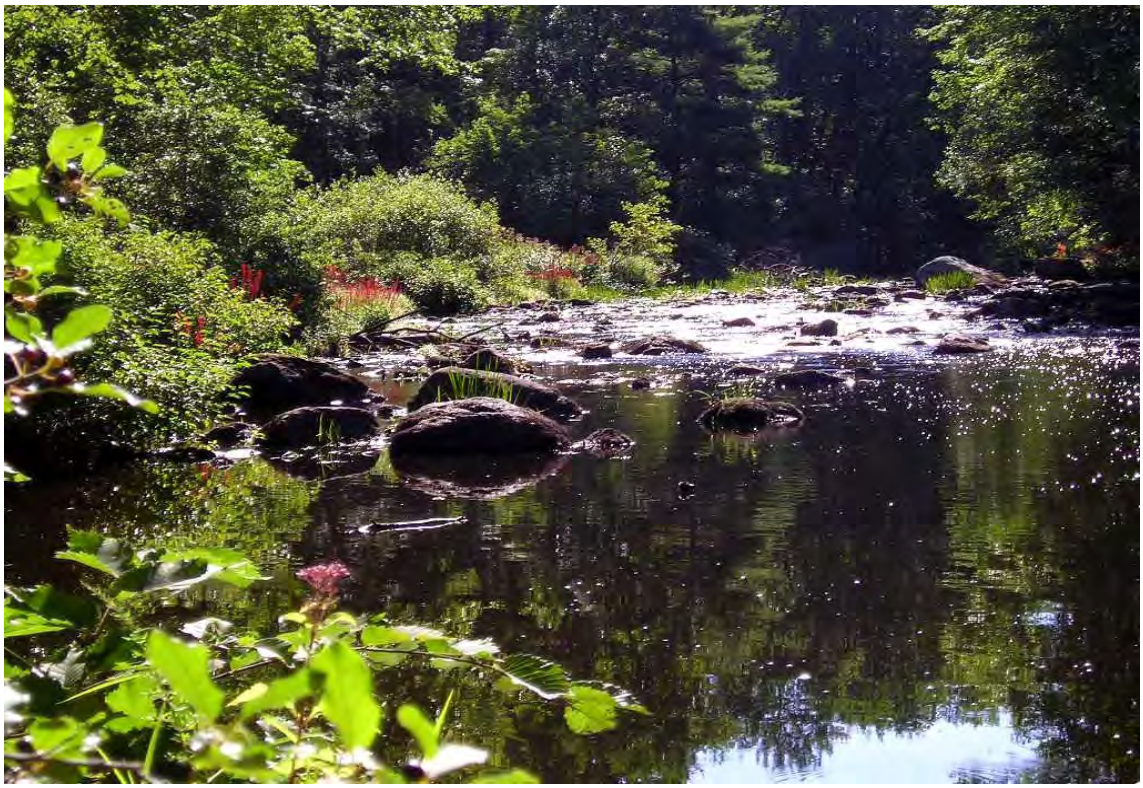
CHICOPEE RIVER WATERSHED
SMART MONITORING PROGRAM 2005-2010
TECHNICAL MEMORANDUM CN 425.0



The Ware River, Barre

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Cover photo by Therese Beaudoin, MassDEP. August 23, 2005
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SMART monitoring logo designed by Robert Kimball and Barbara Kimball.

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LIST OF LATIN NAMES

Latin Name	Common name	Latin Name	Common name
Branta canadensis	Canada goose	*Lontra canadensis*	North American river otter
Callitriche sp.	water starwort	*Lythrum salicaria*	purple loosestrife
Cambaridae family	freshwater crayfishes	*Micropterus dolomieu*	smallmouth bass
Carex sp.	sedge	*Myriophyllum* sp.	milfoil
Castor canadensis	North American beaver	*Pachydiplax longipennis*	blue dasher
Cyprinidae family	daces	*Peltandra virginica*	arrow arum
Decodon verticillatus	swamp loosestrife	Plecoptera order	stoneflies
Elodea sp.	waterweed	*Polygonum* sp.	smartweed/knotweed
Gerridae family	water striders	*Pontedaria cordata*	pickerelweed
Gramineae family	true grasses	*Potamogeton* sp.	pondweed
Lepomis macrochirus	bluegill	*Procyon lotor*	raccoon
Lithobates catesbieanus	American bullfrog	*Sagittaria* sp.	arrowhead
Lithobates clamitans melanotus	green frog	Salmonidae family	salmonids
Lobelia cardinalis	cardinal flower	*Semotilus corporalis*	fallfish
Ludwigia sp.	water primrose	*Vallisneria* sp.	eelgrass/tape grass

LIST OF ACRONYMS

% sat	percent oxygen saturation
305(b)	Section 305(b), Clean Water Act
7Q10	lowest 7-day average streamflow that occurs, on average, once every 10 years
BRP	Bureau of Resource Protection
BWR	Bureau of Water Resources
ºC	degree Celsius
CERO	CEntral Regional Office
CFR	Coldwater Fish Resource
cfs	cubic feet per second
cond	specific conductivity
CSO	Combined Sewer Overflow
DO	dissolved oxygen
DWM	Division of Watershed Management
ºF	degree Fahrenheit
ft	feet
in	inch
m	meter
MA	Massachusetts
MassDCR	Massachusetts Department of Conservation and Recreation
MassDEP	Massachusetts Department of Environmental Protection
MDL	method detection limit
µS/cm	microsiemen per centimeter
MGD	million gallons per day
mg/L	milligrams per liter
mi	mile
mi^2	square mile
NH_3-N	ammonia nitrogen
NHESP	Natural Heritage and Endangered Species Program
NOAA	National Oceanic and Atmospheric Administration
NO_3NO_2-N	nitrate-nitrite nitrogen
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometric Turbidity Unit
NWS	National Weather Service
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RDL	reporting detection limit
RPD	relative percent difference
SMART	Strategic Monitoring and Assessment for River basin Teams
SOP	standard operating procedure
SR	state road
SSolids	suspended solids
SU	standard units
Temp	temperature
TDS	total dissolved solids
TMDL	Total Maximum Daily Load
TN	total nitrogen
TPhos	total phosphorus
Turb	turbidity
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
WES	Wall Experiment Station
WWTP	wastewater treatment plant

INTRODUCTION

The purpose of this technical memo is to present observations and data collected from 2005-2010 in the Chicopee watershed as part of the Strategic Monitoring and Assessment for River basin Teams (SMART) program, highlighting how the program supports and augments programs of the Massachusetts Department of Environmental Protection (MassDEP) Bureau of Resource Protection (BRP, now the Bureau of Water Resources, BWR) Central Regional Office (CERO) and the Division of Watershed Management (DWM).

Overview of Monitoring Plan

Bimonthly water quality monitoring in the Chicopee Watershed began in June 1998. The sampling plan matrix for the SMART monitoring program years 2005-2010 is presented in Table 1; the location of sampling stations is presented in Figure 1. Sampling components at all stations included:

- *in situ* measurements: dissolved oxygen (DO), percent oxygen saturation, pH, specific conductivity, temperature (T), depth and total dissolved solids (TDS);
- physical/chemical constituents: total alkalinity, chlorides, hardness, total suspended solids (TSS), turbidity;
- nutrients: ammonia-nitrogen (NH_3-N), nitrate-nitrite-nitrogen (NO_3_NO_2-N), total nitrogen (TN), and total phosphorus (TP);
- flow measurements (at existing USGS flow gaging stations); and
- general field observations.

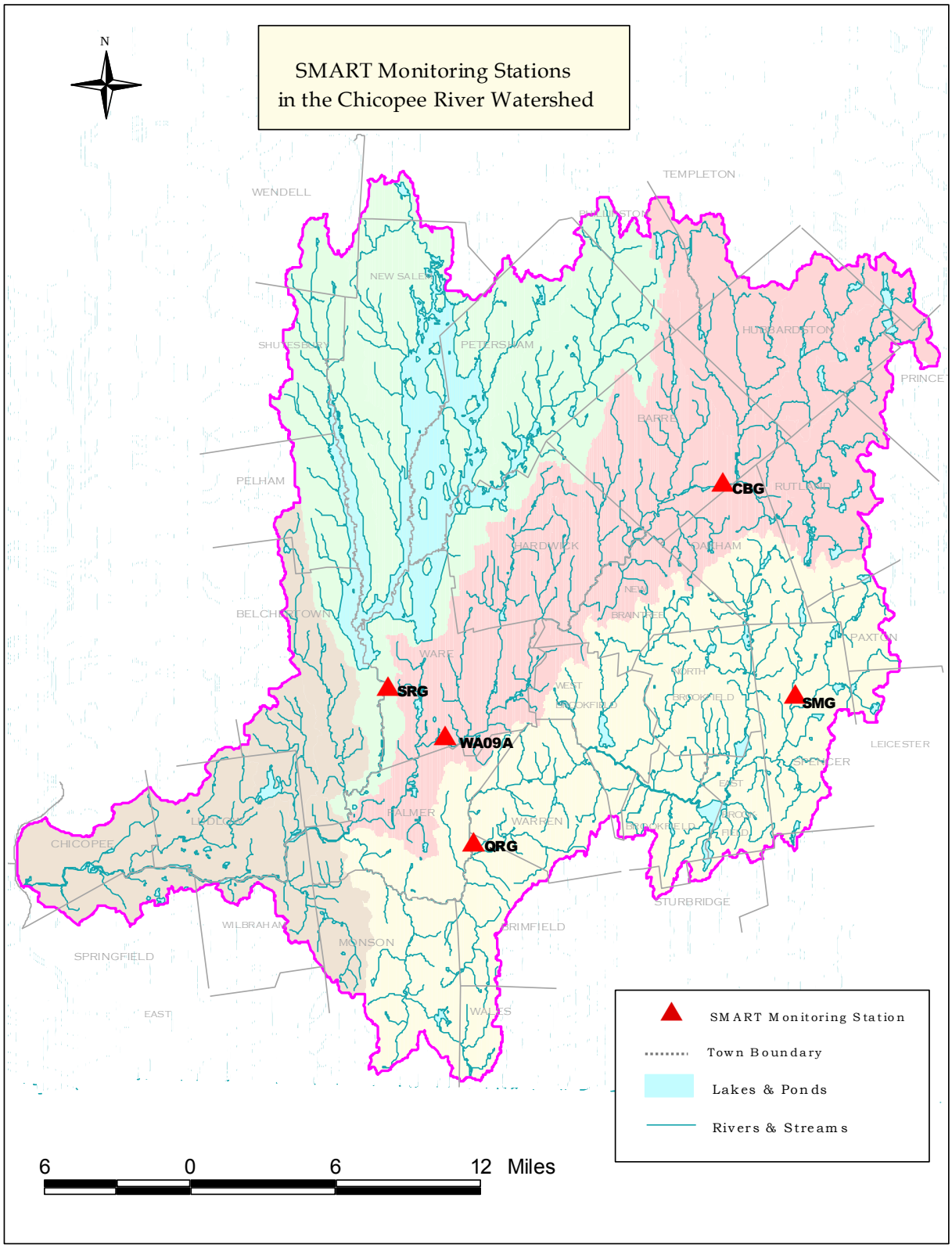
Table 1 Chicopee Basin SMART Sampling Summary – 2005 through 2010

Location and Segment Numbers	Station Name	Station Type	Dates Sampled[1,2]
Swift River @ USGS flow gaging station, River Road, Ware MA36-09	SRG	Reference	2005: 2/16/05, 4/20/05, 6/15/05, 8/23/05, 10/19/05 2006: 1/18/06, 3/15/06, 5/16/06, 7/11/06, 10/4/06, 11/7/06 2007: 3/13/07, 4/17/07, 6/12/07, 8/28/07, 10/16/07 2008: 1/23/08, 3/25/08, 5/20/08, 6/16/08, 7/22/08, 8/18/08, 9/23/08, 11/18/08 2009: 2/23/09, 4/28/09, 6/23/09, 8/25/09, 10/27/09 2010: 2/9/10, 7/20/10, 10/5/10, 11/16/10 [1]Two additional surveys were conducted in 2008 in partnership with the DWM Year 2 monitoring program.
Ware River @ USGS flow gaging station, Worcester Road (State Road, SR-122), Barre MA36-03	CBG	Reference	
Ware River @ Gibbs Crossing, Old Belchertown Road, Ware MA36-06	WA09A	Impact	
Sevenmile River @ USGS flow gaging station, Cooney Road, Spencer MA36-11	SMG	Reference	
Quaboag River @ USGS flow gaging station, Boston Road (SR-67), Palmer MA36-16	QRG	Impact	

Hydrology

The Chicopee watershed, part of the Connecticut River Basin, encompasses 721 square miles (mi^2) and part or all of 39 cities and towns in the central part of Massachusetts (MA). The Chicopee River Basin is comprised of three watersheds, the Swift, Ware, and Quaboag Rivers; these form the mainstem Chicopee River in the village of Three Rivers, Palmer. From there, the Chicopee flows 17.9 miles (mi) westward to its terminus at the Connecticut River in Chicopee, MA. Annual precipitation ranges from 46 to 50 inches (in) over most of the watershed, with a section in the northwest area averaging 50 to 54 in, and a very small area in the southwest ranging from 44 to 46 in (Ostiguy et al 2010). Coldwater Fish Resources (CFR) have been identified on 97 streams within the Chicopee watershed, but not the mainstem itself; for more information see Massachusetts Coldwater Fish Resources (MassDFG 2015). For a detailed description of the Chicopee River Watershed, see Chicopee Rive Watershed Water Quality Assessment Report (Reardon 2012) and Chicopee Watershed Assessment Plan (EOEA 2012).

Figure 1 MassDEP SMART Chicopee River Watershed Water Quality Station Locations



The Swift watershed drains 215 mi^2 in the westernmost Chicopee basin. There are three northern branches that flow into the Quabbin Reservoir (39.4 mi^2), the primary water supply for the Boston area as well as some cities and towns near the reservoir itself (48 cities, towns and districts total). From the outlet of Quabbin Reservoir, the Swift River flows 9.8 mi in a southerly direction to its confluence with the Ware River in Palmer. The entire river system is dominated by reservoir operations at the Quabbin, which is managed by the Massachusetts Department of Conservation and Recreation for flood control and minimum flow release to the Swift River, in addition to water supply. For a detailed description of the Quabbin Reservoir, see Quabbin Water Quality Report 2010 (Lee 2011). Among other streams, the Swift River mainstem, as well as the East, Main and West Branches of the Swift River, are CFRs (MADFG 2013).

Figure 2 Quabbin Reservoir, north from the Quabbin Visitor Center, Belchertown January 24, 2012

The Ware River watershed drains 218 mi^2 in the central part of the Chicopee basin. The East and West branches converge in Barre, above the U.S. Army Corps of Engineers (USACE) Barre Falls Dam flood control project. The Barre Falls Dam is operated as a dry bed reservoir (no recreational pool maintained) in a run-of-river mode most of the time; for more information on the Barre Falls Project see Barre Falls Project (USACE 2013). From the confluence of the East and West Ware Rivers, the Ware River flows in a generally southwest direction approximately 34 mi until joining the Quaboag River in Palmer. The West Branch of the Ware River and the Prince River are CFRs, in addition to numerous other streams (Lee 2011).

The Quaboag watershed drains 212 mi^2 in the southernmost Chicopee watershed. The Quaboag River originates at the outlet of Quaboag Pond in Brookfield and flows southwest until it joins the Ware River. Major CFRs in the Quaboag watershed include the Sevenmile and Cranberry Rivers (Lee 2011).

Quality Assurance/Quality Control

The quality assurance/control (QA/QC) plan for the SMART program is presented in (Control Number) CN 012.1*: Quality Assurance Project Plan* [QAPP] *Strategic Monitoring and Assessment for River basin Teams (SMART) (Blackstone, Chicopee, Concord, French/Quinebaug, Millers, and Nashua Watersheds) 2008-2012* (Beaudoin 2008). The QAPP presents data quality objectives, quality assurance procedures, and other program-specific information.

Aerial photos were obtained from Google Earth (2012a, 2012b, 2012c, 2012d, 2012e) at a height of approximately 4,000 feet (ft) with the exception of Station SRG; as the Quabbin Reservoir and Winsor Dam dominate conditions at this station, the height was extended to approximately 6,535 ft to include these features.

