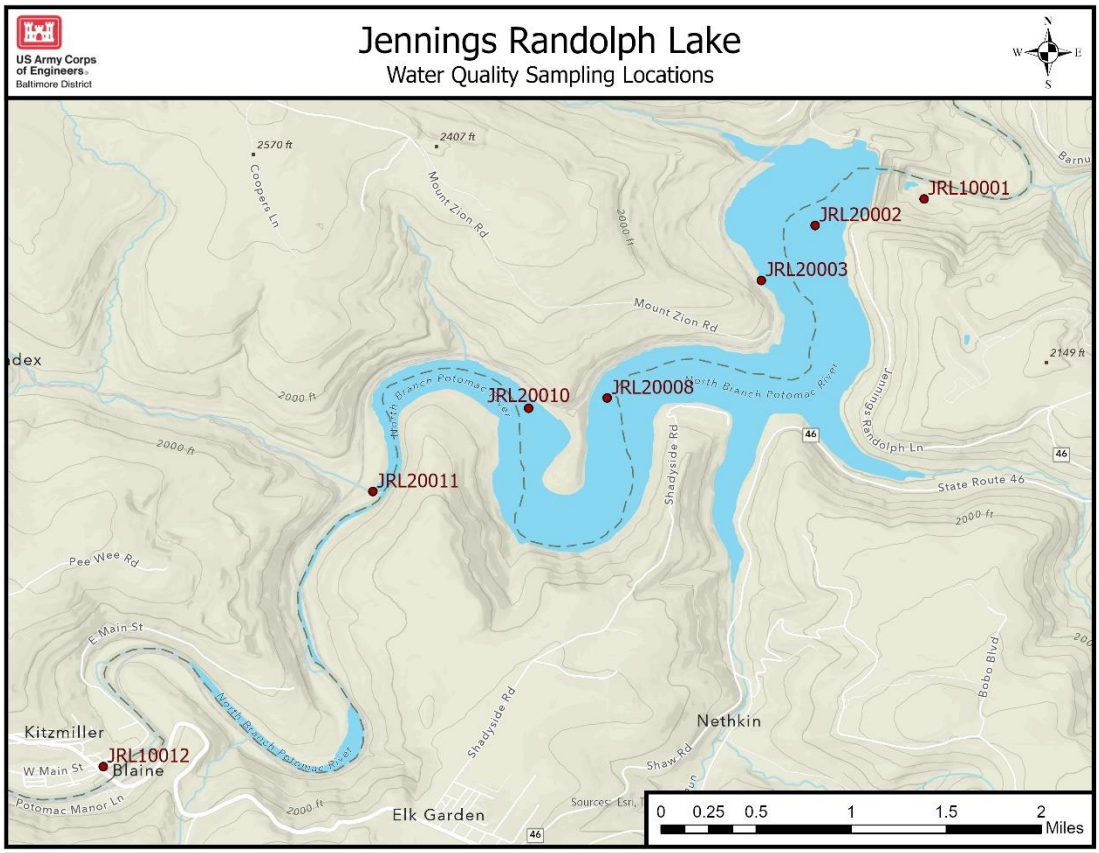
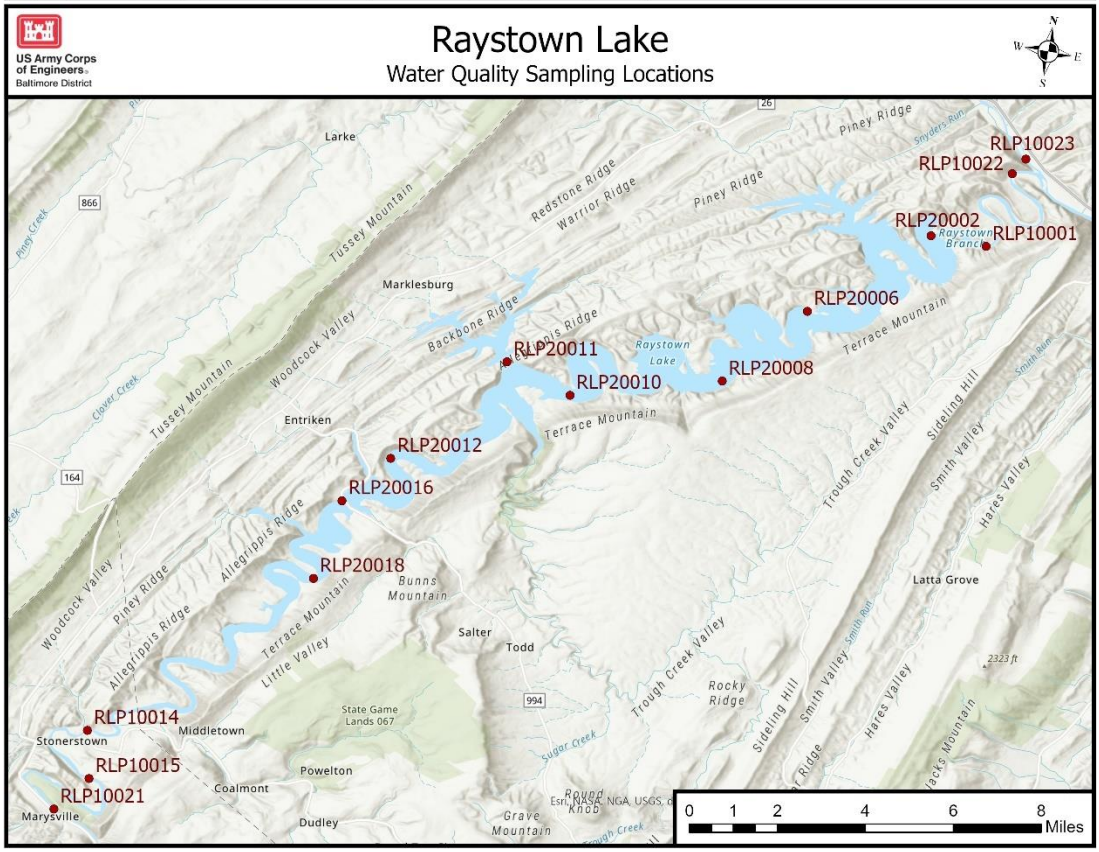

