TOTAL MAXIMUM DAILY LOAD ANALYSIS FOR Blackstone River Watershed

Pathogen and Trace Metals Impairments

Final Report
February 2013

303(d) listings addressed in this study:
Blackstone River (RI0001003R-01A): Pathogens, Cadmium, Lead
Blackstone River (RI0001003R-01B): Cadmium, Lead
Cherry Brook (RI0001003R-02): Pathogens, Copper
Mill River (RI0001003R-03): Pathogens
Peters River (RI0001003R-04): Pathogens, Copper

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Best Management Practice (BMP). Schedules of activities, prohibitions of practices, maintenance procedures, and other management practice to prevent or reduce the pollution of and impacts upon waters of the State. BMPs also include treatment requirements, operating procedures, and practices to control site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

Blackstone Total Maximum Daily Load Study (BTMDL). The study conducted to gather data for this TMDL.

Bypass. This is the diversion of waste streams from any portion of a wastewater treatment facility.

Code of Federal Regulations (CFR). Document that codifies all rules of the executive departments and agencies of the federal government. It is divided into fifty volumes, known as titles. Title 40 of the CFR (referenced as 40 CFR) lists all environmental regulations.

Combined Sewer Overflow (CSO). This refers to the flow from a combined sewer (sewer and stormwater) that is discharged into receiving waters without going to a treatment works. A CSO is distinguished from bypasses, which are diversions of waste streams from any portion of a treatment works.

Designated uses. Those uses specified in water quality standards for each waterbody or segment whether or not they are being attained. In no case shall assimilation or transport of pollutants be considered a designated use.

DOT or RIDOT refers to the Rhode Island Department of Transportation.

EPA refers to the United States Environmental Protection Agency.

Event Mean Concentration (EMC) - A method for characterizing pollutant concentrations in a receiving water from a runoff event. The EMC is the total constituent mass discharge divided by the total runoff volume for a given storm event.

Fecal coliform. A subgroup of the total coliform bacteria. Fecal coliform are found in the intestinal tracts of warm-blooded animals. Their presence in water or sludge is an indicator of pollution and possible contamination by pathogens, disease-causing organisms.

Geographical Information Systems (GIS). Information systems that utilize desktop computers to examine data, query attributes, manage and manipulate the data to conduct spatial analysis and design maps for the output of the analysis. ArcGIS is a combination of two GIS applications utilized in this TMDL.

Load allocation. The portion of a receiving water's loading capacity that is attributed either to its nonpoint sources of pollution or to natural background sources.

Loading capacity. The maximum amount of loading that surface water can receive without violating water quality standards.

Margin of Safety (MOS). A required component of the TMDL that accounts for the uncertainty about the relationship between the pollutant loads and the quality of the receiving waterbody.

Mixing Zone. An area where an effluent discharge undergoes initial dilution and is extended to cover the secondary mixing in the ambient water body. A mixing zone is an allocated impact zone where water quality criteria can be exceeded as long as acutely toxic conditions are prevented.

Most Probable Number (MPN). An estimate of microbial abundance per unit volume of water sample, based on probability theory.

Municipal Separate Storm Sewer System (MS4). A conveyance or system of conveyances, including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, catch basins, curbs, gutters, ditches, man-made made channels, or storm drains owned or operated by a State, city, town, county, or other public body.

Natural background conditions are all prevailing dynamic environmental conditions in a waterbody or segment thereof, other than those human-made or human-induced.

NBC is the Narragansett Bay Commission.

Nonpoint Source or NPS means any discharge of pollutants that does not meet the definition of Point Source in section 502 (14) of the Clean Water Act and these regulations. Such sources are diffuse, and often associated with land-use practices, and carry pollutants to the waters of the State, including but not limited to, non-channelized land runoff, drainage, or snowmelt; atmospheric deposition; precipitation; and seepage.

Point source means any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation or vessel, or other floating craft, from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture.

Primary contact recreational activities. Those activities in which there is prolonged and intimate contact by the human body with the water, involving considerable risk of ingesting water, such as swimming, diving, water skiing and surfing.

Rhode Island Geographic Information System (RIGIS). A consortium of government and private organizations employing computer and communications technology to manage and use a collective database of comprehensive geographically related information specific to Rhode Island.

Rhode Island Pollutant Discharge Elimination System (RIPDES). The Rhode Island system for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing point source discharge permits and imposing and enforcing pretreatment requirements pursuant to Title 46, Chapter 12 of the General Laws of Rhode Island and the Clean Water Act.

Runoff. The water from rain, snowmelt, or irrigation that flows over the land surface and is not absorbed into the ground, instead flowing into surface waters or land depressions.

Secondary contact recreational activities. Those activities in which there is minimal contact by the human body with the water, and the probability of ingestion of the water is minimal, such as boating and fishing.

Storm water. Water consisting of precipitation, runoff, or snowmelt.

Total Maximum Daily Load (TMDL). The amount of a pollutant that may be discharged into a waterbody and still maintain water quality standards. The TMDL is the sum of the individual wasteload allocations for point sources and the load allocations for nonpoint sources and natural background taking into account a margin of safety.

Wasteload allocation means the portion of a receiving water's loading capacity that is allocated to its point sources of pollution.

Water quality criteria means the elements of the State water quality standards, expressed as constituent concentrations, levels, or narrative statements, representing a quality of water that supports a particular use.

Water quality standard means provisions of State or Federal law, which consist of designated use(s) and water quality criteria for the waters of the State. Water Quality Standards also consist of an antidegradation policy.

1.0 INTRODUCTION

1.1 Purpose

This Total Maximum Daily Load (TMDL) plan addresses pathogen impairments to the Rhode Island portion of the Blackstone River and its tributaries Mill River, Peters River, and Cherry Brook, and metals impairments to the Blackstone River, Peters River and Cherry Brook. These waters are listed on Rhode Island's 2012 303(d) List of Impaired Waters as impaired for pathogens as confirmed by elevated levels of enterococcus and fecal coliform bacteria, as well as impaired for lead and cadmium on the Blackstone River, and copper on Cherry Brook and Peters River. These waters do not support their designated uses that are associated with the enterococcus and fecal coliform bacteria criteria, which include primary and secondary contact recreational activities and for the metals impairments, the protection of aquatic life.

In addition, Rhode Island's 303(d) list also identifies the Blackstone River as impaired for dissolved oxygen, phosphorus, and biodiversity (as indicated by benthic macroinvertebrate bioassessments), and elevated levels of PCBs and mercury in fish tissue. Relevant data to understand the dissolved oxygen conditions are largely missing at this time, but it is assumed that reducing the nutrient loading to the Blackstone River will also improve the dissolved oxygen conditions. The total phosphorus (TP) concentrations in the Blackstone River are expected to decrease significantly and dissolved oxygen concentrations are expected to increase, as a result of the permit limit decreases for the upstream wastewater treatment facilities (WWTF) in Worcester, MA and Woonsocket, RI (Berger, 2008). Given the significance of the WWTFs as sources of TP to the Blackstone River, the phosphorus reductions associated with the new permit limits, and that modeling results show that the permitted effluent limits will result in the achievement of the target concentrations in the Blackstone River, a phased approach has been adopted. Once WWTF upgrades have been completed, water quality monitoring, including continuous DO monitoring during critical low-flow periods will be conducted. If the monitoring data indicate violations at that time, additional steps to further reduce the phosphorus loading will be taken.

Pathogen reductions were not determined for the lower portion of the Blackstone River (RI0001003R-01B) since the vast majority of stormwater in this segment discharges to the NBC CSO system. Since the NBC is currently implementing a CSO abatement plan, no TMDL allocations are made for this segment, at this time. Until CSO discharges are mitigated, it is difficult to determine whether reductions are necessary for any remaining separate discharges. TMDL targets for dissolved metals are assigned to this reach since CSO discharges are only one of several pollution sources to this segment identified by the TMDL.

It should also be noted that though data collected in development of this TMDL supported the de-listing of the lead impairment on the Blackstone River main stem, more recent data collected by USGS indicates that the impairment persists in both the upper and lower reaches. The 2010 303(d) list was modified to add this lead impairment to the upper reach of the Blackstone River and the lower reach was added to the 303(d) list in 2012. Impairment for cadmium was also added to both segments of the Blackstone River as a result of the analysis of the USGS data.

Finally, with EPA approval of Rhode Island's site specific copper criteria for the Blackstone, Ten Mile, and Woonasquatucket Rivers based upon water effects ratio, observed copper concentrations are found to be in compliance and thus, these impairments have been de-listed as of the 2010 303(d) list. Table 1.1 includes a description of the waterbodies and impairments addressed by this TMDL.

Table 1.1 Waterbodies and Impairments Addressed by Blackstone River TMDL

Waterbody ID Number	Waterbody Description	Water Quality Classification	Water Quality Impairment
R10001003R-01A	Blackstone River from MA-RI border to CSO outfall at River and Samoset Streets in Central Falls, RI.	B1	Pathogens, Cadmium, Lead
R10001003R-01B	Blackstone River from the CSO outfall at River and Samoset Streets in Central Falls to Slater Mill Dam, Pawtucket, RI	B1	Cadmium, Lead
R10001003R-02	Cherry Brook, N. Smithfield and Woonsocket, RI	B	Pathogens, Copper
R10001003R-03	Mill River, Woonsocket, RI	B	Pathogens
R10001003R-04	Peters River, Woonsocket, RI	B	Pathogens, Copper

As discussed previously, the Blackstone River originates in Massachusetts. In the approved 2010 Integrated List of Waters report (http://www.mass.gov/dep/water/resources/10list6.pdf), the Massachusetts Department of Environmental Protection (MassDEP) lists the 37.6 miles of the Blackstone River as impaired for Metals, Nutrients, Fecal Coliform, Priority Organics, Turbidity, Suspended Solids, and Taste, Odor, and Color. Both the Peters River and Mill River also originate in Massachusetts; the 16.1 miles of the Mill River are listed as impaired for priority organics and metals and the 5.7 miles of the Peters River are impaired for metals, and pathogens.

It should also be noted that the evaluations of water quality conditions for Clean Water Act Sections 305(b) and 303(d) reporting, the assessment methodologies and subsequent listing decisions do vary slightly between Massachusetts and Rhode Island. However, both states have identified metals (i.e., cadmium, lead, and/or copper) and pathogens (*E. coli*, *Enterococci* and/or fecal coliform bacteria) as being problematic in the Blackstone and Peters Rivers. Elevated bacteria (E. *coli*) have also recently been identified as a problem in lower segment of the Mill River before it flows into Rhode Island. A draft bacteria TMDL for pathogens has been prepared by MassDEP, however it has not yet been finalized or approved by EPA. The 2012 *Massachusetts Consolidated Assessment and Listing Methodology (CALM) Guidance Manual* can be downloaded from the MassDEP website at http://www.mass.gov/dep/water/resources/2012calm.pdf.

The State of Rhode Island Department of Environmental Management (RIDEM) has identified water quality impairments in the Blackstone River watershed. Section 303(d) of the Clean Water Act and EPA's Water Quality Planning and Management Regulations (40 CFR Part 130) require States to develop Total Maximum Daily Loads (TMDL's) for waterbodies that are not meeting designated uses.

A TMDL is a tool for implementing state water quality standards in the affected waterbody. The TMDL establishes the allowable pollutant loading to a waterbody and provides a framework for identifying specific actions needed to reach water quality standards. The ultimate goal of the TMDL process is to reduce pollutant loadings to a waterbody in order to improve water quality to the point where state water quality standards are met.

One of the major components of a TMDL is to establish instream numeric endpoints, which are used to evaluate the attainment of acceptable water quality. Instream numeric endpoints represent the water quality goals that are to be achieved by implementing the load or pollutant reductions specified in the TMDL. The endpoints allow for a comparison between current instream water quality conditions and those conditions that are expected to restore beneficial uses. The endpoints are usually based on either the narrative or numeric criteria available in state water quality standards.

1.2 Study Area

The Blackstone River is an important natural, recreational, and cultural resource to both Rhode Island and Massachusetts. In 1986, the Blackstone River Valley National Heritage Corridor was established by Congress to preserve and interpret the significant historic and cultural lands, waterways, and structures within the watershed. Following is a brief summary of the key aspects of the watershed. A detailed description of the watershed is provided in the Final Report 2: Field Investigations (Berger, 2008).

The Blackstone River Watershed, which is located in south-central Massachusetts and northern Rhode Island, has a length of about 77 km (48 mi) and an average width of 19.3 km (12 mi). The total drainage of the watershed is 1,176 km^2 (454 mi^2), with 868 km^2 (335 mi^2) in Massachusetts and 363 km^2 (140 mi^2) in Rhode Island. The river flows south from Worcester, MA to the Main Street Dam in Pawtucket, RI. At this point, it becomes the headwater for the Seekonk River, which is a tidal estuary that flows for approximately seven miles before combining with the Providence River. The Blackstone River is the second largest source of freshwater to Narragansett Bay.

The Massachusetts portion of the watershed encompasses Worcester County and small sections of Middlesex, Norfolk, and Bristol Counties. It encompasses a total of thirty cities and towns including Worcester and Attleboro. In Rhode Island, the watershed encompasses a portion of the following cities and towns: Burrillville, Glocester, North Smithfield, Smithfield, Woonsocket, Cumberland, Lincoln, Central Falls, and Pawtucket.

Primary tributaries to the Blackstone River in Rhode Island are the Branch River, Mill River, Peters River, and Abbot Run Brook. The Mill River has a drainage area of approximately 88 km^2 (35 mi^2), located primarily in Massachusetts. The drainage area is characterized by open land and low-density residential development, with limited areas of high-density urban development. The headwater of the Mill River is North Pond, located in Hopkinton, MA. The Peters River has a smaller drainage area of 33 km^2 (13 mi^2), which is less than half of the Mill River. Its headwaters are located in Bellingham, Massachusetts. The river flows for approximately 5.6 km (3.5 miles) to the State line and continues for an additional 1.5 km (0.94 mi) where it combines with the Blackstone River. Abbott Run Brook has a drainage area of 75 km^2 (29 mi^2), with approximately 30% of its watershed located in Massachusetts, and its headwaters at Arnold Mills Reservoir. The Branch River has a drainage area of 241 km^2 (93 mi^2) with approximately 95% of its watershed within the State of Rhode Island.

The Rhode Island section of the Blackstone River is separated into two reaches, which were identified in Table 1.1 by waterbody ID number. The upper reach is characterized by medium to medium-high residential development with high-density urban development in the City of Woonsocket. The lower reach is characterized by high-density urban development in the City of Pawtucket.

1.3 Pollutants of Concern

As identified by the BTMDL study by The Louis Berger Group (LBG) and United States Geological Survey monitoring, the pollutants of concern are fecal coliform, enterococci, dissolved lead, dissolved cadmium, and dissolved copper.

The State of Rhode Island uses fecal coliform and enterococci as indicator organisms of potential pathogen contamination. Fecal coliform is a subgroup of the total coliform bacteria. These organisms may be separated from the total coliform group by their ability to grow at elevated temperatures and are associated only with the fecal material of warm-blooded animals. The presence of fecal coliform bacteria in aquatic environments indicates that the water has been contaminated with the fecal material of man or other animals. The presence of fecal contamination is an indicator that a potential health risk exists for individuals exposed to this water. Fecal coliform bacteria may occur in ambient water as a result of the discharge of domestic sewage or nonpoint sources of human and animal waste. Enterococci recently replaced fecal coliform as the indicator bacteria for contact recreation uses in the Rhode Island water quality standards. In accordance with the Rhode Island water quality standards, during the transition, fecal coliform may be utilized to evaluate water quality if sufficient enterococci data are not available. This report presents fecal coliform data to document impairment of some waterbodies designated for contact recreation. These criteria are set forth in the State's Water Quality Regulations promulgated by RIDEM's Office of Water Resources.

The enterococcus group is a subgroup of the fecal streptococci that includes *S. faecalis, S. faecium, S. gallinarum, and S. avium.* Though they are not capable of forming spores, enterococci are tolerant of a wide range of environmental conditions: extreme temperature (10-45°C), pH (4.5-10.0), and high sodium chloride concentrations. The enterococci portion of the fecal streptococcus group is a valuable bacterial indicator for determining the extent of fecal contamination of recreational surface waters. Studies at marine and fresh water bathing beaches indicated that swimming associated gastroenteritis is related directly to the quality of the bathing water and that enterococci are the most efficient bacterial indicator of water quality.

Copper (Cu) is ubiquitous in the rocks and minerals of the earth's crust. In nature, copper occurs usually as sulfides and oxides and occasionally as metallic copper. Weathering and solution of these natural copper minerals results in background levels of copper in natural surface waters at concentrations generally well below 20 µg/ (USEPA 1980). Higher concentrations of copper are usually from anthropogenic sources such as WWTF, industrial facilities, and urban runoff.

These sources include corrosion of brass and copper pipes by acidic waters, industrial effluents and fallout, sewage treatment plant effluents, and the use of copper compounds as aquatic plant controls. The levels of copper able to remain in solution are directly dependant on water chemistry. Generally, copper is more soluble in low pH, acidic waters and less soluble in high pH, alkaline waters. Concentrations of 1 to 10µg/l are usually reported for unpolluted surface waters however concentrations in the vicinity of municipal and industrial outfalls, particularly from refining, smelting, or metal plating industries may be much higher (USEPA 1980).

Cadmium (Cd) is a soft, malleable, ductile, bluish-white metal, is an excellent electrical conductor, and shows good resistance to corrosion and attack by chemicals. It is similar in many respects to zinc in its chemical properties. Most cadmium is used in batteries (especially rechargeable nickel-cadmium batteries). As a result of its low coefficient of friction and its high fatigue resistance, cadmium is used in alloys for bearings. Cadmium was used extensively as a protective coating for steel, in much the way that zinc is used today ("Galvanized" steel is zinc-plated). Cadmium plating is still used in some specialized applications, but the toxicity of cadmium has discouraged more common use in plating. Cadmium is naturally present in most environmental media. The largest sources of airborne cadmium in the environment are the burning of fossil fuels such as coal or oil, and incineration of municipal waste materials.

Lead (Pb) reaches the aquatic environment through precipitation, fallout of lead dust, street runoff, and both industrial and municipal wastewater discharges (USEPA 1980). Lead is used in electroplating, metallurgy, and the manufacture of construction material, plastics, and electronics equipment. Lead compounds have very low solubility and are not commonly found in natural, un-impacted waters. Where present, lead compounds are often adsorbed to suspended solids and transported through aquatic systems this way. Lead compounds have been used for batteries, additives in gasoline, pigments and paint, and other metal products. Mining, smelting and other industrial emissions and combustion sources and solid waste incinerators are now the primary sources of lead in the environment. Lead reaches water bodies either through urban runoff or through discharges such as sewage treatment plants and industrial plants. It also may be transferred from the air to surface water through precipitation (rain or snow). Lead toxicity depends on its solubility, which is dependent on pH and other available ions.