PROJECT OBJECTIVES

The primary water quality objectives of the SMART monitoring program are:

- Document baseline water quality by: providing information on low flow/event flow variation, seasonal variation and frequency of selected constituents; and establishing reference distributions of key constituents for ecoregion delineation and "clean water" sites;
- Estimate loads of detected water constituents at key locations by: quantifying nitrogen loadings to coastal waters; and calculating phosphorous loads upstream/downstream of representative land use areas;
- Define long term trends in water quality by: documenting improvements associated with major abatement projects; and identifying trends at least-impacted stations (that may result from factors such as acid precipitation and climate change);
- Assess attainment of water quality uses by: comparing existing water quality with water quality standards; and by assessing use support for the fishable/swimmable goal;
- Provide support for other programs by: determining reference distributions for ecoregion stations; conducting trend analysis for the 305(b) reports[1] and basin plans; quantifying nutrient loadings for load allocations (Total Maximum Daily Loads, or TMDLs); obtaining data on nonpoint source loadings for more intensive Year 2 sampling; providing guidance for volunteer monitoring; collecting data for development of statistically-based water quality standards and for improvement of Combined Sewer Overflow (CSO) and Stormwater policies; and developing a long-term database on conditions at key locations for the development of new programs and basic research.

As stated in the Introduction, this document presents observations and data collected in the Chicopee River Watershed under the SMART program from 2005-2010. An assessment of the data will be presented in future reports.

METHODS

Water quality sampling procedures are included in *Grab Collection Techniques for DWM Water Quality Sampling, Standard Operating Procedure* (MassDEP 1999b). Use of the *in situ* monitoring equipment followed procedures set forth in *CN 4.0 Water Quality Multi-probe Instrument Use, Standard Operating Procedure* [SOP] (MassDEP 1999a). Physical/chemical and nutrient samples were analyzed at the Wall Experiment Station (WES), the MassDEP analytical laboratory located in Lawrence, Massachusetts. All samples were collected, transported, analyzed, and discarded according to chain-of-custody procedures.

In addition to the measurements and analytes noted above, field observations were recorded at each station on standardized field sheets, field notebooks, and as photographs. Field observations included date/time, location, crewmembers, snow cover, canopy cover, water odors, colors, sheens, foams, estimated river height and velocity, weather conditions, observed uses, wildlife, aquatic algae and macrophytes, potential pollution sources, and unusual conditions. Number and type of samples were recorded, as well as the last set of *in situ* data collected. A summary of field observations by station collected during this sampling period are presented in Table 2 through Table 6 following the station descriptions.

Field sheets, raw data files, chain of custody forms, lab reports, and other metadata used in this report are managed and maintained by the MassDEP DWM in the Water Quality Access Database in Worcester, MA. The validation of the water quality data included data entry into DWM databases, data entry quality control checks, analysis for outliers, blank contamination, duplicates, precision, and holding time violations, followed by project level review (MassDEP 2005). The project coordinator, as identified in the QAPP for the SMART program (CN 012.2), reviews the data for reasonableness, completeness and acceptability (Beaudoin 2008).

[1] The 305(b) reports are the biannual reports to the U. S. Congress on water quality that are required under Section 305(b) of the Clean Water Act.

STATION OBSERVATIONS

Station SRG – Swift River at River Road, Ware, MA (river mile 8.155)

Figure 3 Google Earth view of Station SRG area

Figure 4 Station SRG upstream (8/25/2009)

Station SRG is located on the Swift River in Ware, MA within the Lower Worcester Plateau ecoregion. From 2005-2010, the station was sampled 33 times, and access was gained from the eastern shore of the Swift River at the USGS flow gaging station off River Road. Samples were collected by wading to flowing water or with a sampling pole from 2/16/2005 through 11/16/2010. Station SRG serves as a reference station, minimally impacted by anthropogenic activities.

Land uses near this station included water supply watershed, forest, rural residential, and roadways (Figure 3; Google Earth 2012a). The water flowing at this station originates almost entirely from the hypolimnetic release from the 25,000-acre Quabbin Reservoir, located approximately 1.5 miles upstream. Completed in 1939, the Quabbin was created to meet water supply needs in the metropolitan Boston area. In 2010, water was directed from there to the Wachusett Reservoir for water supply on 217 days, with an average of approximately 224 million gallons per day (MGD); an additional 8.25 MGD (approximate) was directed to three local communities via the Chicopee Valley Aqueduct. No municipal National Pollutant Discharge Elimination System (NPDES) discharges are located upstream (design flow greater than 1 MGD). The Swift River corridor at and above Station SRG is designated as Natural Heritage and Endangered Species Program (NHESP) Priority Habitat of Rare Species (see NHESP Priority Habitats of Rare Species, MassGIS 2013).

The river is approximately 25 feet (ft) wide and typically 2 to 4 ft deep (Figure 4), with undercut banks at Station SRG. As this segment of the river reflects hypolimnetic conditions at the Quabbin, water temperature at the station was typically cooler than the other watershed stations in the summer and warmer in the winter. The water level at Station SRG was determined by releases at Winsor Dam, and was frequently out of sync with water levels in the rest of the watershed i.e., high water levels at SRG at the same time as low levels at the other four monitoring stations, and vice versa.

Deciduous and evergreen trees provided shade along the banks; although the canopy did not extend over the channel, the orientation of the river corridor relative to the sun resulted in a mostly shaded streambed during monitoring events; see Table 2 for a summary of field observations at Station SRG. The bottom consisted mainly of cobble and gravel, with sand and a few small boulders also present; traces of silt were occasionally noted. A relict beaver dam was located approximately 420 feet upstream. Aquatic macrophytes observed at Station SRG ranged from sparse to dense coverage, and included year-round beds of *Callitriche* sp. (water starwort), as well as sporadic populations of *Vallisneria* sp. (eel grass, tape grass) and leafless *Potamogeton* sp. (pondweed, 1 event). Periphyton, when noted, consisted of sparse to dense moss (19 of 33 events) and filamentous algae (2 events).

Riverine and terrestrial wildlife observations noted at this station included the evidence of *Castor canadensis* (North American beaver) in the upstream dam and localized branch/shrub damage, birds calling, mosquitoes (sometimes dense) and Salmonidae (trout) and other fish jumping. This section of the river is open to catch-and-release fishing, and fishermen were observed in this stretch of river during this monitoring period. On April 28, 2009, fishermen in the area reported that they were waiting for the trout-stocking truck to arrive.

The water column was clear on all events, with no visible turbidity. Station SRG was characterized by an absence of trash, color, odor and sheens, with foam noted on 4 (n=33) dates.

Station CBG – Ware River at Worcester Road (SR 122), Barre, MA (river mile 30.290)

Figure 5 Google Earth view of Station CBG area

Figure 6 Station CBG upstream (7/20/2010)

Station CBG is located on the Ware River in Barre, MA within the Lower Worcester Plateau ecoregion. From 2005-2010, the station was sampled 33 times, and access was usually gained from the northern shore of the Ware River upstream of the pedestrian bridge at the USGS flow gaging station and the low head Gaging Station Pool Dam above Powdermill Pond on State Road (SR) 122. On January 23, 2008 ice shelves extending from the north shore prevented access from this location; a sampling pole was used from the south shore upstream of the bridge. Samples were collected from shore manually or with a sampling pole from 2/16/2005 through 11/16/2010. Station CBG serves as a reference station, minimally impacted by anthropogenic activities.

Upstream land uses include forest, rural residential, and roadways, with most of the upstream area protected for water supply (Figure 5; Google Earth 2011a). The Ware River Intake is located approximately 0.4 miles upstream; water is diverted from that point to the Quabbin Reservoir to supplement water levels there. Massachusetts Department of Conservation and Recreation (MassDCR) staff were observed collecting water quality samples here as part of an ongoing program (samples collected every other week). There are no upstream NPDES discharges. The Ware River corridor at and above Station CBG is designated as NHESP Priority Habitat of Rare Species (see NHESP Priority Habitats of Rare Species, MassGIS 2013).

The river at this location is a run, approximately 20 ft wide; the depth was generally greater than 3 feet (hip wader height); see Figure 6. Deciduous and evergreen trees provided shade along the banks, while most of the channel was open to the sky. Observations of conditions beneath the surface of the water column were typically limited due to deep color, dense foam, and surface light reflection. When visible, the stream bed consisted of a cement bottom near the foot bridge, with boulder, cobble, gravel and sand upstream. Periphyton was typically visible only near the water surface, and consisted mainly of moss (11of 33 events); the presence of filamentous algae was noted twice, and loose floc once. Cardinal flowers (*Lobelia cardinalis*) were frequently observed along the upstream channel periphery in the summer; additional macrophytes noted at this station include *Callitriche* sp. (water starwort), *Carex* sp. (sedge), Gramineae (grasses), *Ludwigia* sp. (water primrose), and immature emergents. Wildlife and insect observations recorded at this station include *Branta canadensis* (Canada goose), Cyprinidae (dace), Gerridae (water striders), Plecoptera exuviae (stonefly), *Procyon lotor* (raccoon), Salmonidae (trout), unidentified fish, mosquitoes and bird calls. Fishermen were often observed.

When visible, the water column ranged from clear (8) to highly turbid (2). Water color was typically red and/or brown (n=32), and clear on one event (3/25/2008). The river here usually lacked odor (n=23), with fishy noted seven times, musty on two events, and “mountain stream” once. Foam was always present, ranging from moderate to dense. Trash was unobservable on 27 events; when observable, trash was absent.

Station WA09A – Ware River at Gibbs Crossing, Old Belchertown Road, Ware, MA (river mile 8.504)

Figure 7 Google Earth view of Station WA09A area

Figure 8 Station WA09A upstream (4/28/2009)

Station WA09A is located on the Ware River in Ware, MA within the Lower Worcester Plateau ecoregion. The station was sampled 33 times from 2005-2010, and the river was accessed from the eastern shore of the Ware River off Old Belchertown Road, downstream (north) of the Palmer Road (State Road SR-32) Bridge. Samples were collected by wading to flowing water. Station WA09A serves as an impact station as it is located downstream of numerous point and nonpoint sources of pollution, as described below.

Upstream land uses included forest, town center, residential, industrial/commercial, and roadways (Figure 7; Google Earth 2012b). There are no large water withdrawals within 5 river miles upstream. The Ware Wastewater Treatment Plant (WWTP), a major municipal NPDES discharge, is located 2.6 mi upstream. The Ware River corridor at and above Station WA09A is designated as NHESP Priority Habitat of Rare Species (see NHESP Priority Habitats of Rare Species, MassGIS 2013).

The river is a run in this area; the channel is approximately 90 ft wide and 1 to 3+ feet deep. The streambed was typically shaded along the shores (Figure 8). Banks were undercut throughout the site area. The bottom consisted mainly of boulder, cobble, gravel and sand. Periphyton was often present, and included algal films, filamentous algae, and moss (25, n=33 events); loose floc was noted on one event (8/23/2005). Aquatic macrophytes included *Carex* sp. (sedge), *Elodea* sp. (waterweed), Graminae (grass), *Myriophyllum* sp. (milfoil), *Potamogeton* sp. (pondweed) and *Vallisneria* sp., (eel grass or tape grass). Aquatic organisms observed at Station WA09A included *Lepomis macrochirus* (bluegill), *Micropterus dolomieu* (smallmouth bass), *Lithobates catesbieanus* (American bullfrog), *Semotilus corporalis (*fallfish*)* and unidentified fish jumping. Occasional bird calls and mosquitoes were also observed.

The water column at this station was typically clear (23, n=31 observations); slight turbidity was noted on 8 events. Water color was characteristically red (27, n=33); other colors noted included light yellow (3) and clear (3). The water column lacked odor on most events; fishy and musty odors were also noted. Foam was present on most events (30, n=33) and ranged from sparse to very dense; foam density was typically moderate (19). Sheens were not observed during this time period. Minor quantities of trash were noted on most events (26, n=29) and included metals, pipes, tires, a tarp, wooden planks/boards, bottles, broken glass, “fishing trash” and floatables.

Station SMG – Sevenmile River at Cooney Road, Spencer, MA (river mile 5.835)

Figure 9 Google Earth view of Station SMG area

Figure 10 Station SMG upstream (8/23/2005) 2/16/2005 - 3/15/2006

Figure 11 Station SMG upstream (10/27/2009) 5/16/2006 – 11/16/2010

Station SMG is located on the Sevenmile River in Spencer, MA within the Lower Worcester Plateau ecoregion. From 2005-2010, the station was sampled 32 times, and access was gained from the western shore at the USGS flow gaging station, upstream of the Cooney Road Bridge, and downstream of the small (approximately 1 ft height) granite dam from 2/16/2005 to 1/18/2006. Samples were collected by bucket drop from the upstream side of the Cooney Road Bridge on 3/15/2006, then by wading to flowing water or with a sampling pole from the eastern shore downstream of the bridge from 5/16/2006 through 11/16/2010. All locations are considered to represent water quality in this segment of the river. Ice and snow cover prevented access to flowing water on 2/9/2010; no samples were collected on that date. Station SMG serves as a reference station, minimally influenced by anthropogenic activities.

Land uses near and upstream of this station include forest, rural residential, agriculture, and sand/gravel operations (Figure 9; Google Earth 2011a). Station SMG is within the Zone II of (downstream) water supply wells for the town of Spencer. There are no upstream municipal NPDES discharges. The Sevenmile River corridor at and above Station SMG is designated as NHESP Priority Habitat of Rare Species and NHESP Estimated Habitat of Rare Wildlife (see NHESP Priority Habitats of Rare Species (MassGIS 2013).

The river is a run in this reach, approximately 20 ft wide and less than 1 foot deep (Figure 11) both up- and downstream of the Cooney Road Bridge. Trees shade most of the upstream corridor, but the stream between the dam and the bridge is open to the sky. Above the bridge, the bottom consisted mainly of large granite blocks, as well as cobble, gravel and sand; with the exception of the granite blocks, this was also the composition of the substrate downstream of the bridge. Although riparian vegetation was abundant, few aquatic macrophytes were observed within the stream channel; these included *Carex* sp. (sedge), Gramineae (grasses), *Lobelia cardinalis* (cardinal flower), *Ludwigia* sp. (water primrose), *Lythrum salicaria* (purple loosestrife), *Polygonum* sp. (smartweed or knotweed), *Vallisneria* sp. (eel grass or tape grass) and immature submergents. Aquatic organisms noted included Cambaridae (crayfish), Cyprinidae (dace), *Lithobates catesbieanus* (American bullfrog), *Lithobates clamitans melanotus* (green frog) and unidentified fishes and frogs. Other wildlife observations included *Branta canadensis* (Canada goose), *Lontra canadensis* (North American river otter), *Procyon lotor* (raccoon), mussel shells, mosquitoes and bird calls.

The water column noted at this station was always clear (32 events), with slight turbidity noted on 5 events and highly turbid/murky conditions on one (following a snow/rain storm). Water color was typically clear (17); red (11) and light yellow (5) were also noted. The river lacked an odor on most events, with one observation each of “pond” and musty. Foam was sparse on most events (24 of 32), and absent on 7 dates; sheens were not observed. Trash and debris were limited to the granite blocks of the upstream dam.

Station QRG – Quaboag River at Boston Road (SR 67), Palmer, MA (river mile 10.855)

Figure 12 Google Earth view of Station QRG area

Figure 13 Station QRG upstream (8/25/2009)

Station QRG is located on the Quaboag River in Palmer, MA within the Lower Worcester Plateau ecoregion. From 2005-2010, the station was sampled 33 times, and access was gained from the western shore upstream of the USGS flow gaging station near the West Brimfield/Palmer corporate boundary. Samples were collected by wading to flowing water or with a sampling pole from shore. Station QRG serves as an impact station as it is located downstream of numerous point and nonpoint sources of pollution, as described below.

Land uses near and upstream of this station include forest, residential, commercial, sand and gravel operations, railways and roadways (Figure 12; Google Earth 2011c). The nearest upstream municipal NPDES discharge is approximately 2.5 mi. above this site in West Warren. There are no large water withdrawals near Station QRG.