US Army Corps of Engineers
Baltimore District
Jennings Randolph Lake
Water Quality Sampling Locations
JRL10001
JRL20002
JRL20003
JRL20010
JRL20008
JRL20011
JRL10012
Kitzmiller
Blaine
Nethkin
Elk Garden
Mount Zion Rd
Shadyside Rd
State Route 46
Pee Wee Rd
E Main St
W Main St
Potomac Manor Ln
Bobo Blvd
Shaw Rd
Randolph Ln
North Branch Potomac River
0 0.25 0.5 1 1.5 2 Miles


US Army Corps of Engineers
Baltimore District
Raystown Lake
Water Quality Sampling Locations
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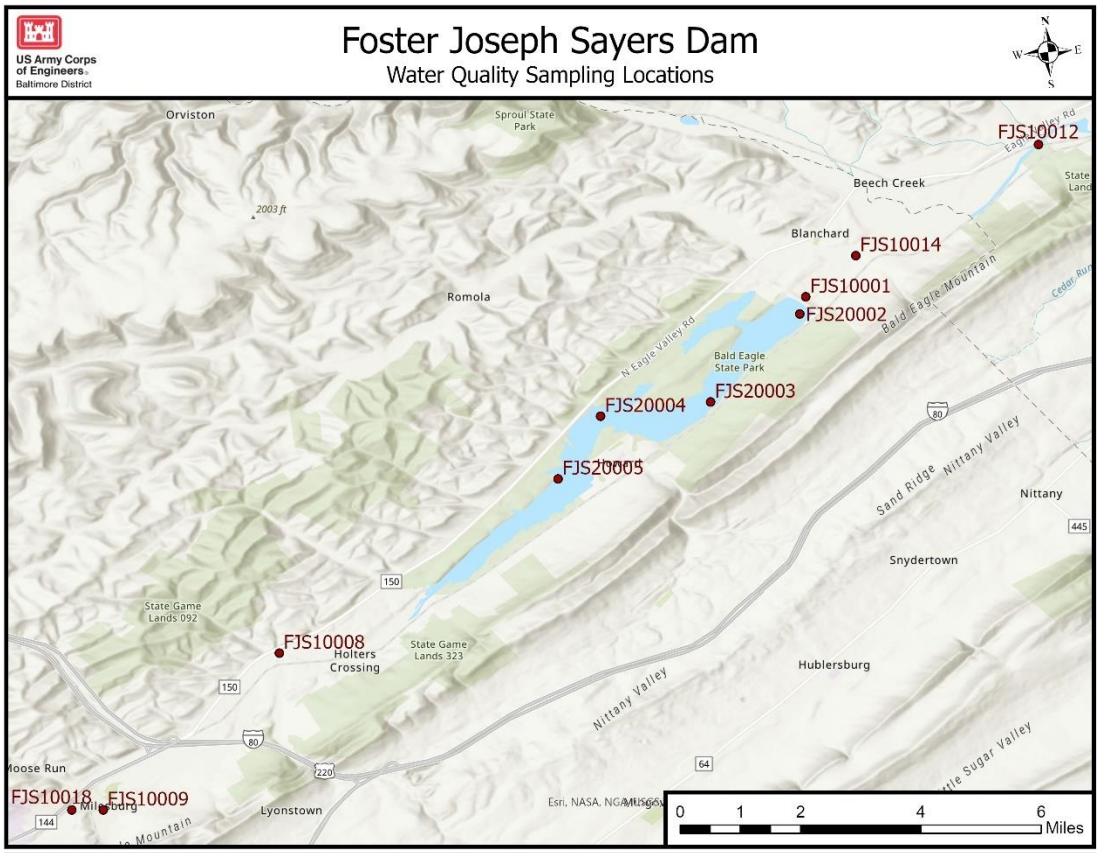
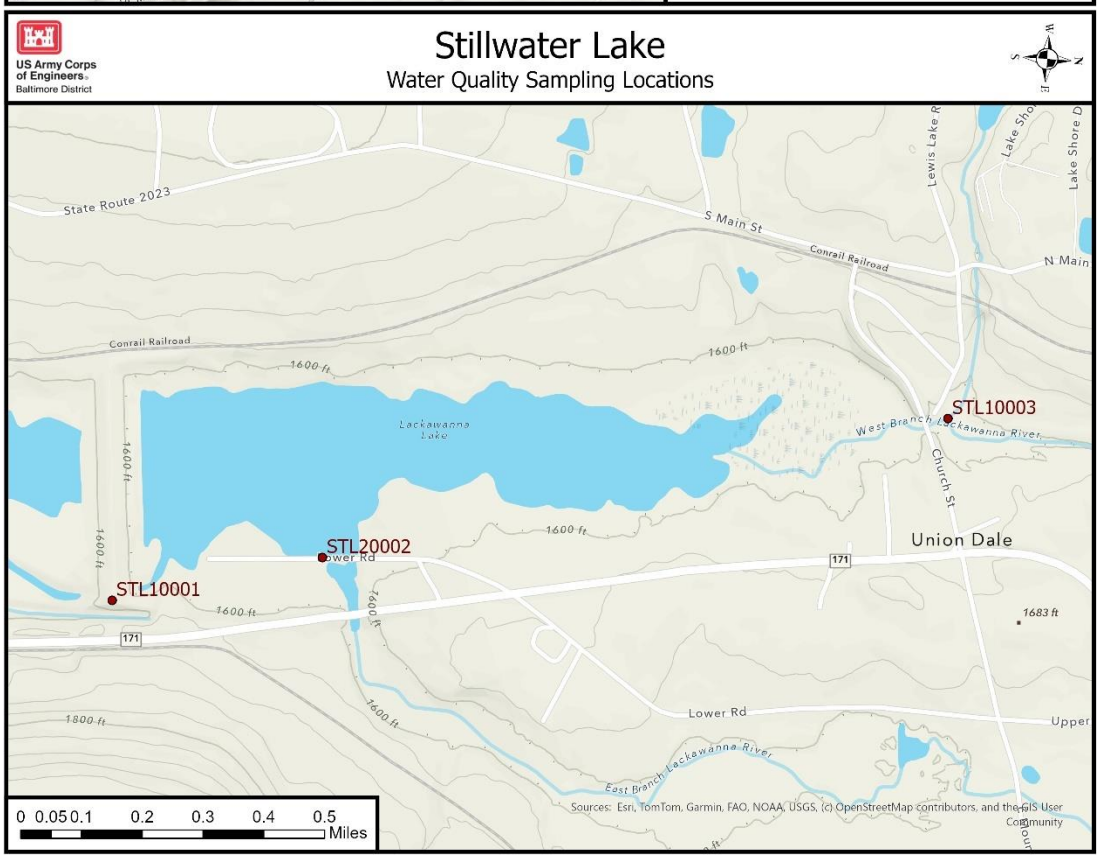
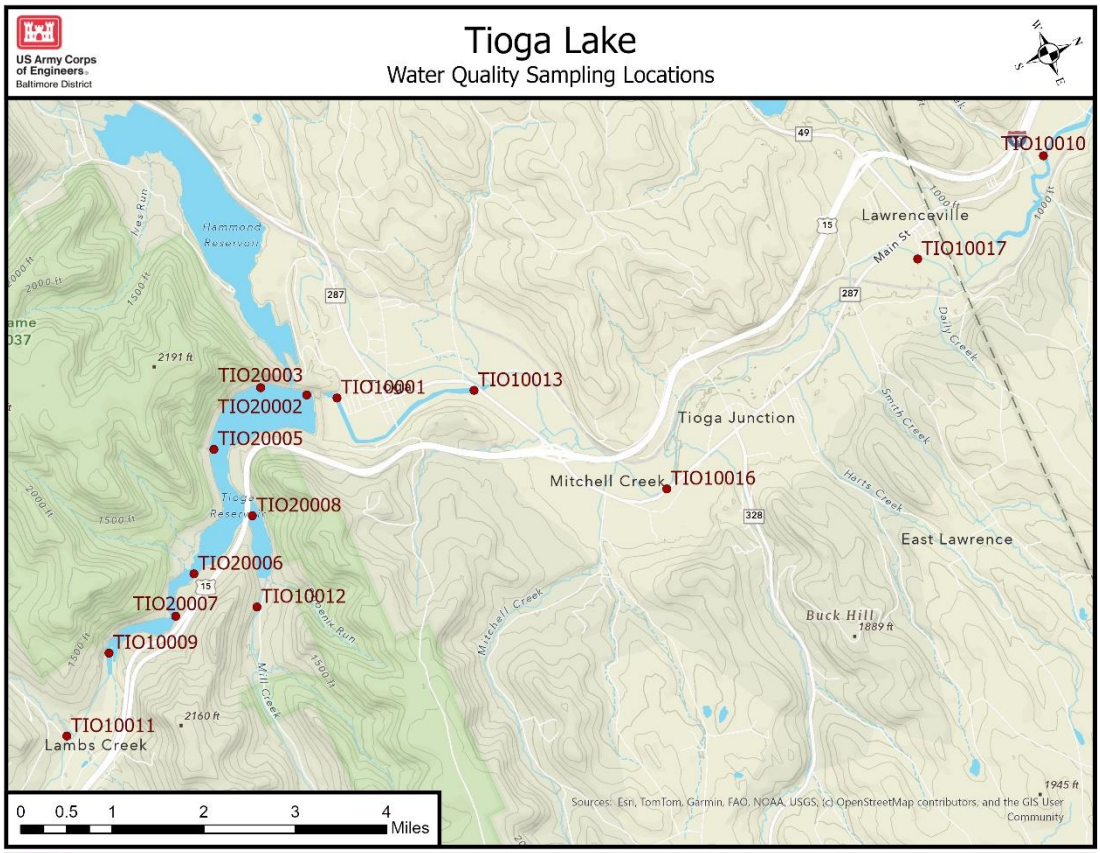
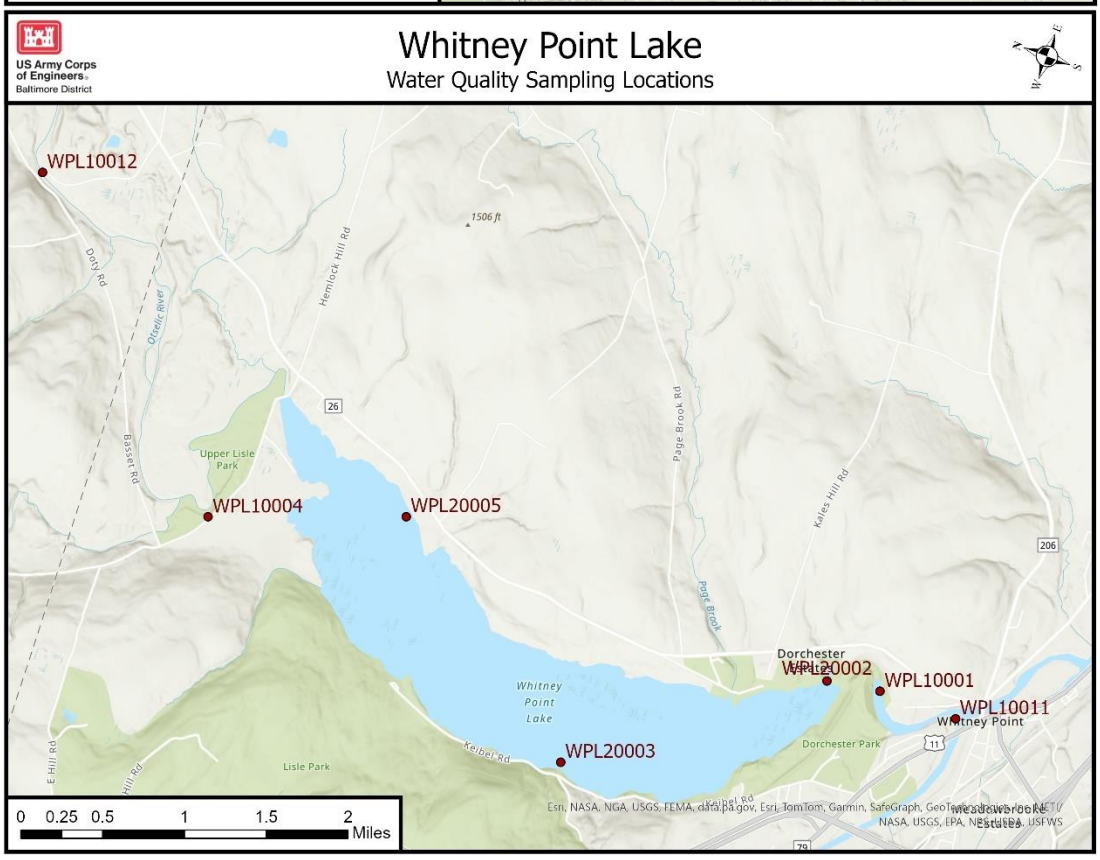
RLP10022
RLP20002
RLP10001
RLP20006
RLP20011
RLP20010
RLP20008
RLP20012
RLP20016
RLP20018
RLP10014
RLP10015
RLP10021
Larke
Marklesburg
Entriken
Salter
Todd
Latta Grove
Middletown
Stonerstown
Powelton
Coalmont
Marysville
Dudley
Tussey Mountain
Woodcock Valley
Backbone Ridge
Allegrippis Ridge
Terrace Mountain
Little Valley
Bunns Mountain
Piney Ridge
Redstone Ridge
Warrior Ridge
Trough Creek Valley
Sideling Hill
Smith Valley
Hares Valley
Rocky Ridge
Raystown Lake
Raystown Branch
State Game Lands 067
0 1 2 4 6 8 Miles