1.4 Applicable Water Quality Standards

As stated in 40 CFR 131.2, “[water quality] standards serve the dual purposes of 1) establishing the water quality goals for a specific waterbody and 2) serving as the regulatory basis for the establishment of water-quality based treatment controls and strategies beyond the technology-based levels of treatment required by section 301(b) and 306 of the Act.” The purpose of a TMDL is to calculate the amount of a pollutant that receiving waters can assimilate without exceeding water quality standards or compromising their designated use. Therefore, it is important to know exactly which regulations apply to the waterbody for which a TMDL is developed. The relevant portions of the state’s Water Quality Regulations are described below.

1.4.1 Designated Uses

Section 8.B of the Water Quality Regulations (RIDEM, 2006) describes the water use classification. All surface waters shall be assigned to a class that is defined by the designated uses, which are the most sensitive, and therefore, governing water uses which it is intended to protect. Surface waters may be suitable for other beneficial uses, but shall be regulated to protect and enhance the designated uses. In no case shall waste assimilation or waste transport be considered a designated use.

Section 8.C (3) states that all freshwaters hydrologically connected to and upstream of Class B, B1, SB, SB1, C, or SC waters shall be Class B unless otherwise identified in the regulations. Blackstone River is listed as Class B1. Cherry Brook, Mill River and Peters River are listed as Class B waters.

The following excerpt from Rule 8.B (1) of the Regulations describes Class B and B1 freshwaters:

Applicable for Class B -These waters are designated for fish and wildlife habitat and primary and secondary contact recreational activities. They shall be suitable for compatible industrial processes and cooling, hydropower, aquacultural uses, navigation, and irrigation and other agricultural uses. These waters shall have good aesthetic value.

The same applies to Class B1 with the caveat that primary contact recreational activities may be impacted due to pathogen from approved wastewater discharges. However, all Class B criteria must be met.

1.4.2 Numeric Water Quality Criteria

Rule 8.D of the Water Quality Regulations establishes physical, chemical, and biological criteria as parameters of minimum water quality necessary to support the water use classifications of Rule 8.B. Therefore, sections of Rule 8.D are also applicable. In particular, Rule 8.D (2) establishes class-specific criterion for freshwaters. The following bacteria criteria apply to Class B and B1 waters for fecal Coliform:

Fecal Coliform
Primary Contact Recreational/Swimming Criteria:
Not to exceed a geometric mean value of 200 MPN/100 ml and not more than 10% of the total samples taken shall exceed 400 MPN/100 ml, applied only when adequate enterococci data are not available.

Enterococci
Primary Contact Recreational/Swimming Criteria:

Non-Designated Bathing Beach Waters Geometric Mean Density:	*54 colonies/100 ml*
Designated Bathing Beach Waters Geometric Mean Density:	*33 colonies/100 ml*
Single Sample Maximum:*	*61 colonies/100 ml*

** Criteria for determining beach swimming advisories at designated beaches as evaluated by the Department of Health.*

Metals
The water quality standards for toxics, including dissolved metals, set forth in Appendix B of the State of Rhode Island Department of Environmental Management Water Quality Regulations

(DEM December 2009) state that "to protect aquatic life, the one-hour average concentration of a pollutant should not exceed the acute criteria more than once every three years on the average. The four-day average concentration of a pollutant should not exceed the chronic criteria more than once every three years on the average. These aquatic life criteria shall be achieved in all waters, except mixing zones, regardless of the waters' classification. In addition, the acute and chronic aquatic life criteria for freshwaters shall not be exceeded at or above the lowest average 7 consecutive day low flow with an average recurrence frequency of once in 10 years (7Q10)".

The chronic and acute freshwater criteria of these metals apply to the dissolved form and are calculated using water hardness (in mg/l as CaCO3) based on equations in Table 2-Appendix B of Rhode Island's Water Quality Regulations shown below in Table 1.2. Hardness is a measure of the concentration of cations in solution (Minton 2002), with hardness usually measured as calcium carbonate ($CaCO_3$) equivalents in mg/l. An increase in hardness decreases the toxicity of metals, because calcium and magnesium cations compete with the metal ions for complexing sites, allowing fewer metal complexes to form and therefore resulting in a lower level of toxicity (Minton 2002).

Table 1.2 Applicable Freshwater Criteria Equations

Parameter	**ACUTE (µg/L)** CF x $e^{(m_a [\ln Hardness] + b_a)}$			**CHRONIC (µg/L)** CF x $e^{(m_c [\ln Hardness] + b_c)}$		
	CF =	m_a	b_a	CF =	m_c	b_c
Cadmium (Cd)	@	1.0166	-3.924	@	0.7409	-4.719
Copper (Cu)*	0.96	0.9422	-1.700	0.96	0.8545	-1.702
Lead (Pb)	#	1.273	-1.46	#	1.273	-4.705

= Lead Conversion Factors: Acute and Chronic CF= 1.46203 – [(ln H) x 0.145712]
@ = Cadmium Conversion Factors: Acute CF= 1.136672 – [(ln H) x 0.041838]; Chronic CF= 1.101672 – [(ln H) x 0.041838]
* Site specific copper criteria have been adopted for the mainstem of the Blackstone River: acute = 20.41 µg/L and chronic = 14.45 µg/L.. The criteria presented here are applicable to all other freshwaters in the watershed

DEM evaluated existing water quality data available for each waterbody from the 2005-2006 Blackstone River TMDL Study (referred to as BTMDL) and from USGS monitoring data collected at Manville Dam and Roosevelt Avenue stations from 2007-2011 to determine appropriate hardness levels to use in calculating the water quality criteria used to establish the waterbody specific water quality targets for the TMDL. The BTMDL data analysis resulted in several observations. As expected, hardness values in the watershed decreased with increasing flows, with mean dry weather hardness values higher than wet weather values. Waterbody hardness was slightly higher at the Millville, MA station (W-01), with a decrease in concentrations by the Manville Dam station (W-02), due to dilution by the tributaries of Branch, Mill and Peters Rivers. After the Manville Dam station (W-02), there would be a slight increase in the mean hardness concentrations but the difference between the mean hardness values for the stations at Ashton Dam (W-03), Lonsdale Avenue Bridge (W-04), and Slater Mill Dam (W-05) would range between 1 to 2 mg/L. The mean dry weather concentrations were significantly higher than the mean wet weather concentrations for both segments of the Blackstone River, with a difference ranging between 8 to 10 mg/L.

There was also a significant difference between the mean hardness values in the USGS data for the Rhode Island stations on the Blackstone River, depending upon the flow in the river. The mean hardness was 58 mg/L during lower flows while the average hardness observed during higher flows was 36 mg/L for the Rhode Island river segments. The observed hardness at Millville, MA during low flows was slightly lower that the Rhode Island side with a mean hardness of 54 mg/L, however, the high flow mean hardness was slightly higher at 40 mg/L.

Observed mean hardness concentrations for the BTMDL dry and wet weather survey data for the Peters River and Cherry Brook were significantly different as well. Peters River mean dry weather hardness for the Rhode Island stations was 62 mg/L and the mean wet weather value was 35 mg/L, while Cherry Brook mean dry weather hardness was 71 mg/L and the mean wet value was 35 mg/L. The observed mean dry weather hardness values for the Mill River Rhode Island stations was 39 mg/L while the wet weather mean was slightly lower at 36 mg/L.

One exceedance of the chronic criteria is acceptable given that the State's WQRs stipulate "the four-day average concentration of a pollutant should not exceed the chronic criteria more than once every three years on the average". However, more than one exceedance would constitute a violation of chronic criteria and would necessitate calculating a required reduction.

Similarly, one exceedance of the acute criteria is acceptable given that the State's WQRs stipulate "the one-hour average concentration of a pollutant should not exceed the acute criteria more than once every three years on the average". However, more than one exceedance would constitute a violation of acute criteria and would necessitate calculating a required reduction.

In some instances, a single exceedance of the criteria may be viewed as non-compliance with the standards if there is strong evidence that the criteria could be exceeded again within a three-year period. More specifically, one exceedance may be considered a violation of criteria where RIDEM has knowledge of an actual or potential upstream pollution source or where the exceedance occurred during a wet weather event, and it is considered likely that the condition would reoccur and the criteria would be exceeded again within a three year period.

With the exception of the site specific copper criteria established for the mainstem of the Blackstone River, to calculate the target copper, lead, and cadmium criteria concentrations, RIDEM evaluated hardness value distributions during both dry and wet weather conditions, as follows:

The Blackstone mainstem stations used the USGS dissolved metals data and the associated hardness values for each survey date to determine the applicable criteria. The USGS hardness values for the two Rhode Island stations were averaged together to use a common hardness value for both river stations for each survey date. The resultant criteria were compared against the observed dissolved metal collected at each sample location for each survey date. For the State Line location (Millville, MA USGS station) the applicable criteria were determined using the observed hardness associated with the samples collected for each survey date.

Peters River and Cherry Brook used the BTMDL field survey data to determine the applicable criteria. The procedure followed is the same as in the BTMDL Field Study Report (Berger, 2008) and is described below.

1. Dry weather criteria were calculated as follows: Hardness values for Stations W-15 and W-16 were averaged for each survey date to get an average hardness for that waterbody segment. These averaged hardness values were used to calculate applicable acute and chronic criteria for each survey date. The State Line Station (W-14) and Cherry Brook (W-31) used the hardness value associated with each survey. These hardness values were used to calculate the acute and chronic criteria. The observed and allowable loads that were calculated were compared to determine the required reductions for the waterbody segment.
2. Wet weather criteria was calculated as follows:
    - Acute criteria: The average hardness of all stations on a waterbody segment by run was used to calculate the criteria for wet weather events. The hardness values for Stations W-15 to W-16 were averaged and that value used to determine the criteria. The State Line Station (W-14) and Cherry Brook again had only one value. The individual observed loads were compared to the calculated allowable load to determine the required reduction.

    - Chronic criteria: The average hardness of all runs during a wet weather survey for each station on a waterbody segment was used to calculate the chronic criteria. The allowable load was determined using the EMC flow and the calculated chronic criteria for that station. The observed load for the station was calculated using the EMC flow and concentration from the BTMDL Field Data Report (Berger, 2008). The observed load was compared to the allowable load to determine the required reductions.

Table 1.3 summarizes the range of observed hardness values in the Blackstone Watershed. As described previously, hardness data collected by USGS at the Millville, MA station was used to represent the State Line values, whereas hardness data collected at Manville Dam and Roosevelt Avenue stations were averaged to represent hardness values in the Rhode Island portion of the Blackstone River For Cherry Brook and the Mill and Peters Rivers the BTMDL hardness data were used. The resulting range of numeric water quality concentration criteria for dissolved cadmium (Cd), copper (Cu), and lead (Pb) are shown in Table 1.4. With the exception of the site specific copper (Cu) criteria established for the mainstem of the Blackstone River, these criteria are calculated using the lowest mean dry or wet weather hardness concentrations for all waterbodies where exceedances occurred during the field study for the BTMDL.

Table 1.3 Summary of Observed Hardness as $CaCO_3$ (mg/L)

Waterbody Segment	Low Flow - Dry Weather		High Flow - Wet Weather	
	Minimum	Maximum	Minimum	Maximum
Blackstone River State Line	38	65	20	45
Blackstone River* R10001003R-01(A & B)	38	72	20	45
Mill River RI0001003R-03	26	55	17	45
Peters River RI0001003R-04	42	78	5	68
Cherry Brook RI0001003R-02	43	85	32	36

*The average hardness of Manville Dam and Roosevelt Avenue for each survey date

Table 1.4 Range of Water Quality Criteria Utilized for the Blackstone River Watershed TMDL

Hardness as $CaCO_3$ (mg/L)	Cadmium (µg/L)		Lead (µg/L)		Copper (µg/L)	
	Acute Criteria	Chronic Criteria	Acute Criteria	Chronic Criteria	Acute Criteria	Chronic Criteria
5.00	0.11	0.03	1.80	0.07	0.80	0.69
30.00	0.62	0.11	17.0	0.66	4.32	3.20
50.00	1.03	0.15	30.1	1.17	6.99	4.95
70.00	1.42	0.19	43.7	1.70	9.60	6.60
90.00	1.82	0.23	57.6	2.24	12.2	8.18

1.4.3 Massachusetts and RI Water Quality Criteria Comparison

A summary of the numeric primary contact bacteria standards for Massachusetts and Rhode Island is shown below in Table 1.5. The Massachusetts Water Quality Standards no longer contain a criterion for fecal coliform and the state revised its standards in 2007 to include e-coli and enterococcus. The previous DRAFT MA Pathogen TMDL for the Blackstone River Basin used a similar approach to RIDEM in developing the TMDL. Although it is not anticipated that there will be significant conflicts between the measures that will be taken between the two states to address bacteria impairments, the comparison of the Massachusetts-RI water quality standards is show since the load reductions required for bacteria between the two states may not be directly comparable due to differences in the two state's water quality standards.

Table 1.5 Massachusetts and Rhode Island Pathogen Surface Water Quality Criteria

Massachusetts Applicable Surface Water Quality Criteria		
	Primary Contact Recreation	
Waterbody Class	**Geometric Mean (Colonies/100ml)**	**90th Percentile (Colonies/100ml)**
B	126 E. coli	Not Applicable
	33 Enterococci	Not Applicable
Rhode Island Applicable Surface Water Quality Criteria		
	Primary Contact Recreational	
Waterbody Class	**Geometric Mean (MPN/100ml)**	**90th Percentile (MPN/100ml)**
B/B1	200 Fecal Coliform	400 Fecal Coliform
	Geometric Mean (Colonies/100ml)	**90th Percentile (Colonies/100ml)**
	54 Enterococci	Not Applicable

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2.0 DESCRIPTION OF THE STUDY AREA

2.1 Blackstone River Stream System

The river has had a significant historical role in the industrialization of the northeast and an equally significant role in the environmental health of the Seekonk River and Narragansett Bay. This 48-mile river is a major source of suspended solids, nitrogen, metals, and organics to these waters, resulting in impacts to fishing, shell fishing, tourism, and recreation. Resuspension and movement of contaminated sediments, headwaters defined by drainage from Worcester, the second largest city in New England and its wastewater treatment facility, multiple other wastewater treatment facility discharges, stormwater contributions from CSO facilities and urban centers, and fluctuations in water levels due to hydropower operations, create a river system with problems characteristic of many others in the United States.

There are 452 miles of river and perennial streams in the Blackstone River basin. The primary tributaries in Massachusetts are Kettle Brook, Quinsigamond River, Mumford River, and West River. Primary tributaries in Rhode Island are Abbott Run Brook, Mill River, Peters River, and Branch River. There are 183 lakes and ponds, 107 of them larger than 10 acres, and the largest being Lake Quinsigamond in Shrewsbury, with an area of 781 acres. The majority of the lakes are formed or enlarged by impoundments. The watershed has a total of 102 dams, with 19 dams on the mainstem of the Blackstone River. Figure 2.1 shows the Blackstone River Watershed.

In 2001, RIDEM contracted with The Louis Berger Group to characterize water quality conditions and pollution sources causing impairments of the Blackstone, Mill, and Peters River, Valley Falls Pond, and Scott Pond, in support of the development of TMDLs for each water body. The first phase of the assessment project, to compile existing water quality and pollution source data including land use data for the Rhode Island portion of the Blackstone River watershed and to identify data gaps, was completed in the spring of 2004. Detailed information on the Blackstone River Watershed can be found in the report, Water Quality – Blackstone River, Final Report 1: Existing Data, Volume I and II. The report can be found on the RIDEM website at:
http://www.dem.ri.gov/programs/benviron/water/quality/rest/pdfs/blackapps.pdf

2.1.1 Mill River

As mentioned previously, the Mill River has a drainage area of approximately 88 km^2 (35 mi^2) with most of the area in Massachusetts. The drainage area is characterized by open land and low-density residential development with limited areas of high-density, urban development. North Pond in Hopkinton, MA is the headwater for the river. The river flows into Harris Pond at the MA-RI state line, and serves as a water supply for the City of Woonsocket. After Harris Pond, the river flows for approximately 3,200 feet before being conveyed underground to the Blackstone River. This underground passage is 1,150 feet long through two 10 feet wide by 12 feet high concrete conduits built in 1963 by the Army Corps of Engineers as part of a city-wide flood control project. Tributaries to the Mill River are Hop Brook, Quick River, Spring Brook, and Muddy Brook, all of which are located in Massachusetts.

2.1.2 Peters River

The headwaters for the Peters River are located in Bellingham, MA, with a total drainage area of 33 km^2 (13 mi^2). The river flows south for approximately 3.5 miles to the state line and continues for another mile through Rhode Island before it joins with the Blackstone River in Woonsocket. The drainage area is characterized by medium to medium-high residential development with high-density urban development in Woonsocket. Peters River flows for approximately 5,000 feet before being conveyed underground through a 10-foot by 10-foot concrete conduit at Elm Street. The river travels another 1,180 feet before its confluence with the Blackstone River. As with the Mill, the Corps of Engineers built this conduit in 1963 for flood control. The tributaries to the River are Bungay Brook, Arnold Brook, and unnamed streams that originate in Franklin State Forest.

2.1.3 Cherry Brook

The headwaters for Cherry Brook are Cedar Swamp Brook, a large wetland area located in North Smithfield, RI, at a low point between Woonsocket Hill and Whortleberry Hill Roads. The drainage area is approximately 85 km^2 (33 mi^2). The main stem of the brook is approximately 6.3 km (3.8 miles) long and flows in a northwest direction until it crosses under Route 146A, where it bends to the southeast and eventually joins the Blackstone River adjacent to the Providence and Worcester (P&W) railroad easement at Olo Street. The area is characterized by rural and low-density residential development at the headwater, with medium-density residential and urban development as it travels through Woonsocket, RI. Tributaries to the brook are several unnamed first order streams that join Cherry Brook at various points along its mainstem.

2.2 Watershed History

The Blackstone River has a long history of pollution that began in 1793 at Slater Mill in Pawtucket, Rhode Island, the site of the first textile mill. The success of the Slater Mill inspired other entrepreneurs to build their own mills, first throughout the Blackstone Valley and then eventually all over New England. To take advantage of waterpower sources, new mill villages were built where once only field and forest stood. Through the 1800’s, the river became the hardest working river in the United States, with one dam for every mile of river. With headwaters in Worcester, MA, the Blackstone flows south where it discharges into the Seekonk River in Pawtucket, RI.

