CHICOPEE RIVER WATERSHED
SMART MONITORING PROGRAM 2011-2013
TECHNICAL MEMORANDUM CN 414.0

Swift River, Ware/Belchertown

Prepared By:
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Commonwealth of Massachusetts
Executive Office of Energy and Environmental Affairs
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Cover photo by Therese Beaudoin, MassDEP. July 24, 2012
All photos in document taken by Therese Beaudoin. MassDEP. CERO.
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
Anas platyrhynchos	mallard duck	*Lythrum salicaria*	purple loosestrife
Branta canadensis	Canada goose	*Neovison vison*	American mink
Brasenia schreberi	watershield	*Peltandra virginica*	arrow arum
Callitriche sp.	water starwort	Picidae family	woodpeckers
Carex sp.	sedge	*Poecile* sp.	chickadee
Cathartes aura	turkey vulture	*Pontedaria cordata*	pickerelweed
Chrysemys picta	painted turtle	*Potamogeton* sp.	pondweed
Culicidae family	mosquitoes	*Potamogeton crispus*	curly-leaf pondweed
Decodon verticillatus	swamp loosestrife	*Potamogeton epihydrus*	ribbonleaf pondweed
Elodea canadensis	waterweed	*Sagittaria* sp.	arrowhead
Gerridae family	water striders	Simuliidae family	blackflies
Gramineae family	true grasses	*Symplocarpus foetidus*	skunk cabbage
Isoetes sp.	quillwort	Unionidae family	freshwater mussels
Leersia oryzoides	rice cutgrass	*Vallisneria* sp.	eelgrass/tape grass
Lithobates catesbeianus	American bullfrog	*Zonotrichia albicollis*	white-throated sparrow
Lobelia cardinalis	cardinal flower		

LIST OF ACRONYMS

% sat	percent oxygen saturation
305(b)	Section 305(b), federal Clean Water Act 1972
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
EOEA	Executive Office of Environmental Affairs
ºF	degree Fahrenheit
ft	feet
in.	inch
m	meter
MA	Massachusetts
MassDCR	Massachusetts Department of Conservation and Recreation
MassDEP	Massachusetts Department of Environmental Protection
MassDFG	Massachusetts Department of Fish and Game
MDL	method detection limit
µS/cm	microsiemens per centimeter
MGD	million gallons per day
mg/L	milligrams per liter
mi	mile
mi^2	square mile
MWRA	Massachusetts Water Resources Authority
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 2011-2013 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 2011-2013 is presented in Table 1; the location of sampling stations is presented in Figure 1. Sampling components at all stations included *in situ* measurements, physical/chemical and nutrient sampling, flow measurements (at existing United States Geological Survey, or USGS, gaging stations), and general field observations. 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.

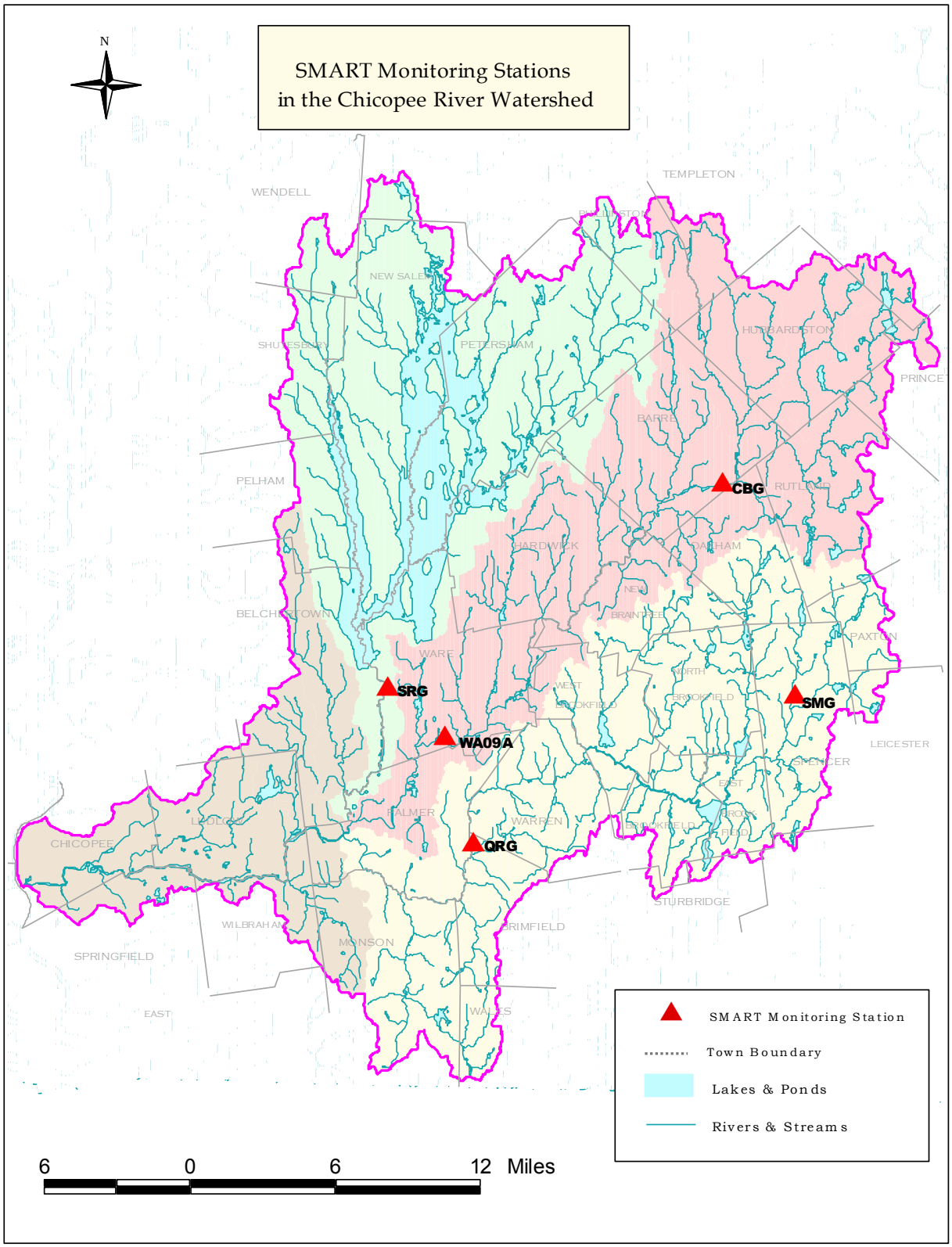
Table 1 Chicopee Basin SMART Sampling Summary – 2011 through 2013

Location and Segment Numbers	Station Name	Station Type	Dates Sampled[1]
Swift River @ USGS flow gaging station, River Road, Ware MA36-09	SRG	Reference	2011: 3/22/11, 4/26/11, 6/21/11, 8/30/11, 10/25/11 2012: 1/24/12, 3/27/12, 5/23/12, 7/24/12, 9/25/12, 11/13/12 2013: 2/26/13, 4/23/13
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

Figure 1 SMART Monitoring Stations in the Chicopee River Watershed



Chicopee River Watershed, see Chicopee River Watershed Water Quality Assessment Report (Reardon 2008) and Chicopee Watershed Assessment Plan (EOEA 2005).

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 (MassDCR) 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 2013 (MassDCR 2014). 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 June 21, 2011

The Ware River watershed drains 218 mi^2 in the central part of the Chicopee basin. The East and West branches converge in Barre, just 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 2015). 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 Prince River and the West Branch of the Ware 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 (MassDCR 2014).

