Massachusetts Department of ENVIRONMENTAL PROTECTION

2014 DWM ENVIRONMENTAL MONITORING OVERVIEW

(CN 412.0)

A brief overview of the surface water monitoring performed in 2014 by personnel of the MassDEP's Division of Watershed Management (DWM) is presented here. Information pertaining to the individual components of DWM's Surface Water Monitoring Program is presented at http://www.mass.gov/eea/agencies/massdep/water/watersheds/water-quality-monitoring-program.html#1.

The main programmatic objectives of the DWM related to surface water quality monitoring are to:

- Collect chemical, physical and biological data to assess the degree to which designated uses, such as aquatic life, primary and secondary contact recreation, fish consumption and aesthetics, are being met in waters of the Commonwealth;
- Collect chemical, physical and biological data to support analysis and development of implementation plans to reduce pollutant loads to waters of the Commonwealth;
- Screen fish in selected waterbodies for fish tissue contaminants (metals, PCBs and organochlorine pesticides) to provide for public health risk assessment;
- To the extent feasible, locate pollution sources and promote and facilitate timely correction;
- Over the long term, collect water quality data to enable the determination of trends in parameter concentrations and/or loads;
- Develop new or revised standards, which may require short-term research monitoring directed towards the establishment or revision of water quality policies and standards; and to
- Measure the effectiveness of water quality management projects or programs such as the effectiveness of implementing TMDLs, Best Management Practices (BMP) for the control of nonpoint pollution, or a state-wide policy or permitting program.

Quality assurance is maintained for DWM's watershed monitoring program to ensure implementation of an effective and efficient sampling design, to meet programmatic goals and to provide data meeting specific data quality objectives. The U.S. Environmental Protection Agency (USEPA) has approved a comprehensive Quality Assurance Program Plan (QAPP) that applies to the generation and use of surface water quality data by DWM for a five-year period (2010 – 2014). This five-year *program* QAPP is annually supplemented by project-specific Sampling and Analysis Plans (SAPs), which provide detailed information regarding individual *project* organization, tasks, background, sampling design and non-direct measurements. More information pertaining to the DWM's Quality Management Program and the 2010 – 2014 QAPP can be found on-line at

http://www.mass.gov/eea/agencies/massdep/water/watersheds/environmental-monitoring-quality-management-program.html.

Since 1992, water quality monitoring, assessment and selected management activities of the MassDEP have been sequentially performed in accordance with a rotating five-year watershed schedule. While the DWM Watershed Planning Section continues to monitor surface waters on a rotating basis, the makeup of the watershed groups that are the focus of monitoring each year was adjusted in 2009 to more efficiently focus limited resources in the field and laboratory, and to respond to evolving requirements of the Environmental Protection Agency (EPA) for surface water data and related information to support reporting under the Clean Water Act (CWA). An explanation of how and why the new watershed alignment was established is presented at http://www.mass.gov/eea/agencies/massdep/water/watersheds/adjustments-to-surface-water-monitoring-program.html. While the watersheds were originally arranged to evenly distribute the administrative workload (i.e., permit issuance) from year to year, the water resources to be monitored (i.e., river miles) were not equitably distributed and were scattered throughout the Commonwealth. The new alignment balances the allocation of monitoring resources each year and focuses them more efficiently in one region.

The 2014 surface water monitoring program continued the implementation of the statistically valid sampling design for Massachusetts' shallow (i.e., "wadable") streams that was initiated in 2010. The EPA strongly encourages states to adopt this approach for one or more waterbody types. The probabilistic survey design provides for the assessment of 100% of waters in a target population by monitoring a random sample of those waters. The ultimate goal of the DWM is to expend about 35% of annual monitoring resources on the probabilistic monitoring effort to satisfy the reporting requirements of CWA Section 305(b) while allotting the remaining 65% to deterministic or targeted data collection efforts such as the identification of pollution sources or the development of TMDLs. With the loss of full-time monitoring personnel in recent years, however, probabilistic monitoring efforts have consumed more than 50% of DWM's annual surface water monitoring resources, leaving less than half of those monitoring resources available each year for targeted monitoring activities. This trend continued in 2014. All of the monitoring activities of the DWM in 2014 are briefly described below.