In conjunction with the Industrial Revolution was the need for a transportation revolution to cheaply and efficiently move heavy cargo between the mills on the river and the port of Providence. The river itself was impassible to large boats, and horse drawn wagons too slow and expensive. The first solution was the construction of the Blackstone Canal in 1824-1828. Canal continued operations until the arrival of the railroads in the 1830’s. The final blow to the canal was the construction of the Providence to Worcester Railroad in 1847. The Boston to Worcester line in 1835, followed by the P&W in 1847 allowed for the fast, cheap and reliable transport of raw materials, finished goods and farm products between the villages of the Blackstone Valley and the ports of Providence and Boston. Rail service also made practical the conversion of the textile mills of the valley from waterpower to steam power by the 1860's and 1870's.

By the early 1900s, the upper Blackstone River in Massachusetts was grossly polluted. The intense industrial usage of the Blackstone left a legacy of pollution. Textile manufacturers discharged dyes, leather and metal working plants discharged heavy metals, and woodworking companies discharged varnish, solvents, and paints. Many of these pollutants can still be found in the river's sediments today, over 100 years after they were released. These pollutants continue to influence water quality and overall health of the Blackstone River's ecosystem.

During the early 1900s, the textile industry that supported much of the Blackstone River Valley began to fold. Southern mills, which had produced only 6 percent of the nation's cotton in1880, were successfully competing with mills in the Northeast. By 1923, half of the nation's cotton was produced in the South. Between 1920 and 1980, most of the Blackstone Valley's cotton mills closed and 90 percent of the woolen and worsted mills were shut down. The valley lost population, and in 1971 the Blackstone River was labeled "one of America's most polluted rivers" by an article in *Audubon* magazine.

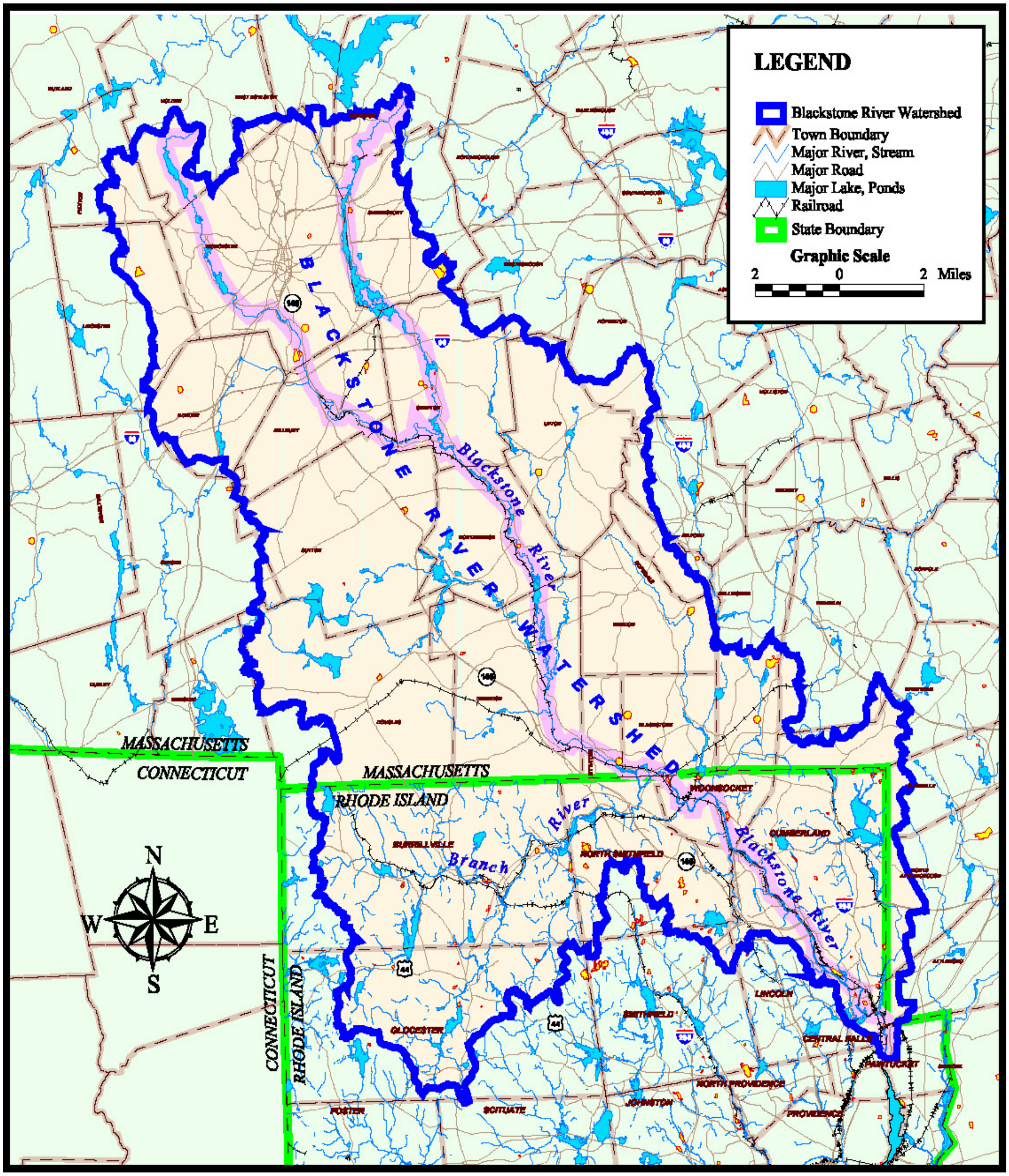

Figure 2.1 Blackstone River Watershed

3.0 WATER QUALITY MONITORING

Water monitoring is an essential component of Rhode Island's overall approach to protecting and restoring its vital water resources, including Narragansett Bay. Section 106(e)(1) of the CWA, requires States to develop a comprehensive monitoring and assessment strategy, and to report the condition of their water resources. The decision-making process for assessing and reporting on the quality of the State's waters is documented in the Rhode Island Consolidated Assessment and Listing Methodology (RI CALM). The CALM provides a description of the sampling approach, a list of parameters to be tested, and a schedule for collecting data and information on all waterbodies identified in the 305(b) and 303(d) lists. The Rhode Island Water Monitoring Strategy that was finalized in September 2005 can be found on RIDEM's website at:

http://www.ci.uri.edu/Projects/RI Monitoring/Docs/DEM_WQ_Oct_14_05.pdf

The strategy describes existing efforts as well as new monitoring initiatives that need to be implemented in order to meet the state's data needs regarding water resources for the period 2005-2010.

Currently, the Narragansett Bay Commission (NBC), the U.S. Geological Survey (USGS), and volunteers working with the University of Rhode Island's Watershed Watch Program conduct monitoring within the watershed. These data sources supplement the statewide watershed assessment program that rotates between basins. Summaries of the monitoring programs in the RI portion of the Blackstone River watershed are described briefly below.

RIDEM also conducts program-specific monitoring activities including targeted water quality investigations of impaired waters that address data gaps, identify pollution sources and recommend actions to control or eliminate sources in order to return water quality to acceptable conditions. The BTMDL study is one example of an intensive water quality sampling program contracted by the department to provide data for a TMDL.

3.1 Applicable Studies - Pathogens

3.1.1 Narragansett Bay Commission (NBC)

Created in 1982, the Narragansett Bay Commission assumed responsibility for the deteriorating wastewater collections and treatment facilities of the City of Providence. In 1992, NBC merged with the Blackstone Valley District Commission (BVDC) to assume responsibility for portions of their wastewater collections and treatment facilities. Currently, NBC directs sewage to two wastewater treatment facilities located at Bucklin Point in East Providence, RI and Field's Point in Providence, RI. The Bucklin Point facility services Central Falls, Cumberland, Pawtucket, and portions of Lincoln, East Providence and Smithfield. The Field's Point facility services the communities of Johnson, Providence, North Providence, and portions of Lincoln and Cranston.

Within these communities, NBC has approximately 110 miles of interceptor sewers ranging in size from 6 to 110 inches in diameter. In November 2008, NBC activated the Combine Sewer Overflow (CSO) tunnel that is a 3.1mile tunnel that is 300 feet below the surface of Providence and is 26 feet in diameter. This tunnel is designed to retain the overflow from many of the 66 active CSO overflows that periodically discharge combined sewage and stormwater into the lower Woonasquatucket and Moshassuck Rivers and the Providence River. Currently, NBC monitors thirteen CSOs located along the mainstem of the Blackstone River between the Lonsdale Avenue Bridge and Slater Mill Dam. Until recently, there were fourteen CSOs, but OF-102 has been permanently sealed.

NBC routinely monitors Providence-area rivers for fecal coliform bacteria as part of their Combined Sewer Overflow (CSO) Project and for routine maintenance activities of CSO interceptors and regulators. In 1998, NBC began river monitoring to locate pollutant sources within the district sampling on a weekly to bi-weekly basis under wet and dry conditions. The NBC laboratory analyzes for fecal coliform bacteria using the A1 Medium method within a 24-hr period. Two of the sample locations are on the mainstem of the Blackstone River, which were also sites chosen during the BTMDL data collection surveys. The sample locations are the bridge crossing at Lonsdale Avenue in Central Falls (W-04), and at the end of the Blackstone River at Slater Mill Dam (W-05) in Pawtucket, Rhode Island. The statistics for the past five years of data collection are shown in Table 3.1.

Table 3.1 Fecal Coliform Geomean and 90th Percentile Values for NBC Sampling Locations

Monitoring Location	Fecal Coliform (MPN/100ml)	2005	2006	2007	2008	2009	All Samples
Whipple Bridge (W-04)	Geomean	217	206	120	223	102	164
	90th Percentile	1,740	2,300	686	1,500	430	930
Slater Mill Dam (W-05)	Geomean	361	276	179	321	137	244
	90th Percentile	2,300	1,800	1,272	2,300	930	2,300

3.1.2 U.S. Geological Survey

As part of the statewide watershed assessment program for basins draining into Narragansett Bay, the USGS has been collecting water quality data at Manville Dam and at Roosevelt Avenue in Pawtucket, RI since 2007. The constituents that are sampled on a monthly basis include fecal coliform and enterococci for a total of twelve samples annually. Fecal coliform data are available at the Roosevelt Avenue station only, while enterococci data are available at both the Manville and Roosevelt Avenue stations. Trace metal samples were also collected at both stations as described in a later section. Statistical data summaries are for the fecal coliform and enterococci are presented in Tables 3.2 and 3.3 respectively.

Table 3.2 Fecal Coliform (MPN/100ml) for the USGS Roosevelt Avenue Station

Statistical Function	2007	2008	2009	2010	2011	All Samples
Geomean	156	817	294	1,190	323	450
90th Percentile	494	5,920	930	9,000	984	5,920
Number of Samples	10	12	10	11	9	52

Table 3.3 Enterococci* (CFU/100ml) for the USGS Millville, MA, Manville Dam and Roosevelt Avenue Stations

Station	Millville, MA		Manville Dam, RI		Roosevelt Ave., Pawtucket, RI	
	Geomean	# Samples	Geomean	# Samples	Geomean	# Samples
2007	40.7	11	70.7	11	55.6	11
2008	138.7	12	141.2	12	213.0	12
2009	58.6	10	39.3	9	45.3	10
2010	46.6	10	51.1	8	131.5	10
2011	98.0	10	77.7	10	81.5	10
All Samples	69.7	53	72.7	50	91.7	53

*Note that Enterococci water quality data is expressed as geomean only.

3.1.3 University of Rhode Island Watershed Watch

The URI Watershed Watch program works with local communities and volunteers to assess water quality, and provide information for more effective management of critical water resources. Watershed Watch volunteers sampled the Blackstone River at Manville Dam from May through October of 2007 and 2008. Enterococci were among the constituents sampled and this data was provided to RIDEM for the baseline monitoring database. Table 3.4 is a summary of the results.

Table 3.4 Watershed Watch Enterococci* (CFU/100ml) Summary for the Manville Dam Station

Station	2007		2008		All Samples	
	Geomean	# Samples	Geomean	# Samples	Geomean	# Samples
Manville Dam	14.6	6	83.5	6	34.9	12

*Note that Enterococci water quality data is expressed as geomean only.

3.1.4 DEM's Ambient River Monitoring Program

DEM Office of Water Resources continues to implement the rotating basin monitoring strategy for wadeable rivers and streams to reduce the large gap in available data on RI rivers and streams. This approach integrates biological, chemical and physical monitoring and involves an intensive data collection effort using a geometric design of locating stations. The protocol, which involves an intense data collection effort and includes 5 sampling events, is conducted over a 12 month period - 3 sampling events for an entire suite of parameters that are collected during the critical biological index period, and 2 additional sampling events for bacteria are conducted during the critical summer months for this indicator. In the Blackstone River basin, samples were collected on Cherry Brook and were included as part of the data set used for the statistical summary for fecal coliform in this section. No samples were collected along the mainstem of the Blackstone River due to the recently completed BTMDL study. Table 3.5 is a summary of the pathogen data from the program.

Table 3.5 Rotating Basin Pathogen Summary for Cherry Brook (BTMDL Station W-31)

Parameter	Geomean	90th Percentile	# Samples
Fecal Coliform	877 MPN/100ml	2,280 MPN/100ml	5
Enterococci *	697 CFU/100ml	-	5

* Note that Enterococci water quality data is expressed as geomean only.

3.1.5 Blackstone River TMDL Study

The primary goal of the Blackstone TMDL study was to obtain the information needed to develop TMDLs for the impairments identified in the State's Integrated Water Quality Monitoring Report (RIDEM, 2008). The Rhode Island portion of the Blackstone River watershed was separated into three river reaches based on contaminant loadings identified during the Blackstone River Initiative (BRI; Wright et al., 2001), however for purposes of this TMDL, the river is segmented consistent with the two established Waterbody IDs as described below. Water quality sampling of the BTMDL study was focused on the Rhode Island portion of the Blackstone River, but included one station (W-01) located in Millville, Massachusetts, approximately one mile from the RI-MA state line. Figures 3.1 and 3.2 show the station locations in the upper and lower portions of the watershed, and Table 3.6 has the street or highway crossing listed for each station.

The BTMDL stations reoccupied many of the BRI stations in Rhode Island allowing some data comparisons between the 1993 and the 2005 studies. A more detailed description of the BTMDL study and the data can be found in the report, "Water Quality – Blackstone River Final Report 2: Field Investigations" (Berger, 2008) and on the RIDEM website at:

http://www.dem.ri.gov/programs/benviron/water/quality/rest/pdfs/blackwq2.pdf

The BTMDL sampling locations described relative to the two established Blackstone River segments are as follows:

The upper reach (Waterbody ID R10001003R-01A) runs from the MA/RI State line to the first CSO outfall located at River and Samoset Streets in Central Falls. The upper portion of this reach bracketed by Station W-01 and Station W-02 at Manville Dam encompasses the largest urban area (Woonsocket) along the Rhode Island portion of the Blackstone River, as well as three of the four largest tributaries (Branch, Mill, and Peters Rivers), and the only municipal wastewater treatment facility on the mainstem of the Rhode Island segment. This section was one of the areas highlighted in the BRI as a significant contributor of contaminants. The lower portion of this waterbody segment is the most rural of the RI segment of the Blackstone River. This rural portion runs from the Manville Dam at Station W-02 to Whipple Bridge at Lonsdale Avenue (Station W-04). The pollutant loads contributed in this portion of the river are smaller.

The lower reach (Waterbody ID R10001003R-01B) runs from the first CSO located at River and Samoset Streets to Slater Mill Dam (Station W-05), thus bracketing the second largest urban area along the Blackstone River in Rhode Island, as well as the fourth largest tributary (Abbott Run Brook), and the only CSOs along the RI portion of the river. This reach was also identified in the BRI as a reach of concern.