The river is a run in this area, approximately 100 ft wide and 1 to 3+ feet deep (Figure 13). The railroad corridor is adjacent to the river upstream. Deciduous trees provide shade along the shoreline. The bottom consisted mainly of sand, with boulder, cobble, gravel and silt also present. Emergent plants were dense and diverse along the channel edges, but streambed vegetation was present only in a narrow band along the shoreline. Aquatic macrophytes observed at this station include *Carex* sp. (sedge), *Decodon verticillatus* (swamp loosestrife), *Elodea* sp. (waterweed), Graminae (grass), *Lobelia cardinalis* (cardinal flower), *Lythrum salicaria* (purple loosestrife), *Myriophyllum* sp. (milfoil), *Peltandra virginica* (arrow arum), *Pontedaria cordata* (pickerelweed), *Sagittaria* sp.(arrowhead), *Vallisneria* sp. (eelgrass/tape grass) and immature submergents. Other biota observations included *Lepomis macrochirus* (bluegill), *Lithobates catesbieanus* (North American bullfrog), *Lithobates clamitans melanotus* (green frog), *Pachydiplax longipennis* (blue dasher), unidentified fish and frogs, mosquitoes and birds calling.

The water column noted at this station was typically clear (21 of 33 monitoring runs) or slightly turbid (7), with moderate to high turbidity observed on five events. The water color was usually red (19, n=33); additional colors included light yellow (7), brown (2), clear (4) and grey (1). The station was characterized by a lack of water odors (32, n=33) with one observation of “eutrophic pond”. Foam was present on most events (29 of 33), mostly sparse to moderately dense. Trash was present on 20 sample dates, including tires, beer bottles/cans, broken glass, a rectangular white tube, cigarette butts and floatables.

Table 2 MassDEP SMART 2005 - 2010. Station SRG. Summary of Observations.

Survey Dates	Substrate	Trash	Periphyton	Color	Odor	Foam	Sheen	Turbidity	Wet/Dry Conditions
2/16/2005	Cobble/gravel/sand/silt	None	Sparse: dark green filamentous; dense: moss	Clear	None	None	None	Clear	Wet
4/20/2005	Boulder/cobble/gravel/sand	None	Moderate: moss	Clear	None	None	None	Clear	Dry
6/15/2005	Cobble/gravel/sand	None	Moderate: moss	Clear	Strong fishy	None	None	Clear	Dry
8/23/2005	Cobble/gravel/sand	None	None	Clear	None	None	None	Clear	Dry
10/19/2005	Cobble/gravel/sand	None	Moderate: moss	Clear	None	None	None	Clear	Dry
1/18/2006	Boulder/cobble/gravel	None	Moderate: moss	Clear	None	None	None	Clear	Wet
3/15/2006	Cobble/gravel/sand	None	Moss	Clear	None	None	None	Clear	Wet
5/16/2006	Cobble/gravel/sand	None	Moderate: moss	Clear	None	None	None	Clear	Wet
7/11/2006	Boulder/cobble/gravel/sand	None	Sparse: moss	Clear	None	None	None	Clear	Dry
10/4/2006	Cobble/gravel/sand	None	Dense: moss	Clear	None	None	None	Clear	Dry
11/7/2006	Cobble/gravel/sand	None	Very dense: moss	Clear	None	Very sparse	None	Clear	Dry
3/13/2007	Cobble/gravel/sand	None	Moderate: moss	Clear	None	None	None	Clear	Wet
4/17/2007	Unobservable	None	None	Clear	None	None	None	Clear	Wet
6/12/2007	Cobble/gravel/sand	None	Moderate: moss	Clear	None	None	None	Clear	Dry
8/28/2007	Cobble/gravel/sand	None	Dense: moss	Clear	None	None	None	Clear	Dry
10/16/2007	Cobble/gravel/sand	None	Moderate: moss	Clear	None	None	None	Clear	Dry
1/23/2008	Cobble/gravel/sand	None	None	Clear	None	None	None	Clear	Wet
3/25/2008	Gravel/sand/silt	None	None	Clear	None	None	None	Clear	Dry
5/20/2008	Cobble/gravel/sand	None	None	Clear	None	None	None	Clear	Dry
6/16/2008	Cobble/gravel/sand	None	None	Clear	None	None	None	Clear	Dry
7/22/2008	Cobble/gravel/sand/silt	None	None	Clear	None	None	None	Clear	Dry
8/18/2008	Cobble/gravel/sand/silt	None	None	Clear	None	None	none	Clear	Wet
9/23/2008	Cobble/gravel/sand/silt	None	Sparse: green filamentous; sparse, moss	Clear	None	Sparse	None	Clear	Dry
11/18/2008	Cobble/gravel/sand/silt	None	None	Clear	None	None	None	Clear	Wet
2/24/2009	Cobble/gravel/sand	None	None	Clear	None	None	None	Clear	Wet
4/28/2009	Cobble/gravel/sand	None	None	Clear	None	None	None	Clear	Dry
6/23/2009	Cobble/gravel/sand/silt	None	Moderate: moss	Clear	None	None	None	Clear	Wet
8/25/2009	Cobble/gravel/sand	None	None	Clear	None	None	None	Clear	Wet
10/27/2009	Cobble/gravel/sand	None	None	Clear	None	Very sparse	None	Clear	Wet
2/9/2010	Cobble/gravel/sand/silt	None	None	Clear	None	None	None	Clear	Dry
7/20/2010	Boulder/cobble/gravel/sand	None	Sparse: moss	Clear	None	None	None	Clear	Wet
10/5/2010	Cobble/gravel/sand/silt	None	Dense: moss	Clear	None	Very sparse	None	Clear	Wet
11/16/2010	Boulder/cobble/gravel/sand	None	Sparse: moss	Clear	None	None	None	Clear	Dry

Table 3 MassDEP SMART 2005 - 2010. Station CBG. Summary of Observations.

Survey Dates	Substrate	Trash	Periphyton	Color	Odor	Foam	Sheen	Turbidity	Wet/Dry Conditions
2/16/2005	Unobservable	Unobservable	Unobservable	Light yellow/tan	None	Moderate	None	Unobservable	Wet
4/20/2005	Unobservable	Unobservable	Unobservable	Red	Strong fishy	Dense	None	Clear	Dry
6/15/2005	Unobservable	Unobservable	Unobservable	Deep red	Fishy	Dense	Pollen	Moderate	Dry
8/23/2005	Cobble/gravel/sand/silt	None	Very dense: loose floc; moss	Brown	Fishy	Foam	None	Slight	Dry
10/19/2005	Unobservable	Unobservable	Unobservable	Red	None	Moderate	None	Unobservable	Dry
1/18/2006	Unobservable	Unobservable	None	Light brown	None	Moderate	None	Clear	Wet
3/15/2006	Cement	None	None	Slight red	None	Moderate	None	Clear	Wet
5/16/2006	Unobservable	Unobservable	Unobservable	Red	None	Moderate	None	Clear	Wet
7/11/2006	Unobservable	Unobservable	Unobservable	Red/light yellow	Fishy	Dense	Pollen	Highly turbid/murky	Dry
10/4/2006	Unobservable	Unobservable	Unobservable; very dense: moss	Slight red	None	Dense	None	Slight	Dry
11/7/2006	Unobservable	Unobservable	Unobservable	Light yellow	None	Moderate	None	Unobservable	Dry
3/13/2007	Unobservable	Unobservable	Sparse: moss	Slight red	None	Moderate	None	Clear	Wet
4/17/2007	Unobservable	Unobservable	Unobservable	Light yellow	None	Very dense	None	Unobservable	Wet
6/12/2007	Unobservable	Unobservable	Dense: bright green filamentous	Brown/red	None	Dense	None	Slight	Dry
8/28/2007	Cement	Unobservable	Moderate: brown filamentous; very dense: moss	Red	Fishy	Moderate	None	Moderate	Dry
10/16/2007	Unobservable	Unobservable	Unobservable	Red	None	Moderate	None	Unobservable	Dry
1/23/2008	Unobservable	Unobservable	Unobservable	Red	None	Moderate	None	Clear	Wet
3/25/2008	Boulder/cobble/cement	None	None	Clear	None	Moderate	None	Clear	Dry
5/20/2008	Boulder/cement	None	Dense: moss	Slight red	None	Moderate	None	Clear	Dry
6/16/2008	Unobservable	Unobservable	Very dense: moss	Red	Slight fishy	Moderate to dense	None	Moderate	Dry
7/22/2008	Cobble/gravel/sand	Unobservable	Very dense: moss	Red	None	Moderate	None	Moderate	Dry
8/18/2008	Unobservable	Unobservable	Unobservable	Red	None	Dense	Pollen	Moderate	Wet
9/23/2008	Unobservable	Unobservable	Very dense: moss	Red	None	Dense	None	Moderate	Dry
11/18/2008	Unobservable	Unobservable	Unobservable	Red	None	Dense	None	Unobservable	Wet
2/24/2009	Unobservable	None	None	Deep red	None	Dense	None	Unobservable	Wet
4/28/2009	Cement	None	Dense: moss	Red	Fishy	Dense	None	Slight	Dry
6/23/2009	Unobservable	Unobservable	Unobservable; dense: moss	Deep red	"Mountain stream"	Dense, natural	None	Unobservable	Wet
8/25/2009	Unobservable	Unobservable	Unobservable	Red	Musty	Dense, natural	Pollen, sparse to moderate	Moderate	Wet
10/27/2009	Unobservable	Unobservable	Very dense: moss	Red	None	Moderate	None	Slight	Wet
2/9/2010	Unobservable	Unobservable	Unobservable	Red	None	Moderate	None	Unobservable	Dry
7/20/2010	Unobservable	Unobservable	Dense: moss	Brown/red	None	Moderate to dense	None	Highly turbid/murky	Wet
10/5/2010	Unobservable	Unobservable	Unobservable	Deep red	Musty	Dense	None	Unobservable	Wet
11/16/2010	Unobservable	Unobservable	Unobservable	Red	None	Moderate to dense, @50%	None	Unobservable	Dry

Table 4 MassDEP SMART 2005 - 2010. Station WA09A. Summary of Observations.

Survey Dates	Substrate	Trash	Periphyton	Color	Odor	Foam	Sheen	Turbidity	Wet/Dry Conditions
2/16/2005	Cobble/gravel/sand	Minor: illegal dumping	None	Clear	None	Very sparse	None	Clear	Wet
4/20/2005	Boulder/cobble/gravel/sand	Broken glass, metals, floatables, tires, tarp	None	Red	None	Moderate	None	Clear	Dry
6/15/2005	Boulder/cobble/gravel/sand	Broken glass, metals	Sparse: green filamentous	Deep red	None	Moderate	None	Slight	Dry
8/23/2005	Boulder/cobble/gravel/sand	Metals	Very dense: green filamentous; sparse: black/green film; very dense: brown loose floc; very dense: moss	Brown	None	Sparse	None	Slight	Dry
10/19/2005	Unobservable	Unobservable	Unobservable	Red	None	Moderate	None	Slight	Dry
1/18/2006	Unobservable	Unobservable	Unobservable	Clear	None	Moderate	None	Clear	Wet
3/15/2006	Boulder/cobble/gravel/sand	Metals, boards, broken glass	None	Light yellow	None	None	None	Clear	Wet
5/16/2006	Unobservable	Unobservable	Unobservable	Brown	None	Moderate	None	Slight	Wet
7/11/2006	Boulder/cobble/gravel/sand	None	Sparse: green/brown filamentous	Red	None	Dense	None	Clear	Dry
10/4/2006	Unobservable	Trash	Very dense: grey/brown filamentous	Light yellow	Fishy	Very dense	None	Clear	Dry
11/7/2006	Boulder/cobble/gravel/sand	Trash	Moderate: brown filamentous	Red	None	Moderate	None	Clear	Dry
3/13/2007	Unobservable	Metals	Unobservable	Light yellow	None	Moderate	None	Slight	Wet
4/17/2007	Unobservable	Trash	Unobservable	Red	None	Moderate	None	Unobservable	Wet
6/12/2007	Cobble/gravel/sand	Wood, metal debris	Sparse: moss	Red	None	Moderate	None	Clear	Dry
8/28/2007	Boulder/cobble/gravel/sand	Metals, wood	Very dense: green film; very dense: moss	Red	None	Sparse	None	Clear	Dry
10/16/2007	Boulder/cobble/gravel/sand/silt	Broken glass, floatables, metals	Very dense: brown filamentous	Red	None	Sparse	None	Clear	Dry
1/23/2008	Cobble/gravel/sand	Metals, floatables, bottles	Green filamentous	Red	None	None	None	Clear	Wet
3/25/2008	Cobble/gravel/sand	Minor trash	None	Clear	None	Moderate	None	Clear	Dry
5/20/2008	Cobble/gravel/sand	Metals	Sparse: brown filamentous	Red	None	Sparse to moderate	None	Clear	Dry
6/16/2008	Cobble/gravel/sand/silt	Planks, metals, broken glass, floatables	Very dense, moss	Red	None	Moderate	None	Clear	Dry
7/22/2008	Cobble/gravel/sand	Minor: metals, planks, floatables	Dense: green filamentous; dense: green film	Red	Musty	Moderate	None	Slight	Dry
8/18/2008	Cobble/gravel/sand/silt	Minor: metals, planks	Moderate: green film	Red	None	Moderate	None	Clear	Wet
9/23/2008	Cobble/gravel/sand	Minor: planks, metals, broken glass	Dense: brown filamentous	Red	None	Sparse	None	Clear	Dry
11/18/2008	Cobble/gravel/sand	Metals	None	Red	None	Moderate	None	Clear	Wet
2/24/2009	Cobble/gravel/sand	Minor	None	Red	None	Sparse	None	Clear	Wet
4/28/2009	Cobble/gravel/sand	Bottles, broken glass	Dense: green film	Red	None	Sparse	None	Clear	Dry
6/23/2009	Unobservable	Unobservable	Unobservable	Red	None	Moderate	None	Unobservable	Wet
8/25/2009	Unobservable	Planks, metals	Unobservable	Red	Musty	Moderate	None	Slight	Wet
10/27/2009	Unobservable	Trash	Unobservable	Red	None	Moderate	None	Slight	Wet
2/9/2010	Cobble/gravel/sand	None	None	Red	None	None	None	Clear	Dry
7/20/2010	Cobble/gravel/sand	Floatables	Sparse: moss	Red	None	Moderate	None	Clear	Wet
10/5/2010	Boulder/cobble/gravel/sand	Minor: pipes, planks	Sparse: moss	Red	None	Sparse, natural	None	Clear	Wet
11/16/2010	Boulder/cobble/gravel/sand/silt	None	--	Red/light yellow	None	Sparse	None	Clear	Dry

Table 5 MassDEP SMART 2005 - 2010. Station SMG. Summary of Observations.