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 (2015a, 2015b, 2015c, 2015d, 2015e) at a height of approximately 4,000 feet (ft).

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 (2015a, 2015b, 2015c, 2015d, 2015e) 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] of the federal Clean Water Act) 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 2011-2013. 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.

Each station selected for the SMART Monitoring program is described according to key characteristics associated with water quality at that location, as follows:

- Reference conditions: a stream segment that is minimally influenced by anthropogenic activities;
- Impact: a stream location where several sources of pollution come together and can be used to calibrate a mass balance model, or where critical reactions take place such as at an oxygen sag point; and
- Boundary: at a pour point i.e., where water leaves a designated river basin at a confluence with another stream, or at a state line.

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

[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.

project coordinator, as identified in the QAPP for the SMART program (CN 012.2), reviews the data for reasonableness, completeness and acceptability (Beaudoin 2008).

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 (8/30/2011)

Station SRG is located on the Swift River in Ware, MA in the Lower Worcester Plateau ecoregion. From 2011-2013, the station was sampled 12 times. Access was from the eastern shore at the USGS flow gaging station off River Road. Samples were collected by wading to flowing water or with a sampling pole. Station SRG is a reference station, minimally influenced by anthropogenic activities.

Land uses near this station included protected water supply watershed, forest, rural residential, and roadways (Figure 3; Google Earth 2012a). 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 2015). The water at this station originates largely 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 2013, water was directed from there to the Wachusett Reservoir on 230 days, with an average of approximately 212.64 million gallons per day (MGD); an additional 8.25 MGD (approximate) was directed to three local communities via the Chicopee Valley Aqueduct (MassDCR 2014). No municipal National Pollutant Discharge Elimination System (NPDES) discharges are located upstream (design flow greater than 1 MGD).

At Station SRG, the river is approximately 25 feet (ft) wide and typically 2 to 4 ft deep (Figure 4), with undercut banks. As water quality in this segment reflects the conditions at the bottom (hypolimnetic) of Quabbin Reservoir, water temperature was typically cooler than other watershed stations in the summer and warmer in the winter. The water level at Station SRG reflected operations at Quabbin Reservoir's Winsor Dam, and was frequently out of sync with the rest of the watershed e.g., a high water level at SRG in the absence of recent precipitation/snowmelt concurrent with low levels at the other four SMART stations.

Deciduous and evergreen trees provided shade along the banks; although the canopy did not extend over the channel, the river corridor was mostly shaded during monitoring events (see Figure 5); see Table 2 for a summary of field observations at Station SRG. The bottom consisted mainly of cobble, gravel and sand, as well as a few boulders; traces of silt were occasionally noted. Aquatic macrophytes observed at Station SRG ranged from none to dense, and were typically sparse; plants included nearly year-round beds of water starwort (*Callitriche* sp.), as well as occasional patches of tape grass (*Vallisneria* sp.). Periphyton was noted on most events, and typically consisted of sparse to dense moss; a very dense layer of light green algal film was observed on 5/23/2012. Riverine and terrestrial wildlife observations included songbirds, mosquitoes (Culicidae family), blackflies (Simuliidae family) and a single large fish (6/21/2011). This section of the river is open to catch-and-release fishing, and fishermen were observed on numerous dates.

The water column was clear on all events, with no visible turbidity. Trash, color, odor, foams and sheens were absent.

Figure 5 Station SRG Water column at sampling location 11/13/2012

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

Figure 6 Google Earth view of Station CBG area

Figure 7 Station CBG upstream (8/30/2011)

Station CBG is located on the Ware River in Barre, MA within the Lower Worcester Plateau ecoregion. From 2011-2013, the station was sampled 13 times. Access was from the northern shore of the Ware River upstream of the pedestrian bridge at the USGS flow gaging station above Powdermill Pond on State Road (SR) 122. Samples were collected from shore manually or with a sampling pole. Station CBG serves as a reference station, minimally influenced by anthropogenic activities.

Upstream land uses included forest, rural residential, and roadways, with most of the upstream area protected for water supply (Figure 6; Google Earth 2011a). 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 2015). The Ware River Intake operated by the Massachusetts Water Resources Authority (MWRA), is located approximately 0.4 miles upstream; water is diverted from that point to the Quabbin Reservoir and/or Wachusett Reservoir for water supply. There are no upstream NPDES discharges.

The river at this location was a run, approximately 20 ft wide; the depth was generally too deep to wade; see Figure 7. Deciduous and evergreen trees provided shade along the banks, while most of the channel was open to the sky (see Figure 8). Observations of conditions beneath the surface of the water column were unobservable on 6 of 13 monitoring dates due to deep color, dense foam, and surface light reflection. When visible, the stream bed consisted of a cement bottom near the foot bridge. Periphyton was typically visible only near the water surface, and consisted mainly of moss (7of 13 events). Cardinal flowers (*Lobelia cardinalis*) were observed along the upstream channel on 8/30/2011; tape grass (*Vallisneria* sp.) was the only other macrophyte noted in this area. Wildlife and insect observations recorded at this station include songbirds, as well as rabbit and dog tracks in the snow on the banks and the pedestrian bridge. Fishermen were observed on 5/27/2012.

When visible, the water column ranged from clear (3) to highly turbid (2). Water color was typically red and/or brown (n=12), and clear on one event (3/22/2011). The river here usually lacked odor (n=12), with musty noted on 5/23/2012. Foam was always present, ranging from sparse to dense. Trash was unobservable on 10 events; when observable, trash was absent.

Figure 8 Station CBG Water column at sampling location 6/21/2011

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

Figure 9 Google Earth view of Station WA09A area

Figure 10 Station WA09A upstream (9/25/2012)

Station WA09A is located on the Ware River in Ware, MA within the Lower Worcester Plateau ecoregion. The station was sampled 13 times from 2011-2013, 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 9; Google Earth 2012b). 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 2015). There are no large water withdrawals within 5 river miles upstream. The Ware Wastewater Treatment Plant (WWTP), a major municipal NPDES discharger, is located 2.6 mi upstream.

The river was a run in this area; the channel was approximately 90 ft wide and 1 to 3+ feet deep (Figure 10). Hurricane Irene caused flooding across the state on 8/28/2011; flattened vegetation on the banks reflected recent inundation on 8/30/2011. The streambed was typically shaded along the shores. Banks were undercut throughout the site area. The bottom consisted mainly of boulder, cobble, gravel and sand; silt was also noted on 4 events. When observable, periphyton was often present, and included moss, algal films and filamentous algae (sometimes very dense; see Figure 11 below). Aquatic macrophytes included watershield (*Brasenia schreberi*), waterweed (*Elodea canadensis*), grasses (Graminae family), quillwort (*Isoetes* sp.), pickerelweed *(Pontedaria cordata*), pondweed (*Potamogeton* sp.), curly-leaf pondweed (*P. crispus*), ribbonleaf pondweed (*P. epihydrus*) and skunk cabbage *(Symplocarpus foetidus*). Wildlife, insects and aquatic organisms observed at Station WA09A include American mink (*Neovison vison),* mosquitoes (Culicidae family), water striders (Gerridae family), freshwater mussels (Unionidae family), and minnows.

The water column at this station was typically clear; slight turbidity was noted on 3 events (n=13). Water color was typically red; other colors noted included light yellow and clear. Foam was present on most events, and ranged from very sparse to moderate. The water column lacked odors and sheens throughout this time period. Minor quantities of trash were noted on half of the sampling dates, and included metals, wooden planks/ties, broken glass, bucket, plastic chair, bright green ribbon and floatables. Canoeists were observed in this reach on 10/25/2011.

