

**Quality Assurance Program Plan:
Surface Water Monitoring & Assessment (2025-2029)**



Commonwealth of Massachusetts
Executive Office of Energy and Environmental Affairs
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Quality Assurance Program Plan: Surface Water Monitoring & Assessment (2025-2029)

Prepared by:
Watershed Planning Program
Division of Watershed Management, Bureau of Water Resources
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Cover Photo

A tributary to Depot Brook, Washington, MA. Photo courtesy of Dan Davis (MassDEP)

Notice of Availability

[This report is available on the Massachusetts Department of Environmental Protection website.](#)

[Watershed Planning Program](#)

The mission of the Watershed Planning Program (WPP) in the Massachusetts Department of Environmental Protection is to protect, enhance, and restore the quality and value of the waters of the Commonwealth. Guided by the federal Clean Water Act, WPP implements this mission statewide through five Sections that each have a different technical focus: (1) Surface Water Quality Standards; (2) Surface Water Quality Monitoring; (3) Data Management and Water Quality Assessment; (4) Total Maximum Daily Load; and (5) Nonpoint Source Management. Together with other MassDEP programs and state environmental agencies, WPP shares in the duty and responsibility to secure the environmental, recreational, and public health benefits of clean water for all people of the Commonwealth.

[Acknowledgements](#)

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Surface Water Monitoring & Assessment (2025-2029)**

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FOREWORD

This Quality Assurance Program Plan (QAPP) pertains to surface water data collection by the Watershed Planning Program (WPP) in the Division of Watershed Management, Bureau of Water Resources, Massachusetts Department of Environmental Protection (MassDEP). It addresses all chemical, physical and biological monitoring to be performed by WPP from 2025 through 2029 (with annual addendum updates). Appendices as part of this QAPP include stand-alone laboratory QA Plans, field and laboratory Standard Operating Procedures (SOPs), project-level QAPPs, Sampling and Analysis Plans (SAPs), and other supporting documentation. These are included as accompanying compressed files.

For additional information that is not contained in this QAPP, see other applicable and current MassDEP policies, procedures, and plans.

WPP's programmatic QAPP is generally consistent with the intent of [EPA's Quality Policies](#) and [EPA-Region 1 Quality Policies](#).

EPA guidance and requirement documents used to guide development of this QAPP include:

- EPA Guidance on Systematic Planning using the Data Quality Objectives Process (QA/G-4; EPA/240/B-06/001, February 2006)
- EPA Region 1 Quality Assurance Project Plan Program Guidance (R1/LSASD/QAB Revision 1 May 2024)
- EPA Guidance on Choosing a Sampling Design for Environmental Data Collection (QA/G-5S, EPA/240/R-02/005; December 2002)
- EPA Guidance on Quality Assurance Project Plans for Modeling (QA/G-5M, EPA/240/R-02/007; December 2002)
- EPA Guidance for Standard Operating Procedures (QA/G-6, EPA/600/B-07/001; April 2007)
- EPA Guidance on Environmental Data Verification and Data Validation (QA/G-8, EPA/240/R-02/004; November 2002 and reissued January 2008)
- EPA QAPP Guidance for Projects Using Only Existing (Secondary) Data, Rev. #2, 10/13/09, EPA-Region 1
- Quality Assurance Project Plans CIO 2105-S-02.1 the Quality Assurance Project Plan Standard, issued April 3, 2024

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Italics used in tables refer to parameters not currently in use but can be on an as needed basis.

List of Acronyms:

ACOE	US Army Corps of Engineers
AED	Automated Electronic Defibrillation
ALU	Aquatic Life Use
ANSI	American National Standards Institute
AVS	Acid Volatile Sulfide
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
BPJ	Best Professional Judgment
BST	Bacteria Source Tracking
BWR	Bureau of Water Resources
CAF	Corrective Action Form
COD	Chemical Oxygen Demand
CMR	Code of Massachusetts Regulations
CN	Control Number (documents)
CPR	Cardiopulmonary Resuscitation
CSO	Combined Sewer Overflow
CWA.....	Clean Water Act
CWF	Cold Water Fishery
DCR	Massachusetts Department of Conservation and Recreation
DMF	DFG Division of Marine Fisheries
DMR	Discharge Monitoring Report (NPDES)
DO	Dissolved Oxygen
DFG.....	Massachusetts Department of Fish and Game
DFW	DFG Division of Fisheries and Wildlife
DPH.....	Massachusetts Department of Public Health
DQO	Data Quality Objective
DWM	MassDEP Division of Watershed Management
EDC.....	Endocrine Disrupting Chemicals
EEA	Executive Office of Energy and Environmental Affairs
EHSS.....	Evidence of Human Sewage Source
EPA	United States Environmental Protection Agency
EPT.....	Ephemeroptera, Plecoptera, Trichoptera
FPS.....	Feet Per Second
FWA	Fluorescent Whitening Agents
GPS.....	Global Positioning System
IBI.....	Index of Biotic Integrity
ILW.....	Integrated List of Waters
ISO	International Organization for Standardization
LFM	Laboratory Fortified Matrix
MAP2.....	Massachusetts Probabilistic Monitoring and Assessment Program
MassDEP	Massachusetts Department of Environmental Protection
MassGIS	Massachusetts Geographic Information System

MDL.....	Method Detection Limit
MOU.....	Memorandum of Understanding
MPN	Most Probable Number
MRL.....	Minimum Reporting Limit
NERL	New England Regional Laboratory (EPA)
NPDES.....	National Pollutant Discharge Elimination System
ORS.....	MassDEP Office of Research and Standards
PAH	Polycyclic Aromatic Hydrocarbon
PALIS.....	Pond and Lake Information System
PCB	Polychlorinated Biphenyl
PFAS.....	Per- and Polyfluoroalkyl Substances
PFD	Personal Flotation Device
PPCP.....	Pharmaceuticals and Personal Care Products
QAP	Quality Assurance Plan (laboratory)
QAPP.....	Quality Assurance Project Plan (or program plan)
QA/QC.....	Quality Assurance/ Quality Control
QMP	Quality Management Plan
RBP	Rapid Bioassessment Protocol
SARIS	Stream and River Inventory System
SEM.....	Simultaneously Extracted Metals
SWQS.....	Surface Water Quality Standards
TALUs.....	Tiered Aquatic Life Uses
TMDL.....	Total Maximum Daily Load
TNTC	Too Numerous to Count
TOXTD	MassDEP Toxicity Testing Database
TSS.....	Total Suspended Solids
USGS.....	United States Geological Survey
WAAS	Wide Area Augmentation System
WBS	Waterbody System Database
WES	MassDEP Wall Experiment Station
WPP	MassDEP Watershed Planning Program
WWF	Warm Water Fishery
WWTP	Wastewater Treatment Plant

List of Units:

- cfs cubic feet per second
- cfu colony forming unit
- mg/Kg milligram per kilogram
- mg/L milligram per liter
- mg/m³ milligram per cubic meter
- mi² square mile
- mL milliliter
- µg/kg microgram per kilogram
- µg/L microgram per liter
- µS/cm microsiemens per centimeter
- ng nanogram
- ppb parts per billion
- ppm parts per million
- SU standard units

SECTION A: PROJECT MANAGEMENT

A3. DISTRIBUTION LIST

The following groups have been made aware of this QAPP:

- MassDEP management and WPP staff
- MassDEP QA Managers (BWR)
- MassDEP Wall Experiment Station (relevant staff)
- EPA-Region 1 (relevant staff)

The WPP Quality Assurance Analyst will be responsible for the maintenance and distribution of this QAPP. The updates will be provided by uploads to the MassDEP website, EPA SharePoint, and emails to the distribution list. Electronic copies of this QAPP have been placed on the WPP SharePoint and the MassDEP website: [WPP QAPP for Surface Water Monitoring & Assessment \(2025-2029\)](#).

A4. PROGRAM DESCRIPTION & ORGANIZATION

This QAPP covers ambient surface water monitoring conducted by the Watershed Planning Program (WPP) in the Division of Watershed Management, Bureau of Water Resources MassDEP. A “quality system” approach forms the basis for WPP’s generation of usable data of documented quality. This approach is detailed in the EPA-approved MassDEP Quality Management Plan (QMP) for Federally Funded Programs (MassDEP 2025). The MassDEP QMP is consistent with EPA’s Quality Policy and related guidance. The QAPP process is one part of a programmatic focus on data quality. As set forth in the departmental QMP, program-level and project-specific QAPPs, SOPs, and other plans and policies, WPP strives to set and maintain a high standard for all its work.

WPP is responsible for multiple technical focus areas that are core MassDEP requirements under the Clean Water Act (CWA), as listed below.

- Massachusetts Surface Water Quality Standards
- Surface Water Quality Monitoring
- Water Quality Assessment
- Total Maximum Daily Loads (TMDLs)
- Nonpoint Source Management

A central component in implementing these programs is water quality monitoring to determine pollutant levels and loads, biotic metrics of ecological integrity, designated use impairments and attainments, and in general, the “state of the waters.” Monitoring performed as part of these programs meets the ten basic elements of a State water resource monitoring program outlined by EPA and the prerequisites of CWA section 106(e)(1) or CWA s.106(e)(1). These ten elements are generally as follows:

1. **Monitoring Program Strategy:** A comprehensive long-term monitoring program strategy that serves Massachusetts water quality management needs and addresses all State waters, including streams, rivers, lakes, reservoirs, estuaries, coastal areas, wetlands, and groundwater.
2. **Monitoring Objectives:** Monitoring objectives that are effective in generating data that serve management decision needs.
3. **Monitoring Design:** An approach and rationale for selection of sample sites that best serve the monitoring objectives. The monitoring program ultimately will integrate several monitoring designs (e.g., fixed station, intensive and screening-level monitoring, rotating basin, etc.) to meet the full range of decision needs.
4. **Core and Supplemental Water Quality Indicators:** Core indicators are selected to represent each applicable designated use, plus supplemental indicators selected according to site-specific or project-specific decision criteria.
5. **Quality Assurance:** Quality management plans and quality assurance program/project plans are developed and implemented (maintained and peer reviewed in accordance with EPA policy) to ensure the scientific validity of monitoring and laboratory activities, and to ensure that State reporting requirements are met.
6. **Data Management:** An electronic data system is developed and utilized for water quality, fish tissue, toxicity, sediment chemistry, habitat, biological data, with timely data entry (following appropriate metadata and State/Federal geolocational standards) and public access.
7. **Data Analysis/Assessment:** The State has a methodology for assessing attainment of water quality standards based on analysis of various types of data (chemical, physical, biological, land use) from various sources, for all waterbody types and all State waters. The methodology includes criteria for compiling, analyzing, and integrating all readily available and existing information (e.g., volunteer monitoring data, discharge monitoring reports).
8. **Reporting:** The State produces timely, complete water quality reports and lists called for under federal regulatory requirements.
9. **Programmatic Evaluation:** The State, in consultation with its EPA Region, conducts periodic reviews of each aspect of its monitoring program to determine how well the program serves its water quality decision needs for all State waters, including all waterbody types.
10. **General Support and Infrastructure Planning:** Current and future resource requirements (funding, staff, training, laboratory resources) for fully implementing the monitoring program strategy.

A detailed description of the key elements of Massachusetts water quality monitoring programs and strategy can be found in CN 203.6 *Monitoring and Assessing Water Quality in Massachusetts to Support Multiple Water Resource Management Objectives under the Clean Water Act, 2025 - 2035* (MassDEP, 2025).

Figure 1 provides an overview of specific personnel involved in data collection and use at WPP. Table 1 provides more detailed descriptions of the roles and responsibilities for MassDEP staff and state/contract laboratory staff (as of December 2025).

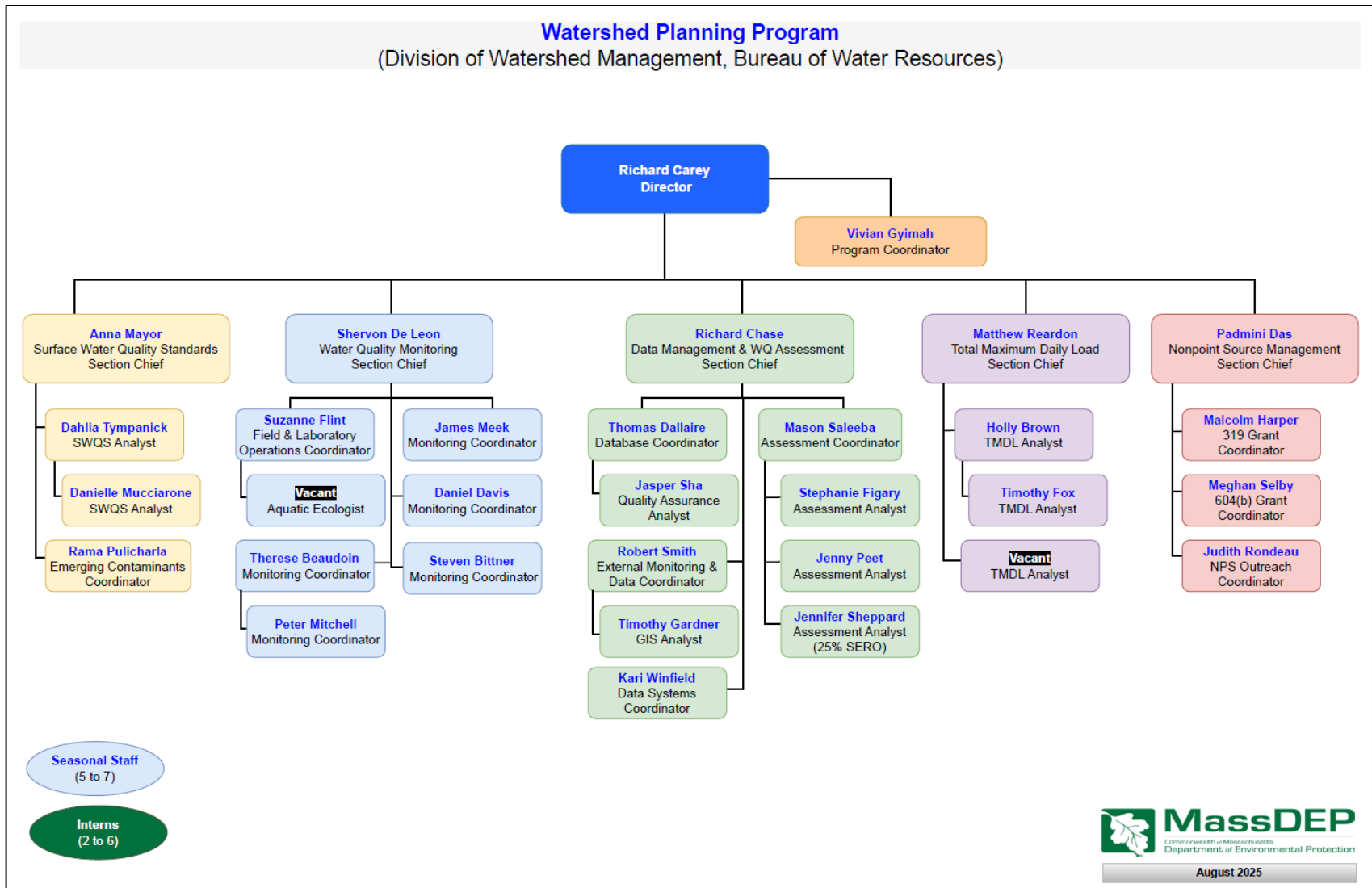


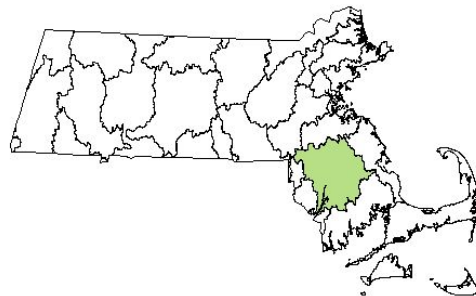
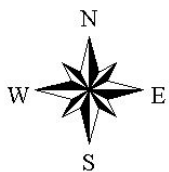
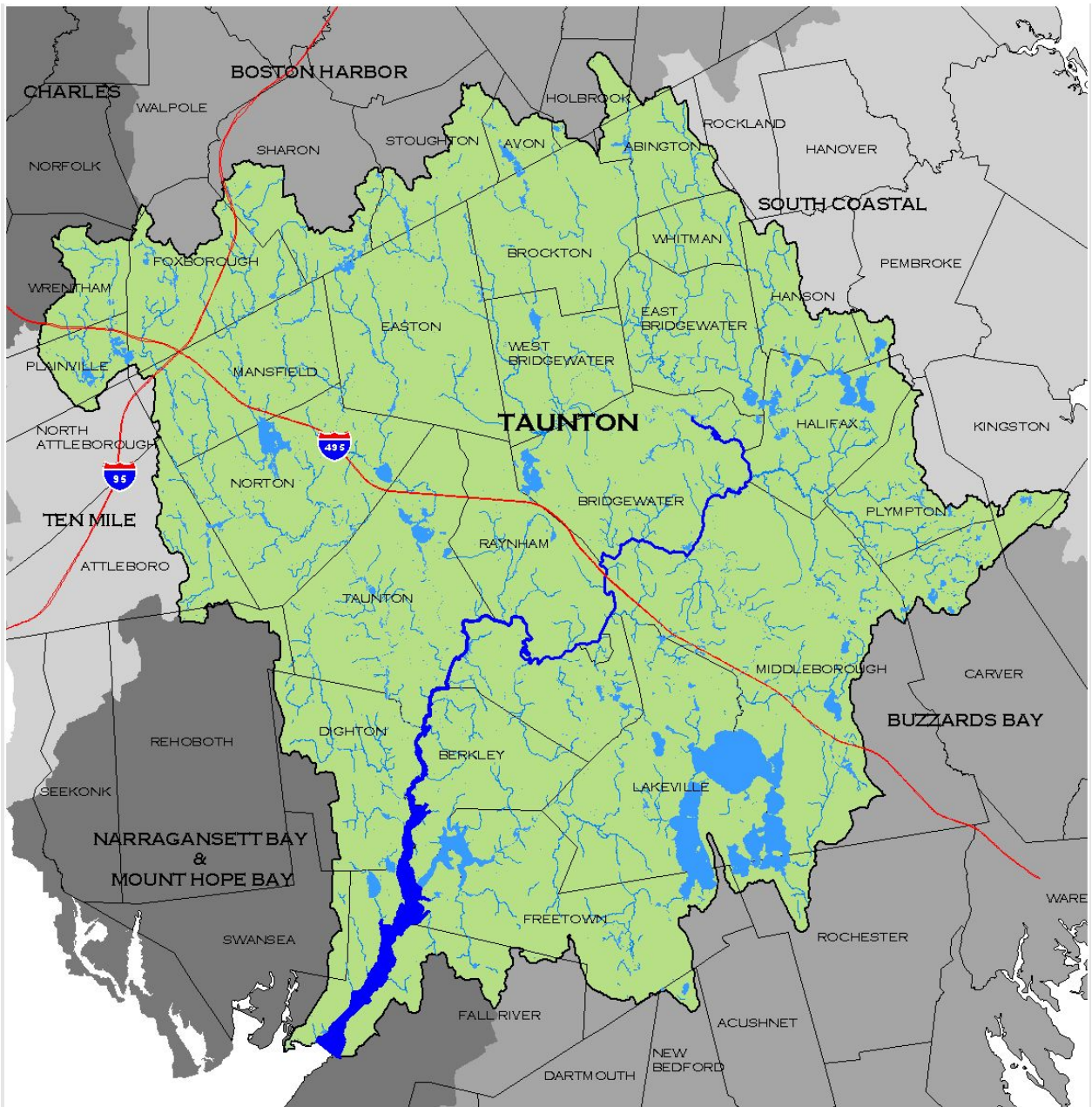
Figure 1: Organization Chart for the Watershed Planning Program in the Division of Watershed Management, Bureau of Water Resources, Massachusetts Department of Environmental Protection (August 2025).

Table 1: Program Roles and Responsibilities related to monitoring and data use

Personnel, Title and/or Primary role	Responsibilities
Richard O. Carey, Ph.D., Director, Watershed Planning Program (WPP)	Overall management of administrative and technical work by the Watershed Planning Program
Anna Mayor, Section Chief, Surface Water Quality Standards, WPP	Provides technical and administrative oversight in the development and evaluation of ambient water quality standards
Shervon De Leon, Section Chief, Surface Water Quality Monitoring, WPP	Manages the planning and coordination of all environmental monitoring by WPP, including technical oversight, staff assignments, and scheduling
Richard Chase, Section Chief, Data Management & Water Quality Assessment, WPP	Oversees CWA s.305(b) assessments and management of WPP monitoring data and associated QA/QC
Matthew Reardon, Section Chief, TMDL, WPP	Manages the development and implementation of Total Maximum Daily Loads (TMDLs).
Padmini Das, Ph.D., Section Chief, Nonpoint Source Management, WPP	Oversees nonpoint source grant programs (CWA s.319 and s.604(b)), including grant administration and project review
Jasper Sha, QA Analyst, WPP	Performs overall QA/QC for environmental monitoring and data handling at WPP, including SOP development, training, data review and validation, QAPP development, QC reporting, and coordination with labs and EPA. The QA Analyst assists with calibration and maintenance of multi-probe instruments and other instrumentation as applicable and maintains independent oversight of project operations. The QA Analyst has an independent line of communication to project managers and senior managers
Robert Smith, Ph.D., External Monitoring & Data Coordinator, WPP	Coordinates with statewide monitoring groups, compile and analyze data, and perform quality reviews of external data submittals
Suzanne Flint, Field and Lab Operations Coordinator, WPP	Oversees WPP field and laboratory operations including instrument calibration, post-field checks, maintenance, data uploads, and laboratory and field safety. Oversees analyses carried out in WPP labs and coordinates with QA Analyst

Personnel, Title and/or Primary role	Responsibilities
James Meek, Pete Mitchell, Dan Davis, Therese Beaudoin, and Steven Bittner; Monitoring Coordinators, WPP	Design SAPs, coordinate surveys, perform waterbody assessments, prepare technical memoranda, and related tasks. Includes sampling, analysis, and generation of valid chemical, physical, and biological data
Mason Saleeba, Assessment Coordinator, WPP; Jenny Peet, Jennifer Sheppard, and Stephanie Figary Ph.D., Assessment Analysts, WPP	Coordinate waterbody assessments relative to established designated uses in the Massachusetts Surface Water Quality Standards (e.g., primary and secondary contact, aesthetics, aquatic life use, and fish consumption)
Tom Dallaire, Database Coordinator, WPP; Kari Winfield, Data Systems Coordinator, WPP	Manage monitoring data, including downloading and processing of raw multi-probe data, data entry, LIMS and probe data processing, QC coordination, EQUIS and EDGE database development, data requests and public data delivery, database exports, etc.
Timothy Gardner, GIS Analyst, WPP	Performs geo-referencing for WPP monitoring stations, ArcGIS products, and assessment support
Rama Pulicharla Ph.D., Emerging Contaminants Coordinator, WPP	Supports the development of QAPPs and SAPs involving emerging contaminants and water quality standards review for these chemicals
Survey crews (WPP staff, seasonal employees)	Conduct chemical, microbiological and biological surveys to collect data under the direction of WPP Monitoring Coordinators and relevant WPP SOPs
Holly Brown, Timothy Fox; TMDL Analysts, WPP	Develop sampling plans/designs and QAPPs for TMDL-related sampling, as well as for any special TMDL surveys, training, modeling, project management, etc.
Beth McDonough, Tess Burdin, Peter Piro, Elsy Naveo, Noelle Peluso, Zohreh Shafiei, Lisa Jordan, John Bardzik, Matthew Freedman, Dritan Hoxha, Emily Blumsack, Joshua Wood, Jean Tang, Sangwon Min, and Madhuri Tummalapalli; MassDEP Division of Environmental Laboratory Sciences (DELS), Senator William X. Wall Experiment Station (WES) (Laboratory)	Responsible for overall laboratory management, quality assurance/quality control and data management (LIMS), supervision of the three major DELS-WES laboratories (i.e., Microbiology and Toxicology Laboratory, Inorganic Chemistry Laboratory, and Organic Chemistry Laboratory), and environmental sample analyses and reporting

Personnel, Title and/or Primary role	Responsibilities
Parinya Panuwet, Ph.D., Director, DELS-WES	Lab direction, management, technical oversight, quality assurance and lab data production related to the performance of water quality analyses according to established EPA/other methods and WES laboratory SOPs
Miscellaneous labs under contract	Overall lab management and technical oversight regarding the performance of water quality analyses and submittal of validated data to WPP in compliance with contractual arrangements



Taunton Watershed

NOTE for SECTION A5: See also annual sampling & analysis plans (SAPs) for additional, project-specific objectives. Stand-alone SAPs are developed each year, based on current monitoring needs.

A5 PROGRAM GOALS AND OBJECTIVES

WPP's surface water monitoring efforts support MassDEP's programmatic goals and functions to protect and restore water quality. The 10-year Monitoring Strategy for 2025-2035 (MassDEP, 2025) provides a brief history of MassDEP's monitoring programs, from the 1970's under the Massachusetts Division of Water Pollution Control to the present. The strategy examines program priorities and data needs and sets forth a plan for achieving a comprehensive water resource monitoring program that continues to embody EPA's fundamental ten elements and meets the prerequisites of CWA s.106(e)(1).

The current Monitoring Strategy describes a comprehensive monitoring program that serves multiple water resource management needs and addresses all surface waters. As such, the monitoring program is designed to provide data and information from streams, rivers, lakes, reservoirs, estuaries, coastal areas and wetlands to support the major objectives listed below.

- Develop policies, water quality standards, and identify emerging issues
- Assess the status or condition of Massachusetts' waters (CWA s.305(b))
- Develop, implement, and evaluate pollution control strategies (CWA s.303(d))
- Measure the effectiveness of water quality management programs
- Maintain reserve monitoring capacity to respond to unforeseen data needs

Major themes, inherent to both MassDEP's water management programs and associated monitoring elements, are as follows: 1) the focus on the watershed as the fundamental planning unit for water quality management; 2) the assessment of biological communities, such as aquatic macroinvertebrates, fish, or algae as reliable indicators of water quality conditions and ecosystem health; 3) the application of new technology and streamlined systems for data processing and analysis to support monitoring and assessment activities; and 4) the formation and reliance on partnerships and collaboration to meet water quality goals.

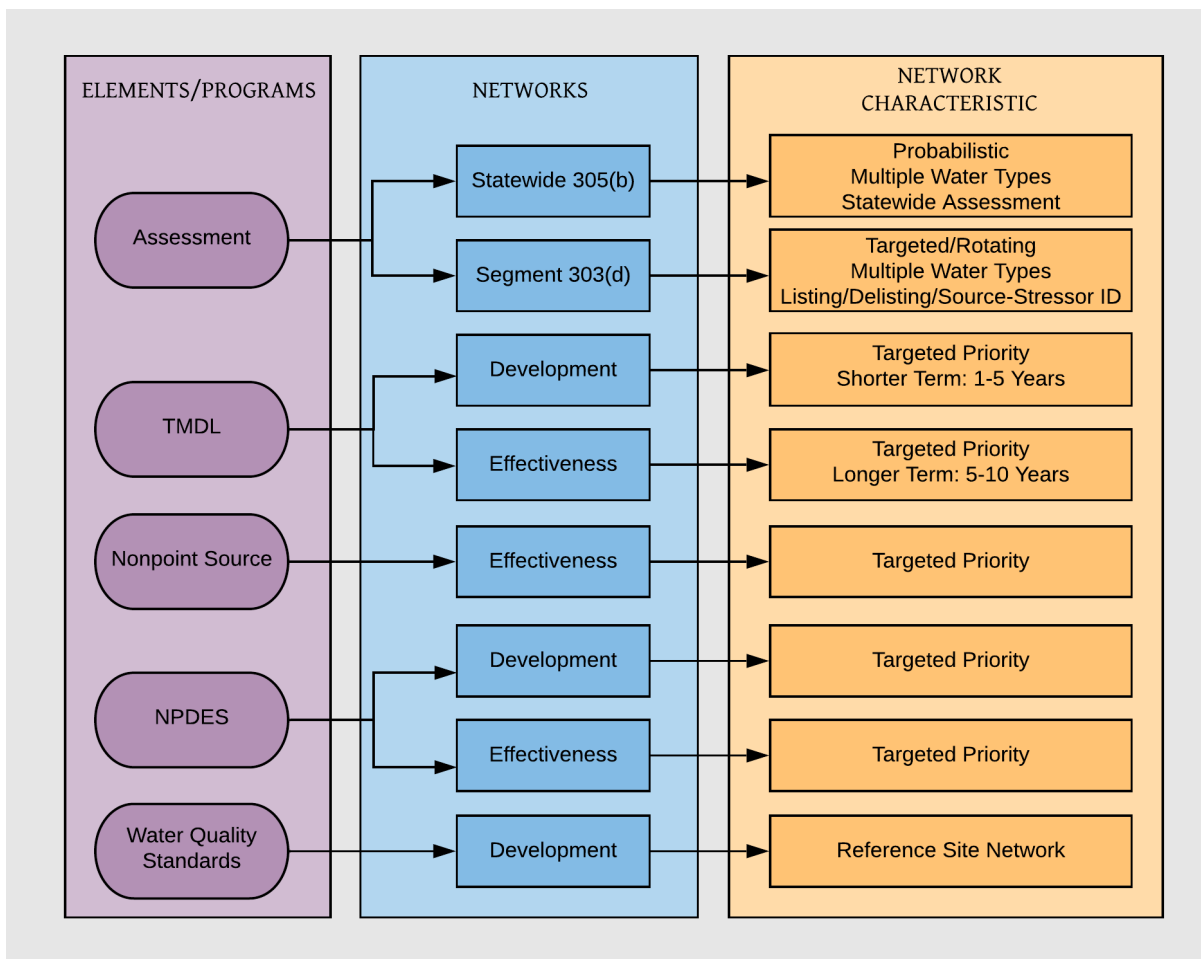


Figure 2: Monitoring Networks for Multiple Water Management Objectives

In total, eighteen monitoring program elements are included in the 2025-2035 Monitoring Strategy to meet the defined monitoring objectives. These monitoring elements include both probabilistic (random) and deterministic (targeted) sampling networks. Furthermore, these designs encompass both rotating watershed monitoring cycles as well as non-rotating, priority-driven schedules to support multiple objectives (Figure 2). (Individual elements are detailed below in Section B, Sampling Process Design.)

Probabilistic Monitoring:

EPA encourages states to adopt networks of randomly selected sampling sites that will allow for statistically unbiased assessments that can be applied at larger scales (e.g., statewide). Because statistically valid inferences can be drawn for an entire population of waterbodies by sampling a set of sites randomly selected from that population, a probabilistic design can, with a single sample at each site, provide a snapshot of the percentage of waters attaining water quality standards and supporting designated uses. A single sample at each site, however, does not allow for the assessment of individual waterbodies. Therefore, WPP added adequate spatial, temporal and analytical coverage to its random survey designs to assess the designated use support status, and identify causes and sources of impairment, for individual waterbodies. Over the last 15 years, WPP

has completed statewide probabilistic surveys of wadeable streams (2011-2015), lakes and ponds (2016-2018), and coastal waters (2020-2023), and will be conducting probabilistic surveys of rivers and wadeable streams again starting in 2026.

Targeted Monitoring:

Targeted monitoring networks are also an integral component of WPP's monitoring strategy to obtain the data and information needed to identify causes and sources of impairments, and to develop and implement control strategies, such as TMDLs, watershed-based plans, NPDES permits and BMPs. Furthermore, targeted monitoring may provide data to define new and emerging issues or to support the development of water quality standards and policies. Over the last 30 years WPP has sampled targeted waterbodies throughout the state, primarily for water chemistry, pathogenic indicators, fish tissue contaminants, and biological end-points, such as benthic macroinvertebrates and fish communities (Figure 3).

Basin Rotation for Targeted Monitoring:

The use of the watershed, or river basin, as a fundamental planning unit for water quality management is a guiding principle in the development of the strategy. WPP employs a rotating basin approach to targeted monitoring. However, flexibility is maintained within that schedule to perform additional monitoring to meet other water management program needs. To that end, WPP currently employs a sequential schedule that provides the opportunity for monitoring to be carried out in each watershed at least once every seven years, yet allows for monitoring resources to be disproportionately applied in each watershed to fulfill specific water resource management objectives (Figure 2).

Massachusetts' 27 major watersheds and coastal drainage areas have been arranged by geography (and hydrology) into four major groups, or cohorts (A-D), each consisting of three to ten "basins". In turn, each major cohort is subdivided into minor cohorts, each of which represents one year of the seven-year monitoring schedule (Figure 4). The seven-year basin rotation schedule runs through 2027 when it will be reassessed to ensure that all targeted priorities can be addressed.

WPP will continue to employ technology and enhance monitoring functions through the deployment of metered probes, remote sensing, data loggers and other emerging technologies. Ongoing efforts will be maintained to automate data validation and enhance data flows, through the application of Geographical Information Systems (GIS) and specialized programming used to evaluate data and make watershed assessment and listing decisions. WPP continues to improve its electronic data management systems and to implement measures for reporting and distributing water monitoring data and information to multiple end users in government, the private sector and the public. WPP employs a data storage and retrieval system (Environmental Quality Information System, EQiS) capable of managing data from multiple water monitoring program elements and facilitates the transfer of WPP data and information to EPA's Water Quality Exchange (WQX). Updates to WQX are made as data become validated and finalized. Field data collection using EQiS Data Gathering Engine (EDGE) forms on field tablets began in the fall of 2024 and is now standard practice for water quality surveys.

WPP regularly seeks relevant surface water quality data from non-MassDEP sources (i.e., “external” data) for assessing surface water quality in accordance with requirements set forth in s.305(b) and s.303(d) of the federal Clean Water Act (CWA). In assessing surface water quality in the Commonwealth and in preparing lists of impaired waters to meet CWA requirements, states must consider all existing and readily available data and information. In addition to data collected by WPP (i.e., “internal” data), WPP solicits external data and information from all potential non-MassDEP data providers. Monitoring data sought by MassDEP may be generated by sister agencies, federal agencies, towns/municipalities, tribal nations, academic institutions, and community science organizations such as volunteer monitoring organizations and lake associations. Other sources of data, for example, are the Massachusetts Drinking Water Program, Massachusetts Division of Conservation and Recreation, Massachusetts Office of Coastal Zone Management, National Estuaries Partnership Programs (MassBays, Buzzards Bay, and Narragansett Bay), United States Geological Survey (USGS), Massachusetts Wetlands Program, University of Massachusetts-Amherst, Connecticut River Conservancy, Buzzards Bay Coalition, and Ipswich River Watershed Association. Quality assurance for state and federal agencies is provided through program-specific QAPPs managed by the partner organization and not addressed here. Other partners such as towns and municipalities, volunteer monitoring organizations, and academic institutions develop QAPPs that are reviewed by WPP and/or the EPA. WPP works with partner organizations to ensure QAPPs are effective for the proposed work and support WPP’s justification for any use of data for program activities (including surface water quality assessments).

Numerous external partners collect water quality data with the intent, in addition to their own program goals, that WPP will use the data for making decisions about use attainment and other watershed management decisions. To make better use of these external data sources, the efforts of WPP’s QA Analyst and External Data & Monitoring Coordinator help to ensure data quality, facilitate outreach and communication with external groups, and development of robust and expedient data review and analysis tools to increase the effective use of external data for all WPP activities (especially for making use-attainment decisions).

In addition to monitoring and managing water resources at the watershed level and relying increasingly on partnerships to meet water quality objectives, several program enhancements will be integrated into the strategic monitoring plan. For example, MassDEP will continue to emphasize the use of biological communities, such as macroinvertebrates and fish, as the most effective indicators of water quality conditions and ecosystem health and is evaluating various newer techniques for interpreting biological data (e.g., multi-metric indices; tiered aquatic life use).

While the restoration of impaired waters will remain a primary goal of MassDEP and its many partners, the preservation of healthy watersheds will also be emphasized. The surface water monitoring program is designed to not only identify impaired waters and support clean-up activities, but to highlight high-quality waters in need of further measures to ensure their protection. Consistent with EPA’s [Healthy Watersheds Protection Program](#),

protection measures may be implemented through the development of watershed-based plans and §319 grant projects.

Of the eighteen monitoring program elements recommended in the 2025-2035 Monitoring Strategy, this QAPP is intended to cover the QA/QC requirements of the data collection by MassDEP WPP. Collaborative projects and projects under the direction of other groups are covered in separate program-specific QAPPs.

Figure 3: MassDEP WPP Historical Water Quality, Benthic and Fish Toxics Sampling Stations (1983 – 2022) (Note: fish population stations not shown)

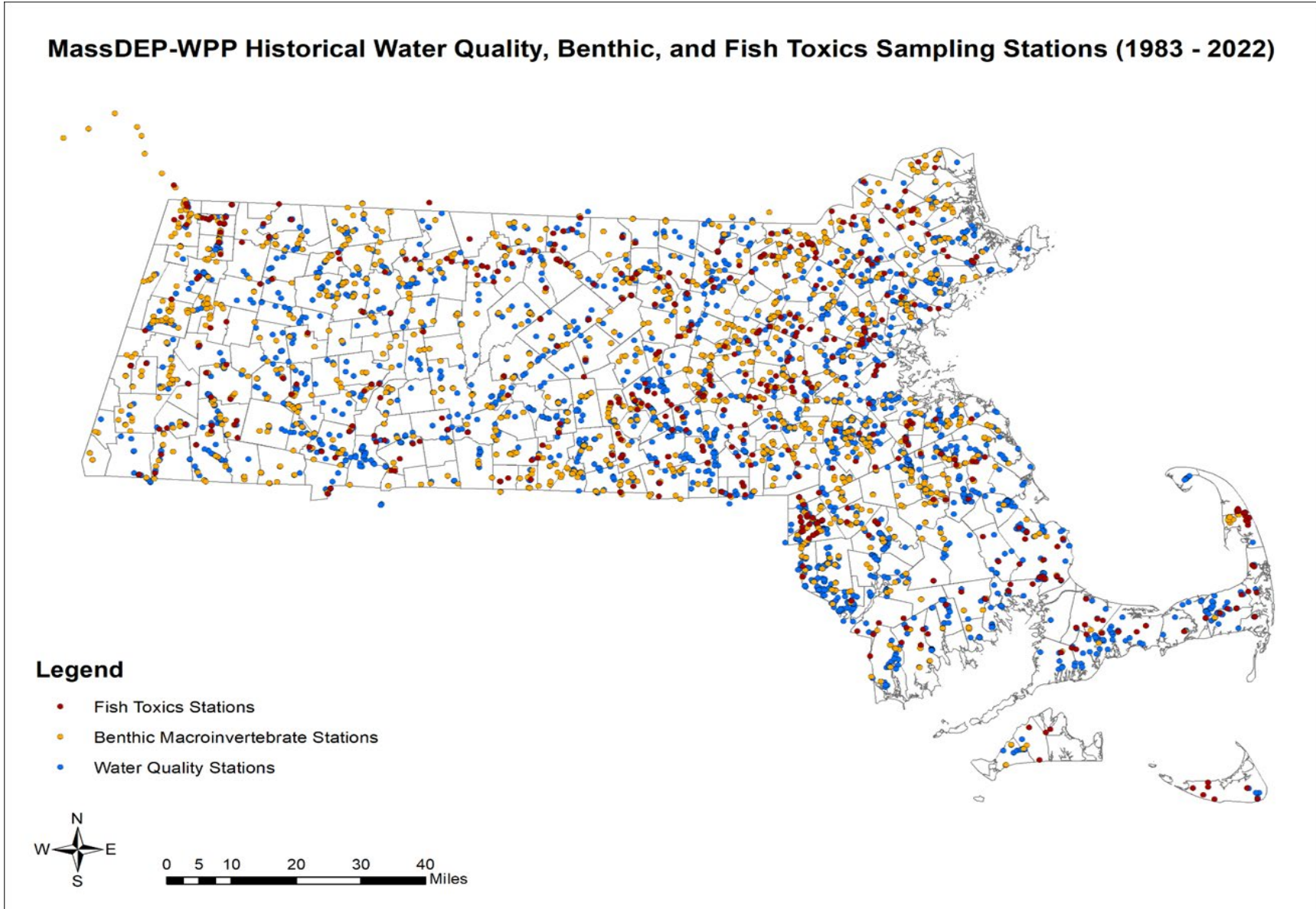
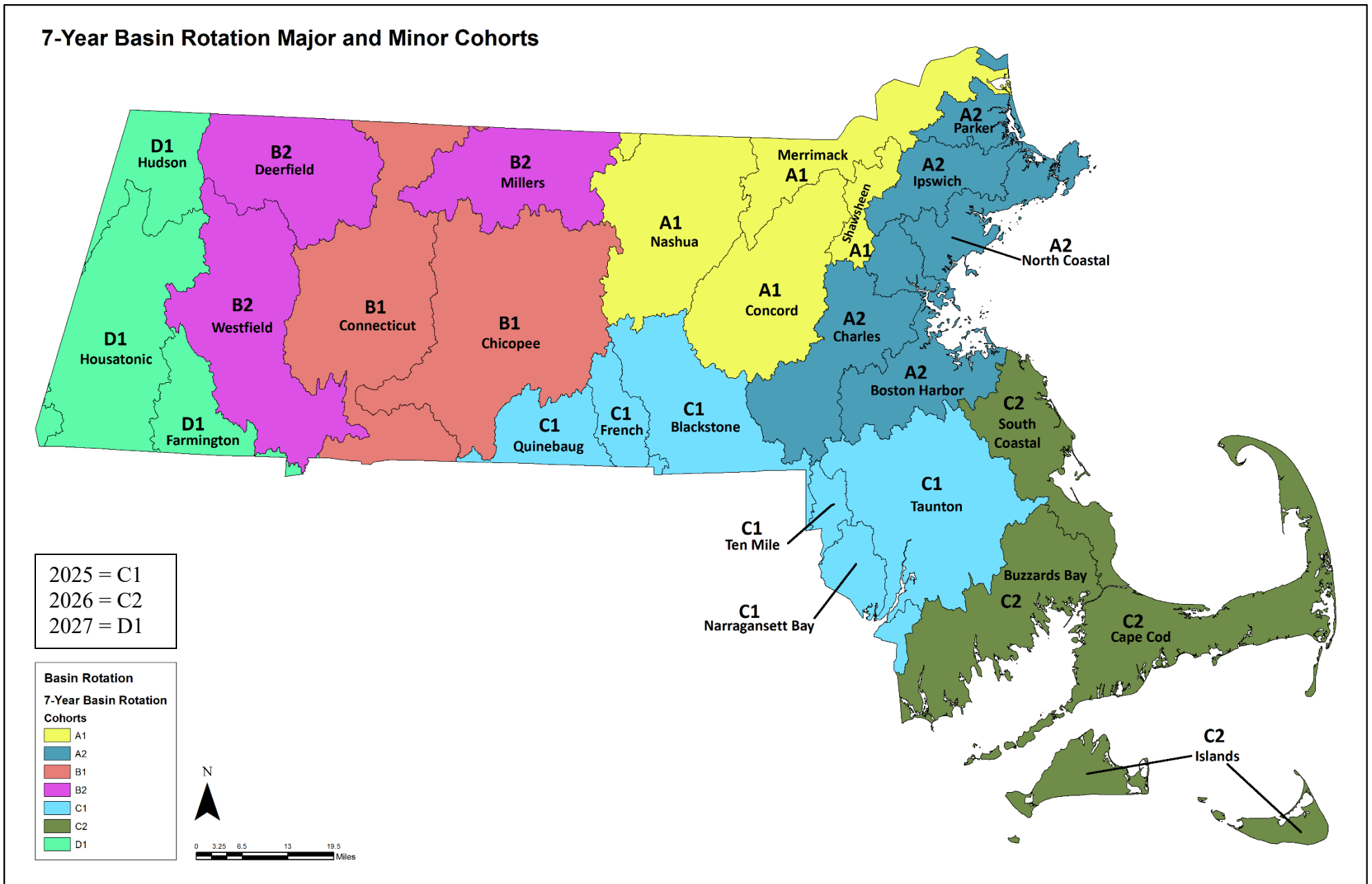
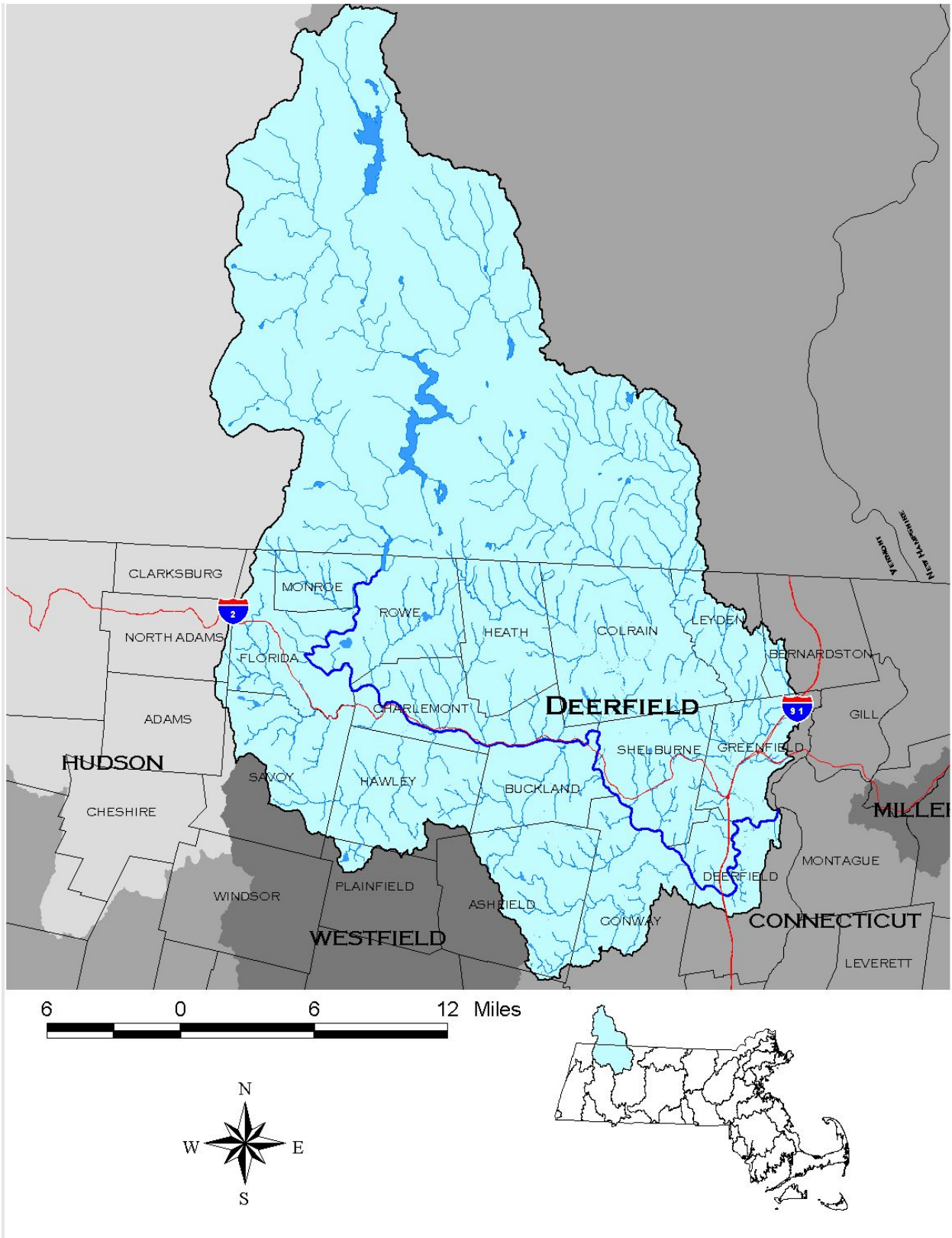


Figure 4: Massachusetts River Basins and Seven-Year Rotation (Note: Boston Harbor sub-basins [Mystic, Neponset, Weymouth-Weir] not





Deerfield Watershed

A6 PROJECT SCHEDULING & COORDINATION

The schedule and logistics for WPP's annual monitoring are dependent on several factors, including:

- available staff
- available resources (equipment, funds, laboratories, etc.)
- anticipated data needs (internal)
- requests for data (by external parties)
- availability of "external" data (gathered by external groups)
- related efforts by others (e.g., planned/on-going projects, monitoring, etc.)