Table 3.6 BTMDL Sampling Station Locations

Station	Waterbody	Location	Latitude	Longitude	River Miles From Mouth
W-01	Blackstone River	Railroad bridge adjacent RT 122, Millville, MA	42˚ 01' 22.49"	71˚ 34' 19.86"	19.1
W-23	Branch River	RT 146A Bridge	41˚ 59' 59.94"	71˚ 33' 09.85"	17.4
W-21	Blackstone River	Singleton Street Bridge	42˚ 00' 35.75"	71˚ 31' 45.67"	15.5
W-31	Cherry Brook	Olo Street culvert exit	41˚ 59' 57.03"	71˚ 31' 23.00"	14.7
W-32	Front Street Drain	Behind apartments at Front St. and S. Main St.	41˚ 59' 53.73"	71˚ 31' 02.97"	14.3
W-22	Blackstone River	Bernon Street bridge	42˚ 00' 00.44"	71˚ 30' 48.50"	13.9
W-11	Mill River *(MA/RI border)*	Harris Pond Dam at bottom of dam	42˚ 00' 54.87"	71˚ 30' 25.55"	-
W-12	Mill River (pre-culvert entry)	North of Social Street at culvert inlet	42˚ 00' 34.18"	71˚ 30' 24.70"	-
W-13	Mill River (BR confluence)	North of Clinton Street at culvert exit to Blackstone R.	42˚ 00' 24.56"	71˚ 30' 17.20"	13.2
W-14	Peters River *(MA/RI border)*	Diamond Hill bridge crossing	42˚ 00' 56.13"	71˚ 29' 35.10"	-
W-15	Peters River (pre-culvert entry)	Elm Street culvert inlet	42˚ 00' 34.72"	71˚ 30' 02.11"	-
W-16	Peters River (BR confluence)	South of Cumberland St at culvert exit to Blackstone R.	42˚ 00' 24.66"	71˚ 30' 10.03"	13.1
W-17	Blackstone River	Bridge crossing at Hamlet Ave and RT 122	42˚ 00' 10.73"	71˚ 29' 53.28"	12.8
W-33	Sylvestre Pond Outflow	Adjacent power line towers behind Woonsocket WWTF	42˚ 00' 02.66"	71˚ 29' 49.81"	12.6
W-24	Woonsocket WWTF	Effluent discharge of WWTF	41˚ 59' 56.32"	71˚ 29' 44.11"	12.5
W-02	Manville Dam	Upstream side of Manville Dam on East bank	41˚ 58' 18.54"	71˚ 28' 14.11"	9.9
W-03	Blackstone River	Bike path bridge under RT 116 (GW Highway bridge)	41˚ 56' 17.11"	71˚ 26' 01.57"	6.6
W-34	Blackstone Canal at Lonsdale	Overflow of Blackstone Canal north of Front Street (RT123)	41˚ 54' 41.85"	71˚ 24' 28.10"	3.9
W-04	Blackstone River	RT 22 bridge crossing	41˚ 54' 40.59"	71˚ 24' 10.22"	3.7
W-35	Un-named brook near Ann&Hope warehouse	Outfall behind Ann & Hope south end of warehouse	41˚ 54' 39.65"	71˚ 23' 47.73"	3.3
P-04	Blackstone River	On mainstem above Valley Falls Pond inlet	41˚ 53' 54.74"	71˚ 23' 41.40"	2.3
W-25	Blackstone River	RT 114 bridge crossing	41˚ 53' 57.30"	71˚ 23' 24.74"	2.0
W-26	Abbott Run Brook	Mill Street bridge crossing	41˚ 54' 02.40"	71˚ 23' 08.33"	1.8
W-05	Slater Mill Dam	Upstream side of Slater Mill Dam on South bank	41˚ 52' 36.86"	71˚ 22' 55.71"	0.0

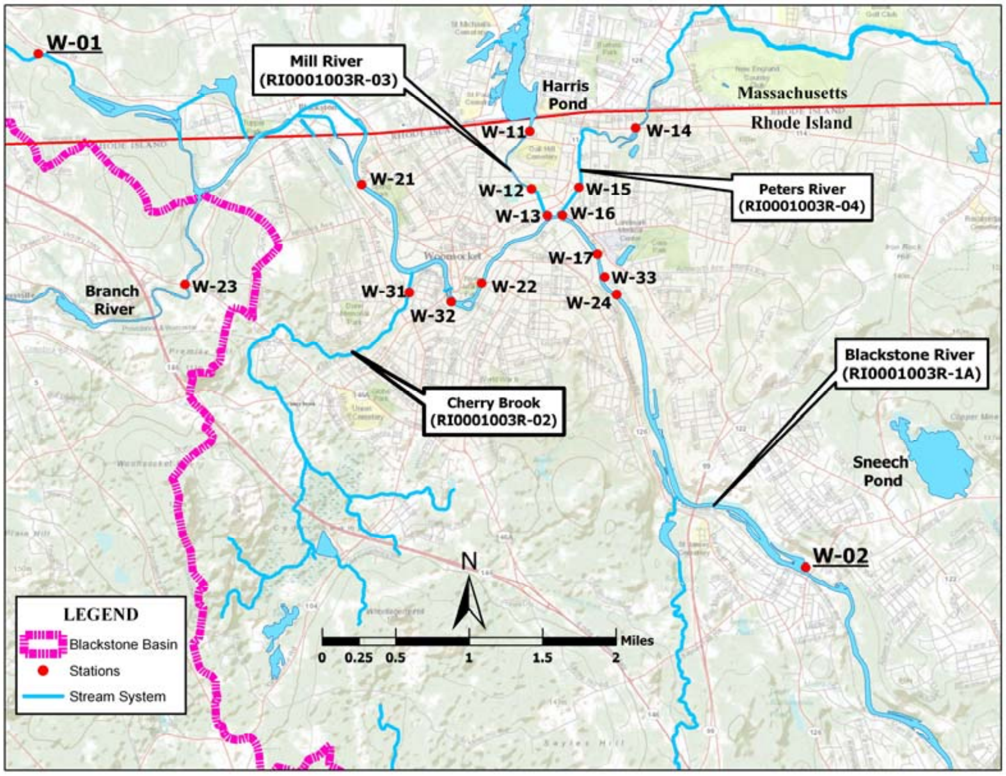

Figure 3.1 Water Quality Stations in the Rhode Island Upper Portion of Blackstone Watershed

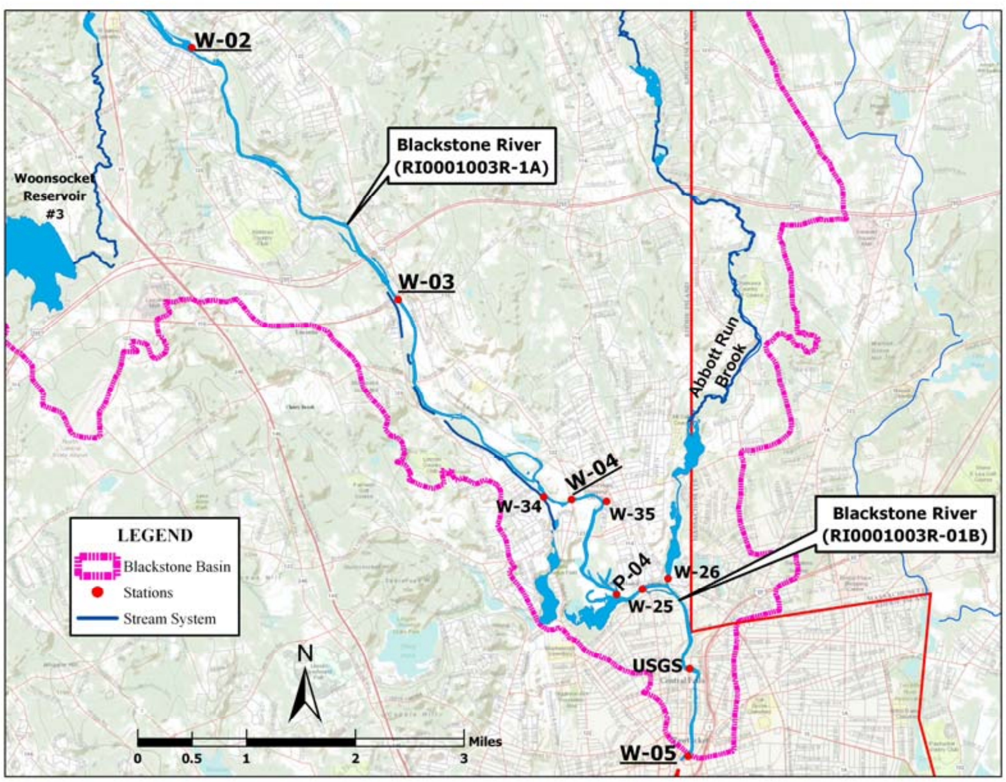

Figure 3.2 Water Quality Stations in the Rhode Island Lower Portion of Blackstone Watershed

The water quality monitoring surveys carried out by LBG consisted of eighteen dry weather surveys from March 16, 2005 through February 17, 2006, and four wet weather surveys completed between July and October 2005. Three of the surveys covered the Blackstone Watershed, while the second storm (WW-02) focused only on the RI portion of the Mill and Peters Rivers. The Blackstone mainstem stations (W-01, 02, 03, 04, 05) were sampled biweekly from May through October, and once a month from November through April. Secondary and tertiary stations were sampled three times over the summer from July through September. Secondary stations included the Mill and Peters River stations, as well as an additional Blackstone station at W-17. Tertiary stations were three additional Blackstone River stations (W-21, 22, 25), Branch River (W-23), Woonsocket WWTF (W-24), Abbott Run (W-26), Cherry Brook (W-31), Front Street Drain (W-32), Sylvester Pond Outlet (W-33) and the Blackstone Canal Overflow (W-34).

Tables 3.7 and 3.8 show the statistical summaries for the BTMDL monitoring conducted on the Blackstone River Watershed in 2005-2006 for fecal coliform and enterococci. The tables include the Rhode Island water quality classification for each location, number of samples taken, geometric mean criteria, and 90th percentile criteria. Since 90^{th} percentile criteria apply only to fecal coliform, this summary is not present for enterococci.

As is evidenced by the data, elevated pathogen levels are observed at the Massachusetts –Rhode Island state line on the Blackstone, and Peters Rivers during dry and wet weather. Dry weather pathogen concentrations in the Blackstone River exceeded the 200 MPN/100ml geometric criteria for fecal coliform both at the Millville, MA (W-01) station and at Hamlet Avenue/RT 122 Bridge (W-17). From the State line, fecal coliform concentrations decreased slightly but then increased again at the Hamlet Avenue bridge crossing; within this reach, possible sources of bacteria include the Branch River, Mill River, and Cherry Brook – as well as possible dry weather sources within the City of Woonsocket. Cherry Brook had among the highest fecal coliform geomean concentrations in dry weather at 1,260 MPN/100ml.

The lowest pathogen concentrations on the Mill River occurred at the State line; mid and lower section, Stations W-12 and W-13 both exceeded the geomean criteria during dry weather with fecal coliform geomean concentrations at 436 and 215 MPN/100ml respectively. Also, the Mill River was the only major tributary to exceed the State’s enterococci criteria with dry weather geomean values of 156.9 CFU/100ml at Station W-12, and 72 CFU/100ml at Station W-13. On the Peters River, dry weather pathogen concentrations increased slightly from the State line to its confluence with the Blackstone River, but all geomean concentrations were below pathogen criteria. Though many stations on the Blackstone, Peters and Mill River met the geomean criteria during dry weather, most had exceedances of the 90^{th} percentile criterion.

With few exceptions, wet weather values far exceeded dry weather values at all stations. The highest fecal coliform geomean concentrations were observed at the Millville, MA station (W-01) and the Slatersville Mill station (W-05), with values of 1,119 and 1,224 MPN/100ml, respectively; both likely reflecting upstream CSO discharges. The diluting effects of the Branch River are obvious as you travel from the State line station (W-01) to Station W-21 and inputs from the City of Woonsocket and the Mill and Peters River are evident with the increasing concentrations observed at the Hamlet Avenue Bridge crossing (W-17). Significant wet weather

Table 3.7 BTMDL Study Fecal Coliform Data

Station	Waterbody	Class	Number of Samples		Geometric Mean (MPN/100ml)			90th Percentile (MPN/100ml)		
			Dry	Wet	Criteria	Observed		Criteria	Observed	
						Dry	Wet		Dry	Wet
W-01[a]	Blackstone River Millville, MA		18	28	200	**211**	**1,119**	400	**1,420**	**9,000**
W-21	Blackstone River RI0001003R-01A	B1	3	7	200	106	**700**	400	130	**7,460**
W-22			3	7		116	**621**		218	**2,580**
W-17			6	7		**454**	**988**		**800**	**2,640**
W-02			18	28		150	**656**		**740**	**5,000**
W-03			18	29		97	**595**		**860**	**3,400**
W-04			18	29		111	**703**		**950**	**2,940**
P-04[b]			6	2		88	**503**		220	**1,013**
W-25			3	8		44	**569**		180	**3,600**
W-05	Blackstone River RI0001003R-01B	B1	18	28	200	153	**1,224**	400	**700**	**11,100**
W-11[c]	Mill River		8	19	200	38	113	400	188	300
W12	Mill River R10001003R-03	B	8	19	200	**436**	**1,475**	400	**1,910**	**10,400**
W-13			7	19		**215**	**1,216**		**1,680**	**16,200**
W-14[c]	Peters River		8	19	200	121	**3,093**	400	**620**	**17,000**
W-15	Peters River R10001003R-04	B	8	19	200	176	**2,978**	400	**797**	**17,000**
W-16			4	10		180	**6,123**		279	**17,000**
W-31	Cherry Brook R10001003R-02	B	3	7	200	**1,260**	**3,628**	400	**4,160**	**30,200**

a - Station W-01 is located in MA at the railroad bridge crossing adjacent to RT122; b - Station P-04 is on the Blackstone River above the entrance to Valley Falls Pond;
c - Stations located at MA/RI border.

Table 3.8 BTMDL Study Enterococci* Data

Station	Waterbody	Class	Number of Samples		Geometric Mean (CFU/100ml)		
			Dry	Wet	Criteria	Observed	
						Dry	Wet
W-01[a]	Blackstone River Millville, MA		18	27	-	14	230.9
W-21	Blackstone River RI0001003R-01A	B1	1	-	54	<10	-
W-22			1	-		<10	-
W-17			6	-		13.1	-
W-02			18	27		10.2	**202.8**
W-03			17	28		7.4	**203.0**
W-04			18	28		8.0	**247.3**
P-04[b]			5	2		7.5	44.3
W-25			1	-		<10	-
W-05	Blackstone River RI0001003R-01B	B1	18	28	54	12.1	**224.8**
W-11[c]	Mill River		6	7	-	7.3	61.3
W12	Mill River R10001003R-03	B	6	7	54	**156.9**	**3,928.6**
W-13			5	7		**72.0**	**2,076.3**
W-14[c]	Peters River		6	7	-	41.5	**13,801.2**
W-15	Peters River R10001003R-04	B	6	7	54	50.7	**16,408.4**
W-16			3	7		15.0	**16,257.1**
W-31	Cherry Brook R10001003R-02	B	1	-		**200**	-

* Note that Enterococci water quality criterion is expressed as geomean only.

a - Station W-01 is located in MA at the railroad bridge crossing adjacent to RT122; b - Station P-04 is on the Blackstone River above the entrance to Valley Falls Pond; c - Stations located at MA/RI border

sources of pathogens are evident on both the Mill and Peters River with geomean concentrations ranging as high as 1,475 MPN/100ml on the Mill River and to 6,123 MPN/100 ml on the Peters River. Given very high concentrations of fecal coliform at the State line on the Peters River, wet weather sources in both MA and RI must be controlled. On the Mill River, no wet weather sources from MA are evident.

Cherry Brook had among the highest wet weather values observed during the BTMDL study, with a wet weather fecal coliform geomean of 3,628 MPN/100ml and a high geomean value of 25, 495 MPN/100ml for Storm 1. All Rhode Island stations on the Blackstone, Mill and Peters Rivers exceeded the 54 CFU/100ml enterococci criteria with Station W-04 having the highest geomean concentration of 247.3 CFU/100ml. Enterococci were also contributed by Massachusetts with a wet weather geomean value at Station W-01 of 230.9 CFU/100ml.

3.1.6 Summary of Pathogen Conditions

A summary of pathogen data collected as part of the BTMDL study, USGS and RIDEM baseline monitoring are presented in Tables 3.9 and 3.10. Samples collected by the USGS at the last two primary stations (W-04 and W-05) were factored into the statistical summaries as are additional samples taken by RIDEM staff during several field investigations conducted in the Cherry Brook Watershed to isolate hot spots.

Table 3.9 Statistical Summary of Fecal Coliform Data

Station	Waterbody	Class	Number of Samples	Geometric Mean (MPN/100ml)		90th Percentile (MPN/100ml)	
				Criteria	Observed All Samples	Criteria	Observed All Samples
W-01[a]	Blackstone River Millville, MA	B1	46	200	**583**	400	**5,500**
W-21	Blackstone River RI0001003R-01A	B1	10	200	**397**	400	**2,690**
W-22			10		**375**		**2,370**
W-17			13		**690**		**2,260**
W-02			46		**368**		**3,000,**
W-03			47		**298**		**2,340**
W-04			47		**346**		**2,400**
P-04[b]			8		136		**498**
W-25			11		**282**		**3,000**
USGS[d]	Blackstone River RI0001003R-01B	B1	52	200	**450**	400	**5,920**
W-05			46		**542**		**4,000**
W-11[c]	Mill River	B	27	200	82	400	300
W12	Mill River R10001003R-03	B	27	200	**1,028**	400	**9,000**
W-13			26		**762**		**10,500**
W-14[c]	Peters River	B	27	200	**1,184**	400	**17,000**
W-15	Peters River R10001003R-04	B	27	200	**1,288**	400	**17,000**
W-16			14		**2,236**		**17,000**
W-31	Cherry Brook R10001003R-02	B	17	200	**1,934**	400	**14,600**

a - Station W-01 is located in MA at the railroad bridge crossing adjacent to RT122; b - Station P-04 is on the Blackstone River above the entrance to Valley Falls Pond; c - Stations located at MA/RI border; d- USGS station located at Roosevelt Avenue in Pawtucket, RI

Table 3.10 Statistical Summary of Enterococci Data

Station	Waterbody	Class	Number of Samples	Geometric Mean (CFU/100ml)	
				Criteria	Observed All Samples
W-01[a]	Blackstone River Millville, MA	B1	98[c]	54	**72.2**
W-21	Blackstone River RI0001003R-01A	B1	1	54	<10
W-22			1		<10
W-17			6		13.3
W-02			95[c]		**68.6**
W-03			46		**58.0**
W-04			47		**64.5**
P-04*			7		12.4
W-25			1		<10
USGS[d]	Blackstone River RI0001003R-01B	B1	53	54	**91.7**
W-05			47		**71.7**
W-11[b]	Mill River	B	13	54	23
W12	Mill River R10001003R-03	B	13	54	**888.6**
W-13			12		**511.6**
W-14[b]	Peters River	B	13	54	**946.5**
W-15	Peters River R10001003R-04	B	13	54	**1,139.2**
W-16			10		**1,999.3**
W-31	Cherry Brook R10001003R-02	B	6	54	**566**

*Station P-04 is on the Blackstone River above the entrance to Valley Falls Pond
a - Station W-01 is located in MA at the railroad bridge crossing adjacent to RT122; b - Stations located at MA/RI border
c – Includes USGS data collected at Millville, MA (W-01) and Manville Dam (W-02), d- USGS station located at Roosevelt Avenue in Pawtucket, RI

Overall, for fecal coliform, all Blackstone River main stem stations exceeded the State's standard, with Hamlet Avenue Bridge ranked number one with a geomean of 690 MPN/100ml. The next highest station sampled during the BTMDL was W-01 in Massachusetts at 583 MPN/100ml. Station W-01 also ranked number one in the upper segment of the Blackstone River for enterococci with a geomean value of 72.2 CFU/100ml. The highest enterococci geomean value for a Rhode Island station was the USGS site at Roosevelt Avenue in Pawtucket, just above the BTMDL Station at Slater Mill Dam (W-05), and within the segment impacted by combined sewage overflows. This lower segment of the Blackstone is not included in this TMDL for pathogen impairments as explained in section 1.1. When compared to the 1991 Blackstone River Initiative (BRI) study, the pattern of fecal coliform concentrations are similar during both dry and wet weather.

In addition to the above studies, RIDEM staff conducted field investigations in and around those areas that were identified as 'hot spots' in the Berger Report (February 2008). To date, water quality sampling has been conducted in the watersheds of Cherry Brook and Mill River. The results of those surveys will be discussed later in this document, however Table 3.11 shows the observed fecal coliform values from the three field investigations conducted in the Cherry Brook watershed. A map depicting the location of these sampling stations is shown in Figure 4.1.The last groups of samples were collected during a wet weather event. Field surveys were conducted on an outfall draining a large area of Cumberland and discharging below the Ann & Hope parking lot (OF-317) that was identified in the report as a major contributor of fecal coliform, with a dry weather geometric mean value of 7,559 MPN/100ml for four water quality samples taken from November 2005 to February 2006.