Survey Dates	Substrate	Trash	Periphyton	Color	Odor	Foam	Sheen	Turbidity	Wet/Dry Conditions
2/16/2005	Cobble/gravel/sand	Granite blocks	Green filamentous	Red	None	None	None	Clear	Wet
4/20/2005	Boulder/cobble/gravel	Granite blocks	Moderate: green filamentous; moss	Clear	None	Sparse	None	Clear	Dry
6/15/2005	Boulder/cobble/gravel/sand/silt	Granite blocks	Very dense: moss	Slight red	"Pond"	Sparse	None	Clear	Dry
8/23/2005	Boulder/gravel/sand/silt	Granite blocks	Moss	Clear	None	Foam	None	Clear	Dry
10/19/2005	Boulder/cobble/gravel/sand	Granite blocks	None	Clear	Slight musty	None	None	Clear	Dry
1/18/2006	Boulder/cobble/gravel/sand	Granite blocks	Sparse: bright green filamentous	Clear	None	None	None	Clear	Wet
3/15/2006	Boulder/cobble/gravel/sand	Granite blocks	Moderate: green filamentous	Clear	None	Sparse	None	Clear	Wet
5/16/2006	Cobble/gravel/sand	Granite blocks	None	Clear	None	Very sparse	None	Clear	Wet
7/11/2006*	Cobble/gravel/sand/silt	None	Sparse: green filamentous	Red/light yellow	None	Sparse	None	Clear	Dry
10/4/2006	Cobble/gravel/sand/silt	None	Very dense: brown filamentous	Light yellow	None	Very sparse	None	Clear	Dry
11/7/2006	Boulder/cobble/gravel/sand	None	None	Clear	None	Sparse	None	Clear	Dry
3/13/2007	Cobble/gravel/sand	None	None	Light yellow	None	Very sparse	None	Clear	Wet
4/17/2007	Cobble/gravel/sand	None	Unobservable	Light yellow	None	Sparse	None	Slight	Wet
6/12/2007	Cobble/gravel/sand/silt	None	None	Red	None	Sparse	None	Clear	Dry
8/28/2007	Cobble/gravel/sand/silt	None	Very dense: green filamentous and green film	Clear	None	None	none	Clear	Dry
10/16/2007	Cobble/gravel/sand/silt	None	Moderate: brown filamentous	Clear	None	None	None	Clear	Dry
1/23/2008	Cobble/gravel/sand	None	None	Clear	None	None	None	Clear	Wet
3/25/2008	Cobble/gravel/sand	None	Sparse: green filamentous	Clear	None	Very sparse	None	Clear	Dry
5/20/2008	Cobble/gravel/sand	None	None	Clear	None	Sparse	None	Clear	Dry
6/16/2008	Cobble/gravel/sand/silt	None	None	Red	None	Sparse	None	Clear	Dry
7/22/2008	Cobble/gravel/sand/silt	None	Dense: green film	Red	None	Sparse	None	Slight	Dry
8/18/2008	Cobble/gravel/sand/silt	None	Very dense: green film	Red	None	Sparse	None	Clear	Wet
9/23/2008	Cobble/gravelsand	None	Brown filamentous	Clear	None	Sparse	None	Clear	Dry
11/18/2008	Cobble/gravel/sand/silt	None	None	Red	None	Sparse	None	Clear	Wet
2/24/2009	Cobble/gravel/sand	None	None	Clear	None	None	None	Clear	Wet
4/28/2009	Cobble/gravel/sand	None	Sparse: green filamentous	Red	None	Sparse	None	Clear	Dry
6/23/2009	Cobble/gravel/sand/silt	None	Sparse: green film	Clear	None	Sparse	None	Clear	Wet
8/25/2009	Cobble/gravel/sand	None	Moderate: green film	Red	None	Sparse	None	Clear	Wet
10/27/2009	Cobble/gravel/sand	None	Very dense: green filamentous	Red	None	Sparse	None	Clear	Wet
2/9/2010	Station not sampled on this date; not accessible due to snow/ice								
7/20/2010	Cobble/gravel/sand/silt	None	None	Clear	None	Sparse	None	Clear	Wet
10/5/2010	Cobble/gravel/sand/silt	None	Sparse: moss	Light yellow	None	Sparse	None	Clear	Wet
11/16/2010	Cobble/gravel/sand/silt	None	Very dense: green film (100%)	Clear	None	Sparse	None	Clear	Dry

Table 6 MassDEP SMART 2005 - 2010. Station QRG. Summary of Observations.

Survey Dates	Substrate	Trash	Periphyton	Color	Odor	Foam	Sheen	Turbidity	Wet/Dry Conditions
2/16/2005	Boulder/sand/silt/mud	Trash	None	Red	None	Very sparse	None	Clear	Wet
4/20/2005	Boulder/cobble/gravel/sand/silt	Floatables	None	Slight brown	None	Sparse	None	Clear	Dry
6/15/2005	Boulder/gravel/sand/silt/mud	Tire, floatables	None	Deep red	None	Sparse	None	Clear	Dry
8/23/2005	Boulder/cobble/gravel/sand/silt/mud	Tires	Moderate: green/black film	Clear	None	None	None	Clear	Dry
10/19/2005	Unobservable	Unobservable	Unobservable	Red	None	Moderate	None	Slight	Dry
1/18/2006	Boulder/sand/mud	None	None	Clear	None	Very sparse	None	Clear	Wet
3/15/2006	Boulder/cobble/gravel/sand	None	None	Clear	None	None	None	Clear	Wet
5/16/2006	Unobservable	Unobservable	Unobservable	Brown	None	None	None	Highly turbid/murky	Wet
7/11/2006	Cobble/sand/trace/mud	None	None	Red/light yellow	None	Sparse	None	Slight	Dry
10/4/2006	Cobble/gravel/sand/silt	Floatables, tire	Sparse: green filamentous	Light yellow	Eutrophic pond	None	None	Clear	Dry
11/7/2006	Gravel/sand/silt	Trash	Sparse: brown filamentous	Red/light yellow	None	Sparse	None	Clear	Dry
3/13/2007	Sand/silt/mud	None	None	Light yellow	None	Very sparse	None	Slight	Wet
4/17/2007	Unobservable	Unobservable	Unobservable	Grey	None	Moderate	None	Highly turbid/murky	Wet
6/12/2007	Boulder/cobble/gravel/sand/silt	Tires, beer bottles	Moderate: brown film	Red	None	Moderate	None	Clear	Dry
8/28/2007	Cobble/gravel/sand/silt	Tires, beer cans	Dense: green/brown film	Red	None	Very sparse	None	Clear	Dry
10/16/2007	Boulder/cobble/gravel/sand/silt	Tire	None	Clear	None	Sparse	None	Clear	Dry
1/23/2008	Gravel/sand	None	None	Light yellow	None	Sparse	None	Clear	Wet
3/25/2008	Boulder/sand	None	None	Clear	None	Moderate	None	Clear	Dry
5/20/2008	Gravel/sand/silt	Broken glass, beer cans	Sparse: filamentous	Red	None	Moderate	None	Moderate	Dry
6/16/2008	Boulder/cobble/gravel/sand/silt	Broken glass, rectangular white tube	None	Red	None	Moderate	None	Clear	Dry
7/22/2008	Gravel/sand/silt	Minor	None	Red	None	Moderate	None	Slight	Dry
8/18/2008	Unobservable	Unobservable	Unobservable	Red	None	Dense	None	Moderate	Wet
9/23/2008	Boulder/cobble/gravel/sand/silt	None	Moderate: brown filamentous	Red	None	Moderate	None	Slight	Dry
11/18/2008	Boulder/cobble/gravel/sand/silt	None	None	Red	None	Moderate	None	Clear	Wet
2/24/2009	Cobble/gravel/sand/silt	Tires (2)	Filamentous	Clear	None	Very sparse	None	Clear	Wet
4/28/2009	Sand/silt	None	Moderate: green filamentous	Red	None	Very sparse	None	Clear	Dry
6/23/2009	Cobble/sand/silt	Minor: beer cans, tire	None	Red	None	Moderate	Manganous	Slight	Wet
8/25/2009	Boulder/cobble/gravel/sand/silt	None	None	Red	None	Moderate	None	Clear	Wet
10/27/2009	Cobble/gravel/sand/silt	Minor: cigarette butts	None	Red	None	Moderate	None	Clear	Wet
2/9/2010	Unobservable	Unobservable	Unobservable	Light yellow	None	None	None	Moderate	Dry
7/20/2010	Cobble/gravel/sand/silt	None	Sparse: brown/tan filamentous	Red	None	Sparse	Very sparse, manganous	Clear	Wet
10/5/2010	Sand/silt	None	None	Red	None	Moderate	None	Clear	Wet
11/16/2010	Boulder/sand/silt	None	None	Light yellow	None	Sparse	None	Slight	Dry

SURVEY CONDITIONS

Stream discharge and precipitation data are used to determine hydrologic conditions and, consequently, if water quality surveys should be described as dry or wet weather events. Precipitation data for each monitoring event were obtained from the National Oceanic and Atmospheric Administration (NOAA). The presence/absence of precipitation during the five days prior to each sampling event was based on the National Weather Service (NWS) data located on their website NOAA Climatological Data Publications (NOAA 2015). Precipitation records from the weather station at the Barre Falls Dam formed the basis of the wet/dry weather determination for all stations from February 2005 through July 2008. However, data from this location are not available from August 2008 through November 2010; climate data from the station in Ware were utilized for this time period. Average precipitation ranges from 46 to 50 inches across most of the Chicopee watershed; a small area ranges from 50 to 54 inches in the mountainous northwest area (Ostiguy et al 2010).

During dry weather, trace amounts of precipitation may fall, but there is no measurable change in stream flow. The USGS operates five real time stream gaging stations in the Chicopee River Watershed that are applicable to this water quality data set, as shown below:

- Swift River at West Ware, MA Station 01175500 (USGS 2011a),
- Ware River near Barre, MA Station 01172500 (USGS 2011b),
- Ware River at Gibbs Crossing, MA Station 01173500 (USGS 2011c)
- Sevenmile River near Spencer, MA Station 01175670 (USGS 2010d) and
- Quaboag River at West Brimfield, MA Station 01176000 (USGS 2010e).

Data from these stations are available at Current Conditions for Massachusetts: Streamflow (USGS 2013).

The period of record mean streamflow values are the mean of daily mean values for each day for 79-80 years of record (10/1/1930 – 9/30/2010) at the USGS gage on the Ware River at Gibbs Crossing, recorded in cubic feet per second (cfs). The daily mean data are reported at Daily mean discharge (USGS 2011f). The monthly mean discharge values are found at Monthly mean discharge (USGS 2011g).

Wet weather is defined as precipitation within a five-day antecedent period that leads to more than a slight increase in stream discharge (i.e., flow) at the five stations listed above. Under dry weather conditions, trace amounts of precipitation may fall, but no measurable change in stream flow occurs. Several of the Chicopee Watershed gaging stations were affected by flow manipulation and it was difficult to distinguish man-made from climate fluctuations on some dates. In addition, streamflow may be affected by runoff from snowmelt.

Table 7 (precipitation) and Table 8 (stream discharge) contain information on survey conditions during each sampling event. Both the precipitation and the stream discharge data were used to estimate hydrological conditions during water quality sampling. Low flows were compared to the 7Q10 flow (lowest 7-day average streamflow that occurs, on average, once every 10 years) at the Ware River gage at Gibbs Crossing, Ware which is 22 cfs (Wandle 1984). When precipitation and discharge data were inconclusive, field observations were used to determine wet/dry conditions. Snowfall, snow on the ground, and maximum daily temperature data were consulted in addition to discharge data to determine runoff conditions during winter monitoring events. Air temperature was recorded at each station in degrees Fahrenheit (ºF).

February 16, 2005 - In the 5-day period preceding this winter monitoring event, 1.08 inches (in) of precipitation was recorded at the Barre Falls Dam. Snow on the ground fell from 8 inches on February 11 to 2 inches on February 16; the maximum daily temperature ranged from 30 to 52ºF during this period. Discharge data recorded at the Ware River at Gibbs Crossing station indicate flows rose from February 14-16. Precipitation, snow pack and discharge data reflect wet weather/runoff conditions. Air temperature ranged from 33 to 50ºF and cloud cover from 35 to 100%.

April 20, 2005 - Precipitation and discharge data indicate a lack of rainfall and decreasing flow during the five days before this monitoring event, indicating dry weather conditions. Air temperature ranged from 72 to 86ºF under sunny skies. Buds were just beginning to emerge on trees and shrubs.

June 15, 2005 - Minor levels of rain were recorded at the Barre Falls Dam in the five days preceding this event (Σ=0.12 in). Discharge patterns varied at area gages, generally falling from June 10-15 with a slight increase mid-day June 14th, decreasing to pre-storm levels by June 15th. Precipitation and discharge indicate dry weather conditions. Air temperature ranged from 57 to 59ºF under overcast skies.

August 23, 2005 - Rain totaled 0.32 in at Barre Falls on August 22. Discharge varied little at area gages during the preceding five days. Field observations note low turbidity at all stations. Field observations and discharge data indicate dry weather conditions. Air temperature ranged from 69 to 78ºF and cloud cover from 0 to 40%.

October 19, 2005 - A large volume of rain fell in the 5 days preceding this event (Σ=3.91 inches), most in a storm event on October 15th. Discharge at area gages peaked on October 15th, falling to pre-storm levels by October 16th. Field observations indicate low turbidity at all stations. Based on discharge data and field observations, data collected on this date reflect dry weather conditions. Air temperature ranged from 55 to 68ºF and cloud cover from 85 to 100%. Foliage on deciduous trees and shrubs was changing and beginning to fall.

January 18, 2006 - Precipitation during the 5-day period prior to this event total 1.38 in, with additional 0.11 in recorded on the sampling date (rain began mid-way through the monitoring activities). Discharge at the Sevenmile River (Spencer), Ware River (Ware) and the Quaboag River (West Brimfield) rose on this date, beginning at approximately 06:00 a.m.; flows at the Ware River, Barre reflect a non-natural pattern, possibly as a result of flood control operations at the Barre Falls Dam. Water quality on this date reflects wet weather/runoff conditions. Air temperature ranged from 52 to 57ºF; overcast skies gave way to rain by approximately 10:00 a.m.

March 15, 2006 - Precipitation measured at the Barre Falls Dam was approximately 0.56 inches spanning the 5 days before this monitoring event, in a single event on March 14th. Discharge rose concurrently with this storm at the gages on the Sevenmile River (Spencer), Ware River (Ware) and the Quaboag River (West Brimfield), and had not returned to pre-event levels by the completion of the sampling run (the Ware River, Barre gage reflects flow manipulation). Water quality data collected on this date reflect wet weather/runoff conditions. Air temperature ranged from 37 to 41ºF. Cloud cover at the first station was approximately 15%; by the 2nd station, snow flurries were falling, which continued through the remainder of monitoring activities.

May 16, 2006 – This mid-spring monitoring event fell within a wet period, with a total of 2.57 in of precipitation recorded at Barre Falls in the five preceding days. Discharge rose at area gages throughout this period. Water quality data collected on this date reflect wet weather/runoff conditions. Air temperature ranged from 52 to 56ºF; overcast skies at the first station developed rain and drizzle by the 2nd and subsequent stations. Foliage was partly to completely out on trees and shrubs.

July 11, 2006 – A dry period preceded this summer monitoring run (0.02 in precipitation at Barre Falls July 6-11)). Discharge at area gages decreased steadily throughout this period. Water quality data reflect dry weather conditions. Air temperature ranged from 72 to 81ºF under overcast skies.

October 4, 2006 - This early fall monitoring event followed Tropical Storm Isaac, which dropped approximately 1 inch of rain on the area on October 2nd. Discharge rose from October 1-2 at area gages, then decreased to approximately pre-storm levels by the onset of sampling activities. Field observations note low turbidity at all stations. Water quality reflects dry weather conditions. Air temperature ranged from 57 to 77°F, with clear skies developing to mostly cloudy conditions. Foliage was changing on trees and shrubs throughout the watershed, with a few leaves down.

November 7, 2006 - This mid-fall sampling event was conducted during a dry period, in which 0.25 in of precipitation was recorded at Barre Falls Dam from November 2-3. Discharge decreased steadily at area gages from November 2-7. Low turbidity levels were observed throughout the watershed. Data collected on this event reflect dry weather conditions. Air temperature ranged from 38 to 55°F under overcast skies.

March 13, 2007 – On March 11th, 0.70 in of rain was recorded at the Barre Falls Dam gage. Snowfall there fell from 2 inches on the ground on March 8th to 1 inch on March 13. Discharge rose at area gages on that date and, in general, remained elevated through March 13th. Water quality data reflect wet weather/runoff conditions. During monitoring activities, air temperature rose from 36 to 52ºF under mostly cloudy to overcast skies.

April 17, 2007 – Spring monitoring fell within a storm event that brought 2.82 inches of precipitation to the area on April 16-17, of which approximately an inch was as snow (measured at Barre Falls); none remained on the ground. Maximum daily temperature ranged from 47 to 49ºF. Discharge approximately tripled from April 15-17; field observations indicate elevated water levels at all stations. Water quality reflects wet weather/runoff conditions. Air temperature measured in the field ranged from 60 to 65ºF. Heavy wet snow at the first station (Sevenmile River) developed to rain/drizzle by the third station (Swift River); rain persisted through the rest of the monitoring event. Foliage was beginning to bud.

June 12, 2007 - Approximately 0.15 inches of rain fell in the area from June 7-11; precipitation noted on June 12th occurred after sampling activities concluded. Light rain was noted the previous evening at the Worcester and Chicopee Falls weather stations. Discharge decreased steadily at area gages during this 5-day period. Water quality data reflect dry weather conditions. Air temperature ranged from 70 to 83ºF and cloud cover from 35 to 100%.

August 28, 2007 - This mid-summer event fell within a dry period; discharge decreased steadily from August 23-28. Water quality data reflect dry weather conditions. Air temperature ranged from 66 to 82ºF and 0 to 90% cloud cover.

October 16, 2007 – Precipitation totaled 1.06 inches in the five days preceding this fall sampling event, all within a storm event on October 11-12. The hydrograph shows both rain and non-precipitation fluctuations in discharge from October 11-16 at the Ware River gages as well as the Swift and the Sevenmile Rivers. Discharge at the Quaboag River decreased from October 12-16, but not to pre-storm levels. Field observations indicate low to very low water levels at all stations. Water quality data reflect dry weather conditions. Air temperature ranged from 48 to 62ºF under clear skies. Leaves were changing and partly down on watershed trees and shrubs.