In general, the typical schedule for planning and conducting WPP surveys and using data to generate reports and to make decisions is outlined in Figure 5.

Coordination between WPP staff helps to formulate sampling plans. Information from other groups, such as EPA, USGS, Mass DCR, Mass DFG, other MassDEP programs, consultants and contractors, and volunteer monitoring associations, also assist in allocating monitoring resources. WPP often requests and receives in-kind assistance from EPA-R1. This assistance can be for sampling, sample analysis, ambient toxicity testing, discharge compliance monitoring, or other EPA-R1 capabilities.

WPP Monitoring Coordinators lead efforts to plan and conduct field surveys for water quality, benthic macroinvertebrates, fish populations, fish tissue toxic contaminants, benthic algae, harmful algal blooms (HABs), flow (as needed), and other project-specific survey needs. Survey planning usually includes the following tasks:

- Identification of sampling/data need
- Discussions with project partners and interested parties
- Development of project-specific Sampling & Analysis Plans
- Field-reconnaissance of watersheds to be sampled
- Designing economical and efficient field survey routes to be taken by survey crews
- Documenting required survey routing, station information and logistics in crew-specific Survey Books
- Pre-logging samples into the WES State Laboratory Information Management System (WinLIMS)
- Preparing Chains of Custody for samples (WES and contract labs)
- Setting up field sheets and field tablets with preliminary information
- Scheduling field crew members and vehicles (with WPP's Monitoring Coordinators)
- Preparing crew-specific, pre-labeled sample containers, and
- Scheduling and assembling required field gear for field crews

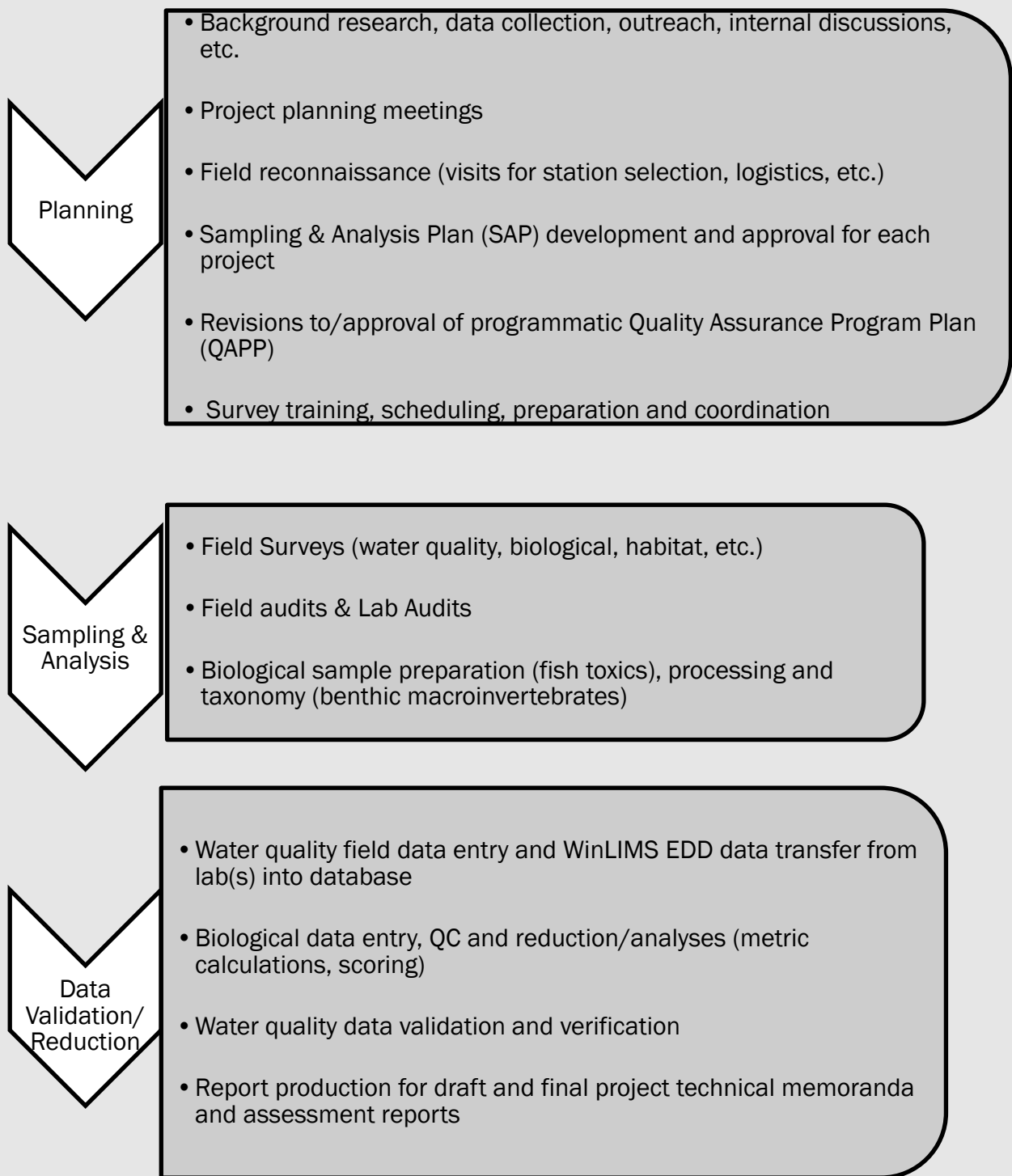
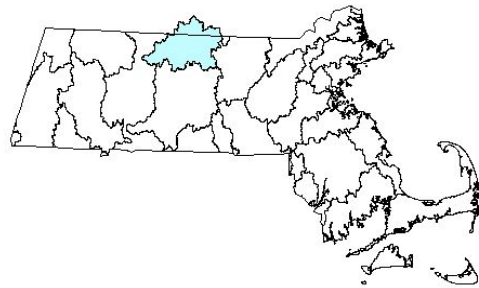
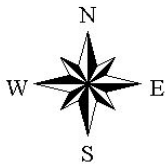
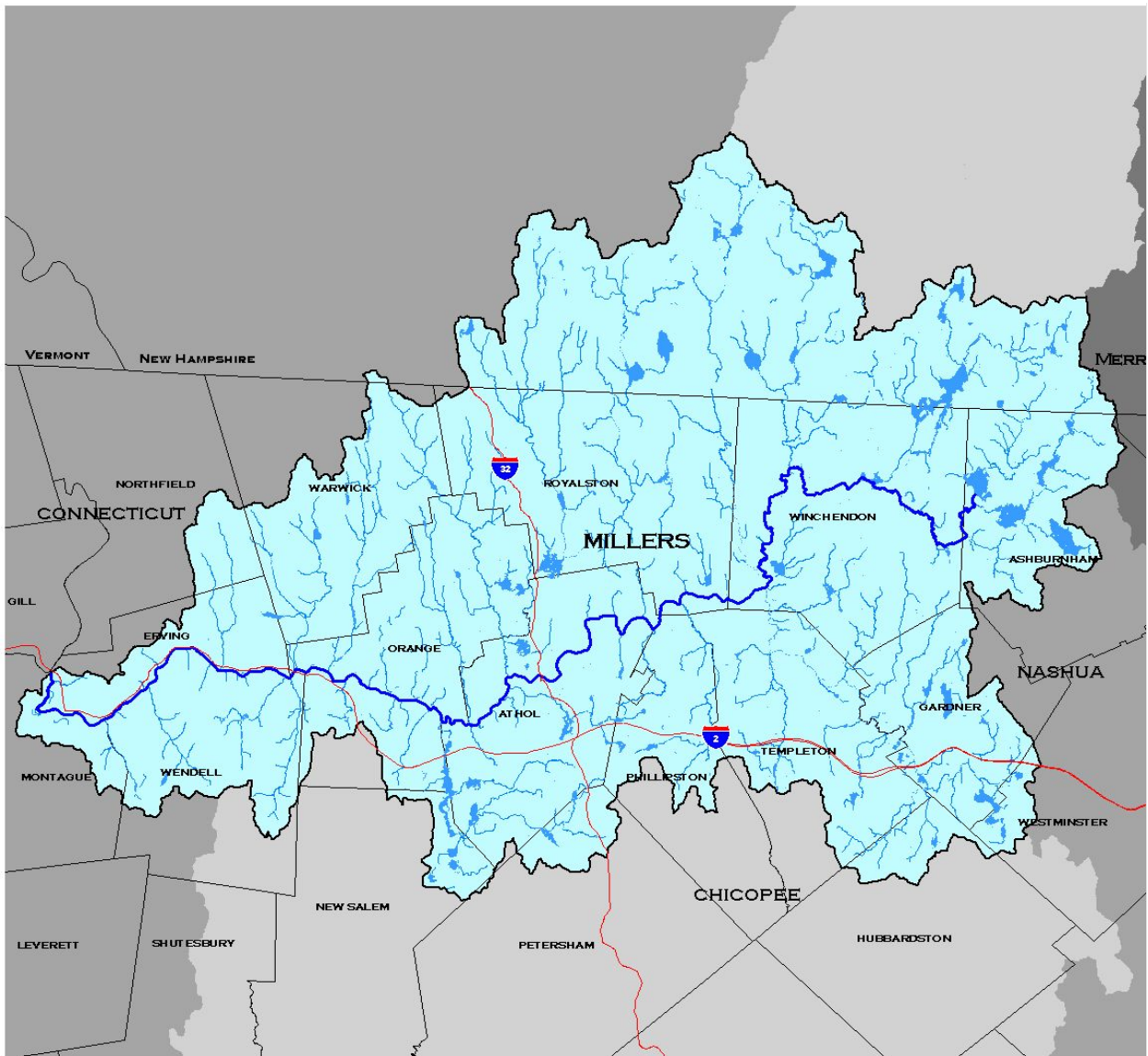


Figure 5: Major Planning Tasks for WPP Watershed Monitoring Projects



Millers Watershed

A7 DATA QUALITY OBJECTIVES AND CRITERIA

Quality assurance activities, as detailed in this and other WPP QAPPs, result in data of known and documented quality. Parameter-specific data quality objectives (DQOs) are outlined in Table 2.

Failure to meet these planned DQOs may subject project data to qualification or censoring during post-monitoring quality control review, but decisions to censor or qualify data are not based solely on meeting DQOs. As outlined in Section D of this QAPP, WPP uses all available information and best professional judgement in its evaluation of data quality.

Method detection and reporting limit information in Table 2 is based on the latest determinations by MassDEP's Division of Environmental Analysis, Wall Experiment Station (WES) in Lawrence, MA, EPA's New England Regional Laboratory (NERL) in North Chelmsford, MA., misc. private contract labs and WPP's internal labs in Worcester, MA. In all cases, suitable method detection limits (MDLs) and minimum reporting limits (MRLs) are required for all analyses (e.g., MRLs < applicable criteria).

Where applicable, standards, criteria and thresholds related to individual parameters in Table 2 can be found in the Massachusetts Surface Water Quality Standards ([314 CMR 4.00](#)).

The data quality concepts of precision, accuracy, representativeness, completeness and comparability and sensitivity (PARCCS) are discussed below, along with other data quality issues, such as holding time, sensitivity and detection limits. While more commonly associated with quantitative chemical data, these concepts can also be applied to qualitative/quantitative physical and biological data, as applicable.

For data quality issues related to WPP's use of secondary data (i.e., data generated by others), see Section B9 of this QAPP.

A7.1 Accuracy

Accuracy is determined by how close a reported result is to a true or expected value and the degree to which bias is avoided or minimized.

Laboratory accuracy will be determined by following the policy and procedures provided in the laboratory's Quality Assurance Plan and analyte-specific WPP SOPs. These generally employ estimates of percent recoveries for known internal standards, matrix spikes and performance evaluation samples, and evaluation of blank contamination.

Depending on the analyte, specific accuracy objectives can be concentration-based (e.g., +/- 0.010 mg/L at concentrations < 0.05 mg/L and +/- 20% at concentrations > 0.05 mg/L) or can be defined in terms of percent recovery percentages (e.g., 80-120% recovery of matrix spike/PE sample).

Accuracy for multi-probe measurements is tested prior-to-use using standards that bracket the measurement range and after use checked against standards to determine if probes remained in calibration at the end of the measurement period. The field and lab thermometer calibration with use of a NIST-certified thermometer is used to check thermometer accuracy as seen in Table 19 and 20. Lower limit accuracy for dissolved oxygen (DO) is checked using a zero DO standard. The post-sampling checks of each unit ensure that the readings taken during the survey(s) were within QC acceptance limits for each multi-probe analyte.

Accuracy assessment for biological identifications usually entails verification and confirmation of voucher specimens and/or random samples by expert peer(s).

A7.2 Precision

Precision is a measure of the degree of agreement among repeated measurements and is estimated through sampling and analysis of replicate (e.g., duplicate, triplicate) samples.

Laboratory precision of lab duplicates will be determined by following the policy and procedures provided in the laboratory's Quality Assurance Plan and individual WPP SOPs. This varies depending on the lab and analyte but typically involves analysis of same-sample lab duplicates and matrix spike duplicates.

Overall precision objectives using relative percent difference (RPD) of field duplicate samples vary depending on the parameter and typically range from 10-25% RPD. WPP recognizes that precision estimates based on small numbers can result in relatively high RPDs (due to small number effect).

Precision of the multi-probe measurements can be determined by taking duplicate (via a second placement of the unit) readings at the same station location. This is often performed for lake surveys. Multi-probe precision objectives generally range from 5-10% RPD depending on the parameter.

In general, assessment of precision for biological samples typically involves comparison of identifications, counts and other measures by the same analyst and/or by separate analysts using same and duplicate samples. The type of QC sampling depends on the type of biological sample being collected.

A7.3 Representativeness

Representativeness refers to the extent to which measurements characterize the true environmental condition. Sampling locations and survey times are selected to ensure that the samples taken represent typical field conditions at the time and location of sampling, and not anomalies due to uncommon effects. In some cases, stations are chosen to evaluate site-specific impacts (i.e., "hot spots") which dictate the representativeness of distinct conditions. Other factors, such as seasonality and weather conditions, must be considered by data users when evaluating what the resulting data represents (e.g., wet weather water quality).

A7.4 Completeness

Completeness refers to the amount of valid data collected using a measurement system. It is expressed as a percentage of the number of valid measurements that should have been collected. For WPP monitoring, the completeness criterion is typically 80-100%. This assumes that, at most, one event out of five might be cancelled for some reason that could cause an incomplete data set with up to 20% of the planned-on data not obtained.

A7.5 Comparability

Comparability refers to the extent to which the data from a study is comparable to other studies conducted in the past or from other areas. For WPP monitoring, the use of standardized sampling and analytical methods, units of reporting, and site selection procedures help to ensure comparability of data. Review of existing data and methods used to collect historical data have been reviewed and considered in the sampling design. Efforts to enhance data comparability are made where possible and appropriate.

A7.6 Sensitivity

Sensitivity characterizes the ability of the method or instrument to discriminate between measurement responses. The specifications for sensitivity are unique to each analytical instrument and are typically defined in laboratory Quality Assurance Plans (QAPs) and SOPs.

A7.7 Detection Limits

In general, detection limits define the smallest amount of analyte that can be detected above signal noise and within certain confidence levels. Typically, Method Detection Limits (MDL) are calculated in the laboratory by analyzing a minimum of seven low-level standard solutions using a specific method. (Detection limits in the traditional sense do not apply to some measurements such as pH and temperature that have essentially continuous scales.) Multiplication factors are typically applied to MDL values by labs to express Minimum Reporting Limits (MRL) that define a level above which there is greater confidence in reported values. Where low-level results are needed, WPP sometimes requests that labs, if possible, report results down to the MDL value with qualification as appropriate (rather than “<RDL”).

A7.8 Holding Times

Most analytes have standard holding times (maximum allowed time from collection to analysis) that have been established to ensure analytical accuracy. Where established holding times are exceeded, violations are considered during the data validation process.

A7.9 Standard Protocols

The use of approved field and laboratory SOPs by WPP and its agents provides a high level of assurance that programmatic data quality objectives shall be met consistently. As noted above, use of standard methodologies also helps data comparability and accuracy.

A7.10 Performance Auditing

Subject to adequate time and resources, scheduled and unscheduled field audits are conducted by WPP's QA Analyst to evaluate implementation of field methods, consistency with this QAPP and compliance with sampling SOPs. Ideally, field audits are planned for each WPP survey type (e.g., water quality, benthic macroinvertebrate, fish, etc.) and each survey crew member every monitoring season. Due to limited resources and multiple staff involved, WPP's QA Analyst annually prioritizes which field audits to do.

Proficiency testing of laboratory analytical accuracy and precision is sometimes performed for several analyte groups (e.g., nutrients, metals, chlorophyll *a*, toxins, bacteria). These are single- and/or double-blind lab QC audits using WPP-prepared solutions and purchased QC check samples. All audit results are compared to "true" values/results, evaluated against acceptance limit criteria and used to help validate the data. Results are also provided to lab analysts, Monitoring Coordinators and data users.

A7.11 Modeling Projects

The data quality objectives for any modeling data generated by WPP or its agents are addressed in WPP's most current version of its TMDL modeling QAPP (Appendix A).

Table 2: Data Quality Objectives for WPP Monitoring (Note: Parameters in italics represent currently inactive parameters.)

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
WPP Instruments (YSI EX01 and EX02, SUNA, Onset DO/T, Onset conductivity loggers, and Tidbit loggers; depth finder)								
Temperature	SM 2550	°C	0-30° C	NA	NA	+/- 0.15 °C	+/- 0.2°C	0.01 °C
Temperature (deployed)	SM 2550	°C	0-30° C	NA	NA	+/- 0.3 °C	+/- 0.3 °C between deployed and side-by-side QC reading	0.01 °C
pH	SM 4500-H ⁺	standard units	4-9 s.u.	NA	NA	+/- 0.2 s.u.	+/- 0.1 s.u.	0.01 s.u.
pH (deployed)	SM 4500-H	standard units	4-9 s.u.	NA	NA	+/- 0.2 s.u.	+/- 0.4 s.u. between deployed and side-by-side QC reading	0.01 s.u.
Dissolved Oxygen (optic)	HACH 10360 ASTM D888-05	mg/L	0-14 mg/L	NA	0.2 mg/L	+/- 0.2 mg/L	+/- 0.2 mg/L	0.01 mg/L
Dissolved Oxygen (deployed)	ASTM D888-05	mg/L	0-14 mg/L	NA	0.2 mg/L	+/- 0.2 mg/L	+/- 0.5 mg/L between deployed and side-by-side QC reading	0.01 mg/L
% Oxygen Saturation	---	%	0.2-110 %	NA	NA	+/- 2 %	5%	0.1 %

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
Nitrate-N (deployed)	Patton and Kryskalla (2011)	mg/L	0-0.25 mg/L	NA	NA	Up to 14 mgN/L: 10% 14-28 mgN/L: 15%; 28-42 mgN/L: 20%	+/- 0.3 mg/L	0.0001 mg/L
Specific Conductance	SM 2510	µS/cm	75-700 µS/cm (fresh)	NA	NA	+/- 1% of reading	5%	4 digits
Specific Conductance (deployed)	SM 2510	µS/cm	75-700 µS/cm (fresh)	NA	NA	+/- 2% of reading	5% between deployed and side-by side QC reading	4 digits
Total Dissolved Solids (TDS) - calculated value	---	mg/L	50-5000 (fresh-brackish)	---	---	---	10%	0.1 mg/L
Salinity	SM 2520B	PSU	0-35	NA	NA	0.2	+/- 0.1 PSU	0.01 PSU
Turbidity	ISO 7027 USGS TWRI Book 9 Section 6.7	NTU	0.1-100	NA	NA	2 NTU	10%	0.1 NTU

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
Chlorophyll fluorescence (in-vivo screening)	Turner SCUFA fluorometry YSI fluorometry probes (IVF)	µg/L (RFU)	0-100	0.2	1.0	---	30%	0.1 µg/L (0.1% RFU)
Phycocyanin (in-vivo screening)	YSI fluorometry (IVF, BGA-PC)	cells/mL (RFU)	0-200,000	220 (est.)	500	---	30%	1 cell/mL (0.1% RFU)
	Turner Cyclops 7	µg/L	0-500	1 (est.)	2			0.1 µg/L
Depth	---	meters	0-10	NA	0.1	0.1 m	10%	0.01 m
Secchi disc (lakes)	MassDEP protocol	meters	0-5 m	NA	NA	NA	10 %	0.1 m
<i>Transparency tube</i>	---	<i>cm</i>	<i>Reserved⁷</i>					
Lake Bathymetry	MassDEP protocol	meters	0-100 m	NA	NA	+/- 0.5 meter for indiv. datum	+/- 0.5 meter for indiv. datum	0.1 m
GPS	MassDEP protocol	meters	---	NA	NA	+/- 2 meters (WAAS-corrected)	+/- 2 meters	---
Physico-chemical (water)								

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
Total Phosphorus (TP) Ortho-phosphate as P <i>Total Dissolved P (TDP)</i> <i>Dissolved Reactive P (DRP)</i> <i>Total Reactive P (TRP)</i>	SM 4500-P F LSBSOP-OPHOS-TP13	mg/L	0-0.15	0.004	0.010	80-120% recovery of QC standard and LFM <0.05 mg/L, 0.005 mg/L >0.05 mg/L, 10%	<0.05 mg/L, 0.005 mg/L >0.05 mg/L, 10%	NA
Total Nitrogen (TN) Total Dissolved N (TDN)	SM 4500-N C LSBSOP-NO2-NO34	mg/L	0-2	0.3	0.3	80-120 % recovery for QC std. and LFM	0.02 mg/L or 25%	NA
Ammonia Nitrogen (NH3-N)	SM 4500NH3-BH LSBSOP-AMMO3	mg/L	0-0.5 mg/L	0.024 mg/L	0.075 mg/L	80-120% recovery for QC standard and LFM	0.01 mg/L or 20%	NA
Nitrate-Nitrite-N (NO3-NO2-N)	SM 353.2 LSBSOP-NO2-NO34	mg/L	0-1 mg/L	0.046 mg/L	0.1 mg/L	80-120 % recovery for QC std. and LFM	0.02 mg/L or 25%	NA

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
Total Kjeldahl Nitrogen (TKN)	EPA 351.2	mg/L	0-1 mg/L	---	0.10 mg/L	80-120 % recovery for QC std. and LFM	0.02 mg/L or 25%	NA
Total Suspended Solids (TSS)	SM 2540D LSBSOP-TSS_TDS7	mg/L	0-100 mg/L	---	1.0 mg/L	80-120 % recovery for QC std. and/or LFM	1.5 mg/L or 40%	NA
Turbidity (WPP lab)	EPA 180.1 SM 2130B	NTU	1-100 NTU	0.2 NTU (est.)	0.5 NTU (est.)	1% of full scale (0-10) 5% full scale (0-100)	20%	0.01 NTU
Salinity	Refractometer	PSU	Reserved					
Alkalinity	SM 2320B	mg/L as CaCO ₃	Neg.-200 mg/L	---	2.0 mg/L	80-120 % recovery for QC std. and LFM <20 mg/L: 2 mg/L >20 mg/L: 10 %	2.0 mg/L or 20%	NA

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
Hardness	SM 2340B (and EPA 200.7)	mg/L as CaCO ₃	0-100 mg/L	---	2.0 mg/L	80-120 % recovery for QC std. and LFM for Ca and Mg (200.7 / 200.8 methods)	20%	NA
Chloride	SM-4500-Cl-E	mg/L	0-100 mg/L	0.89 mg/L	1.0 mg/L	90-110 % recovery for QC std. and LFM	20%	NA
<i>Biochemical Oxygen Demand (BOD-5 and 21-day "ultimate" BOD)</i>	<i>SM 5210B</i>	<i>mg/L</i>	<i>Reserved</i>					
<i>Chemical Oxygen Demand (COD)</i>	<i>EPA 5220B</i>	<i>mg/L</i>	<i>Reserved</i>					
<i>Total Oxygen Demand (TOD)</i>	<i>ASTM D6238-98</i>	<i>mg/L</i>	<i>Reserved</i>					

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
Dissolved Organic Carbon (DOC)	SM 5310C	mg/L	0-10 mg/L	---	0.50 mg/L	80-120 % recovery for QC std., lab fortified blank and matrix	20%	NA
Sulfate	EPA 300.0	mg/L	0-10 mg/L	0.07 mg/L	0.15 mg/L est.	80-120 % recovery for QC std., lab fortified blank and matrix	20%	NA
UVA254	SM 5910B	cm ⁻¹	0-0.5 cm ⁻¹	0.1 cm ⁻¹ (est.)	0.1 cm ⁻¹ (est.)	Compare to expected absorbances of KHP QC stds. To verify RSD<20%	20%	NA

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
Sodium	EPA 200.7	mg/L	0-10 mg/L	---	2.0 mg/L	80-120 % recovery for QC std., LFB, LFM	20%	NA
Potassium	EPA 200.7	mg/L	0-10 mg/L	0.73 mg/L	2.0 mg/L	80-120 % recovery for QC std., LFB, LFM	20%	NA
<i>Silica</i>	<i>EPA 200.7</i>	<i>mg/L</i>	<i>0-10 mg/L</i>	<i>0.03 mg/L</i>	<i>0.1 mg/L est.</i>	<i>80-120 % recovery for QC std., LFB, LFM</i>	<i>20%</i>	<i>NA</i>
<i>Perchlorate</i>	<i>EPA 314.0, 314.1, 314.2, 331.0</i>	<i>µg/L</i>	<i>0-5</i>	<i>0.2 (est.)</i>	<i>1.0 (est.)</i>	<i>80-120 % recovery for QC std. and lab fortified matrix</i>	<i>5 µg/L or 20%</i>	<i>NA</i>

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
Color (true) (WPP lab)	SM 2120C	CU	0-500	2	5	80-120% of standard <5 CU for blanks	<50 CU, 10 CU >50 CU, 20%	1 CU
Chlorophyll a (WPP lab)	EPA 445.0 modified	µg/L	0-100	0.1	0.2	75-125 % for QC std.	2.0 µg/L or 20%	0.1 µg/L
Microcystin-LR	Abraxis ELISA	µg/L	0-20 µg/L	0.15 µg/L	0.15 µg/L	0.20 µg/L (est.)	20%	0.10 µg/L
Microcystins (total) and Nodularins	EPA 546 (ELISA)	µg/L	0-100 µg/L	0.10 µg/L	0.30 µg/L	TBD	20%	0.01 µg/L
Anatoxin-a (total)	Eurofins Abraxis Anatoxin-a (Total) ELISA Product #520060	µg/L	0-100 µg/L	0.1 µg/L	0.3 µg/L	TBD	20%	0.01 µg/L
Saxitoxin	Reserved	µg/L	---	0.015 µg/L	0.04 µg/L	---	<15%	---
Cylindrospermopsin	SM 546	µg/L	---	0.04 µg/L	0.1 µg/L	---	<15%	---
<i>BMAA</i>	<i>Reserved</i>	<i>µg/L</i>	---	<i>4.0 µg/L</i>	<i>12.0 µg/L</i>	---	<15%	---

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
Fluorescent Whitening Agents (FWA) ³ OB1 OB2 FWA1 FWA2 FWA4	SPE-HPLC-FL (WES)	µg/L	---	---	0.20 µg/L 0.20 µg/L 0.01 µg/L 0.10 µg/L 0.20 µg/L	40-140% recovery for LFM and LFB	30% RSD	baseline separation of indiv. analytes
Optical Brighteners (WPP)	DWM CN 58.0	P/A	---	---	---	N.A.	N.A.	P/A test
Detergents (WPP) (CHEMets kit K-9400)	EPA 425.1	mg/L linear ABS (eq. wgt. 325)	---	0.125 mg/L	0.25 mg/L	0.5 mg/L (est.)	30%	0.25 mg/L (0-3 mg/L range)
Ammonia-N test strips (screening)	HACH Aquacheck (DL65059)	mg/L	0-5 mg/L	0.125 mg/L (est.)	0.25 mg/L	0.5 mg/L (est.)	30%	0.25 mg/L (0-6 mg/L range)
Aluminum	EPA 200.8	µg/L	0-100 µg/L	---	40 µg/L (est) (5.0)	85-115 % recovery for QC std. and LFB 70-130% for LFM	20%	NA

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
<i>Antimony</i>	<i>EPA 200.8</i>	<i>µg/L</i>	<i>0-20 µg/L</i>	---	<i>0.50 µg/L (est) (0.50)</i>	<i>Same as above</i>	<i>20%</i>	<i>NA</i>
<i>Arsenic</i>	<i>EPA 200.8</i>	<i>µg/L</i>	<i>0-20 µg/L</i>	---	<i>1.5 µg/L (est) (0.50)</i>	<i>Same as above</i>	<i>20%</i>	<i>NA</i>
<i>Barium</i>	<i>EPA 200.8</i>	<i>µg/L</i>	<i>0-10 µg/L</i>	---	<i>0.50 µg/L (est) (0.20)</i>	<i>Same as above</i>	<i>20%</i>	<i>NA</i>
<i>Beryllium</i>	<i>EPA 200.8</i>	<i>µg/L</i>	<i>0-5 µg/L</i>	---	<i>0.60 µg/L (est) (0.20)</i>	<i>Same as above</i>	<i>20%</i>	<i>NA</i>
<i>Cadmium</i>	<i>EPA 200.8</i>	<i>µg/L</i>	<i>0-10 µg/L</i>	---	<i>0.50 µg/L (est) (0.10)</i>	<i>Same as above</i>	<i>20%</i>	<i>NA</i>
<i>Calcium</i>	<i>EPA 200.7</i>	<i>mg/L</i>	<i>0-50</i>	--	<i>0.1 mg/L</i>	<i>Same as above</i>	<i>20%</i>	<i>NA</i>
<i>Chromium</i>	<i>EPA 200.8</i>	<i>µg/L</i>	<i>0-10 µg/L</i>	---	<i>0.80 µg/L (est) (0.50)</i>	<i>Same as above</i>	<i>20%</i>	<i>NA</i>
<i>Cobalt</i>	<i>EPA 200.8</i>	<i>µg/L</i>	<i>0-10 µg/L</i>	---	<i>0.50 µg/L (est) (0.20)</i>	<i>Same as above</i>	<i>20%</i>	<i>NA</i>
<i>Copper</i>	<i>EPA 200.8</i>	<i>µg/L</i>	<i>0-20 µg/L</i>	---	<i>0.90 µg/L (est) (0.20)</i>	<i>Same as above</i>	<i>20%</i>	<i>NA</i>

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
<i>Iron</i>	<i>EPA 200.8</i>	<i>µg/L</i>	<i>0-10 µg/L</i>	---	<i>0.50 µg/L (est) (50)</i>	<i>Same as above</i>	<i>20%</i>	<i>NA</i>
<i>Lead</i>	<i>EPA 200.8</i>	<i>µg/L</i>	<i>0-10 µg/L</i>	---	<i>0.50 µg/L (est) (0.20)</i>	<i>Same as above</i>	<i>20%</i>	<i>NA</i>
<i>Magnesium</i>	<i>EPA 200.7</i>	<i>mg/L</i>	<i>0-10</i>	--	<i>0.1 mg/L</i>	<i>Same as above</i>	<i>20%</i>	<i>NA</i>
<i>Manganese</i>	<i>EPA 200.8</i>	<i>µg/L</i>	<i>0-10 µg/L</i>	---	<i>0.50 µg/L (est) (0.20)</i>	<i>Same as above</i>	<i>20%</i>	<i>NA</i>
<i>Mercury</i>	<i>EPA 245.1 EPA 7470A</i>	<i>µg/L</i>	<i>0-5 µg/L</i>	---	<i>0.50 µg/L (est)</i>	<i>Same as above</i>	<i>20%</i>	<i>NA</i>
<i>Molybdenum</i>	<i>EPA 200.8</i>	<i>µg/L</i>	<i>0-10 µg/L</i>	---	<i>0.50 µg/L (est) (0.50)</i>	<i>Same as above</i>	<i>20%</i>	<i>NA</i>
<i>Nickel</i>	<i>EPA 200.8</i>	<i>µg/L</i>	<i>0-10 µg/L</i>	---	<i>0.50 µg/L (est) (0.20)</i>	<i>Same as above</i>	<i>20%</i>	<i>NA</i>
<i>Selenium</i>	<i>EPA 200.8</i>	<i>µg/L</i>	<i>0-20 µg/L</i>	---	<i>8.0 µg/L (est) (1.0)</i>	<i>Same as above</i>	<i>20%</i>	<i>NA</i>
<i>Silver</i>	<i>EPA 200.8</i>	<i>µg/L</i>	<i>0-10 µg/L</i>	---	<i>0.50 µg/L (est) (0.20)</i>	<i>Same as above</i>	<i>20%</i>	<i>NA</i>
<i>Thallium</i>	<i>EPA 200.8</i>	<i>µg/L</i>	<i>0-5 µg/L</i>	---	<i>0.50 µg/L (est) (0.50)</i>	<i>Same as above</i>	<i>20%</i>	<i>NA</i>

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
Vanadium	EPA 200.8	µg/L	0-5 µg/L	---	0.50 µg/L (est) (0.20)	Same as above	20%	NA
Zinc	EPA 200.8	µg/L	0-50 µg/L	---	0.60 µg/L (est) (5.0)	Same as above	20%	NA
Extractable petroleum Hydrocarbons (EPH)	MA EPH	µg/L	Reserved (aliphatic: C9 - C18; C19 - C36) (aromatic: C11 - C22)					
Pesticides (various)	EPA 507 EPA 508 EPA 608 EPA 8081A & 3510	µg/L	Reserved					
Polychlorinated Biphenyls (PCBs)	EPA 608 EPA 8082 & 3510	µg/L	Reserved					
Semi-volatile organics	EPA 8270D/625	µg/L	Reserved					
Volatile organics	EPA 8260B/624	µg/L	Reserved					
Pharmaceuticals and Personal Care Products (PPCPs)	EPA 525.2 (modified) EPA 1694 EPA 1698 USGS O-2080-08	ng/l	Reserved					

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
6PPD-quinone	EPA 1634	ng/L	---	0.43 ng/L	2 ng/L	70 – 130%	30%	1 Unit
<i>Microplastics</i>	<i>Pending</i>	---	<i>Reserved</i>					
Per- and Polyfluoroalkyl Substances (PFAS) in surface water	EPA 1633A	ng/L	---	0.4-2 ng/L (for most of typ. 40 compounds; varies by analyte)	1.6-6.4 ng/L (for most of typ. 40 compounds; varies by analyte)	70-130 % recovery for QC std. and LFB; 50-150% for LFM <MRL for blanks	30% RSD	---
<i>Caffeine</i> ³	<i>Modified EPA 525.2</i>	<i>µg/L</i>	---	<i>0.016 µg/L</i>	<i>0.10 µg/L</i>	<i>70-130% recovery for LFM and LFB</i>	30%	---
<i>Flow (Q)</i>	<i>USGS TWRI Bk 3</i>	<i>cfs</i>	<i>variable</i>	<i>NA</i>	<i>NA</i>	<i>15% (estimated)</i>	<i>15% (same crew)</i>	<i>NA</i>
<i>Water velocity (V)</i>	<i>USGS TWRI Bk 3, Book 8 Ch. B2 Individ. protocols</i>	<i>fps</i>	<i>0-5</i>	<i>NA</i>	<i>NA</i>	<i>2% (estimated)</i>	<i>+/- 0.2 fps</i>	<i>0.001 fps</i>
<i>Staff gage readings</i>	<i>USGS TWRI Bk 3</i>	<i>feet</i>	---	<i>NA</i>	<i>NA</i>	<i>0.01</i>	<i>+/- 0.02 feet</i>	<i>0.02 ft</i>

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
<i>Time-of-Travel</i>	<i>USGS TWRI Bk 3</i>	<i>Reserved (µg/L (dye); hrs since injection; miles travelled; flow)</i>						
Microbiological								
<i>E. coli</i> , Enterococci bacteria (Colilert®, Enterolert®) @WES/WPP	SM 9223B	MPN/100 mL	0-2420 (max. with quanti-tray for undiluted samples)	1 MPN/100 mL	MPN of 1 /100 mL	Presence or >2420 MPN on positive control and absence or 0 (<RDL) for negative control	Within 50 CFUs, OR For Log ₁₀ duplicate data: <30% (<50 CFU) <20% (50-500 CFU) <10% (500-5000 CFU) < 5% (>5000 CFU)	NA
<i>Fecal coliform bacteria (MF)</i>	SM 9222D	cfu/100 mL	0-5000	5 cfu/100 mL	5 cfu/100 mL (WES lab)	"TNTC" on positive control and 0 or < RL for negative control	Same as above	NA
<i>Bacteroidetes human marker³ (HF183 @ 68C)</i>	WES nested PCR	P/A	---	---	---	Same as above	Same as above	P/A test
<i>Enterococci bacteria (MF)</i>	EPA 1600	cfu/100 mL	0-5000	5 cfu/100 mL	5 cfu/100 mL (WES)	Same as above	Same as above	NA
Biological								

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
Macrophyte Percent Cover (lakes)	MassDEP protocol	0-100%	NA	NA	NA	NA (if true % cover were known, results would be expected to be +/- 20%)	NA	NA
Macrophyte Identification	MassDEP protocol	NA	NA	NA	NA	Qualitative assessment by aquatic plant experts in DWM via spot checking/testing the accuracy of identification using the same plants.	Qualitative assessment based on same-plant identifications by other survey crewmembers	NA

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
Habitat Assessment	USEPA RBP III	NA	NA	NA	NA	NA	Qualitative evaluation based on duplicate assessment by other survey crewmembers	NA
Benthic Macroinvertebrates (taxonomy)	USEPA RBP III WPP SOP	NA	NA	NA	NA	Quantitative assessment: 10% of samples reevaluated for taxonomy	NA	NA
Benthic Macroinvertebrates (field collection efficiency)	USEPA RBP III WPP SOP	NA	NA	NA	NA	NA	NA	NA
Benthic Macroinvertebrates (sample residue processing efficiency)	USEPA RBP III WPP SOP	NA	NA	NA	NA	Qualitative assessment: 10% of samples split for full analysis	NA	NA

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
Benthic Macroinvertebrates (sample sorting efficiency)	USEPA RBP III WPP SOP	NA	NA	NA	NA	Quantitative assessment: 10% of individual sample residues reevaluated	NA	NA
Benthic Macroinvertebrates, Marine	NCCA Laboratory Operations Manual WPP SOP	NA	NA	NA	NA	Quantitative assessment: 10% of individual sample residues reevaluated	NA	NA
Diatoms	---	---	---	---	---	---	---	---
Algae (counts)	WPP SOP (Genus w/ biovolume)	cells/mL	NA	0	0	NA	< 25% RPD for repeat counts	NA

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
Algae (identification)	WPP SOP	NA	NA	NA	NA	Qualitative assessment; spot checks of taxonomic accuracy using same sample by separate experts	NA	NA
Periphyton (% cover)	USEPA RBP III	%	0-100%	NA	NA	NA	< 25% RPD for repeat field assessments	NA

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
Fish Population	USEPA RBP III	NA	NA	NA	NA	Qualitative assessment, based on in-field or lab specimen verification by other trained fish taxonomists (for fish type/sp.)	Qualitative and/or quantitative assessment based on replicate analysis of an adjacent reach by the same taxonomists	NA
<i>Ambient freshwater toxicity (acute, chronic)</i>	<i>EPA 2021.0 EPA 2002.0</i>	<i>Reserved</i>						
Sediment Quality								
<i>Total Organic Carbon</i>	<i>EPA 9060 (Lloyd Kahn)</i>	<i>g/kg dry</i>	<i>---</i>	<i>---</i>	<i>0.1</i>	<i>---</i>	<i>< 20% RPD for field duplicates</i>	<i>---</i>

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
<i>Acute freshwater sediment toxicity (% survival and growth)</i>	<i>EPA/600/R-99/064</i>	<i>%</i>	<i>---</i>	<i>NA</i>	<i>NA</i>	<i>Statistical significance of survival and growth vs. test control</i>	<i>---</i>	<i>---</i>
<i>% Solids/ % water</i>	<i>ASTM E203; SM 2540G</i>	<i>%</i>	<i>---</i>	<i>NA</i>	<i>NA</i>	<i>---</i>	<i>+/- 10 % for field duplicates</i>	<i>---</i>
<i>Grain size</i>	<i>ASTM D422</i>	<i>% of various sizes</i>	<i>---</i>	<i>NA</i>	<i>NA</i>	<i>---</i>	<i>+/- 15 % for field duplicates</i>	<i>NA</i>
<i>Total Phosphorus (TP)</i>	<i>EPA 3050B USGS I-6600-88 SM 4500-P-E</i>	<i>mg/kg dry</i>	<i>Reserved</i>					
<i>Total Nitrogen (TN)</i>	<i>TBD</i>	<i>mg/kg dry</i>	<i>Reserved</i>					

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
Acid Volatile Sulfide (AVS)- Simultaneously Extracted Metals (SEM)	EPA, 1991	umol/g dry wt. (AVS) mg/kg dry wt. (SEM)	---	---	AVS= 0.05 umol/g (2 µg/g) (see also metals RLs)	75-125 % recovery for aqueous lab QC stds. and lab fortified matrix	< 30% for field duplicates	NA
Silver (Ag)	EPA 200.7/EPA 6010B	mg/kg dry	---	---	(3) mg/kg dry	70-130 % recovery for aqueous lab standards and LFM	< 30% for field duplicates	NA
Aluminum (Al)	EPA 200.7/EPA 6010B	mg/kg dry	---	---	(20) mg/kg dry	70-130 % recovery	< 30%	NA
Arsenic (As)	EPA 200.7/EPA 6010B	mg/kg dry	---	---	(10) mg/kg dry	70-130 % recovery	< 30%	NA
Barium (Ba)	EPA 200.7/EPA 6010B	mg/kg dry	---	---	(3) mg/kg dry	70-130 % recovery	< 30%	NA
Beryllium (Be)	EPA 200.7/EPA 6010B	mg/kg dry	---	---	(1) mg/kg dry	70-130 % recovery	< 30%	NA
Calcium (Ca)	EPA 200.7/EPA 6010B	mg/kg dry	---	---	(20) mg/kg dry	70-130 % recovery	< 30%	NA

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
<i>Cadmium (Cd)</i>	<i>EPA 200.7/EPA 6010B</i>	<i>mg/kg dry</i>	---	---	<i>(3) mg/kg dry</i>	<i>70-130 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Cobalt (Co)</i>	<i>EPA 200.7/EPA 6010B</i>	<i>mg/kg dry</i>	---	---	<i>(3) mg/kg dry</i>	<i>70-130 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Chromium (Cr)</i>	<i>EPA 200.7/EPA 6010B</i>	<i>mg/kg dry</i>	---	---	<i>(3) mg/kg dry</i>	<i>70-130 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Copper (Cu)</i>	<i>EPA 200.7/EPA 6010B</i>	<i>mg/kg dry</i>	---	---	<i>(3) mg/kg dry</i>	<i>70-130 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Iron (Fe)</i>	<i>EPA 200.7/EPA 6010B</i>	<i>mg/kg dry</i>	---	---	<i>(10) mg/kg dry</i>	<i>70-130 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Potassium (K)</i>	<i>EPA 200.7/EPA 6010B</i>	<i>mg/kg dry</i>	---	---	<i>(500) mg/kg dry</i>	<i>70-130 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Magnesium (Mg)</i>	<i>EPA 200.7/EPA 6010B</i>	<i>mg/kg dry</i>	---	---	<i>(20) mg/kg dry</i>	<i>70-130 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Manganese (Mn)</i>	<i>EPA 200.7/EPA 6010B</i>	<i>mg/kg dry</i>	---	---	<i>(2) mg/kg dry</i>	<i>70-130 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Sodium (Na)</i>	<i>EPA 200.7/EPA 6010B</i>	<i>mg/kg dry</i>	---	---	<i>(500) mg/kg dry</i>	<i>70-130 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Nickel (Ni)</i>	<i>EPA 200.7/EPA 6010B</i>	<i>mg/kg dry</i>	---	---	<i>(6) mg/kg dry</i>	<i>70-130 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Lead (Pb)</i>	<i>EPA 200.7/EPA 6010B</i>	<i>mg/kg dry</i>	---	---	<i>(10) mg/kg dry</i>	<i>70-130 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Antimony (Sb)</i>	<i>EPA 200.7/EPA 6010B</i>	<i>mg/kg dry</i>	---	---	<i>(10) mg/kg dry</i>	<i>70-130 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Selenium (Se)</i>	<i>EPA 200.7/EPA 6010B</i>	<i>mg/kg dry</i>	---	---	<i>(10) mg/kg dry</i>	<i>70-130 % recovery</i>	<i>< 30%</i>	<i>NA</i>

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
<i>Thallium (Tl)</i>	<i>EPA 200.7/EPA 6010B</i>	<i>mg/kg dry</i>	---	---	<i>(20) mg/kg dry</i>	<i>70-130 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Vanadium (V)</i>	<i>EPA 200.7/EPA 6010B</i>	<i>mg/kg dry</i>	---	---	<i>(3) mg/kg dry</i>	<i>70-130 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Zinc (Zn)</i>	<i>EPA 200.7/EPA 6010B</i>	<i>mg/kg dry</i>	---	---	<i>(3) mg/kg dry</i>	<i>70-130 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Mercury (Hg), total</i>	<i>EPA 200.7/EPA 6010B</i>	<i>mg/kg dry</i>	---	---	---	<i>70-130 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>PCB Arochlor 1232</i>	<i>EPA 8082/3541</i>	<i>µg/g dry</i>	---	<i>0.026 µg/g dry</i>	<i>0.078 µg/g dry</i>	<i>65-135 % recovery for lab QC stds. and LFM</i>	<i>< 30% for field duplicates</i>	<i>NA</i>
<i>PCB Arochlor 1242</i>	<i>EPA 8082/3541</i>	<i>µg/g dry</i>	---	<i>0.0052 µg/g dry</i>	<i>0.0156 µg/g dry</i>	<i>65-135 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>PCB Arochlor 1248</i>	<i>EPA 8082/3541</i>	<i>µg/g dry</i>	---	<i>0.012 µg/g dry</i>	<i>0.036 µg/g dry</i>	<i>65-135 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>PCB Arochlor 1254</i>	<i>EPA 8082/3541</i>	<i>µg/g dry</i>	---	<i>0.011 µg/g dry</i>	<i>0.033 µg/g dry</i>	<i>65-135 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>PCB Arochlor 1260</i>	<i>EPA 8082/3541</i>	<i>µg/g dry</i>	---	<i>0.040 µg/g dry</i>	<i>0.120 µg/g dry</i>	<i>65-135 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>HCCP</i>	<i>EPA 8081A/3541</i>	<i>µg/g dry</i>	---	<i>0.075 µg/g dry</i>	<i>0.225 µg/g dry</i>	<i>60-140 % recovery for lab QC stds. and LFM</i>	<i>< 30%</i>	<i>NA</i>