Table 3.11 Cherry Brook Fecal Coliform (MPN/100ml) Results for RIDEM Staff Field Surveys

Station ID	Nearest Street Crossing	8/20/2009	9/2/2009	10/7/2009*	Geomean
W-31	Olo Street	930		9,300	2,941
CB01	Mason Street	430			
CB02	Alice Avenue	93			
CB03	RT146A	15,000			
CB04	Pound Hill Road	46,000	43	4,300	2,041
CB05	Un-named dirt road		23	2,300	230
CB06	Woonsocket Hill Road		150	43,000	2,540
CB07	Knollridge Drive		93		
CB08	RT146		43		

* Wet weather event

3.2 Applicable Studies - Trace Metals

3.2.1 U.S. Geological Survey

As part of the statewide watershed assessment program for basins draining into Narragansett Bay, the USGS has been collecting water quality data at since 2007 at Millville, MA, Manville Dam in Manville, RI, and Roosevelt Avenue in Pawtucket, RI. During this period, dissolved cadmium and lead samples were also collected and analyzed, but on a less frequent basis. Between 2007 and 2011, a total of nineteen samples were collected at Millville, MA and sixteen samples per station were collected at the RI sites for the above constituents. A summary of the data for this period is shown in Table 3.12 below.

Table 3.12 Trace Metal Summary for the USGS Manville Dam and Roosevelt Avenue Stations

Metal	Millville, MA		Manville Dam		Roosevelt Avenue	
	Mean (µg/L)	Maximum (µg/L)	Mean (µg/L)	Maximum (µg/L)	Mean (µg/L)	Maximum (µg/L)
Cadmium	0.30	1.10	0.19	0.36	0.18	0.36
Lead	0.81	3.37	0.76	2.58	0.72	2.58

3.2.2 Blackstone River TMDL Study

Details of the water quality monitoring surveys carried out by LBG are described in detail in section 3.1.5 above. Consistent with EPA's Technical Support Document for Water Quality-based Toxics Control (1991), dissolved metals data for this TMDL were evaluated under both low and high flow conditions. Following is a description of flow conditions monitored during the BTMDL study. During the study period extending from 2004 to 2006, the monthly mean flows for the Blackstone River in Woonsocket (at the Manville Dam USGS Gage) ranged from a low of approximately 300 cfs in August to a high of 1,500 cfs in March. The flows reached a peak of over 13,000 cfs in October 2005. The flow in the Blackstone River at Slater Mill Dam for the dry weather surveys ranged from 119 cfs to 2,440 cfs, with a mean of 845 cfs. During wet weather events, the Blackstone River flows at Slater Mill Dam ranged from 163 cfs for Storm 3 to 2,267 cfs for Storm 4, with a mean flow for all storms of 1,322 cfs at the mouth of the Blackstone.

Dry flows in the Mill River at the confluence with the Blackstone ranged from a low of 3.9 cfs (ft^3/sec) in September 2005 to a high of 94 cfs in February 2006. The Peters River saw dry weather flows at the confluence vary from 0.90 cfs in August 2005 to 51 cfs in February 2006. The mean dry weather flow in the Mill was 40.9 cfs while the Peters had a mean dry weather flow of 19.3 cfs. During wet weather events, flows for the Mill ranged from a low of 3.9 cfs for Storm 2 to 183 cfs for Storm 4. The Peters River wet weather flows ranged from a low of 2.70 cfs for Storm 2 to a maximum of 90 cfs for Storm 4. The mean wet weather flows for all storms in the Mill and Peters Rivers were 83.9 cfs and 40.3 cfs respectively. The average annual rainfall in Woonsocket is approximately 50 inches per year, ranging from 27 to 65 inches.

Table 3.13 presents a summary of the results of the BTMDL study monitoring conducted on the Blackstone River Watershed in 2005-2006 for lead and copper combined with the USGS monitoring results from 2007-2011 for lead and cadmium.

3.2.3 Summary of Trace Metals Concentrations

Following the procedure described in Section 1.4.2, available trace metals data were evaluated for compliance with applicable criteria. The results of this assessment are described below. There were no acute lead criteria exceedances at any stations monitored in the Blackstone Watershed during the BTMDL dry weather surveys. Chronic criteria was exceeded only once on the mainstem during the October 22, 2005 survey when flows in the Blackstone were nearly five times higher than the historical mean daily flow for October. However, more recent data collected at the USGS stations at Manville Dam and Roosevelt Avenue in Pawtucket, RI indicate that both segments of the river exceeded the chronic criteria for dissolved lead. While these exceedances occurred during dry and wet weather surveys and under a variety of flow conditions, the highest lead concentrations occurred during high flows when the watershed received one to three or more inches of rainfall. The flows associated with these wet weather events were in the two percentile range with measured flows ranging between 3300 to 8300 ft^3/sec. The range of criteria for the Blackstone Watershed is shown in Table 6.1. The data tables for the TMDL dissolved metals analyses including all applicable criteria are provided in Appendix B.

Table 3.13 Summary of BTMDL and USGS Blackstone River Watershed Dissolved Trace Metal Data

Waterbody and ID	Station	Observed Cd (µg/L)					Observed Cu (µg/L)					Observed Pb (µg/L)				
		Dry		Wet		Criteria Exceeded (Dry or Wet)	Dry		Wet		Criteria Exceeded (Dry or Wet)	Dry		Wet		Criteria Exceeded (Dry or Wet)
		Mean	Max	Mean	Max		Mean	Max	Mean	Max		Mean	Max	Mean	Max	
Blackstone River, Millville MA	W-01[a]	0.29	0.40	0.30	1.10	Acute (2 Wet) Chronic (6 Dry, 11 Wet)	5.70	10.00	6.60	8.60		0.60	0.76	0.90	3.37	Chronic (4 Wet)
Blackstone River RI0001003R-01A	W-21						5.60	6.60	7.20	10.00		0.22	0.29	0.97	1.00	
	W-22						5.60	6.30	7.50	10.00		0.27	0.47	0.34	0.49	
	W-17						4.80	6.60	5.80	7.90		0.32	0.48	0.27	0.42	
	W-02						4.30	7.10	5.10	6.40		0.42	1.30	0.45	1.40	
	USGS[1]	0.21	0.23	0.18	0.36	Chronic (4 Dry , 10 Wet)	3.25	4.01	3.15	4.72		0.47	0.64	0.86	2.58	Chronic (5 Wet)
	W-03						4.60	8.90	5.00	6.80		0.41	1.50	0.37	1.00	
	W-04						4.30	5.90	5.20	8.50		0.40	1.40	0.34	0.72	
	P-04						4.30	4.30	5.50	5.80		<0.04	<0.04	0.14	0.15	
	W-25						4.60	5.40	4.80	5.50		0.23	0.29	0.17	0.24	
Blackstone River RI0001003R-01B	USGS[2]	0.20	0.23	0.16	0.36	Chronic (4 Dry, 9 Wet)	3.36	3.72	3.06	4.31		0.43	0.90	0.82	2.58	Chronic (5 Wet)
	W-05						3.90	5.10	4.80	6.00		0.41	1.40	0.32	0.78	
Mill River[C]	W-11[b]						1.90	2.60	1.84	3.25		0.44	0.96	0.20	0.66	Chronic (1 Dry)
Mill River[C] RI0001003R-03	W-12						2.00	2.90	2.07	3.90		0.48	0.95	0.33	0.75	Chronic (1 Dry)
	W-13						2.40	3.80	2.60	4.30	Acute (1 Wet)	0.54	0.80	0.48	1.28	Chronic (1 Dry)
Peters River	W-14[b]						1.70	2.10	2.91	4.40	Acute (4 Wet) Chronic (1 Wet)	0.42	0.78	0.38	1.10	
Peters River RI0001003R-04	W-15						2.10	2.90	2.91	4.30	Acute (4 Wet) Chronic (1 Wet)	0.42	0.44	0.30	0.52	
	W-16						1.90	2.10	3.05	4.70	Acute (3 Wet) Chronic (1 Wet)	0.15	0.18	0.43	0.82	
Cherry Brook[C] RI0001003R-02	W-31						2.40	2.80	4.40	5.20	Acute (1Wet) Chronic (2 Wet)	0.89	1.77	0.83	1.00	Chronic (1 Dry)

Station P-04 is on the Blackstone River above the Valley Falls Pond entrance. 1 – USGS station at W-02 (Manville Dam), 2 – USGS station at Roosevelt Avenue;
a - Station W-01 is located in MA at the railroad bridge crossing adjacent to RT122; b - Stations located at MA/RI border. c - The Cherry Brook and Mill River Stations had one exceedance of the chronic lead criteria during dry weather under unusually high stream flow conditions. These were not assessed as violations because the criteria allow for a single exceedance once every three years. A more detailed explanation of the Mill River data review and delisting justification is on the RIDEM website at:
http://www.dem.ri.gov/programs/benviron/water/quality/pdf/iwqmon10.pdf

When dry weather concentrations for lead are compared between the USGS and BTMDL data sets, the more recent data provided by the USGS shows an increase of the average lead concentrations in the mainstem of the Blackstone River. The USGS mean lead concentrations at the Millville, MA station is only slightly higher than the BTMDL data, however, the mean USGS values for the Rhode Island stations are more than two times the mean lead values reported in the BTMDL data. The mean lead concentrations for the BMDL at Millville, Manville and Slater Mill were 0.46µg/L, 0.37µg/L and 0.36µg/L respectively. The USGS mean concentrations for Millville, Manville and Roosevelt Avenue were 0.57µg/L, 0.76µg/L and 0.75µg/L respectively. While the average flow values are similar for all stations for both sets of samples, the individual flows associated with the maximum observed concentrations for the USGS data are significantly lower. The Millville station had a maximum lead concentration of 1.3µg/L at 1600 cfs for the BTMDL while the maximum lead value for the USGS data was 1.23µg/L at a flow of 632 cfs. Similarly, the Manville Dam lead maximum concentration for the BTMDL was 1.3µg/L at 2315 cfs and the maximum USGS lead concentration at Manville was 2.58µg/L at 1350 cfs. Although the BTMDL station at Slater Mill Dam was slightly downstream of the Roosevelt Avenue USGS station, the observed concentrations and flows were 1.4µg/L at 2440 cfs and 2.58µg/L at 961 cfs. The USGS data set maximums at Manville Dam and Roosevelt Avenue of 2.58µg/L were collected two days apart which accounts for the lower flow of 961 cfs recorded at the Roosevelt Avenue station. The river was on the receding leg of a storm hydrograph because two days prior to the sampling date in June 2011, Worcester, MA had a rainfall total of 3.14 inches over a 4 day period.

There were no acute or chronic exceedances of dissolved lead during wet weather surveys for the Mill or Peters Rivers. Compared to the BRI, the dry weather concentrations of dissolved lead are considerably lower for the BTMDL surveys.

There were not any dry weather exceedances of dissolved copper criteria at any of the BTMDL stations. During wet weather, one acute and two chronic exceedances were observed in Cherry Brook, while all stations on the Peters River had both acute and chronic exceedances of the dissolved copper criteria. The Peters River average dissolved copper concentrations for wet weather showed a slight increase from Station W-14 at the state line to W-16 at the confluence with the Blackstone River. The mean wet weather concentration for the Peters River ranged from 2.91µg/L at W-14 to 3.05µg/L at W-16. All exceedances of the state's dissolved copper criteria occurred during the second storm event in September 2005.

Chronic criteria for dissolved cadmium were exceeded at both USGS stations located in RI for more than eighty percent of the sampling events that the USGS conducted on the Blackstone River between 2007 and 2011. The USGS data set for the station at Manville Dam had the highest mean dissolved cadmium value at 0.19µg/L. Both the Manville Dam and Roosevelt Street stations had a high single survey dissolved cadmium value of 0.36µg/L during April 17-18, 2007 survey.

The station located at Millville, MA exceeded the dissolved cadmium criteria ninety percent of the time with a mean concentration of 0.30µg/L for the nineteen sampling events conducted by the USGS. The maximum dissolved cadmium value observed at Millville, MA was 1.10µg/L on March 23, 2010 at a flow of 2055 cfs. This survey was a wet weather event with 1.9 inches of precipitation recorded in Worcester, MA. Table 3.13 is a summary of the trace metal data collected during the BTMDL and USGS studies.

3.2.4 Trace Metal Load Calculations

Trace metal loads were calculated from the observed flow and concentration data in the BTMDL Field Survey Report for Peters River and Cherry Brook, and from the USGS data for the Blackstone River Stations. The dry weather loads for Peters River and Cherry Brook used the flow and concentration data from each dry weather survey. These load calculations can be found in Appendix B and were compared to the allowable acute and chronic loads that were calculated using the criteria and the observed flows. The wet weather loads were calculated two ways. The flow and concentration data for each survey run and for each wet weather event was used to calculate a load. This load was compared against the load calculated using the acute criteria. The Event Mean flow and concentration for each station and for each wet weather event was calculated and compared to the chronic load for that station for the particular wet weather event.

The Blackstone River station loads were calculated using the USGS data. The observed dissolved metals concentration and associated flow for each survey was used to calculate a load. This load was then compared against the chronic criteria load calculated using the same flow data and the chronic criteria concentration determined using the mean observed hardness values of the Manville Dam and Roosevelt Avenue on the date samples were collected. Survey dates within 48 hours of each other for the USGS stations are considered to have occurred on the same date for purposes of calculating an average hardness value for the RI stations. Table 3.14 shows the range of loads for the dissolved metals addressed in this TMDL.

Table 3.14 Range of Loads Observed in the Blackstone River, Peters River and Cherry Brook

Waterbody ID	**Range of Observed Dissolved Metals Loads (lbs/day)**		
	Cadmium	**Copper**	**Lead**
MA-RI State Line at Blackstone River	0.15 - 22.1	--	0.23 – 38.4
Blackstone River (RI0001003R-01A)	0.13 - 16.8	--	0.15 - 56.6
Blackstone River (RI0001003R-01B)	0.15 - 12.9	--	0.18 - 29.3
MA-RI State Line at Peters River	--	0.03-1.25	--
Peters River (RI0001003R-04)	--	0.01-1.43	--
Cherry Brook (RI0001003R-02)	--	0.01-0.15	--

3.2.5 Additional Studies on the Blackstone Watershed

The Blackstone River has been the focus of many water quality studies in the past. As part of this TMDL, a synthesis of the many surveys in the Blackstone River Watershed was done by The Louis Berger Group which is summarized in Water Quality – Blackstone River, Final Report 1: Existing Data (Berger, 2004). Table 3.15 shows those water quality studies that were conducted in the Rhode Island portion of the watershed and had fecal coliform and trace metals listed as analytical parameters. These studies provided RIDEM staff the information that was used to evaluate possible sources that contributed to the current observed pollutant concentrations in the watershed. None of the historical data were used in the TMDL analysis calculations.

Table 3.15 Historic Water Quality Studies in the Blackstone River Watershed

Study	Parameters	Period of Study
URI Wet Weather Study (Wright, et al., 1991)	Fecal coliform, metals, nutrients, PCBs, PAHs, TSS, petroleum hydrocarbon	Oct 1988-Jun 1989 3 storm events
System wide Modeling for Providence CSO Program (URI-CVE, 1992)	Fecal coliform, metals, nutrients, TSS	May 1990-Sep1990 4 storm events
Blackstone River 1990, Pollutant Discharges and Water Quality Review (Wright, et al., 1991)	Fecal coliform, TSS, BOD, pH, lead, ammonia, total phosphorus	1988-1989 Monthly monitoring
URI Watershed Watch, Lakes Monitoring Data (URI, unpublished data)	Fecal coliform, secchi depth, algae density, nutrients, DO, alkalinity, anions, E. coli	1993-2000
RIDEM Chemical Monitoring for Section 305b Assessment (RIDEM, 2000)	Fecal coliform, temp, DO, total lead and copper, nutrients	1991-2000
USGS Water Resources Data (USGS, 2000)	Fecal coliform, temp, DO, total metals, nutrients,	1990-1999
Water Quality Sampling of Tributaries (NBC, 1997-1999)	Fecal Coliform	1997-present
RIPDES Permitted Discharges (RIDEM, unpublished data)	Fecal coliform, metals, nutrients	1997-2001
Blackstone River Initiative (Wright, et al., 2001)	Fecal coliform, temp, DO, total metals, nutrients	1991-1993

4.0 POLLUTION SOURCES

Sources of fecal coliform bacteria, copper and lead in the Rhode Island portion of the Blackstone River watershed were identified through both the review of historical information that was conducted by The Louis Berger Group (LBG) at the start of the BTMDL study (Berger, 2004) and the previously described BTMDL water quality monitoring surveys conducted along the length of the river during dry and wet weather. RIDEM staff also conducted a number of follow-up surveys to identify potential sources, particularly in the areas of Cherry Brook, the so called Ann and Hope outfall downstream of Station W-04 on the Blackstone River, and Narragansett Bay Commission CSO #107 that drains into Valley Falls Pond from Richmond Street along the southern shore.

In the lower portion of the Blackstone River serviced by Combined Sewers, NBC’s Semi-Annual Reports on Implementation of Best Management Practices Plan for Field’s Point and Bucklin Point Service Areas were reviewed for information related to the dry weather performance of CSOs. The LBG also complied outfall mapping information from municipalities along the mainstem and conducted an extensive reconnaissance of the river to identify many of the outfalls that flow into the river under wet and sometimes, dry weather conditions. Priority outfalls with high fecal coliform levels are listed in Table 4.2 of the TMDL.

The TMDL examination of potential sources in the area also looked at possible contributions from industrial and commercial uses along the Blackstone River. To assure full compliance with existing industrial stormwater permitting requirements, facilities that could potentially be regulated under the Multi-Sector General Permit were identified and mapped using existing records of businesses in the area and GIS programs.
Actual and potential sources of pathogen and metals contamination to the Blackstone River and its tributaries include stormwater runoff; RIPDES permitted discharges, both illegal and “legal” dry weather discharges from stormwater outfalls; dry and wet weather CSO discharges, failing septic systems, animal waste and sediment resuspension, as summarized in Table 4.1 and further discussed below.