Figure 11 Station WA09A Water column at sampling location 9/25/2012

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

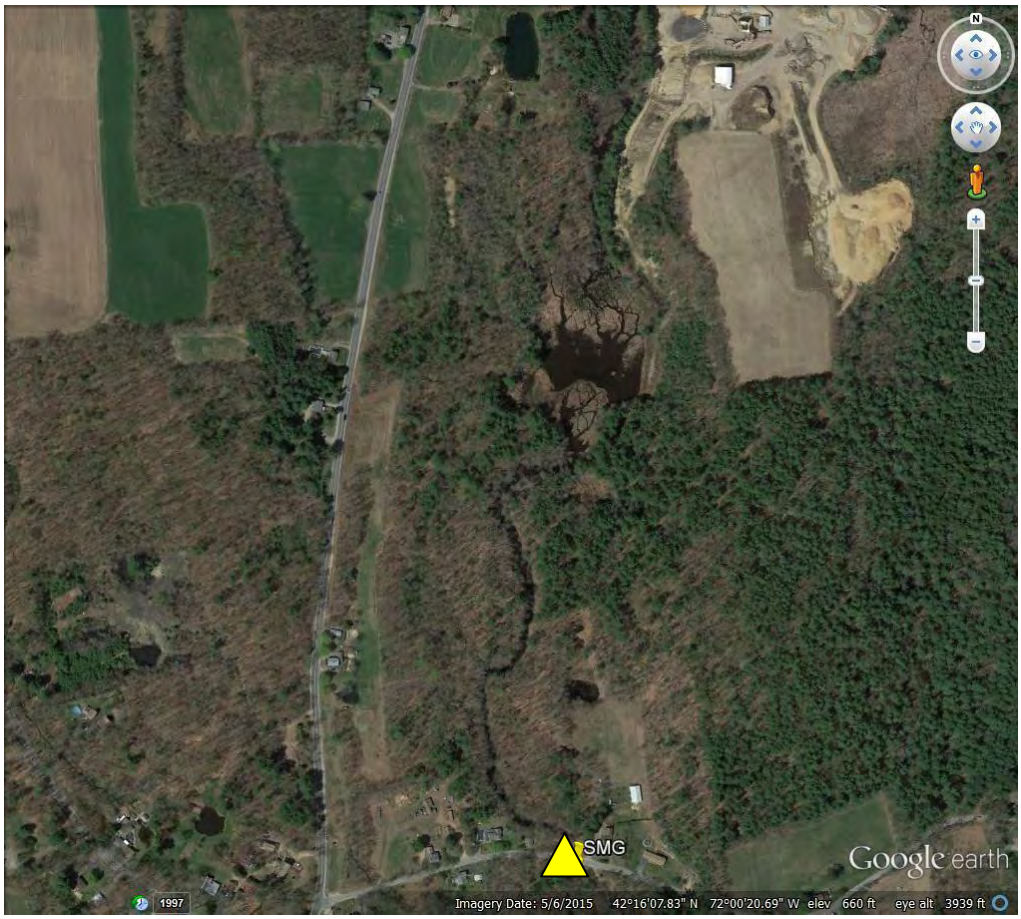


Figure 12 Google Earth view of Station SMG area

Figure 13 Station SMG upstream (7/24/2012)

Station SMG is located on the Sevenmile River in Spencer, MA within the Lower Worcester Plateau ecoregion. From 2011-2013, the station was sampled 13 times, and access was from the eastern shore at the USGS flow gaging station downstream of the Cooney Road Bridge by wading to flowing water or with a sampling pole. Station SMG serves as a reference station, minimally impacted by anthropogenic activities.

Land uses near and upstream of this station included forest, rural residential, agriculture, and sand/gravel operations (Figure 12; Google Earth 2011a). 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 2015). 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 river is a run in this reach, approximately 20 ft wide and 1 ft deep (Figure 13). Trees provided shade over most of the upstream corridor, but the area around the Cooney Road Bridge was open to the sky. The bottom consisted mainly of cobble, gravel and sand, with a few boulders; silt was noted on more than half of the monitoring dates (Figure 14). Periphyton ranged from sparse to very dense on most events, and included moss, filamentous algae, and algal films. Few aquatic macrophytes were observed within the stream channel; these included sedges (*Carex* sp.), grasses (Gramineae family) and cardinal flower (*Lobelia cardinalis*). Wildlife, insects and birds observed at Station SMG in this time period included Canada goose (*Branta canadensis*), mosquitoes (family Culicidae) and unidentified fish and frogs. Songbirds included chickadee (*Poecile* sp.) and white-throated sparrow (*Zonotrichia albicollis)*.

The water column noted at this station was clear on most sampling events, and slightly turbid on two. Water color was typically clear; red, light yellow and milky were also noted. The river lacked an odor on most events, with one observation each of “eutrophic pond” and musty. Very sparse to sparse foam was noted on every sampling date; sheens and trash were absent in this area during this time period.

Figure 14 Station SMG Water column at sampling location 7/24/2012

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

Figure 15 Google Earth view of Station QRG area

Figure 16 Station QRG upstream (7/24/2012)

Station QRG is located on the Quaboag River in Palmer, MA within the Lower Worcester Plateau ecoregion. From 2011-2013, the station was sampled 13 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 included forest, residential, commercial, sand and gravel operations, railways and roadways (Figure 15; Google Earth 2011c). The nearest upstream municipal NPDES discharge is approximately 2.5 mi upstream in West Warren. There are no large water withdrawals near Station QRG.

The river was a run in this area, approximately 100 ft wide and 1 to 3+ feet deep (Figure 16). The railroad corridor was adjacent to the river upstream. Deciduous trees provided shade along the western and part of the eastern shoreline (Figure 17). The bottom consisted mainly of sand, with boulder, cobble, gravel and silt also present. Aquatic macrophytes observed at this station include sedge (*Carex* sp.), swamp loosestrife (*Decodon verticillatus*), waterweed (*Elodea* sp.), grass (Graminae family), rice cutgrass (*Leersia oryzoides*), cardinal flower (*Lobelia cardinalis*), purple loosestrife (*Lythrum salicaria*), arrow arum (*Peltandra virginica*), pickerelweed (*Pontedaria cordata*), pondweed (*Potamogeton* sp.) and arrowhead (*Sagittaria* sp.). Other observations include mallard duck (*Anas platyrhynchos),* Canada goose (*Branta canadensis*), turkey vulture (*Cathartes aura*), painted turtle (*Chrysemys picta),* mosquitoes (Culicidae family), North American bullfrog (*Lithobates catesbeianus*), woodpecker (Picidae family), blackflies (Simuliidae family), unidentified fish and frogs, and songbirds.

Conditions at this station were unobservable on four sampling dates due to solar reflection. The water column noted at this station was typically clear, red and lacking odor. Sparse foam was present on most events. Trash was present on 5 dates (unobservable on 4), and included tires, beer bottles/cans, unidentifiable items and floatables.

Figure 17 Station QRG Water column at sampling location 6/21/2011

Table 2 MassDEP SMART 2011 - 2013. Station SRG. Summary of Observations.