US Army Corps of Engineers
Baltimore District
Foster Joseph Sayers Dam
Water Quality Sampling Locations
N
W
E
S
Orviston
Sproul State Park
FJS10012
Beech Creek
Blanchard
FJS10014
FJS10001
FJS20002
Romola
Bald Eagle Mountain
Bald Eagle State Park
N Eagle Valley Rd
FJS20004
FJS20003
FJS20005
Sand Ridge
Nittany Valley
Nittany
Snydertown
State Game Lands 092
FJS10008
Holters Crossing
State Game Lands 323
Hublersburg
Nittany Valley
Moose Run
FJS10018
FJS10009
Lyonstown
Esri, NASA, NGA, USGS
0 1 2 4 6
Miles


US Army Corps of Engineers
Baltimore District
Stillwater Lake
Water Quality Sampling Locations
State Route 2023
S Main St
Conrail Railroad
N Main
Lewis Lake Rd
Lake Shore Dr
Conrail Railroad
1600 ft
Lackawanna Lake
STL10003
West Branch Lackawanna River
Church St
STL20002
Lower Rd
Union Dale
STL10001
171
1683 ft
1800 ft
Lower Rd
Upper
East Branch Lackawanna River
0 0.05 0.1 0.2 0.3 0.4 0.5
Miles
Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community