PROBABILISTIC MONITORING & ASSESSMENT PROGRAM (MAP2) – The goals of the probabilistic survey are to provide an unbiased assessment (Support/Impaired) of aquatic life, recreational and aesthetic uses in wadable (i.e., 1^{st} – 4^{th} Strahler Order), non-tidal perennial streams of Massachusetts, and, over time, to provide an analysis of trends in the use assessments of those streams. The random sampling design allows for the determination, with a known statistical confidence, the percentage of wadable stream miles supporting and not supporting their designated uses. To implement the survey, Massachusetts' 1^{st} – 4^{th} order streams were apportioned into five separate groups or strata, one of which – the "Midwestern Group" – was the focus of monitoring in 2014. The Chicopee and Connecticut watersheds comprise this group.

A total of 37 sites were monitored in 2014 (Table 1). The sites were divided into seven groups that were visited on a weekly rotation to facilitate survey logistics and balance the sample load to the respective analytical laboratories. The primary objective at each sampling site was to collect sufficient data to assess, using the DWM's existing assessment methodology, the status (support/impaired) of aquatic life, recreational and aesthetic uses. All sampling and QA/QC was performed in accordance with the DWM's standard operating procedures, QAPP

and SAP. A list of the water quality and ecological variables measured at each site, along with their sampling frequencies, is presented in Table 2.

Table 1. Location of randomly selected sites in the midwestern watersheds of Massachusetts that were sampled in 2014 as part of the probabilistic wadable stream survey.

Site	Watershed	Waterbody	Site Description
MAP2-486	Connecticut	Mill River	[East Of North Street, Approximately 1000 Feet Upstream Of The Confluence Of Esther Brook, Whatley]
MAP2-488	Chicopee	Ware River	[Approximately 1400 Feet Downstream From Red Bridge/Hardwick Roads, Hardwick/New Braintree]
MAP2-489	Chicopee	Quaboag River	[South Of Main Street (Route 67), Approximately 1300 Feet Upstream From West Warren Mill Pond Dam (Nat Id: Ma00902), Warren]
MAP2-492	Chicopee	Hop Brook	[Approximately 1500 Feet Upstream Of Inlet To Quabbin Reservoir, New Salem]
MAP2-496	Connecticut	Fall River	[Approximately 1800 Feet Upstream From Eastern End Of Factory Hollow Road, Greenfield (Approximately 800 Feet Upstream Of Power Lines)]
MAP2-499	Connecticut	Unnamed Tributary	[Unnamed Tributary To Scarboro Pond, Approximately 900 Feet Upstream/South Of Gulf Road, Belchertown]
MAP2-500	Chicopee	Unnamed Tributary	[Unnamed Tributary To East Branch Ware River Approximately 2000 Feet Upstream Of Confluence, North Of Cloverdale Lane, Rutland]
MAP2-501	Connecticut	Scantic River	[Approximately 2300 Feet Downstream/South Of Mill Road, Hampden]
MAP2-502	Connecticut	Cranberry Pond Brook	[Approximately 1400 Feet North From Reservation Road And The Outlet Of Cranberry Pond, Sunderland]
MAP2-503	Connecticut	Unnamed Tributary	[Unnamed Tributary To North Branch Manhan River North Of Pomeroy Meadow Road Approximately 3200 Feet Upstream From Confluence, Southampton]
MAP2-504	Chicopee	Muddy Brook	[Approximately 2200 Feet Upstream/North From Muddy Brook Road, Hardwick]
MAP2-506	Chicopee	Roaring Brook	[Approximately 800 Feet Upstream/West Of Rockrimmon Street, Belchertown]
MAP2-508	Chicopee	Unnamed Tributary	[Unnamed Tributary To Quabbin Reservoir, Approximately 1200 Feet Upstream/East From Cooleyville Road (And Approximately 500 Feet Downstream/Northwest From Hunt Road), New Salem]
MAP2-509	Chicopee	Chicopee Brook	[Route 32 Crossing Nearest Green Street, Monson]

Table 1. Location of randomly selected sites in the midwestern watersheds of Massachusetts that were sampled in 2014 as part of the probabilistic wadable stream survey.