Survey Dates	Substrate	Trash	Periphyton	Color	Odor	Foam	Sheen	Turbidity	Wet/Dry Conditions
3/22/2011	Cobble/gravel/sand	None	Sparse: moss	Clear	None	None	None	Clear	Wet
4/26/2011	Cobble/gravel/sand	None	Sparse: moss	Clear	None	None	None	Clear	Wet
6/21/2011	Cobble/gravel/sand	None	Dense: moss	Clear	None	None	None	Clear	Dry
8/30/2011	Boulder/cobble/gravel/sand/silt	None	Sparse: moss	Clear	None	None	None	Clear	Wet
10/25/2011	Cobble/gravel/sand	None	Sparse: moss	Clear	None	None	None	Clear	Dry
1/24/2012	Unobservable	None	Unobservable	Clear	None	None	None	Clear	Wet
3/27/2012	Boulder/cobble/gravel/sand	None	None	Clear	None	None	None	Clear	Dry
5/23/2012	Boulder/cobble/gravel/sand/silt	None	Very dense: very light green film; sparse: moss	Clear	None	None	None	Clear	Dry
7/24/2012	Boulder/cobble/gravel/sand	None	Sparse: moss	Clear	None	None	None	Clear	Dry
9/25/2012	Cobble/gravel/sand	None	Moderate: moss	Clear	None	None	None	Clear	Dry
11/13/2012	Boulder/cobble/gravel/sand/silt	None	Sparse: moss	Clear	None	None	None	Clear	Dry
2/26/2013	Station not sampled on this date; not accessible due to steep, icy banks								
4/23/2013	Boulder/cobble/gravel/sand/silt	None	Sparse: moss	Clear	None	None	None	Clear	Dry
-- : Data not available									

Table 3 MassDEP SMART 2011 - 2013. Station CBG. Summary of Observations.

Survey Dates	Substrate	Trash	Periphyton	Color	Odor	Foam	Sheen	Turbidity	Wet/Dry Conditions
3/22/2011	Unobservable	Unobservable	Unobservable	Clear	None	Moderate	None	Unobservable	Wet
4/26/2011	Unobservable	Unobservable	Unobservable; moss, where visible	Slight red	None	Moderate	None	Unobservable	Wet
6/21/2011	Unobservable	Unobservable	Very dense: moss	Red	None	Dense	None	Moderate	Dry
8/30/2011	Cement channel	None	Moderate: moss	Red, tannic	None	Dense	None	Clear	Wet
10/25/2011	Unobservable	Unobservable	Unobservable	Red	None	Moderate	None	Unobservable	Dry
1/24/2012	Unobservable	Unobservable	Unobservable	Red	None	Sparse	None	Unobservable	Wet
3/27/2012	Unobservable	Unobservable	Unobservable	Red	None	Moderate	None	Unobservable	Dry
5/23/2012	Unobservable	Unobservable	Unobservable; very dense moss, where visible	Red, strong	Musty	Dense	None	Slight	Dry
7/24/2012	Concrete channel	None	Dense: moss	Brown/red	None	Dense	None	Highly murky	Dry
9/25/2012	Unobservable	Unobservable	Unobservable; dense moss where visible	Brown/red	None	Moderate	None	Highly murky	Dry
11/13/2012	Unobservable	Unobservable	Unobservable	Red	None	Moderate	None	Unobservable	Dry
2/26/2013	Cement channel	None	None	Red	None	Moderate	None	Clear	Wet
4/23/2013	Unobservable	Unobservable	Dense: moss	Red, slight/light yellow, slight	None	Moderate	None	Clear	Dry

-- : Data not available

Table 4 MassDEP SMART 2011 - 2013. Station WA09A. Summary of Observations.

Survey Dates	Substrate	Trash	Periphyton	Color	Odor	Foam	Sheen	Turbidity	Wet/Dry
3/22/2011	Unobservable	Unobservable	Unobservable	Light yellow	None	Sparse	None	Unobservable	Wet
4/26/2011	Unobservable	Unobservable	Unobservable	Slight red	None	Moderate	None	Clear	Wet
6/21/2011	Boulder/cobble/gravel/sand/silt; embedded	None	Dense: brown silt-covered filamentous	Red	None	Sparse	None	Slight	Dry
8/30/2011	Unobservable	Unobservable	Unobservable	Red, deep	None	Sparse	None	Slight	Wet
10/25/2011	Boulder/cobble/gravel/sand; embedded	None	None	Red	None	Moderate	None	Clear	Dry
1/24/2012	Boulder/cobble/gravel/sand	Minor: broken glass, wooden ties, floatables	None	Red, slight/light yellow	None	Sparse/moderate	None	Clear	Wet
3/27/2012	Boulder/cobble/gravel/sand	Minor: bucket, wooden planks	Very dense: dark green film	Red	None	Moderate	None	Clear	Dry
5/23/2012	Boulder/cobble/gravel/sand; highly embedded	Sparse: metals, plastic chair	Sparse: brown film	Red, strong	None	Sparse	None	Clear	Dry
7/24/2012	Boulder/cobble/gravel/sand/silt	Minor: planks	Sparse: light green filamentous; very dense brown film	Light yellow	None	Very sparse	None	Slight	Dry
9/25/2012	Boulder/cobble/gravel/sand/silt	Minor: planks	Very dense: bright green filamentous; moderate brown film; sparse moss	Clear	None	None	None	Clear	Dry
11/13/2012	Boulder/cobble/gravel/sand/silt	Unobserable; bright green ribbon (?), planks, bricks	Unobservable; sparse moss, where visible	Red, slight/light yellow, slight	None	Moderate	None	Unobservable	Dry
2/26/2013	Unobservable	Unobservable	Unobservable	Clear	None	None	None	Clear	Wet
4/23/2013	Unobservable	Unobservable	Unobservable	Light yellow, slight	None	Sparse	None	Clear	Dry

-- : Data not available

Table 5 MassDEP SMART 2011 - 2013. Station SMG. Summary of Observations.

Survey Dates	Substrate	Trash	Periphyton	Color	Odor	Foam	Sheen	Turbidity	Wet/Dry
3/22/2011	Cobble/gravel/sand	None	None	Clear	None	Very sparse	None	Clear	Wet
4/26/2011	Cobble/gravel/sand	None	Moderate: dark green filamentous	Clear	None	Sparse	None	Clear	Wet
6/21/2011	Cobble/gravel/sand/silt	None	Dense: brown silt-covered filamentous; sparse: moss	Clear	None	Sparse	None	Clear	Dry
8/30/2011	Cobble/gravel/sand	None	None	Clear	None	Sparse	None	Clear	Wet
10/25/2011	Cobble/gravel/sand/silt	None	None	Light grey/milky	None	Sparse	None	Slight	Dry
1/24/2012	Cobble/gravel/sand	None	None	Clear	None	None	None	Clear	Wet
3/27/2012	Cobble/gravel/sand	None	Dense: dark green filamentous	Clear	None	Sparse	None	Clear	Dry
5/23/2012	Boulder/cobble/gravel/sand/silt	None	Sparse: green filamentous; dense: film; sparse: moss	Red	None	Sparse	None	Clear	Dry
7/24/2012	Boulder/cobble/gravel/sand/silt	None	Very dense: brown film	Light yellow/milky	Eutrophic pond	Very sparse	None	Slight	Dry
9/25/2012	Boulder/cobble/gravel/sand/silt	None	Very dense: dark olive film	Clear	None	Very sparse	None	Clear	Dry
11/13/2012	Boulder/cobble/gravel/sand/silt	None	Very dense: green film	Light yellow	Musty, slight	Very sparse	None	Clear	Dry
2/26/2013	Boulder/cobble/gravel/sand/silt	None	Sparse: green film	Clear	None	Very sparse	None	Clear	Wet
4/23/2013	Boulder/cobble/gravel/sand/silt	None	Dense: bright green filamentous	Clear	None	Sparse	None	Clear	Dry

-- : Data not available

Table 6 MassDEP SMART 2011 - 2013. Station QRG. Summary of Observations.