January 23, 2008 - Winter monitoring was preceded by 0.52 inches of precipitation in the 5 days before this event, all within a storm on January 18-19. Two inches of snow fell at Barre Falls on January 18th, with snow on the ground decreasing from 4 inches on January 18th to 2 inches on January 23rd. Snow cover at the Ware station ranged from 10 to 8 inches during the same period. Maximum daily temperature ranged from 21 to 42ºF. Discharge at the Ware River, Barre and the Swift River changed little over the previous week; the hydrographs at the Sevenmile, Quaboag and Ware Rivers (Ware) indicate anthropogenic fluctuations during this period. Field observations indicate snow cover in the watershed ranged from patches at the southernmost stations (Ware River, Ware, Quaboag River) to 8+ inches at the Sevenmile River. Based on snow on the ground data, water quality reflects wet weather/runoff weather conditions. Air temperature dropped from 26 to 38ºF under clear skies.

March 25, 2008 - In the five days prior to this spring sampling event, a total of 0.75 inches of precipitation was measured at Barre Falls, all within a storm on March 20th. Discharge reflected non-precipitation fluctuations at the Ware River, Barre and the Swift River in the week preceding this event; discharge at the other watershed gages indicate generally decreasing flows. Field observations note high water levels throughout the watershed, with normal levels at the Swift River. The water column was clear i.e., no visible turbidity at all stations. Water quality data reflect dry weather conditions. Air temperature ranged from 31 to 47ºF under clear skies. Foliage had not begun to emerge.

May 20, 2008 - Approximately an inch of precipitation was measured at Barre Falls in the 5 days preceding this spring monitoring event, most in a storm event on May 17th. Discharge patterns at most watershed gages reflect anthropogenic influences; flows at the Quaboag River and the Ware River (Barre) rose from May 16-18th, then fell steadily to May 20th. Field observations note relatively low conductivity levels (<112 µS/cm) at all stations. Water quality reflects dry weather conditions. Air temperature ranged from 60 to 65ºF with clear skies becoming overcast during monitoring activities. Foliage had emerged on trees and shrubs throughout the watershed.

June 16, 2008 – A storm event on June 15th brought 0.44 inches of rain to the area. Discharge generally decreased at area gages over the preceding week; the Ware River (Ware) and Sevenmile River stations reflect non-precipitation fluctuations. Water quality data reflect dry conditions for this event. Air temperature ranged from 63 to 68ºF with overcast skies and intermittent drizzle.

July 22, 2008 – This summer monitoring event occurred within a rainy period that brought approximately 1 inch of precipitation to the area from July 19-22. Discharge rose at the Ware River, Barre, as well as the Sevenmile and Quaboag Rivers. Water quality data reflect dry conditions on this event. Air temperature ranged from 72 to 80ºF with mostly cloudy skies becoming overcast by mid-morning.

August 18, 2008 - Precipitation in the 5 days preceding this monitoring event totaled 1.33 inches at the Ware weather station. Although discharge was well above the daily mean value throughout the watershed, the hydrograph reflected anthropogenic flow patterns at all stations. Moderate turbidity was noted on the Quaboag and Ware Rivers (Barre). Based on precipitation and field observations, data collected during this event reflect wet weather/runoff conditions. Air temperature ranged from 72 to 90ºF under clear skies.

September 23, 2008 – Early fall sampling fell within a dry period, with no precipitation recorded at Ware. Discharge decreased steadily at all stations except the Swift River, where the hydrograph reflected anthropogenic manipulation. Water quality data reflect dry weather conditions. Air temperature ranged from 49 to 67ºF under clear skies.

November 18, 2008 – Over an inch of rain fell on the area in the five-day period preceding this event, with 0.84 inches on November 16th. Data collected during this event reflect wet weather/runoff conditions. Air temperature ranged from 31 to 47ºF with cloud cover ranging from 0 to 20%. Foliage was completely off the trees throughout the watershed.

February 23, 2009 – This winter monitoring event was preceded by a five-day period in which 0.35 inches of precipitation was noted at the Ware weather station, and an additional 0.37 inches fell on February 23rd before monitoring activities began; snow accounted for 2.0 inches of precipitation. Maximum daily temperature (Worcester) from February 18-23 ranged from 25 to 42ºF; snow on the ground increased from 3 to 5 inches on February 18-19, then to 4 inches at Ware from February 20-23. Field notes indicate snow throughout the watershed. Discharge patterns reflected anthropogenic fluctuations at all stations. Data collected on this date reflect wet weather/runoff conditions. Air temperature ranged from 28 to 36ºF; skies were mostly cloudy.

April 28, 2009 - Precipitation in the five days preceding this event was limited to 0.30 inches of rain on April 23rd. Discharge generally decreased at area gages during this period. Based on precipitation and flow, data reflect dry weather conditions. Air temperature ranged from 74 to 89ºF under sunny skies. Foliage was beginning to emerge at all stations.

June 23, 2009 – Early summer monitoring was conducted during a wet period, with precipitation totaling 1.29 inches at Ware in the preceding five days, most in a single storm on June 19 (1 inch). Discharge reflected precipitation patterns at the Sevenmile and Quaboag Rivers, with flow not returned to pre-storm levels before monitoring activities. The Swift and Ware Rivers (Barre) indicated anthropogenic fluctuations. Based on precipitation and discharge, water quality data collected on this event reflect wet weather/runoff conditions. Air temperature ranged from 67 to 74ºF under cloudy skies.

August 25, 2009 – This event also followed a wet period, in which 3.5 inches of precipitation (associated with Hurricane Bill) was recorded at Ware during the preceding 5 days. Discharge reflected precipitation input throughout the watershed. Data collected on this event reflect wet weather/runoff conditions. Air temperature ranged from 76 to 80ºF, with clear skies developing <30% cloud cover.

October 27, 2009 - Precipitation in the 5 days preceding this fall monitoring event totaled 1.11 inches in Ware, entirely with a storm from October 24-25. Discharge rose concurrently and had not returned to pre-storm levels before sampling activities began. Data collected on this event reflect wet weather/runoff conditions. Air temperature ranged from 38 to 54ºF under cloudy skies. Foliage had changed and leaves were mostly down in the watershed.

February 9, 2010 – No precipitation was recorded at the Ware station in the five days preceding this winter survey. No snow fell during this period; snow on the ground decreased from 3 inches (February 4-5) to 2 inches (February 6-9). Maximum daily temperature ranged from 21 to 35ºF. Discharge at all stations was affected by anthropogenic fluctuations. Water quality on this event reflects dry weather conditions. Air temperature ranged from 24 to 44ºF under clear skies.

July 20, 2010 - Summer monitoring was preceded by a 5 day-period with 1.87 inches of rain recorded in Ware, 1.8 inches of which was with a storm on July 17-18. Discharge at the Ware River, Barre indicates that flows had not returned to pre-storm levels by the commencement of monitoring activities; all other gages reflect non-natural fluctuations. Water quality reflects wet weather/runoff conditions. Air temperature ranged from 71 to 81ºF under mostly cloudy to overcast skies.

October 5, 2010 – Remnants of Tropical Storm Nicole brought 3.29 inches of rain to the area on October 1-2, with light rain on October 4-5. Discharge peaked with precipitation on October 2nd and had not fallen to pre-storm levels before sampling began. Data reflect wet weather/runoff conditions. Air temperature ranged from 53 to 57ºF under overcast skies with intermittent drizzle. Foliage was partially changed and mostly still on the trees throughout the watershed.

November 16, 2010 – Precipitation on November 15-16 totaled 0.10 in at the Ware weather station (none in the preceding 4 days), while discharge at area gages did not increase with this rainfall. Data reflect dry weather conditions. Air temperature ranged from 49.5 to 53ºF under overcast skies with intermittent sprinkles.

Table 7 Chicopee Basin Precipitation Data Summary 2005-2010							
Survey Dates	**5 Days**	**4 Days**	**3 Days**	**2 Days**	**1 Day**	**Sample**	**Wet/Dry[3]**
2/16/2005	0.48[1,2]	0	T	0	0.60	0.17	Wet
4/20/2005	0	0	0	0	0	0	Dry
6/15/2005	T	0	0	0.04	T	0.08	Dry
8/23/2005	0	0	0	0.02	0.32	0	Dry
10/19/2005	0.17	3.22	0.46	0	0.06	T	Dry
1/18/2006	0	0.25	1.08	0.05	0	0.11	Wet
3/15/2006	T	0	0	T	0.56	T	Wet
5/16/2006	0.02	0.44	0.97	0.70	0.44	0.08	Wet
7/11/2006	0.02	0	0	0	0	0	Dry
10/4/2006	T	0.37	0	0.99	0	0.02	Dry
11/7/2006	0.10	0.15	0	0	0	0	Dry
3/13/2007	0	0	0	0.70	0	0	Wet
4/17/2007	0	0.88	0	T	2.15	0.67	Wet
6/12/2007	0	0	0.11	0.04	0	0.40	Dry
8/28/2007	T	0	0	0	0	0	Dry
10/16/2007	0.03	1.03	0	0	0	0	Dry
1/23/2008	0.43	0.09	0	0	0	-	Wet
3/25/2008	0.75	T	0	0	0	0	Dry
5/20/2008	0	0.01	0.88	0.01	0.08	0	Dry
6/16/2008	0.39	0	0	0	0.44	0.02	Dry
7/22/2008	0	0	0.06	0.08	0.59	0.23	Dry
8/18/2008	0.53	0	0.03	0.22	0.55	0	Wet
9/23/2008	0	0	0	0	0	0	Dry
11/18/2008	T	0.24	0.06	0.84	0	0	Wet
2/23/2009	0	0.28	0.07	0	0	0.37	Wet
4/28/2009	0.30	T	0	0	0	0	Dry
6/23/2009	0.05	1.01	0.01	0.14	0.08	0.05	Wet
8/25/2009	0	0	2.14	0.15	1.21	0	Wet
10/27/2009	0	0	0.11	1.00	0	0	Wet
2/9/2010	0	0	0	0	0	0	Dry
7/20/2010	0.07	0	1.40	0.40	0	0.15	Wet
10/5/2010	0.02	0.95	2.34	0	0.09	0.03	Wet
11/16/2010	0	0	0	0	0.01	0.09	Dry

[1]Official data (in inches of precipitation) from the National Weather Service station at Barre Falls Dam from 2005 through July 2008 available at NOAA Climatological Data Publications (NOAA 2015).
[2] data were unavailable at Barre Falls from August 2008 through November 2010; data from Ware were used.
[3] = Based on precipitation, streamflow and other relevant data.
T = trace amount; an amount too small to measure
– = No record. Data not recorded, determined unreliable by quality control check, or not received in time for publication.

Table 8 USGS Flow Data Summary Discharge 2005-2010
Ware River at Gibbs Crossing, MA[1]

Survey Dates	5 Days	4 days	3 Days	2 Days	1 Day	Sample	Monthly[2]	Daily[3]
2/16/2005	670[e]	521[e]	369[e]	359[e]	491	714	468.6	335
4/20/2005	1,280	1,230	1,180	1,120	1,170	972	1,420	602
6/15/2005	215	248	208	221	185	195	198.9	266
8/23/2005	52	52	50	50	50	47	56.8	111
10/19/2005	529	4,020	2,530	1,050	838	908	976.1	182
1/18/2006	1,070	1,350	1,720[e]	1,100[e]	1,030[e]	1,470[e]	976.4	294
3/15/2006	289	298	305	306	483	516	291.7	523
5/16/2006	174	231	374	498	632	627	462.3	378
7/11/2006	304	230	238	194	179	309	340.6	134
10/4/2006	66	73	112	159	133	114	216.9	140
11/7/2006	324	294	270	245	238	215	546.1	228
3/13/2007	207[e]	199[e]	192[e]	589	661	648	648.7	504
4/17/2007	560	973	866	887	2,530	2,610	1,060	661
6/12/2007	389	318	282	271	259	324	217.0	247
8/28/2007	94	90	89	87	85	61	116.5	106
10/16/2007	22	80	102	60	56	39	71.3	182
1/23/2008	398[e]	395[e]	367[e]	339[e]	305[e]	277[e]	359.4	343
3/25/2008	1,120	1,110	984	890	829	894	1,044	571
5/20/2008	192	181	359	337	310	264	310.6	363
6/16/2008	99	128	91	76	136	85	146.2	258
7/22/2008	62	63	64	67	95	104	362.6	148
8/18/2008	412	337	286	355	307	221	302.6	133
9/23/2008	338	266	232	203	200	195	472.1	196
11/18/2008	268	220	337	490	535	408	358.4	261
2/23/2009	351[e]	367[e]	397[e]	347[e]	355[e]	355[e]	392.9	379
4/28/2009	716	619	552	511	440	363	560.5	495
6/23/2009	405	561	618	518	467	438	323.7	225
8/25/2009	116	162	301	305	556	323	389.7	101
10/27/2009	159	136	157	396	369	314	199.9	202
2/9/2010	370[pe]	350[pe]	304[p]	291[p]	284[pe]	274[pe]	378.8	306
7/20/2010	81[p]	88[p]	169[p]	188[p]	159[p]	145[p]	111.0	138
10/5/2010	63[p]	192[p]	313[p]	261[p]	193[p]	116[p]	169.1	133
11/16/2010	327[p]	273[p]	248[p]	235[p]	224[p]	193[p]	250.7	262

[1]Daily Data (cfs) for Station 01173500 Ware River at Gibbs Crossing, Ware, MA data found at USGS 01173500 WARE RIVER AT GIBBS CROSSING, MA (USGS 2011c); all data were approved for publication; processing and review completed.

[2]Mean of monthly mean discharge (cfs) based on data collected at Station 01173500 Ware River at Gibbs Crossing, Ware, MA from 08/1/1912 to 9/3/2011 found at USGS 01173500 WARE RIVER AT GIBBS CROSSING, MA USGS Surface-Water Monthly Statistics for Massachusetts (USGS 2011g)

[3]Mean of daily mean discharge (cfs) based on data collected at Station 01173500 Ware River at Gibbs Crossing, Ware, MA from 8/20/1912 to 11/24/2009 found at USGS 01173500 WARE RIVER AT GIBBS CROSSING, MA USGS Surface-Water Daily Statistics for Massachusetts (USGS 2011f)

[e] = Estimated value

[p] = Provisional data subject to revision

7Q10 = 22 cfs at Station 01173500 Ware River at Gibbs Crossing, Ware, MA (Wandle 1984)

RESULTS AND QUALITY ASSURANCE/QUALITY CONTROL

The results of SMART monitoring conducted in the Chicopee watershed from 2005 through 2010 are included below. *In situ* multiprobe readings, including temperature, pH, dissolved oxygen, percent oxygen saturation, depth, specific conductivity and total dissolved solids are presented for each station in Table 9 through Table 13. Nutrient and chemistry data are presented in Table 14 through Table 18. Most results are expressed as milligrams per liter (mg/L). Exceptions include: depth in meters (m); temperature in degrees Celsius (ºC); pH in Standard Units (SU); conductivity in microsiemens per centimeter (µS/cm); dissolved oxygen saturation in percent (%); and turbidity, in Nephelometric Turbidity Units (NTU).

Field sheets, field notebooks, chain of custody forms, raw data files, lab reports and other metadata are maintained by the Massachusetts Department of Environmental Protection (MassDEP) Bureau of Resource Protection (BRP) CEntral Regional Office (CERO) in Worcester, MA and data are stored electronically in the Division of Watershed Management's (DWM) water quality database. Detailed information regarding the data validation process is explained in the separate document, *CN 56.2 Standard Operating Procedures Data Validation and Usability* (MassDEP 2005). Specific validation criteria used for 2005-2010 data include, but are not limited to: conformance to the SMART Monitoring Quality Assurance Project Plan (Beaudoin 2008) and DWM standard operating procedures (SOPs), precision, accuracy, representativeness, holding times, sample preservation, frequency of field QC samples, contamination of field blanks, stability of multiprobe readings and documentation. The following data qualifiers were applied as needed:

Multiprobe data qualifiers:
** = Missing data.
-- = No data.
= Censored data (data that have been discarded for some reason).
c = Greater than calibration standard used for pre-calibration, or outside the acceptable range about the calibration standard.
i = Inaccurate readings from multiprobe likely.
m = Method not followed; one or more protocols contained in the DWM Multi-probe SOP not followed.
r = Data not representative of actual field conditions.
s = Field sheet recorded data were used to accept data, not data electronically recorded in the Multi-probe surveyor unit, due to operator error or equipment failure.
u = Unstable readings.