Site	Watershed	Waterbody	Site Description
MAP2-510	Connecticut	Elmer Brook	[Approximately 1400 Feet Downstream/South From Pearl Street, South Hadley]
MAP2-511	Chicopee	Unnamed Tributary	[Unnamed Tributary To Turkey Hill Brook, Approximately 170 Feet Downstream/West From Paxton Road, Spencer]
MAP2-513	Connecticut	Unnamed Tributary	[Unnamed Tributary Eventually To The Connecticut River, Approximately 340 Feet Upstream/Southeast From Bowles Fountain Road, Springfield]
MAP2-514	Connecticut	West Branch Mill River	[Approximately 1400 Feet Upstream From Old Goshen Road, Williamsburg]
MAP2-518	Connecticut	Mountain Brook	[Approximately 1200 Feet Downstream From Shutesbury Road, Leverett]
MAP2-519	Connecticut	North Branch Manhan River	[Approximately 2500 Feet Downstream From Loudville Road, Easthampton]
MAP2-520	Chicopee	Ware River	[Approximately 2250 Feet Upstream From Palmer Road (Route 32), Ware]
MAP2-521	Chicopee	Quaboag River	[Approximately 5550 Feet Upstream From Old West Brookfield Road, Warren (Approximately 500 Feet Downstream From The Confluence Of Sullivan Brook)]
MAP2-523	Chicopee	Coys Brook	[Approximately 900 Feet Upstream From Tucker Road, North Brookfield]
MAP2-526	Connecticut	Broad Brook	[West Of Holyoke Road (Route 141), Approximately 2300 Feet Upstream From Mouth At Inlet Of Nashawannuck Pond, East Hampton]
MAP2-530	Connecticut	Unnamed Tributary	[Unnamed Tributary To The Connecticut River, Approximately 450 Feet Downstream From Mcclellan Farm Road, Deerfield]
MAP2-533	Connecticut	Unnamed Tributary	[Unnamed Tributary To Watchaug Brook, Approximately 2400 Feet Downstream From Pease Road, East Longmeadow]
MAP2-534	Connecticut	Pond Brook	[Approximately 675 Feet Downstream From Lake Pleasant Road, Montague]
MAP2-538	Connecticut	Unnamed Tributary	[Unnamed Tributary To Fort River Approximately 850 Feet Upstream From Moody Bridge Road, Hadley]
MAP2-539[a]	Chicopee	Unnamed Tributary	[Unnamed Tributary To Perry Pond Approximately 5200 Feet Upstream From Old East Brookfield Road, North Brookfield]
MAP2-540	Chicopee	West Branch Fever Brook	[Approximately 2000 Feet Upstream Of Road Crossing Of The Restricted Portion Of Monson Turnpike, Petersham]
MAP2-541	Chicopee	Vinica Brook	[Approximately 5000 Feet Upstream From Moulton Hill Road, Monson]

Table 1. Location of randomly selected sites in the midwestern watersheds of Massachusetts that were sampled in 2014 as part of the probabilistic wadable stream survey.

Site	Watershed	Waterbody	Site Description
MAP2-545	Connecticut	Unnamed Tributary	[Unnamed Tributary Coming From And Draining To The State Of Connecticut, Approximately 300 Feet Upstream From South West Street, Agawam]
MAP2-546[a]	Chicopee	Unnamed Tributary	[Unnamed Tributary To The Cranberry River, Approximately 300 Feet Upstream From Cranberry Meadow Road, Spencer]
MAP2-547[b]	Connecticut	Tucker Brook	[East Of Sampson Road, Huntington Approximately 2.2 Miles From The Mouth At The Inlet Of Tighe Carmody Reservoir, Southampton]
MAP2-550	Connecticut	Long Plain Brook	[West Of Route 63, Approximately 2.5 Miles Upstream/North Of Blue Hill Road, Leverett]
MAP2-552	Chicopee	Purgee Brook	[Approximately 200 Feet Upstream Of Confluence With Quabbin Reservoir, Pelham]
MAP2-558	Connecticut	Bachelor Brook	[West Of Route 47, Approximately 1300 Feet Upstream Of Confluence With Connecticut River, South Hadley]

a – Macroinvertebrate data not collected due to low water.
b – Incomplete water quality dataset due to access issues.

Table 2. Sampling frequency of water quality and ecological variables measured at probabilistic sites.