4.1 Stormwater

Stormwater runoff is a significant source of pollution to the Blackstone River and its tributaries, particularly in the more urbanized areas of Woonsocket, Lincoln, and Cumberland. The majority of stormwater in the watershed’s other two urban centers, Pawtucket and Central Falls is discharged into Combined Sewer Overflows and is discussed separately below. Throughout the non-CSO portion of the watershed, storm drainage systems collect, concentrate and route polluted runoff from streets and highways directly to the river. Stormwater from privately owned property, such as parking lots, and commercial and industrial areas may be discharged into these municipal or state owned drainage systems or may be conveyed directly to the Blackstone River via overland flow, stormwater pipes, or other conveyances. The storm drain network in the watershed is extensive, and although outfall locations have largely been mapped only limited mapping of storm drain networks is available.

Table 4.1 Actual and Potential Sources of Pathogens and Metals to the Blackstone River Watershed

Source	Location/ Explanation
Stormwater Runoff	Throughout watershed especially in more urban areas. Runoff from parking lots, streets, roofs, and runoff contaminated with pet, feral, animal wastes, and heavy metals (Cu, Pb, and Cd).
Urban Runoff from Dry Weather	Overland flows from various land use practices enter storm drains, which including lawn irrigation runoff, car washing, sidewalk washing and commercial pavement washing. These urban flows can contain bacteria and metals.
RIPDES sanitary and industrial wastewater discharges	There is one major RIPDES permittee, Woonsocket WWTF, and two minor RIPDES permittees, Okonite Company and OSRAM Sylvia discharging effluent containing the TMDL's pollutants of concern into the Blackstone River. Watershed –wide, there are several MSGP holders that discharge stormwater from areas where metal contamination may be present.
Wet and Dry Weather CSO Discharges	In Rhode Island, CSOs discharge into the lower Blackstone River reach between Whipple Bridge and Slater Mill Dam. CSOs carry sanitary waste and stormwater runoff. Their discharges contain floating debris, pathogens, stormwater runoff and raw sewage. Dry weather CSO discharges can occur when the conduits are blocked with debris, garbage, and structure failures.
Animal Waste	Watershed wide. Pet waste left on pavement, thrown into catch basins or left on lawns can be washed into storm drains by rain or melting snow. Farm animals also may contribute to elevated bacteria levels due to contaminated runoff and/or unrestricted access of farm animals to wetlands and surface waters. Feral animals attracted by garbage and other litter can congregate, resulting in their waste being transported through runoff into the river.
Illegal Sources	Watershed wide. Illegal sources include illicit connections of sanitary wastewater to storm drains, as was discovered in the area of Broad and Blackstone Streets in Cumberland.
Septic System Failures	Failing or improperly designed or installed on-site septic tanks and/or drain fields that allow discharge of partially treated or untreated effluent
Sediment Resuspension/ Sloughing	Metals such as Cd, Cu, and Pb have an affinity for sediments. Previous studies have identified impoundments in the Massachusetts portion of the Blackstone River where sediments have become entrenched behind dams. Flow fluctuations due to precipitation, runoff, and hydropower operations may increase bank scouring, sloughing, and re-suspension of bottom sediment. This re-suspended contaminated material moves into the water column and can be transported and redeposited several miles downstream.
Waste Sources	Waste sources include waste cleanup such as superfund sites, federal facilities, brownfields, underground storage tank system releases and waste lagoons
Massachusetts Source	The BTMDL data showed significant pollutant loads coming across the state line for both bacteria and metals. Historically, NPDES permitted facilities in MA were issued permits with winter bacteria limits that were documented to cause exceedances in the RI portion of the river, where no seasonal bacteria criteria are applied. More recent NPDES permits have resolved this issue. CSO discharges in Worcester may also contribute to elevated pollutant concentrations in the RI portion of the Blackstone.
Branch River	Results of the BTMDL field study show that the Branch River is a consistent and significant source of lead to the Blackstone during dry weather. Wet weather contributions of lead from the Branch River are relatively low and not a concern.

The following municipal separate storm sewer system (MS4) operators have applied for coverage under the Rhode Island Phase II Stormwater General Permit (issued in 2003) and have prepared the required Phase II Stormwater Management Plans (SWMPP): the Rhode Island Department of Transportation (RIPDES permit RIR040036), Woonsocket (RIR040016), Lincoln (RIR040021), Cumberland (RIR040035), Pawtucket (RIR040024) and Central Falls (RIR040041). North

Smithfield (RIR040013) is more of a rural community and has the majority of the stormwater runoff discharging into the Branch River, which is not a part of this TMDL.

During the BTMDL field surveys of the Blackstone, Mill, and Peters Rivers, many more outfalls and pipes were discovered than were shown on stormwater maps obtained from towns and cities in the watershed. These pipes may be owned by the Rhode Island Department of Transportation and/or private landowners. During the study, samples were collected during dry weather periods from pipes and outfalls that had flows. Additionally, several stations were visited multiple times to collect samples under varying weather conditions. Section 5 of the field investigations final report http://www.dem.ri.gov/programs/benviron/water/quality/rest/pdfs/blackwq2.pdf has more detail of these sources, and Table 4.2 is a summary of significant sources that were sampled during the study. The outfalls listed all discharge into the Blackstone River mainstem unless otherwise noted.

The amount of impervious areas in a watershed also affects the water quality of rivers and streams within the watershed. Recent study results from USGS in the New Hampshire seacoast region confirm that the percent impervious surface in a watershed can be used as an indicator of stream quality: the biological condition score was negatively correlated with the percent impervious surface (Deacon, et.al. 2005). Furthermore, a growing number of northeastern states are recognizing the relationship between impervious cover and water quality impairments, and are utilizing percent impervious cover as a surrogate target for TMDL analyses.

Urban/suburban land uses dramatically change watershed hydrology by affecting the quantity and quality of runoff. Urban development results in increases in stormwater runoff peaks and volumes and increased frequency of runoff from smaller storms. With increasing impervious cover within a watershed, the greater quantities of stormwater runoff wreak havoc with the physical structure and stability of streams and the habitat for aquatic life, and less base flow is available to aquatic life in streams during low flow periods. Typically, water quality also deteriorates with increasing imperviousness.

With funding from a 2008 104b3 grant, RIDEM developed methodologies utilizing the Geographic Information System (GIS) to identify 1) industrial activities subject to Multi Sector General Permit (MSGP) requirements but had not yet applied for coverage under the permit or for a 'No Exposure' exemption, and 2) highly impervious parcels in the Blackstone River watershed. Industrial activities subject to MSGP requirements based upon their Standard Industrial Code (SIC) located in the Blackstone River watershed within the municipalities of Lincoln, Woonsocket, Cumberland, North Smithfield, Burrillville, Smithfield, and Glocester were identified. To identify these businesses an online reference database, *Reference*USA, was utilized. Businesses were "filtered" based on watershed boundary, SIC code, permit history and facility operation. The businesses were notified of their potential need for the MSGP through a mailing. The notification included a letter, postcard, flow chart explaining the MSGP Permit requirements and list of SIC codes subject to MSGP requirements. Mailings were sent to 200 businesses and responses received from over 90%. Many of the industries were either no longer in businesses or able to submit 'No Exposure' certification and a few businesses submitted their application for MSGPs. Through this grant project, RIDEM confirmed that all industrial facilities subject to the MSGP requirements have either submitted the no exposure documentation exempting them from the general permit or have applied for application under the general permit.

The GIS analysis to evaluate parcel level impervious cover was completed for the municipalities of Woonsocket, Lincoln, Cumberland, and North Smithfield. These municipalities were chosen specifically because they border the Blackstone River and/or tributaries addressed in this TMDL, and rely solely upon separate storm sewer systems. Individual parcels having 2 or more acres of impervious cover, and contiguous parcels that together comprise 2 or more acres of impervious cover were identified. Two hundred and twenty-three highly impervious parcels have been identified. A listing of these highly impervious parcels has been included in Appendix C. Outfalls co-located in the vicinity of the contiguous parcels comprising highly impervious areas have been added to the list of priority outfalls in Table 4.2.

4.2 RIPDES (Rhode Island Pollutant Discharge Elimination System) Sources

The Rhode Island Pollution Discharge Elimination System Program (RIPDES) is responsible for permitting industrial and municipal wastewater discharges to all Rhode Island waters. The Woonsocket WWTF, RIPDES permit number RI0100111, discharges municipal wastewater to the upper reach of the Blackstone River (Segment 1A). The observed average discharge and total lead (Pb), total cadmium (Cd) and fecal coliform concentrations at the WWTF for 2005 through 2010 are listed in Table 4.3.

During the field portion of the BTMDL, the Woonsocket WWTF was operating under a permit with cadmium limits of 2.7µg/L and 7.3 µg/L respectively for the average monthly and maximum daily values. Lower cadmium permit limits became effective October 1, 2008; the new permit limits for cadmium are 0.66 µg/L and 4.32 µg/L respectively for the average monthly and daily maximum values. As shown in Table 4.3, observed Total Cadmium concentrations discharged from the Woonsocket WWTF were significantly reduced beginning in 2009 as compared to the pre-2009 data results.

There are a number of other industrial facilities that discharge into the Blackstone River that are operating under RIPDES permits. Of these, three (Okonite Company, OSRAM Sylvania Products, and Woonsocket Water Treatment Facility) are considered minor dischargers, and only OSRAM Sylvania Products, located on the lower reach (Segment 1B) historically discharged lead, a pollutant of concern relative to this TMDL. This facility discharges both contact and non-contact cooling water which is defined as water that is used to reduce temperature and which does not come into direct contact with any raw materials or intermediate, final or waste product (other than heat). Table 4.4 shows the permit limits and the average trace metal concentrations discharged by OSRAM (1995 to 2004) in its effluents into the Blackstone River. A new permit is in the final stages of approval for the facility that shows it will not be discharging lead or other pollutants of concern to this TMDL into the Blackstone River. This new RIPDES permit also shows a reduced maximum discharge for the plant from 350,000 GPD to 150,000 GPD.

Table 4.2 Priority Outfalls

BTMDL Data Report ID	Outfall Size (inches)	Dry Flow (cfs)	Wet Flow Estimated (cfs)	Highest Observed Fecal Coliform (MPN/100ml)	Highest Observed Dissolved Copper (µg/L)	Highest Observed Dissolved Lead (µg/L)	Drains 2 or more Impervious Acres	Presumed Ownership*
Woonsocket								
Blackstone River								
201	48	0.14	5.0	110	1.8	0.19	√	Woonsocket/ DOT
205	60	-	0.20	270	5.3	5.7		Woonsocket/ DOT
213	36							Woonsocket
214	48	0.14					√	Woonsocket
215	36							Woonsocket
218	30						√	Woonsocket
219	72	0.75		300	4.2	0.23	√	Woonsocket/ DOT
222	36							Woonsocket
225	42							Woonsocket
231	48	2.0	5.0	16,000	3.1	1.5	√	Woonsocket
233	30						√	Woonsocket
234	36 x 36							Woonsocket
235	15		0.10	2,200	8.5	2.0		Woonsocket
242	30	0.08	0.20	3,000	12.0	3.7		Woonsocket/ DOT
243	48		0.40	1,700	17.0	8.1	√	Woonsocket/ DOT
244	18		0.2	130	5.4	3.4		Woonsocket
245	36 x 48						√	Woonsocket/ DOT
247	72		3.5	>16,000	8.9	4.6	√	Woonsocket/ DOT
251	24							Woonsocket
252	24							Woonsocket
255	27						√	Woonsocket
258	60		0.25	>16,000	12.0	3.3	√	Woonsocket
260	24							Woonsocket/ DOT

BTMDL Data Report ID	Outfall Size (inches)	Dry Flow (cfs)	Wet Flow Estimated (cfs)	Highest Observed Fecal Coliform (MPN/100ml)	Highest Observed Dissolved Copper (µg/L)	Highest Observed Dissolved Lead (µg/L)	Drains 2 or more Impervious Acres	Presumed Ownership*
263	36	0.15	2.5	>16,000	7.1	3.5	√	Woonsocket/ DOT
266	48	0.50	6.0	220	4.8	0.7	√	Woonsocket/ DOT
Mill River								
703	24							Woonsocket/ DOT
704	36		0.5	2,400	5.7	7.2	√	Woonsocket
Peters River								
802	24	1.5	5		2.5	1.1	√	Woonsocket/ DOT
804	72						√	Woonsocket/ DOT
806	18-24							Woonsocket
815	24	0.10			1.7		√	Woonsocket
Cumberland								
Blackstone River								
353	42x48				4.5		√	Cumberland/ DOT
333	Unk	0.50	2.0	2,400			√	Cumberland/ DOT
325	48x48		2.0	>16,000	6.3	0.94	√	Cumberland/ DOT
324	24	0.05	0.5	>16,000	16.0	2.1	√	Cumberland
323	24						√	Cumberland
320	24						√	Cumberland/ DOT
319	30						√	DOT
304	12	0.40	0.80	>16,000	5.5	1.3	√	Cumberland/ DOT
302	36	0.01	0.13	>16,000	14.0	11.0	√	DOT
301	36		4.0		2.9	0.41	√	Cumberland
317	48 x 96	0.25	6.0	>16,000	23.0	2.0	√	Cumberland/ DOT
314	24						√	Cumberland/ DOT
311	24	0.30-0.50	1.2	>16,000	14.0	2.3	√	Cumberland
312	24						√	Cumberland

BTMDL Data Report ID	Outfall Size (inches)	Dry Flow (cfs)	Wet Flow Estimated (cfs)	Highest Observed Fecal Coliform (MPN/100ml)	Highest Observed Dissolved Copper (µg/L)	Highest Observed Dissolved Lead (µg/L)	Drains 2 or more Impervious Acres	Presumed Ownership*
Lincoln								
Blackstone River								
440	24							Lincoln/ DOT
438	24	0.10						Lincoln
437	24	0.10	0.30	500				Lincoln
435	24 x 24	0.15	0.30	>16,000	5.1	1.7	√	Lincoln
448	21x24	0.05	0.42	>16,000	9.2	4.3		Lincoln/ DOT
431	36	1.2			2.0	1.8		Lincoln/ DOT
446	30							Lincoln
428	24 x 2	1.2	7.0	230	3.3	0.61	√	Lincoln
450	36	variable						Lincoln
416	30 x 24						√	Lincoln
410	24							Lincoln
422	24	0.05	0.30	1,700	1.4			Lincoln

*RIDEM has presumed ownership of the outfalls based upon the road (state or town) closest to the outfall

Table 4.3 Woonsocket WWTF Discharge and Constituent Annual Monthly Mean Values from 2005-2010

Year	Observed Discharge MGD (ft^3/sec)	Total Pb Observed Concentration (µg/L)	Total Cd Observed Concentration (µg/L)	Fecal Coliform Observed Concentration (MPN/100 ml)
2005	8.4 (13.0)	1.72	2.53	5
2006	9.0 (13.9)	1.27	0.72	4
2007	7.1 (11.0)	2.68	1.35	3
2008	8.7 (13.5)	1.41	1.03	3
2009	6.9 (10.7)	1.00	0.60	3
2010	7.6 (11.8)	1.00	0.48	4

Table 4.4 Minor RIPDES Industrial Dischargers

Facility	RIPDES Permit Number	Parameter	Maximum Daily Discharge (GPD)	Maximum Daily Limits (µg/L)	Average Monthly Limits (µg/L)	Average Daily Concentration for period of Record (µg/L)
OSRAM Sylvania Products, Inc.	RI001180	Lead	350,000	2,417	94	33

Other industrial facilities regulated under a Multi Sector General Permit (MSGP) for industrial stormwater discharges are listed in Table 4.5. The listing of these activities includes the current permit number and the type of discharge associated with that site.

4.3 Combined Sewer Overflow (CSO)

A combined sewer system is a wastewater collection system owned by a municipality (as defined by Section 502(4) of the Clean Water Act) that conveys domestic, commercial, and industrial wastewater and stormwater runoff through a single pipe system to a publicly owned treatment works (POTW). A CSO is defined as a discharge from a point prior to the POTW treatment plant. CSOs generally occur in response to wet weather events. During wet weather periods, the hydraulic capacity of the combined system may become overloaded, causing overflows to receiving waters at the discharge points.

Thirteen CSOs discharge into the Blackstone River between Whipple Bridge (W-04) and Slater Mill Dam (W-05). The operation and maintenance of these CSOs is the responsibility of the Narragansett Bay Commission (NBC), a POTW which is responsible for the combined sanitary and storm sewers, sanitary sewers, and the wastewater treatment plants at Fields Point in Providence and Bucklin Point in East Providence. CSO discharges include a mix of domestic, commercial, and industrial wastewater and stormwater runoff. As such, CSO discharges contain human, commercial, and industrial wastes as well as pollutants washed from streets, parking lots, and other surfaces.

Table 3.1 shows the annual geomean and 90th percentile fecal coliform values for the instream dry weather sampling by NBC at Whipple Bridge and Slater Mill Dam Although most CSO overflows occur during wet weather events, when storm lines are blocked by garbage and debris, or a structural failure has occurred, CSO discharges may occur even during dry weather periods. Table 4.5 shows the bypass events reported to RIDEM from 2007 to the summer of 2009.

Table 4.5 Sewer Bypasses Reported to RIDEM between 2007 and 2009

Bypass Event Date	Event Duration	Amount Bypassed	Location	Cause	Precipitation Previous 24 Hrs (inches)
4/7/2007	18 hrs	50,000 gal	Manhole at Manville Road	Sewer line blockage	0.0
2/13/2008	2 hrs	1,000 gal	Manhole at Clinton Street	Heavy rain event	3.01
3/5/2008	1.5 hrs	25,000 gal	CSO 213 Pleasant Street and Jenks Way	Blockage	0.0
3/18/2008	1.5 hrs	400 gal	CSO 208 Exchange Street	Blockage	0.0
11/6/2008	12 days	3,000,000 gal	CSO 206 Blackstone Street and Roosevelt Ave.	Regulator Blockage	0.97
1/17/2009	4 hrs	300 gal	1182 River Street	Sewer line blockage	0.0
3/8/2009	2 hrs	10 gal	Manhole at South Main Street and River Street	Construction debris	0.0
5/12/2009	Unknown	5 gal	Diamond Hill Road and Bound Road	Sewer line blockage	0.0
5/16/2009	Unknown	Unknown	Elbow Street	Sewer line blockage	0.0

4.4 Domestic Animal and Vermin Waste

Pet waste left to decay on streets, sidewalks, or on grass near the street may be washed into storm sewers by rain or melting snow. Dogs in particular are likely a major source of fecal coliform bacteria in urban runoff, given their population density and daily defecation rate. DNA fingerprinting techniques have clearly shown pet waste to be a major contributor of bacteria in urban and suburban watersheds. A study by Lim and Oliveri (1982) found that dog feces were the single greatest source contributing fecal coliform and fecal strep bacteria in highly urban Baltimore catchments. RIDEM staff observed significant amounts of pet waste in areas frequented by people walking their dogs in municipal parks and around apartment and condominium complexes that are located adjacent to the mainstem of the Blackstone River and its tributaries.