Laboratory sample data qualifiers:
** = Missing data.
-- = No data.
= Censored data (data that have been discarded for some reason).
[ ] = A result reported inside brackets has been censored, but is shown for informational purposes.
b = Blank contamination in lab reagent blanks and/or field blank samples.
d = Precision of field duplicates (as Relative Percent Difference, RPD) did not meet project data quality objectives identified for program or in QAPP.
e = Not theoretically possible. Specifically, used for bacteria data where colonies per unit volume for *E. coli* bacteria are greater than fecal coliform bacteria.
h = Holding time violation (usually indicating possible bias low).
j = 'Estimated' value; 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 detection limit (RDL) and greater than the method detection limit (MDL) (RDL > x > MDL). Also used to note where values have been reported at levels less than the MDL.
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, and missing data.

Table 9 MassDEP SMART 2005-2010. Station SRG. *In Situ* Multiprobe Data.

Date	OWMID	Time	Depth	Temp	pH	Cond@ 25C	TDS	DO	SAT
		(24hr)	(m)	(C)	(SU)	(us/cm)	(mg/l)	(mg/l)	(%)
2/16/2005	SM-6149	10:35	0.5	2.1	6.2	57	37	14.1	103
4/20/2005	SM-6191	10:47	0.6	7.1	6.4	49	32	12.9	106
6/15/2005	SM-1363	10:49	0.7	16.5	6.3	49	32	10.0	102
8/23/2005	SM-1445	10:40	0.5	12.2	6.8	49	32	11.9	111
10/19/2005	SM-1515	10:50	0.3	14.0	6.5	63	41	10.1	98
1/18/2006	SM-1585	10:19	1.2	3.7	6.5	50	33	13.1	99
3/15/2006	SM-1655	10:38	1.0	2.2	6.4	50	33	14.4	104
5/16/2006	SM-1725	10:38	0.8	10.7	6.4	49	32	11.1 i	100 i
7/11/2006	SM-1783	10:44	0.9 i, s	18.6	6.7	48	31	9.6	102
10/4/2006	SM-1875	10:45	0.4	13.4	6.6	50	33	11.2	107
11/7/2006	SM-1935	10:13	0.4	11.2	6.6	51	33	10.9	100
3/13/2007	SM-2005	10:43	0.3	2.0	6.5	58	38	15.8	114
4/17/2007	SM-2075	10:56	1.7	3.4	6.4	49	32	13.4	100
6/12/2007	SM-2145	10:34	0.6	17.8	6.7	48	31	9.9	104
8/28/2007	SM-2215	10:25	0.6	12.6	6.8	47	31	11.6	109
10/16/2007	SM-2285	11:05	0.3	14.6	6.7	50	32	10.4	102
1/23/2008	SM-2355	10:31	0.4	2.3	6.6	52	34	13.9	101
3/25/2008	SM-2425	10:50	## i	2.3	6.5	51	33	14.4	105
5/20/2008	SM-2495	11:38	0.5	11.5	6.7	47	31	11.4	105
6/16/2008	SM-2541	10:41	0.4	15.5	6.6	49	32	10.5	106
7/22/2008	SM-2601	10:55	0.5	12.1	6.5	51	33	11.4	106
8/18/2008	SM-2647	10:29	0.3	15.8	6.6	52	34	10.5	106
9/23/2008	SM-2707	10:28	0.5	14.1	6.6	51	33	10.6 i	103 i
11/18/2008	SM-2777	10:52	0.4	9.5	6.7	55	35	11.3	99
2/23/2009	SM-2847	12:46	0.5	2.1	6.6	49	32	14.4	104
4/28/2009	SM-2919	10:15	0.8	8.9	6.5	47	30	11.9	103
6/23/2009	SM-2991	10:27	0.4	11.1	6.1	59	38	10.9	99
8/25/2009	SM-3063	10:34	## i	13.1	6.4	49	32	10.4	99
10/27/2009	SM-3135	10:30	0.5	12.2	6.7	51	33	9.8	91
2/9/2010	SM-3207	10:24	0.2	1.1	6.5	52	34	13.3	94
7/20/2010	SM-3279	10:24	0.6	13.3	6.7	47	30	11.2	107
10/5/2010	SM-3351	10:48	0.4	17.0	6.7	49	32	9.2	96
11/16/2010	SM-3423	10:21	0.4	11.0	6.6	50	33	10.8	98

Table 10 MassDEP SMART 2005-2010. Station CBG. *In Situ* Multiprobe Data.

Date	OWMID	Time	Depth	Temp	pH	Cond@ 25C	TDS	DO	SAT
		(24hr)	(m)	(C)	(SU)	(us/cm)	(mg/l)	(mg/l)	(%)
2/16/2005	SM-6148	9:37	1.7	0.2	5.9	90	59	14.2	98
4/20/2005	SM-6190	9:51	1.9	11.3	5.5	85	56	10.3	94
6/15/2005	SM-1361	9:55	1.6	22.4	6.2	106	69	8.3	95
8/23/2005	SM-1443	9:45	1.6	21.5	6.6	115	75	8.4	94
10/19/2005	SM-1513	9:55	0.2	11.3	5.4	92	60	10.5	96
1/18/2006	SM-1583	9:27	0.4	0.1	5.7	80	52	14.2	97
3/15/2006	SM-1653	9:41	1.9	3.1	6.0	74	48	13.2	98
5/16/2006	SM-1723	9:42	2.1	10.2	5.8	66	43	10.4 i	92 i
7/11/2006	SM-1781	9:46	1.5	22.9	6.4	81	53	8.5	99
10/4/2006	SM-1873	9:48	1.4	14.1	6.6	78	51	10.5	102
11/7/2006	SM-1933	9:23	1.4	4.2	6.2	95	62	13.6	104
3/13/2007	SM-2003	9:41	2.0	0.0	6.2	90	58	13.9	96
4/17/2007	SM-2073	10:06	0.3	3.0	5.3	55	36	13.2	98
6/12/2007	SM-2143	9:33	1.6	20.6	6.3	76	50	8.1	90
8/28/2007	SM-2213	9:26	1.5	22.0	6.7	102	66	8.2	94
10/16/2007	SM-2283	10:04	1.3	11.4	6.7	90	59	6.1 u	56 u
1/23/2008	SM-2353	9:22	1.3	0.0	6.2	107 u	70 u	15.1	103
3/25/2008	SM-2423	9:39	0.3	1.8	5.9	83	54	14.5	104
5/20/2008	SM-2493	10:20	0.9	13.0	6.4	89	58	9.8	92
6/16/2008	SM-2539	9:34	0.7	19.3	6.5	117	76	9.3	101
7/22/2008	SM-2599	9:40	1.6	23.9	6.7	103	67	8.0	95
8/18/2008	SM-2645	9:20	1.2	20.2	6.4	80	52	9.0	99
9/23/2008	SM-2705	9:19	1.4	13.7	6.5	84	55	10.4 i	100 i
11/18/2008	SM-2775	9:41	1.5	5.0	6.4	79	51	12.8	101
2/23/2009	SM-2845	9:46	0.9	-0.1	6.3	111	72	15.2	103
4/28/2009	SM-2917	9:08	1.5	18.9	6.4	101	65	9.2	99
6/23/2009	SM-2989	9:16	0.0	17.2	6.0	77	50	9.1	95
8/25/2009	SM-3061	9:13	## i	23.1	6.4	73	48	8.2	96
10/27/2009	SM-3133	9:17	1.1	8.8	6.3	82	53	11.3	97
2/9/2010	SM-3205	9:10	0.3	0.0	6.0	99	65	14.3	98
7/20/2010	SM-3277	9:11	1.5	24.8	6.5	92	60	7.7	93
10/5/2010	SM-3349	9:45	1.3	13.2	6.3	106	69	10.4	99
11/16/2010	SM-3421	9:09	1.0	6.2	6.2	103	67	13.0	105

Table 11 MassDEP SMART 2005-2010. Station WA09A. *In Situ* Multiprobe Data.

Date	OWMID	Time	Depth	Temp	pH	Cond@ 25C	TDS	DO	SAT
		(24hr)	(m)	(C)	(SU)	(us/cm)	(mg/l)	(mg/l)	(%)
2/16/2005	SM-6150	11:05	0.6	0.6	6.4	76	50	14.6	102
4/20/2005	SM-6192	11:13	0.6	12.6	6.5	93	61	11.2	105
6/15/2005	SM-1366	11:21	0.3	22.3	6.7	117	76	7.9	91
8/23/2005	SM-1448	11:23	0.6	21.4	7.5	163	106	10.0	113
10/19/2005	SM-1518	11:20	0.5	11.8	6.3	90	58	10.5	97
1/18/2006	SM-1588	10:49	0.7	0.8	6.2	131	85	14.0	98
3/15/2006	SM-1658	11:11	0.4	4.1 u	6.6 u	98 u	64 u	13.5 u	103 u
5/16/2006	SM-1728	11:11	0.5	10.7	6.5	85	55	10.6 i	96 i
7/11/2006	SM-1786	11:18	0.2	23.8	7.0	108	70	8.3	99
10/4/2006	SM-1878	11:15	0.2	15.5	7.0	127	83	10.6	107
11/7/2006	SM-1938	10:53	0.3	5.6	6.7	107	69	12.7	101
3/13/2007	SM-2008	11:14	0.5	0.4 u	6.5 u	92 u	60 u	14.3 u	99 u
4/17/2007	SM-2078	11:25	1.2	4.2	6.2	63	41	12.9	99
6/12/2007	SM-2148	11:04	0.4	21.1	6.8	98	64	8.8	99
8/28/2007	SM-2218	11:02	0.6	22.7	7.2	144	93	8.9	104
10/16/2007	SM-2288	11:37	0.3	11.9	7.0	158	102	10.7	99
1/23/2008	SM-2358	11:00	0.4	0.0	6.5	105	68	15.0	103
3/25/2008	SM-2428	11:26	## i	3.0	6.4	90	58	14.3	106
5/20/2008	SM-2498	12:10	0.3	14.4	6.8	103	67	10.5	103
6/16/2008	SM-2544	11:18	0.2	19.9	6.8	132	86	8.4	93
7/22/2008	SM-2604	11:29	0.3	24.8	7.1	123	80	8.4	101
8/18/2008	SM-2650	11:02	0.3	21.4	6.9	101	66	9.1	103
9/23/2008	SM-2710	10:58	0.7	14.4	7.0	117	76	10.9 i	107 i
11/18/2008	SM-2780	11:27	0.4	5.7	6.8	93	60	12.6	101
2/23/2009	SM-2850	11:38	0.2	0.2	6.6	141	92	14.8	102
4/28/2009	SM-2922	10:44	0.4	18.5	6.7	118	77	9.4	100
6/23/2009	SM-2994	10:54	0.4	17.9	6.7	93	60	9.0	95
8/25/2009	SM-3066	11:10	## i	23.2	7.0	100	65	8.5	100
10/27/2009	SM-3138	10:57	0.4	9.1	6.8	99	65	11.2	97
2/9/2010	SM-3210	10:58	0.3	0.0	6.7	117	76	14.2	98
7/20/2010	SM-3282	10:59	0.2	25.1	7.2	130	84	8.3	100
10/5/2010	SM-3354	11:20	0.2	14.0	6.9	122	80	9.9	96
11/16/2010	SM-3426	10:50	0.2	6.7	6.8	119	77	12.5	103

Table 12 MassDEP SMART 2005-2010. Station SMG. *In Situ* Multiprobe Data.

Date	OWMID	Time	Depth	Temp	pH	Cond@ 25C	TDS	DO	SAT
		(24hr)	(m)	(C)	(SU)	(us/cm)	(mg/l)	(mg/l)	(%)
2/16/2005	SM-6147	8:59	0.6	0.2	6.2	81	52	14.1	97
4/20/2005	SM-6189	9:08	0.2	12.9	6.4	82	53	10.1	96
6/15/2005	SM-1359	9:10	0.1	20.1	6.1	88	57	7.7	85
8/23/2005	SM-1441	8:58	0.2	16.9	7.0	109	71	9.4	97
10/19/2005	SM-1511	9:09	0.4	11.2	6.0	78	51	9.9	90
1/18/2006	SM-1581	8:47	0.4	0.5	6.0	77	50	13.3	92
3/15/2006	SM-1651	8:56	0.2	2.9	6.2	71	46	13.2	97
5/16/2006	SM-1721	8:50	0.5	10.9	6.1	76	50	10.4 i	94 i
7/11/2006	SM-1779	8:57	0.3	22.0	6.9	83	54	7.8	89
10/4/2006	SM-1871	9:00	0.2	13.4	6.9	102	66	10.2	98
11/7/2006	SM-1931	8:47	0.2	3.9	6.6	70	46	12.8	98
3/13/2007	SM-2001	8:57	0.4	0.0 u	6.2 u	76 u	49 u	13.8 u	95 u
4/17/2007	SM-2071	9:16	0.5	4.2	5.9	65	42	12.0	92
6/12/2007	SM-2141	8:44	0.3	19.9	6.6	76	50	8.4	92
8/28/2007	SM-2211	8:43	0.2	18.2	7.0	126	82	8.8	94
10/16/2007	SM-2281	9:12	0.2	8.1	6.6	126	82	10.6	90
1/23/2008	SM-2351	8:37	0.2	-0.1	6.4	81	53	14.4	99
3/25/2008	SM-2421	9:01	0.2	2.6	6.4	79	51	13.6	100
5/20/2008	SM-2491	9:37	0.4	12.1	6.6	84	55	10.5	98
6/16/2008	SM-2537	8:52	0.3	17.7	6.7	92	60	8.8	92
7/22/2008	SM-2597	8:44	0.2	21.4	6.8	94	61	7.9	90
8/18/2008	SM-2643	8:33	0.3	18.5	6.8	83	54	8.5	91
9/23/2008	SM-2703	8:42	0.2	11.9	6.5	89	58	10.2 i	94 i
11/18/2008	SM-2773	8:57	0.3	3.9	6.7	87	56	12.6	96
2/23/2009	SM-2843	8:57	0.3	-0.3	6.2	95	62	14.7	100
4/28/2009	SM-2915	8:27	0.3	16.8	6.4	90	58	8.9	92
6/23/2009	SM-2987	8:38	0.4	17.3	6.4	90	58	8.6	90
8/25/2009	SM-3059	8:30	## i	21.7	6.8	83	54	7.8	89
10/27/2009	SM-3131	8:34	0.3	7.6	6.7	87 u	56 u	11.0	92
2/9/2010	SM-3203	**	**	**	**	**	**	**	**
7/20/2010	SM-3275	8:26	0.2	22.0	7.0	111	72	8.2	94
10/5/2010	SM-3347	9:00	0.4	12.8	6.8	100 u	65 u	9.6	91
11/16/2010	SM-3419	8:22	0.3	7.2	6.4	108	70	11.5	96

Table 13 MassDEP SMART 2005-2010. Station QRG. *In Situ* Multiprobe Data.