Variable	Sample Frequency (Minimum)
Bacteria (*E. coli*)	5
Nutrients (TN,TP, Nitrate/Nitrite, Ammonia)	5
Color	5
Turbidity	5
Chloride	5
Metals	3
Dissolved Oxygen/Temperature Probe Deploys (June-September)	continuous
Habitat Assessment	1
Fish Community	1
Macroinvertebrate Community	1

Individual components of the wadable stream survey are described below.

***Water Quality (Chemical, Microbiological and Physical)*:** Each month, from May to September, grab water samples were collected at each site, field preserved, as appropriate, and delivered to the Senator William X. Wall Experiment Station in Lawrence (WES) for nutrient (total phosphorus, total nitrogen, nitrate/nitrite nitrogen and ammonia nitrogen) and chloride analysis and a commercial laboratory for bacterial (*E. coli)* analysis. Samples were also collected and transported to the DWM's Worcester Office where they were analyzed for turbidity and true color. Water quality sondes were deployed *in-situ* from June to September to obtain long-term continuous temperature and dissolved oxygen data. Finally, samples for the analysis

of dissolved metals were collected from each site on three occasions using wade-in, clean-hands techniques. Samples were filtered, preserved and delivered to the USEPA's New England Regional Laboratory (NERL) in Chelmsford for analysis.

***Biological Monitoring (Macroinvertebrates, Fish, Habitat)*:** Benthic macroinvertebrate and fish community assessments, along with associated habitat evaluations, were performed to assess the *Aquatic Life Use* status. These communities integrate environmental conditions (chemical – including nutrients and toxics, and physical – including flow and water temperature) over extended periods of time and are excellent measures of a waterbody's overall "health".

The benthic macroinvertebrate community was sampled once during the index period July through August, at all but two sites, using Rapid Bioassessment Protocols (RBP) III or a modification thereof, depending upon available habitat. For example, typical RBP III kick-sampling protocols could not be used at low-gradient sites so a multi-habitat sampling method (i.e., multiple net sweeps) was employed. Specimens were preserved in the field and transported to the DWM lab for further processing. Where applicable, benthic macroinvertebrate functional feeding group, community composition, biotic index using pollution tolerance, and abundance metrics will be calculated to determine biological condition and *Aquatic Life Use* status.

Fish community sampling for the presence/absence of resident fish species was performed once at each site during August - September. Fish were collected within a 100-meter reach using a backpack or tote barge-mounted electro-fishing equipment and held in plastic buckets containing stream water. Fish were identified to species and a minimum of 25 individuals of each species were measured and weighed. Fish were then redistributed throughout the reach.

DETERMINISTIC ("TARGETED") MONITORING PROGRAM (TMP) – Several waterbodies were selected, or "targeted", for monitoring activities designed to fulfill the needs for specific data and information to support such program elements as TMDL development and implementation, human health risk assessment and climate change. While the probabilistic monitoring described above was focused in the Midwestern Group of watersheds in accordance with DWM's rotating watershed schedule, targeted monitoring activities were carried out in watersheds scattered throughout Massachusetts. More detail pertaining to the targeted monitoring activities of the DWM in 2014 is presented below.

Reference Site Network (RSN): The DWM has identified the need to characterize the reference condition for Massachusetts' surface waters to support multiple program objectives including, but not limited to, the interpretation of biological data obtained from the probabilistic monitoring network as well as the development of biocriteria and nutrient criteria. For example, the DWM is currently exploring the development of tiered aquatic life uses that will increase the accuracy of aquatic life use assessments and improve water quality goal-setting processes. An understanding of the inter-year and intra-year variation within the indices of biotic integrity used for assessment is a critical initial step toward the development and implementation of biocriteria and tiered aquatic life use.

Least-disturbed reference sites were selected from the two most prominent Level III ecoregions (Northeastern Highlands, Northeastern Coastal Plain) in Massachusetts through the application of a Human Disturbance Index that was derived from six individual streamflow and landscape disturbance indicators. A total of ten (10) sites were chosen for intensive study over three years, beginning in 2011. Over time, the number of sites in this network expanded until, in 2014, a total of 22 sites were sampled (Table 3). The primary objective at each sampling site was to collect

sufficient data to begin evaluating inter-year and intra-year variation in the biological communities. Monitoring activities included habitat assessment; macroinvertebrate and fish population assessments; and physicochemical sampling. All sampling and QA/QC was performed in accordance with the DWM's standard operating procedures, QAPP and SAP. A list of the water quality and ecological variables measured at each site, along with their sampling frequencies, is presented in Table 4. More detail pertaining to each component of the RSN is presented below.