Survey Dates	Substrate	Trash	Periphyton	Color	Odor	Foam	Sheen	Turbidity	Wet/Dry Conditions
3/22/2011	Unobservable	Unobservable	Unobservable	Clear	None	Sparse	None	Unobservable	Wet
4/26/2011	Unobservable	Unobservable	Unobservable	Red, slight	None	Moderate	None	Unobservable	Wet
6/21/2011	Boulder/cobble/gravel/sand/silt	Minor: beer bottle	None	Red	None	Dense	None	Slight	Dry
8/30/2011	Unobservable	Unobservable	Unobservable	Brown/red	None	Dense	None	Moderate	Wet
10/25/2011	Gravel/sand	None	None	Red	None	Sparse	None	Clear	Dry
1/24/2012	Boulder/cobble/gravel/sand/silt	None	Dense: brown film	Light yellow	None	Sparse	None	Slight	Wet
3/27/2012	Boulder/cobble/gravel/sand	None	None	Red	None	Sparse	None	Clear	Dry
5/23/2012	Boulder/cobble/gravel/sand	Minor: beer cans	Very dense: olive green filamentous	Red	None	Sparse	Sparse, manganous	Slight	Dry
7/24/2012	Boulder/cobble/gravel/sand/silt	Minor: tires, unknown pieces	Sparse: dark green filamentous	Light yellow	None	None	None	Clear	Dry
9/25/2012	Boulder/cobble/gravel/sand/silt	None	None	Clear	None	Sparse	None	Clear	Dry
11/13/2012	Unobservable	Unobservable	Unobservable	Red	None	Moderate	None	Unobservable	Dry
2/26/2013	Boulder/cobble/gravel/sand/silt	Minor: plastic bottles	None	Clear	None	None	None	Clear	Wet
4/23/2013	Unobservable	Minor: floatables	None	Clear	None	Sparse	None	Clear	Dry

-- : Data not available

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 New England (NOAA 2015). Precipitation records from the weather station at Belchertown formed the basis of the wet/dry weather determination for all stations from March 2011 through April 2013. 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 data set:

- 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 2015).

The period of record mean streamflow values are the mean of daily mean values for each day for 84-85 years of record (10/1/1930 – 2/4/2015) 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 11 (precipitation) and Table 12 (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, as well as snowfall, snow on the ground, and maximum daily temperature data. Air temperature was recorded in degrees Fahrenheit (ºF).

March 22, 2011 – The Ware River and other local waters were impacted by snowmelt early to mid-March, 2011; water levels above flood stage caused flooding in numerous towns throughout the watershed (Bock 2011). In the 5-day period preceding this event, 0.59 inches (in) of precipitation was recorded at the Belchertown climate station; see Table 7 for climate data for this time period. The maximum daily temperature ranged from 34 to 63ºF. In general, discharge at most of the watershed flow gages decreased from March 19-21, rose slightly mid-day March 21, and returned to pre-storm levels before sampling began. At the Swift River gage, flows varied little from March 15-21, then rose from mid-day March 21 to March 22. Water quality data collected on this date reflect wet weather/runoff conditions. Air temperature ranged from 35 to 40ºF, and cloud cover was overcast throughout monitoring. Trees and shrubs had not yet begun to bud.

Table 7 Climate Conditions at Belchertown, MA from March 17-22, 2011[1]

Parameter	March 17	March 18	March 19	March 20	March 21	March 22
Max Temperature (ºF)[2]	40	61	63	43	46	34
Precipitation (in as water)	0.62	0	0	0	0	0.29
Snowfall (in)	-	-	-	-	-	1.0
Snow on the ground (in)	-	-	-	-	-	1

[1]Data from the Belchertown weather station are available at NOAA Climatological Data Publications (NOAA 2015).
[2]Temperature data were not available for the Ware station; data from the Belchertown station are reported.
- No record. Data not recorded or not received in time for publication.

April 26, 2011 - Precipitation from April 21-26, 2011 totaled 0.71 in at the Belchertown climate station. Discharge data reflect the rainfall input; although discharge decreased steadily from April 24-26, flows did not return to pre-storm levels before the commencement of monitoring activities. Data reflect wet weather/runoff conditions. Air temperature ranged from 55 to 70ºF; cloud cover ranged from 90 to 100%. Throughout the watershed, no snow remained and buds were beginning to emerge on trees and shrubs.

June 21, 2011 – An early summer storm brought 0.37 in rainfall to the area on June 18, 2011. Discharge patterns reflected the precipitation input, and generally returned to pre-storm levels by June 20th. Precipitation and discharge indicate dry weather conditions. Air temperature ranged from 63 to 84ºF under sunny skies.

August 30, 2011 – Hurricane Irene brought over 4 in rain to the area from August 28-29, 2011; in general, discharge mirrored the precipitation pattern. Data reflect wet weather/runoff conditions. Air temperature ranged from 63 to 74ºF under sunny skies.

October 25, 2011 - A storm event dropped over an inch of rain on the area on October 20-21, 2011, and 0.1 in fell on the sampling date, prior to the commencement of sampling activities. In general, discharge at area gages rose on October 20th and returned to pre-storm levels by October 24th. Based on discharge data and field observations, data collected on this date reflect dry weather conditions. Air temperature ranged from 41 to 59ºF and cloud cover from 0 to 30%. Most foliage on deciduous trees and shrubs had changed and dropped throughout the watershed.

January 24, 2012 - Precipitation during the 5-day period prior to this event totaled 0.59 in (as water; 5.5+ in as snow); see Table 8 for climate data for this time period. In general, discharge at area gages rose on January 23-24. Field observations note that snow on the ground ranged from 0-3 inches at SMART stations. The maximum daily temperature on January 24 was above freezing throughout monitoring activities, indicating snowmelt conditions. Water quality on this date reflects wet weather/runoff conditions. Air temperature ranged from 35 to 52ºF; overcast skies cleared (<5 to <20% cloud cover) by approximately 10:00 a.m.

Table 8 Climate Conditions at Belchertown, MA from January 19-24, 2012[1]

Parameter	Jan 19	Jan 20	Jan 21	Jan 22	Jan 23	Jan 24
Max Temperature (ºF) [2]	32	38	24	26	28	46
Precipitation (inches as water)	0.07	0.15	T	0.19	0	0.18
Snowfall (inches)	-	2.0	T	3.5	-	-
Snow on the ground (inches)	-	-	-	-	-	-

[1]Data from the Ware weather station are available at NOAA Climatological Data Publications (NOAA 2015).
[2]Temperature data were not available for the Ware station; data from the Belchertown station are reported.
- No record. Data not recorded or not received in time for publication.

March 27, 2012 – This early spring monitoring event was preceded by a five-day period with only trace precipitation recorded at the Belchertown climate station. Overall, discharge decreased from March 22-27 at area gages. Water quality data collected on this date reflect dry weather conditions. Air temperature ranged from 25 to 35ºF under sunny skies.

May 23, 2012 –Little precipitation fell in the five days preceding this mid-spring sampling event (0.03 in). In general, discharge fell at area gages throughout this period. Water quality data collected on this date reflect dry weather conditions. Air temperature ranged from 64 to 82ºF; cloud cover ranged from 80 to 100%.

July 24, 2012 – A summer storm brought 0.48 in rain to the Belchertown climate station; other stations reported lower amounts (0.23 in, Worcester; 0.24 in Hardwick; 0.44 in Ware). Despite the precipitation, discharge at gages throughout the watershed varied little throughout this period. Water quality data reflect dry weather conditions. Air temperature ranged from 73 to 87ºF; cloud cover ranged from 50 to 100%.