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
<i>Trifluralin</i>	<i>EPA 8081A/3541</i>	<i>µg/g dry</i>	---	<i>0.079 µg/g dry</i>	<i>0.237 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>HCB</i>	<i>EPA 8081A/3541</i>	<i>µg/g dry</i>	---	<i>0.035 µg/g dry</i>	<i>0.105 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>a-BHC</i>	<i>EPA 8081A/3541</i>	<i>µg/g dry</i>	---	<i>0.0024 µg/g dry</i>	<i>0.0072 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>b-BHC</i>	<i>EPA 8081A/3541</i>	<i>µg/g dry</i>	---	<i>0.0083 µg/g dry</i>	<i>0.0249 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Lindane</i>	<i>EPA 8081A/3541</i>	<i>µg/g dry</i>	---	<i>0.0037 µg/g dry</i>	<i>0.0111 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>d-BHC</i>	<i>EPA 8081A/3541</i>	<i>µg/g dry</i>	---	<i>0.0054 µg/g dry</i>	<i>0.0162 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Heptachlor</i>	<i>EPA 8081A/3541</i>	<i>µg/g dry</i>	---	<i>0.0030 µg/g dry</i>	<i>0.0090 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Aldrin</i>	<i>EPA 8081A/3541</i>	<i>µg/g dry</i>	---	<i>0.0026 µg/g dry</i>	<i>0.0078 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Heptachlor Epoxide</i>	<i>EPA 8081A/3541</i>	<i>µg/g dry</i>	---	<i>0.0023 µg/g dry</i>	<i>0.0069 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>DDE</i>	<i>EPA 8081A/3541</i>	<i>µg/g dry</i>	---	<i>0.0024 µg/g dry</i>	<i>0.0072 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>DDD</i>	<i>EPA 8081A/3541</i>	<i>µg/g dry</i>	---	<i>0.0024 µg/g dry</i>	<i>0.0072 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>DDT</i>	<i>EPA 8081A/3541</i>	<i>µg/g dry</i>	---	<i>0.0044 µg/g dry</i>	<i>0.0132 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Methoxychlor</i>	<i>EPA 8081A/3541</i>	<i>µg/g dry</i>	---	<i>0.0051 µg/g dry</i>	<i>0.0153 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
<i>Chlordane</i>	<i>EPA 8081A/3541</i>	<i>µg/g dry</i>	---	<i>0.063 µg/g dry</i>	<i>0.189 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Toxaphene</i>	<i>EPA 8081A/3541</i>	<i>µg/g dry</i>	---	<i>0.074 µg/g dry</i>	<i>0.222 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Phenol</i>	<i>EPA 8270C</i>	<i>µg/g dry</i>	---	<i>0.26 µg/g dry</i>	<i>0.78 µg/g dry</i>	<i>60-140 % recovery for lab QC stds. and LFM</i>	<i>< 30%</i>	<i>NA</i>
<i>2-Chlorophenol</i>	<i>EPA 8270C</i>	<i>µg/g dry</i>	---	<i>0.32 µg/g dry</i>	<i>0.96 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>2-Nitrophenol</i>	<i>EPA 8270C</i>	<i>µg/g dry</i>	---	<i>0.17 µg/g dry</i>	<i>0.51 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Dichlorophenol</i>	<i>EPA 8270C</i>	<i>µg/g dry</i>	---	<i>0.33 µg/g dry</i>	<i>0.99 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Naphthalene</i>	<i>EPA 8270C</i>	<i>µg/g dry</i>	---	<i>0.17 µg/g dry</i>	<i>0.51 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>4-Chloro-3-methylphenol</i>	<i>EPA 8270C</i>	<i>µg/g dry</i>	---	<i>0.32 µg/g dry</i>	<i>0.96 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Trichlorophenol</i>	<i>EPA 8270C</i>	<i>µg/g dry</i>	---	<i>0.37 µg/g dry</i>	<i>1.11 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Dimethyl phthalate</i>	<i>EPA 8270C</i>	<i>µg/g dry</i>	---	<i>0.32 µg/g dry</i>	<i>0.96 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Acenaphthylene</i>	<i>EPA 8270C</i>	<i>µg/g dry</i>	---	<i>0.36 µg/g dry</i>	<i>1.08 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Acenaphthene</i>	<i>EPA 8270C</i>	<i>µg/g dry</i>	---	<i>0.35 µg/g dry</i>	<i>1.05 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
<i>Fluorene</i>	<i>EPA 8270C</i>	<i>µg/g dry</i>	---	<i>0.32 µg/g dry</i>	<i>0.96 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Diethyl phthalate</i>	<i>EPA 8270C</i>	<i>µg/g dry</i>	---	<i>0.13 µg/g dry</i>	<i>0.39 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Pentachlorophenol</i>	<i>EPA 8270C</i>	<i>µg/g dry</i>	---	<i>0.17 µg/g dry</i>	<i>0.51 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Phenanthrene</i>	<i>EPA 8270C</i>	<i>µg/g dry</i>	---	<i>0.13 µg/g dry</i>	<i>0.39 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Anthracene</i>	<i>EPA 8270C</i>	<i>µg/g dry</i>	---	<i>0.27 µg/g dry</i>	<i>0.81 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Fluoranthene</i>	<i>EPA 8270C</i>	<i>µg/g dry</i>	---	<i>0.13 µg/g dry</i>	<i>0.39 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Pyrene</i>	<i>EPA 8270C</i>	<i>µg/g dry</i>	---	<i>0.08 µg/g dry</i>	<i>0.24 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Butyl-benzo-phthalate</i>	<i>EPA 8270C</i>	<i>µg/g dry</i>	---	<i>0.11 µg/g dry</i>	<i>0.33 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Bis(2-ethylhexyl)adipate</i>	<i>EPA 8270C</i>	<i>µg/g dry</i>	---	<i>0.10 µg/g dry</i>	<i>0.3 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Benzo(a)anthracene</i>	<i>EPA 8270C</i>	<i>µg/g dry</i>	---	<i>0.08 µg/g dry</i>	<i>0.24 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Chrysene</i>	<i>EPA 8270C</i>	<i>µg/g dry</i>	---	<i>0.23 µg/g dry</i>	<i>0.69 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Benzo(b)fluoranthene</i>	<i>EPA 8270C</i>	<i>µg/g dry</i>	---	<i>0.10 µg/g dry</i>	<i>0.3 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Benzo(k)fluoranthene</i>	<i>EPA 8270C</i>	<i>µg/g dry</i>	---	<i>0.08 µg/g dry</i>	<i>0.24 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
<i>Benzo(a)pyrene</i>	<i>EPA 8270C</i>	<i>µg/g dry</i>	---	<i>0.26 µg/g dry</i>	<i>0.78 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Indeno(,2,3-cd)pyrene</i>	<i>EPA 8270C</i>	<i>µg/g dry</i>	---	<i>0.27 µg/g dry</i>	<i>0.81 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Dibenzo-a,h-Anthracene</i>	<i>EPA 8270C</i>	<i>µg/g dry</i>	---	<i>0.19 µg/g dry</i>	<i>0.57 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Benzo-ghi-perylene</i>	<i>EPA 8270C</i>	<i>µg/g dry</i>	---	<i>0.17 µg/g dry</i>	<i>0.51 µg/g dry</i>	<i>60-140 % recovery</i>	<i>< 30%</i>	<i>NA</i>
<i>Total PAHs</i>	---	<i>µg/g dry</i>	---	---	---	---	---	<i>NA</i>
<i>Pesticides (various)</i>	<i>Reserved</i>							
<i>Polychlorinated Biphenyls (PCBs)</i>	<i>Reserved</i>							
<i>Extractable Petroleum Hydrocarbons (EPH)</i>	<i>Reserved</i>							
<i>VOCs</i>	<i>EPA 5035A EPA 8260B (SW-846)</i>	<i>Reserved</i>						
<i>Per- and Polyfluoroalkyl Substances (PFAS) in sediments</i>	<i>Reserved</i>							
Fish Tissue Toxics ⁵								
<i>-Length</i>	<i>Fish Processing SOP</i>	<i>mm</i>	<i>150-800mm</i>	<i>N/A</i>	<i>N/A</i>	<i>0.1 mm</i>	<i>0.1 mm</i>	<i>NA</i>

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
-Weight (wet)	Fish Processing SOP	Grams wet	80-4000 g	N/A	N/A	20 g	20 g	NA
-Age	Fish Processing SOP	years	1-10 years	N/A	N/A	+/- 1 yrs	+/-1 yrs	NA
-Sex	Fish Processing SOP	---	---	---	---	---	---	---
-Condition	Fish Processing SOP	---	---	---	---	---	---	---
-Gonad Weight	Fish Processing SOP	Grams wet	0.1-60	N/A	N/A	20 g	20 g	NA
Lipids	Thermo AN #337	%	2-40%	N/A	N/A	25%	30%	NA
Arsenic	EPA 6020B	µg/g wet	0-1 µg/g	0.019 µg/g	0.056 µg/g	25%	30%	NA
Cadmium	EPA 6020B	µg/g wet	0-1 µg/g	0.006 µg/g	0.022 µg/g	25%	30%	NA
Lead	EPA 6020B	µg/g wet	0-1 µg/g	0.20 µg/g	0.60 µg/g	25%	30%	NA
Mercury	EPA 7473	µg/g wet	0-5 µg/g	--	0.006 µg/g	25%	30%	NA
Selenium	EPA 6020B	µg/g wet	0-1 µg/g	0.061 µg/g	0.111 µg/g	25%	30%	NA

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
PCB Arochlor 1232	EPA 8082A	µg/g wet	0-5 µg/g	---	0.010 µg/g	25%	30%	NA
PCB Arochlor 1242	EPA 8082A	µg/g wet	0-5 µg/g	---	0.010 µg/g	25%	30%	NA
PCB Arochlor 1248	EPA 8082A	µg/g wet	0-5 µg/g	---	0.010 µg/g	25%	30%	NA
PCB Arochlor 1254	EPA 8082A	µg/g wet	0-5 µg/g	---	0.010 µg/g	25%	30%	NA
PCB Arochlor 1260	EPA 8082A	µg/g wet	0-5 µg/g	---	0.010 µg/g	25%	30%	NA
Chlordane	EPA 8081B	µg/g wet	0-5 µg/g	---	0.20 µg/g	25%	30%	NA
Toxaphene	EPA 8081B	µg/g wet	0-5 µg/g	---	0.20 µg/g	25%	30%	NA
a-BHC	EPA 8081B	µg/g wet	0-5 µg/g	---	0.010 µg/g	25%	30%	NA
b-BHC	EPA 8081B	µg/g wet	0-5 µg/g	---	0.010 µg/g	25%	30%	NA
Lindane	EPA 8081B	µg/g wet	0-5 µg/g	0.0060 µg/g	0.010 µg/g	25%	30%	NA
d-BHC	EPA 8081B	µg/g wet	0-5 µg/g	0.028 µg/g	0.010 µg/g	25%	30%	NA
Hexachloro-cyclopentadiene	EPA 8081B	µg/g wet	0-5 µg/g	0.010 µg/g	0.10 µg/g	25%	30%	NA
Hexachlorobenzene	EPA 8081B	µg/g wet	0-5 µg/g	0.084 µg/g	0.10 µg/g	25%	30%	NA

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
Endosulfan I	EPA 8081B	µg/g wet	0-5 µg/g	0.0031 µg/g	0.010 µg/g	25%	30%	NA
Trifluralin	EPA 8081B	µg/g wet	0-5 µg/g	0.047 µg/g	0.010 µg/g	25%	30%	NA
Heptachlor	EPA 8081B	µg/g wet	0-5 µg/g	0.0060 µg/g	0.010 µg/g	25%	30%	NA
Heptachlor Epoxide	EPA 8081B	µg/g wet	0-5 µg/g	0.014 µg/g	0.010 µg/g	25%	30%	NA
Methoxychlor	EPA 8081B	µg/g wet	0-5 µg/g	0.026 µg/g	0.010 µg/g	25%	30%	NA
DDD	EPA 8081B	µg/g wet	0-5 µg/g	0.007 µg/g	0.010 µg/g	25%	30%	NA
DDE	EPA 8081B	µg/g wet	0-5 µg/g	0.010 µg/g	0.010 µg/g	25%	30%	NA
DDT	EPA 8081B	µg/g wet	0-5 µg/g	0.011 µg/g	0.010 µg/g	25%	30%	NA
Endosulfan I	EPA 8081B	µg/g wet	0-5 µg/g	0.021 µg/g	0.010 µg/g	25%	30%	NA
Aldrin	EPA 8081B	µg/g wet	0-5 µg/g	0.0080 µg/g	0.010 µg/g	25%	30%	NA
Endrin	EPA 8081B	µg/g wet	0-5 µg/g	0.0036 µg/g	0.010 µg/g	25%	30%	NA
PCNB	EPA 8082A	%	50-150 µg/g	NA	NA	40%	NA	NA
PCB Congener BZ # 8	EPA 8082A	µg/g wet	0-0.02 µg/g	0.0024 µg/g	0.0072 µg/g	25%	30%	NA

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
PCB Congener BZ #11	EPA 8082A	µg/g wet	0-0.02 µg/g	---	0.020 µg/g	25%	30%	NA
PCB Congener BZ # 18	EPA 8082A	µg/g wet	0-0.02 µg/g	---	0.020 µg/g	25%	30%	NA
PCB Congener BZ # 28	EPA 8082A	µg/g wet	0-0.02 µg/g	---	0.020 µg/g	25%	30%	NA
PCB Congener BZ # 44	EPA 8082A	µg/g wet	0-0.02 µg/g	---	0.020 µg/g	25%	30%	NA
PCB Congener BZ # 52	EPA 8082A	µg/g wet	0-0.02 µg/g	---	0.020 µg/g	25%	30%	NA
PCB Congener BZ# 66	EPA 8082A	µg/g wet	0-0.02 µg/g	---	0.020 µg/g	25%	30%	NA
PCB Congener BZ# 77	EPA 8082A	µg/g wet	0-0.02 µg/g	---	0.020 µg/g	25%	30%	NA
PCB Congener BZ# 81	EPA 8082A	µg/g wet	0-0.02 µg/g	---	0.020 µg/g	25%	30%	NA
PCB Congener BZ# 95	EPA 8082A	µg/g wet	0-0.02 µg/g	---	0.020 µg/g	25%	30%	NA
PCB Congener BZ # 101	EPA 8082A	µg/g wet	0-0.02 µg/g	---	0.020 µg/g	25%	30%	NA
PCB Congener BZ# 105	EPA 8082A	µg/g wet	0-0.02 µg/g	---	0.020 µg/g	25%	30%	NA
PCB Congener BZ# 114	EPA 8082A	µg/g wet	0-0.02 µg/g	---	0.020 µg/g	25%	30%	NA
PCB Congener BZ# 118	EPA 8082A	µg/g wet	0-0.02 µg/g	---	0.020 µg/g	25%	30%	NA

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
PCB Congener BZ# 123	EPA 8082A	µg/g wet	0-0.02 µg/g	---	0.020 µg/g	25%	30%	NA
PCB Congener BZ# 126	EPA 8082A	µg/g wet	0-0.02 µg/g	---	0.020 µg/g	25%	30%	NA
PCB Congener BZ # 128	EPA 8082A	µg/g wet	0-0.02 µg/g	---	0.020 µg/g	25%	30%	NA
PCB Congener BZ # 138	EPA 8082A	µg/g wet	0-0.02 µg/g	---	0.020 µg/g	25%	30%	NA
PCB Congener BZ # 153	EPA 8082A	µg/g wet	0-0.02 µg/g	---	0.020 µg/g	25%	30%	NA
PCB Congener BZ# 156	EPA 8082A	µg/g wet	0-0.02 µg/g	---	0.020 µg/g	25%	30%	NA
PCB Congener BZ# 157	EPA 8082A	µg/g wet	0-0.02 µg/g	---	0.020 µg/g	25%	30%	NA
PCB Congener BZ# 167	EPA 8082A	µg/g wet	0-0.02 µg/g	---	0.020 µg/g	25%	30%	NA
PCB Congener BZ# 169	EPA 8082A	µg/g wet	0-0.02 µg/g	---	0.020 µg/g	25%	30%	NA
PCB Congener BZ# 170	EPA 8082A	µg/g wet	0-0.02 µg/g	---	0.020 µg/g	25%	30%	NA
PCB Congener BZ# 180	EPA 8082A	µg/g wet	0-0.02 µg/g	---	0.020 µg/g	25%	30%	NA
PCB Congener BZ # 187	EPA 8082A	µg/g wet	0-0.02 µg/g	---	0.020 µg/g	25%	30%	NA
PCB Congener BZ# 189	EPA 8082A	µg/g wet	0-0.02 µg/g	---	0.020 µg/g	25%	30%	NA

Analyte	Analytical Method(s)	Units	Expected Range (appx.)	Method Detection Limit (MDL) ¹	Minimum Reporting Limit (MRL) ¹	Accuracy ² (+/-)	Overall Precision (RPD or other) ²	Resolution
PCB Congener BZ # 195	EPA 8082A	µg/g wet	0-0.02 µg/g	---	0.020 µg/g	25%	30%	NA
PCB Congener BZ # 206	EPA 8082A	µg/g wet	0-0.02 µg/g	---	0.020 µg/g	25%	30%	NA
PCB Congener BZ # 209	EPA 8082A	µg/g wet	0-0.02 µg/g	---	0.020 µg/g	25%	30%	NA
Per- and Polyfluoroalkyl Substances (PFAS) ⁴	EPA 1633A	ng/g wet	0-100 ng/g	Approx. 0.1-2 ng/g (for most; varies by analyte and lab)	Approx. 0.4-50 ng/g (for most; varies by analyte and lab)	40%	30%	NA

¹ Detection and reporting limit information in Table 2 is based primarily on the WES lab, unless otherwise noted for WPP and other labs.

² Accuracy and precision goals are based on potential error introduced via both field and lab activity. The analytical method limits are published in the analytical method and/or provided by the lab, as are the achievable laboratory limits. Multi-Probe information for accuracy, precision and resolution is based on manufacturer's specifications. RPD precision objectives relate to field duplicates.

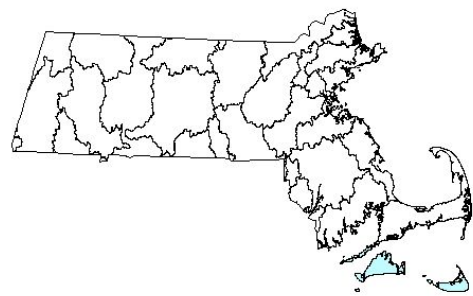
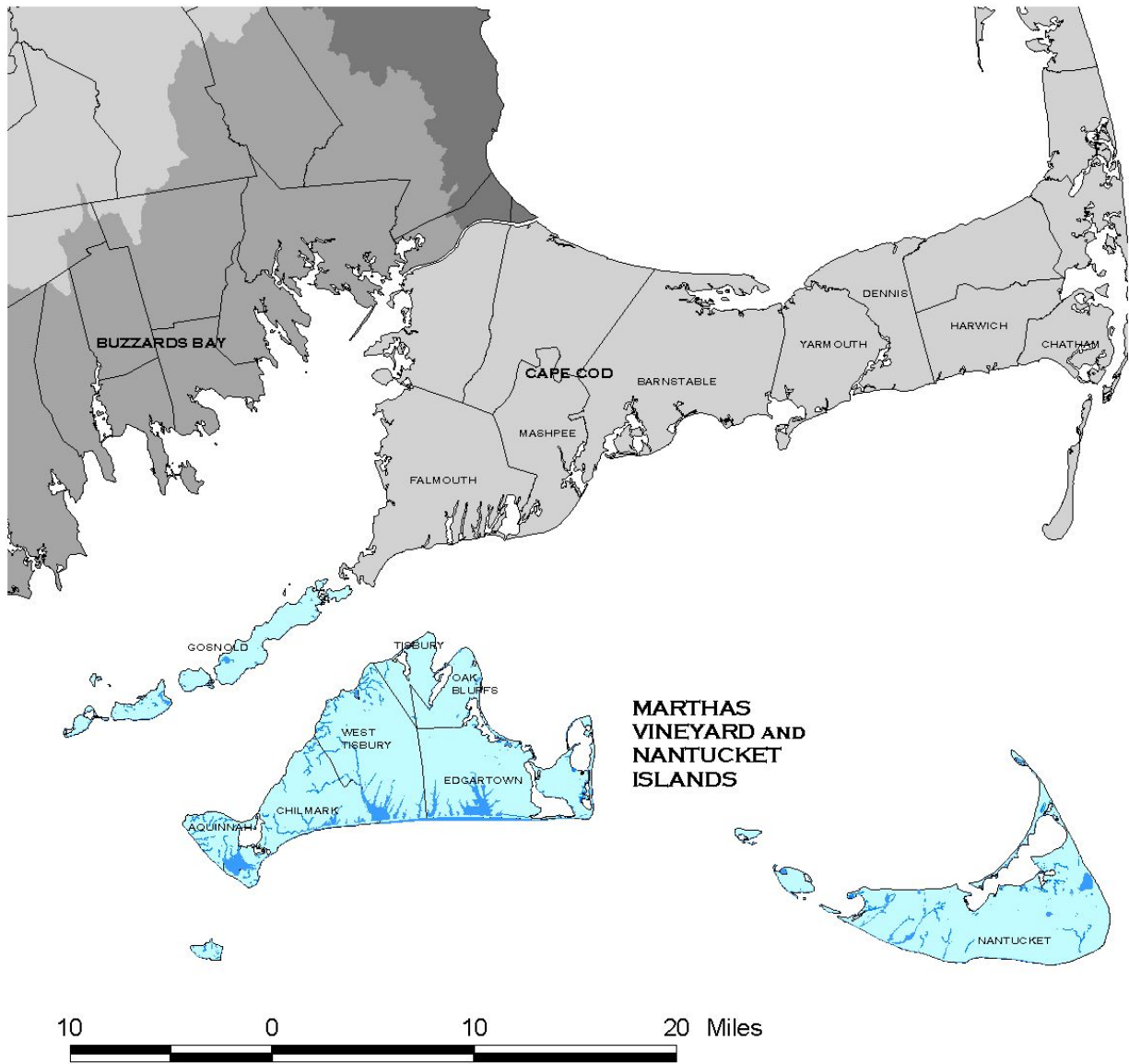
³ These analytes comprise the Evidence of Human-Sewage Source (EHSS) suite of tests performed at WES as part of bacteria source tracking studies to assist in locating and fixing microbial pollution sources.

⁴ Metals RL information in parentheses () indicates RLs attainable by the EPA backup lab in North Chelmsford, MA.

⁵ Fish tissue PCB/pesticide MDL/MRL values are based on most recent analyses by WES, and as all DL values, subject to change. PAH analysis for fish tissue samples is not normally performed for DWM samples, and so DQO's for these are not presented here.

⁶ Parameters in *italics* represent currently inactive parameters (Inactive tests that are not currently being performed but can be implemented if needed).

⁷ Parameters in *italics* represent currently inactive parameters (Reserved analytes are those that we have not performed but can be if required in the future).



Islands Watershed

A8 TRAINING

Annual and/or as needed training in field and laboratory methods and procedures is provided to staff (full-time and seasonals) to ensure consistent adherence to SOPs and data quality. The main focus of this training is to review both the fundamentals and finer details of sample collection, associated documentation, lab requirements and protocols and safety issues. Types of available training are summarized in Table 3.

Training is dependent on the specific type of monitoring planned and the level of staff experience (e.g., if flow surveys are not currently planned, then flow training is not provided). If, however, the need arises during the season, additional training is scheduled prior to actual survey. The training primarily focuses on seasonal staff while also providing review for full-time staff.

Table 3: Types of WPP Training (Italics indicate trainings not currently in use)

Training	Description	Trainer(s)
CPR-AED and First Aid *	Practice of Cardiopulmonary Resuscitation (CPR), Automated Electronic Defibrillation (AED) and first aid techniques to rescue and aid victims	American Red Cross and/or ARC-certified MassDEP instructors, Shervon De Leon
Health & Safety	Discussion of safety precautions both in the field and in the lab	Suzanne Flint
Quality Assurance	QA/QC-related topics (as needed)	Jasper Sha
Multi-probe Use	Discussion and practicum on how to use multi-probe units in the field to collect water quality data (single-use and deployment)	Suzanne Flint
Water quality surveys (general)	Discussion of survey preparation, field procedures and special considerations (e.g., clean metals sampling) for stream and pond surveys	James Meek, Dan Davis, Pete Mitchell, Steven Bittner, Therese Beaudoin, subject matter-expert staff
Lake Monitoring	Review of SOPs for lake/pond surveys, including safety, boat use, sampling gear, aquatic plant identification, etc.	James Meek, Therese Beaudoin
Benthic Macroinvertebrate and Periphyton surveys	Field and lab instruction on survey preparation, sample collection, field data collection, sample sorting, etc.	Steven Bittner, subject matter-expert staff
Electrofishing surveys	How to assist in performing electrofishing surveys safely and with minimal field error (fish toxics and populations)	Dan Davis, Pete Mitchell, Steven Bittner

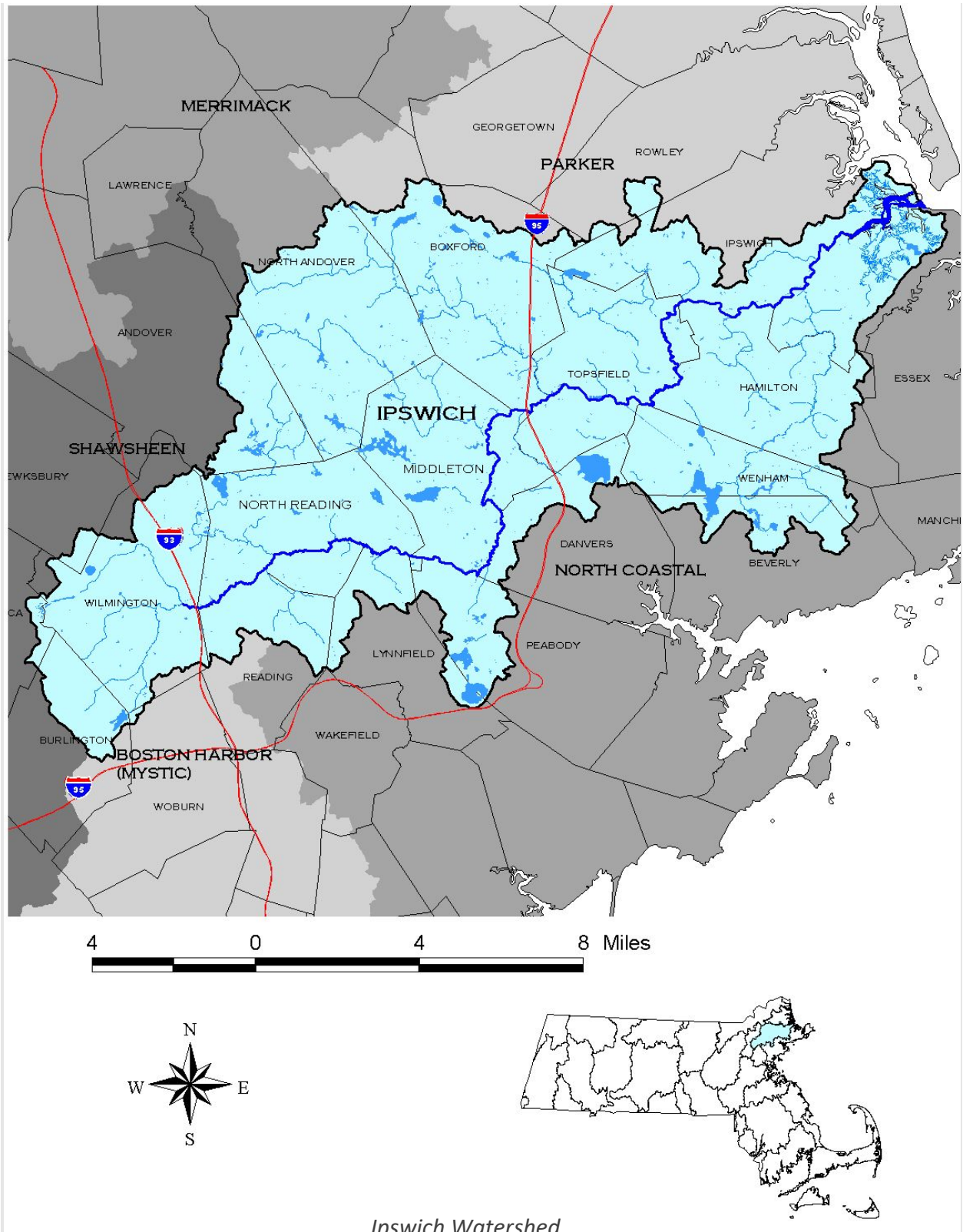
Training	Description	Trainer(s)
<i>E. coli</i> by Colilert® (also Enterolert®)	Review of SOP for sample analysis at WPP lab, including safety and waste management issues	Suzanne Flint
Chlorophyll <i>a</i>	How to perform sampling & analysis for chlorophyll <i>a</i> content in water and biological samples	Suzanne Flint, subject matter-expert staff
Color, turbidity and hardness analyses	How to perform lab analyses for true color, total hardness and turbidity (WPP lab)	Suzanne Flint
Decontamination for invasives control	Overview of decontamination issues and requirements for WPP surveys to prevent the spread of invasive organisms	James Meek, Dan Davis
Field metadata and lab data reporting and management	Review of procedures for lab recordkeeping and data entry into WPP databases for both field and lab data	Tom Dallaire, Tim Gardner, Kari Winfield, Jasper Sha
<i>Flow Measurement</i>	<i>Discussion and practicum on proper preparation and performance of flow surveys, including use of velocity meters and data processing</i>	<i>TBD (as needed)</i>
<i>Bacteria (and pollutant) source tracking</i>	<i>Review of BST “toolbox” for both field and lab activities, including successes/failures based on working knowledge base</i>	<i>Jenny Sheppard</i>

* Highly recommended for field and lab staff but not required.

Staff serving as monitoring survey crew leaders should have the following desired qualifications:

- Familiarity with this QAPP (and the project SAP as applicable) and all applicable SOPs
- Completion of applicable training (e.g., water quality/multiprobe sampling)
- Prior field experience with survey equipment and with similar monitoring surveys
- Recent training in CPR-AED/first aid by the American Red Cross (at least one certified person per survey crew is recommended)
- Massachusetts Boater Safety Certificate (seasonals receive their training from Massachusetts Environmental Police yearly)
- HAZWOPER training (8-hour refresher)
- Be physically able to access the stations, carry equipment and samples, and perform the sampling

All field survey crew personnel and WES/WPP lab personnel are trained in the proper application of SOPs. Training can take place in the office, field or laboratory, and can take place prior to data collection and/or “on the job.” WPP training activity is documented using standard training signature sheets with the aim of navigating to an online repository of training information. All training records are stored at WPP’s office in Worcester, MA.



Ipswich Watershed

A9 DOCUMENTATION AND RECORDS

A9.1 Field Records

Observations made and measurements taken in the field are recorded on standardized WPP Field Sheets (paper) through the summer of 2024. In the fall of 2024 WPP implemented the use of the EQUIS Data Gathering Engine (EDGE) software running on ruggedized field tablets and paper field sheets in parallel to collect field data. Field data collected are now uploaded directly to WPP's EQUIS water quality database. EQUIS-EDGE software/data forms will be reviewed annually and updated as needed. For the 2025 field season (only), field data will continue to be collected on paper field sheets as backup (waterproof "Rite-in-the-Rain" paper is used exclusively and no PFAS is used in the making or contained in the material). When used, paper field sheets are scanned to create an electronic backup record. While paper field sheets are always available to use when needed (e.g., tablet failure, unsupported survey types), the EDGE field tablets are now the main vehicle for field metadata collection for water quality surveys.

EQUIS-EDGE software has been customized to collect the same information previously collected on paper field sheets including the following.

- "Rivers & Streams"
- "Lakes & Ponds"
- "Pipes and Conduits"

Planned/Later implementation in EQUIS-EDGE:

- "Multi-Probe Deployment"

Samples of selected completed WPP Field Sheets can be found in Appendix G. While each field sheet type is unique, common information recorded on field sheet forms/EQUIS-EDGE includes, but is not limited to:

- Site name and watershed location
- Station Description (including GPS coordinates)
- Station Access Information
- Sample Name and ID #
- Personnel on-site performing the sampling
- Dates and times of sample collection
- Pertinent observations regarding uses (aquatic life, recreation, etc.)
- Summary of weather conditions
- Site observations and any aberrant sample handling comments
- Sample collection information (sample collection methods and devices, sample collection depth /heights, sample preservation information, matrix sampled, etc.)

Certain information that will not change can be pre-filled out prior to the survey to save time in the field. Other information that is time-, location- and/or condition-specific is entered at the station only. Completed EQUIS-EDGE forms are uploaded at the end of each survey. Any paper sheets (for surveys for which EQUIS-EDGE has not yet been implemented) should be filled out completely using (blue) ink pens. Upon completion of

the survey, each completed paper field sheet is submitted to WPP's Field and Laboratory Operations Coordinator for scanning and hard copy filing.

Survey guidebooks are provided to each crew led by the Monitoring Coordinator. These books contain detailed driving directions and maps to each sequential sampling station, along with photos, helpful hints, contact information and survey-specific emergency hospital locations.

Multiprobe and Deployed Logger Files

Electronic records include field data and calibration files from discrete and continuous multiprobe and single probe (temperature) deployments and associated side-by-side QC measurements. Procedures for uploading data files from water quality probes are described in the instrument SOPs. Data management and data validation procedures for these files are documented in WPP data processing and validation SOPs (Appendix D).

Other Digital Field Records

Use of digital cameras (and video as appropriate) and project-specific "trail" cameras for photo documentation and GPS for geo-referencing augment metadata information. The need to collect digital photos is project-specific, and at the discretion of the field crew. When collected, digital pictures and videos are uploaded to WPP's secure network drive using a dedicated photo documentation folder, in project-specific sub-folders, and renamed as applicable. In 2025, WPP intends to create a new MS SharePoint media library.

A9.3 Laboratory Records

WES Laboratory (Lawrence, MA)

The WES laboratory tracks samples via a web-based Laboratory Information Management System (WinLIMS) system. A standard chain-of-custody (COC) form generated by pre-logging samples in WinLIMS is used to transfer sample custody for all samples from WPP staff to the WES laboratory. See Appendix G for sample WES COC form. These forms are scanned and included as attachments when results are released.

The WinLIMS system provides efficient and accurate data transfers to WPP's database system (i.e., LIMS EDD extracts) and allows pre-logging of samples by WPP staff to generate COC forms and bottle labels for samples going to WES. WinLIMS is a cloud-based Commercial off the Shelf system (COTS) that is implemented under contract with a software vendor. The terms of the contract include off-site redundancy, uptime/downtime and backup/disaster recovery requirements that are consistent with the Massachusetts Executive Office of Technology Services and Security (EOTSS) standards.

In general, most hard copy records including logbooks, data analysis books, control charts, chain of custody forms, log-in sheets and data reports are archived for storage within a secure building (WES laboratories, Main Office, and Records Storage) according to MassDEP recordkeeping requirements. See the WES QA Plan for more information on laboratory recordkeeping.

WPP Laboratory (Worcester, MA)

For samples to be analyzed at WPP's laboratory, a WPP COC form is used to transfer sample custody for all samples from WPP staff to the WPP laboratory.

WPP laboratories track sample information in various ways, depending on the type of analysis performed. Lab records are kept in both paper and digital formats. Hard copy lab records include data bench sheets and calibration records and are stored according to MassDEP recordkeeping requirements. Electronic lab notebooks are also used for analyses. These result in batch-specific electronic lab data files, which are used to produce analyte-specific electronic data deliverables (EDDs) for upload to WPP's database system.

Contract laboratories

Contract lab COC forms are used when available and when deemed sufficient to meet WPP's information needs. In some cases, WPP may use the WES lab style COC form for non-WES lab samples if a contract lab COC form is found to be insufficient. When contract labs are used, scanned copies of completed COC forms are included in the data report packages, which are filed in WPP project folders. Contract labs are required to submit formal EDDs using WPP's standard format and specification so that contract lab data can be uploaded to WPP's database system with minimal transcription errors.

A9.4 Data-Related Records (electronic)

The majority of program data records are in electronic format. Electronic office records pertinent to WPP's data operations and available to staff include, but are not limited to, the following types of information on Microsoft SharePoint:

- Probe QC and calibration records
- Draft and Final data (QC levels 1 through 5; see Section D1)
- Digital photo-documentation (site reconnaissance, surveys, etc.)
- Survey guidebooks
- Field sheet data and metadata (following data entry)
- EQulS-EDGE field data
- Working files and data analyses
- Standard Operating Procedures (field, office, lab) and policies
- Standard forms
- QC records
- Secondary data (from sources external to WPP)
- Internal databases
- Draft and final reports and plans (e.g., TMDL, water quality assessments, Sampling & Analysis Plans, etc.)

A9.5 Document Tracking: "Control Numbers"

The WPP QC Analyst assigns document control numbers (CNs) to all Quality Assurance Project Plans, SOPs, Assessment Reports and other documents generated by WPP. Assigning a CN provides a formal reference number for citation purposes and helps to

ensure differentiation of multiple versions of a document when they exist. All documents with a CN can be electronically accessed internally by WPP staff using the WPP Document Repository.

A9.6 Sampling Station Registration

Prior to visiting sampling stations for data collection, WPP's electronic station definition files are updated to create new (proposed) stations where needed. Each unique location (or station) sampled is given a "Unique ID" number and description including latitude/longitude. Unique IDs are recorded on all field sheets, along with a field sheet number, prior to entry of field sheets in another database. At the completion of the survey season, pre-registered station locations are verified as those sampled. All station information is maintained in a database.

A9.7 Documentation Protocols

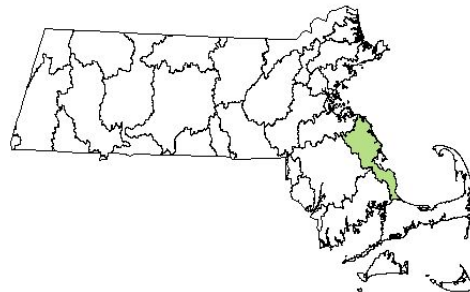
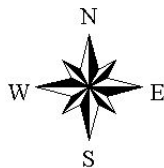
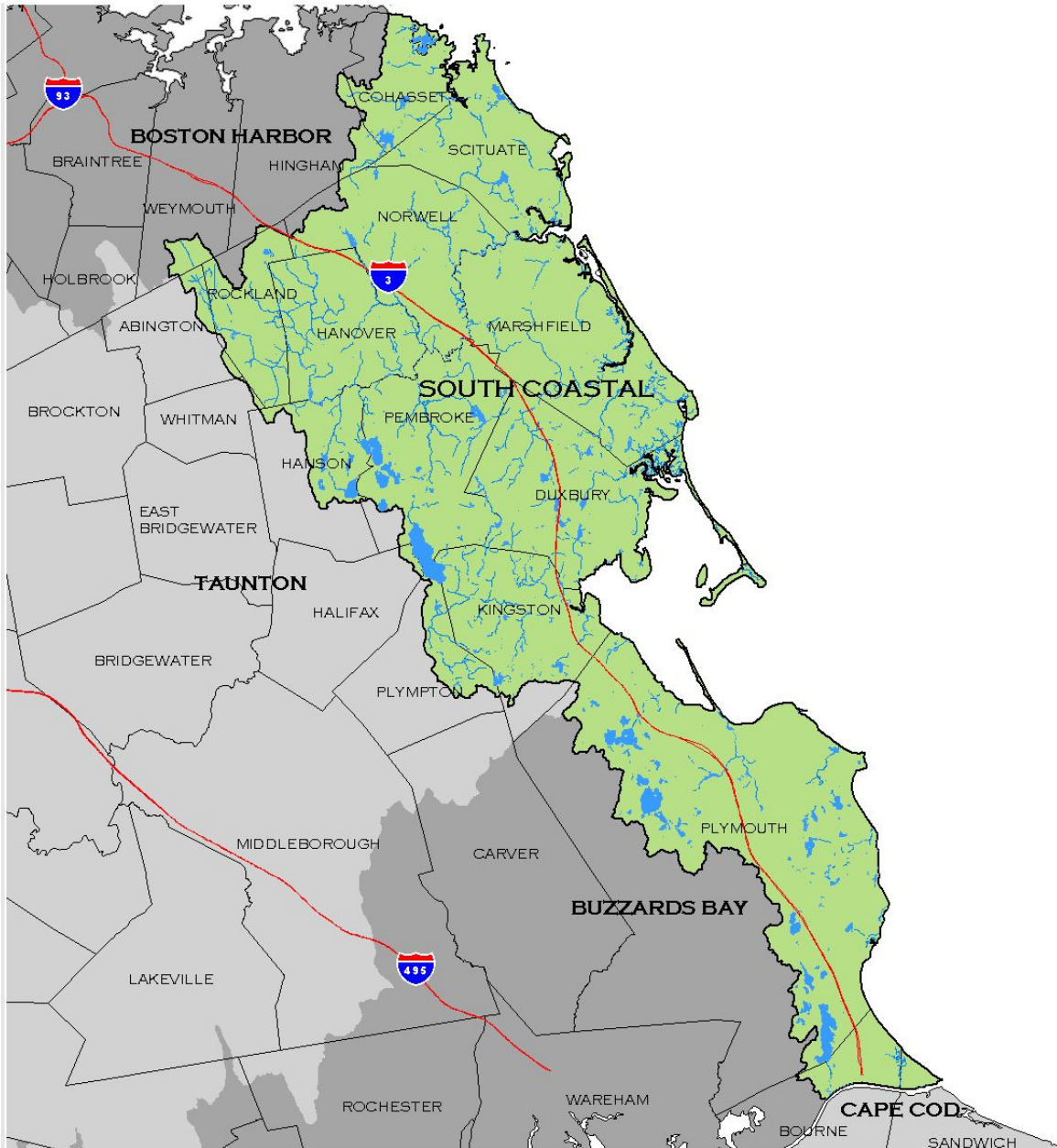
All WPP digital records related to data collection are considered formal records subject to WPP and MassDEP-wide (i.e., State Record Retention requirements) documentation protocols. Depending on record category, the duration for retention varies at least from seven to ten years. Due to the capacity of electronic storage, digital records are effectively in perpetuity.

Example documentation procedures include, but are not limited to:

- Use of indelible ink (not pencil) for paper records
- No omissions in the data (completeness)
- 100% QC checks on any manually entered data
- No use of erasing, "white-outs", removal of pages, and multiple crossovers to correct errors. When errors occur, they should be corrected according to the following procedures:
 - Draw a single line through the incorrect entry, insert the correct entry into the closest space available and initial and date the correction
 - Groups of related errors on a single page should have one line through the entries and should be initialed and dated with a short comment supplied for the reason of data deletion
- Use of Control Numbers for key documents
- Retention of original data downloads from field instruments

Table 4: WPP Project Documentation and Data Records

Sample Collection Records	Health & Safety Records	Fixed Laboratory Records	Data and QA/QC Assessment Records
Field Sheets (paper; backup) and electronic (EQuIS-EDGE) field data EDDs	Safety Data Sheet (SDS)	Chain of Custody (COC) Forms	Data Validation Report for specific data sets
Chain of Custody Forms	Hazardous Waste Generation Forms and Waste Receipt Forms	Laboratory Raw Data Reports and bench sheets	QA/QC section in published reports (e.g., Tech Memos)
Digital photos (tablets, cameras, phones)	Safety Training forms	Electronic Laboratory Data (WinLIMS, EDDs)	MS Excel data validation workbooks
Survey-related Correspondence (e.g., e-mail)	---	Analytical Instrument Logbooks	Technical Correspondence (e.g., e-mail)
GPS waypoints	Corrective Action Forms	Laboratory QC Results	Raw, preliminary and final data files (QC1-QC4)
Probe/data logger raw data downloads	Incident Report Forms	Level 1 and Level 2 Data QC reviews (WES)	Station definition files
Field Training forms	---	Performance Evaluation Test Results	Lab audit data and/or reports
Corrective Action Forms	---	MDL Studies	---
Field audit data and/or reports	---	Probe Instrument Calibration Logbook, User Reports, and Maintenance Logbook, electronic data downloads	---
---	---	Lab Training Forms	---



South Coastal Watershed

SECTION B: DATA GENERATION AND ACQUISITION

B1 SAMPLING PROCESS DESIGN

B1.1 Long-Term Design Strategy

WPP's ambient surface water monitoring program is a vital component of a comprehensive statewide monitoring approach to protect and restore the waters of the Commonwealth. The long-term approach for watershed-scale monitoring is to effectively utilize a combination of targeted, probabilistic, fixed-site and objective-driven monitoring, to address multiple objectives. WPP's 10-year monitoring strategy (2025 -2035) is discussed in detail in Section A5, above.

Requirements to support two of the objectives (waterbody assessments and TMDL development) are that the monitoring strategy be:

- statewide in scale
- comprehensive (all water bodies in the Commonwealth are assessed)
- repeated at regular intervals
- planned to increase the number of stream miles and lake acres assessed, and
- structured to reduce the historical bias toward problem areas

Collaboration on specific projects augments WPP's ability to assess other waterbody types, geographic areas, and objectives. Collaborative projects, which reflect WPP monitoring priorities but are managed by other groups, are to be covered in separate, project-specific QAPPs. For 2025-2029, collaborative projects include:

- **Southeast Estuaries Project (SEEP):** WPP is targeting the restoration of estuaries in coastal watersheds in Southeast Massachusetts. Despite the significant progress made, with around 30% of nitrogen impaired estuarine areas having an EPA-approved TMDL, 32% still require restoration planning. WPP will develop QAPPs and SAPs as needed to conduct monitoring necessary to develop TMDLs (Appendix B).
- **Nutrient Impaired Lake (NIL) TMDL Development:** A NIL is defined as a lake or pond that has been listed as impaired for causes related to nutrient pollution. WPP has developed a lake TMDL prioritization process (MassDEP, 2024). As funding and staff resources allow, WPP plans to develop lake nutrient TMDLs and restoration plans (Appendix B).
- **Assessment and TMDL Monitoring in Quinebaug River Watershed:** Through a joint funding agreement with the U.S. Geological Survey (USGS), WPP initiated a multi-year monitoring sampling project in the Quinebaug River Watershed. Water quality sampling in the upper Quinebaug River watershed is being conducted to determine whether several waterbodies are meeting the Massachusetts Surface Water Quality Standards (MA SWQS; 314 CMR 4.00) (MassDEP, 2021). Sampling is also being conducted to evaluate the relative contribution of nutrients. The work will support a planned TMDL by Connecticut Department of Energy and Environmental Protection (CT DEEP) for West Thompson Lake, an impoundment of the Quinebaug River in Connecticut.