Table 3. Location of selected "reference/least disturbed" sites that were sampled in 2014 as part of the reference site network.

Site	Watershed	Waterbody	Site Description
CP01	Deerfield	Chapel Brook	[approximately 300 feet upstream of Main Poland Road, Conway]
CR01	Deerfield	Cold River	[approximately 325 feet upstream of Mohawk Trail (Route 2), Florida/Savoy (upstream of Black Brook confluence)]
DU01	Deerfield	Dunbar Brook	[west of River Road, approximately 1400 feet upstream from the Dunbar Brook Dam (MA00222), Florida]
GR01	Deerfield	Green River	[east of Green River Road, Colrain approximately 50 feet upstream/north of the confluence of Thorne Brook, Leyden]
TB01[a]	Deerfield	Thorne Brook	[east of Green River Road, approximately 100 feet upstream of confluence with the Green River, Leyden]
BH01	Bash Bish	Bashbish Brook	[south of Falls Road, approximately 200 feet upstream of the confluence of Wright Brook, Mount Washington]
YB02	Housatonic	Yokun Brook	[approximately 1800 feet upstream of Edgewood Drive, Lenox]
FB01	Westfield	Factory Brook	[east off Town Hill Road, approximately 4400 feet upstream of confluence with the Westfield River, Middlefield]
SB01	Westfield	Sanderson Brook	[Sanderson Brook Road bridge nearest Route 20, Chester]
WE01	Housatonic	West Brook	[approximately 1300 feet downstream of the Beartown Road crossing nearest the intersection with Beartown Mountain Road, Great Barrington]
WB01	Millers	Whetstone Brook	[approximately 160 feet downstream of Kentfield Road (Kempfield Road), Wendell]
WSR01	Chicopee	West Branch Swift River	[approximately 640 feet upstream from Cooleyville Road Extension, Shutesbury]
EBT01	Millers	East Branch Tully River	[approximately 2000 feet upstream from Route 68 (Warwick Road), Royalston]
MS01	Nashua	Mason Brook	[approximately 1450 feet upstream/north from Brooks Crossing, Townsend]
PHB01	Nashua	Pearl Hill Brook	[approximately 2775 feet downstream/north from Vinton Pond Road, Townsend]

Table 3. Location of selected "reference/least disturbed" sites that were sampled in 2014 as part of the reference site network.

Site	Watershed	Waterbody	Site Description
TR01	Nashua	Trout Brook	[approximately 140 feet upstream of Manning Street, Holden]
WBW01[b]	Buzzards Bay	West Branch Westport River	[east of Route 81, Tiverton RI approximately 3500 feet upstream of the inlet of Grays Mill Pond, Little Compton, Rhode Island]
BCB01	Buzzards Bay	Bread and Cheese Brook	[approximately 980 feet downstream of Route 177, Westport]
RA00	Taunton	Rattlesnake Brook	[approximately 1300 feet upstream/east from Route 24/79 (Amvets Memorial Highway), Freetown]
EB01	Blackstone	Emerson Brook	[approximately 200 feet upstream of the Route 146 southbound off-ramp to Chocolog Road, Uxbridge]
RTB01	Blackstone	Roundtop Brook	[approximately 1400 feet downstream/south from the confluence of Tinkerville Brook, Burriville, Rhode Island (approximately 1600 feet from MA/RI border)]
BB01	Quinebaug	Browns Brook	[approximately 2120 feet upstream from May Brook Road, Holland]

a – Water quality data not collected on one sampling event due to unsafe conditions.
b – Fish population data not collected due to the river running dry.

Table 4. Sampling frequency of water quality and ecological variables measured at RSN sites.

Variable	Sample Frequency (Minimum)
Nutrients (TN,TP, Nitrate/Nitrite, Ammonia)	4
Color	4
Turbidity	4
Chloride	4
Dissolved Oxygen/Temperature Probe Deploys (May-September)	continuous
Habitat Assessment	1
Fish Community	1
Macroinvertebrate Community	1

***Water Quality (Physico-chemical)*:** Approximately monthly, from May to August, grab water samples were collected at each site, field preserved, as appropriate, and delivered to the Senator William X. Wall Experiment Station in Lawrence (WES) for nutrient (total phosphorus, total nitrogen, nitrate/nitrite nitrogen and ammonia nitrogen) and chloride analysis and the DWM lab in Worcester for turbidity and color analysis. In addition, water quality sondes were deployed *in-situ* from May to September to obtain long-term continuous temperature and dissolved oxygen data.