September 25 2012 - An early fall storm brought nearly a half inch of precipitation to the area on Sept 23, 2012. Discharge at area gages generally decreased from Sept 19-23, rose with the precipitation input, then continued to decrease beyond pre-storm flows. Data reflect dry weather conditions. Air temperature ranged from 48 to 71°F under sunny skies. Foliage was changing on trees and shrubs throughout the watershed, with a few leaves down.

November 13, 2012 - This mid-fall sampling event began near the end of a storm event in which 0.14 in of precipitation was recorded at Belchertown on this date; see Table 9 for climate data from November 8-13, 2012. An inch of snow that fell on Nov. 8th had melted by the next day. At most area gages, discharge increased at area gages from November 9-10 then decreased to pre-storm flows by the commencement of monitoring activities. Data collected on this event reflect dry weather conditions. Air temperature ranged from 45 to 50°F; drizzle and rain at the first two stations monitored (Station SMG, CBG) abated, with overcast skies over the remainder of the monitoring event.

Table 9 Climate Conditions at Belchertown, MA from November 8-12, 2012[1]

Parameter	Nov 8	Nov 9	Nov 10	Nov 11	Nov 12	Nov 13
Max Temperature (ºF) [2]	35	40	58	52	60	62
Precipitation (inches as water)	0.06	0.02	0	0	0	0.14
Snowfall (inches)	0.5	0	0	0	0	0
Snow on the ground (inches)	1	0	0	0	0	0

[1]Data from the Ware weather station are available at NOAA Climatological Data Publications (NOAA 2015).
[2]Temperature data were not available for the Ware station; data from the Belchertown station are reported.
- No record. Data not recorded or not received in time for publication.

February 26, 2013 - Winter monitoring was preceded by 0.11 inches of precipitation in a storm event from Feb. 24-25 (as water, approximately 1 in as snow); see Table 10 for climate data for February 21-26, 2013. Maximum daily temperature ranged from 34 to 38ºF from Feb. 24-26. Discharge at area gages varied, with no common pattern apparent. Mid-day peaks at gages on the Ware River at Gibbs Crossing (Ware) and the Sevenmile River (Spencer) may reflect snowmelt. Field observations indicate snow cover in the watershed ranged from patches at the southernmost stations (Ware River, Ware, Quaboag River) to 6 inches at the Ware River (Barre) and the Sevenmile River. Based on precipitation and temperature data, as well as field observations, data reflects wet weather/runoff weather conditions. Air temperature ranged from 36 to 41ºF under overcast skies.

Table 10 Climate Conditions at Belchertown, MA from February 21-26, 2013[1]

Parameter	Feb 21	Feb 22	Feb 23	Feb 24	Feb 25	Feb 26
Max Temperature (ºF) [2]	31	29	40	34	34	38
Precipitation (inches as water)	0	0	0	0.03	0.08	0
Snowfall (inches)	0	0	0	T	1.0	0
Snow on the ground (inches)	-	-	-	-	-	-

[1]Data from the Ware weather station are available at NOAA Climatological Data Publications (NOAA 2015).
[2]Temperature data were not available for the Ware station; data from the Belchertown station are reported.
- No record. Data not recorded or not received in time for publication.

April 23, 2013 – On April 20, 2013 a storm brought 0.62 in of rain to the area. In general, discharge rose at area gages from April 20-21, then steadily decreased. Data reflect dry weather conditions. Air temperature rose from 37 to 42ºF; drizzle and rain at the first two stations monitored (Station SMG, CBG) subsided, and skies remained overcast throughout the remainder of the monitoring event. Trees and shrubs were budding throughout the watershed.

Table 11 Chicopee Basin Precipitation Data Summary 2011-2013[1]							
Survey Dates	**5 Days**	**4 Days**	**3 Days**	**2 Days**	**1 Day**	**Sample**	**Wet/Dry[2]**
3/22/2011	0.62	0	0	0	0	0.29	Wet
4/26/2011	0	0	0.09	0.56	0.03	0.03	Wet
6/21/2011	0.12	0	0.25	0	0	0	Dry
8/30/2011	0	0.81	0	2.54	1.71	0	Wet
10/25/2011	1.15	0.01	0	0	0	0.10	Dry
1/24/2012	0.07	0.15	T	0.19	0	0.18	Wet
3/27/2012	0	0	0	T	T	0	Dry
5/23/2012	0	0	0	0	0.01	0.02	Dry
7/24/2012	0	0	0	0	0.04	0.44	Dry
9/25/2012	0	0	0	0.48	0	0	Dry
11/13/2012	0.06	0.02	0	0	0	0.14	Dry
2/26/2013	0	0	0	0.03	0.08	0	Wet
4/23/2013	0	T	0.62	0	0	0	Dry

[1]Official data from the National Weather Service station at Belchertown from 2011 through April 2013 available at NOAA Climatological Data Publications (NOAA 2015); data expressed as inches of water.
[2] Based on precipitation, streamflow and other relevant data.
T = trace amount; an amount too small to measure

Table 12 USGS Flow Data Summary Discharge (cfs) Ware River at Gibbs Crossing, MA[1] 2011-2013								
Survey Dates	**5 Days**	**4 days**	**3 Days**	**2 Days**	**1 Day**	**Sample**	**Monthly[2]**	**Daily[3]**
3/22/2011	1,750	1,640	1,710	1,440	1,250	1,240	1,389	643
4/26/2011	1,010	808	735	900	837	739	750.6	498
6/21/2011	299	246	305	242	216	192	385.0	231
8/30/2011	111	215	253	1,890	2,070	944	338.3	105
10/25/2011	751	803	710	667	557	480	577.7	223
1/24/2012	389[e]	371[e]	346[e]	339[e]	360[e]	411[e]	456.0	353
3/27/2012	225	225	213	195	186	179	284.3	610
5/23/2012	372	295	263	218	205	200	277.3	328
7/24/2012	46	45	44	42	42	48	61.0	180
9/25/2012	84	76	65	74	67	60	77.5	149
11/13/2012	150	154	164	169	163	154	177.0	263
2/26/2013	288[e]	292[e]	288[e]	299[e]	323[e]	308[e]	365.8	392
4/23/2013	394	349	410	440	393	357	508.0	536

[1]Daily Data 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 except where noted as estimated.
[2]Mean of monthly mean discharge (cfs) based on data collected at Station 01173500 Ware River at Gibbs Crossing, Ware, MA 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 based on data collected at Station 01173500 Ware River at Gibbs Crossing, Ware, MA from 10/1/1930 to 1/31/2015 found at USGS 01173500 WARE RIVER AT GIBBS CROSSING, MA USGS Surface-Water Daily Statistics for Massachusetts (USGS 2011f)
[e] = Estimated value
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 2011 through 2013 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 13 through Table 17. Nutrient and chemistry data are presented in Table 18 through Table 22. 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 Procedure. Data Validation and Usability* (MassDEP 2005). Specific validation criteria used for 2011-2013 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 (MassDEP 2005). 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 13 MassDEP SMART 2011-2013. 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)	(%)
3/22/2011	SM-3501	11:13 AM	1.1i	4.1	6.5	92	60	13.8	106
4/26/2011	SM-3573	11:04 AM	0.8	12.3	6.9	101	65	11.1	104
6/21/2011	SM-3645	11:45 AM	0.4	23.1	7.4	114	74	8.9	104
8/30/2011	SM-3717	12:06 PM	1.2	20.7	6.9	81	52	9.0	101
10/25/2011	SM-3789	11:28 AM	0.8	11.1	7.2	96	62	11.7	106
1/24/2012	SM-3861	11:28 AM	0.7	2.7	7.0	121	79	##i,u	##i,u
3/27/2012	SM-3933	11:13 AM	##i	8.1	7.3	116	76	12.5	106
5/23/2012	SM-4005	11:10 AM	##i	21.0	7.6	106	69	9.4	106
7/24/2012	SM-4077	11:40 AM	##i	26.1	7.8	149	97	9.4i	116i
9/25/2012	SM-4149	11:33 AM	##i	15.5	7.7	129	84	10.8	108
11/13/2012	SM-4221	11:02 AM	##i	9.4	7.2	121	79	12.2	107
2/26/2013	SM-4287	9:55 AM	**	**	**	**	**	**	**
4/23/2013	SM-4359	10:07 AM	##i	5.5	6.7	51i	33i	14.0	111