- **Marine Benthic Monitoring:** Monitoring will be conducted in select estuaries. WPP developed the Massachusetts Estuaries Project Marine Benthic Monitoring Quality Assurance Project Plan in 2025, which can be used by towns or contractors for the purpose of collecting benthic data to inform management decisions for Massachusetts estuaries.
- **Mount Hope Bay and Buzzards Bay Estuary Monitoring:** WPP and USGS are collaborating to monitor Mount Hope Bay and selected Buzzards Bay estuaries to characterize current water quality conditions, assess nutrient-related impacts, capture conditions before and after planned upgrades to wastewater treatment facilities, and to provide data to review existing coastal and marine dissolved oxygen criteria in the MA SWQS (314 CMR 4.00). WPP owns three YSI marine water quality monitoring buoys. USGS manages the deployment of the MassDEP-owned buoy in Mount Hope Bay and contributes to the existing Narragansett Bay Fixed-Site Monitoring Network (NBFSMN). Two buoys are being deployed at selected locations in Buzzards Bay to evaluate nutrient, biological indicator, and hypoxia levels (Appendix B).
- **Nutrient Loading in the Merrimack River:** WPP and USGS have collected nutrient and probe data along the Merrimack River including the marine segments (2021-2024). A summary report will be prepared in 2025.
- **National Water Quality Initiative (NWQI):** The Natural Resources Conservation Service (NRCS), United States Department of Agriculture (USDA), developed the NWQI to address nonpoint sources of pollution associated with agriculture within relatively small watersheds, identified and prioritized by individual states. With support from EPA, WPP monitored conditions in the James and Unkety Brook watersheds (2021-2023) and is monitoring the Upper Manhan River in Easthampton, Southampton, and Westfield (2024-2025).
- **Emerging Contaminants:** In 2024, WPP conducted a study at 36 waterbodies across Massachusetts, including 10 freshwater and 26 coastal locations, to test for PFAS contamination using EPA's 1633A method. At freshwater locations, surface water samples, whole-body fish samples, skinless-boneless fish fillet samples, and invertebrate composite samples were collected and analyzed. At coastal locations, surface water samples, skinless-boneless fish fillet samples, and shellfish composite samples were collected and analyzed. Going forward, WPP aims to expand its monitoring of emerging contaminants across Massachusetts over the next five years (2025-2030). To broaden its focus to other contaminants of concern, WPP is planning to monitor 6PPD and 6PPDq, pharmaceuticals and personal care products, pesticides, and microplastics (and PFAS monitoring where needed). To support this expanded monitoring, WPP will develop necessary QAPPs and SAPs to ensure accurate data collection.
- **Bathymetric mapping:** WPP will continue to share bathymetric data with MA DFG to generate lake and pond bathymetric maps for online publication.
- **Fish Toxics Monitoring:** Since 1993/94 MassDEP has participated in the Interagency Committee on Freshwater Fish Toxics Monitoring and Assessment (Interagency Committee). The committee consists of MassDEP (WPP, the Office of Research and Standards [ORS], and the Senator William X. Wall Experiment Station [WES]), the Massachusetts Department of Public Health (DPH), and the

Massachusetts Department of Fish and Game (DFG). The committee developed a Memorandum of Understanding (MOU) to guide the prioritization of fish tissue toxics monitoring requests received from the public. The committee reviews the requests each spring and the chosen lakes/rivers are surveyed by MassDEP staff. The objective of public request is to screen edible fillets of fishes for a variety of contaminants (typically mercury, arsenic, cadmium, selenium, and where they are suspected, for polychlorinated biphenyls ([Aroclors and toxic congeners], and organochlorine pesticides). Tissue samples from collected fish are sent to WES or other laboratories for analysis. All data are sent to DPH and MassDEP ORS for risk assessment and site-specific advisory issuance if appropriate.

Over the years the number of external data providers has increased substantially, providing new and varied sources of information to support water management decision-making. For example:

- WPP's CWA s.604(b) Water Quality Management Planning Grants to outside parties have substantially supported nonpoint source management and other assessments.
- Also, since 2018, WPP has provided [Water Quality Monitoring Grants](#) to eligible volunteer monitoring groups and coalitions to monitor water quality.
- Other potential data providers include academic institutions, government agencies, watershed associations, NPDES permit holders and environmental consultants.
- MassDEP continues to work collaboratively with various groups to optimize MassDEP's utilization of their data. The acquisition of valid scientific data are achieved, in part, by ensuring that interested monitoring parties develop SOPs and QAPPs that will increase the likelihood that these external data sources can be used to fulfill selected CWA requirements (e.g., CWA s.305(b)/s.303(d) assessment and listing functions).
- WPP provides assistance to external groups related to QAPP development, review and approval, as well as to monitoring program development, grant funding, and data sharing.

B1.2 Short-Term Sampling Plans

The decision-making process regarding where, when, how, why and what to sample is complex and challenging. The overall scope of the monitoring effort is limited by available human resources, equipment, funds, competing needs and priorities. Each year and as needed, WPP staff develop Sampling and Analysis Plans (SAPs) which guide data gathering activities. For details regarding project-specific sampling locations, frequencies, analytes, methods, etc., see the separate and individual SAPs. These SAPs are supplements to this programmatic QAPP, and their contents mirror selected QAPP Standard Guidance elements (i.e., A4-A6, B1, and B2) as they pertain to those projects.

B1.3 Core Indicators

Although highly project-dependent on specific SAPs, WPP typically monitors specific core and supplemental indicators to assess the aquatic life uses, water contact recreational

uses, and other human health-related water uses as defined in the Massachusetts Surface Water Quality Standards (MA SWQS; 314 CMR 4.00), as indicated below. Core and Supplemental indicators used by WPP are shown below (Table 5).

Table 5: Core and Supplemental Indicators

INDICATOR TYPE	AQUATIC LIFE	RECREATION	FINFISH/SHELLFISH CONSUMPTION
Core	Macroinvertebrate community Fish community Periphyton/Phytoplankton Macrophyton Habitat quality * Dissolved oxygen pH Temperature Lake trophic status Toxic pollutants (e.g., metals, chloride, PFAS)	Beach closures Pathogens (e.g., <i>E. coli</i> and enterococci) Transparency Harmful Algal Blooms, Chlorophyll Macrophyte density Land-use/% impervious cover	Fish consumption Advisories Fecal Coliform Mercury PCBs Pesticides Shellfish bed closures (non-management)
Supplemental	Toxicity tests (water, sediment) Tissue chemical assays Nutrients Chlorophyll Sediment chemistry Organism condition factor Non-native species Land-use/% impervious cover Fish kills Pollutant loadings Suspended solids Turbidity Specific Conductance Misc. emerging contaminants	Aesthetics Objectionable deposits (scums, sheens, etc.) Flow/water level, Sediment quality Color/Turbidity pH PFAS Combined Sewer Overflows (CSOs)	Toxic Pollutants Contaminants of concern (e.g., PFAS, PPCPs) Pathogens

* Water quantity (discharge), geomorphology (slope, bank stability, channel morphology), substrate (sediment type, embeddedness) and riparian zone (shoreline vegetation, canopy)

B1.4 Probabilistic Sampling

The goal of the Massachusetts Probabilistic Monitoring and Assessment Program (MAP2) is to provide a comprehensive assessment of the condition of surface waters in

Massachusetts through the implementation of probabilistic sampling designs. With completion of the wadeable rivers and streams (2010-2015), lakes (2016-2018), coastal areas (2020 – 2023) probabilistic surveys, MAP2 will focus again on wadeable rivers and streams from 2025 – 2028.

MAP2 Wadeable Rivers and Streams (2025 – 2028)

The target population for the MAP2 wadeable rivers and streams survey is defined as all wadeable 1st – 5th Strahler stream order non-tidal perennial rivers and streams with a total drainage greater than 1.5 km² within the Commonwealth of Massachusetts. The major river basins in the Commonwealth were regionally assigned to four groups (four strata) with each group containing an approximately equal quantity of river and stream miles. During each year of the four-year cycle, approximately 20 sites in one basin group (strata) will be monitored by WPP personnel in the Division of Watershed Management, MassDEP, thus covering the entire state in four years.

The goal of the MAP2 wadeable rivers and streams survey is to collect sufficient data at a minimum of 80 probabilistically (random) selected sites throughout the Commonwealth to assess the status of designated uses (Aquatic Life Use, Recreational Use, Aesthetic Use) and stressors in the target population to comply with s.305(b) of the Clean Water Act (CWA) in the Integrated Report. The types of data that will be collected at each of the sites to reach this goal are:

- Nutrients (total phosphorus, total nitrogen, nitrate-nitrite, and ammonia)
- Chloride
- Dissolved organic carbon (DOC)
- *Escherichia coli* bacteria
- Instantaneous dissolved oxygen, temperature, pH, and specific conductivity
- Continuous dissolved oxygen and temperature (8-week duration)
- Aesthetics observations
- Benthic macroinvertebrate community
- Fish community
- Habitat assessments

B1.5 Targeted Sampling Designs (2025-2029)

Rotating Basin Monitoring

Targeted monitoring of lakes, rivers and estuaries is needed to provide data and information to support the development and implementation of various measures to restore impaired waters. These measures include the identification or verification of causes and sources of impairment, calculation and implementation of TMDLs and watershed-based plans to manage point and nonpoint sources of pollution, issuance of NPDES wastewater discharge permits, and installation of stormwater controls and BMPs. As detailed in Section A5, above, WPP has established a sequential schedule (Table 6) that provides the opportunity for monitoring to be carried out in each watershed at least once every seven years, yet allows for monitoring resources to be disproportionately applied in each watershed to fulfill specific water resource management objectives. Massachusetts'

27 major watersheds and coastal drainage areas have been arranged by geography (and hydrology) into four major groups, or cohorts (A-D), each consisting of from three to ten basins. Each major cohort is subdivided into one or two minor cohorts, each of which represents one year of the seven-year monitoring schedule (Figure 4).

Table 6: WPP Seven-Year Rotating Basin Cycle (2021-2027)

NAME	Major Cohort	Total Yrs. in Cohort	Minor Cohort	NHD Water Resource Estimations					Assessment Units	
				Perennial River Miles	River Mi / Year	Lakes > 5 Acres	Lake Acreage	Lakes / Year	River Segments (Total Length Miles)	Lake Segments (Total Area Acres)
Concord (SuAsCo)	A	2 (2021-2022)	A1	529	1324	134	7186	367	53 (187)	61 (6572)
Merrimack			A1	344		93	5071		39 (140)	29 (3515)
Nashua			A1	664		126	10344		79 (273)	69 (9524)
Shawsheen			A1	98		12	408		21 (65)	14 (406)
Ipswich			A2	157		68	2992		22 (97)	39 (1922)
North Coastal			A2	116		64	2698		22 (41)	42 (2006)
Parker			A2	81		24	588		7 (28)	12 (290)
Charles			A2	384		113	3726		45 (178)	50 (2824)
Boston Harbor			A2	274		100	4352		60 (166)	50 (2982)
Connecticut	B	2 (2023-2024)	B1	999	1722	96	3358	233	63 (345)	46 (2460)
Chicopee			B1	907		168	31113		51 (259)	74 (29797)
Millers			B2	435		97	4762		30 (134)	64 (3846)
Westfield			B2	630		85	4295		63 (320)	33 (3648)
Deerfield			B2	474		21	788		130 (366)	22 (561)
Ten Mile	C	2 (2025-2026)	C1	92	1322	21	937	611	10 (35)	12 (595)
Taunton			C1	746		223	13697		49 (222)	87 (10901)
Narragansett Bay			C1	178		29	4552		20 (65)	6 (3769)
Blackstone			C1	334		148	6509		48 (168)	100 (5177)
Quinebaug			C1	210		56	2451		28 (86)	25 (1980)
French			C1	97		56	3603		18 (39)	43 (3420)
Buzzards Bay			C2	479		210	6546		25 (79)	72 (4983)
South Coastal			C2	244		131	4925		22 (58)	75 (4214)
Cape Cod	C2	177	280	11567	16 (33)	68 (5706)				

NAME	Major Cohort	Total Yrs. in Cohort	Minor Cohort	NHD Water Resource Estimations					Assessment Units	
				Perennial River Miles	River Mi / Year	Lakes > 5 Acres	Lake Acreage	Lakes / Year	River Segments (Total Length Miles)	Lake Segments (Total Area Acres)
Islands			C2	86		69	5738		6 (12)	5 (106)
Housatonic	D	1 (2027)	D1	547	952	117	5982	194	35 (219)	33 (4284)
Hudson			D1	229		13	759		26 (109)	8 (716)
Farmington			D1	175		64	3907		40 (108)	18 (2135)

Basic assessment monitoring will be performed in each minor cohort for one year and will be consecutive within major cohorts (e.g., A2 will always follow A1). However, the extended time allotted to the major cohorts (two years for all but three basins) allows for the basic schedule to be adapted to fulfill specific data needs. As such, the level of effort applied to monitoring within each major cohort, will not necessarily be evenly distributed through the minor cohorts, individual basins, or particular sites, but will vary depending on priorities and objectives (see Table 7 draft list of priorities). Targeted monitoring may be focused anywhere within the major cohort and, if necessary, extend through all or a portion of the time allotted to that cohort.

Table 7: Assessment Prioritization

Priority	Priority Order	General Category	Category Descriptions ¹
High	1	Reassessment	Reassessment of Assessment units in Category 5 for nutrient impairments. Prioritization based on severity of impairment and age of data.
High	2	Unassessed (suspect impairment)	Assessment units listed in Category 3 or waters without an assessment unit where there are indications it could be listed in Categories 4c or 5 for at least one impairment cause (i.e., unassessed waters suspected to be impaired).
Medium	3	Reassessment	Reassessment of Assessment units in Category 5 for pathogen impairments. Prioritization based on severity of impairment and age of data.
Medium	3	Unassessed (suspect support)	Assessment units listed in Category 3 or waters without an assessment where there are indications it could be listed in Category 1 or 2 (i.e., unassessed waters likely to support uses). Prioritized by likelihood of support and external interest (potential NPS projects/healthy watershed based plan, etc.).
Low	4	CWF Determination	Assessment units or waters without an assessment unit thought to be an undesignated or under documented Cold Water Fishery (CWF). Medium if also in priority order #3.

¹ Assessment units placed in prioritization categories based on available information from multiple sources (monitoring data, landscape data, pollution control measures, assessment methodologies, etc.).

B1.6 Targeted Monitoring for Rivers and Streams

Targeted monitoring of rivers and streams is planned according to the seven-year flexible rotating basin schedule described above and may consist of chemical, physical, and biological sampling components depending on the survey goals. Planned surveys are conducted in both dry and wet weather, and surveys are cancelled only when wet weather conditions result in unsafe sampling conditions with the exception of macroinvertebrate studies after high flow. Planning and implementation of wet weather surveys are only conducted if a specific project calls for it. Sampling locations for rivers and streams are intended to represent lotic water conditions, although some locations in and near wetlands may also represent wetland water quality conditions.

River & stream water quality surveys typically consist of five or six monthly sampling events from April 1 to October 15 (primary contact recreation period) on rivers and streams. Example analytes can include pH, dissolved oxygen, temperature, conductivity, turbidity, total suspended solids, chloride, nutrients (TP, TN, NO₃/NO₂-N, NH₃-N), dissolved metals (Ca, Mg, and Na), dissolved organic carbon (DOC), and indicator bacteria (*E. coli* for freshwater and enterococci for coastal areas).

New analytes:

The Massachusetts Surface Water Quality Standards (MA SWQS; 314 CMR 4.00) include the copper Biotic Ligand Model (BLM) as an option to derive freshwater copper criteria. The BLM generates criteria values that incorporate the effects of water chemistry on the bioavailability and toxicity of copper, requiring ten water chemistry parameters as inputs. As resources allow, WPP may include the following ten additional analytes to aid implementation of the BLM: DOC, major cations (Ca, Mg, Na, & K), major anions (SO₄ & Cl), alkalinity, and sulfide. Hardness will also be included to calculate copper criteria using the hardness-based equations. Additionally, MassDEP may amend the MA SWQS in the future to include EPA's recommended update to the selenium (Se) criteria. Therefore, the sampling of selenite and selenate as well as total selenium may be warranted. Updated secondary contact recreational criteria (*E. coli*, enterococcus); PFOA, PFOS, and associated benchmarks; cyanobacteria toxins microcystin and cylindrospermopsin; updated marine DO (7-day average, 24-hour minima, and preferred bottom sampling) are all potential criteria considered for adoption in upcoming MA SWQS triennial reviews.

The **biological monitoring component** in rivers typically consists of habitat assessments and surveys to collect macroinvertebrates, fish, aquatic plants, algae, and periphyton. These assessments help determine aquatic life use-support status. WPP has completed a macroinvertebrate IBI and is developing a bioassessment methodology using diatoms with further details on our [Water Quality Assessments page](#) under the Macroinvertebrate Indices of Biotic Integrity (IBI) section.. The implementation of bioassessment methods increases the accuracy and precision of aquatic life use assessments and improves water quality goal-setting processes.

Macroinvertebrates:

MassDEP conducts biological monitoring of wadeable streams using standardized sampling and assessment methods designed to evaluate the biotic condition of benthic macroinvertebrate communities. WPP's approach is adapted from the U.S. EPA Rapid

Bioassessment Protocols (RBPs) and has been refined to support the development and application of regionally calibrated Indices of Biotic Integrity (IBIs) for both high-gradient and low-gradient streams in Massachusetts. The field collections use gradient-specific methods, with single-habitat kick-net sampling used in high-gradient streams targeting riffle habitats, while multi-habitat sampling is used in low-gradient systems, with targeted habitats such as root mats, aquatic vegetation, and woody debris. These samples are collected to support biocriteria development assessments for 305(b) reporting and impaired water listings for 303(d) decisions under the Clean Water Act, outlined in the Massachusetts Consolidated Assessment and Listing Methodology ([CALM](#)) Guidance Manual. The collected samples are processed in the laboratory, which includes sorting, taxonomic identification, and enumeration. Biological condition is interpreted using biological metric scoring and IBI models specific to the site's stream type (high- or low-gradient). Consistent with WPP's assessment framework, categories of biological condition are defined based on IBI score thresholds, distinguishing between non-impaired, slightly impaired, moderately impaired, and severely impaired conditions.

Fish Community and Cold Water Fisheries:

The finfish community as a measure of biological integrity is sampled. Fish community data quality and comparability are assured through the use of qualified fisheries professionals and the application of consistent methods. WPP utilizes a standardized method based on the EPA Rapid Bioassessment Protocol V (RBP V) to improve data comparability among wadeable sampling sites throughout the state. Electrofishing has generally proven to be the most comprehensive and effective single method for collecting fish, and is, therefore, the preferred method for obtaining a representative sample of the fish community at each sampling site. Fish (except young-of-the-year) collected within the study reach are identified to species (or subspecies), counted, and examined for external anomalies (i.e., deformities, eroded fins, lesions, and tumors). Aquatic life use-support status is derived from knowledge of the environmental requirements (i.e., water temperature and clarity, dissolved oxygen content, etc.) and relative tolerance to water pollution of the fish species collected. In accordance with Chapter 131 §4 of the Massachusetts General Laws, Scientific Collection Permits are renewed annually for any project collecting fish.

Algae and Cyanobacteria:

Algae represent a third biological community that is typically assessed as part of the biomonitoring efforts. The analysis of the attached algae or periphyton community in shallow streams or the phytoplankton in deeper rivers and lakes employs an indicator species approach whereby inferences on water quality conditions are drawn from an understanding of the environmental preferences and tolerances of the species present. Algal indicators of the presence of elevated metals concentrations, nutrient enrichment, or other pollutants are noted. Because the algal community typically exhibits dramatic temporal shifts in species composition throughout a single growing season, results from a single sampling event are generally not indicative of historical conditions. For this reason, algal community assessments are more useful as supplemental information to the assessments of other communities that serve to integrate conditions over a longer time period. In some instances, where information pertaining to primary production is required,

algal biomass analysis or chlorophyll determinations may be performed. Results of these analyses are used to evaluate the trophic status of lakes, ponds, and impoundments. Similar information from riverine and coastal waters is used to identify those waterbodies subjected to excessive nutrient enrichment. Results at public drinking water reservoirs can indicate whether land uses need to be addressed as sources of nutrients and can help water suppliers adjust treatment processes if necessary.

Cyanobacteria are a normal part of the algal assemblage of a lake/pond or even streams/rivers. But when their growth is excessive, indicated by blooms, and when they are present for extended periods of time, they may indicate nutrient enriched waters and can produce harmful levels of cyanotoxins. Harmful algal blooms (HABs) pose the risk of potential toxicity to recreational users of the lakes and ponds as well as field personnel who may be exposed dermally or through aerosols in their normal work. Consistent with MassDEP's HAB protocols (Appendix B), cyanobacteria samples may be collected by field personnel when a possible bloom or excessive algal growth is observed and reported. WPP assessment protocols require that both a temporal pattern as well as elevated cell counts be documented to establish that an impairment may exist. To establish this pattern, samples should be collected approximately every 10 days for the duration of the bloom or three times over the recreational period. Analysis includes identification of taxa present, cell counts, and, if toxin-producing cyanobacteria are present, samples may be sent for cyanotoxin analysis (e.g., microcystin, cylindrospermopsin and/or anatoxin-a). If a HAB is present, field staff are alerted so safety measures can be taken in future work at this waterbody. The local Board of Health and Mass DPH are also notified if a bloom is confirmed at a recreational area.

Toxic contaminants in biota:

Assays for the presence of toxic contaminants in fish tissue is another important WPP monitoring element. These data help assess the risk to human consumers associated with the consumption of freshwater finfish. In the past fish collection efforts were generally restricted to waterbodies where wastewater discharge data or previous water quality studies indicated potential toxic contamination problems. More recently concerns about mercury contamination from both local and far-field sources have led to a broader survey of waterbodies throughout Massachusetts.

Through a cooperative monitoring effort including MassDEP, DFG, and DPH, fish sampling is performed at sites at the recommendation of the Inter-Agency Fish Toxics Committee each year. Edible fillets from fish can also be analyzed for the presence of mercury, arsenic, cadmium, and selenium. Fillets from selected waterbodies are also analyzed for other contaminants as determined, such as PCBs, organochlorine pesticides, and PFAS. Uniform protocols, designed to assure accuracy and prevent cross-contamination of samples, are followed for fish collection, processing and shipping. Fish are typically obtained with electrofishing gear or gill nets. Lengths and weights are measured and fish are visually examined for tumors, lesions, or other indications of disease. Data are provided to DPH, the agency responsible for performing risk assessments and issuing public health advisories. Other tissue assays to trace the fate and transport of toxic

contaminants in the aquatic environment are performed on a limited basis, primarily to support waste site clean-up activities.

B1.7 Targeted Lake Sampling

Lake sampling consists of biological surveys of the macrophyton (i.e., aquatic vascular plants) community, "in-situ" measurements using metered probes, and limited water quality sampling. Lake surveys typically include sampling and measurements for chlorophyll *a*, Secchi depth, nutrients and dissolved oxygen/temperature profiles, and measurements with continuous dissolved oxygen and temperature probes deployed at various depths. Lake surveys are generally conducted on multiple days for TMDL development and consist of bathymetric mapping; physical, chemical and biological sampling of the open water areas, tributary stream(s), and outlet; and a quantitative and qualitative mapping of the aquatic macrophyton community. The lake is sampled during the summer months when productivity is high and in late spring and early fall.

B1.8 Specific Objective Monitoring Projects

In addition to the targeted monitoring on the rotating basins schedule, other monitoring projects supporting specific goals are conducted each year. For 2025-2029, current, planned and/or potential projects (detailed below) include but are not limited to: Mystic Lakes TMDL Study, Reference Site Network, Chloride, 6PPD/6PPD-q, and Biocriteria Development/ Macroinvertebrate monitoring. (See annual SAPs in Appendix C). Targeted projects conducted in collaboration with other groups/agencies are listed above (Section B1.1) and covered under separate QAPPs.

Mystic River Watershed Lakes TMDL Study:

The Mystic River Watershed Lakes TMDL Study is a multi-year project (2019 – 2022, 2025) in collaboration with EPA Region 1's NERL (See Appendix C for 2025 SAP). The project aims to determine the current trophic status of the lakes, and to support calibration of a Lake Loading Response Model (LLRM) and development of TMDLs for Horn Pond, Wedge Pond, and Spy Pond. A collaborative project to determine the internal load is also being conducted in 2025 (Appendix B). Additionally, the data collected will be used to assess the status of designated uses (Aquatic Life Use, Recreational Use, Aesthetic Use) at the sampled lakes. The data that will be collected in 2025 are:

- Vertical profile deployments (dissolved oxygen, temperature)
- Vertical profiles (dissolved oxygen, temperature, pH, conductivity)
- Sediment cores

Statewide Bathymetry Project:

Initiated in the spring of 2024, the project aims to collect digital depth data from lakes, ponds, and major rivers throughout Massachusetts. These data are only currently available for fewer than 10% of Massachusetts freshwater lakes and ponds. The bathymetry data will be used by WPP, as well as by sister agencies (e.g., DFG, DCR) and the public. WPP will use these data to develop lake classification metrics for assessment processes, in TMDL development, to support ongoing Targeted Assessment Monitoring (TAM), to obtain maximum depth and other depth statistics for potential amendments to the

Massachusetts Surface Water Quality Standards (MA SWQS; 314 CMR 4.00), and to develop publicly available bathymetric maps of state waters. Data collection planning is coordinated with the Division of Fisheries and Wildlife (MassWildlife) in DFG. Bathymetry data are collected using Lowrance bathymetry units with transducer arrays capable of collecting depth, biovolume, and bottom hardness data. Logged data are uploaded and processed via the online Biobase system to create maps and data tables. The raw data files are stored via OneDrive at MassDEP and shared with DFG for processing and use in their existing bathymetric mapping program. The resulting maps and data will be made publicly available via DFG.

Regional Monitoring Network – Streams:

The Regional Monitoring Network – Streams (RMN - Streams) is an EPA-guided, multi-State, project that is designed to provide long-term ecological data for the purposes of trend analysis, and comparison with other, more synoptic, data sets. The project design establishes sentinel sites that are monitored with a minimum of effort and expense across the nation. WPP has been a participant in RMN – Streams since 2011. WPP currently monitors six sites in Massachusetts (Cold River, Avery Brook, West Branch Swift River, Hubbard River, Parkers Brook, and Browns Brook) from four ecoregions. All six sites represent “least impacted” conditions when considering direct human influences within the contributing watersheds. Current activities at these sites include the collection of continuous air and water temperature measurements, and ambient dissolved oxygen and conductivity measurements through the long-term deployment of data logging devices. Data from these devices yields continuous data, providing more consistent and complete information than discrete data collection. WPP also deploys three “game cameras” to supply USGS with images to support their flow estimation project. WPP’s six sites are visited quarterly when data are recovered from deployed logging devices and cameras, and quality control measurements are taken to ensure all deployed devices are properly operating. Upon each quarterly visit, nutrient (total phosphorous, total nitrogen, nitrate / nitrite, and ammonia) and chloride samples are collected. Annually, a benthic macroinvertebrate sample is collected from each site for evaluation of benthic community health and for assessment of the “Aquatic Life Use” in accordance with the Massachusetts Consolidated Assessment and Listing Method (CALM) Guidance Manual. Quality-controlled RMN stream data are provided to EPA for national assessment.

Regional Monitoring Network – Lakes:

The EPA, Office of Research and Development, is supporting EPA regional offices, states, tribes, river basin commissions, other federal agencies, universities, and other entities to establish Regional Monitoring Networks (RMNs) for freshwater lakes. RMNs are a collaborative effort to collect long-term monitoring data at targeted sites to identify and detect changes and trends over time due to natural variability (e.g., changing climatic conditions) The intent is to pool the RMN data at a regional scale, which will enable more robust analyses and allow for detection of widespread patterns that may otherwise be missed at the state and local level. Currently, there are two lake RMNs (Northeast and Midwest) active in the United States (USEPA, 2020). The objectives of the RMNs align with and supplement Clean Water Act (CWA) goals (fills data gaps, protocol consistency,

emerging technology utilization) and therefore have been integrated into the monitoring efforts of WPP for lakes since 2023.

WPP currently monitors two lakes, Upper Spectacle Pond in Sandisfield, MA and Russell Pond in Russell, MA, as part of the Northeast RMN. WPP is collecting the following data to support the objectives of the Northeast RMN:

- Discrete vertical profile (dissolved oxygen, temperature, pH, conductivity)
- Continuous vertical profile (dissolved oxygen, temperature)
- Secchi disk transparency
- Nutrients (total phosphorus, total nitrogen)
- Water chemistry (alkalinity, hardness, turbidity, chloride, dissolved organic carbon)
- Chlorophyll *a*
- Phytoplankton community
- Littoral macroinvertebrate community
- Water level
- Ice cover duration
- Aesthetics observations
- Human disturbance observations
- Bathymetry

Chloride Monitoring:

Road salt is applied to roadways in winter as a deicer and when applied, NaCl has been found to be the major source of elevated sodium and chloride in Massachusetts streams. Chloride is a recognized toxin with the potential to impair waterbodies, impact biological communities, and contribute to year-round elevated chloride levels in streams and groundwater. This multi-year project involves collecting continuous conductivity data to estimate chloride levels using a conductivity-chloride regression developed by WPP. Estimated chloride data will help assess the effects of seasonal road salt (NaCl) applications on surface water quality and may be compared with EPA ambient criteria for acute and chronic toxicity. The results of this study have the potential to impair waterbodies for chloride and provide baseline data for potential development of TMDLs. Sampling locations focus on streams near major highways or in heavily urbanized areas. Monitoring occurs from October to June, covering the winter season. Continuous conductivity data are collected using HOBO U24 freshwater data loggers. Attended, discrete quality control (QC) readings will be taken at each visit using separate YSI/Hydrolab multiprobe instruments. On at least two of the survey rounds, water samples will be collected and analyzed for chloride (only). For assessment purposes and to determine potential chloride impairments in fresh surface waters, MassDEP analysts developed a linear regression model to estimate chloride concentrations from specific conductance (SC) measurements. Appendix F of the [2024 Massachusetts Consolidated Assessment and Listing Methodology Guidance Manual](#) details the development of the linear regression model.

Biocriteria Development:

Biocriteria development monitoring focuses on biological communities (macroinvertebrates, fish, and periphyton) and associated water quality conditions at sites

across a human disturbance gradient (e.g., pristine to severely disturbed). Biocriteria are commonly expressed as multimetric indices of biotic integrity (IBI) and the metrics comprising an IBI are selected based on the strength of their ecological response to human disturbance. The implementation of biocriteria increases the accuracy and precision of aquatic life use assessments and improves water quality goal-setting processes. WPP has previously developed biocriteria using benthic macroinvertebrate assemblages.

The IBI's have been used for site-specific assessments. The focus of this project was macroinvertebrate monitoring, implemented on a statewide or regional scale, to support WPP's biocriteria development. The finalized monitoring data have been used by WPP to study the response of biological communities to human disturbance for further biocriteria development. After the initial phases of biocriteria development were completed, additional work was completed to address gaps in the Massachusetts macroinvertebrate dataset. The two most significant data gaps were:

- High gradient streams in the Western Highlands with high levels of human disturbance (Figure 7)
- Low gradient streams in the Central Hills and southeastern Massachusetts with low levels of human disturbance (i.e., reference) (Figure 7)

Filling these data gaps helped to refine, expand, and improve the accuracy of the macroinvertebrate biocriteria for the existing IBIs.

From 2022-2025, WPP will focus on collecting periphyton samples from high-gradient, wadeable streams throughout Massachusetts with the intent to develop biocriteria based on the diatom assemblage. Sampling is still ongoing with no reported end date currently. WPP intends to develop a stream diatom IBI that should be responsive to nutrient enrichment and other environmental stressors. The diatom and macroinvertebrate IBI will provide MassDEP with assessment tools that are sensitive to a broad range of stressors in a multi-faceted biomonitoring framework applicable throughout Massachusetts. Biological monitoring samples are limited to hard inorganic or organic substrata in high-gradient wadeable sections of streams and rivers while targeting diatom communities in riffle/run habitats between July to the end of September. Field sampling will include collection of periphyton from hard substrates for diatom species identification, biomass estimates, and DNA metabarcoding analysis (time permitting). Chlorophyll *a*, true color samples, and water chemistry samples will be analyzed in lab.

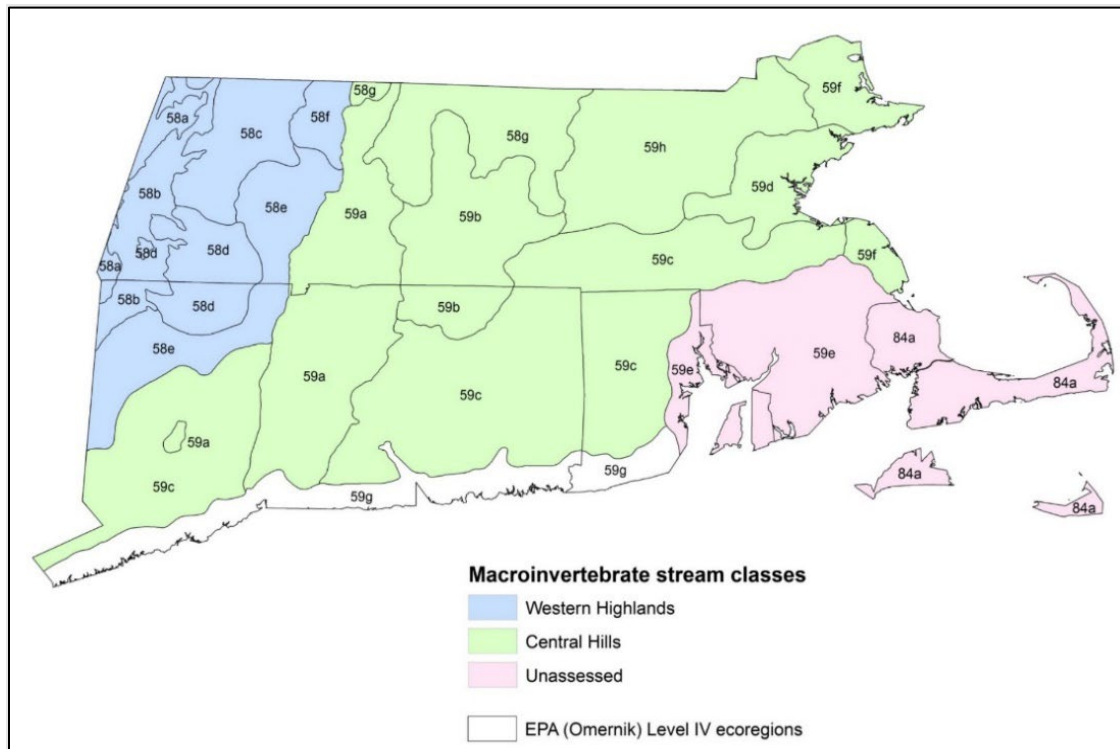


Figure 6: Macroinvertebrate Stream Classes in Southern New England (Jessup and Stemp 2019)

Cold Water Fisheries (CWF):

Monitoring of the stream fish assemblage to determine Cold Water Fishery status is an integral component of the MassDEP water quality management program, and its importance is reflected in state stream class and use-support designations. Assessments of the Cold Water fish assemblage help to ensure the overall structure and function of the Cold Water ichthyofaunal community and ultimately protect surface water resource quality. The data collected will support identification of Cold Water Fisheries, §305(b) assessments, and development of a revised procedure for designating a freshwater river or stream as a Cold Water in the Massachusetts Surface Water Quality Standards (MA SWQS; 314 CMR 4.00).

For general fish population investigations, WPP uses a consistent, standardized method based on the fish protocols in EPA's *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish* (Barbour et al. 1999) to improve data comparability among wadeable sampling sites throughout the state. The CWF monitoring efforts will use a revised version of these methods to focus on cold water species. Fish collection procedures will prioritize sampling habitats within a stream that will maximize the potential for collecting cold water species (e.g., portions of the stream with overhanging banks, suitable cover, and potential for cold water seeps or cooler water habitats). Whenever possible, the sample reach should be sampled sufficiently upstream of any bridge or road crossing to minimize the hydrological effect on overall habitat quality. Wadeability and accessibility may ultimately govern the exact placement of the sample reach. A habitat assessment is performed (and in some cases

physical/chemical parameters are measured) concurrently with fish sampling to document and characterize available habitat specifics within the sample reach.

All fish sampling gear types are generally considered selective to some degree; however, electrofishing has proven to be the most comprehensive and effective single method for collecting stream fishes. Pulsed DC electrofishing is the method of choice to obtain a representative sample of the fish community at each Massachusetts sampling station. The accurate identification of each fish collected is essential, and species-level identification is required. Field identifications are acceptable; however, voucher specimens must be retained for laboratory identification if there is any doubt about the correct identity of the specimen. To identify reproducing populations of Cold Water species (as opposed to stocked individuals), the collection of young-of-the-year brook trout and any slimy sculpin will be emphasized. Full methods are detailed in CN 533.1 *Fish Collection Procedures for the Evaluation of Potential Cold Water Fisheries in Wadeable Streams*.

Emerging Contaminant Monitoring:

WPP is developing a five-year Emerging Contaminants Workplan (2025-2030). Guided by this plan (and related QAPP), WPP plans to initiate a pilot study investigating the chemicals 6PPD and 6PPD-q in 2025/2026. 6PPD is added to tires as a hardener to prevent degradation, and it sloughs off as tires wear on roadways. Stormwater runoff plays a critical role in the transport of 6PPD. During storm events, rainwater flushes the 6PPD particles from the roadways, carrying them into nearby storm drains or over land and into surface waters. In the process, 6PPD rapidly oxidizes to form 6PPD-q, which has been shown to be toxic to aquatic life at very low concentrations. The increased surface runoff during storm conditions is expected to elevate 6PPD-q levels in aquatic environments, further heightening exposure risks for vulnerable aquatic life.

The 6PPD and 6PPD-q monitoring project aims for better understanding of the presence/absence of 6PPD and the levels of 6PPD-q in surface water impacted by stormwater. This sampling initiative will focus on measuring contaminant presence and concentrations in rivers and streams within the greater Worcester area, specifically in areas influenced by urban development, impervious surfaces, and/or traffic density. Samples will be collected in two rounds, each including the same 20 locations, at two distinct time periods during summer and fall 2025. In each round, samples will be collected under baseline (dry) weather conditions and wet conditions in the selected waterbodies. The water samples collected in this project will be analyzed by using EPA's Draft Method 1634 (EPA 2024a), a standardized approach for detecting 6PPD-q in both surface water and stormwater. This study will also measure the presence/absence of 6PPD in the collected water samples using the same method.

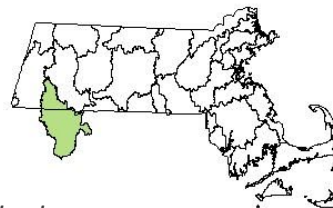
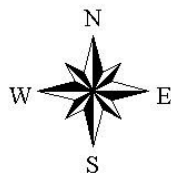
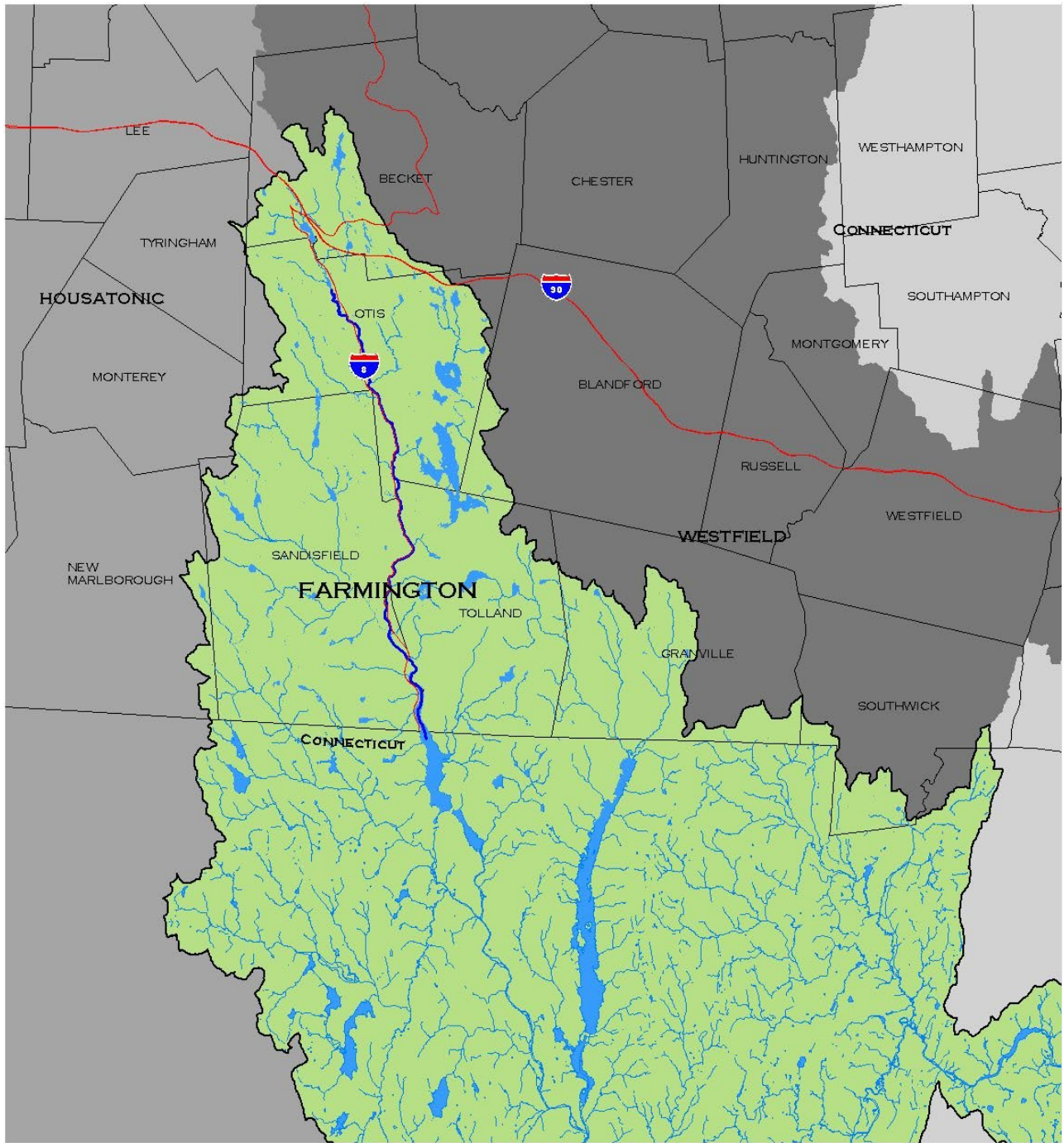
Under CWA section 304(a)(2)(B) EPA has developed acute (1-hour exposure duration) screening values for 6PPD and 6PPD-q at 8,900 ng/L and 11 ng/L, respectively, in freshwater. Given the acute toxicity of 6PPD-q at low concentrations, as noted in EPA documentation, and its stability in water for more than 24 hours, concerns arise regarding its potential impact on sensitive fish species such as *Salmonidae*. This study will compare

the presence/absence of 6PPD and the 6PPD-q levels in normal weather and during storm events to better understand contaminant fate and transport in stormwater conditions.

B1.9 How Data Are Used

In addition to direct uses, such as comparison to the Massachusetts Surface Water Quality Standards (MA SWQS; 314 CMR 4.00) or EPA criteria, specific ways in which WPP's final data are used include, but are not limited to, the following:

- Assessment decision-making as directed in the latest Massachusetts [Consolidated Assessment and Listing Methodology](#) (CALM) [Guidance Manual](#) (specific to a given biennial Integrated Reporting cycle; documents the procedures used to make assessment and listing decisions in that cycle)
- Model input (e.g., hydrologic, water quality models)
- Mass balance calculations (e.g., pollutant loading)
- Criteria development (e.g., nutrients, marine DO, biocriteria)
- Inferential statistics (e.g., probability-based sampling data)
- NPDES permit-writing
- TMDL-related data analyses and determinations
- Cold Water Fishery designations
- Freshwater fish consumption advisories (in coordination with DPH)
- Harmful algal bloom assessments
- Trend analysis (e.g., fish tissue Hg concentrations, in coordination with MassDEP ORS)
- Descriptive statistics (e.g., geomeans for bacteria data, minima/maxima for dissolved oxygen and temperature, analysis of variance [ANOVA]) with or without uncertainty statements
- Future sampling plan development
- Non-MassDEP studies and data requests (WPP data provided to other groups)
- Evaluation of the effectiveness of water quality programs (such as NPS management), based on improvements in water quality or waterbody health



Farmington Watershed

B2 SAMPLING METHODS

B2.1 Sampling-Related SOPs

All WPP field sampling follows the most current and approved WPP Standard Operating Procedures (SOPs), as listed in Table 8, along with applicable standard reference documents used for SOP development. The SOPs listed in all tables will be updated by the author on a biannual basis unless required sooner.

Table 8: WPP Field Method SOPs (*italics indicate SOPs that are not currently in use*)

Control Number(s)	SOP subject matter	Applicable “Standard” Method Reference(s)
CN 0.2.1	Field safety	---
CN 1.23	Sample collection (general)	- USGS TWRI Book 9 USGS. National Field Manual for the Collection of Water-Quality Data (1998) - Standard Methods for the Examination of Water and Wastewater (24 th edition, 2023)
CN 1.31	Use of sample collection pole	---
CN 1.36	Hinged Pole Sampler	---
<i>CN 1.56</i>	<i>Stormwater Sampling</i>	---
<i>CN 1.56</i>	<i>Peristaltic Pump Sampler</i>	---
CN 1.992	WinLIMS pre-login (WES lab only)	---
CN 3.44	Chlorophyll <i>a</i> sampling	---
CN 4.26	Multiprobe use	- Hydrolab, YSI, Onset manuals
CN 4.26	YSI EX01 Quickguide	
CN 4.42	Multiprobe deployment	- Hydrolab, YSI, Onset manuals
CN 4.42	Onset DO/T logger Quickguide	- Onset DO/T meter manual
CN 4.42	HOBO TidBits	---
CN 35.0	Periphyton Sampling	---
CN 39.4	Benthic macroinvertebrate/Habitat	- Modified RBP (EPA) - USGS TWRI Book 5 (1987)
CN 40.4	Fish collection/preparation for fish tissue analysis	- EPA guidance for fish sampling and analysis for fish advisories (1995) - USGS TWRI Book 5 (1987)
CN 151.1	Secchi transparency	- EPA Volunteer Lake Monitoring methods manual (1991)
CN 59.6	Equipment Washing	---
CN 59.6/59.96	Decontamination to prevent the spread of invasives	---

Control Number(s)	SOP subject matter	Applicable “Standard” Method Reference(s)
CN 60.0	Periphyton (benthic algae)	- Modified RBP (EPA) - USGS TWRI Book 5 (1987)
CN 75.3	Fish Population	- Modified RBP (EPA) - USGS TWRI Book 5 (1987)
<i>CN 101.3</i>	<i>Metals sampling (clean technique)</i>	- <i>USGS TWRI Book 9 (1998)</i> - <i>EPA Method 1669 Sampling Ambient Water for Trace Metals at EPA WQ Criteria Levels (1996)</i>
CN 004.42	Continuous temperature monitoring	- Onset Stowaway® and ProV2 manuals
CN 004.42	Onset HOBO Shuttle Quickguide	- Onset manual
CN 004.42	Continuous Conductivity	---
CN 533.1	Fish Collection for Cold Water Fisheries	---
<i>CN 68.0-68.6 (archive)</i>	<i>Flow monitoring SOP and quickguides</i>	- <i>USGS TWRI Book 3</i> - <i>Sontek, Swoffer, Gurley, Global Water manuals</i>
<i>CN 71.0 (archive)</i>	<i>Sediment sampling</i>	- <i>USGS TWRI Book 9 Chapter A8 (1998)</i>
CN 623.0	Edge Quickguide	In Development
<i>draft</i>	Edge SOP	In Development

B2.2 Field Safety

WPP’s Monitoring Coordinators and crew members receive field safety training, use best professional judgment in the field, and at no time allow personal health & safety to be compromised. The “SAFETY FIRST” principle applies at all times.