***Biological Monitoring (Macroinvertebrates, Fish, Habitat)*:** Benthic macroinvertebrate and fish community assessments, along with associated habitat evaluations, were performed to assess the *Aquatic Life Use* status. These communities integrate environmental conditions (chemical – including nutrients and toxics, and physical – including flow and water temperature) over extended periods of time and are excellent measures of a waterbody's overall "health".

The benthic macroinvertebrate community was sampled at each site once during the index period July through August using Rapid Bioassessment Protocols (RBP) III or a modification thereof, depending upon available habitat. For example, typical RBP III kick-sampling protocols could not be used at low-gradient sites so a multi-habitat sampling method (i.e., multiple net sweeps) was employed. Specimens were preserved in the field and transported to the DWM lab for further processing. Where applicable, benthic macroinvertebrate functional feeding group, community composition, biotic index using pollution tolerance, and abundance metrics will be calculated for analysis.

Fish community sampling for the presence/absence of resident fish species was performed once at each site during the late summer. Fish were collected within a 100-meter reach using a backpack or tote barge-mounted electro-fishing equipment and held in plastic buckets containing stream water. Fish were identified to species and a minimum of 25 individuals of each species were measured and weighed. Fish were then redistributed throughout the sampled reach.

Field and Lab Support for the Assessment and Management of Cyanobacteria Blooms: MassDEP continued to provide technical expertise and laboratory support for the investigation of potentially toxic algae (cyanobacteria) blooms. Working from MassDEP's DWM-Worcester and Southeast Regional (SERO) offices, respectively, and in collaboration with MassDPH, staff biologists performed cyanobacterial counts and identifications on water samples to determine whether cell counts exceeded MassDPH advisory levels for recreational waters. Lab services and technical support were provided to State and Federal agency personnel and local public health officials. Phytoplankton samples were collected from several water bodies and taxonomic identifications and counts were forwarded to MassDPH for risk assessment and management. A list of water bodies from which MassDEP processed samples is presented in Table 5.

Table 5. Water bodies from which algae samples were obtained for taxonomic identifications and counts. Results were submitted to MassDPH.

Waterbody	Municipality	Sampling Events
Buffumville Reservoir	Charlton	2
Fort Meadow Reservoir -Memorial Beach	Marlborough	2
Fort Meadow Reservoir-Centennial Beach	Hudson	2
Indian Lake	Worcester	2
Lake Attitash	Amesbury	2
West White Island Pond	Plymouth	1
East White Island Pond	Plymouth	1
Cliff Pond	Brewster	6
East Monponsett Pond (2 sites)	Halifax	26
Hamblin Pond	Barnstable/Marstons Mills Village	5
Long Pond Reservoir at raw water tap within water supply treatment plant	Falmouth	44
Queen Sewell Pond	Bourne/Buzzards Bay Village	2
Salls Pond	Brewster	1

Savery Pond	Plymouth	1
Silver Lake at raw water tap within water supply treatment plant	Pembroke	12
Wampatuck Pond	Hansen	6
West Monponsett Pond (3 sites)	Halifax and Hansen	30

Fish Toxics Monitoring: DWM staff worked with personnel from the Department of Conservation and Recreation (DCR) to collect water and fish samples from Quabbin Reservoir in support of ongoing research by MassDEP's Office of Research and Standards (ORS) on mercury in fish. A one-day water-monitoring event included *in situ* measurements of pH, temperature, dissolved oxygen and specific conductance, as well as the collection of water samples for chemical analysis. Analyses for nutrients (i.e., ammonia-N, nitrate-N/nitrite-N, total nitrogen and total phosphorus), chloride, total alkalinity, and selected metals were performed at MassDEP's Wall Experiment Station (WES). Finally, a total of 20 individual fish samples were collected, processed and delivered to WES for mercury analysis.