Table 14 MassDEP SMART 2011-2013. 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)	(%)
3/22/2011	SM-3493	9:01 AM	0.3	2.5	5.7	69	45	14.2	104
4/26/2011	SM-3565	9:04 AM	1.3	11.7	6.1	75	49	10.5	97
6/21/2011	SM-3637	9:25 AM	1.0	20.9	6.5	97	63	9.0	101
8/30/2011	SM-3709	9:45 AM	1.8	18.5	5.7	54	35	8.1	87
10/25/2011	SM-3781	9:00 AM	1.2	9.2	6.4	79	51	11.4	99
1/24/2012	SM-3853	9:00 AM	1.1	0.3	6.3	85u	55u	##i,u	##i,u
3/27/2012	SM-3925	8:57 AM	##i	7.3	6.6	75	49	12.8	106
5/23/2012	SM-3997	9:02 AM	##i	18.3	6.5	69	45	9.7	103
7/24/2012	SM-4069	9:22 AM	##i	23.0	6.8	90	58	8.4i	98i
9/25/2012	SM-4141	9:18 AM	##i	14.1	6.7	93	60	9.6	94
11/13/2012	SM-4213	8:52 AM	##i	8.2	6.2	83	54	12.8	108
2/26/2013	SM-4285	8:58 AM	0.0i	0.2	6.3	99	64	14.6	101
4/23/2013	SM-4357	9:01 AM	##i	10.3	6.4	80i	52i	11.6	104

Table 15 MassDEP SMART 2011-2013. 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)	(%)
3/22/2011	SM-3498	10:40 AM	0.7	2.8	6.2	84	55	14.2	105
4/26/2011	SM-3570	10:30 AM	0.5	11.9	6.6	93	60	10.9	101
6/21/2011	SM-3642	11:12 AM	0.1	21.2	6.9	123	80	9.0	102
8/30/2011	SM-3714	11:25 AM	0.5	19.0	6.5	74	47	8.9	97
10/25/2011	SM-3786	10:58 AM	0.4	10.1	6.8	96	63	11.6	103
1/24/2012	SM-3858	10:49 AM	0.4	1.0	6.7	110	71	##	##
3/27/2012	SM-3930	10:35 AM	##	8.7	6.9	102	67	11.3	97
5/23/2012	SM-4002	10:34 AM	##	19.3	6.9	96	62	9.3	100
7/24/2012	SM-4074	11:05 AM	##	24.6	7.3	167	109	8.8	106
9/25/2012	SM-4146	10:57 AM	##	14.3	7.3	147	95	10.7	105
11/13/2012	SM-4218	10:28 AM	##	8.4	6.6	122	79	12.0	102
2/26/2013	SM-4290	10:27 AM	0.0	1.1	6.8	128	83	14.9	105
4/23/2013	SM-4362	10:38 AM	##	10.7	6.8	96	62	11.8	106

Table 16 MassDEP SMART 2011-2013. 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)	(%)
3/22/2011	SM-3491	8:23 AM	0.3	2.9	6.0	73	47	13.2	98
4/26/2011	SM-3563	8:19 AM	0.3	11.5	6.5	82	53	10.6	98
6/21/2011	SM-3635	8:21 AM	0.3	18.1	6.2	90	58	8.4	89
8/30/2011	SM-3707	9:02 AM	0.6	18.7	6.1	68	44	7.8	85
10/25/2011	SM-3779	8:15 AM	0.4	9.5	6.6	77	50	11.1	97
1/24/2012	SM-3851	8:18 AM	0.4	0.5	6.4	90	58	##i,u	##i,u
3/27/2012	SM-3923	8:16 AM	##i	4.0	6.4	83	54	12.9	99
5/23/2012	SM-3995	8:17 AM	##i	18.3	6.7	77	50	8.5	90
7/24/2012	SM-4067	8:37 AM	##i	21.0	7.0	118	77	8.0i	90i
9/25/2012	SM-4139	8:31 AM	##i	10.9	6.7	92	60	10.2	92
11/13/2012	SM-4211	8:10 AM	9.4	9.4	6.5	84	55	11.0	96
2/26/2013	SM-4283	8:14 AM	0.0i	0.9	6.5	94	61	14.6	103
4/23/2013	SM-4355	8:20 AM	##i	9.5	6.7	86i	56i	11.8	104

Table 17 MassDEP SMART 2011-2013. 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)	(%)
3/22/2011	SM-3501	11:13 AM	1.1	4.1	6.5	92	60	13.8	106
4/26/2011	SM-3573	11:04 AM	0.8	12.3	6.9	101	65	11.1	104
6/21/2011	SM-3645	11:45 AM	0.4	23.1	7.4	114	74	8.9	104
8/30/2011	SM-3717	12:06 PM	1.2	20.7	6.9	81	52	9.0	101
10/25/2011	SM-3789	11:28 AM	0.8	11.1	7.2	96	62	11.7	106
1/24/2012	SM-3861	11:28 AM	0.7	2.7	7.0	121	79	##	##
3/27/2012	SM-3933	11:13 AM	##	8.1	7.3	116	76	12.5	106
5/23/2012	SM-4005	11:10 AM	##	21.0	7.6	106	69	9.4	106
7/24/2012	SM-4077	11:40 AM	##	26.1	7.8	149	97	9.4	116
9/25/2012	SM-4149	11:33 AM	##	15.5	7.7	129	84	10.8	108
11/13/2012	SM-4221	11:02 AM	##	9.4	7.2	121	79	12.2	107
2/26/2013	SM-4293	11:04 AM	0.0	2.9	7.0	148	96	14.7	109
4/23/2013	SM-4365	11:08 AM	##	10.7	7.3	118	77	12.3	111

Table 18 MassDEP SMART 2011-2013. 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)
3/22/2011	SM-3494	10:00	3	9.2	6	6	2.0	0.3h	0.13a	<0.02	0.02	<0.005
4/26/2011	SM-3566	9:53	4	8.6	7	1	<1.0	0.6h	0.16a	<0.02	<0.02	0.005
6/21/2011	SM-3638	10:24	**	7.9	6	9	<1.0	**	0.11a	<0.02	<0.02	<0.005
8/30/2011	SM-3710	10:50	3	8.6	8	14	<1.0	0.3h	0.12a	<0.02	<0.02	<0.005
10/25/2011	SM-3782	10:21	5	8.3	7	10	<1.0	0.4h	0.12a	<0.02	<0.02	<0.005
1/24/2012	SM-3854	10:08	3	8.1	7	2	1.0	0.3	0.14	<0.02	0.02	<0.005
3/27/2012	SM-3926	9:55	2	8.1	7	10	<1.0	0.3b	0.12	<0.02	<0.02	<0.005
5/23/2012	SM-3998	9:55	3d	8.6	6	11	<1.0	0.4	0.081	<0.02	<0.02	<0.005
7/24/2012	SM-4070	10:25	2	7.6	7	13	1.4h	0.4b	0.11	<0.02	<0.02	<0.005
9/25/2012	SM-4142	10:17	3	10	8	7	5.4	0.5	0.15	<0.02	<0.02	<0.005
11/13/2012	SM-4214	9:48	3	9.1	7	101	<1.0	0.4b	0.13	<0.02	<0.02	<0.005d
2/26/2013	SM-4286	**	**	**	**	**	**	**	**	**	**	**
4/23/2013	SM-4358	9:57 AM	4	8.9	8	1	6.8	0.4	0.14	<0.02	<0.02	<0.005