US Army Corps of Engineers
Baltimore District
Tioga Lake
Water Quality Sampling Locations
TIO10010
Lawrenceville
TIO10017
Main St
TIO20003
TIO20002
TIO20005
TIO10001
TIO10013
Tioga Junction
Mitchell Creek
TIO10016
TIO20008
East Lawrence
TIO20006
TIO20007
TIO10012
TIO10009
Buck Hill
1889 ft
TIO10011
Lambs Creek
2160 ft
2191 ft
1945 ft
Hammond Reservoir
Ives Run
Daily Creek
Smith Creek
Harts Creek
Mill Creek
0 0.5 1 2 3 4 Miles
Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community


US Army Corps of Engineers
Baltimore District
Whitney Point Lake
Water Quality Sampling Locations
WPL10012
WPL10004
WPL20005
WPL20002
WPL10001
WPL10011
Whitney Point
WPL20003
Dorchester
Dorchester Park
Upper Lisle Park
Lisle Park
Whitney Point Lake
Hemlock Hill Rd
Page Brook Rd
Kattes Hill Rd
Keibel Rd
Bassett Rd
E Hill Rd
Hill Rd
Otselic River
1506 ft
0 0.25 0.5 1 1.5 2 Miles
Esri, NASA, NGA, USGS, FEMA, data.pa.gov, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, USFWS

Appendix D: Parameter Justifications

Acidity, Total: Total acidity measures the water's capacity to neutralize bases and indicates the extent of acidification, often from AMD. Elevated acidity can be harmful to aquatic life. Monitoring this parameter helps to identify impacted waters and guide remediation strategies.

Alkalinity, Total and Phenolphthalein: This reflects a waterbody's ability to neutralize acids and buffer pH changes. Low alkalinity increases vulnerability to acidification, which can negatively affect aquatic communities and reservoir operations. Measuring this provides insight to water stability and informs protection efforts for sensitive ecosystems.

Benthic Macroinvertebrates: These are an excellent indicator of long-term water quality and habitat conditions. Because some species are sensitive to pollutants and environmental changes, monitoring populations provides a biological assessment of stream health and helps to identify areas needing restoration.

Calcium, Total: This is important for evaluating conditions that influence both ecological health and the potential for invasive species. Calcium is identified as a Tier 1 parameter in NAB's Early Detection and Rapid Response Protocol for Zebra Mussels, as it is a key factor in their survival and reproduction. Regular monitoring supports informed invasive species management strategies and helps prioritize monitoring efforts in areas where conditions are favorable for zebra mussel establishment.

Chlorophyll a: This is a pigment in algae, and its concentration reflects the amount of algal biomass. High quantities often indicate nutrient pollution and potential for harmful algal blooms. Monitoring this parameter helps assess eutrophication and guide nutrient management to protect aquatic life and water quality. This parameter is used, in conjunction with Secchi Depth and Total Phosphorus, to calculate Carlson's Trophic State Index at USACE reservoirs.

Dissolved Oxygen: DO is essential for fish and aquatic organisms to survive. Low DO concentrations, often caused by excess nutrients or organic pollution, can lead to hypoxia and fish kills. High DO concentrations, often caused by dam releases, can lead to supersaturation and fish kills. Tracking DO helps to identify ecosystem stress and supports efforts to reduce impacts downstream of our dams.

pH: Monitoring pH is essential for maintained a balanced aquatic environment. Extreme pH levels can harm fish and disrupt chemical processes in the water. Changes in pH can result from acid rain, mining, or industrial runoff, making consistent monitoring a key to identifying threats to river health and water usability.

Secchi Depth: This is a simple but effective way to measure water clarity, which reflects sediment levels and algal abundance. Poor clarity reduces sunlight penetration, harming submerged aquatic vegetation. Readings help to track sediment pollution and algal blooms that impact habitat and recreation. This parameter is used, in conjunction with Chlorophyll a and Total Phosphorus, to calculate Carlson's Trophic State Index at USACE reservoirs.