Lake Monitoring: Baseline lakes sampling in the summer of 2014 focused on follow-up monitoring of the East and West White Island Pond in Plymouth as part of the implementation of the TMDL for phosphorus. In addition, DWM sampled East and West Monponsett ponds in Halifax as the next likely targets for TMDL development. Data from this sampling effort will support a pre-draft TMDL for these lakes and also may be used for regulatory purposes. Sampling consisted of four monthly visits to each lake and samples were also collected from inlet streams and observations were made of duckweed on White Oak Reservoir. Data collection focused on total phosphorus and total nitrogen. Secchi disk transparency, color, chlorophyll *a* and multi-probe data were also collected. Blooms of cyanobacteria were identified and counted and results passed on to MassDPH for evaluation and, where applicable, public advisories against swimming or contact due to toxic cyanobacteria.

Monitoring to Assess TMDL Implementation in the Assabet River Watershed: Ongoing efforts were continued in 2014 to document changes in the amount of aquatic plant biomass in the Assabet River system as a result of municipal wastewater treatment plant upgrades to remove phosphorus. In 2004, the Total Maximum Daily Load (TMDL) for total phosphorus in the Assabet River was approved by the EPA. The goal of the TMDL was to decrease the concentration of the nutrient phosphorus and to mitigate the ecological effects of eutrophication in the river. These effects were, for the most part, direct consequences of the excessive growth of aquatic macrophytes. Specifically, the TMDL called for a 50 percent reduction in aquatic plant biomass (e.g., duckweed). A program was initiated in 2009 to monitor each summer the effectiveness of the Assabet TMDL implementation measures. In 2014, observations of duckweed coverage of both open water and bank/littoral areas were made every other week from the beginning of May through the end of September. The observations were mapped in the field onto standardized forms indicating the percentage range of coverage from fixed vantage points around the various impoundments. Photographs were also taken from each observation point.

Monitoring to Assess Climate Change: DWM staff continued to monitor air and water temperature and collect macroinvertebrate samples at five sites in Massachusetts as part of an ongoing collaborative effort among multiple federal and state agencies, NGOs, and academic institutions across New York and New England to assess the effects of climate change in the Northeast. Spearheaded by the EPA, this effort is aimed at coordinating temperature and biological data collection across the region. Similar "regional" collaborations have been

established across the country.

In Massachusetts the five sites are Hubbard River in Granville, Brown's Brook in Holland, Parker's Brook in Oakham, West Branch Swift River in Shutesbury, and Cold River in Florida. UMass/Amherst and MassWildlife's Division of Ecological Restoration (DER) are the other partners on the "Massachusetts Team." DER has installed flow-gaging equipment at the three sites without USGS gages and is developing flow rating curves for them. UMass is playing a coordinating role and also plans to address the fisheries component.

Monitoring Assistance to CERO: DWM staff assisted personnel of MassDEP's Central Regional Office (CERO) with water and biological monitoring of Cooledge Brook, Northborough as part of an ongoing site investigation. Multiprobes (2 sites) and thermistors (6 sites) were deployed to record conventional field measurements, such as dissolved oxygen, pH, specific conductance and temperature. In addition, macroinvertebrate, fish and periphyton community assessments were carried out at several locations along the brook.

Bacteria Source Tracking Activities of the Southeast Regional Office (SERO): The DWM regional monitoring coordinator, aided by a seasonal employee, used the IDEXX quanti-tray system on site in the Southeast Region lab, to determine the concentration of "indicator bacteria" (*E.coli* and Enterococcus) in surface water, at stormdrain outfalls and within drainage infrastructure (manholes).

Additional source tracking tools used were:

- Hach test kits: to determine detergent concentrations.
- Ammonia and potassium meters: to determine ammonia/potassium ratios

These data were combined with field observations and in some cases, discussions with local watershed groups and/or municipal officials to refine sampling locations, in an attempt to track and isolate the dry-weather source(s) of *E. coli* and/or Enterococcus bacteria. A small number of opportunities for "Human Marker" analyses (fluorescent whitening agents, DNA, and caffeine) were made available by the WES State Lab. These analyses were utilized in cases where bacteria concentrations were high but no obvious source could be immediately located, in an attempt to determine if the bacteria were from a human or animal source.

Subwatersheds where bacteria source tracking was conducted are presented in Table 6.