WPP’s “standard-issue” Field Kits are brought on each field survey. These kits include miscellaneous items often needed in the field, including safety equipment such as plastic gloves, safety glasses, sunscreen, insect repellent, ivy wash, etc.

First Aid Kits containing basic first aid materials are included in the field gear for every crew, as a standard. In situations where sampling stations are far from the vehicle, crews have been instructed to take the first aid kit to the station.

Training in cardiopulmonary resuscitation/automatic electronic defibrillation (CPR/AED) and basic first aid procedures for WPP survey personnel is strongly encouraged. An Adult CPR/AED review training course is held annually at WPP’s office in Worcester (MassDEP’s CERO) and other regional MassDEP offices.

Each crew member is expected to dress appropriately for the season, weather and field conditions, and wear personal protective equipment (PPE) as needed. Each crew member has also been advised to wear orange, reflective safety vests, especially when sampling in high vehicular traffic areas. These vests are available to staff along with other PPE. To assist crews in survey preparation, survey trip checklists and field kit checklists are used.

A WPP “safety officer” has been designated and helps to coordinate procurement of safety equipment, safety training, annual safety reporting and assistance as needed.

B2.3 Field Equipment

A partial list of primary field equipment used by WPP is provided in Table 9. Archived documents can be accessed when needed.

Table 9: WPP Field Equipment and Supplies (Italics indicate equipment that is currently not in use)

Equipment or Supplies	CN # reference	NOTES
Field kits	CN 0.2.1	Each includes first aid kit
PFDs	CN 0.2.1	---
Bottles	CN 1.23	See Table 10
Cleats for boots	CN 0.2.1	For added traction when wading
Filters and Syringes	CN 1.23	Filtration for dissolved samples
Edge Tablet	CN 623.0	Required for electronic field sheet data collection
GPS units (hand-held and vehicle)	---	Manufacturer’s manuals
Multi-probe loggers for unattended deployment	CN 4.42	DO/T primarily. Also, pH and conductivity feasible for deployment
4+ parameter multi-probes (discrete or attended)	CN 4.26	DO/T/pH/conductivity/etc.
Probe deployment apparatus	CN 4.42	Multiple sizes depending on logger type deployed
Single probes (discrete and continuous)	CN 4.26	e.g., temperature Hobo MX 2204 Tidbits with “out of water” detect 24-hour continuous recording at 30 min intervals for 3-6 month durations per site (typ.)
Van Dorn bottle samplers	CN 1.23	---
Chlorophyll <i>a</i> integrated sampling tubes	CN 1.23	Rigid tube/fixed depth and flex tube/variable depth

Equipment or Supplies	CN # reference	NOTES
Sample collection poles	CN 1.31	Extension poles to sample hard to reach areas
NIST-traceable thermometers	CN 004.42	Field/lab QC for temperature
Backpack electroshockers	CN 75.3	---
Electroshocking boat	CN 75.3 CN 40.4	---
Large sampling boats	---	e.g., Boston Whaler
Small sampling boats	---	Canoes and rowboats
Outboard boat motors	---	Including three electric motor
Marine buoys	---	Three YSI marine buoys
Portable spectrophotometer (field/lab)	CN 2.3 (archive)	Mainly for in-lab use (HACH spectrophotometer)
Portable turbidimeter (field/lab)	CN 95.3	Mainly for in-lab use
Colilert® / Enterolert® analysis (field/lab) incubators	CN 198.2	In-lab use (2 incubators)
Colilert® / Enterolert® analysis (field/lab) sealer	CN 198.2	In-lab use
QC/PT audit samples	---	Quantitative QC known samples for nutrients (TP, TN, NH3, etc.), chlorophyll <i>a</i> , bacteria (e.g., <i>E. coli</i>), metals, etc.
<i>Flow meters</i>	<i>CN 68.0 (archive)</i>	<i>Propeller and acoustic Doppler technology</i>
<i>Staff gages</i>	<i>CN 68.0 (archive)</i>	<i>Each 3 feet long</i>
<i>Dye testing</i>	<i>CN 68.0 (archive)</i>	<i>For time-of-travel, mixing zone studies, etc.</i>
<i>Portable peristaltic pump</i>	<i>CN 1.56 (archive)</i>	<i>For use in hard-to-sample areas, for field-filtration, etc.</i>
<i>Sediment samplers</i>	<i>CN 71.0 (archive)</i>	---

B2.4 Bottle Groups, Types and Preservatives for Typical Analytes

Bottle group designations, associated parameters, and bottle type and preservative requirements for water, sediment and tissue sample analytes are shown in Table 10.

B2.5 Field Sample “OWMID #” Allocations

Sample identification numbers are systematically allocated by WPP’s Database Coordinator when needed. When paper field sheets are needed, printed OWMID # labels are provided to each project lead for use on the field sheet forms. This process helps to avoid using ID#s more than once, misinterpretation of written ID#s, and other sample ID-related problems.

For Rivers, Lakes and Pipe surveys, six-digit ID# (e.g., 36-2105) labels are provided to be used for each separate sample, using designated, 2-digit project prefixes.

To facilitate logging samples into the WinLIMS system at the WES laboratory, bottle-group codes (Table 10) will be appended to the OWMID#s; for example, sample # 36-2105 for nutrients will be designated 36-2105_N.

B2.6 Field Quality Control (see B5)

B2.7 Field Documentation (see A9)

Table 10: Bottle Group Codes, Container Types and Field Preservation Methods for WPP Samples ¹ (Italics indicate bottle groups that are currently not in active use)

ANALYTE GROUP & Bottle code		PARAMETERS	Bottle type(s) ⁽²⁾	SPECIAL preservative ⁽³⁾
WATER & BIOLOGICAL				
Chemistry	C	Total Alkalinity	HDPE (500 mL)	None, except for hardness by SM 2340B where HNO ₃ is used to pH < 2
Chemistry	H	Total Hardness	HDPE (500 mL)	2 mL 1:1 HNO ₃ pH<2 (<i>Lab</i>)
Chemistry (WPP)	R	Turbidity and color	HDPE (120-250 mL)	None
Nutrients +	N N2	Total phosphorus, total nitrogen, ammonia nitrogen, nitrate-nitrite nitrogen (and chloride)	HDPE (120-500 mL)	H2SO4 (9N, 1 mL) to pH < 2
Chloride	CL	Chloride	HDPE NM (60 mL)	None
Solids (in water)	S	Total suspended solids	HDPE (1000 mL)	None
Bacteria	B	<i>E. coli</i> and Enterococci (typically)	Sterile, sealed plastic (120-250 mL)	Sodium thiosulfate (Na ₂ S ₂ O ₃) for dechlorination as needed
Chlorophyll (in water)	I	Chlorophyll <i>a</i>	HDPE (250-1000 mL) Amber WM Round econ. Quality	None
Algae (in water)	A	Phytoplankton ID and enumeration	HDPE (120-250 mL) Amber WM rectangular	Lugol's solution
Cyanotoxins	CT	Microcystins (total), and nodularins	Amber glass (120 mL)	None
Metals	M	Mg ⁺ , Na ⁺ , Ca ⁺ and Dissolved Hardness	Certified, trace-clean HDPE (250-500 mL)	1:1 HNO ₃ to pH < 2 ⁽⁴⁾

ANALYTE GROUP & Bottle code		PARAMETERS	Bottle type(s) ⁽²⁾	SPECIAL preservative ⁽³⁾
<i>Metals (total recoverable)</i>	<i>M2</i>	<i>Same as above (unfiltered)</i>	<i>Certified, trace-clean HDPE (500 mL)</i>	<i>1:1 HNO3 to pH < 2 ⁽⁴⁾</i>
Organic Carbon	OC	Total/Dissolved Organic Carbon	Two 40 mL Clear Type-1 Glass vials	Field-filtered; 0.25 mL phosphoric acid to pH<2 (in bottle)
Ortho-Phosphate as P	N3	Ortho-phosphate	HDPE, 120 mL	None
Benthic algae	A	ID and enumeration	Glass vials (2-4 dram with screw type caps) in a 1-liter jar half filled with in-stream water to keep the vials from heating. HPDE amber WM Rectangular, 250 mL	M3 or Lugol's (as needed) Refrigerated/iced at lab until analysis
Benthic Macroinvertebrates	---	ID and enumeration	2 liter wide-mouth leak-proof Nalgene bottle. Specimen vials (in 1l Nalgene PMP jars)	Denatured 100% reagent alcohol (5% methanol, 5% isopropanol, 90% ethanol). Refrigerated/iced (if not preserved)
<i>Phosphate fractions</i>	<i>P1 P2</i>	<i>Total Reactive P Dissolved Reactive P</i>	<i>HDPE (250-500 mL)</i>	<i>None</i>
<i>Oxygen Demand</i>	<i>OD</i>	<i>BOD, COD, TOD</i>	<i>Glass "BOD" bottles (300 mL with glass stopper)</i>	<i>None for BOD 1:1 H2SO4 to pH < 2 for COD</i>
<i>FWA</i>	<i>FWA</i>	<i>Fluorescent Whitening Agents</i>	<i>Amber glass (500 mL)</i>	<i>None</i>
<i>Toxicity</i>	<i>TOX</i>	<i>various toxicity end points, including whole effluent toxicity and ambient toxicity</i>	<i>PE (sufficient volume to meet lab analytical requirements)</i>	<i>None</i>
<i>UV-Absorbing</i>	<i>UVA</i>	<i>UVA254</i>	<i>HDPE, 500-1000 mL (C)</i>	<i>None</i>

ANALYTE GROUP & Bottle code		PARAMETERS	Bottle type(s) ⁽²⁾	SPECIAL preservative ⁽³⁾
<i>Volatile Organics</i>	VOC	<i>Various</i>	<i>Glass with Teflon-lined septum caps (40 mL)</i>	<i>1:1 HCL (no headspace)</i>
<i>Hydrocarbons</i>	HC	<i>Oil and grease, total petroleum hydrocarbons, various poly-aromatic hydrocarbons</i>	<i>Amber glass (1000 mL)</i>	<i>1:1 H2SO4 to pH < 2</i>
<i>PCBs and Pesticides (in water)</i>	PCB	<i>Various</i>	NA	None
<i>Extractable Organics</i>	EOC	<i>Various</i>	<i>Amber glass (1000 mL)</i>	None
<i>Misc. Ions</i>	C2	<i>Sulfate and chloride by 300.0)</i>	<i>HDPE, 500-1000 mL (C)</i>	None
PFAS	PFAS	Per- and polyfluoroalkyl substances	HDPE (250 mL) (two per sample), certified PFAS-free	None
<i>Chlorophyll (in benthic algae)</i>	I	<i>Chlorophyll a</i>	<i>jars (containing acetone; at lab after scraping substrate)</i>	<i>90% acetone in a buffered aqueous solution (at lab)</i>
<i>Perchlorate</i>	PER	<i>Perchlorate</i>	<i>HDPE (120 mL)</i>	None
<i>Human Markers of Sewage Source</i>	HM	<i>E. coli, fecal coliform, Enterococci, Bacteroidetes and Enterococci human markers, caffeine, FWAs, and OBs</i>	<i>Amber glass 1000 mL; 2 liters per site (1L for micro/FWAs and 1L for caffeine); extra 2 liters at one site for caffeine lab QC</i>	<i>None (sterile bottle for micro); WES lab prepared</i>
<i>Algal Toxins</i>	AT	<i>Anatoxin-a, cylindrospermopsin</i>	<i>Amber glass vial (120 mL)</i>	<i>Ascorbic acid, 0.10 g/L</i>
<i>Phycocyanin</i>	PC	<i>Phycocyanin</i>	<i>TBD</i>	<i>TBD</i>
FISH TISSUE				
<i>Metals</i>	---	<i>Mercury, Selenium, Arsenic, Cadmium</i>	<i>HPDE cup (at lab after processing)</i>	<i>Ice/refrigeration @ < 6C in dark, followed by freezing</i>
<i>PCBs and Organochlorine Pesticides (fish)</i>	---	<i>Various (including PCB congeners and arochlors)</i>	<i>Glass specimen jar</i>	<i>Ice/refrigeration @ < 6C in dark, followed by freezing</i>

ANALYTE GROUP & Bottle code		PARAMETERS	Bottle type(s) ⁽²⁾	SPECIAL preservative ⁽³⁾
PFAS (in tissue)	---	Per- and polyfluoroalkyl substances	TBD by project-specific QAPP	TBD by project-specific QAPP
SEDIMENTS				
<i>Sediment toxicity (e.g., Hyalella azteca, Chironomus tentans)</i>	TOX	---	<i>HDPE plastic or glass; 3 liters if two-species test; or 2 liters of one-species test</i>	<i>Ice/refrigeration @ < 6C in dark</i>
<i>AVS/SEM (acid-volatile sulfide/ simultaneously-extracted metals)</i>	---	---	<i>4 oz. WM amber glass w/ Teflon-lined cap (120 mL)</i>	<i>Ice/refrigeration @ < 6C in dark</i>
<i>Polycyclic aromatic hydrocarbons (PAHs)</i>	PAH	<i>Various</i>	<i>4 oz. WM amber glass w/ Teflon-lined cap (120 mL; > 200 grams)</i>	<i>Ice/refrigeration @ < 6C in dark</i>
<i>PCB arochlors</i>	PCB	<i>Various</i>	<i>4 oz. WM amber glass (120 mL; > 200 grams)</i>	<i>Ice/refrigeration @ < 6C in dark</i>
<i>Chlorinated Pesticides</i>	PEST	<i>Various</i>	<i>4 oz. WM amber glass (120 mL; > 200 grams)</i>	<i>Ice/refrigeration @ < 6C in dark</i>
<i>TOC/DOC</i>	SOC	---	<i>4 oz. WM amber glass</i>	<i>Ice/refrigeration @ < 6C in dark</i>
<i>Metals (total concentrations for each element)</i>	M	<i>Various</i>	<i>plastic or glass 4 oz./120 mL</i>	<i>Ice/refrigeration @ < 6C in dark</i>
<i>% solids/ % water</i>	---	---	<i>4 oz. WM amber glass</i>	<i>Ice/refrigeration @ < 6C in dark</i>
<i>Grain size distribution</i>	---	---	<i>1 liter</i>	<i>N.A.</i>

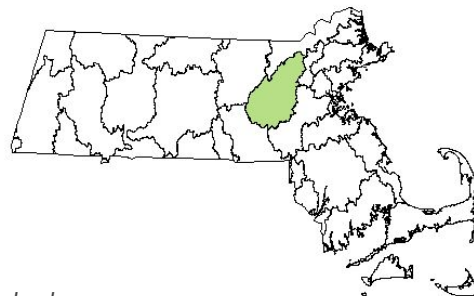
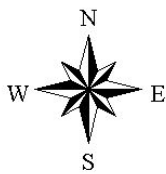
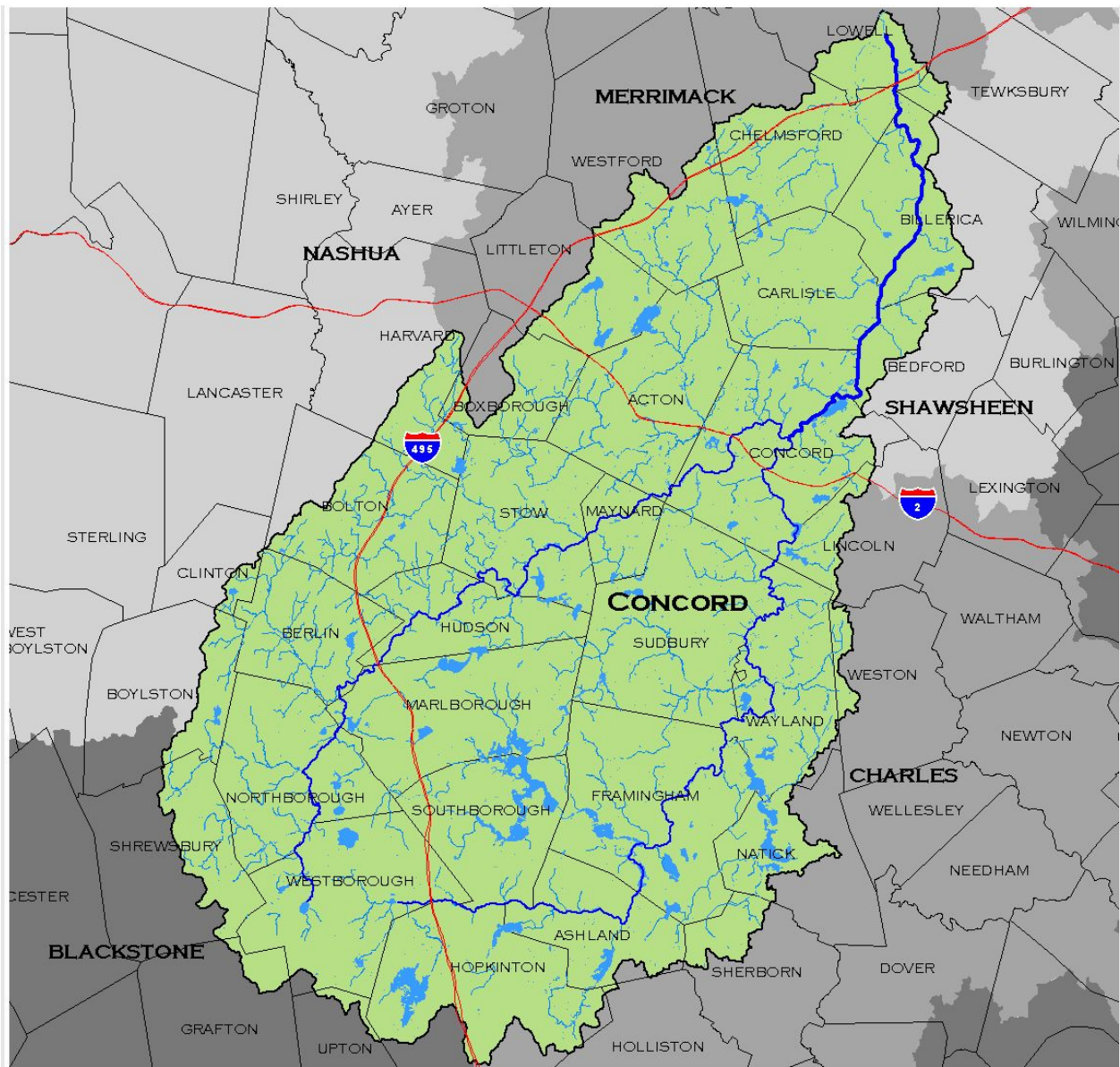
ANALYTE GROUP & Bottle code		PARAMETERS	Bottle type(s) ⁽²⁾	SPECIAL preservative ⁽³⁾
<i>Nutrients (TP, TN)</i>	<i>N</i>	<i>TP, TN</i>	<i>HDPE plastic or glass</i>	<i>Ice/refrigeration @ < 6C in dark</i>
<i>PFAS (in sediment)</i>	<i>PFAS</i>	<i>Per- and polyfluoroalkyl substances</i>	<i>TBD by project-specific QAPP</i>	<i>TBD by project-specific QAPP</i>

¹ For any given analyte, bottle type and preservative recipe are generally independent of analytical method. Differences in required preservative within a bottle group are addressed on a case-by-case basis.

² In all cases, new, pre-cleaned bottles are used.

³ Wet ice to < 6 deg. C in dark cooler is standard short-term storage for all water samples.

⁴ Acid addition for preservation is typically done at the lab within 24 hours.



Concord Watershed

B3 SAMPLE HANDLING AND TRACKING

B3.1 Assignment of LOCATION ID#s (Station ID and Unique ID)

Prior to each survey, the Monitoring Coordinator must verify that each station has been given two location-specific IDs: a project-specific Station ID# (e.g., BB01) (or project station name) and more importantly, a permanent Unique ID# (e.g., W0657). Both ID#s are used on WPP field sheets. If unplanned station visits occur for which the Station ID and/or the Unique ID were not provided, the Monitoring Coordinator shall get both immediately following the survey and insert the IDs onto the appropriate field sheet. Station locations are verified at the end of the season as part of field sheet data entry and validation. All station information is maintained in the database.

B3.2 Assignment of SAMPLE ID#s (“OWMID”)

See B2.5. The Database Coordinator provides each Monitoring Coordinator with sample ID#s or OWMIDs for each season (e.g., on pre-printed labels when using paper field sheets—one ID per label) for their specific project. The assigned OWMIDs are applied using the EDGE tablets and the paper back up field sheets as needed. The Monitoring Coordinators are responsible for avoiding the use of duplicate OWMIDs. Multi-probe and deployed probe data at each station also get separate Sample IDs. If the ID label sheets are lost, new sheets containing new numbers are generated by the Database Coordinator. Typically, each survey crew lead is provided with an extra ID label sheet for use as needed (e.g., in the survey guidebooks, so that they are returned). If a labeling mistake is made, the old label is crossed out with a single line and a new label is affixed next to the old one. To facilitate logging samples with the WinLIMS system at the WES laboratory, bottle-group codes (Table 10) will be appended to the OWMIDs; for example, sample # 36-2105 for nutrients will be designated 36-2105_N.

B3.3 WinLIMS Pre-login

For samples planned to be delivered to the WES laboratory, samples are pre-logged into the WES WinLIMS database using a WinLIMS web interface customized for WPP use. The specific procedures for pre-logging samples in this way are provided in CN 001.992. Based on their unique SAPs, Monitoring Coordinators plan their use of OWMIDs using a MS Excel spreadsheet. This is required for all WPP surveys. Changes/corrections to COC forms can be made prior to initiation of sampling run; however, these changes must be made to the finalized COC form, entered into WinLIMS, and reflected on the labels affixed to bottles prior to the survey. Once samples have been submitted to WES, no changes may be made to data in WinLIMS. If changes are needed after delivery of samples to WES, these changes need to be coordinated directly with WES staff.

B3.4 Sample Bottle Labeling

Bottle labels are printed on waterproof label-paper by the Monitoring Coordinators as part of the survey preparation. Pre-printed bottle labels are affixed to bottles prior to the bottles getting wet. An example of the required container label displaying the OWMIDs is shown in

Appendix G. To minimize sample bottle mix-ups, labeled bottles are placed in individual bottle bags - each bag containing all the bottles for each specific station.

B3.5 Sample Preparation (following Collection)

Depending on the analyte, samples may need to be prepared for later analysis (e.g., filleting fish for tissue samples, filtering for true color, chlorophyll *a*, dissolved nutrients). For water samples, this usually involves filtration to remove suspended solids or generate a non-filterable residue (e.g., via 0.45µ filter). In certain instances, involving dissolved analyte fractions (e.g., total dissolved phosphorus), every attempt is made to filter samples immediately after collection in the field (and noted on the field sheet and COC). Where this cannot be accomplished, samples are filtered as soon as possible.

B3.6 Sample Preservation and Transport

Most samples are typically delivered to the state laboratory, Wall Experiment Station (WES) in Lawrence, Massachusetts. Samples can also be delivered to one or more contract labs for analysis. Samples to be analyzed at the WPP lab (typically samples for color, turbidity, chlorophyll *a*, aquatic plants, and *E. coli* and/or enterococci by Colilert® / Enterolert®) are delivered to the WPP lab in Worcester, MA. If samples are delivered by a person(s) that was not involved in taking the sample, the COC form will be filled out and signed off during the transfer.

All collected samples are preserved in coolers containing wet ice to <6 deg. C. during transport. Samples may be delivered directly from the field to the lab or held temporarily in a storage fridge at WPP before delivery to WES, if hold times allow. The storage fridge at WPP is monitored daily for storage temperature (<6 deg.C).

All bacteria samples are delivered to the appropriate lab(s) for analysis within six hours of collection. Typically, bacteria sample bottles contain sodium thiosulfate for dechlorination, in case of residual chlorine. (The presence of residual chlorine is site-specific; lack of sodium thiosulfate in sample bottles is only allowed when there is no possibility of residual chlorine being present at each location.)

Nutrient (e.g., TP, TN, NH₃-N, NO₃/NO₂-N) samples are preserved with sulfuric acid (9N) immediately after collection. Acid preservative for nutrient samples is added from purchased vials in the field by WPP field staff. Metals samples are preserved with HNO₃ to pH<2 at the WPP lab. For all preservation requirements for samples, see Table 10.

B3.7 Sample Delivery (and Use of Chain-of-Custody (COC) Forms)

When field samples arrive at the lab, the WPP staff relinquishes custody of samples to the laboratory staff. The sample containers are removed from the shipping or transportation cooler and visually inspected for damage such as leakage, breakage, or contamination. The samples received are then compared with accompanying custody and analysis specification forms to make sure that the paperwork agrees with the labels on each sample container. Standard COC forms are used to transfer sample custody from staff

transporting the samples to the WES, WPP, or other labs as appropriate. All individuals who handle samples are required to sign and date the COC forms. After samples have been officially transferred and assigned laboratory identification numbers, they are stored, distributed and analyzed according to the lab's QA Plan and SOPs.

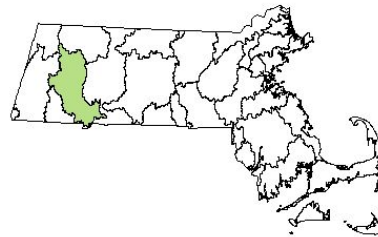
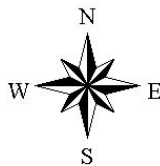
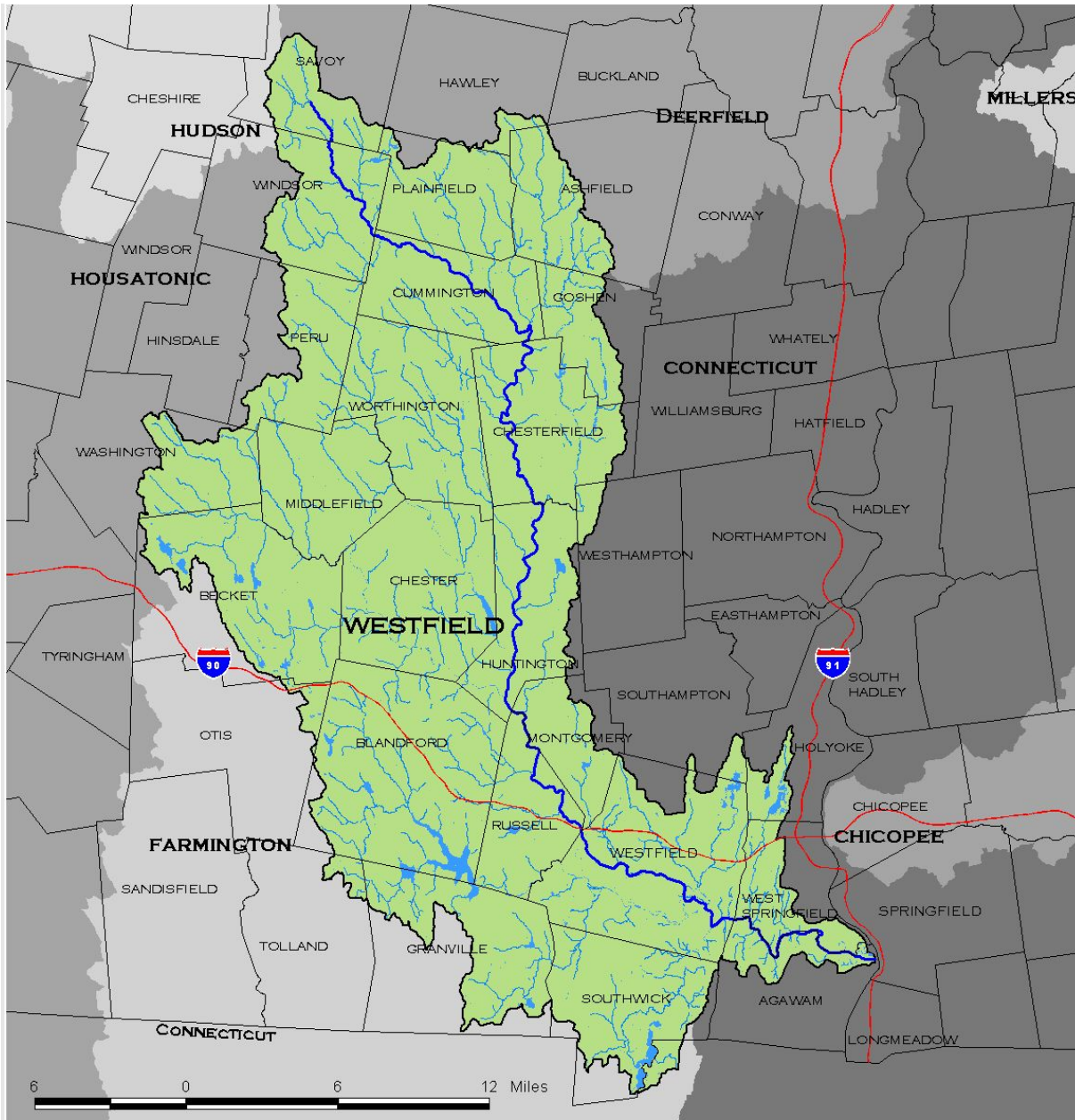
The proper procedure for filling out a COC form and transferring sample custody is documented in the respective laboratory Quality Assurance Plans, and in this QAPP. A copy of the WES SOP for filling out the COC form is posted in the WPP lab. In practice, Monitoring Coordinators prepare the COC forms automatically using the WES WinLIMS pre-login procedures (for WES samples) and/or via PC/manual (for all other labs). Once prepared, survey paperwork is checked for errors prior to use.

COC users are advised to:

- Sign into and out of the storage fridge when samples are kept temporarily in cold storage (<6 deg. C) at WPP prior to delivery to the lab
- Check that the Sample Field ID (OWMID), Site Name (e.g., PB01) and sample-specific dates/times for all samples are filled out correctly
- List the MassDEP Division always, specifically and consistently as "DWM-WPP"
- List the Project Name consistently
- Be specific in the Analysis Requested column; including analyte (and specific method if appropriate)
- Always use sample preservation codes
- Have copies of the completed COC forms sent to WPP electronically
- Hide the identity of field QC samples from the lab

B3.8 Lab Sample Tracking

The WES laboratory tracks samples via WinLIMS. The WPP labs use lab bench sheets (paper and electronic) and standardized lab data reports to keep track of samples. WPP ensures that similar internal mechanisms are in place for any contract labs it employs.



Westfield Watershed

B4 ANALYTICAL METHODS

All WPP samples are analyzed using standard protocols contained in accepted WES lab, WPP lab, or other laboratory-specific SOPs. Analyses are consistent with each lab's laboratory Quality Assurance Plan and Lab Safety Plan.

B4.1 WPP Lab SOPs

All WPP lab work follows the most current and approved SOPs, as listed in Table 11: WPP Lab Method and provided in Appendix D.

Table 11: WPP Lab Method SOPs (Italics indicate WPP lab SOPs that are currently not in active use)

Control Number	SOP
CN 0.36	WPP lab safety
CN 0.421	EDD template and guidelines
<i>CN 2.3</i>	<i>Color analysis</i>
CN 3.44	Chlorophyll <i>a</i> analysis
CN 4.26, 4.61, 4.42	Probe calibrations, various units (lab)
CN 04.991	Deionized water system maintenance and operation
CN 39.4	Benthic macroinvertebrate analysis
CN 40.4	Fish Toxics Collection and Preparation
CN 35.1	Benthic algae analysis
CN 95.3	Turbidity analysis
<i>CN 150.1</i>	<i>Cyanobacteria counts</i>
CN 198.2	Colilert® (and Enterolert®) bacteria analysis
<i>CN 409.0/409.5</i>	<i>Phycocyanin analysis</i>
<i>CN 536.0</i>	<i>Hanna potassium meter</i>
<i>CN 58.0, 58.5</i>	<i>Optical brighteners</i>
<i>CN 143.0</i>	<i>Detergents analysis (kit)</i>
<i>CN 399.0</i>	<i>Hanna portable photometer</i>

B4.2 WES and Contract Lab SOPs

Upon request and as applicable, the WES lab, EPA-NERL lab and contract laboratories employ the following laboratory procedures for WPP samples (Table 12).

When contracting with external contract labs, state-certification for method-specific project analytes (via the MassDEP Laboratory Certification Office) is preferred, but not essential. Certification status is reviewed along with lab QAPs, SOPs and other QA documentation when selecting labs and evaluating data.

Table 12: WES, EPA and Contract Lab Analysis Method SOPs for WPP Samples (Italics indicates lab SOPs that currently not in active use for WPP samples)

Document Title
Laboratory Quality Assurance Plan
Anatoxin-a ELISA (Abraxis)
EPA 8081B, 8082A Modified - Determination of Organochlorine Pesticides, PCB Aroclors, and PCB Congeners in Fish and Biological Tissue
<i>BacteroidetesG - Bacteroidetes Group Marker by PCR Assay Based on AEM 66:1587</i>
<i>BacteroidetesHF -Bacteroidetes Human-Specific Marker - Modified Method of AEM 66:1587</i>
<i>BeacteroidetesHF183 – Bacteroidetes Human-Specific Marker – PCR-Mod. Waters Res. 70:37-349</i>
<i>EPA 525.5 mod. - Caffeine in Water by Solid-Phase Extraction and Capillary Column Gas Chromatography/Mass Spectrometry</i>
<i>ENT-esp Marker - Determination of Enterococcal esp Gene (Sewage Marker) Based on ES&T 39:283</i>
<i>EPA Method 1603 – E. coli Membrane Filtration Procedure</i>
EPA Method 200.7 – Determination of Metals & Trace Elements & Hardness in Water & Wastes by ICP-AES
<i>EPA Method 200.8 – Determination of Metals and Trace Elements by ICP-MS</i>
<i>USEPA Method 245.1 – Determination of Mercury in Water by Cold Vapor AA Spectrometry</i>
<i>EPA 300.0 – Inorganic Ions</i>
EPA 7473 – Mercury in Solids and Solutions using the Milestone DMA-80 Mercury Analyzer
SM 4500 NH ₃ – Standard Methods for the Examination of Water and Wastewater
<i>USEPA Method 351.2 – Determination of Kjeldahl Nitrogen, Colorimetric Semi-Automated Block Digester, Auto Analyzer</i>
USEPA Method 353.2 –Rev 2.0: Determination of Nitrate Nitrite Nitrogen, Colorimetric-Automated
<i>EPA Method 507 – Determination of Nitrogen & Phosphorus Containing Pesticides in Water by GC & ECD</i>
<i>EPA Method 508 – Determination of Chlorinated Pesticides in Water by GC with an ECD</i>
<i>USEPA Method 524.2 – Measurement of Purgeable Organic Compounds in Water by Capillary Column GC/MS</i>

Document Title
<i>EPA 525.2 – Organic Compounds by Liquid-Solid Extraction and Capillary Column GC/MS</i>
<i>EPA Method 546: Determination of Total Microcystins and Nodularins in Drinking Water and Ambient Water by Adda Enzyme-Linked Immunosorbent Assay</i>
<i>EPA Method 3050B – Acid Digestion of Sediments, Sludges, and Soils</i>
<i>EPA Method 3015 – Sample Preparation Procedure for Microwave-Assisted Acid Digestion of Aqueous Samples and Extracts</i>
<i>EPA Method 5035A – Sampling Volatile Organic Compounds in Soils and Sediments</i>
<i>EPA Method 8081A & 3510 (water) & 3541 (soils) – Determination of Chlorinated Pesticides in Soils & Water</i>
<i>EPA Method 8082 & 3541 (soils) & 3510 (waters) – Determination of PCBs in Soil & Waters</i>
<i>EPA Method 8260B – Determination of Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)</i>
<i>EPA Method 8270C – Determination of Semi-Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)</i>
Processing Fish Samples Intended for Contaminant Analysis
<i>EPA 3051A Microwave Assisted Acid Digestion of Sediments, Sludges, Soils, and Oils for Fish Tissue</i>
<i>EPA 6020B Inductively Coupled Plasma- Mass Spectrometry for Fish Tissue (as, Cd, Se)</i>
<i>EPA 8081B, 8082A Organochlorine Pesticides by Gas Chromatography, Polychlorinated Biphenyls (PCBs) by Gas Chromatography</i>
<i>FWA - Determination of Fluorescent Whitening Agents in Water and Wastewater using 100 mL</i>
<i>Determination of PCB Toxic Congeners in Water and Wastewater</i>
<i>Determination of PCB Toxic Congeners in Soils and Sediments</i>
<i>SM 2540B – Total Solids Dried at 103-105C</i>
<i>SM 2540C – Total Dissolved Solids Dried at 180C</i>
<i>SM 2540G – Total Fixed and Volatile Solids in Semi-Solid Samples</i>
<i>SM 9223 – MPN Enzyme Substrate Coliform Test MPN Procedure for Analysis of Potable and Non-Potable Water Samples</i>
<i>SM 9222D – Standard Fecal Coliform Membrane Filtration Procedure</i>
<i>SM2320B - Determination of Alkalinity by the Titration Method</i>
<i>SM2540D – Determination of Total Suspended Solids Dried at 103-105°C</i>
<i>SM 4500 Cl⁻ E – Determination of Chloride</i>
<i>SM 4500 PE – Determination of Total Phosphorus, Ascorbic Acid Method</i>

Document Title
SM 4500-P F Automated Ascorbic Acid Reduction Method
SM 4500-N C Persulfate Method
SM 2340 B Hardness by Calculation
SM 5310 C Examination of Water and Wastewater
EPA 180.1 Determination of Turbidity by the Nephelometric Method
<i>SM 2130 B Determination of Turbidity by the Nephelometric Method</i>
EPA 455 <i>In Vitro</i> Determination of Chlorophyll <i>a</i> and Pheophytin <i>a</i> in Marine and Freshwater Algae by Fluorescence
SM 4500-NH3 G Automated Phenate Method
SM 4500-NO3 F Automated Cadmium Reduction Method
<i>SM 5210 – Determination of Biochemical Oxygen Demand (BOD)</i>
<i>SM 5220B – Determination of Chemical Oxygen Demand, Open Reflux Method</i>
<i>SM 5540C – Determination of Anionic Surfactants as MBAS</i>
<i>SM 9213D – E. coli Membrane Filtration</i>
<i>SM 9215B – Heterotrophic Plate Count – Pour Plate Procedure</i>
<i>SM 9222B - Total Coliform Membrane Filtration Procedure</i>
<i>SM 9222D - Fecal Coliform Membrane Filtration Procedure</i>
<i>SM 9223 - Enzyme Substrate Coliform Test Presence-Absence Procedure for Potable Water</i>
<i>SM 9223-MPN - MPN Enzyme Substrate Coliform Test</i>
<i>Multiwave Microwave Digestion for Fish Tissue</i>
SM 9223 B Enzyme Substrate Assay for Measuring Total Coliforms and <i>E. Coli</i>
<i>MA EPH Method – Determination of Extractable Petroleum Hydrocarbons</i>
<i>Evaluation of Alkaline Persulfate Digestion as an Alternative to Kjeldahl Digestion for Determination of Total and Dissolved Nitrogen and Phosphorus in Water, WRIR 03-4174</i>
PFAS 1633A method (in process) Tissue and Water
<i>EIASOP-INGNO2/NO30 SOP for Nitrate/Nitrite and TN by Lachat Analyzer</i>
LSBSOP-OPHOS-TP13 – SOP for Total Phosphate and Ortho-phosphate Analysis by Lachat Analyzer
LSBSOP-NO2-NO40 SOP for NO3/NO2-N, NH3-N

Document Title
LSBSOP-AMMO3 SOP for Ammonia
LSBSOP-TSS-TDS7 Total Suspended Solids
General Technical Approach -- Algal analysis for identifications, counts, and biovolumes
Contract lab SOPs vary from year to year, depending on WPP's needs. See Appendices C and G and subsequent QAPP addendums for specific SOP references. A QAPP addendum will be submitted any time a new lab and/or method is added.

B4.3 Analytical Methods, Reporting Units and Holding Times

The methods and associated holding times for common WPP parameters are provided in Table 12 primarily for methods used by the WES and WPP labs, but also for those that may be employed by contract labs to be used from 2025-2029. In many cases, WPP's contract labs use the same or similar standard methods (and associated holding times). WPP ensures that identical (or similar) established methods are employed by all contract labs in order to be able to compare data from different labs. Detection limits (MDLs, MRLs, RLs) using these methods can vary within labs (temporally) and among different labs. For detection limit information, see Table 2 (Element A7). WPP's aqueous samples may be frozen prior to analysis in cases of anticipated and unavoidable holding time exceedances. Decisions to freeze samples, such as nutrients, are avoided as much as possible, and when necessary, the resulting data are automatically qualified (when freezing is not a standard preservation step) or censored as appropriate during WPP's data validation.

Table 13: Analytical Methods and Holding Times for typical WPP surface water samples (Italics indicate analytes/methods that are currently not in active use for WPP samples)

Parameter	Units	Method(s)	Holding Time (days)
WATER			
Chloride	mg/L	SM 4500-CL-(E)	28
Alkalinity	mg/L	SM 2320-B	14
<i>Color (true)</i>	<i>CU</i>	<i>SM 2120-C</i>	2
Hardness	mg/L as CaCO ₃	SM 2340-B (EPA 200.7)	180
	<i>mg/L as CaCO₃</i>	<i>SM 2340-C</i>	2
Turbidity	NTU	EPA 180.1	2
	<i>NTU</i>	<i>SM 2130-B</i>	2
Total Suspended Solids	mg/L	LSBSOP-TSS_TDS7	7
	<i>mg/L</i>	<i>EPA 160.2</i>	7
<i>E. coli - Modified m-TEC</i>	<i>CFU/100mL</i>	<i>EPA 1603</i>	<i>6 hours (collection to lab receipt) and analysis within 2 hours of receipt.</i>

Parameter	Units	Method(s)	Holding Time (days)
<i>E. coli</i> - MTEC	CFU/100mL	SM 9213-D	Same as above
<i>E. coli</i> - MF	CFU/100mL	EPA 1103.1	Same as above
<i>E. coli</i> - "Colilert"®	MPN/100mL	SM 9223-B	Same as above
Enterococci	CFU/100mL	EPA 1600	Same as above
	MPN/100mL	"Enterolert"®	Same as above
	MPN/100mL	ASTM D6503-99	Same as above
<i>Enterococcus</i> HM gene (EHSS suite)	PCR (2005 ES&T 39:283-287)	WES PCR methods	540
<i>Bacteroidetes</i> Human Markers (EHSS suite)	PCR (2000 AEM 66:1587-1594)	WES PCR methods	365
<i>Bacteroides</i> HM HF183	PCR-Mod. Water Res. 70:337-349 (HF183)	WES PCR methods	365
Total Nitrogen	mg/L	USGS I-4650-03 LSBSOP-NO2-NO34 SM 4500-N C	28
Kjeldahl-N	mg/L	EPA 351.2	28
Nitrate/Nitrite-N	mg/L	EPA 353.2	28
Ammonia-N	mg/L	EPA 350.1 (rev. 2.0)	28
	mg/L	LACHAT 10-107-06-1-B	28
	mg/L	ASTM D6919-03	28
	mg/L	SM 4500-NH3-G	28
	mg/L	SM 4500NH3-BH LSBSOP-AMMO3	28
Ammonia-N (screening)	mg/L	HACH Aquachek test strips (DL65059)	ASAP (8 hours)
Dissolved Reactive Phosphorus (DRP)	mg/L	SM 4500-P-A, B1, E	2
Total Dissolved Phosphorus (TDP)	mg/L	SM 4500-P-E	2
Total Reactive Phosphorus (TRP)	mg/L	SM 4500-P-E	2
Total Phosphorus	mg/L	USGS I-4650-03 SM 4500-P-F	28

Parameter	Units	Method(s)	Holding Time (days)
Ortho-phosphorus	mg/L	LSBSOP-OPHOS-TP13	28
<i>Microcystins (screening)</i>	$\mu\text{g/L}$	<i>ELISA (Envirologix Quali-Tube™) WPP Lab</i>	2
Microcystins and Nodularins	$\mu\text{g/L}$	EPA 546	14
Anatoxin-a, Total and Cylindrospermopsin	$\mu\text{g/L}$	Eurofins Abraxis Anatoxin-a (Total) ELISA Product #520060	14
Chlorophyll <i>a</i>	$\mu\text{g/L}$ mg/m ³	EPA 445.0 (modified, Welschmeyer)	1 (sample filtration) 21 (analysis, frozen filter)
Total Hardness	$\mu\text{g/L}$	EPA 200.7	No established time limit
<i>Caffeine (EHSS suite)</i>	$\mu\text{g/L}$	<i>EPA 525.2 (modified)</i>	14
<i>OB-1, OB-2, FWA-4, FWA-1 & FWA-2</i>	$\mu\text{g/L}$	<i>SPE-HPLC-FL</i>	7
<i>Sulfate and Chloride</i>	<i>mg/L</i>	<i>EPA 300.0</i>	28
<i>UVA254</i>	<i>cm⁻¹</i>	<i>SM 5910B</i>	14
Si, Na, K, etc.	mg/L	EPA 200.7	180 days
TOC/DOC	mg/L	SM 5310-C EPA 9060 A	28 days
<i>BOD</i>	<i>mg/L</i>	<i>SM 5210 B</i>	1
<i>COD</i>	<i>mg/L</i>	<i>SM 5220</i>	1
<i>Volatile organics</i>	$\mu\text{g/L}$	<i>EPA 624</i>	14
<i>Extractable Organics</i>	$\mu\text{g/L}$	<i>SM 5520</i>	7 (extraction) 40 (analysis)
<i>Oil and grease, total petroleum hydrocarbons, numerous poly-aromatic hydrocarbons</i>	$\mu\text{g/L}$	<i>SM 5520D, (O&G) EPA 625</i>	28 (O&G)
<i>Perchlorate</i>	$\mu\text{g/L}$	<i>EPA 314.0</i>	28
<i>Emerging Contaminants (PPCPs, EDCs, etc.)</i>	$\mu\text{g/L}$	<i>EPA 1694 EPA 1698</i>	2-7 days (analyze extracts within 40 days)
PFAS	ng/L	EPA Method 1633	90 days to extraction (frozen) 28 days to analysis of frozen extract
FISH TISSUE			
Hg	$\mu\text{g/g}$ (wet)	EPA 7473	28

Parameter	Units	Method(s)	Holding Time (days)
<i>PCBs and Organochlorine Pesticides</i>	$\mu\text{g/g}$ (wet)	<i>Modified AOAC 983.21</i>	180 (frozen)
Metals (Cd, As, Se)	$\mu\text{g/g}$ (wet)	EPA 6020B	180 (frozen)
PFAS	ng/L	EPA Method 1633	90 days to extraction (frozen) 28 days to analysis of frozen extract
SEDIMENT			
<i>Acute freshwater toxicity (sediment)</i>	<i>(% survival and growth)</i>	<i>EPA/600/R-99/064</i>	14
<i>Total Organic Carbon (sediment)</i>	<i>g/kg dry</i>	<i>EPA 9060 (Lloyd Kahn)</i>	14
<i>% Solids/ % water (sediment)</i>	%	<i>ASTM E203; SM 2540G</i>	14
<i>Grain size (sediment)</i>	<i>% of various sizes</i>	<i>ASTM D422</i>	14
<i>AVS-SEM (sediment)</i>	<i>$\mu\text{mol/g}$ dry wt. (AVS) mg/kg dry wt. (SEM)</i>	<i>EPA, 1991</i>	21
<i>PCBs (sediment)</i>	$\mu\text{g/g}$ dry	<i>EPA 8082/3541</i>	14
<i>Organochlorine Pesticides (sediment)</i>	$\mu\text{g/g}$ dry	<i>EPA 8081A/ 3541</i>	14
<i>PAHs (sediment)</i>	$\mu\text{g/g}$ dry	<i>EPA 8270C</i>	14
<i>Metals (sediment)</i>	mg/kg dry	<i>EPA 200.7 EPA 6010B</i>	180
<i>Hg (sediment)</i>	mg/kg dry	<i>EPA 245.1 EPA 7473 EPA 1631</i>	28
PFAS	ng/L	EPA 1633	90 days to extraction (frozen) 28 days to analysis of frozen extract

* Changes to analytes and/or methods shall be noted in annual addendums

B4.5 EPA-NERL Assistance

Upon request, the EPA-New England Regional Laboratory in North Chelmsford, MA can provide assistance in a number of monitoring areas, including lab analyses. Where appropriate, WPP requests that its standard template for Electronic Data Deliverables (EDD) be used for EPA data reporting.