Date	OWMID	Time	Depth	Temp	pH	Cond@ 25C	TDS	DO	SAT
		(24hr)	(m)	(C)	(SU)	(us/cm)	(mg/l)	(mg/l)	(%)
2/16/2005	SM-6152	11:43	0.7	2.2	6.8	130	84	14.4	105
4/20/2005	SM-6194	11:49	0.7	15.8	7.4	108	70	11.0	110
6/15/2005	SM-1369	11:53	0.4	21.9	7.2	146	95	8.7	99
8/23/2005	SM-1451	12:04	0.3	22.7	8.7	167	108	10.4	120
10/19/2005	SM-1521	11:54	1.5	12.6	6.5	66 u	43 u	10.3	97
1/18/2006	SM-1591	11:20	0.8	2.3	6.5	128	83	13.5	98
3/15/2006	SM-1661	11:46	0.7	5.5	7.1	102	67	13.6	108
5/16/2006	SM-1731	11:45	0.6	11.4	6.9	111	72	10.8 i	98 i
7/11/2006	SM-1789	11:54	0.5	24.7	7.6	114	74	8.3	100
10/4/2006	SM-1881	11:50	0.3	16.8	7.7	129	84	10.9	112
11/7/2006	SM-1941	11:24	0.5	6.1	7.1	111	72	13.1	105
3/13/2007	SM-2011	11:55	0.7	2.6	6.7	106	69	13.7	100
4/17/2007	SM-2081	11:54	1.2	5.4	6.5	71	46	12.5	99
6/12/2007	SM-2151	11:38	0.4	23.0	7.3	104	68	9.0	105
8/28/2007	SM-2221	11:38	0.3	23.3	8.3	29	19	9.6	113
10/16/2007	SM-2291	12:18	0.2	12.1	7.6	158	103	12.3	114
1/23/2008	SM-2361	11:35	0.7	0.2	6.8	146	95	15.4	106
3/25/2008	SM-2431	11:55	0.8	4.6	6.8	97	63	13.8	107
5/20/2008	SM-2501	12:43	0.4	14.8	7.2	111	72	10.5	104
6/16/2008	SM-2547	11:57	0.4	19.8	7.3	128	83	9.3	102
7/22/2008	SM-2607	12:05	0.3	25.6	8.1	105	68	8.9	109
8/18/2008	SM-2653	11:40	0.6	22.2	7.3	108	70	8.9	102
9/23/2008	SM-2713	11:33	0.6	16.0	7.3	104	68	10.2 i	104 i
11/18/2008	SM-2783	12:04	0.7	6.0	7.3	108	70	13.2	106
2/23/2009	SM-2853	12:11	0.2	1.4	6.9	140	91	14.9	106
4/28/2009	SM-2925	11:13	0.6	19.0	7.4	113	74	10.1	109
6/23/2009	SM-2997	11:23	0.4	19.0	7.3	115	75	9.2	99
8/25/2009	SM-3069	11:42	## i	24.7	7.7	105	68	8.5	102
10/27/2009	SM-3141	11:25	0.5	9.4	7.2	114	74	11.5	100
2/9/2010	SM-3213	11:35	0.7	0.0	7.0	125	82	14.5	99
7/20/2010	SM-3285	11:31	0.2	25.8	8.3	80	52	9.0	110
10/5/2010	SM-3357	11:55	0.3	14.6	7.3	152	99	10.6	104
11/16/2010	SM-3429	11:23	0.4	8.1	7.6	146	95	12.6	107

Table 14 MassDEP SMART 2005-2010. Station SRG. Chemistry Data.

Date	OWMID	Time	Alkalinity	Hardness	Chloride	E_coli	Ssolids	Turb	TN	NH3-N	NO3-NO2-N	TPhos
		(24hr)	(mg/l)	(mg/l)	(mg/l)	(MPN/100ml)	(mg/l)	(NTU)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
2/16/2005	SM-1149	10:29	4	11	11	**	<1.0	0.4	0.21	<0.02	0.07	0.006
4/20/2005	SM-1191	10:41	2	8.1	7	**	<1.0	0.3	0.15	<0.02	<0.02	0.005
6/15/2005	SM-1362	10:46	3	7.6	8	**	1.2	0.6	0.15	0.04	<0.02	0.007
8/23/2005	SM-1444	10:35	3	7.7	8	**	<1.0	0.3	0.10	<0.02	<0.02	<0.005
10/19/2005	SM-1514	10:45	4	11	9	**	<1.0	0.3	0.15	<0.02	0.03	0.005
1/18/2006	SM-1584	10:10	3	7.8	7	**	1.6	0.5h	0.13	<0.02	0.04	0.006h
3/15/2006	SM-1654	10:30	3	7.7	8	**	<1.0	0.2	0.12	<0.02	<0.02	0.008
5/16/2006	SM-1724	10:30	2	7.8	8	**	2.6	##h	0.16	<0.02	<0.02	<0.005
7/11/2006	SM-1782	10:30	2	7.9	7	**	<1.0	0.2h	0.13	<0.02	<0.02	<0.005
10/4/2006	SM-1874	10:35	3	8.6	8	**	<1.0	0.3h	0.13	<0.02	<0.02	<0.005
11/7/2006	SM-1934	10:05	3	8.4	7	**	<1.0	0.4h	0.13	<0.02	0.02	<0.005
3/13/2007	SM-2004	10:25	3	9.7	9	**	<1.0	0.4h	0.16	<0.02	0.06	<0.005
4/17/2007	SM-2074	10:45	3	7.6	7	**	5.1	0.4h	0.17	<0.02	<0.02	0.010
6/12/2007	SM-2144	10:25	4	7.7	7	**	<1.0	0.3h	0.098	0.02	0.02	<0.005
8/28/2007	SM-2214	10:12	4	7.6	7	4	1.3	0.3h	0.11	<0.02	<0.02	<0.005
10/16/2007	SM-2284	10:57	3	8.1	6	11	<1.0	0.3h	0.12	<0.02	<0.02	<0.005
1/23/2008	SM-2354	10:25	4	9.3	7	3	<1.0	0.2h	0.15	<0.02	0.02	<0.005
3/25/2008	SM-2424	10:45	4	9.0	6	<1	<1.0d	0.2h	0.13	<0.02	0.02	<0.005
5/20/2008	SM-2494	11:25	3	7.9	7	##h	1.8	0.4h	0.18	<0.02	<0.02	0.005
6/16/2008	SM-2540	10:25	<2	8.3	6	5	<1.0	0.3h	0.13	<0.02	<0.02	<0.005
7/22/2008	SM-2600	10:43	**	9.2	4	5	<2.0d	**	0.13	<0.02	<0.02	<0.005
8/18/2008	SM-2646	10:20	**	9.4	5	60	2.1	0.8	0.11	<0.02	<0.02	<0.005
9/23/2008	SM-2706	10:15	2	9.8	6	7	32	0.4h	0.12	<0.02	<0.02	0.008
11/18/2008	SM-2776	10:45	<2	9.9	5	8	6.6	0.3h	0.14	<0.02	<0.02	0.006
2/23/2009	SM-2846	10:55	2	8.2	6	<1	<1.0	0.2	0.13	<0.02	<0.02	<0.005
4/28/2009	SM-2918	10:05	11	8.3	6	<1	<1.0d	0.3	0.13	<0.02	<0.02	<0.005
6/23/2009	SM-2990	10:20	4	10	9	10	<1.0	0.3b	0.17	<0.02	0.02	<0.005
8/25/2009	SM-3062	10:24	3	9.7	7	25	<1.0	0.3	0.14	<0.02	<0.02	<0.005
10/27/2009	SM-3134	10:20	3	9.0	7	2	<1.0	0.3	0.14	<0.02	<0.02	<0.005
2/9/2010	SM-3206	10:10	2	**	7	<1	<1.0	0.4h	0.14	<0.02	0.03	<0.005
7/20/2010	SM-3278	10:14	2	8.2	4	2	<1.0	0.3h	0.11	<0.02	<0.02	<0.005
10/5/2010	SM-3350	10:37	4	8.5	7	17	6.5d	1.4h,j	0.13	<0.02	<0.02	0.009
11/16/2010	SM-3422	10:10	4	8.7	5	2	<1.0	0.3h	0.15	<0.02	<0.02	<0.005

Table 15 MassDEP SMART 2005-2010. Station CBG. Chemistry Data.

Date	OWMID	Time	Alkalinity	Hardness	Chloride	E_coli	Ssolids	Turb	TN	NH3-N	NO3-NO2-N	TPhos
		(24hr)	(mg/l)	(mg/l)	(mg/l)	(MPN/100ml)	(mg/l)	(NTU)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
2/16/2005	SM-1148	9:30	<2	11	18	**	1.0	1.0	0.29	0.04	0.10	0.013
4/20/2005	SM-1190	9:41	3	11	19	**	2.0	1.9	0.43	<0.02	<0.02	0.030
6/15/2005	SM-1360	10:46	8	14	21	**	9.1	4.3	0.77	0.04	0.07	0.060
8/23/2005	SM-1442	9:35	5	14	23	**	2.0	3.0	0.37	<0.02	0.04	0.034
10/19/2005	SM-1512	9:50	**	12	17	**	3.7	2.4	0.39	0.03	<0.02	0.025
1/18/2006	SM-1582	9:15	2	9.5	16	**	<1.0	0.6h	0.23	<0.02	0.08	0.011h
3/15/2006	SM-1652	9:35	4	8.8	14	**	<1.0	1.0	0.26	<0.02	0.06	0.014
5/16/2006	SM-1722	9:30	<2	7.7	12	**	2.1	##h	0.32	<0.02	<0.02	0.018
7/11/2006	SM-1780	9:35	4	11	16	**	4.3	2.9h	0.55	0.05	0.07	0.044
10/4/2006	SM-1872	9:35	4	11	14	**	2.0	1.7h	0.38	<0.02	<0.02	0.024
11/7/2006	SM-1932	9:15	3	11	21	**	<1.0	1.1h	0.28	<0.02	<0.02	0.014
3/13/2007	SM-2002	9:30	5	12	15	**	1.3	1.2h	0.41	0.09	0.17	0.012
4/17/2007	SM-2072	9:55	<2	6.3	9	**	2.7	1.3h	0.23	<0.02	0.02	0.014
6/12/2007	SM-2142	9:30	5	10	14	**	3.0	2.3h	0.40	0.05	0.06	0.028
8/28/2007	SM-2212	9:15	6	13	21	50	1.5	2.4h	0.31	<0.02	0.03	0.025
10/16/2007	SM-2282	9:58	6	13	16	53	2.6	2.5h	0.42	<0.02	<0.02	0.031
1/23/2008	SM-2352	9:15	4	15	22	4	<1.0	0.6h	0.27	<0.02	0.05	0.008
3/25/2008	SM-2422	9:30	20	9.6	16	3	<1.0d	0.6h	0.15	<0.02	<0.02	0.006
5/20/2008	SM-2492	10:08	13	11	18	##h	1.8	1.6h	0.30	<0.02	<0.02	0.020
6/16/2008	SM-2538	9:25	6	15	24	32	2.3	2.8h	0.44	0.03	0.03	0.031
7/22/2008	SM-2598	9:25	**	14	18	172	2.9d	**	0.49	0.02	0.04	0.032
8/18/2008	SM-2644	9:10	**	12	13	45	2.0h	2.7	0.40	<0.02	<0.02	0.024
9/23/2008	SM-2704	9:10	4	12	17	41	1.3	1.8h	0.32	0.02	<0.02	0.021
11/18/2008	SM-2774	9:30	<2	11	14	21	1.4	1.4h	0.28	<0.02	<0.02	0.015
2/23/2009	SM-2844	9:40	2	13	23	6	<1.0	0.6	0.24	0.02	0.06	0.008
4/28/2009	SM-2916	8:58	4	13	20	23	<1.0d	1.2	0.30	<0.02	<0.02	0.018
6/23/2009	SM-2988	9:07	4	11	15	65	2.5	1.6b	0.40	0.02	<0.02	0.025
8/25/2009	SM-3060	9:05	5	12	13	138	3.5	3.0	0.53	0.03	0.03	0.039
10/27/2009	SM-3132	9:10	7	13	16	73	1.6	1.8	0.37	<0.02	0.03	0.023
2/9/2010	SM-3204	9:00	3	**	22	4	1.0	0.9h	0.32	0.05	0.10	0.011
7/20/2010	SM-3276	8:59	5	14	15	57	3.1	3.2h	0.50	0.02	<0.02	0.034
10/5/2010	SM-3348	9:35	5	16	18	**	3.8d	2.4h,j	0.49	<0.02	<0.02	0.026
11/16/2010	SM-3420	8:59	3	14	17	17	1.7	1.4h	0.27	<0.02	<0.02	0.011

Table 16 MassDEP SMART 2005-2010. Station WA09A. Chemistry Data.

Date	OWMID	Time	Alkalinity	Hardness	Chloride	E_coli	Ssolids	Turb	TN	NH3-N	NO3-NO2-N	TPhos
		(24hr)	(mg/l)	(mg/l)	(mg/l)	(MPN/100ml)	(mg/l)	(NTU)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
2/16/2005	SM-1150	11:00	5	16	21	**	2.9	2.4	0.58	0.08	0.31	0.027
4/20/2005	SM-1192	11:12	4	13	19	**	2.4	1.6	0.37	<0.02	0.05	0.025
6/15/2005	SM-1364	11:15	10	18	21	**	3.6d	2.8	0.73	<0.02d	0.28	0.057
8/23/2005	SM-1446	11:10	13	26	33	**	<1.0	1.3	0.81	<0.02	0.53	0.031
10/19/2005	SM-1516	11:15	5	15	13	**	3.7	2.2	0.52	<0.02	0.14	0.035
1/18/2006	SM-1586	10:40	4	13	27	**	3.9d	2.6h	0.41	0.06	0.19	0.018h
3/15/2006	SM-1656	11:00	6	14	18	**	2.5	1.8	0.56	0.10	0.27	0.030d
5/16/2006	SM-1726	11:00	3	13	16	**	4.0	##d,h	0.49	0.06	0.10	0.037
7/11/2006	SM-1784	11:05	8	17	19	**	1.7	2.5h	0.74	0.06	0.28	0.055
10/4/2006	SM-1876	11:05	11	21	23	**	1.1	1.5	0.58	0.04	0.27	0.030
11/7/2006	SM-1936	10:45	6	15	21	**	1.7	1.5h	0.47	0.05	0.16	0.022
3/13/2007	SM-2006	11:05	6	14	17	**	4.5	3.2h	0.75	0.19	0.34	0.043
4/17/2007	SM-2076	11:15	3	8.8	11	**	13	4.0h	0.46	0.04d	0.15	0.048
6/12/2007	SM-2146	11:00	8	16	17	**	5.6	2.5h	0.62	0.06	0.22	0.053
8/28/2007	SM-2216	10:50	12	26	28	118	<1.0	1.0h	0.69	<0.02	0.42	0.025
10/16/2007	SM-2286	11:30	15	30	25	86	<1.0	1.6h	0.85	0.02	0.56	0.033
1/23/2008	SM-2356	10:58	5	18	22	74	1.7	1.0h	0.46	0.02	0.24	0.016
3/25/2008	SM-2426	11:15	3	12	17	1050d	##d	0.7h	0.30	0.02	0.12	0.012
5/20/2008	SM-2496	12:05	5d	17	20	##h	2.5d	1.6	0.45	<0.02	0.14	0.031
6/16/2008	SM-2542	11:05	8	21	24	387	1.7	2.1h	0.63	0.04	0.29	0.040
7/22/2008	SM-2602	11:20	**	24	23	118	##d	**	0.52	0.04d	0.22	0.030
8/18/2008	SM-2648	10:55	**	18	18	78	1.6d	2.2	0.47	<0.02	0.15	0.027
9/23/2008	SM-2708	10:50	9	21	20	219	2.3d	1.9h	0.47	<0.02	0.23	0.025
11/18/2008	SM-2778	11:17	6	16	15	236	2.1	1.9h	0.41	0.03	0.11	0.024
2/23/2009	SM-2848	11:30	5	19	28	144	1.2	1.2	0.56	0.09	0.35	0.018
4/28/2009	SM-2920	10:35	6	18	23	84	##d	1.2	0.36	<0.02	0.13	0.022
6/23/2009	SM-2992	12:45	7	15	18	105	3.9	2.2b	0.52	0.04	0.14	0.036
8/25/2009	SM-3064	10:55	9	19	17	150	1.6	2.3	0.54	<0.02	0.16	0.041
10/27/2009	SM-3136	10:50	4	17	19	156	2.5	2.4	0.47	<0.02	0.12	0.031
2/9/2010	SM-3208	10:50	4	**	22	78	1.4	1.4	0.58	0.12	0.30	0.022
7/20/2010	SM-3280	10:45	10	21	23	140	<1.0	2.4h	0.56	0.02	0.21	0.034
10/5/2010	SM-3352	11:13	7	21	21	104	##d	2.2j	0.50	0.02	0.20	0.030
11/16/2010	SM-3424	10:40	5	19	16	411	1.6d	1.5h	0.48	<0.02	0.22	0.017

Table 17 MassDEP SMART 2005-2010. Station SMG. Chemistry Data.