Highlights of the 2014 sampling season

- The successful multi-year partnership with the City of Brockton continued with joint source tracking efforts, discovery of multiple new sources and corrections within the drainage infrastructures, influencing Trout Brook, Salisbury Brook and Salisbury Plain River.

- The successful multi-year partnership with the City of Norwood continued with a day of renewed focused source tracking on the lower section of an unnamed tributary to Hawes Brook, a number of potential sources were ruled out. Human marker hits on this stretch of tributary in 2013 prompted the additional work in this area. The City in partnership with consultants CDM continued to use dye tests, smoke tests and cameras to actively investigate the Nichols Street drainage area (Germany Brook) and the Arcadia Road drainage area (tributary to Hawes Brook) for sources highlighted by SEROBST in 2013.

- The partnership with EPA Region-1 and Rhode Island DEM continued into this year, with the goal of conducting bacteria source tracking throughout the Palmer River Watershed. SEROBST focused source tracking efforts on Torrey Creek (with field support from the Town of Seekonk Conservation Agent), Fullers Brook and the mainstem Palmer River upstream of Old Providence road (by way of canoe). On the mainstem an oxbow and drainage from a specific farm property were identified as significant dry weather sources. This partnership is expected to continue into next year with some additional focus on the Torrey Creek area and investigation of the relationship of tidal stage to bacteria concentrations in the mainstem.

- The successful partnership with the City of Taunton continued with joint source tracking efforts on Cobb Brook and the Mill River. As a result of these investigations:

    - A direct toilet connection to Cobb Brook was discovered and removed.
    - A hotspot area was confirmed on an unnamed tributary to the Mill River related to a drainage area on Warren Street. The City of Taunton is currently actively investigating this drainage area with camera and dye testing and a records inspection of all the relevant houses.

- A relationship was formed with the Town of Wareham and the Department of Public Health (Beaches department) over swimming beach closures, due to high bacteria counts for "Briarwood Beach" on the Weweantic River. SEROBST conducted a site walk with concerned beach association members and Town employees and set up a sampling plan. SEROBST collected a few rounds of samples in the beach area as well as within some adjoining marsh areas. Samples were also collected for Human marker analysis. Human sources were ruled out as the cause of the beach closures. The most likely source of bacteria in this area (also supported by WES analysis) is sea-birds.

Table 6. Subwatersheds where bacteria source tracking was conducted over the course of approximately 40 sample days. Note: This table includes only the names of those municipalities where sampling took place and new sub-watersheds are highlighted in **bold.**

Name	Basin	Segment	Municipalities sampled	Number of sample days
Speedway Brook	Ten Mile River	52-05_2006	Attleboro	3 + Human Marker
Sevenmile River	Ten Mile River	52-08_2006	Attleboro & Pawtucket	2 + Human Marker
Runnins River	Narragansett Bay	53-01_2006	Seekonk	2 + Human Marker
Palmer River	Narragansett Bay	53-05_2006	Seekonk & Rehoboth	3
Fullers Brook	Narragansett Bay	53-12_2006	Rehoboth	2
Rocky Run Brook	Narragansett Bay	53-16_2006	Rehoboth	1
Torrey Creek	Narragansett Bay	53-17_2010	Rehoboth	4
Cobb Brook	Taunton	62-43_2006	Taunton	1
Taunton River	Taunton	62-02_2006	Taunton	3
Salisbury Plain River	Taunton	62-05_2006	Brockton	4
Trout Brook	Taunton	62-07_2006	Brockton	4
Salisbury Brook	Taunton	62-08_2006	Brockton	4
Beaver Brook	**Taunton**	**62-09_2010**	**East Bridgewater**	**3**
Mill River	Taunton	62-29_2006	Taunton	9
Shumatuscacant River	Taunton	62-33_2006	Abington	3

Lovett Brook	Taunton	62-46_2010	Taunton	1
Hawes Brook	Neponset	73-16_2006	Norwood	1
Weir River	**Boston Harbor**	**74-02_2006**	**Hingham**	**3**
French Stream	South Coastal	94-03_2008	Hanover	1 + Human Marker
Weweantic River	**Buzzards Bay**	**95-05_2006**	**Wareham**	**2 + Human Marker**
South River	South Coastal	94-09_2006	Marshfield	1
White Island Pond	**Buzzards Bay**	**MA95166-2012**	**Plymouth**	**4**