B4.6 Laboratory Data Reporting Formats

WES lab, WPP lab, EPA-NERL and contract lab final data and associated internal lab QC results are provided to WPP's Data Management Team in digital format (e.g., WinLIMS downloads, pdf e-files, or Electronic Data Deliverables in Excel format).

The WES lab data can be accessed by WPP through the WinLIMS system as soon as data are finalized. These represent final laboratory data for WPP review and subsequent data validation. Following preliminary WPP QC review for completeness and typographic errors, lab data can be released to the Monitoring Coordinators and other data users as "raw" data (QC status 1).

B4.7 WES Lab Data Qualifiers

The WES lab makes every effort to avoid the use of data qualifiers through sound lab practices, including efficient sample tracking, diligent reagent preparation and quality control, multi-level data reviews, and re-testing as needed. In some instances, however, qualification of data are necessary and, in all cases, helpful when needed. WES laboratory staff may use the following standard data qualifiers/text results, as reported via WinLIMS:

WES WinLIMS Qualifiers:

- B = Analyte detected in a blank (LRB-MB, FB-FRB, or TB) above the QC Limit. Results are qualified when the field sample concentration is less than 10 times the concentration in the blank
- B1 = For Presence/Absence tests, analyte detected in a blank (LRB-MB, FB-FRB, or TB) above QC Limit. Results are qualified
- BNC = Required FB-FRB or TB not collected/received
- E = Estimated Result: Exceeds the upper cal. range or the upper bacterial count limit
- HA = Samples analyzed past holding time
- HA-Hg = Holding time not met but previous studies by WES show that frozen fish samples are stable for mercury for at least one year
- HR = Samples received past holding time
- J1+ = Estimated Result: LFM-MS outside acceptance limits; if biased high, only applicable field sample results \geq MRL (field sample results $< 1/3$ MRL or $< MRL$ are NOT qualified)
- J1- = Estimated Result: LFM-MS recovery outside acceptance limits, biased low: all applicable field sample results qualified
- J2+ = Estimated Result: LFB-LCS recovery outside acceptance limits; if biased high, only applicable field sample results \geq MRL are qualified (field sample results $< 1/3$ MRL or $< MRL$ are NOT qualified)
- J2- = Estimated Result: LFB-LCS recovery outside acceptance limits, biased low; all applicable field sample results are qualified
- J3 = Estimated Result: SAMPLE DUPL, FIELD DUPL, LFB-LCS Duplicate, or LFM-MS Duplicate (RPD or ROL) outside acceptance limits; if the duplicate recovery is

biased high, field sample results \geq MRL are qualified (field sample results $< 1/3$ MRL or $< \text{MRL}$ are NOT qualified)

- J4 = Estimated Result: Dilution water supersaturated with oxygen
- J5+ = Estimated Result: QCS, QCS-LC, QCS-HC, or QCS-SRM recovery outside acceptance limits; if biased high; only applicable field sample results \geq MRL are qualified (field sample results $< 1/3$ MRL or $< \text{MRL}$ are NOT qualified)
- J5- = Estimated Result: QCS, QCS-LC, QCS-HC, QCS-SRM recovery outside acceptance limits, biased low; all applicable field sample results are qualified
- J6+ = Estimated Result: IS recovery outside acceptance limits, biased high; only applicable field sample results \geq MRL for target analytes covered by affected IS are qualified (field sample results $< 1/3$ MRL or $< \text{MRL}$ for target analytes covered by affected IS are not qualified)
- J6- = Estimated Result: IS recovery outside acceptance limits, biased low: all applicable field sample results for target analytes covered by affected IS are qualified
- J7+ - Estimated Results: Surrogate recovery outside acceptance limits for field samples, quality control samples, and/or CCC, biased high: only applicable field sample results \geq MRL for target analytes covered by affected surrogate are qualified (field sample results $< 1/3$ MRL or $< \text{MRL}$ for target analytes covered by affected surrogate are NOT qualified)
- J7- = Estimated Result: Surrogate recovery outside acceptance limits for field samples, quality control samples, and/or CCC, biased low; all applicable field sample results for target analytes covered by affected surrogate are qualified
- J10 = Insufficient sample volume received to run method-required LFM-MS
- J11 = Insufficient sample volume received to run method-required sample duplicate or LFM-MS duplicate
- JO = Other QC criteria not met (see comments)
- L = Estimated Result: Below the lower calibration range
- M = Estimated Result: Analyte concentration \geq MDL but $< \text{MRL}$
- MPA = Microbiology Precision Acceptable-Organism conc. In field sample and/or duplicate are $< 10x$ the lower MPN quantitation limit or outside ideal plate count quantitation range; data acceptable, qualification NOT required
- N = GC/MS non-target tentatively identified compound (TIC)-no standard available for quantitation
- R = Data rejected due to severe QC, quantitation, and/or qualitative ID deficiencies
- SC = Incorrect sample container used
- SP = Sample preserved improperly in the field
- ST = Sample temperature outside of acceptance limits at receipt

B4.8 EPA-NERL Qualifiers

When EPA provides water quality lab services to MassDEP (e.g., for ambient metals analysis), the following standard data symbols are used. During data validation, these are applied to WPP final results “as-is” or using the equivalent standard WPP qualifier.

- RL = Reporting limit
- ND = Not Detected above Reporting limit

- NA = Not Applicable
- NC = Not calculated since analyte concentration is ND
- J = Estimated value because sample associated with out of range CCV
- J1 = Estimated value due to MS recovery outside acceptance criteria
- J2 = Estimated value due to LFB result outside acceptance criteria
- J3 = Estimated value due to RPD result outside acceptance criteria
- L = Estimated result below reporting limit (RL)
- B = Analyte is associated with the lab blank or trip blank contamination. Value is qualified if concentration is >RL and >one-tenth the concentration measured in the sample
- R = No recovery was calculated since the analyte concentration is greater than four times the spike level
- LRB = Laboratory Reagent Blank
- RPD = Relative Percent Difference
- H = Sample did not meet hold time

B4.9 Use of Contract Labs

Based on the specific analytical needs of WPP projects, laboratory services are sometimes contracted via Statewide Contracts and Request for Responses (RFR) or a Master Services Agreement (MSA). As of July 2025, WPP has established contracts with several labs as pre-approved for use by WPP under an existing laboratory services MSA and Statewide contract.

For all contract laboratories, WPP requires that its standard template for Electronic Data Deliverables (EDD) be used for data reporting.

B4.10 Contract Lab Qualifiers

When WPP employs a private laboratory for analytical services, the qualifiers used varies from lab to lab and are specified in each lab's QAP. Any lab qualifiers applied by contract labs (outside labs) may be applied directly to the final results if the qualifier is the same as WPP's or translated to an equivalent qualifier used by WPP (e.g., a "J1" qualifier from a contract lab would be translated to "J" and applied to the data).

B4.11 WPP Lab Qualifiers

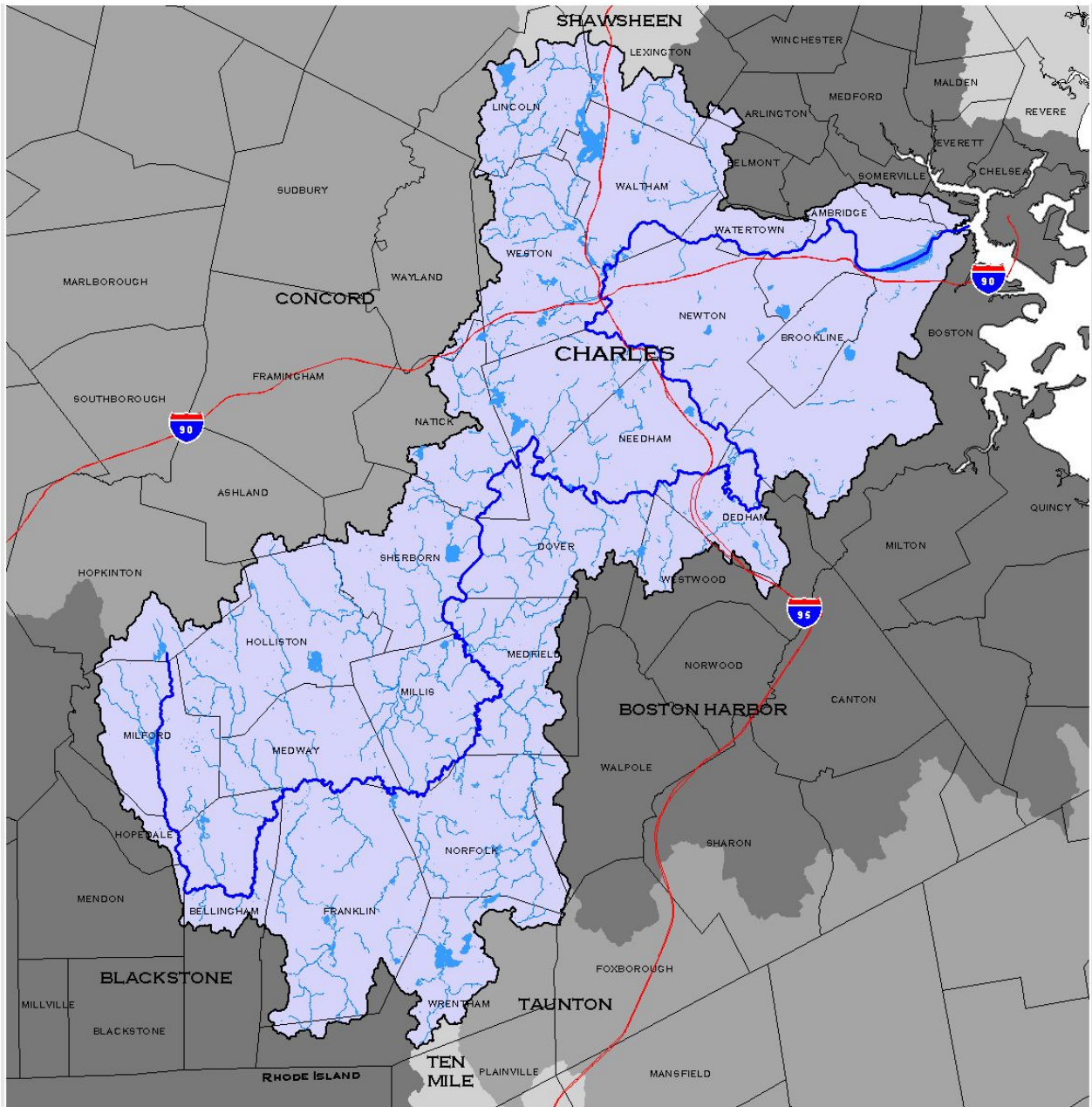
WPP lab staff use the following standard preliminary lab qualifiers for in-house analyses (e.g., true color, chlorophyll *a*, turbidity, *E. coli*, etc.) when needed. However, the final data qualifiers are applied during formal data validation.

WPP Lab Qualifiers and Reporting Conventions:

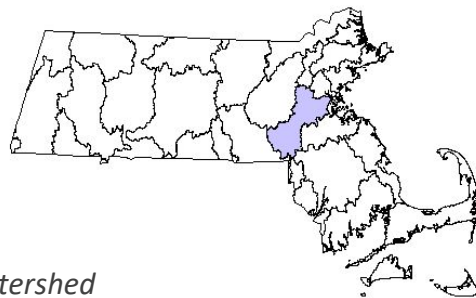
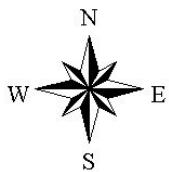
- "B" = Analyte found in reagent blank
- "H" = Analytical holding time exceeded
- "D" = duplicate RPDs exceed DQOs
- "J" = misc. QC criteria not met
- "<X" = sample concentration < MDL and "X" is numeric method detection limit value

- “<Y” = sample concentration < RDL and “Y” is numeric reporting limit value
- “>Z” = sample concentration > UQL and “Z” is the upper quantitation limit value
- ** = missing result
- ## = censored data
- ^^ = no measurement/sample collected (e.g., stream dry)

All preliminary lab qualifiers are reviewed during the data validation process. Note: WPP lab qualifiers are distinct from WPP final data qualifiers used in data validation. See Element D1.2 for a complete description of final WPP data qualifiers that are used when reporting data.



4 0 4 8 Miles



Charles Watershed

B5 QUALITY CONTROL

By providing important information necessary to assess data quality, WPP's quality control program serves to minimize cumulative uncertainty for measured variables. Lab audits will continue as usual for the WES lab and contract labs as resources allow.

B5.1 Field Quality Control

WPP surveys are planned well in advance to ensure proper coordination takes place among all parties, to allow adequate preparation time for crews, and to ensure proper procedures are followed. Well-planned and executed surveys help to minimize field error.

Water Quality Survey QC:

To estimate the overall precision or repeatability of results, a subset of WPP field samples are replicated by taking co-located, duplicate grab samples. Approximately 10% of the total number of samples and a minimum of one per survey per analyte group is typically collected. Where co-located, duplicate grab samples cannot be taken for any reason, it is noted on the field sheet what alternate type of field duplicate was collected. On a project-specific basis, QC samples may be taken at a higher or lower percentage.

In addition, ambient field blanks or equipment blanks, if appropriate, are taken at 10% of total samples to evaluate if any sample contamination may have occurred due to improper sample collection, atmospheric fallout or other causes. Blank samples may be taken at a higher or lower percentage, depending on the project.

Performance Evaluation (PE) or diluted Certified Reference Material samples may also be delivered to a lab to evaluate lab analytical accuracy and precision. Typically, WPP evaluates a sub-set of analyses each year by providing labs with PE samples for which WPP knows the "true" concentrations (e.g., *E. coli* count, nutrient/metal concentrations, etc.). These QC samples may be single-blind (sample type known by the lab, but not concentration) or double-blind (concentration unknown AND sample disguised as a real sample). These are prepared by WPP, by its agents, or are purchased through a Proficiency Test (PT) provider.

Training sessions for WPP field monitoring staff are held each spring, prior to any field surveys, to ensure that field measurements and samples will be taken consistent with accepted and approved SOPs. For experienced staff, these can be a basic review session, but for seasonal staff, a more thorough approach covers all aspects of field work.

In addition, field audits can be performed by WPP's QA Analyst to ensure consistent application of field protocols among different field crews.

See Table 15 through Table 18 for quality control requirements for water quality analytes, multiprobe parameters (including continuous deployment) and for continuous temperature sensors, respectively.

Biological Survey QC:

See biological programs QAPPs and SOPs (Appendices A, C, and D).

B5.2 Lab Quality Control

WPP requires sufficient laboratory quality control for all its data generation activities. Laboratory quality control processes are described in the WES lab and WPP lab QAPs and SOPs, as well as in the QA documentation for contract labs. Required lab quality control procedures include but are not limited to detailed recordkeeping, SOPs that are current/updated, participation in proficiency testing studies, use of appropriate QC samples (e.g., lab blank, reagent blanks, sample duplicate and matrix spike analyses), and keeping internal control and calibration charts.

For detailed descriptions of calibration and maintenance procedures for WES and other labs, see the applicable lab QAPs and SOPs, adopted herein by reference.

Operating specifications for WPP’s reagent water system are detailed in Table 14.

For all labs used, WPP requests that laboratory quality control data be included with submitted data packages. Analysis of these lab QC data helps inform WPP’s data validation process.

Table 14: Operating Specifications for WPP Reagent Water System

Manufacturer/Brand	Barnstead/Thermolyne E-pure®
Series	1090
Water quality output	Type 1 RGW per ASTM D1193; 18.2 M-ohm-cm
Max. flow rate	2.5 LPM (pressure-feed @ 60 HZ)
Feedwater requirements	HQ tap water or better
Resistivity measurement	0.01-18.2M-ohm-cm (temperature-compensated at 25 deg. C); +/-3%
Treatment methods (cartridges)	Cellulose/resin filtration (pretreatment), ion-exchange (deionization), activated carbon organics filtration, 0.2u final filtration
# cartridges	4

Table 15: Field Sampling Quality Control Requirements for Water Quality Analytes

QC SAMPLE TYPE	Frequency	Corrective Action	Persons Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Ambient Field Blanks and/or Equipment Blanks, or Trip Blanks (as appropriate)	Minimum 10% of samples collected, and a minimum of 1 per survey	Qualify or censor data as necessary	Monitoring Coordinator and QA Analyst	Accuracy (contamination)	No target analytes exceeding MDL (preferred) or RL
Field Duplicates	Minimum 10% of samples collected, and a minimum of 1 per survey	Evaluate and compare lab dups and field dups (overall precision). Censor or qualify data as necessary	Monitoring Coordinator and QA Analyst	Overall Precision	See Table 2 for precision DQOs
Performance Evaluation (PE) Samples	Evaluations will be scheduled based on availability, project specifics, and dependent on circumstance	Discuss with lab; rerun test samples. Censor or qualify data as necessary	QA Analyst and Lab Coordinator	Accuracy	Same as QC/PT sample acceptance criteria (provided by PT lab)

Table 16: General Field & Laboratory Quality Control Requirements for Biological Samples

QC SAMPLE TYPE	Frequency	Corrective Action	Persons Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Field Duplicates	Minimum 10% of samples collected, and a minimum of 1 per survey	Evaluate and compare duplicate data; censor or qualify data as necessary	Monitoring Coordinator	Overall Precision	See Table 2 for precision DQOs

QC SAMPLE TYPE	Frequency	Corrective Action	Persons Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Duplicate habitat assessment	Every station; every survey	Disagreement in habitat parameter scoring will be discussed and resolved before the Habitat Assessment can be considered complete.	Monitoring Coordinator and field crew	Precision	See Table 2 for DQO
“Expert” verification of taxonomic IDs & enumerations	As needed and spot checks	Work with taxonomist to determine correct identity when there is disagreement. Seek assistance from authority on the taxonomic group if identity cannot be resolved.	Monitoring Coordinator	Accuracy	See Table 2 for DQO
QC checks on sorting efficiency (inverts)	10% of samples	Repicking of the subsample with the addition of the “discovered” specimens.	Monitoring Coordinator	Completeness	>90% sorting efficiency

Table 17: Field and Laboratory Quality Control Requirements for Discrete/Attended Multi-Probe Instruments

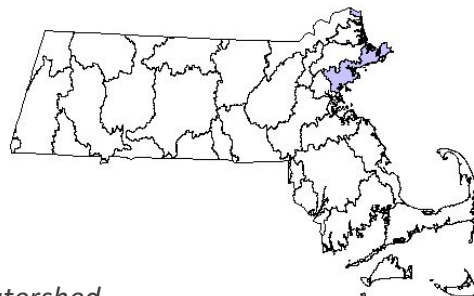
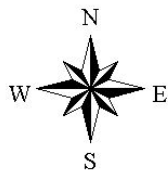
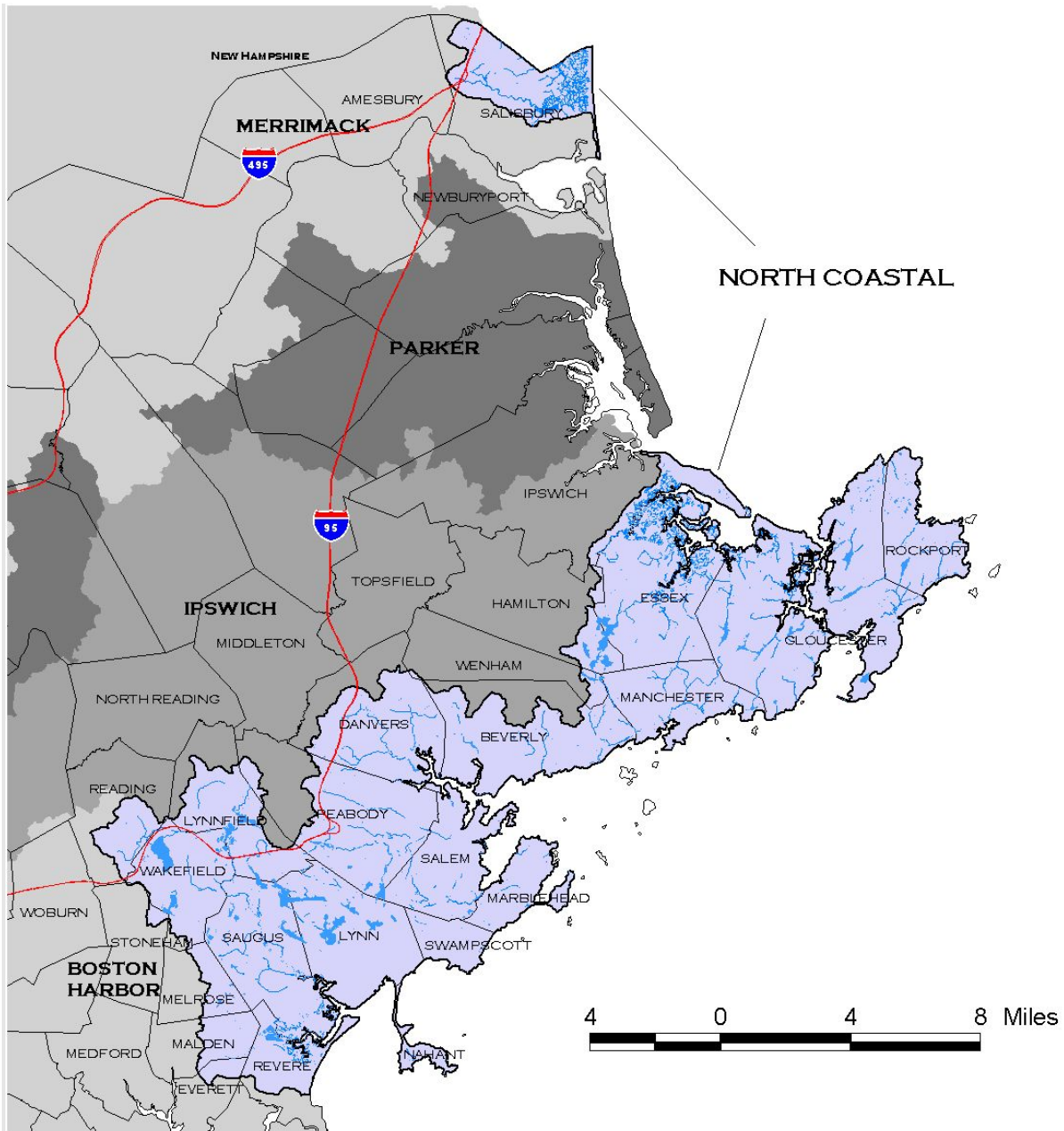
QC SAMPLE TYPE	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action (CA)	Persons Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Pre-Calibration (or pre-deployment)	Each day used	See SOP (CN 4.26 and 004.42) and multi-probe instrument manuals	Re-calibrate to within allowable specs.	Field & Lab Operations Coordinator & QA Analyst	Accuracy/bias Contamination	Must meet or exceed instrument accuracy specs

QC SAMPLE TYPE	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action (CA)	Persons Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Field Duplicate reading (Lakes only)	Approximately 10% of sites, minimum of one per trip	RPD < 10%	Re-deploy and start reading sequence again	Field survey crew leader	General precision	RPD < 10%
Post-Survey (or post-deployment) Check and User Report	End of each day or after deployment	See SOPs (CN 4.26 and 004.42) and multi-probe instrument manuals	If outside acceptance limits, discard or qualify data	Field & Lab Operations Coordinator & QA Analyst	Accuracy/bias Contamination	Must meet or exceed instrument accuracy specs

Table 18: Field and Laboratory Quality Control Requirements for Continuous/Unattended Probes

QC SAMPLE TYPE	Frequency/ Number	QC Acceptance Limits	Corrective Action (CA)	Persons Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Pre-Deployment QC Check	Before every use for each sensor	D.O.% Sat: +/- 3% Temperature: +/- 0.3 deg. C (vs. NIST-certified lab thermometer) Sp.Cond: +/- 2% or 15 µS/cm (vs. lab standard) Time: +/- 1 minute	Replace with more accurate sensor	Field & Lab Operations Coordinator & QA Analyst	Accuracies for D.O., temperature, Sp.cond., and time compared against 100% saturation concentration, lab standard, NIST-traceable thermometer and PC network clock, respectively	See SOP (CN 004.42) and sensor specifications

QC SAMPLE TYPE	Frequency/ Number	QC Acceptance Limits	Corrective Action (CA)	Persons Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
During-Deployment QC checks (Field Duplicate readings)	Each sensor; min. 1X/month (or more freq. for shorter duration deployments)	D.O. % Sat: +/- 5% Temperature: +/- 0.5 deg. C (vs. NIST-certified lab thermometer) Sp.Cond: +/- 2% or 15 µS/cm Time: +/- 1 minute	Replace with more accurate sensor; re-deploy	Project Coordinator & QA Analyst	Accuracy as above	See SOP (CN 004.42) and sensor specifications
Post-Deployment Checks	After every use for each sensor	D.O. % Sat.: +/- 3% Temperature: +/- 0.5 deg. C (vs. NIST-certified lab thermometer) Sp.Cond: +/- 2% or 15 µS/cm (vs. lab standard) Time: +/- 1 minute	If data outside acceptance limits, censor or qualify data	Field & Lab Operations Coordinator & QA Analyst	Accuracy as above	See SOP (CN 004.42) and sensor specifications



North Coastal Watershed

B6 FIELD EQUIPMENT TESTING, INSPECTION AND MAINTENANCE

All field equipment used by WPP to collect environmental data are inspected, maintained, calibrated (as applicable) and tested prior to use.

In addition to rigorous pre-survey calibrations, water quality instruments are also checked following use to ensure they were operating properly during field data collection. A summary of inspection and maintenance procedures for each instrument type is contained in Table 19.

Table 19: WPP Field Equipment Calibration, Inspection and Maintenance (italics indicate equipment items that are currently not in active use)

Instrument	Person(s) Responsible	Frequency of Calibration	Inspection Activity and Frequency	Maintenance Activity and Frequency	Testing Activity and Frequency	Corrective Action (CA)	SOP Reference
Multiprobes: * YSI EXO1	Suzanne Flint, Monitoring Coords.	Pre-cal/re-cal prior to and within 24 hours of use Post-use QC checks	Visual & Electronic; Monthly and/or before each use	Hardware & Software Repair and maintenance as needed.	Pre-survey calibration & post-survey QC checks	Re-calibrate as necessary during pre-calibration; censoring or qualifying data if post-survey check indicates excessive drift or inaccuracies in comparison to pre-calibrated readings and standard solutions	CN 4.26

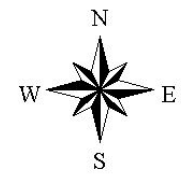
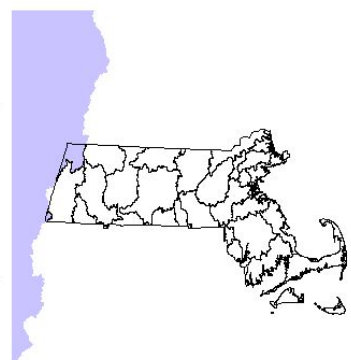
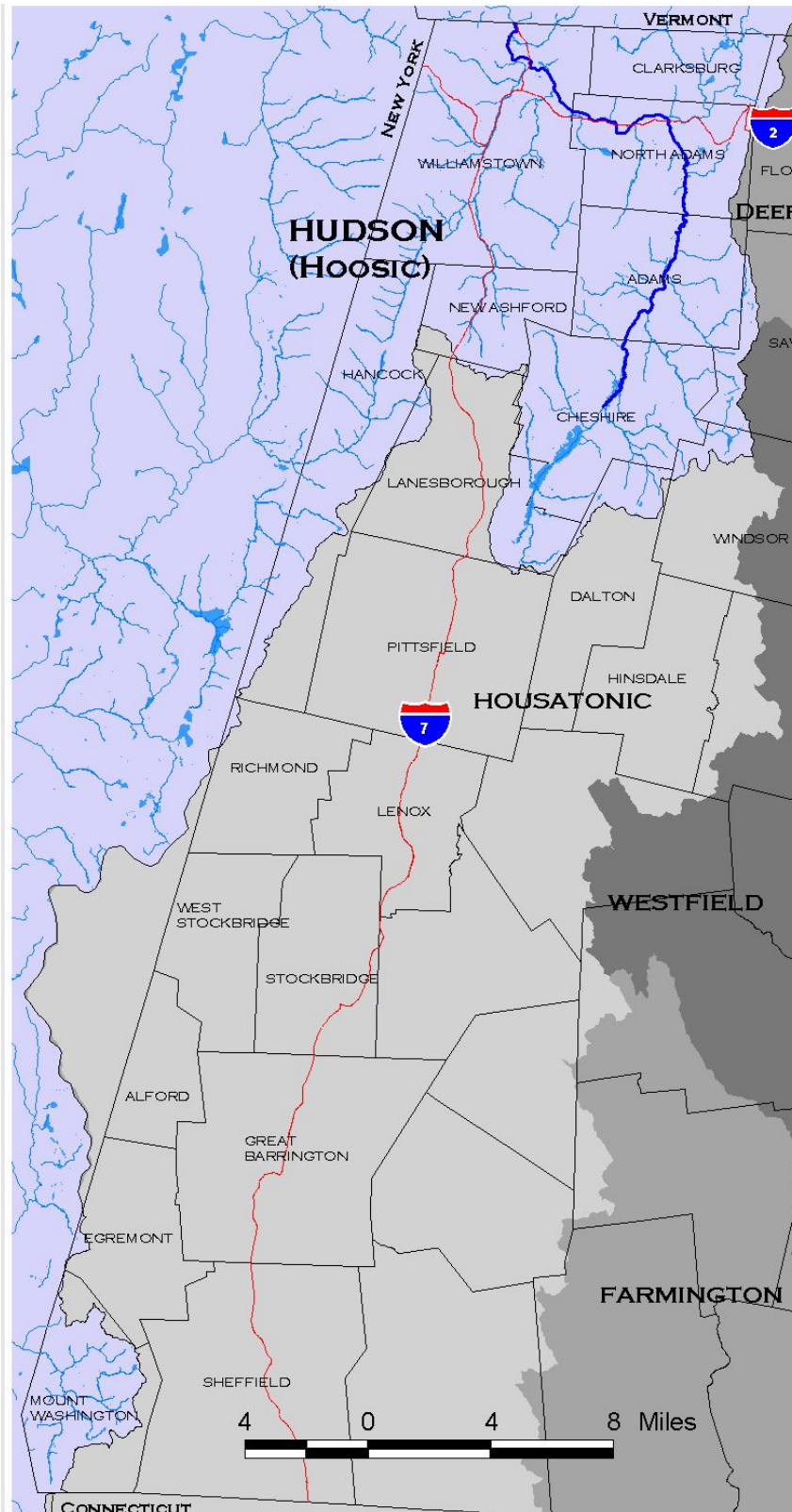
Instrument	Person(s) Responsible	Frequency of Calibration	Inspection Activity and Frequency	Maintenance Activity and Frequency	Testing Activity and Frequency	Corrective Action (CA)	SOP Reference
Backpack electrofisher (battery and gas-powered; e.g., Smith Root Model 12/15, Coffelt Mark 10.BP4, Halltech HT-2000 or equivalent)	Daniel Davis, Peter Mitchell	---	Visual inspection before use; check battery charge before use	<p>Clean the electrode ring and rat tail cathode with steel wool twice per year</p> <p>Winterize the gas-powered electro-fisher by adding gas stabilizer to the main and spare fuel tanks at the end of the sampling season.</p> <p>Recharge batteries immediately after use.</p>	Set for effective use for conditions at site	Clean and adjust as needed	CN 533.1

Instrument	Person(s) Responsible	Frequency of Calibration	Inspection Activity and Frequency	Maintenance Activity and Frequency	Testing Activity and Frequency	Corrective Action (CA)	SOP Reference
Barge electrofisher (gas powered; e.g., Smith Root Model SR6, SR7 or equivalent)	Daniel Davis, Peter Mitchell	---	Visual inspection before use; all items should be checked for tightness (tightened if necessary) prior to each survey.	Change the Honda™ generator oil once per year. Clean the hull of the electro-fishing barge, cathode plate, and the anode rings with steel wool once per year or as needed.	Set for effective use for conditions at site	Clean and adjust as needed	CN 533.1
Lowrance depth finders (lakes)	Daniel Davis, Monitoring Coords.	See SOP 151.1	See SOP 151.1	See SOP 151.1	See SOP 151.1	See SOP 151.1	See SOP 151.1
Phycocyanin Probe (Turner Cyclops/ Databank)	Suzanne Flint	Annually (Spring) using standard. Before and after each use using solid secondary standard	Visual, before and after each use	Cleaning as needed; before and after each use	See SOP 409.0	Re-calibrate as needed during pre-calibration; censoring or qualifying data if post-survey check indicates excessive drift or inaccuracies	CN 409.0, CN 409.5

Instrument	Person(s) Responsible	Frequency of Calibration	Inspection Activity and Frequency	Maintenance Activity and Frequency	Testing Activity and Frequency	Corrective Action (CA)	SOP Reference
NIST-traceable thermometer	Suzanne Flint, Monitoring Coords.	Annually, and as needed based on QC checks.	Visual & Electronic; Before and after each use	As needed	Annual (Spring) comparison to NIST-traceable thermometer	Replace unit as needed	CN 004.42
Temperature -only Loggers * (Onset PROV2, TidBits)	Suzanne Flint, Monitoring Coords.	NA. Check annually	Visual & Electronic; Before, during and after each use; if possible, review data while deployed to ensure working order and accuracy	NA	Annual (Spring) QC check against WPP NIST-traceable thermometer and PC network clock, per SOP.	Replace with working sensor.	CN 004.42
Cond/Temp loggers	Suzanne Flint	NA. Check before and after field deployment	Visual & Electronic; Before and after each use	NA	Annual (Spring) QC check against WPP NIST-traceable thermometer and PC network clock, per SOP.	Replace with working sensor.	CN 004.42

Instrument	Person(s) Responsible	Frequency of Calibration	Inspection Activity and Frequency	Maintenance Activity and Frequency	Testing Activity and Frequency	Corrective Action (CA)	SOP Reference
Onset DO/T	Suzanne Flint	Before and after field deployment	Visual & Electronic; Before and after each use	NA	Annual (Spring) QC check against WPP NIST-traceable thermometer and network clock, per SOP.	Replace with working sensor.	CN 004.42
GPS (vehicle; hand-held)	Monitoring Coordinators	---	Settings (annually)	As needed per manual	Annually	---	---
<i>Master-Flex peristaltic pump (field filtration)</i>	<i>Suzanne Flint</i>	<i>NA</i>	<i>Before each use (in the lab)</i>	<i>As needed.</i>	<i>Before each use (in the lab).</i>	<i>Repair as needed.</i>	<i>CN 1.23</i>

* WPP checks temperature loggers and probes annually against a NIST-traceable thermometer at near 0.0 ° C and room temperature (approx. 20-22 ° C).



Hudson/Hoosic Watershed

B7 LAB INSTRUMENT CALIBRATION, INSPECTION AND MAINTENANCE

All laboratory instruments involved in analyses of WPP samples are inspected, maintained, calibrated (as applicable) and tested prior to use. Details on the calibration of each WPP lab analytical instrument are contained in Table 20.

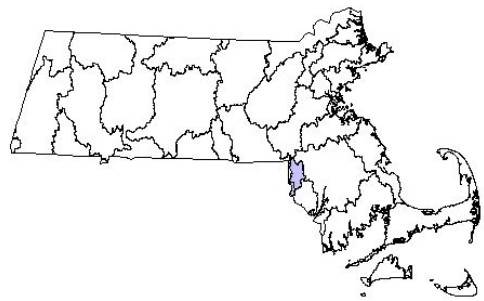
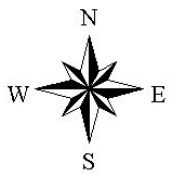
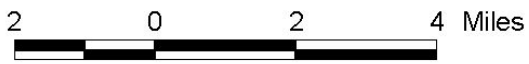
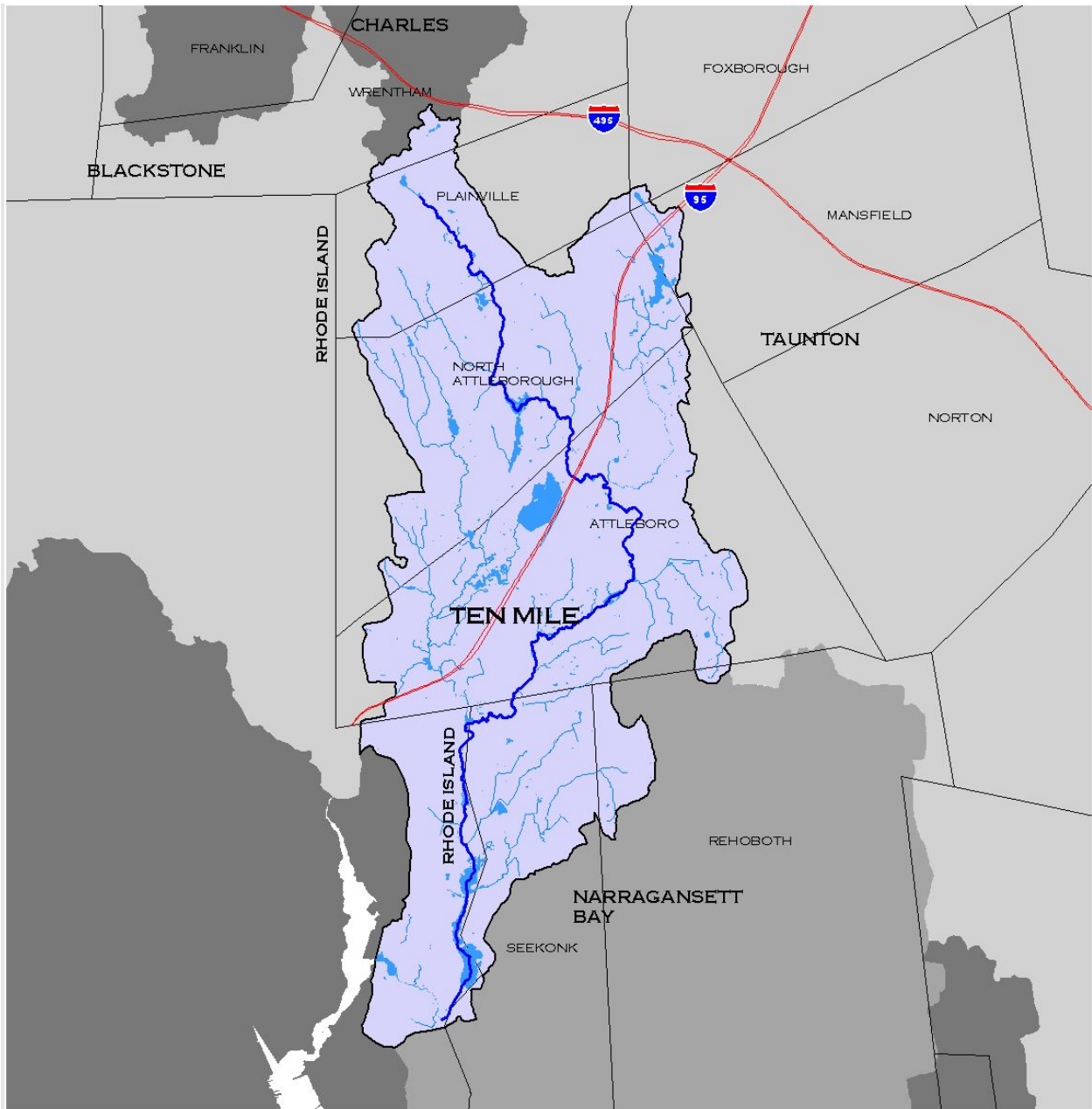
For detailed descriptions of calibration procedures for WES and other lab instrumentation, see the applicable lab QAPs and SOPs, adopted herein by reference.

Table 20: WPP Analytical Instruments Calibration and Maintenance

Instrument	Person(s) Responsible	Frequency of Calibration	Inspection Activity and Frequency	Maintenance Activity and Frequency	Testing Activity and Frequency	Corrective Action (CA)	SOP Reference
NIST-traceable thermometer (lab) *	Suzanne Flint	Annually, and as needed based on QC checks.	Visual & Electronic; Before and after each use	As needed	Annual re-calibration by manufacturer vs. NIST-certified	Send to manufacturer for re-calibration per SOP	CN 4.26 CN 004.42
IDEXX Colilert System (sealer, incubators, incubator thermometers, etc.)	Suzanne Flint, Seasonal Staff	Incubators: check operating temperature prior to each use. Incubator thermometers : annually to NIST-traceable	Visual checks prior to each use, including incubator temperature checks	Per equipment manual (IDEXX, Inc.)	NA	Apply temperature correction factors to incubator temps as needed	CN 198.2
Turner TD-700 Fluorometer (Chl <i>a</i> analysis)	Suzanne Flint	Prior to and following the sampling season	Calibration uses pure or re-hydrated Chlorophyll <i>a</i> preparations, or a solid standard	As needed per SOP	Periodic QC checks using dehydrated Chl <i>a</i> during seasonal use	Re-calibrate as necessary per SOP	CN 3.44

Instrument	Person(s) Responsible	Frequency of Calibration	Inspection Activity and Frequency	Maintenance Activity and Frequency	Testing Activity and Frequency	Corrective Action (CA)	SOP Reference
Turbidimeter (AQUAfast AQ4500)	Suzanne Flint Users (checks)	Calibration using a range of standards: every 3 months. Low standard check: prior to each use	Visual; daily when in active use.	As needed per SOP	Periodic QC checks during use per SOP	Censor or qualify data if QC check data indicate excessive drift or inaccuracies in comparison to standard calibration solutions	CN 95.3
Microscopes	Suzanne Flint	As needed per manual	Prior to every use (general operation)	As needed per manual	NA	NA	CN 150.1 CN 150.4 CN 39.4
Barnstead E-PURE® reagent water system	Suzanne Flint	NA	Weekly and prior to every use (general operation)	Annually and as needed (Change DI/AC cartridges, 0.2 final filter; disinfect) O-ring replacement	Prior to every use	Varies. If < 18.2 meg.Ω-cm If leaking If low flow/clog Pump problem	CN 4.991

* The NIST-traceable thermometer is calibrated annually at four temperatures (from 0-100 ° C) and issued a traceable certificate. The calibration is consistent with ISO 17025 and ANSI/NCSL Z540-1.



Ten Mile Watershed

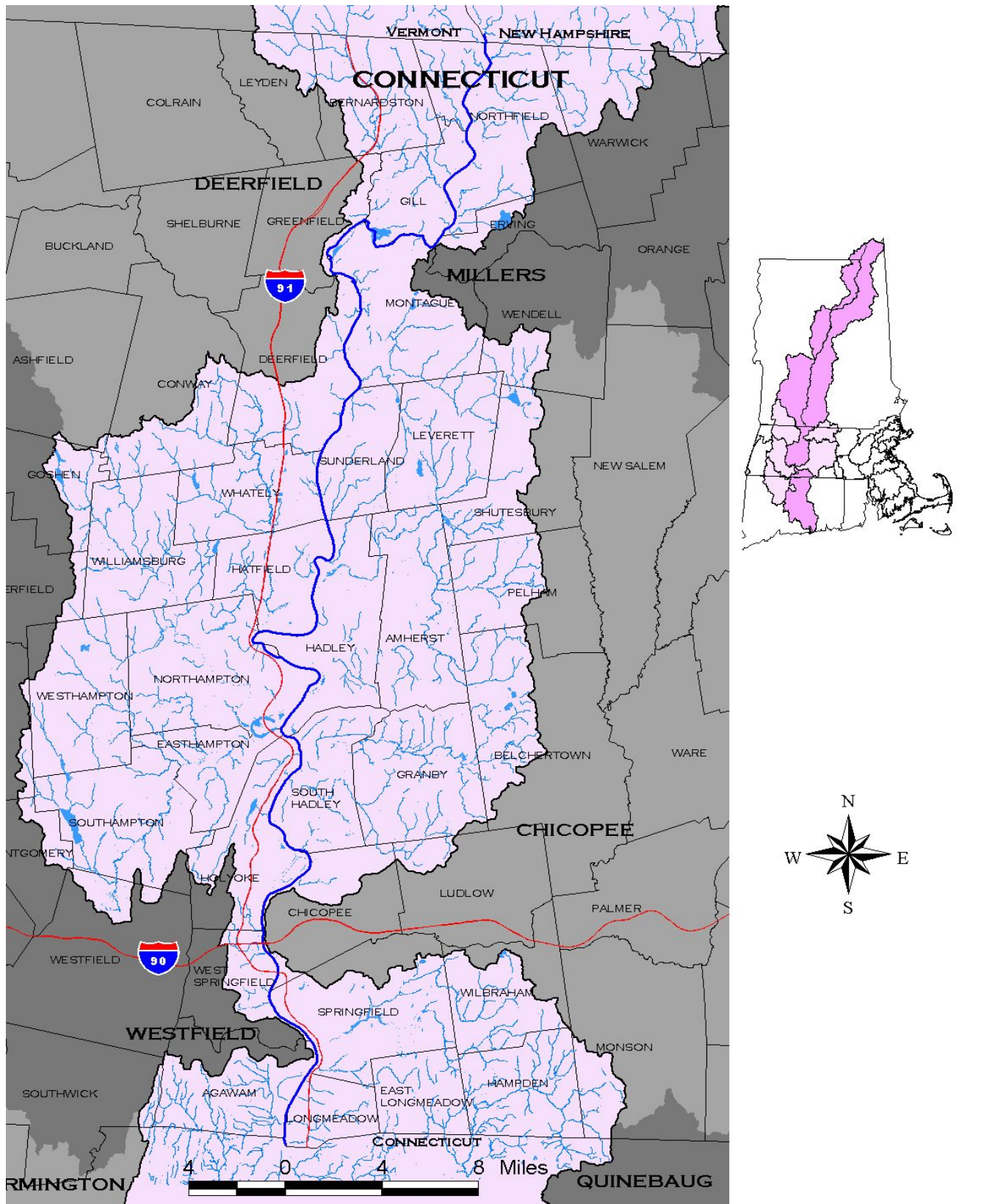
B8 INSPECTION OF SUPPLIES

Based on their individual responsibilities, designated WPP staff are responsible for ensuring the adequacy of supplies and equipment necessary to perform monitoring surveys. Equipment and supplies are ordered annually and as needed to meet specific monitoring and analytical needs. Wherever feasible, WPP strives to avoid or minimize the use of hazardous materials, to minimize the environmental impacts of its purchasing decisions, and to make cost-effective purchasing decisions. Table 21: WPP Supplies provides some examples of types of supplies used by WPP (not exhaustive).