Date	OWMID	Time	Alkalinity	Hardness	Chloride	E_coli	Ssolids	Turb	TN	NH3-N	NO3-NO2-N	TPhos
		(24hr)	(mg/l)	(mg/l)	(mg/l)	(MPN/100ml)	(mg/l)	(NTU)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
2/16/2005	SM-1147	8:45	5	14	10	**	1.0	1.1	0.39	0.03	0.22	0.012
4/20/2005	SM-1189	9:00	12	16	13	**	1.2	1.3	0.30	<0.02	0.06	0.015
6/15/2005	SM-1358	9:05	11	17	13	**	2.9	4.4	0.54	0.03	0.08	0.026
8/23/2005	SM-1440	8:45	12	25	14	**	5.0	2.1	0.43	<0.02	0.18	0.023
10/19/2005	SM-1510	8:55	4	13	12	**	<1.0	0.9	0.25	<0.02	0.03	0.011
1/18/2006	SM-1580	8:30	4	13	12	**	1.1	0.7h	0.27	<0.02	0.17	0.007h
3/15/2006	SM-1650	8:50	6m	12m	11m	**	1.6m	1.2m	0.32m	<0.02m	0.15m	0.012m
5/16/2006	SM-1720	8:35	5	14	12	**	2.3	##h	0.23	<0.02	0.02	0.012
7/11/2006	SM-1778	8:45	9	15	11	**	10	2.5h	0.50	0.03	0.11	0.034
10/4/2006	SM-1870	8:35	10	22	13	**	<1.0	1.3h	0.36	<0.02	0.16	0.013
11/7/2006	SM-1930	8:35	7	15	13	**	1.0	1.0h	0.28	<0.02	0.08	0.010
3/13/2007	SM-2000	8:45	7	14	11	**	2.1	1.8h	0.49	0.07	0.26	0.016
4/17/2007	SM-2070	9:05	2	10	11	**	3.8	1.7h	0.31	<0.02	0.14	0.014
6/12/2007	SM-2140	8:30	9	15	11	**	5.3	2.9h	0.53	0.07	0.13	0.031
8/28/2007	SM-2210	8:25	9	30	14	32	<1.0h	1.0h	0.29	<0.02	0.15	0.008
10/16/2007	SM-2280	9:15	11	31	13	39	<1.0	0.7h	0.28	<0.02	0.15	0.005
1/23/2008	SM-2350	8:30	6	16	16	25	<1.0	0.5h	0.33	<0.02	0.18	0.005
3/25/2008	SM-2420	8:45	4	13	13	4	<1.0d	0.6h	0.24	<0.02	0.10	0.005
5/20/2008	SM-2490	9:20	4	15	15	##h	<1.0	1.1h	0.26	<0.02	<0.02	0.012
6/16/2008	SM-2536	8:35	7	20	13	120	2.4	2.1h	0.40	0.02	0.08	0.020
7/22/2008	SM-2596	8:35	**	22	11	770	**	**	0.67	0.04	0.09	0.077
8/18/2008	SM-2642	8:20	**	19	9	26	2.3h	2.6	0.38	0.02	0.07	0.015
9/23/2008	SM-2702	8:30	7	18	12	42	<1.0	1.3h	0.27	<0.02	0.07	0.010
11/18/2008	SM-2772	8:35	6	15	14	15	<1.0	1.0h	0.24	<0.02	<0.02	0.012
2/23/2009	SM-2842	8:40	5	16	15	18	<1.0	0.7	0.32	0.02	0.18	0.006
4/28/2009	SM-2914	8:15	8	18	15	24	4.6d	1.7	0.32	0.02	0.07	0.017
6/23/2009	SM-2986	8:27	6	17	15	46	4.2	2.4b	0.35	0.05	0.07	0.021
8/25/2009	SM-3058	8:20	7	17	13	88	3.0	2.5	0.39	<0.02	0.03	0.023
10/27/2009	SM-3130	8:25	7	18	14	49	4.9	1.6	0.26	<0.02	0.04	0.012
2/9/2010	SM-3202	**	**	**	**	**	**	**	**	**	**	**
7/20/2010	SM-3274	8:15	8	26	15	62	1.1	2.6h	0.41	<0.02	0.16	0.016
10/5/2010	SM-3346	8:50	7	21	15	50	1.5d	1.4h,j	0.32	<0.02	<0.02	0.013
11/16/2010	SM-3418	8:10	4	21	14	7	<1.0	0.9h	0.24	<0.02	0.05	0.007

Table 18 MassDEP SMART 2005-2010. Station QRG. Chemistry Data.

Date	OWMID	Time	Alkalinity	Hardness	Chloride	E_coli	Ssolids	Turb	TN	NH3-N	NO3-NO2-N	TPhos
		(24hr)	(mg/l)	(mg/l)	(mg/l)	(MPN/100ml)	(mg/l)	(NTU)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
2/16/2005	SM-1152	11:35	6	19	24	**	2.1	2.2	0.59	0.05	0.36	0.033
4/20/2005	SM-1194	11:40	9	17	20	**	3.4	1.9	0.39	<0.02	0.04	0.031
6/15/2005	SM-1367	11:45	11	22	27	**	2.0	2.0	0.66	0.03	0.19	0.061
8/23/2005	SM-1449	11:55	13	24	33	**	<1.0	1.3	0.63	<0.02	0.21	0.091
10/19/2005	SM-1519	11:46	4	14	13	**	4.5	3.5	0.51	<0.02	0.08	0.040
1/18/2006	SM-1589	11:10	6	17	23	**	3.9	2.4	0.49	0.02	0.32	0.024h
3/15/2006	SM-1659	11:35	6	17	18	**	3.5	1.9	0.54	<0.02	0.29	0.031
5/16/2006	SM-1729	11:40	5	19	20	**	11	##h	0.76	0.04	0.10	0.099
7/11/2006	SM-1787	11:40	12	20	19	**	2.6	2.3h	0.58	0.03	0.10	0.060
10/4/2006	SM-1879	11:40	12	22	22	**	1.3	1.6	0.44	<0.02	0.09	0.047
11/7/2006	SM-1939	11:10	8	18	19	**	1.9	1.8	0.43	<0.02	0.10	0.032
3/13/2007	SM-2009	11:40	7	17	17	**	5.1	3.8h	0.82	0.13	0.42	0.043
4/17/2007	SM-2079	11:45	2	11	9	**	11	4.1h	0.51	<0.02	0.23	0.037
6/12/2007	SM-2149	11:25	10	19	17	**	3.0	2.0h	0.45	0.03	0.12	0.044
8/28/2007	SM-2219	11:26	8	24	27	58	<1.0	0.8h	0.51	<0.02	0.21	0.079
10/16/2007	SM-2289	12:10	13	27	25	48	1.1	1.1	0.49	<0.02	0.22	0.079
1/23/2008	SM-2359	11:27	7	25	27	11	2.1	1.4h	0.61	<0.02	0.33	0.022
3/25/2008	SM-2429	11:50	4	16	18	5	2.3d	0.9h	0.35	<0.02	0.16	0.016
5/20/2008	SM-2499	12:30	7	20	20	##h	5.1	2.5	0.44	<0.02	0.04	0.041
6/16/2008	SM-2545	11:45	9	24	21	76	<1.0	1.8h	0.50	0.02	0.12	0.041
7/22/2008	SM-2605	11:53	**	25	13	47	2.4d	**	0.11	0.03	0.04	0.046
8/18/2008	SM-2651	11:25	**	21	16	54	4.3	3.7	0.52	0.02	0.04	0.048
9/23/2008	SM-2711	11:23	9	20	16	45	2.8	1.8h	0.46	0.04	0.07	0.039
11/18/2008	SM-2781	11:50	6	20	16	38	1.9	2.0h	0.43	<0.02	0.12	0.029
2/23/2009	SM-2851	12:05	6	22	25	12	1.9	1.6	0.56	0.06	0.33	0.020
4/28/2009	SM-2923	11:01	10	19	19	49	3.3d	1.4	0.36	<0.02	0.08	0.029
6/23/2009	SM-2995	11:15	10	22	20	172	2.9	<0.10b	0.48	0.03	0.08	0.039
8/25/2009	SM-3067	11:32	12	22	17	93	2.6	1.9	0.51	<0.02	0.06	0.050
10/27/2009	SM-3139	11:18	6	20	20	44	1.1	2.1	0.41	<0.02	0.07	0.032
2/9/2010	SM-3211	11:25	6	**	23	36	3.2	2.0	0.60	0.05	0.34	0.027
7/20/2010	SM-3283	11:20	11	24	25	68	2.3	1.9	0.43	<0.02	0.07	0.048
10/5/2010	SM-3355	11:47	9	27	23	64	2.0d	2.0j	0.63	<0.02	0.18	0.033
11/16/2010	SM-3427	11:12	8	26	23	18	1.6	1.6	0.36	<0.02	0.03	0.025

REFERENCES

Beaudoin, T. 2008 (unpublished). *CN 012.1: Strategic Monitoring and Assessment for River basin Teams Quality Assurance Project Plan. 2008-2012.* Commonwealth of Massachusetts. MassDEP. CEntral Regional Office. Worcester, MA.

EOEA. 2012 [online]. *Chicopee River Basin. Five-Year Watershed Action Plan. 2005-2010.* June 2005. Massachusetts Executive Office of Environmental Affairs. Retrieved July 10, 2012. Available at http://www.mass.gov/eea/docs/eea/water/wap-chicopee-river.pdfhttp:/www.mass.gov/Eoeea/docs/eea/water/wap_chicopee_river.pdf

Google Earth. 2012a. "SRG". 42°16'4.59"N and 72°19'58.39"W. Imagery March 29, 2012. Retrieved July 10, 2012.

Google Earth. 2012b. "WA09A". 42°14'19.83"N and 72°17'9.88"W. Imagery March 29, 2012. Retrieved July 10, 2012.

Google Earth. 2011c. "CBG". 42°23'28.73"N and 72° 3'52.34"W. Imagery September 20, 2010. Retrieved July 10, 2012.

Google Earth. 2011d. "SMG". 42°15'53.23"N and 72° 0'17.42"W. Imagery September 20, 2010. Retrieved July 10, 2012.

Google Earth. 2011e. "QRG". 42°10'53.35"N and 72°15'48.53"W. Imagery September 20, 2010. Retrieved July 10, 2012.

Lee, Y. 2011 [online]. *Water Quality Report: 2010. Quabbin Reservoir Watershed. Ware River Watershed.* Commonwealth of Massachusetts. Department of Conservation and Recreation (MADCR). Office of Watershed Management. Division of Water Supply. Belchertown, MA. Retrieved October 24, 2011. Available at http://www.mass.gov/eea/docs/dcr/watersupply/watershed/2010quabbinwqreport.pdf

MassDEP. 2005. *CN 56.2. Standard Operating Procedure. Data Validation and Usability.* Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA.

MassDEP. 1999a. *CN 4.0 Water Quality Multi-probe Instrument Use, Standard Operating Procedure.* Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA.

MassDEP. 1999b. *Grab Collection Techniques for DWM Water Quality Sampling, Standard Operating Procedure.* Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA.

MassGIS. 2013 [online]. *Natural Heritage and Endangered Species Program. Priority Habitats of Rare Species.* Commonwealth of Massachusetts. Executive Office of Administration and Finance. Geographic Information Systems. Retrieved December 11, 2013. Available at http://www.mass.gov/anf/research-and-tech/it-serv-and-support/application-serv/office-of-geographic-information-massgis/datalayers/prihab.html

MassDFG. 2015 [online]. *Coldwater Fish Resources List.* French and Quinebaug Watersheds. Massachusetts Department of Fish and Game, Division of Fisheries and Wildlife. Westborough, MA. Retrieved August 11, 2015. Available at http://www.mass.gov/eea/agencies/dfg/dfw/wildlife-habitat-conservation/coldwater-fish-resources-list.html

NOAA. 2015 [online]. *Climatological Data Publications. Massachusetts.* U. S. Dept. of Commerce. NOAA Satellite and Information Service. National Climatic Data Center. Image and Publications System. Retrieved August 4, 2015. Available at http://www.ncdc.noaa.gov/IPS/cd/cd.html;jsessionid=1CB121D95499F2E6677D736184136915?_page=0&jsessionid=1CB121D95499F2E6677D736184136915&state=MA&_target1=Next+%3E

Ostiguy, Lance J., Weiskel, Peter K. and Stacey A. Archfield. 2010 [Online]. *Average Annual Precipitation, in Inches, for Massachusetts as Computed over the Period 1971-2000 Using the Parameter-Elevation Regressions on Independent Slopes (PRISM) Model. Appendix 1, Figure 1-2.* October 18, 2011. Available at http://pubs.usgs.gov/sir/2009/5227/pdf/Appendix/sir2009-5227_appendix1_fig2.pdf

Reardon, Matthew. 2012 [online]. *Chicopee River Basin. 2003 Water Quality Assessment Report*. Report Number 36-AC-3. DWM Control Number 106.5. October 2008. Commonwealth of Massachusetts. MassDEP. Division of Watershed Management. Worcester, MA. 10 July 2012. Available at http://www.mass.gov/dep/water/resources/36wqar03.pdfhttp:/www.mass.gov/dep/water/resources/wqassess.htm

USACE. 2013 [online]. *Barre Falls Dam. Hubbardston Massachusetts.* United States Army Corps of Engineers. Hubbardston, MA. December 11, 2013. Available at http://www.nae.usace.army.mil/Missions/Recreation/BarreFallsDam.aspx

USGS. 2013 [online]. *National Water Information System: Web Interface. Current Conditions for Massachusetts: Streamflow. 150 site(s) found.* United States Geological Survey. December 11, 2013. Available at http://waterdata.usgs.gov/ma/nwis/current/?type=flow

USGS. 2011a [online]. Discharge and gage height at the USGS Swift River at West Ware, MA (USGS station number 01175500) from October 1, 1912 to current year. 29 December 2011. Available at http://waterdata.usgs.gov/ma/nwis/uv/?site_no=01175500&PARAmeter_cd=00065,00060

USGS. 2011b [online]. Discharge and gage height at the Ware River near Barre, MA (USGS station number 01172500) from July 27, 1946 to current year. 29 October 2011. Available at http://waterdata.usgs.gov/ma/nwis/dv/?site_no=01172500&PARAmeter_cd=00060,00065

USGS. 2011c [online]. Discharge and gage height at the Ware River at Gibbs Crossing, MA (USGS station number 01173500) from August 20, 1912 to current year. 29 December 2011. Available at http://waterdata.usgs.gov/ma/nwis/dv/?site_no=01173500&PARAmeter_cd=00060,00065

USGS. 2011d [online]. Discharge and gage height at the Sevenmile River near Spencer, MA (USGS station number 01175670) from December 1, 1960 to current year. 29 December 2011. Available at http://waterdata.usgs.gov/ma/nwis/dv/?site_no=01175670&PARAmeter_cd=00060,00065

USGS. 2011e [online]. Discharge and gage height at the Quaboag River at West Brimfield, MA (USGS station number 01176000) from August 19, 1912 to current year. 29 December 2011. Available at http://waterdata.usgs.gov/ma/nwis/dv/?site_no=01176000&PARAmeter_cd=00060,00065

USGS. 2011f [online]. *USGS Surface-Water Daily Statistics for Massachusetts*. USGS Ware River at Gibbs Crossing, MA (USGS station number 01173500) Mean of daily mean values for each day for 79 - 80 years of record in cfs (Calculation Period 1930-10-01 -> 2010-09-30). 29 December 2011. Available at http://waterdata.usgs.gov/ma/nwis/dvstat/?referred_module=sw&site_no=01173500&por_01173500_1=1269242,00060,1,1912-08-20,2009-11-24&format=html_table&stat_cds=mean_va&date_format=YYYY-MM-DD&rdb_compression=file&submitted_form=parameter_selection_list

USGS. 2011g [online]. *USGS Surface-Water Monthly Statistics for Massachusetts*. USGS Ware River at Gibbs Crossing, MA. (USGS station number 01173500). Monthly mean in cfs (Calculation Period: 1930-10-01 -> 2009-10-31). 29 December 2011. Available at http://waterdata.usgs.gov/ma/nwis/monthly/?referred_module=sw&site_no=01173500&por_01173500_1=1269242,00060,1,1912-08,2012-01&format=html_table&date_format=YYYY-MM-DD&rdb_compression=file&submitted_form=parameter_selection_list

Wandle. 1984 [online]. *Gazetteer of Hydrologic Characteristics of Streams In Massachusetts – Connecticut River Basin.* USGS Water-Resources Investigations Report 84-4282. Prepared in cooperation with the Commonwealth of Massachusetts Department of Environmental Quality Engineering Division of Water Pollution Control. Boston, MA. 1984. Retrieved 27 July 2015. Available at http://pubs.usgs.gov/wri/1984/4282/report.pdf