Table 19 MassDEP SMART 2011-2013. 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)
3/22/2011	SM-3492	8:51	<2	9.5	11	4	<1.0	0.6h	0.19a	0.02	0.04	0.008
4/26/2011	SM-3564	8:54	3	10	14	11	1.6	1.0h	0.24a	<0.02	<0.02	0.010
6/21/2011	SM-3636	9:00	**	14	17	59	2.0	**	0.41	0.02	<0.02	0.026
8/30/2011	SM-3708	9:42	3	8.3	9	186	2.5	1.9h	0.45	<0.02	<0.02	0.026
10/25/2011	SM-3780	8:56	4	11	16	12	1.4	1.5h	0.27	<0.02	<0.02	0.014
1/24/2012	SM-3852	8:52	5	12	15	4	4.9	0.9	0.24	<0.02	0.07	0.009
3/27/2012	SM-3924	8:50	4	12	12	23	3.2	2.2b	0.27	<0.02	0.03	0.017
5/23/2012	SM-3996	8:55	5d	11	11	64	3.2	2.4	0.33	0.02	<0.02	0.023
7/24/2012	SM-4068	9:13	7	13	15	71	3.2h	4.2b	0.32	<0.02	<0.02	0.029
9/25/2012	SM-4140	9:08	6	14	18	23	1.8	2.4	0.32	<0.02	<0.02	0.020
11/13/2012	SM-4212	8:45	3	13	15	3	1.9	1.6b	0.29	<0.02	<0.02	0.013d
2/26/2013	SM-4284	8:52 AM	4	13	18	6	<1.0	1.0	0.25	<0.02	0.07	0.008
4/23/2013	SM-4356	8:52 AM	4	10	16	20	1.7	1.0	0.26	<0.02	<0.02	0.011

Table 20 MassDEP SMART 2011-2013. 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)
3/22/2011	SM-3496	10:35	3	12	14	50	1.7	0.9h	0.31	0.03	0.15	0.013
4/26/2011	SM-3568	10:20	5	14	17	22	2.1	1.1h	0.32	0.02	0.10	0.015
6/21/2011	SM-3640	10:58	**	20	22	84	1.8	**	0.64	0.02	0.30	0.034
8/30/2011	SM-3712	11:22	5	13	12	488	3.8d	2.9	0.57	<0.02	0.09	0.045
10/25/2011	SM-3784	10:52	5d	16	18	86	1.9d	1.9h	0.45	<0.02	0.18	0.024
1/24/2012	SM-3856	10:42	7	17	19	71	2.8	1.7	0.51	0.03	0.34	0.018
3/27/2012	SM-3928	10:26	7	18	17	56	2.5	2.3b	0.55	<0.02	0.32	0.021
5/23/2012	SM-4000	10:25	##d	16	15	49	3.4	2.0	0.49	0.02	0.21	0.032
7/24/2012	SM-4072	11:00	17	27	29	517	1.3h	2.0b	0.70	<0.02	0.37	0.031
9/25/2012	SM-4144	10:50	14	26	28	62	1.4	1.4	0.60	<0.02	0.35	0.021
11/13/2012	SM-4216	10:22	7	20	23	249	1.9	1.8b	0.55	<0.02	0.26	##d
2/26/2013	SM-4288	10:15 AM	6	18	24	249	1.8	1.4	0.57	0.05	0.32	0.020
4/23/2013	SM-4360	10:28 AM	7	15	18	40	2.6	1.5	0.34	<0.02	0.11	0.019

Table 21 MassDEP SMART 2011-2013. 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)
3/22/2011	SM-3490	8:10	4	13	11	5	<1.0	0.6h	0.27	0.02	0.13	0.006
4/26/2011	SM-3562	8:04	5	15	13	6	1.0	0.6h	0.24a	<0.02	0.06	0.007
6/21/2011	SM-3634	8:10	**	19	13	71	2.5	**	0.49	0.03	0.12	0.023
8/30/2011	SM-3706	8:55	5	12	12	88	2.3	1.2h	0.32	<0.02	<0.02	0.015
10/25/2011	SM-3778	8:10	6	15	12	26	1.1	1.3h	0.32	<0.02	0.06	0.010
1/24/2012	SM-3850	8:03	6	16	16	5	4.1	2.6	0.40	0.03	0.18	0.015
3/27/2012	SM-3922	8:10	8	17	11	79	1.9	1.9b	0.33	<0.02	0.10	0.014
5/23/2012	SM-3994	8:05	8d	16	10	81	3.9	2.6	0.31	0.04	0.04	0.020
7/24/2012	SM-4066	8:25	14	29	15	770	10h	3.6b	0.66	<0.02	0.32	0.032
9/25/2012	SM-4138	8:10	11	22	13	25	<1.0	1.6	0.30	<0.02	0.06	0.010
11/13/2012	SM-4210	8:00	8	18	12	10	3.1	1.1b	0.25	<0.02	0.04	0.009d
2/26/2013	SM-4282	8:05 AM	6	16	15	10	1.4	0.8	0.38	<0.02	0.18	0.007
4/23/2013	SM-4354	8:08 AM	7	15	14	24	1.8	0.9	0.28	<0.02	0.06	0.011

Table 22 MassDEP SMART 2011-2013. 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)
3/22/2011	SM-3499	11:05	5	16	15	20	3.0	1.2	0.37	0.02	0.20	0.017
4/26/2011	SM-3571	10:51	6	17	18	33	3.8	1.6h	0.36	<0.02	0.08	0.023
6/21/2011	SM-3643	11:34	**	20	19	119	4.2	**	0.46	0.02	0.04	0.041
8/30/2011	SM-3715	11:58	7	16	14	140	7.1	3.8	0.62	<0.02	0.02	0.048
10/25/2011	SM-3787	11:24	7	18	16	39	2.1	2.0	0.41	<0.02	0.09	0.029
1/24/2012	SM-3859	11:19	7	19	21	29	3.4	1.9	0.47	0.02	0.27	0.021
3/27/2012	SM-3931	11:00	9	21	20	101	2.6	2.1b	0.39	<0.02	0.12	0.024
5/23/2012	SM-4003	11:02	11d	21	18	76	3.8	2.1	0.45	0.02	0.10	0.039
7/24/2012	SM-4075	11:34	13	24	28	172	2.1h	1.9b	0.54	<0.02	0.17	0.078
9/25/2012	SM-4147	11:24	13	23	23	39	1.4	1.7	0.48	<0.02	0.06	0.031
11/13/2012	SM-4219	10:51	9	22	21	88	2.7	2.7b	0.46	<0.02	0.05	0.033d
2/26/2013	SM-4291	10:54 AM	6	23	28	36	2.8	2.0	0.52	<0.02	0.30	0.023
4/23/2013	SM-4363	11:00 AM	8	20	22	15	3.6	1.7	0.45	<0.02	0.05	0.025

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