Following use, efforts are made to recycle used supplies wherever possible. Disposal of liquid and solid waste is done in the most environmentally sensitive ways possible, and in compliance with applicable Massachusetts regulations.

Table 14: WPP Supplies

WPP STAFF	PROGRAM AREA(S)	TYPES OF SUPPLIES
Suzanne Flint	Laboratory and Field Operations	Sampling devices, multi-probe units and supplies, analytical kits, Colilert® / Enterolert® reagents and supplies, sample bottles, QC samples, cameras, GPS units, etc. DIW system maintenance supplies, probes and sonde parts, calibration reagents, water system cartridges, etc.
Suzanne Flint	Lab and Field Safety	Safety equipment and first aid supplies
Dan Davis Pete Mitchell	Fish toxics and community monitoring	Electroshocking equipment, nets, knives, boating supplies, etc. related to fish toxics and fish population sampling
Steven Bittner	Benthic Macroinvertebrates Microscopy	Nets, reagents, bottles, etc. related to benthic macroinvertebrate sampling & analysis, microscopy parts and equipment
James Meek, Therese Beaudoin	Lake and TMDL Monitoring	Depth finders, boating supplies, misc. test equipment
Suzanne Flint	Benthic algae Microscopy	Supplies and reagents for chlorophyll <i>a</i> analysis, benthic algae sampling and analysis
Vivian Gyimah	Vehicles	Maintenance items for vehicles
James Meek Dan Davis Pete Mitchell Steven Bittner Therese Beaudoin	Monitoring	Project-specific supplies and equipment as needed
Suzanne Flint	Purchasing	Procurement of all field, lab and safety equipment and supplies



Connecticut Watershed

NOTE FOR SECTION B9: See also annual project-specific Sampling & Analysis Plans (SAPS) in Appendix F and in the annual QAPP addenda.

B9 NON-DIRECT MEASUREMENTS & USE OF SECONDARY DATA

Given the inherent limitations of any monitoring program, use of reliable, quality-controlled data from external sources has become an integral part of WPP's decision-making. Both in planning its own data collection work and evaluating other's available data, WPP assembles data and information from a wide variety of sources. In situations where there is no current data collected by MassDEP, decisions regarding waterbody health can be made based on external data. This data can be acquired by MassDEP with permission via online resources or voluntarily submitted by external partners.

WPP's limited control over the QA planning and implementation for monitoring projects that generate "external" data limits the consistency of QAPP, SOP and other QA/QC measurements among projects. Any inconsistencies require WPP to independently assess the quality of external data prior to use, such as for water quality assessments. WPP strives to verify accuracy and evaluate the quality of all external data acquired through standardized procedures governing data acquisition, review, and management.

Although WPP's use of secondary data are combined with its own primary data, the uses are generally consistent with [EPA-Region 1 guidance](#) for projects using only secondary data.

B9.1 Sources of Information

Potential sources of external (secondary) data that meet WPP's needs include, but are not limited to, monitoring data from federal, state and municipal programs, various non-governmental organizations (NGOs), grant-funded (CWA s.314, s.319, s.104, or s.604(b)) projects and volunteer monitoring organizations. The following partial list provides some of the possible sources of information for WPP's water quality assessment, TMDL, and other work.

Federal Agencies and Funded Programs:

- U.S. Environmental Protection Agency (EPA)
- National Estuaries Program (NEP)
- U.S. Fish and Wildlife Service (USFWS)
- U.S. Army Corps of Engineers (ACOE)
- National Oceanographic and Atmospheric Administration (NOAA)
- U.S. Geological Survey (USGS)
- Natural Resources Conservation Service (NRCS)
- National Ecological Observatory Network (NEON)

State Agencies:

- Massachusetts Department of Environmental Protection (MassDEP) - Drinking Water Program, Wetlands and Waterways Program, and NPDES Program
- Massachusetts Office of Coastal Zone Management (CZM)

- Massachusetts Department of Conservation and Recreation (DCR)
- Massachusetts Department of Fish and Game (DFG) - Division of Marine Fisheries (DMF), Division of Ecological Restoration (DER)
- Massachusetts Department of Public Health (DPH)
- Massachusetts Water Resources Authority (MWRA)
- Massachusetts Bureau of Geographic Information (MassGIS)

Municipalities:

- Municipal Conservation Commissions (nonpoint source assessment)
- Municipal and Industrial NPDES Permit Monitoring Requirements (including service contracts for toxicity testing)
- Public drinking water system testing

Private Consulting Firms:

- Misc. project data

Academic Institutions and Regional Collaborations:

- Colleges, universities and other academic/research institutions
- Scientific/engineering literature, including conference and symposium papers
- Northeastern Regional Association of Coastal Observing Systems (NERACOOS)

Volunteer Monitoring Organizations:

- Watershed associations
- Lake & Pond associations
- Citizen monitoring groups

B9.2 Types of External Data

The types of external (secondary) data acquired by WPP for potential use vary widely depending on the source (chemical, biological, ecological, regulatory, etc.). The most common types of data acquired for use by WPP are (a) measured surface water quality/quantity data and (b) biological data (less common). These data must be accompanied by clearly interpreted and accurate geospatial data. Other potentially useful types of data include, but are not limited to:

- Hydrologic and water quality model output
- Measured pollutant loads
- Literature values and data
- Historical environmental data
- Permit records (e.g., DMRs)
- Beach and shellfish bed closure records
- Measured fish tissue contaminants
- Sediment quality data
- Weather records

The form these data take must be electronic (e.g., internet, database reports, spreadsheets, etc.) or paper and available in tabular form (i.e., an electronic spreadsheet) or submissions of narrative reports and other “paper files (e.g., in published reports, scientific literature, etc.). These forms of data are accepted but data review is not guaranteed.

B9.3 Data Quality Evaluation for External Data

WPP's process for acquiring and reviewing external data are combined standard procedures for data acquisition, geospatial data review, discrete data review, continuous data review, and biological data review. WPP maintains a website with [guidance on submitting external data](#). WPP's External Monitoring and Data Coordinator regularly performs handling of external data, including coordination and support for external groups, data assessment and management, and integration of external data into WPP's assessment process. The following describes WPP's current external data handling process.

WPP categorizes external data into three levels, which are related to its usability for WPP assessments of surface water quality:

1. Educational/Stewardship-level
2. Screening level
3. Regulatory/Assessment level

While meaningful, data determined to be Level 1 generally do not meet the rigor (i.e., accuracy, precision, frequency, comparability, overall confidence, etc.) required for use in waterbody assessments or TMDL development. MassDEP would not use Level 1 data for CWA s.305(b) or s.303(d) decision-making. These data are commonly collected and/or can be used for educational and/or stewardship purposes. Data classified as Level 1 generally (1) lack an agency-approved QAPP, (2) may not use a state certified or otherwise qualified laboratory for analyses, and/or (3) lack representative, documented, and accurate data and/or metadata. Regardless of usability, WPP encourages groups to submit for review data that are anticipated to be classified as Level 1.

Screening-level data (Level 2) may meet the data quality objectives in the submitter's QAPP but generally fail to meet one or more WPP criteria required for direct use in assessments (i.e., fail to meet criteria used in WPP's monitoring program QAPP approved by the EPA). These data, however, are important for their potential to direct future sampling efforts or as supporting evidence.

Regulatory/Assessment-level data (Level 3) are determined by MassDEP, based on WPP's external data review procedures, to be directly usable for CWA s.305(b) and s.303(d) decision-making. These data are considered scientifically sound and legally defensible, and are typically the result of extensive planning, attention to detail, relatively stringent data quality objectives, training, standard field and lab procedures, metadata collection, project organization, and data verification. Contingent upon WPP staff review and approval, quality-controlled data can help determine if a waterbody is healthy (i.e., meeting water quality standards) or impaired (i.e., not supporting the designated use).

All external data submitted electronically are reviewed using a consistent procedure. Use of WPP's data submittal template is required for external data submittals. Data providers can submit directly to EPA's Water Quality eXchange (WQX). Data are submitted directly to WPP through an email account (i.e., "the portal") at WQData.Submit@mass.gov. If submitted to WQX, data providers must email WPP notice of the upload and any additional required documentation (e.g., statement of data integrity). **Note: QAPP approval, submittal of the data integrity statement, and/or**

submittal of monitoring data do not guarantee that data will be used by WPP for CWA sections 305(b), 314, and 303(d) decision making.

Upon receipt of the data, WPP staff prepare the data for upload to the External Data Database (EDB). The EDB is a paired database system that utilizes a “front end” for data upload and review and a “back end” for data management and export. The EDB and all raw and processed data files are stored in a secure location in WPP’s data storage systems.

Immediately following upload to the EDB, a preliminary review of the data involves an evaluation of three main criteria for potential use in assessments:

- 1) Monitoring is performed consistent with an acceptable QAPP including acceptable standard operating procedures
- 2) Data resulted from use of an acceptable, preferably state-certified lab (certified for the applicable analyses) that has a documented, acceptable laboratory Quality Assurance Plan (QAP) and Standard Operating Procedures (SOPs)
- 3) Results include documented QA/QC data

Failure to meet any of these basic criteria (i.e., no QAPP, questionable analytical results, or poor QC documentation) undermines confidence in the secondary data. Lack of attention to QA/QC may result in non-use of the data without any further review. If one or more of the basic criteria are not met, the decision to do additional review is made on a case-by-case basis.

A review of geospatial data is performed to ensure that sampling locations are clear and accurate. WPP staff compare the submittal to previous submittals by the data provider and create a validated station definition for each sampling location. The station definition includes a validated station ID, coordinates, description, assessment unit association, and waterbody type among other metadata used for review tracking and data management. The review may result in the censuring of specific observations in the dataset or, if egregious errors in the geospatial data occur, an assignment of a score representing Level 1 data.

Following the geospatial review, WPP staff perform a manual review of the monitoring data. A specific score is assigned to data grouped by: (1) report number; (2) analyte; (3) data year; and (4) laboratory code (with each group assigned a unique identifier called EDRID (External Data Review Identifier)). Data groups are assigned a letter grade score binned by level. Letter grades within Level 1 denote the data as usable for educational purposes only (S); having inconclusive usability (I); or being unusable for any WPP purpose (F). Levels 2 and 3 designate the data as being all usable (highest score), mostly usable, or partially usable with caveats (lowest score). These levels are C, D, and E respectively for screening level data, and are A+, A-, and B respectively for assessment level data.

Scores are assigned subjectively by WPP staff performing the review based on, but not limited to, the following review criteria:

- Clarity, organization, detail, completeness and accuracy of the raw and/or analyzed data (including field sheets, notebook pages, QC analyses, spreadsheet data, etc.)
- Estimates of overall precision of field duplicates/replicates compared to project DQOs contained in the QAPP for the secondary data

- Estimates of accuracy of lab analyses, using field blank data, raw bench sheets, Quality Control/Performance Evaluation (QC/PE) samples, spiked sample matrices, and positive/negative controls (for bacteria samples), as compared to project DQOs
- Clear signs of QAPP implementation (i.e., documentation of actual QC measures to ensure data quality, such as the frequency of instrument calibration and maintenance, problem identification and response, and personnel training)
- Evaluation of field audit information (if available)
- Assessment of holding time violations
- Assessment of the frequency of field QC sampling (vs. QAPP)
- Availability of side-by-side and/or inter-laboratory QC audit information, if available, to assess inter-group and/or inter-lab precision (if available)
- Opportunities for personal communication with project lead(s) and/or QC officer(s), if needed, to address questions (such as, were sample data representative of a waterbody at a specific location?)
- Appropriate and accurate data analyses
- Method consistency among project participants and over time throughout the duration of the project
- Availability of completed COC forms
- Analytical holding time violations
- Frequency of QC samples (blank and duplicates) taken for each survey, and compare to QAPP
- Field blank sample results to verify lack of contamination
- Field duplicate sample results to verify acceptable precision
- Laboratory records (lab notebooks, lab bench sheets, if available) for potential effects on data quality, including multi-probe calibration books for potential effects on data quality
- Quality control results contained in laboratory data reports for potential implications to data quality (based on lab accuracy and precision data), and lab analytical performance during survey period based on results of any QC/PE testing
- Miscellaneous documentation (training records, e-mails, phone records, personal communication, etc.) to highlight any potential problems affecting data quality
- Overall quality of other data, as available (e.g., benthic macroinvertebrates, fish toxics, other “biological” data)
- Raw data field sheets (and field notebook(s) data, if available) for accuracy and consistency with other survey data, especially with regard to station location
- Raw data COC forms for accuracy and potential problems

Data usability determinations are analyte-specific and assigned to EDRID data groups (e.g., phosphorus data are OK, but not chlorophyll *a* data). Usability determinations within data groups may, however, also be time-specific (e.g., do not use data prior to their SOP being in place or training taking place) or location-specific (e.g., do not use data from Station X due to non-representativeness). Per-datum flags are added to the data through a data harmonization procedure that leverages a logic table produced from the manual comments entered by WPP staff during the review. This process allows WPP to identify specific data that should be used with caveats or censored (and not used).

Communication with data providers regarding data completeness, missing information and other questions takes place as necessary. In many cases, additional information is requested by WPP from the data provider to help finalize the review. Decisions on data usability may be postponed pending submittal of additional information, for lack of staff resources to adequately review the data, or for other reasons. Data usability postponed due to missing information is assigned an “I” score (level 1) until the necessary information is provided.

Certain types of data may not be used for assessment per the current Massachusetts Consolidated Assessment and Listing Methodology (CALM) Guidance Manual. Raw data not used for assessment are not formally reviewed nor assigned a usability score. It is stored in WPP’s electronic storage system and provided as needed outside of the standard procedures for external data review and management.

Table 22: Potential Secondary Data Providers to WPP (subject to availability, as agency monitoring programs and group projects can vary from year to year)

Data Source	Surface Waterbody Types	Sample Data Parameters*	Sampling Design	Geographic Area of Activity
Massachusetts Department of Public Health (MA DPH)	Marine beaches	Indicator bacteria	Fixed	Coastal areas
MA DPH (in coordination with MassDEP)	Freshwater beaches	Cyanobacterial toxins and algal counts	Targeted	Statewide
MA DPH (in coordination with MassDEP [WPP and ORS], DFG, and DMF) - Freshwater and marine fish advisories - Selected project data	Lakes & ponds Rivers	Metals, toxins (in fish tissue) Sediment quality Water quality	Targeted	Statewide
Massachusetts Department of Conservation and Recreation (DCR) - cooperatively with USGS	Weather Streamflow (general)	Precipitation Drought status (varies by program)	Fixed and variable	Varies by program
MA DCR	Lakes and ponds	Secchi depth Nutrients Chlorophyll <i>a</i> Bacteria Non-native plants	Targeted	Statewide

Data Source	Surface Waterbody Types	Sample Data Parameters*	Sampling Design	Geographic Area of Activity
MA DCR - cooperatively with Massachusetts Water Resources Authority	Drinking-water protection	Nutrients alkalinity, hardness bacteria/ pathogens macroinvertebrates	Fixed site	Quabbin Reservoir, Ware River, and Wachusett Reservoir watersheds
MA DCR	Public beaches	Bacteria	Fixed site	Statewide
MA DCR - Areas of Critical Environmental Concern (ACEC)	All	---	---	Statewide
MassDEP (in coordination with UMass-Dartmouth SMAST (Mass. Estuaries Project))	Estuaries Coastal tributaries	Nitrogen Salinity Bacteria DO/T Phosphorus Eelgrass	Fixed site	Mass. estuaries
MassDEP - Coastal ecology	Estuaries	Eelgrass coverage	Fixed site	Mass. estuaries
MassDEP - Lake management	Lakes & ponds	Herbicide applications	---	Statewide
MassDEP - Wetlands Monitoring	Wetlands	Various	Project-specific	Statewide
MassDEP - Waste site cleanup	Any potentially affected waters	Varies by project	Varies by project	Site-specific
MassDEP - Sustainable Water Management Initiative (SWMI-related information, including DFG and USGS data)	Rivers & Streams	In-stream flow Fisheries (inc. CWF) GIS Water usage ecological	Historical data and modeling	Statewide
MassDEP - Division of Municipal Services	All	Indicative summaries for grant projects	Varies by project	Statewide

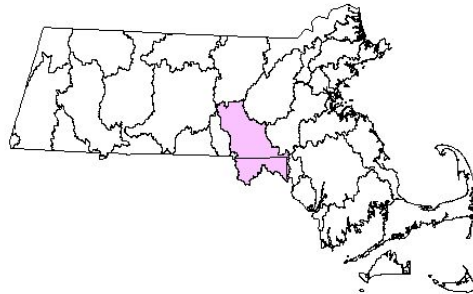
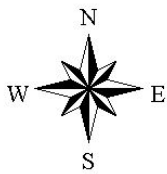
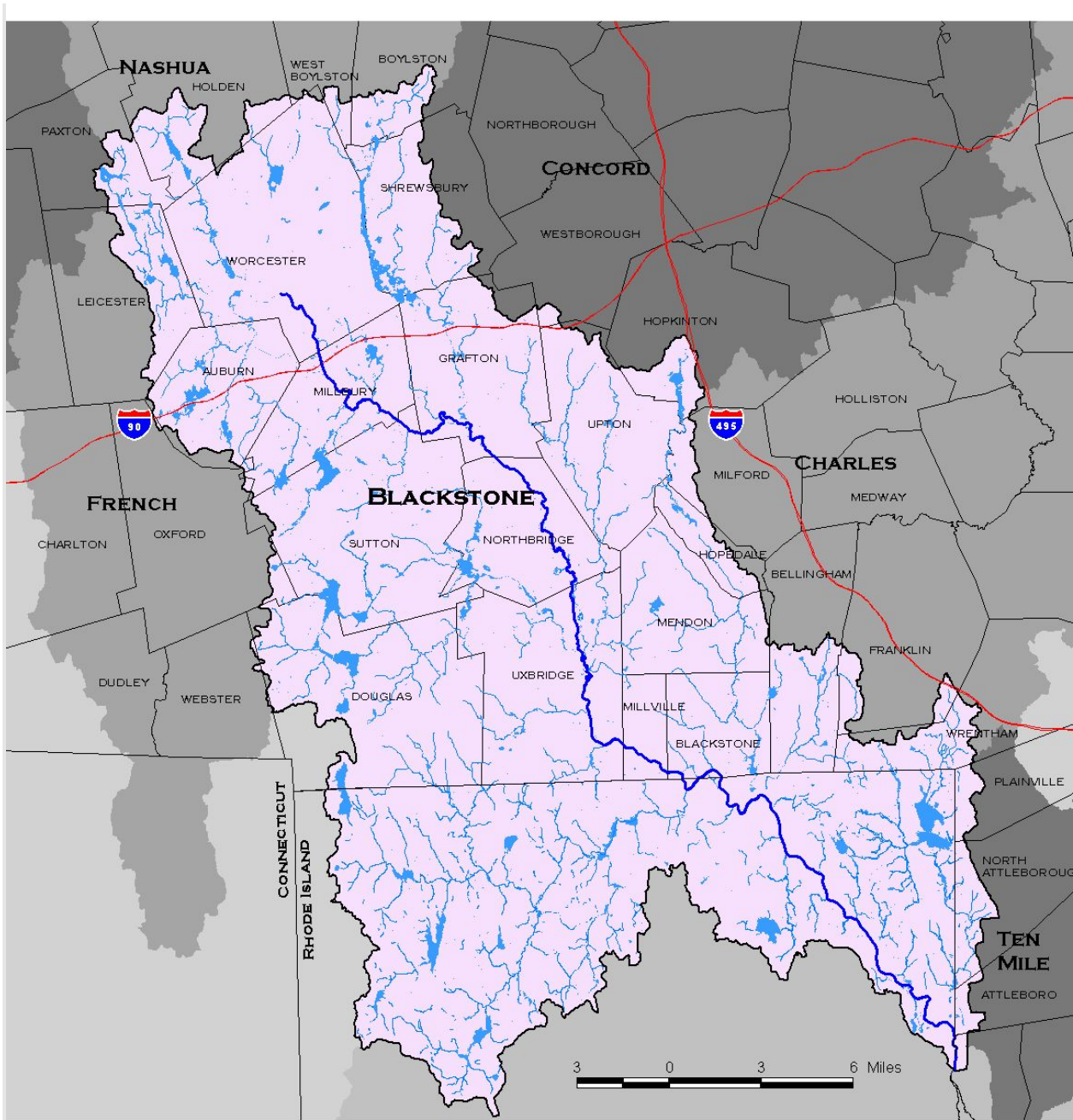
Data Source	Surface Waterbody Types	Sample Data Parameters*	Sampling Design	Geographic Area of Activity
		Pre- and post-project data (when available)		
Department of Fish and Game (DFG) - Division of Fisheries and Wildlife	Lakes & ponds Rivers & streams	Fish populations Target fish community Bathymetry Trout-stocked waters Cold Water Fisheries	Targeted	Statewide
MA. DFG - Division of Marine Fisheries	Marine shellfishing areas, rivers & streams	Saxitoxin (in tissue) Fish passage Dissolved oxygen temperature bacteria Fish counts and restoration data	Fixed site	Coastal areas
MA. DFG - Division of Ecological Restoration	Rivers & streams Wetlands Salt marshes Lakes & ponds	Streamflow Temperature Habitat Macroinvertebrates Aesthetics Dam removal	Targeted	Varies by project
Massachusetts Office of Coastal Zone Management (CZM) - Coastal Water Quality - grant projects	Coastal streams and wetlands	Dissolved oxygen pH nutrients salinity macroinvertebrates invasive species	Fixed site	Coastal areas
Massachusetts Bureau of Geographic Information (MassGIS)	All	Multiple layers	---	Statewide
Boston Water & Sewer Commission	Piped flows	CSOs	fixed	Greater Boston

Data Source	Surface Waterbody Types	Sample Data Parameters*	Sampling Design	Geographic Area of Activity
Massachusetts Dept. of Transportation - Highway Division Environmental	Highway runoff	Road-salt related data	Fixed site	Statewide
Massachusetts Water Resources Authority	Boston Harbor and tributaries Water supply reservoirs	Nutrients Bacteria Physical/clarity DW parameters CSO discharges	Fixed site	Central to eastern MA.
Massachusetts Bays National Estuary Program Buzzards Bay National Estuary Program Narragansett Bay Estuary Program	Bays & estuaries Salt marshes Rivers & streams	Dissolved oxygen Temperature Nutrients Chlorophyll <i>a</i> Fish community Invasive organisms Habitat SAV Sediment quality	Varies by project	Coastal & Marine
Volunteer Lake Associations (various)	Lakes, Ponds	Secchi depth Nutrients Chlorophyll <i>a</i> bacteria	Fixed site	Lake-specific
Volunteer Watershed Associations (various)	Rivers, Streams	Dissolved oxygen pH temperature bacteria nutrients	Fixed site	Basin-specific
Cape Cod Commission, Water Resources Office	Rivers & streams Lakes & Ponds Groundwater Stormwater	Vary by project	Varies by project	Cape Cod
US Army Corps of Engineers, NE District	Reservoirs	Varies by project	Varies by project	Project-based

Data Source	Surface Waterbody Types	Sample Data Parameters*	Sampling Design	Geographic Area of Activity
National Oceanographic and Atmospheric Administration (NOAA) - National Climatic Data Center (NCDC) - National Weather Service	---	Weather parameters Precipitation	Fixed	Statewide
United States Geological Survey (USGS)	Rivers & streams Reservoirs Impoundments Lakes & Ponds	Streamflow Precipitation Water quality Historical data	Fixed site and variable	Varies by project
USEPA National Pollutant Discharge Elimination System (NPDES) (Massachusetts is a non-delegated state)	Lakes & ponds Rivers & streams Bays and estuaries (associated with discharges)	Required parameters for permitted discharges Also, Discharge Monitoring Report (DMR) data (ambient chemistry and whole effluent toxicity) NPDES-regulated communities (e.g., MS4) CSO discharges	Fixed	Permittee-based locations and regional (MS4)
USEPA - WQX database	Lakes & ponds Rivers & streams	various	---	Statewide and neighboring states
USEPA - Superfund sites	Varies by project	Varies by project	Varies by project	On-site, Off-site

Data Source	Surface Waterbody Types	Sample Data Parameters*	Sampling Design	Geographic Area of Activity
USEPA - Region 1 projects	Varies by project	Varies by project	Varies by project	Project-based
USEPA - National Aquatic Resource Survey	coastal waters, lakes & reservoirs, rivers & streams, and wetlands	Varies	Varies	Nation-wide
US Fish & Wildlife Service - NE region	Varies by project	Fish counts Fish community Habitat Invasive species	Varies by project	Location-based (regional offices)
Federal Energy Regulatory Commission (FERC)	Rivers	Licensed facilities	---	Statewide
Bordering states with cross-border segment data (NY, VT, NH, CT and RI)	Rivers Lakes	Varies by State	Varies by project	State-shared watersheds
NEIWPC	Varies by project	Varies by project	Varies by project	Project-based
Misc. Projects (academic, contractor services, other)	Varies by project	Varies by project:	Varies by project	Project-based

* Actual parameters sampled for can vary from year-to-year and from project-to-project for many groups. “Nutrients” can include total phosphorus, dissolved reactive P, total reactive P, total dissolved P, total nitrogen, ammonia-nitrogen, nitrate+nitrite nitrogen, dissolved organic N, etc.



Blackstone Watershed

B10 DATA MANAGEMENT

In coordination with project-level staff, WPP’s data management team facilitates the storage of raw field data, lab data, and associated metadata in both hard copy and electronic formats, performs validation and verification procedures to finalize all data, and provides mechanisms for staff and outside groups to access these data.

In general, only WPP-collected sample data are formally managed in WPP databases. This includes sample data collected by WPP and analyzed by external lab contractors. However, in some cases, the data from monitoring projects in which a WPP contractor collects the samples and provides analytical data to WPP (under an approved project QAPP) are also managed in WPP databases.

For data not collected by WPP staff (including MassDEP project data) directly and submitted to WPP, a separate warehouse is maintained for purposes of storage and review for usability in assessments.

B10.1 Data Management Protocols

Table 23: WPP Data Management SOPs

Control Number	SOP
CN 0.421	EDD template and definitions
CN 0.61	Station definition
CN 56.42, 56.52, 56.62	Data Validation
CN 616.0	External Data Management and Reviews

B10.2 WPP Databases

Environmental databases currently in use by WPP include:

- EarthSoft EQulS, a commercial off-the-shelf data management system, configured for WPP historical and current data
- Data warehouse (1994-2004 data)
- Data warehouse (2005-2024 data)
- Benthic macroinvertebrate database (MABenthos) (1983 – 2024 data)
- Assessment unit database (SegDef)
- Station database (STAID) and associated geodatabase
- ATTAINS assessment/listing reporting (via EPA application)
- Toxicity Testing Data (ToxTD) for whole effluent toxicity (WET) data from NPDES permittees
- External Database warehouse (EDB) for external data

EarthSoft EQulS:

The EQulS database is capable of managing data from multiple water monitoring program elements (water chemistry, microbiological data, and biological data) and facilitates the transfer of WPP data and information to EPA’s Water Quality Exchange (WQX). Data from 2021 through 2024 are planned for migration to EQulS by the end of 2025. Field data collection using EQulS-EDGE

(electronic tablets in the field) for data collection allows for seamless upload of field-collected metadata.

Data Warehouses:

For internal staff use, two separate Access data warehouses exist for WPP water quality data and will continue to be used until staff access to EQUIS is fully implemented. These warehouses have been used to migrate water quality data into the EQUIS WPP database.

MABenthos:

MABenthos is a collection of five databases that contain tables, queries, forms, and reports used to store, manage, and analyze geospatial, habitat, taxonomic, and abundance data for benthic macroinvertebrate samples collected from freshwater stream, river, pond, and lake ecosystems in Massachusetts and bordering states. The database was created in Microsoft Access and contains data collected from 1983 and onward. The database for lakes and ponds is currently in development, and raw data are housed in tabular formats in preparation for input into the final database. WPP developed an Index of Biological Integrity (IBI) to assess streams and rivers for possible listing on the 303(d) list of impaired waterbodies. The IBI is calculated using software developed in R (R Core Team, 2024) that receives harmonized data generated from an MABenthos database.

Assessment Unit Database:

SegDef is an Access database storing metadata for Assessment Units (segments) for multiple §305(b) Assessment cycles. Exports from SegDef are joined with georeferenced segment shapefiles in ArcGIS for staff use and for publication at MassGIS. Exports are uploaded to EPA's Assessment, Total Maximum Daily Load (TMDL) Tracking and Implementation System (ATTAINS) database for each integrated reporting cycle.

Station Georeferencing:

WPP's georeferencing system for all historical and current sampling stations (water quality and biological) includes station descriptions, unique IDs, GPS coordinates, and GIS reference tables and data layers. Station waterbody names are based on MassDEP's inventory coding systems (SARIS - Stream and River Inventory System; PALIS - Pond and Lake Inventory System; and CAMIS - Coastal and Marine Inventory System). The georeferenced data layer of stations and station descriptions is available through MassGIS by searching for the MassDEP Water Quality Monitoring Stations.

ATTAINS:

WPP uses EPA's ATTAINS database to report statewide water quality assessment data, including use attainment, and causes and sources of impairment. Exports from ATTAINS are used to generate the integrated report every two years. ATTAINS is used for tracking TMDL reports and alternative restoration plans. Assessment summaries from WPP probabilistic monitoring projects for rivers, lakes, and coastal waters are also uploaded to ATTAINS as they become available.

ToxTD:

WPP's Toxicity Testing Database (ToxTD) is an MS Access database containing acute and chronic whole effluent toxicity (WET) testing and associated chemistry data submitted by permittees as

required by their National Pollutant Discharge Elimination System (NPDES) permits. The facilities are required to submit reports to MassDEP monthly, quarterly, biannually, or annually based on the permit. These external, secondary data assist in making waterbody assessment decisions.

B10.3 Data Entry Processes

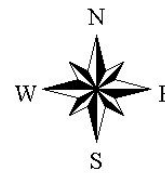
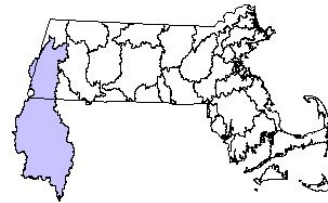
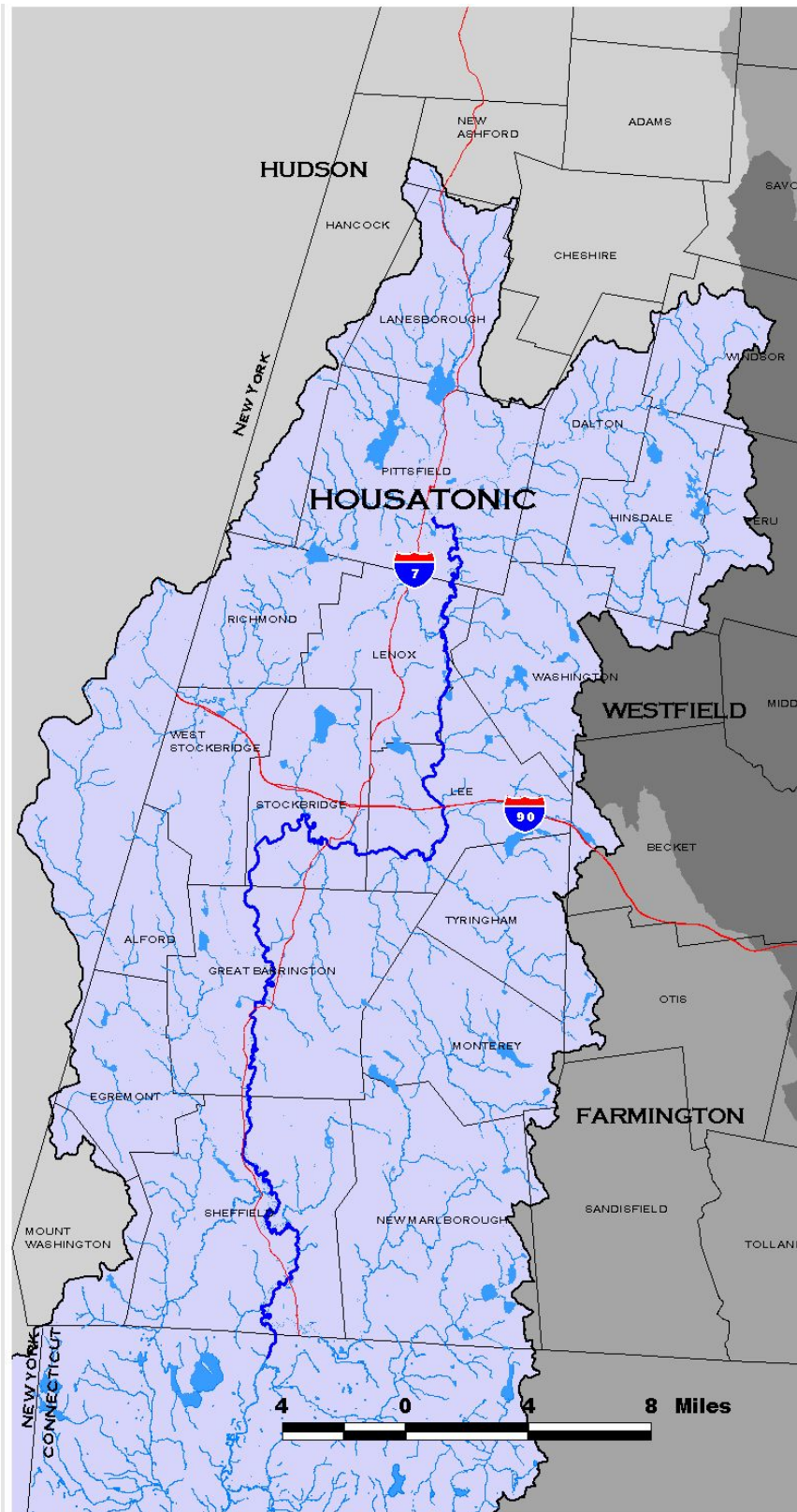
All completed WPP field sheets, and COC forms are scanned, then filed with the data management staff for preliminary review. All hardcopy files are stored at the Worcester office; electronic files and scans are stored in WPP's computer file management systems and backed up as part of the system-wide backups.

In 2025 WPP will be using EQUIS Data Gathering Engine (EQUIS-EDGE) software running on ruggedized field tablets to collect field data previously collected on field sheets. EQUIS-EDGE forms have been developed to capture discrete data for river, lake, and pipe water quality field sheets only; future work is planned for development of forms to capture continuous probe field sheet information. Field data collected will be uploaded directly to WPP's EQUIS water quality database. Until the field testing on the tablets is fully completed, field data will continue to be collected on paper field sheets as backup and scanned. EQUIS-EDGE software has been customized to collect the same information previously collected on paper field sheets.

The data management group has primary responsibility for overseeing field sheet data entry and electronic data file transmission. While Monitoring Coordinators are responsible for ensuring the completeness and quality of field data prior to turning in any paper/electronic field sheets. Data entry staff work closely with the Monitoring Coordinators on any discrepancies found on the field sheets which include incomplete and/or erroneous field-recorded data entry. After discrepancies have been addressed, the data entry QC begins, where all entered data are checked against the original data and metadata by a second WPP staff member.

Laboratory quality-controlled data from WES are available for download via the WES Laboratory Information Management System (WinLIMS) as soon as data are finalized. Lab data from contract labs and WPP's labs are also provided to WPP's QC Analyst and Database Coordinator using standard Electronic Data Deliverable (EDD) templates.

Entered field and lab data/metadata are processed using WPP's data validation procedures and are eventually finalized following completion of the validation steps. See Section D1 for more specific information on WPP's data validation methodology.



Housatonic Watershed

SECTION C: ASSESSMENT AND OVERSIGHT

C1 CORRECTIVE ACTIONS

Recognizing MassDEP's commitment to continual improvement and the common QA theme of "Plan-Do-Check-Act", WPP takes corrective action when necessary, based on a graded approach. Problems encountered that have a direct and meaningful effect on data quality are addressed using formal corrective action forms and communications. Less important issues are resolved on a case-by-case basis using more informal methods (e.g., email clarification).

C1.1 Field-Related Evaluation and Correction

Review of field activities related to data integrity and safety is the joint responsibility of WPP's Monitoring Coordinator for each project, the Field & Lab Operations Coordinator, and the QA Analyst.

The field audit process calls for the QA Analyst to accompany survey crews to evaluate adherence to the applicable SOPs and the program QAPP. Ideally, these field audits attempt to evaluate at least one survey per watershed and each survey crew member a minimum of one time. WPP sampling staff in need of performance improvements may be directed to re-read the relevant SOP and/or may be re-trained. If errors in sampling techniques are consistently identified, mandatory re-training will be scheduled.

When necessary, Root Cause Analyses (RCA) are conducted to determine the primary causal factors that led to an incident and to develop corrective actions. RCAs are performed by the Field & Lab Operations Coordinator or QA Analyst.

C1.2 Lab-Related Evaluation and Correction

WPP's QA Analyst has the primary responsibility to ensure that data from laboratories are consistently of known, documented and usable quality. This is achieved mainly by reviewing lab reports for errors, inconsistencies and poor QC results, as well as via frequent communication with lab staff. Ideally, timely communication regarding the need for corrective action can avoid future problems and/or data censoring.

For all labs used, the QA Analyst works with each lab to avoid misunderstandings. This includes visits to contract labs to discuss methods and logistical specifics. In addition, external, single- and double-blind laboratory audits using quantitative QC check samples are performed for nutrients (TP, NH₃-N, TN, NO₃-NO₂), bacteria, metals and other analytes as needed. WPP can also perform self-audits for Colilert® bacteria analysis using semi-quantitative PE samples (*E. coli* within a defined range) for in-house bacteria analyses.

Assessment of laboratory performance is mainly the responsibility of individual labs used (e.g., WES) prior to data transmittal. Lab audits are conducted by the Field & Lab Operations Coordinator and/or QA Analyst.

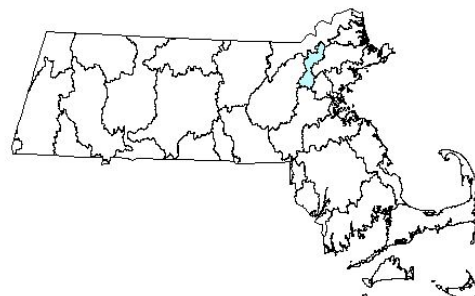
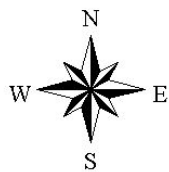
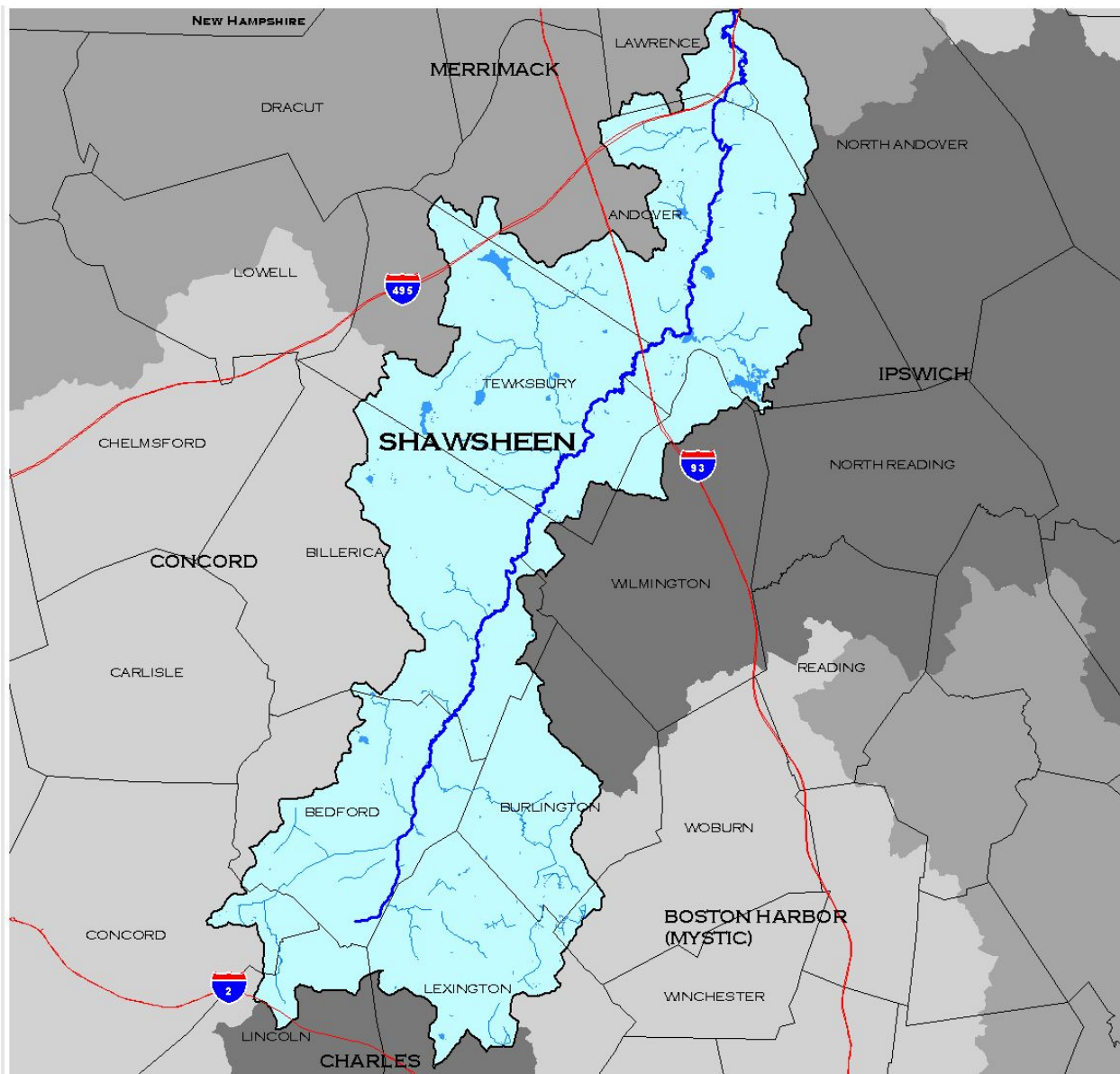
C1.3 Database-Related Evaluation and Correction

WPP's Database Coordinator is responsible for ensuring that housed data are secure, organized, accessible and free from systematic error. The need for corrective actions concerning the database system is attenuated somewhat by the "built-in" QA inherent in database development and maintenance (e.g., locked computer code, redundancy checks, etc.). Nevertheless, issues can arise that require resolution. Database-related issues and problems can be brought to the attention of the Database Coordinator by any staff, but the corrective actions needed to resolve problems are handled by the WPP data management group. Corrective actions take place as soon as possible and can include:

- Changes to the database to correct for transcription errors, based on data entry QC
- Changes to code (VB, R, etc.)
- Changes to import files based on new or updated information, such as WinLIMS data corrections and updates

C1.4 Incident and Corrective Action Forms

Incident Forms are available for reporting issues related to safety or data quality. Corrective Action Forms can be used for further documentation and for recommended improvements. These forms can also be used for all field and laboratory deviations and deficiencies that cannot be handled immediately. Refer to the Corrective Action Procedures SOP (CN 5.0) for more information.



Shawsheen Watershed

C2 REPORTING

C2.1 Program-Level Quality Assurance

Annual quality assurance self-assessments are generated by BWR and other MassDEP Bureaus to evaluate compliance with MassDEP's current Quality Management Plan (QMP). The self-assessments are provided to EPA Region 1. All WPP staff are familiar with the requirements and guidance in the QMP. Periodic training in overall QA within WPP is provided by WPP's QA Analyst.

C2.2 Internal and Online Data Reporting

Final data are made available via the data warehouses and the EQUIS database and reports. WPP's goal for assembling, validating, finalizing, and publishing data are within 6-12 months from completion of data collection. Due to potential complications (e.g., lab turnaround, process inefficiencies, etc.), data publication is often delayed beyond 12 months (from project completion).

[WPP water quality data](#) are made available to the public via a WPP online resource in Excel files or as part of the Water Quality Data Viewer. The following dataset types are available:

- Water quality laboratory data: water quality data generated via laboratory analysis; collected at monitoring stations throughout the Commonwealth
- Water quality discrete probe data: discrete probe data for parameters such as dissolved oxygen, temperature, pH, and specific conductance
- Water quality continuous probe data by deployment: statistical summaries of the unattended, continuously logged data (e.g., averages, maximums, minimums, etc.)
- Water quality continuous probe data by station: summary water quality information based on multiple deployments at each individual station in a given data year
- Water quality continuous probe data (available upon request): water quality readings from continuous probes deployed for durations from a few days to several months at individual stations (most deployments include data collected every 30 minutes or less)
- Biological data (available upon request): collected to assess aquatic life communities, including benthic macroinvertebrates, fish and periphyton
- Marine buoy continuous probe data: water quality readings from continuous probes deployed in coastal areas

WPP water quality data are also made available via an interactive [Water Quality Data Viewer](#).

C2.3 WPP Technical Memoranda

Using final data, WPP staff develop project-specific [Technical Memoranda](#) summarizing findings. These reports are made available internally, as well as posted to the MassDEP webpage.

C2.4 EPA Database Reporting

Once data are finalized, data are exported to EPA's Water Quality Exchange ([WQX](#)) network. The frequency of water quality data transmittals to WQX may vary from once per year to several times per year, depending on the availability of final data.

WPP also employs the [ATTAINS](#) database to track water quality assessment decisions, including causes and sources of impairment.

C2.5 Integrated List

On a biennial basis, WPP generates an *Integrated List of Waters (ILW)* that combines reporting elements required by CWA s.305(b) and s.303(d). The ILW report presents the individual categories of Massachusetts' waters for the current CWA listing cycle. Each waterbody or assessment unit is listed in one of the following five categories:

- Category 1: Unimpaired and not threatened for all designated uses
- Category 2: Attaining some uses and not assessed for others
- Category 3: No uses assessed (insufficient information to make assessments for any uses)
- Category 4a: TMDL is completed
- Category 4b: Impairment controlled by alternative pollution control requirements
- Category 4c: Impairment not caused by a Pollutant - TMDL not required
- Category 5: Impaired or threatened for one or more uses and requiring a TMDL

The latest version of the Integrated List can be found on the MassDEP webpage of [Integrated Lists of Water Related Reports](#).

C2.6 Water Quality Assessments

Results of monitoring efforts, combined with all other reliable information, constitute the basis for making water quality assessments. The Massachusetts Consolidated Assessment and Listing Methodology (CALM) Guidance Manual contains MassDEP's reasoning and justification for site-specific designated use decisions. The latest version of the [CALM](#) is available on the MassDEP webpage.