Livestock and dairy operations are another potential source of bacteria in the watershed. As a follow-up to monitoring conducted by Berger et al, RIDEM staff conducted field surveys in the Cherry Brook Watershed in attempts to determine sources of bacteria causing observed elevations in-stream. Figure 4.1 shows the location of the sites in the Cherry Brook watershed sampled in 2009. Further investigation narrowed the area of concern primarily to the headwaters of Cherry Brook in the vicinity of Pound Hill Road (Stations CB04, CB05, and CB06). Pathogen sampling conducted in August 2009 by RIDEM staff documented that rising levels of fecal coliform also occur at the furthest downstream sampling location at Olo Street (W-31) as compared to upstream concentrations (CB01 and CB02) indicate that sources in the lower reach in Woonsocket are contributing to elevated bacteria levels. Tables 4.6 and 4.7 show the results of those surveys. Wright Dairy Farm is adjacent to the stream at Station CB06; drainage from the farm flows down hill in a northeast direction into the stream system. Uphill from Station CB05, a large manure pile was discovered that may also be a source fecal coliform during wet weather events. These observations have been shared with RIDEM's Division of Agriculture, who is working with the producer to resolve these potential pollution sources.

During the field portion of the BTMDL study, runoff from a small family farm located at the intersection of Carrington Street and Lonsdale Avenue in Lincoln was observed to be flowing off the far side of the farm field into a catch basin at the corner of Lonsdale Avenue and Cook Street, near the Whipple Bridge. During one wet weather event, flow estimated at 0.3 cfs that also contained suspended solids was coming from the farm which has many animals including goats, sheep, cows and chickens, and had a strong septic odor. This flow from the farm area is a likely source of pathogen to the Blackstone River.

4.5 Illicit Sources

One of the pollution hot spots identified in the BTMDL Field Study was a channel that discharges into the Blackstone River adjacent to the Ann & Hope Warehouse parking lot (located at the intersection of Ann and Hope Way and Broad Street) and drains a fairly extensive mixed urban area of Cumberland. RIDEM Office of Compliance and Inspection staff sampled up gradient of the outfall identified in the report as W-35 (OF-317), pulling manhole covers to sample these locations in order to isolate the source of the bacterial pollution to the river. The Office of Compliance and Inspection also dye tested the sewage lines of many of the homes and discovered five residences and a church that were directly connected to the stormwater lines rather than to the sewer lines. Two of the residences were multi-family homes such that a total of 13 sources were found to be discharging sewage directly to the Blackstone River via the storm drain. Since the surveys were completed, all locations have been properly connected to the sewers and the fecal coliform levels have been reduced to 9 MPN/100ml from a high of greater than 16,000 MPN/100ml that was reported during a dry weather survey taken during the BTMDL field work.

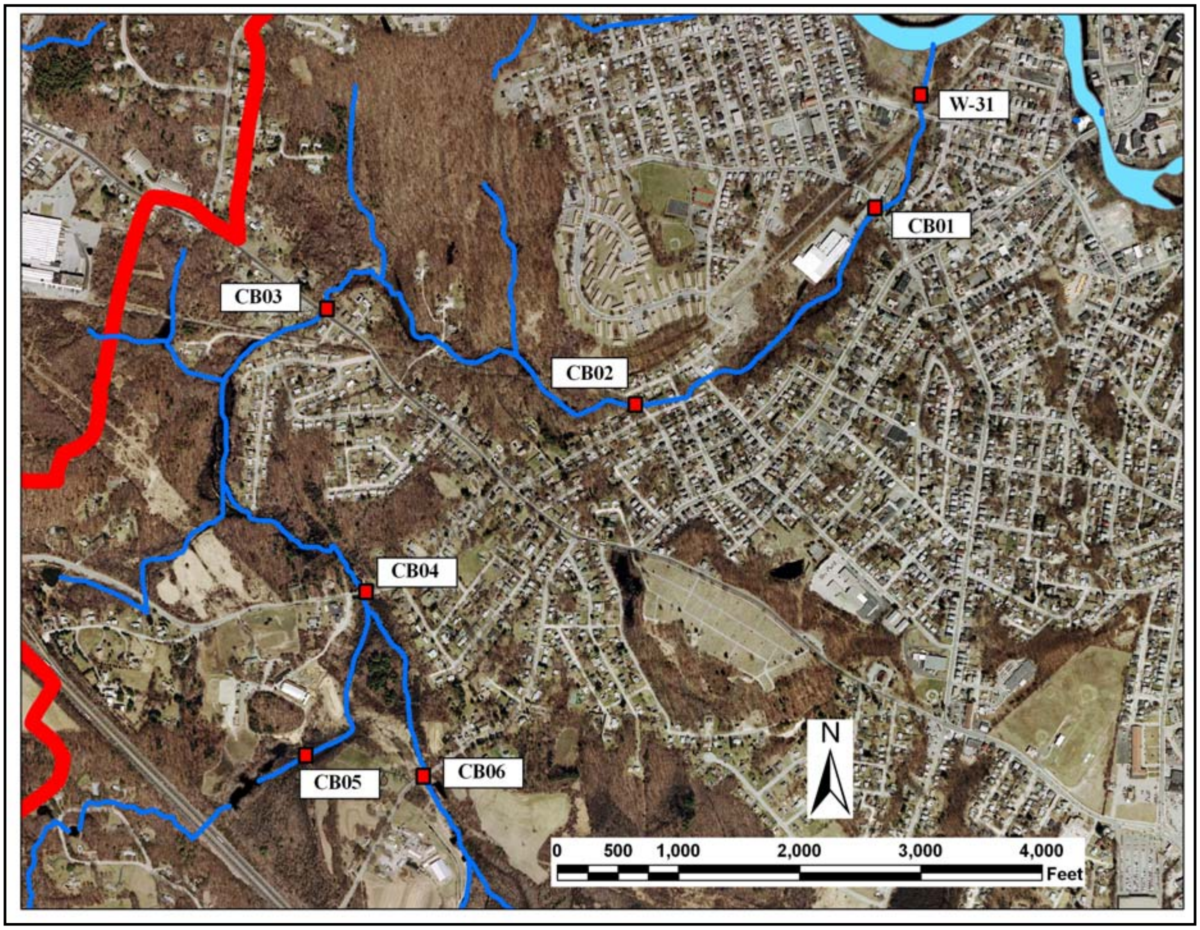

Figure 4.1 Locations of Sampling Stations in the Cherry Brook Watershed.

Table 4.6 Fecal Coliform Results of RIDEM Surveys in Cherry Brook Watershed (MPN/100ml)

Station ID	Nearest Street	9/17/08	5/20/09	7/15/09	7/20/09	8/20/09	8/26/09	9/2/09	10/7/09*	Geomean	90% Percentile
W-31	Olo Street	930	240	460	2,100	930	2,400	--	9,300	1,239	5,160
CB01	Mason Street					430		--	--		
CB02	Alice Avenue					93		--	--		
CB03	RT146A					15,000		--	--		
CB04	Pound Hill Road					46,000		43	4,300	2,041	37,660
CB05	Un-named dirt road					--		23	2,300	230	2,072
CB06	Woonsocket Hill Rd					--		150	43,000	2,540	38,715

* Wet weather event; Underlined values are from Rotating Baseline Study

Table 4.7 Enterococci Results (CFU/100ml) of Surveys in Cherry Brook Watershed

Station ID	8/11/05*	9/17/08	5/20/09	7/15/09	7/20/09	8/26/09	Geomean
W-31	200	219	387	517	1,553	2,420	566

*Sample result from BTMDL study. All other samples were taken by RIDEM staff.

While the Cumberland site is a success story, there are still many more outfalls that flow directly into the Blackstone Watershed that are potential sources of pathogens. Observed elevations of bacteria in the lower reach of Cherry Brook during dry weather suggest possible illicit discharges. The high bacteria levels observed during the dry weather surveys on Mill River also suggest illicit discharges. Table 4.2 lists those outfalls that were sampled during the BTMDL study and which were observed to be flowing during dry weather. As discussed further in the implementation section, those stormwater pipes observed to have elevated dry weather bacteria levels should be prioritized for investigation under the relevant municipalities' and Rhode Island Department of Transportation's illicit discharge detection and elimination programs required by their Rhode Island Pollution Discharge Elimination System (RIPDES) Phase II Stormwater permit.

4.6 Failing Septic Systems

Although the City of Woonsocket is sewered, as is Pawtucket and Central Falls, portions of Lincoln and Cumberland, a significant portion of the watershed is more rural and dependent upon on-site septic systems. Proper maintenance and upkeep of septic systems are critical to both public health and ecological health. A failing system can release untreated or inadequately treated wastewater containing pathogens into the groundwater, and directly or indirectly to surface waters. Storm drains may serve as conduits for inadequately treated wastewater to be discharged into surface waters, in both dry weather via cracked storm drains intercepting the contaminated plumes or in wet weather through the mixing of "surfaced" wastewater and stormwater runoff. Through these pathways, even failing septic systems located away from the direct vicinity of the river may impair water quality. Since 2005, a total of 47 septic system infractions in the watershed of the Blackstone River were identified by RIDEM (see Table 4.8). It should be noted that DEM does not have evidence that these were directly contributing to observed bacteria elevations, though they represent a significant potential source. Figure 4.2 shows septic system-related infractions in the Blackstone Watershed between 2005 and 2009, including Notices of Violation (NOVs) and Notices of Intent (NOIs). Permit applications for septic system repairs within the watershed during this 5 year period are also depicted. NOIs are written notification by RIDEM's Office of Compliance & Inspection (OCI) to private or public property owners that a violation of state environmental law has occurred and that the infraction must be corrected or further enforcement action will be taken. NOVs are written notification by OCI to owners that enforcement action is pending. NOVs are issued for more serious violations or after there has been an inadequate response to a NOI. All septic system repairs, whether the result of NOVs or NOIs, or initiated by the owner to correct a failing or malfunctioning septic system, require a state permit. These permits are recorded with the Office of Water Resources (OWR). The vast majority of NOVs and NOIs displayed in Figure 4.2 are associated with septic system failures.

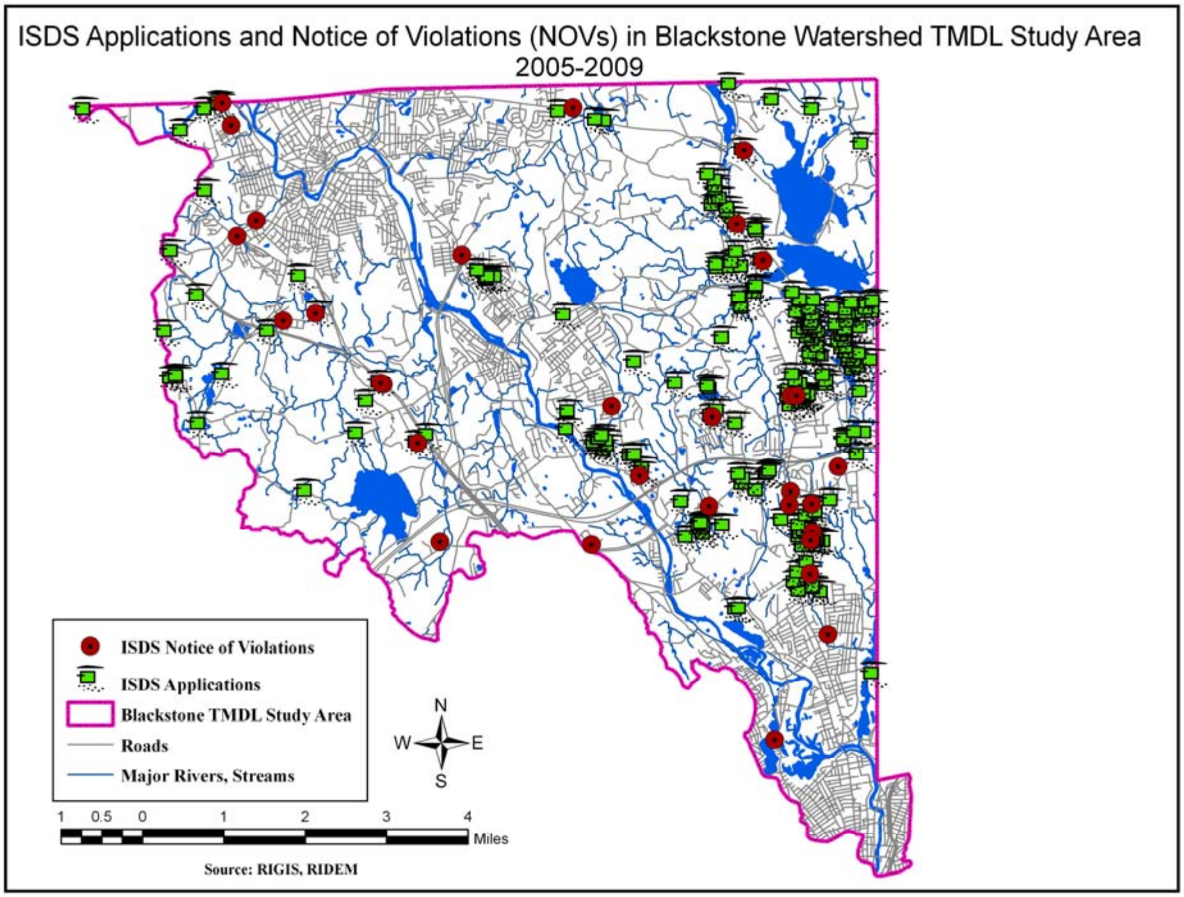

Figure 4.2 ISDS Applications and Infractions in the BTMDL Study Area

The displayed NOVs and NOIs may also include illegal tie-ins to storm drain systems (including both illicit septic and/or laundry connections), illegal direct discharges, and System Suitability Determination Infractions (SSDIs). SSDIs are issued when owners make significant upgrades to residences, such as adding bedrooms, without submitting an application to the Office of Water Resources to determine if the existing system is adequate to service additional demands.

Table 4.8 Septic System Infractions within the watershed of the Blackstone River from 2005 to 2009

Community	2005	2006	2007	2008	2009
Burrillville	1	1	1	1	1
Cumberland	2	4	5	4	3
Lincoln	2	-	3	1	-
N. Smithfield	7	3	2	4	1
Woonsocket	-	1	-	-	1

4.7 Sediment Resuspension and Embankment Sloughing

In previous studies, sediment re-suspension and sloughing of river embankments have been observed in the impoundments along the Massachusetts portion of the Blackstone River. Toxic sediments tend to build on the upstream side of impoundments and these can be transported downstream during periods of high flows. Fisherville Pond and Rice City Pond in Massachusetts are two of the more notable impoundments along the Blackstone due to the large areas of exposed sediments that are present. In the study conducted on these impoundments for the Army Corps of Engineers (Wright, et al, 2004), re-suspension and sloughing was a significant source of sediments in the downstream river reaches. It was also noted in the BRI (Wright, et al, 2001) that Rice City Pond was a significant source of re-suspended sediments during wet weather events. This impoundment is approximately 8.2 miles upstream of W-01. Other impoundments between Fisherville and the MA/RI border that may be potential sinks for toxic sediments include Farnumsville, Riverdale, and the Blackstone Gorge.

During the BTMDL data collection surveys, observed total suspended solids (TSS) at W-01 (mainstem station above the MA-RI state line) during wet weather events were the highest of all mainstem stations on the river. The mean for WW1 (July 8-12, 2005) was 22.9 mg/L, forWW3 (Oct 7-11) it was 24.5 mg/L, and for WW4 (Oct 22-25, 2005), it was 13.9 mg/L. The mean observed TSS values for all RI mainstem stations for these storms were 15.3, 12.1, and 7.5 mg/L respectively. These data suggest that there is not sediment resuspension observed downstream of the RI's impoundments. The flows for these events ranged from 340 – 1650 cfs for WW1, 111-1596 cfs for WW3, and 1349-1863 cfs for WW4. Observed values for WW-3 were the highest of all wet weather events with a maximum of 84.9 mg/L observed at W-01, while the maximum value observed at a RI station was 33.9 mg/L at W-02, located at Manville Dam in Woonsocket.

4.8 Waste Sources

There are numerous waste cleanup sites located within the Blackstone River watershed. Waste cleanup sites include Superfund sites, federal facilities, brownfields, underground storage tank system releases, treatment, storage and disposal facility accidental releases, and oil spills. EPA New England's Office of Site Remediation and Restoration (OSRR) administers the region's waste site cleanup and reuse programs and provides a web site to locate hazardous waste sites in New England (http://www.epa.gov/region1/cleanup/index.html). Section 2.9.6 of the report "Water Quality-Blackstone River, Final Report 1: Existing Data: Volume I: Data Summary" also provides a discussion of existing waste sites. This document is available on RIDEM's website at: http://www.dem.ri.gov/programs/benviron/water/quality/rest/pdfs/blackapps.pdf. According to staff at RIDEM Office of Waste Management, it is reasonable to assume that all old industrial sites within the watershed have some form of groundwater contamination.

In the portion of the Blackstone River watershed addressed in this TMDL, there are approximately 166 Leaking Underground Storage Tanks (LUST), 128 Waste Management Sites, with 17 of these on the Comprehensive Environmental Response Compensation and Liability Information System (CERCLIS) which indicates further investigation may be necessary to determine if these sites should be included on the National Priorities List as a superfund site. Additionally, there are 6 waste lagoons in the watershed, one of which is inactive, three are closed, and two still active at the Riverview Quarry in Cumberland and Wrights Dairy Farm in

North Smithfield. In addition, Woonsocket and Pawtucket have both received Brownfield cleanup funding from EPA.

The Peterson/Puritan site in Cumberland and Lincoln, Rhode Island is a superfund site which is being actively investigated by EPA and encompasses over two miles of mixed industrial/ residential properties. To date, the Remedial Investigation (RI) is complete. The RI was used to characterize the nature and extent of contamination at the site and includes human health and ecological risk assessments. The next step is to complete the Feasibility Study (FS). The FS evaluates alternatives for cleaning the contaminated areas of the Site. The FS for this portion of the Site is ongoing with an expectation for preparing a Proposed Plan for public review by the spring of 2013. The site was not specifically targeted for sampling during the BTMDL field study however, the site is considered a possible source for contaminants of concern to the Blackstone River and watershed.