Specific Conductance: This measures the water's ability to conduct electricity, indicating the presence of dissolved salts and ions. It helps detect pollution from sources like road salts, sewage,

and industrial discharge. Monitoring helps to track changes in salinity and water quality that could affect aquatic life and drinking water supplies.

Water Temperature: Monitoring water temperature is crucial because it directly affects aquatic life and influences species distribution, reproduction, and metabolic rates. Rising temperatures from climate change or thermal pollution can stress cold-water species like trout and amplify harmful algal blooms.

Zebra Mussels: These are an invasive species that can outcompete native mussels, clog infrastructure, and alter ecosystems. Monitoring their spread helps resource managers detect new infestations early and plan for mitigation to protect biodiversity and USACE infrastructure.

Appendix E: 2026 Sampling Plan and Cost Analysis Estimates

CENAB-ENC-W Water Quality Sampling Schedule - 2026								
Reservoir	WQ Operational Change Capabilities	Total Physical Stations	Trips	Water Chemistry Samples			Benthic Macroinvertebrate Samples	
				TW & Inflow	Res.	QA & QC	TW & Inflow	Res.
Almond	No	3	1F	2	2	1	-	-
			2F	2	2			
			3F	2	2			
Aylesworth	No	4	1F	3	1	1	-	-
			2F	3	1			
			3F	3	1			
Bush	Yes	4	1F	2	3	1	-	-
			2F	2	3			
			3F	2	3			
Cowanesque	Yes	6	1F	2	8	1	-	-
			2F	2	8			
			3F	2	8			
Curwensville	No	5	1F	2	6	1	-	-
			2F	2	6			
			3F	2	6			
East Sidney	No	6	1F	3	6	1	4	0
			2F	3	6			
			3F	3	6			
Hammond	No	4	1F	1	6	1	-	-
			2F	1	6			
			3F	1	6			
Indian Rock	No	5	1F	5	0	1	-	-
			2F	5	0			
			3F	5	0			
Randolph	Yes	7	1F	2	11	1	-	-
			2F	2	11			
			3F	2	11			
Raystown	Yes	10	1F	2	18	1	-	-
			2F	2	18			
			3F	2	18			
Sayers	Yes	6	1F	2	9	1	-	-
			2F	2	9			
			3F	2	9			
Stillwater	No	3	1F	2	1	1	-	-
			2F	2	1			
			3F	2	1			
Tioga	Yes	8	1F	2	15	1	-	-
			2F	2	15			
			3F	2	15			
Whitney Point	No	5	1F	2	6	1	2	0
			2F	2	6			
			3F	2	6			
Total	-	76	-	96	276	14	6	0

CENAB-ENC-W Water Quality Biological Sample Analysis Cost Estimate - 2026			
Project	**# of Benthic Samples**	**BSA Benthic Sample Analysis Cost**	**Total ERDC EL Benthic Sample Analysis Cost**
Almond	2	$1,264	$2,503
Aylesworth	0	$0	$0
Bush	0	$0	$0
Cowanesque	2	$1,264	$2,503
Curwensville	0	$0	$0
East Sidney	4	$2,528	$5,005
Sayers	0	$0	$0
Indian Rock	0	$0	$0
Randolph	0	$0	$0
Raystown	0	$0	$0
Stillwater	0	$0	$0
Tioga-Hammond	8	$5,056	$10,011
Whitney Point	2	$1,264	$2,503
Total Biological Sample Cost	18	$11,376	$24,024

***ERDC is likely to have a $1,500 flat rate fee, which is included in the ERDC Total Biological Sampling cost.

CENAB-ENC-W Water Quality Chemical Sample Analysis Cost Estimate - FY26			
Supplies	*Quantity*	*Cost/Unit*	*Total Cost*
Ethanol	2	$189.95	$379.90
Phenolphthalein	2	$21.85	$43.70
Bromcresol Green/Red	1	$30.35	$30.35
Sodium Hydroxide	1	$42.75	$42.75
Sulfuric Acid	2	$34.95	$69.90
pH	2	$39.55	$79.10
Baking Soda	1	$12.37	$12.37
Nitric Acid	2	$88.75	$177.50
Calcium Reagent Set	1	$83.19	$83.19
Total	14	$543.71	$918.76