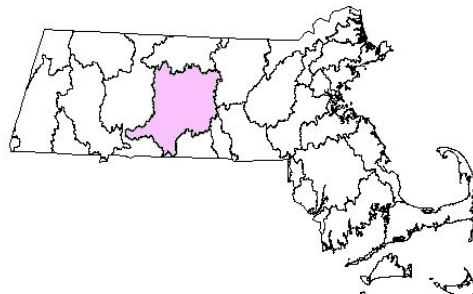
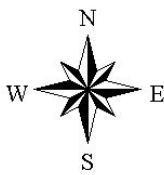
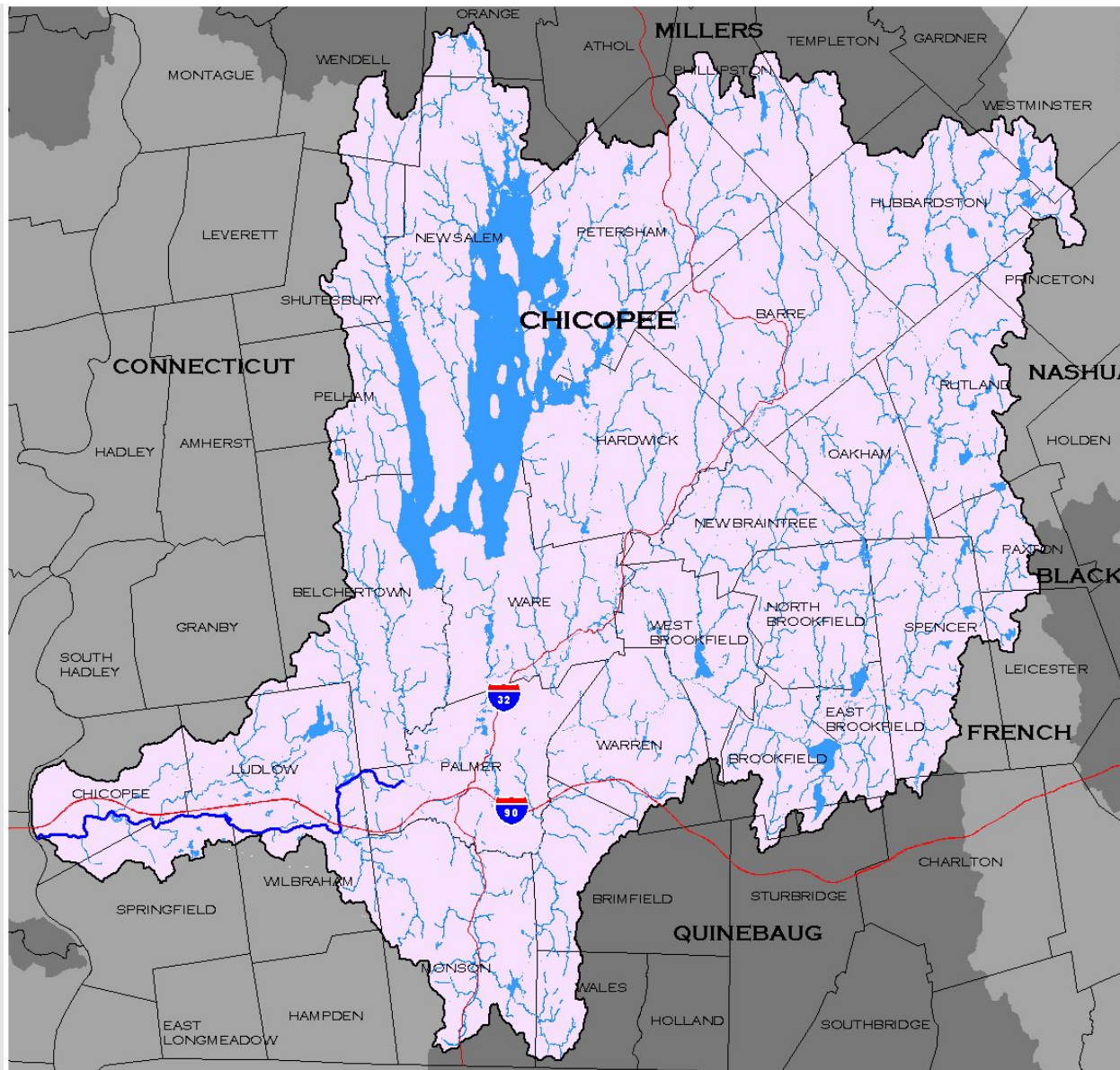
Use-attainment determinations are made for each waterbody segment for which adequate data and information are available. (Many waters remain not assessed for one or more uses in any given assessment cycle and many small and/or unnamed streams and ponds have never been monitored and assessed.) Results of MassDEP water quality assessments are available as appendices as part of the ILW report.

C2.7 TMDLs

Section 303(d) of the Clean Water Act and the EPA's Water Quality Planning and Management Regulations (40 CFR Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are not meeting designated uses under technology-based controls. The TMDL process establishes the maximum allowable loading of pollutants that a waterbody can receive and still meet applicable water quality criteria established in the Massachusetts Surface Water Quality Standards (MA SWQS; 314 CMR 4.00) for the protection of public health and aquatic life and supporting designated beneficial uses of those waters. TMDL analyses are based on available data and information and are documented in TMDL reports. [Final reports](#) are available on the MassDEP webpage.

C2.8 TMDL Modeling Reports

As described in WPP’s TMDL Modeling QAPP (Appendix A), the selection and use of models will be thoroughly documented in Modeling Reports.



Chicopee Watershed

SECTION D: DATA VALIDATION AND USEABILITY

D1 DATA REVIEW AND VALIDATION

WPP uses standardized procedures for managing, reviewing and validating primary water quality data. These procedures are contained in the following SOPs (Appendix D):

- CN 56.42 Data Validation_Atended data
- CN 56.52 Data Validation_Unattended data
- CN 56.62 Data Validation_Laboratory data

NOTE: The review and validation of WPP biological data (e.g., aquatic macroinvertebrates, fish toxics, fish populations) are completed in accordance with the stand-alone QAPPs and SOPs for those programs (available in compressed files accompanying this QAPP).

Review of secondary data sources (gathered by others) for usability is described in Section B9.3.

D1.1 “QC Status” Levels for WPP Data

The following categories of “data readiness” are used at WPP, as it relates to the use and transmission of draft and final data. All WPP data are categorized into five levels, depending on and reflecting the status of review and validation (finalization). The preferred QC Status levels for use and/or release of WPP data are QC Status 4 (final) and QC Status 5 (final, published). Although not recommended, all levels (QC1-5) can be shared with others if requested (e.g., for Freedom of Information Act purposes) with the appropriate disclaimers based on the QC status of the data.

QC Status 1 (QC1): Raw data. Generally not suitable for use or transmission but can be transmitted to other parties upon request provided data are sent as “DRAFT” with standard disclaimers.

QC Status 2 (QC2): Draft data that have been entered into the appropriate WPP electronic system or database and for which data entry QC has taken place. This stage is for technical QC review.

QC Status 3 (QC3): Draft data for which technical QA/QC review (e.g., QC sample results, outlier identification, comparison to project QAPP DQOs, etc.) has taken place. This stage is for project-level review.

QC Status 4 (QC4): Final Data. This level of data reflects project-level review by appropriate staff for reasonableness, completeness and acceptability. These data can be freely used and cited in documents without caution or caveat (reviewed and approved by all appropriate WPP staff).

The following guidelines pertain to receipt and use of QC 4 data:

- When using, analyzing, presenting or transmitting QC4 data, do not make any changes affecting CONTENT, including symbols and qualifiers used, censoring decisions, etc.
- When presenting data, provide KEY to symbols and qualifiers used
- See final data file “READ ME” sheets for additional information

QC Status 5: Final data in a published, citable report. The QC Status 4 guidelines stated above apply to the data contained in a report. QC4-level data have been reviewed and approved by all appropriate WPP staff.

D1.2 WPP Final Data Qualifiers

Standard data symbols are used to denote specific problems or issues for final data. These are applied to both qualified and censored data to provide data users with additional information.

General Symbols (applicable to all data types):

“**##**” = Censored data (i.e., data that have been discarded for some reason; check qualifier symbol for cause(s))

“******” = Missing data (i.e., data that should have been reported, but were not for any reason other than no water)

“**--**” = No data (i.e., data not collected nor intended)

“**^^**” = No water (i.e., a special case of missing data due to dry/no water conditions)

“**<MRL**” = Less than method reporting limit (MRL). Denotes a sample result that went undetected using a specific analytical method or was detected, but the result is less than the allowable reporting limit. The actual, numeric MRL is specified (e.g., <0.2)

Probe-specific Qualifiers:

“**i**” = inaccurate readings from probe likely; may be due to:

- significant pre-survey calibration problems or lacking pre-calibration/check
- post-survey checks outside typical acceptance ranges at post-field calibration checks
- lack of calibration of the depth sensor prior to use or negative depth readings
- checks against laboratory analyses
- water temperatures < 0.1 °C (likely iced conditions)
- anomalous points in continuous data likely caused by instrument problems

“**m**” = method not followed; one or more protocols contained in the probe SOP not followed, i.e., operator error (e.g., less than three readings per station (rivers) or per depth (lakes), or instrument failure not allowing method to be implemented)

“**s**” = field sheet recorded data were used to accept data (i.e., data not electronically recorded in a data logger or in cases where data logging is not possible (e.g., single-probes))

“**u**” = unstable readings, due to lack of sufficient equilibration time prior to final readings, non-representative location, highly-variable water quality conditions, etc. Also used to indicate instability in deployed/continuous readings

“ **c** ” = unit not calibrated for a particular parameter and/or greater than calibration standard used for pre-calibration, or outside the acceptable range about the calibration standard. Typically used for conductivity (>718, 1,413, 2,760, 6,668 or 12,900 $\mu\text{S}/\text{cm}$) or turbidity (>10, 20 or 40 NTU). It can also be used for TDS and Salinity calculations based on qualified (“c”) conductivity data, or that the calculation was not possible due to censored conductivity data (TDS and Salinity are calculated values and entirely based on conductivity reading)

“ **r** ” = data may not be representative due to circumstances and/or conditions at the time of sampling; used to indicate unrepresentative conditions (e.g., probe out of water, backwatered by beaver dam, probe buried, probe iced in) in continuous readings

“ **t** ” = tidal influence likely (not indicative of freshwater flow)

Lab Sample-Specific Qualifiers:

“ **a** ” = accuracy as estimated at WES lab via matrix spikes, PT sample recoveries, internal check standards and lab-fortified blanks did not meet project data quality objectives for program or QAPP

“ **b** ” = blank contamination in lab reagent blanks and/or field blank samples (indicating possible bias high and false positives)

“ **d** ” = precision of field duplicates (as RPD) did not meet project data quality objectives identified for program or in QAPP. Batched samples may also be affected

“ **e** ” = not theoretically possible. Specifically, used for bacteria data where colonies per unit volume for *E. coli* bacteria > fecal coliform bacteria, for lake Secchi and station depth data where a specific Secchi depth is greater than the reported station depth, and for other incongruous or conflicting results

“ **f** ” = frequency of QC duplicates did not meet data quality objectives for program or QAPP

“ **h** ” = holding time violation (usually indicating possible bias low)

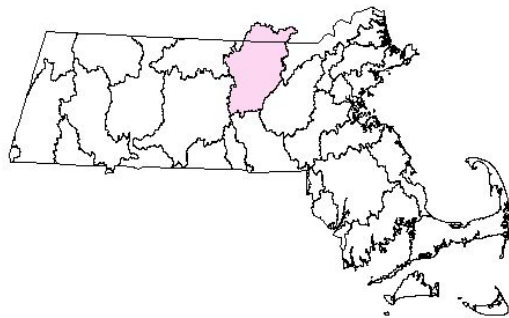
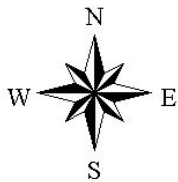
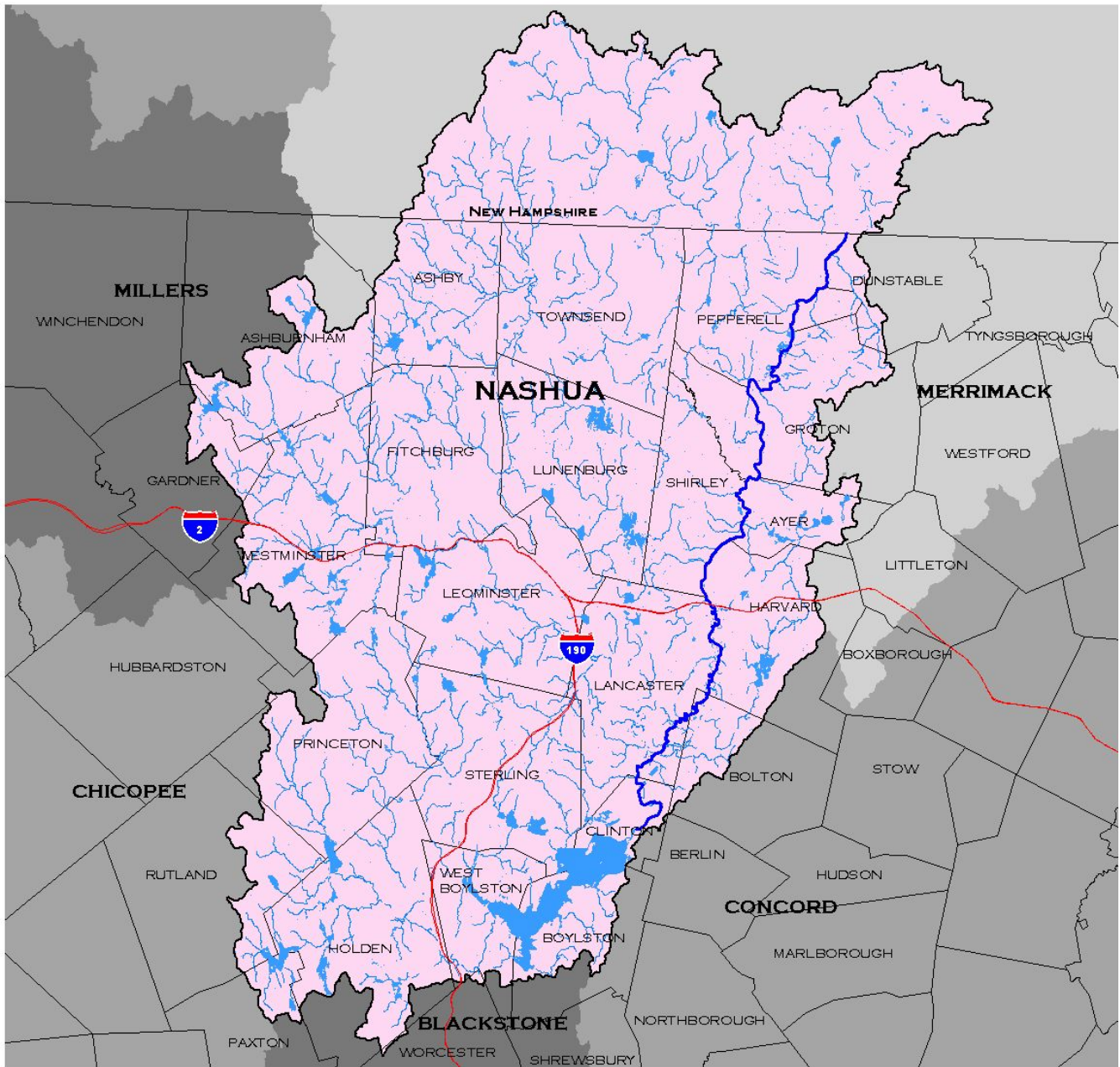
“ **j** ” = ‘estimated’ value; can be used for lab-related issues where certain lab QC criteria are not met and re-testing is not possible (as identified by the WES lab only). Also used to report sample data where the sample concentration is less than the ‘reporting’ limit or RDL and greater than the method detection limit or MDL ($\text{MDL} < x < \text{RDL}$). Also used to note where values have been reported at levels less than the MDL. Also used for estimated ranges based on known metadata

“ **m** ” = method SOP not followed, only partially implemented or not implemented at all, due to complications with sample matrix (e.g., sediment in sample, floc formation), lab error (e.g., cross-contamination between samples), additional steps taken by the lab to deal with matrix complications, lost/unanalyzed samples, use of expired reagents and missing data

“ **p** ” = samples not preserved per SOP or analytical method requirements

“ r ” = data may not be representative due to circumstances and/or conditions at the time of sampling, including the possibility of “outlier” data

“ t ” = tidal influence likely (not indicative of freshwater flow)



Nashua Watershed

D2 DATA VALIDATION METHODOLOGY

D2.1 Validation Process Overview

Water quality data generated by WPP can be deemed suspect or erroneous based on a variety of issues that affect data quality, such as analytical holding time exceedances, poor accuracy and precision, non-representativeness, missing and/or incorrect information, tidal influence, in adherence to field/lab methods, sample mix-ups, stability of probe readings, outliers or unreasonable data, field blank contamination, lack of QC information to evaluate data quality, and other sources of human and mechanical error. WPP's validation approach attempts to systematically accept, qualify or censor data using semi-automated procedures with built-in error-checking. Validation of other data types (e.g., biological, bathymetry) is based on QA/QC and data reviews built into the specific QAPPs and SOPs for that data type. WPP continues to reevaluate current data validation processes and procedures for all data types to look for opportunities for improving efficiencies and accelerating data delivery.

D2.2 Field sheet Metadata

Definitive electronic files containing all entered metadata (e.g., station location information, sample dates/times, sample identifiers) from WPP's paper field sheets undergo 100% data entry proofing prior to data validation. These electronic field sheet files are used, in combination with data files, to generate final QC4 data files. Errors caught during the data validation process may require field sheet metadata to be revised in the original database(s) and electronic field sheet files to be reproduced. All changes to the definitive year-based electronic-field sheet record are documented by email to QC/database staff.

D2.3 Laboratory Data

Chemical and microbiological lab data are validated in a series of automated and manual steps. For each data year, an MS Excel file is compiled from the complete laboratory results including: WinLIMS extract from the WES lab, EDD files from WPP, and contract labs. Initial processing and preliminary QC2 validation are completed using Visual Basic (VB) scripts and MS Excel macros to efficiently manage the large datasets:

- Lab sample IDs are linked to OWMIDs (WPP's sample identifiers).
- Station location information is added to the file using the common data element of "Unique ID" (WPP's station identifiers).
- Field duplicate accuracy, field blank contamination, hold times, and QC sample frequency are checked against QAPP DQOs.
- Standard WPP reporting rules (e.g., rounding and significant figures) are applied.

The automated QC2 data are then manually checked by the QA Analyst with additional qualifiers or censorings applied or removed as needed. Excel output files are read-only, and the data sheet is protected. Following the "technical QC" review (QC2), QC3 project-level review is performed by selected staff to look for potential problems missed during QC2 review. QC3 review involves additional checks for completeness, obvious outliers, incongruities, or other errors. Once any required edits from the QC3 review are made, the data status becomes QC4 (FINAL) followed by QC5 (Published).

D2.4 Discrete/Attended Probe Data

Discrete probe data are also validated in a series of automated and manual steps. Discrete probe data may be stand-alone or may be used as side-by-side QC checks against continuous deployed probes. YSI and Hydrolab multiprobe data files are downloaded from the instrument loggers on a regular basis during the field season and stored in limited-access folders. Data files are processed in year-specific sets. Each file is manually pre-processed to select the "best line" from blocks of data (3 to 5-minute duration, 30 seconds apart to ensure a stable record at each site). During pre-processing, each parameter is assessed for stability and "u" (unstable) qualifiers applied as appropriate. All the "best lines" are assembled and linked to electronic field sheet metadata records. A Visual Basic (VB) script is used to process and efficiently manage the large datasets:

- Identify and correct errors (such as missing or inaccurate OWMIDs, unmatched probe serial numbers, date/time errors, duplicate OWMIDs, etc.)
- Apply additional qualifiers (such as lab QC issues)
- Incorporate in-situ temperature QC measurements (needed to assess temperature-only continuous probe data records) from a separate file
- Apply standard WPP reporting rules
- Join station location information to files based on current station registration records

The automated QC2 data are then manually checked by the QA Analyst with additional qualifiers or censorings applied or removed as needed. Excel output files are read-only and the data sheet protected. Following the "technical QC" review (QC2), QC3 project-level review is performed by selected staff to look for potential problems missed in QC2 review. QC3 review involves additional checks for completeness, obvious outliers, incongruities, or other errors. Once any required edits from the QC3 review are made, the data status becomes QC4 (FINAL) followed by QC5 (Published).

D2.5 Continuous/Unattended Probe Data

Continuous probe data are validated in a series of automated and manual steps. Multiprobe and temperature logger data files are downloaded on a regular basis during the field season and stored in limited-access folders. Data files are processed in year-specific data sets. Each file is pre-processed to link to electronic field sheet metadata records. Automated processes, using Visual Basic (VB) code include:

- Trimming files for start/end times using discrete probe records or field sheet meta data
- Running automated QC checks to identify and correct errors (such as missing or inaccurate OWMIDs, unmatched probe serial numbers, data/time errors, data spikes, etc.)
- Applying data qualifiers based on standard QC criteria
- Applying standard reporting rules are applied
- Joining station location information to files based on most current station registration records
- Calculating basic statistics and producing charts summarizing each data file

The automated QC2 data are then manually checked by the QA Analyst with additional qualifiers or censorings applied or removed as needed. Files are then reviewed against climate data to identify "real" data vs. instrument errors where possible and to identify out-of-water scenarios. Each file contains a "read me" tab, data, a summary statistics sheet, and data graphs. The automated statistics and charts are provided to staff for convenience, and to provide accurate, quality-

controlled and consistent output for the more common statistical measures for DO, conductivity, and temperature. Excel output files are read-only and the data sheet is protected. Following the "technical QC" review (QC2), "QC3 review" is performed by selected staff to look for potential problems missed in QC2 review. Once any required edits from the QC3 review were made, the data status become QC4 (FINAL) followed by QC5 (Published).

D2.6 Benthic Macroinvertebrate Data

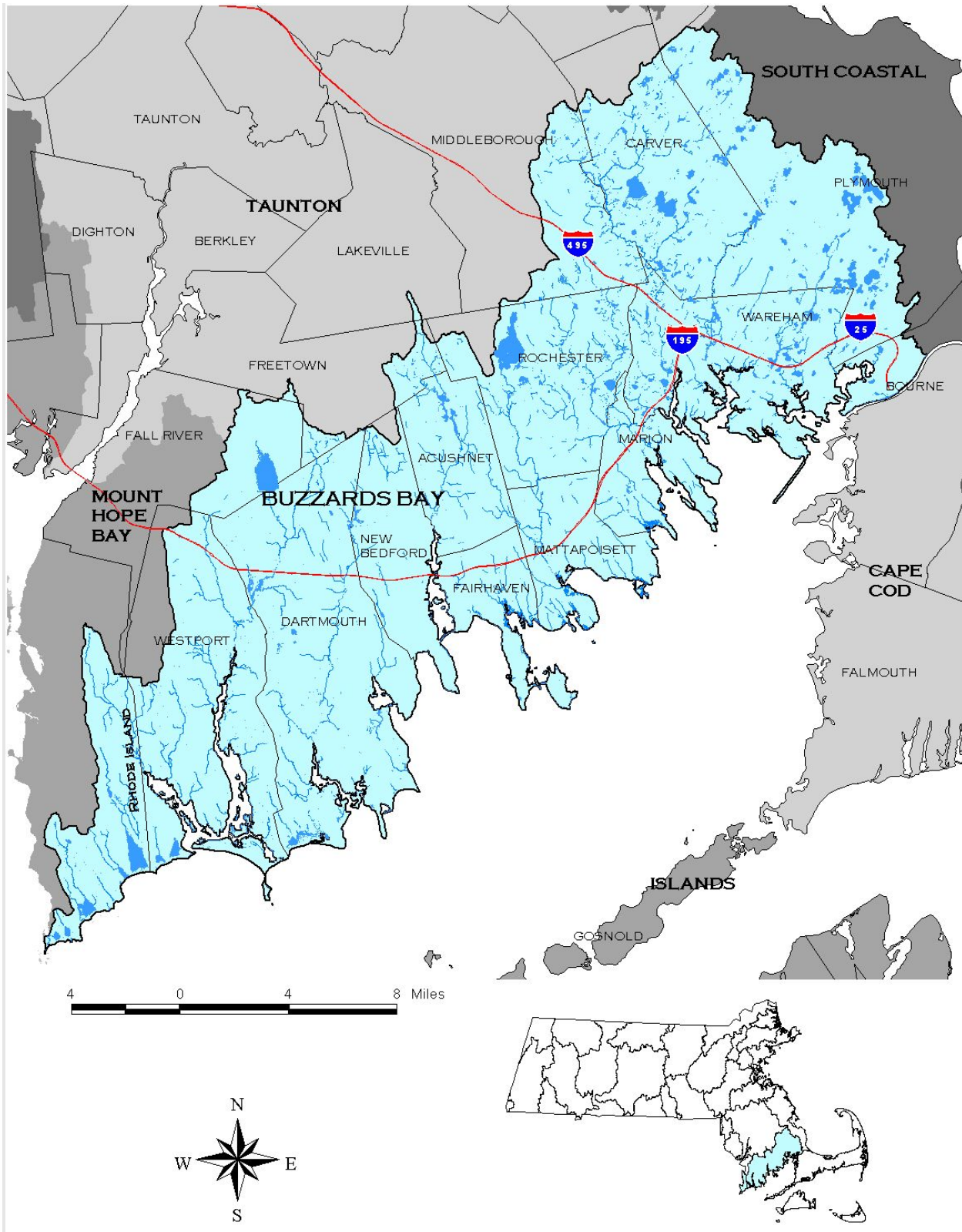
Benthic macroinvertebrate samples are collected by WPP to assess the Aquatic Life Use (ALU). Samples are sorted, enumerated and identified to appropriate taxonomic level(s). Data are finalized as described in the benthic program SOP by a staff biologist's evaluation of the results of QC sampling and expert confirmation of split samples and voucher specimens, and best professional judgement. Final data (meeting defined data quality objectives) are used in a metrics-based scoring system. Results are typically presented in Tech Memos.

D2.7 Fish Population Data

Using electroshocking techniques, fish samples are also collected by WPP to assess aquatic habitat. Live samples are enumerated and identified to species level. Data are finalized as described in the fish population program QAPP (Appendix C, CN 075.3) by a staff biologist's best professional judgement with regard to factors affecting survey data quality, such as survey efficacy (e.g., catch per unit effort) and accuracy of identifications. Final data meeting defined data quality objectives are used to evaluate the health of the fish community in relation to reference and/or expected conditions. Results are typically presented in Tech Memos.

D2.8 Benthic Algae

Periphyton (i.e., benthic attached algae) samples are collected by WPP to assess aquatic habitat and impacts due to excess nutrients. In-situ measurements are taken and samples are collected for identification, density and chlorophyll *a* content. Biological data are finalized by a staff biologist's best professional judgement with respect to accuracy of identifications, adherence to SOPs, and other factors potentially affecting data quality. Laboratory-based chlorophyll *a* data are validated as described above in Section D2.3. Final data meeting defined data quality objectives are used to evaluate waterbody health in relation to reference conditions and are typically presented using Tech Memos.



Buzzards Bay Watershed

D3 DATA USABILITY

Data of known and documented quality (i.e., QC4 and QC5) can be used without caveat for analysis, decision making and reporting (as described in Section C2). The extent to which data are determined to be useful is an ongoing in-house evaluation based on cumulative confidence (and uncertainty) in the data, data conclusiveness and results of QC and data analyses. If certain data do not meet the program DQO's, data may be censored, qualified, or left as draft subject to further review. Any limitations on data use will be detailed in both interim and final reports.

Final monitoring data are used in project-specific technical memoranda, which include summary quality control evaluations. These memoranda support determinations made as part of the watershed assessment and TMDL development processes.

WPP monitoring is evaluated on a continuous basis. Data for each project are evaluated with regard to both programmatic and project-specific objectives. Final data are used to answer important questions related to the current health of surface waters in the Commonwealth and the potential for improvements in environmental quality.

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GLOSSARY:

A common understanding of terminology is critical to an effective QA program. All project personnel should have the same working knowledge of these terms. The following terms are commonly-used in describing project QA/QC, from QAPP development to lab analysis and reporting. In most cases, these suggested definitions are entirely consistent with EPA guidance.

PARCCS Concepts:

Precision: A data quality indicator, precision measures the level of agreement or variability among a set of repeated measurements, obtained under similar conditions. Precision is usually expressed as a standard deviation in absolute or relative terms.

Accuracy: A data quality indicator, accuracy is the extent of agreement between an observed value (sampling result) and the accepted, or true, value of the parameter being measured. High accuracy can be defined as a combination of high precision and low bias.

Representativeness: A data quality indicator, representativeness is the degree to which data accurately and precisely portray the actual or true environmental condition measured.

Comparability: A data quality indicator, comparability is the degree to which different methods, data sets, and/or decisions agree or are similar.

Completeness: A data quality indicator that is generally expressed as a percentage, completeness is the amount of valid data obtained compared to the amount of data planned.

Sensitivity: Similar to resolution, sensitivity refers to the capability of a method or instrument to discriminate between measurement responses. The more sensitive a method is, the better able it is to detect lower concentrations of a variable. Sensitivity may be quantified through detection limits.

General QA/QC:

Analyte: Within a medium, such as water, an analyte is a property or substance to be measured. Examples of analytes would include pH, dissolved oxygen, bacteria, and heavy metals.

Bias: Often used as a data quality indicator, bias is the degree of systematic error or inaccuracy present in the assessment or analysis process. When bias is present, the sampling result value will differ from the accepted, or true, value of the parameter being assessed in one direction. Bias should not be used interchangeably with accuracy.

Censored data: Data that has been found to be unacceptable as a result of the data validation process, including review for conformance to the approved QAPP and data quality objectives for the project (ex. required holding times for analysis, required frequency of field blanks and duplicates/splits, acceptability of precision estimates (standard deviation, SD or relative percent difference, RPD).

Chain-of-Custody: Used for routine sample control for regulatory and non-regulatory monitoring. The chain-of-custody form contains the following information: sample IDs, collection

date/time/samplers, sample matrix, preservation requirements., delivery persons/ date/time, etc. Used also as a general term to include sample labels, field logging, field sheets, lab receipt and assignment, disposal and all other aspects of sample handling from collection to ultimate analysis.

Data users: The group(s) that will be applying the data results for some purpose. Data users can include the principle investigators, as well as government agencies, schools, universities, watershed organizations, and business and community groups.

Data quality objectives (DQOs): Data quality objectives are quantitative and qualitative statements describing the degree of the data's acceptability or utility to the data user(s). They include indicators such as accuracy, precision, representativeness, comparability, and completeness (PARCC). DQOs specify the quality of the data needed in order to meet monitoring project goals.

Matrix: A matrix is a specific type of medium, such as surface water or sediment, in which the analyte of interest may be contained.

Measurement Range: The measurement range is the extent of reliable readings of an instrument or measuring device, as specified by the manufacturer.

Method Validation: Testing procedure for existing, new and modified methods, in which several evaluation steps are typically employed: determinations of MDL, method precision, method accuracy, and sensitivity to variation in method steps ("method ruggedness", SM, 1998).

Minimum Reporting Limit (MRL): Also known as the Reporting Limit (RL), the lower limit that the lab feels comfortable reporting with a high level of certainty. This limit is typically a multiplier of the MDL (2-5X).

Performance Audit: Unscheduled evaluation of field sampling QC or laboratory QC procedures by a third party not directly involved in the taking, transport and analysis of the samples; used to detect deviations from accepted SOPs. Audits can take many forms. Submittal of identical check samples to two different labs is an example of an external, blind performance audit. Inter-lab comparison samples can also be used to test the lab's proficiency in relation to other labs. Results of audits are documented and any necessary corrections recommended.

Practical Quantitation Limit (PQL): The lowest concentration of an analyte that can be reliably measured within specified limits of precision and accuracy during routine laboratory operating conditions. (50 FR 46906, November 13, 1985) PQLs can range from 3-10 times the MDL.

Protocols: Protocols are detailed, written, standardized procedures for field and/or laboratory operations.

Quality assurance (QA): QA is an integrated management system designed to ensure that a product or service meets defined standards of quality with a stated level of confidence. QA activities involve planning quality control, quality assessment, reporting, and quality improvement. These activities can be internal (within the main group) or external (involving outside parties).

Quality assurance project plan (QAPP): A QAPP is a formal written document describing the detailed quality control procedures that will be used to achieve a specific project's data quality requirements. A QAPP is a planning tool to ensure that project goals are achieved. Typically, QAPPs are finalized prior to monitoring activities and any deviations from the final QAPP made during the actual monitoring are noted in a subsequent task, such as the data reporting phase of the project. QAPPs can be of two main types:

- A “project-specific QAPP” provides a QA blueprint specific to one project or task and is considered the sampling and analysis plan/workplan for the project.
- A “generic program QAPP” is an overview-type plan that describes program data quality objectives, and documents the comprehensive set of sampling, analysis, QA/QC, data validation and assessment SOPs specific to the program. An example is a macroinvertebrate monitoring program performed throughout many watersheds within a State.

Quality control (QC): QC is the overall system of technical activities designed to measure quality and limit error in a product or service. A QC program manages quality so that data meets the needs of the user as expressed in a quality assurance project plan. Specific quality control samples include blanks, check samples, matrix spikes and replicates.

Random Sample: A sample chosen such that the choice of each event in the sample is left entirely to chance; an unbiased sample generally representative of the population. Randomness is a property of a sample that must exist for almost any statistical test but may not be appropriate for all sampling designs (ex. Non-random site selection based on targeting specific conditions or based on practical considerations).

Relative standard deviation (RSD): A measure of precision calculated by dividing the std. deviation by the mean, expressed as a percentage. Used when sample number exceeds two.

Relative percent difference (RPD): A measure of precision used for duplicate sample results. It is calculated by dividing the difference between the two results by the mean of the two results, expressed as a percentage. Used when sample number equals two.

Standard deviation(s): Used in the determination of precision, standard deviation is the most common calculation used to measure the range of variation among repeated measurements. The standard deviation of a set of measurements is expressed by the positive square root of the variance of the measurements.

Standard operating procedures (SOPs): An SOP is a written, official document detailing the prescribed and established methods used for performing project operations, analyses, or actions. Each WPP SOP is reviewed and approved for accuracy and applicability.

Trend: Systematic tendency over time in a specific direction in time series data, ideally collected at uniform intervals, collected and analyzed using the same (or comparable) methods and containing no gaps in periodic data.

True value: In the determination of accuracy, observed measurement values are often compared to true, or standard, values. A true value is one that has been sufficiently well established to be used for the calibration of instruments, evaluation of assessment methods or the assignment of values to materials.

Variance: A statistical term used in the calculation of standard deviation, variance is the sum of the squares of the difference between the individual values of a set and the arithmetic mean of the set, divided by one less than the numbers in the set.

Field Quality Control:

Duplicate sample: Used for quality control purposes, field/lab duplicate samples are two samples taken generally at the same time from, and representative of, the same site/sample that are carried through all assessment and analytical procedures in an identical manner. Field duplicate samples are used to measure natural variability as well as the precision of field sampling and lab analytical methods. Lab duplicates are used as a measure of method precision. More than two duplicate samples are referred to as replicate samples.

WPP field blank water: Deionized water made available by properly maintained and -functioning water filtration system located in WPP laboratory.

Environmental sample: An environmental sample is a specimen of any material collected from an environmental source, such as water or macroinvertebrates collected from a stream, lake, or estuary.

Field blank: A field blank is created by filling a clean sample bottle with deionized or distilled water in the field during sampling activities. The sample is treated the same as other samples taken from the field. Field blanks are submitted to the lab along with all other samples and are used to detect any contaminants that may be introduced during sample collection, fixing, storage, analysis, and transport.

Field composite sample: A sample taken by mixing equal volumes of a pre-determined number of grab samples from the same location at different times, i.e., a time-composite. Used to assess average conditions present between the first and last grab samples that are composited. Use time-composite sampling only for those parameters that can be shown to remain unchanged under the specific conditions of composite sample collection. Flow-weighted composite sampling is a variation to time-composite sampling, in which sample volume adjustments are made to each grab based on variations in flow, such as occurs during stormwater monitoring loading studies.

Field integrated sample: A sample taken by simultaneously combining a matrix across vertical or horizontal strata as an evaluation of average composition within the boundaries of the integration (ex. Photic zone sampling for chlorophyll *a*). Sampling tubes can sample continuous, integrated media.

Field Split: A second sample generated from the same sampling location and at the same time by splitting a large volume sample from one sampler deployment into two equal volume samples.

Used to measure precision, except that associated with actual sample collection, and excludes natural variability. Also referred to as duplicate subsample.

Field Duplicate (sequential): A second sample generated from the same sampling location as the initial sample, but from a second sampler deployment immediately after the first. Used to measure overall field sampling precision and includes an unknown amount of natural variability (spatial and temporal), if present.

Field Duplicate (simultaneous): A second sample generated from the same sampling location and at the same exact time as the other sample by simultaneous deployment of two identical sampling devices or by the simultaneous filling of two separate sample bottles. Used to measure overall field sampling precision and includes an unknown amount of natural variability (spatial), if present. Also referred to as a co-located duplicate.

Grab Sample: A manually collected sample at a specific location and time. Given practical constraints and budget limitations, assumptions are usually made that the natural variation is small enough over space/time to consider the grab to be representative of conditions over a greater expanse and/or longer period. In some cases, these assumptions may not always be valid.

Laboratory Quality Control:

Blind sample: A blind sample is a sample submitted to an analyst without their knowledge of its identity or composition. Blind samples are used to test the analyst's or laboratory's expertise in performing the sample analysis.

Calibration Blank: Reagent-grade, purified water (deionized/distilled) used as a zero standard; used to “zero” lab instruments, evaluate instrument drift and check for sample contamination of field blanks.

Calibration Check Standard: A standard used to check the calibration of an instrument between periodic recalibrations.

Detection limits: Applied to both methods and equipment, detection limits are descriptions of the lowest concentration of a target analyte that a given method or piece of equipment can reliably ascertain as greater than zero. Specific detection limits include: Instrument detection limit, level of quantitation, lower level of detection, method detection limit, practical quantitation limit and reporting (detection) limit.

Instrument detection limit (IDL): The concentration that produces a signal greater than five times the signal/noise ratio of the instrument.

Level of Quantitation (LOQ): The concentration that produces a signal sufficiently greater than the blank that it can be detected; typ. The concentration that produces a signal 10*s above the blank signal. Typically, ten times the IDL (SM, 1998).

Lower level of detection (LLD): Measurement level reproducible with 99% certainty; typically, twice the IDL.

Method detection limit (MDL): The MDL is the concentration that produces a signal with a 99% probability that it is different from the blank, after going through the entire method. The smallest amount that can be detected above the noise in a procedure and within a stated confidence level. Typically, four times the IDL.

Practical Quantitation Limit (PQL): The lowest concentration level that several labs can report using the same method and samples; typically, ten times the IDL, and 3-5 times the MDL.

Reporting Limit (RL): Also known as the Reporting Detection Limit (RDL), the lower limit that the lab feels comfortable reporting with a high level of certainty. For practical purposes, the RDL is often equivalent to the MDL when data with values down to the lowest possible limits are needed.

Equipment or rinsate blank: Used for quality control purposes, equipment or rinsate blanks are types of field blanks used to check specifically for carryover contamination from reuse of the same sampling equipment (see field blank).

Lab Split: A sample that has been divided into two or more subsamples. Splits are submitted to different analysts or laboratories and are used to measure the precision of the analytical methods. Lab splits are an external QC protocol.

Lab duplicate: A sample that has been divided into two or more subsamples. It is processed concurrently and identically with the initial sample by the same laboratory. It is used to measure the precision of the analytical methods. Lab duplicates are also referred to as lab splits.

Method Blank: An aliquot of clean reference matrix carried through the analytical process to assess the degree of laboratory contamination and indicate accuracy.

Matrix Spike: A sample to which a known concentration of target analyte has been added. When analyzed, the difference in analyte concentration between a spiked sample and the non-spiked sample should be equivalent to the amount added to the spiked sample. Lab QC sample used to assess sample matrix effects on recovery of target analyte and evaluate accuracy. Also known as Lab-fortified matrix. Duplication of this sample is referred to as matrix spike duplicate or lab-fortified matrix duplicate.

Performance evaluation (PE) samples: A sample of known concentration submitted “blind” (without lab’s knowledge) to the analyst. PE samples are provided to evaluate the ability of the analyst or laboratory to produce analytical results within specified limits, and as an indicator of method accuracy. Also called a laboratory control sample.

Spike Blank: Known concentration of target analyte(s) introduced to clean reference matrix and processed through the entire analytical procedure; used as an indicator of method performance and accuracy. Also known as Lab-fortified blank.

Standard reference materials (SRM): An SRM is a certified material or substance with an established, known and accepted value for the analyte or property of interest. Employed in the

determination of bias, SRMs are used as a gauge to correctly calibrate instruments or assess measurement methods. SRMs are produced by the U. S. National Institute of Standards and Technology (NIST) and characterized for absolute content independent of any analytical method.

Qualifier: Used to indicate additional information about the data and generally denoted as capital letters in data reports. Qualifier acronyms or terms are unique to each laboratory.

Quality Assurance Plan (QAP): A comprehensive laboratory document detailing lab quality control procedures (e.g., WES QAP).

APPENDICES (available separately at the MassDEP website: [2025-2029 Watershed Planning Programmatic QAPP](#))

Appendix A: WPP Project QAPPs

- CN XXX.X Generic QAPP for Model Simulations in the TMDL Program (Draft)
- CN XXX.X QAPP for 6PPD/6PPD-q Monitoring (Draft)

Appendix B: Collaborative Project QAPPs/SOPs

- CN 510.50 Massachusetts Estuaries Project Marine Benthic Monitoring QAPP
- CN 510.60 Massachusetts Estuaries Project Benthic Monitoring Field SOPs
- CN 510.70 Massachusetts Estuaries Project Benthic Monitoring Laboratory SOPs
- CN 614.0 Sediment Phosphorus Flux in Massachusetts Lakes
- CN 613.0 Bathymetric Mapping to Support Mattapoissett Harbor TMDL Development QAPP
- Division of Marine Fisheries QAPP – Excerpt: Section 5 Fish Kill Protocol
- USGS Monitoring Buoy QAPP (Draft)
- MassDPH/MassDEP HAB protocol (Draft)

Appendix C: WPP Annual Sampling & Analysis Plans (SAPs) for 2025

- CN 603.0 Chloride Project SAP 2024-2025
- CN 610.0 Mystic Lakes Dissolved Oxygen Probe Deployment SAP 2025
- CN 615.0 Sediment Phosphorus Flux in Three Massachusetts Lakes: Horn Pond, Wedge Pond, and Spy Pond SAP 2025
- CN 590.0 Regional Monitoring Network SAP

Appendix D: WPP Monitoring, Analytical and Data Management SOPs

- CN 000.2.1 - Field Safety.doc
- CN 000.36 - Laboratory Safety Plan
- CN 000.421 - EDD template.xls
- CN 000.51 - DWM Document Control
- CN 000.61 - Station Definition
- CN 000.83c - DWM Data Use Guidelines
- CN 001.23 - Field Sampling
- CN 001.31 - Sample Collection Pole
- CN 001.36 - Hinged Pole Sampler

CN 001.992 – WinLIMS - SamplePreLog 2025
CN 003.44 - Analysis for Chlorophyll *a*
CN 004.26 - Water Quality Multiprobes
CN 004.42 - Multiprobe Deployment
CN 004.991 - Barnstead E-PURE 2019
CN 005.1 - Corrective Action
CN 035.1 - Periphyton Sampling
CN 039.4 - Benthic Macroinvertebrates
CN 040.4 - Fish Toxics Monitoring
CN 056.42 - Data Validation - Attended Probe Data
CN 056.52 - Data Validation - Unattended Probe Data
CN 056.62 - Data Validation Laboratory Data
CN 059.61 – Field Equipment Decontamination to Prevent the Spread of Invasive Aquatic Organisms
CN 075.3 - Fish Population
CN 095.3 – SOP Analysis for Turbidity
CN 151.1 – Lake Sampling SOP
CN 198.2 - Analysis for Bacteria Using Colilert-Enterolert
CN 306.2 – Probabilistic Site Evaluation Guidelines
CN 533.1 - Fish Collection for Cold Water Fisheries
CN 584.1 – SOP Tam Lake Field Manual Ver 1.1
CN 616.0 – SOP External Data Management and Review
CN 618.0 – Assessment Unit Creation
CN 619.0 – Statewide Bathymetry Project
CN 623.0 – Quick Guide: Edge Field Use
Edge Tablet (draft)

Appendix E: WES Laboratory QA Plan and SOPs

Lab QA Plan Laboratory Quality Assurance Plan
EPA 7473 - Hg in Solids and Solutions by thermal decomp., amalgamation, and AA Spec
Fish Processing SOP- Processing Fish Samples Intended for Contaminant Analysis
SM 2320B - Alkalinity by the Titration Method
SM 4500-P-F - Total Phosphorus, Ascorbic Acid Method
SM 4500-N-C – Total Nitrogen

SM 2340-B – Hardness by Calculation

SM 5310-C – Examination of Water and Wastewater

Method 1633A – PFAS Analysis in Aqueous, Solid, Biosolids, and Tissue Samples by LC-MS/MS

Appendix F: Contract Lab QAPs and SOPs

EPA Region 1 – Laboratory QMP

EPA Region 1 – TN/TP method

LSBSOP-TSS-TDS7 – Determination of Filterable and Non-filterable residue

LSBSOP-OPHOS-TP13 – Total Phosphorus and Orthophosphate Analysis by AQ300 Discrete Analyzer

LSBSOP-NO2-NO34 – Nitrate/Nitrite and Total Nitrogen by Discrete Analyzer

LSBSOP-AMMO3 – The Determination of Ammonia in Water Samples

Pace (Alpha Analytical) – Laboratory QMS

EPA 200.7 - Metals & Trace Elements & Hardness in Water & Wastes by ICP-AES

EPA 353.2 - Nitrate Nitrite Nitrogen, Colorimetric-Automated

EPA Method 546 - Determination of Total Microcystins and Nodularins in Drinking Water and Ambient Water by Adda Enzyme-Linked Immunosorbent Assay

EPA 3051A – Microwave Assisted Acid Digestion of Sediments, Sludges, Soils, and Oils for Fish Tissue

SM 4500-Cl-E – Chloride

SM 4500-NH3 – Nitrogen

SM 4500-NH3 G – Automated Phenate Method

SM 4500-NO3 F – Automated Cadmium Reduction Method

EPA 6020B – Inductively Coupled Plasma- Mass Spectrometry for Fish Tissue (as, Cd, Se)

EPA 8081B – Organochlorine Pesticides by Gas Chromatography

EPA 8082A – Polychlorinated Biphenyls (PCBs) by Gas Chromatography

EPA Draft Method 1634 – Determination of 6PPD-Quinone in Aqueous Matrices Using Liquid Chromatography with Tandem Mass Spectrometry (LC/MS/MS)

Appendix G: WPP Documentation Forms (*examples*)

Field Sheets

Chain of Custody (WES)

Chain of Custody (Contractor example)

Bottle Labels example

Survey Guidebook

Training Record

Attended Probe Request

Deploy Probe Request

Hazardous Waste Generation form

External Data Submittal template

EDD Template

Scientific Collection Permit