4.9 Massachusetts

As part of the BTMDL study, field investigations included collection of samples under both dry and wet weather conditions at stations located just north of the state line on each of the Blackstone, Mill and Peters Rivers to evaluate contributions of pollutants from the Massachusetts portion of the respective watersheds. As documented in the BTMDL report (Berger, 2008) with the exception of fecal coliform, more than 50% of the dry weather annual loads of individual constituents observed at Station W-02 at Manville Dam were contributed by Massachusetts' sources. For fecal coliform, 41% of the annual dry weather fecal coliform load measured at Station W-02 was contributed by Massachusetts' sources (without consideration for bacterial decay). Water quality at Station W-01 in Millville, MA exceeded 200 MPN/100ml fecal coliform criteria for seven of the eighteen surveys. Prior to 2008, MA treatment facilities did not have a fecal coliform limit from November 1 to March 30. BTMDL data showed a geomean of 1056 MPN/100ml for this period of dry weather sampling. A revised NPDES permit issued for Upper Blackstone Water Pollution Abatement District by the USEPA effective on October 1, 2008 limits the maximum daily value at 1,429 MPN/100ml. Massachusetts sources as measured at Station W-01 accounted for 129% of the average wet weather percent load measured at Station W-02 at Manville Dam (not accounting for bacterial decay). By comparison, the Branch, Mill and Peters Rivers' contribution averaged 14%, 11% and 13% respectively over the three storms. For dissolved lead, 67% of the annual dry weather load measured at Station W-02 was contributed by Massachusetts' sources as measured at Station W-01. For wet weather, approximately 97% of the total average wet weather lead load to the reach was accounted for at Station W-02, with Massachusetts sources accounting for 84% of the average wet weather percent load observed at Station W-02.

On the Peters River, unlike the Mill River, sources above the State line are important and do represent a significant portion of the fecal coliform load in the lower stations (W-15 and W-16). Fecal coliform levels in the Peters River exceeded the state's water quality criteria for only three of the eight BTMDL dry weather surveys with a geomean of 121 MPN/100ml at Station W-14. Wet weather fecal coliform levels were significantly higher, with criteria exceedances for 17 of the 18 samples collected at the state line station, and a geomean value of 3,434 MPN/100ml. The state's criteria for Enterococci (54 CFU/100ml) was not exceeded at the state line during the dry weather phase of the BTMDL, however, all wet weather samples did exceed with an observed geomean value of 13, 801 CFU/100ml at Station W-14.

Dissolved copper and lead samples collected as part of the BTMDL field surveys showed that significant sources of these elements are located in the Massachusetts portion of the watersheds for the Mill and Peters Rivers. Although the state's water quality criteria for dissolved lead and copper was not exceeded during dry weather in the Peters River, the Mill River did have a single chronic criteria exceedance at Station W-11, the exit for Harris Pond. During the wet weather portion of the field surveys, no lead exceedances were recorded for either the Mill or the Peters Rivers. However, the Peters did have a single chronic exceedance and three acute exceedances for dissolved copper at the state line station adjacent to Diamond Hill Road. The dry weather load contributed by Massachusetts as compared to the load at the confluence of the Blackstone River for dissolved copper in the Peters River averaged 90%, while the wet weather load ranged from 81 to 93% with a mean of 87% for storms 2 through 4. The Mill River had similar levels of dissolved copper loading for dry and wet weather, averaging 86% and 80% respectively of the values observed at the confluence with the Blackstone River. The Massachusetts portion of the Peters River was the major contributor of dissolved lead at the Peters River confluence with the Blackstone, accounting for a mean of 63% of the load observed at the confluence during dry weather, and averaging 66% during wet weather.

The Blackstone River Initiative (BRI) (Wright, et al, 2001) was a comprehensive study of the Blackstone under dry and wet weather conditions. As part of the report, several tables were generated that ranked the top sources of pollutants of concern in this TMDL. The top dry weather sources of cadmium listed in Table 4.26 were the Upper Blackstone Wastewater Pollution Abatement District (UBWPAD), identified as the number one source contributing an average of 33% of the dry weather load, and the reach of the Blackstone River that included Rice City Pond as the number two source with an average of 10% of the cadmium load to the river. For lead, the top source was the reach that included Fisherville Pond with 24% of the load, followed by the reach between Millville, MA at W-01 to the State Line at 13% and the Rice City Pond reach at 10% of the dry weather load.

The BRI also ranked the wet sources of metals in the Blackstone in Table 7.20. In this table, the reach between McCracken Dam and Singing Dam was the top wet weather source for cadmium with 15% of the load followed by UBWPAD at 14.5% and the reach that includes Rice City Pond (Riverdale Dam to Rice City Pond Dam) at 14% of the wet load. For lead, the headwaters above McKeon Road were the top source at 39% followed by Rice City Pond at 15%. The reaches that included the stormwater discharges for Worcester, MA (11%), Pawtucket (9%) and Woonsocket, RI (5%) rounded out the top five. Figure 4.3 shows the Massachusetts portion of the Blackstone Watershed with the locations discussed above identified on the map.

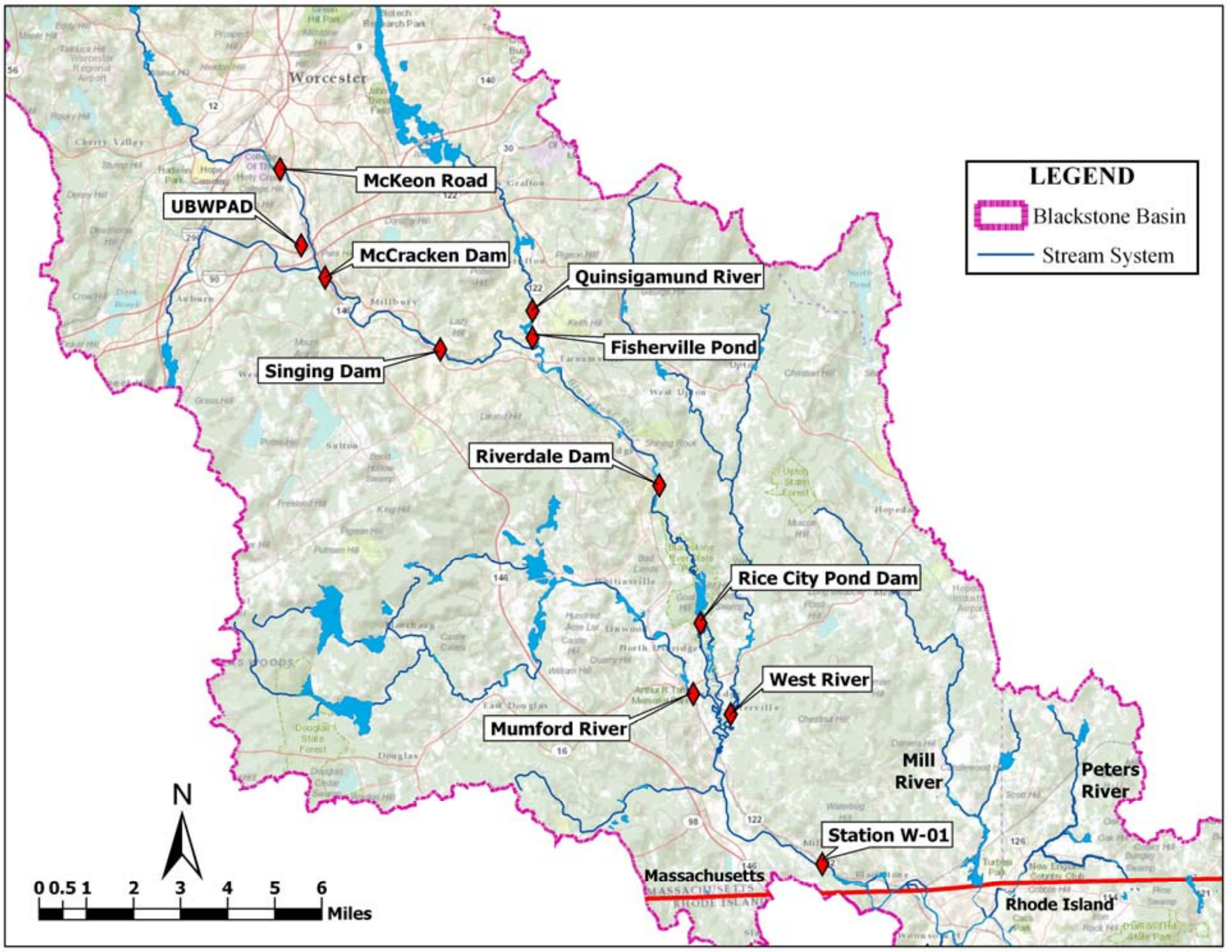

Figure 4.3 Massachusetts Portion of the Blackstone Watershed

Since the BRI, the UBWPAD has reduced its contribution of metals to the river such that it is no longer the largest source in the Blackstone. The most recent permit limits for the UBWPAD has cadmium at 0.2 µg/L and the monthly discharge reports show that the facility is discharging below this limit. A comparison of the observed load at W-01 against the monthly average cadmium discharged at the Upper Blackstone facility since January 2005, the UBWPAD accounts for only 0.4% of the cadmium load at W-01. Currently, the facility does not have a permit limit for lead however, it was not one of the top sources for lead in the BRI report.

The only other treatment facility whose discharge was sampled for metals was Woonsocket WWTF and was not in the top five sources for metals in the BRI report. Comparing the DMR data against the USGS observed loads at Manville Dam (W-02) for the cadmium and lead on sampling dates where exceedances have occurred, the Woonsocket facility accounts for 6.7% of the load for cadmium and 1.2% of the load for lead since the new permit has been in effect starting October 2008.

4.10 Branch River

The Branch River is a significant contributor of fecal coliform to the Blackstone in the RI portion of the river between the state line and Manville Dam (W-02). The Branch River exceeded the State's 200 MPN/100ml limit for three of the four times that it was sampled during the dry weather surveys. A mass balance for surveys 7, 9, and 11 where all stations were sampled showed that an average of 301% of the fecal load at Station W-02 was accounted for. Of this, 109% was contributed by the Branch, followed by 108% at W-01, and the Mill in third at 71% of the load. Over the three storm events, the average contribution from the Branch River was 14.9% of the fecal coliform load observed at W-02. The geomean for storms 1, 3, and 4 were 4,701 (2 samples), 732, and 102 MPN/100ml respectively.

Likewise, for lead, the Branch River was the largest RI contributor at 28% of the dissolved lead load at Manville Dam (W-02) during the dry weather surveys that were used for the mass balance calculations. A total of four dry weather samples were collected for the Branch River, the exceedances of the chronic criteria occurring in 3 of the 4 surveys. These exceedances may be more a result of the low hardness values (17 to 23 mg/l) recorded in the river; however, the source of the lead should be investigated further. It should be noted that although the contributions from the Branch River were consistent and significant, the lead loads from the Branch did not result in significantly higher concentrations at the downstream Blackstone River station at Singleton Street (W-21). During wet weather, the Branch accounted for 2.9% of the dissolved lead load observed at W-02.

RIDEM will further evaluate the sources of lead and pathogens to the Branch River, and needed reductions to meet both Branch River and Blackstone River water quality standards as part of the Branch River TMDL investigation, scheduled to be completed by 2020.

5.0 PATHOGEN TMDL ANALYSIS

As described in EPA guidelines, a TMDL identifies the pollutant loading that a waterbody can assimilate per unit of time without violating water quality standards (40 C.F.R. 130.2). The TMDL is often defined as the sum of loads allocated to point sources (i.e. waste load allocation, WLA), loads allocated to nonpoint sources, including natural background sources (i.e. load allocation, LA), and a margin of safety (MOS). The loadings are required to be expressed as mass per time, toxicity, or other appropriate measures (40 C.F.R. 130.2[I]).

5.1 Water Quality and Resource Impairments

Data collected by RIDEM in the Blackstone Watershed confirm that the both segments of the Blackstone River, Mill and Peters Rivers, and Cherry Brook are not meeting either or both parts of the water quality standards for pathogens. The impaired use is primary and secondary contact recreation for the Class B, B1 and B1 {a} waterbodies. In addition, both segments of the Blackstone River, Peters River, and Cherry Brook exhibit exceedances of dissolved metals aquatic life criteria as stated in Appendix B of the State's Water Quality Regulations. In this case, the impaired use is the protection of aquatic life.

5.2 Numeric Water Quality Targets

The numeric water quality targets are set to the applicable water quality criteria or standard for the Blackstone, Mill and Peters Rivers and Cherry Brook, as described in Section 1.4. Existing Water Quality Criteria for fecal coliform and enterococci bacteria are taken from Table 1.8.D.(2) of DEM's Water Quality Regulations (DEM December 2009). These criteria apply to all waterbody segments in the Blackstone, Mill and Peters Rivers, as well as to Cherry Brook. As stated in the existing Regulations, Class B, B1, and B1 {a} fecal coliform bacteria concentrations are not to exceed a geometric mean value of 200 MPN/100 ml and not more than 10% of the samples can exceed a value of 400 MPN/100 ml. This is the primary contact recreational/swimming criteria for freshwater. Enterococci concentrations for these classes of waters are not to exceed a geometric mean value of 54 CFU/100ml.

5.3 Critical Conditions and Seasonal Variation

The Clean Water Act, Section 303(d)(1)(C) requires that TMDLs "be established at a level necessary to implement the applicable water quality standards with seasonal variations". The current regulation also states that determination of "TMDLs shall take into account critical conditions for stream flow, loading, and water quality parameters" [40 CFR 130.7(c)(1)]. Elevated pathogen levels occur throughout the year and under different flow regimes, however pathogen concentrations are significantly higher and violations of the standards occur with more frequency during and immediately following wet weather events. Critical conditions vary by station therefore the TMDL analysis is inclusive of all seasons and all weather conditions.

5.4 Margin of Safety

The TMDL must contain a margin of safety (MOS) to account for uncertainty in the analysis. The MOS may be incorporated into the TMDL in two ways. One can implicitly incorporate the

MOS by using conservative assumptions throughout the TMDL development process or one may explicitly allocate a portion of the TMDL as the MOS. An explicit margin of safety of 10% was utilized for all pathogen TMDL analyses and was added to the geomean and ninetieth percentile values for fecal coliform and to the geomean values for enterococci to account for the MOS when determining the required reductions.

5.5 Technical Analysis

The technical analyses for the Blackstone River pathogens are based on the data collected as part of the BTMDL study and USGS monitoring data. The analysis for the Cherry Brook watershed used additional data collected as part of the Rotating Basin Base Line Monitoring Program as well as the data collected during the BTMDL study.

The BTMDL pathogen data sets result from surveys accomplished under varying dry and wet weather conditions for each station. Eighteen dry weather surveys were completed for the watershed over a twelve-month period. During that same period, four wet weather surveys were completed. The complete details of these surveys are contained in the report, Water Quality – Blackstone River Final Report 2: Field Investigations (Berger, 2008). Lastly, the USGS data used in the TMDL analysis was collected at Millville, MA, identified as W-01 in the report, Manville Dam which is identified as W-02 in the report, and Roosevelt Avenue Bridge in Pawtucket, RI. In setting reductions to meet the geometric mean part of the standard, a single value for each station was calculated by comparing all the pathogen data collected during the BTMDL and USGS surveys. For Cherry Brook, samples were collected downstream of the Olo Street culvert as part of RIDEM's Rotating Basin Baseline Monitoring Program.

5.6 Establishing the Allowable Loading (TMDL)

EPA guidelines specify that a TMDL identify the pollutant loading that a waterbody can assimilate per unit time without violating water quality standards, with loads expressed as mass per time, toxicity, or any other appropriate measure (40 CFR§130.2). In this TMDL, the allowable load or loading capacity is expressed as concentrations set equal to the applicable water quality standard. Concentration is considered to apply daily because daily values are used to calculate the geometric means and percent variability. The allowable daily load is the criterion concentration multiplied by the flow in the receiving water. For the purposes of implementation and the reasons expressed below, it is recommended that the concentration and percent reduction bacteria TMDL be used.

- Expressing bacteria TMDL reductions in terms of concentration provides a direct link between existing water quality and the numeric water quality criteria.
- Using concentration to set TMDL reductions is more relevant and consistent with water quality standards, which apply for a range of flow and environmental conditions.
- Expressing bacteria TMDL reductions as daily loads can be more confusing to the public and can be more difficult to interpret since they are dependent on flow conditions.

Concentration-based bacteria TMDLs set the WLA and LA equal to the ambient water quality criterion and compliance is measured at ambient stations representative of conditions throughout the water body. Consequently, this TMDL approach represents a very conservative TMDL target-setting. There is a high level of confidence that the TMDLs established are consistent with water quality standards, and the entire loading capacity can be allocated among sources.

Extensive field surveys, water quality monitoring, and a review of aerial and topographic maps were used to establish the link between pollutant sources and instream concentrations. As a first step in determining percent reductions, RIDEM organized the surface waters in the study area into segmented assessment units each with unique waterbody identification numbers.

5.7 Required Reductions

Load/Wasteload Allocations

EPA guidance requires that allowable loads be assigned to either point (wasteload) or nonpoint (load) sources. As is the case for most bacteria impairments, insufficient data existed to accurately differentiate between point (stormwater discharges regulated under RIPDES stormwater permitting program) and nonpoint sources of bacteria. Therefore, as recommended by EPA Region 1, all bacteria source reductions for this TMDL are combined into the wasteload allocation with the allocation for the one Rhode Island RIPDES permitted sanitary discharge (Woonsocket WWTF RI0100111) to the Blackstone River (RI0001003R-01A) set to their permitted discharge limits (or water quality standards) as discussed in a following section. However in implementing this TMDL both point and nonpoint controls will be necessary to meet the plan's water quality goals. Prohibited sources of fecal coliform and/or enterococci bacteria such as failing septic systems that flow (via groundwater seeps and/or overland flow) into storm drains, illegal connections to storm drains, and leaking sanitary sewer lines will receive a waste load allocation of zero (0). For those waterbody segments receiving direct loading of bacteria from upstream portions of the watershed located in Massachusetts, a state line reduction is also included where indicated by available data. In implementing this TMDL, stormwater point and non-point source controls will be necessary in addition to reductions in the Massachusetts portion of the watershed in order to meet water quality goals.

USEPA guidance requires that in waters "impaired by both point and non-point sources, where a point source is given a less stringent wasteload allocation based on an assumption that non-point source load reductions will occur, reasonable assurance must be provided for the TMDL to be approvable" (USEPA, 2001a). This TMDL does not include less stringent WLAs for point sources based on anticipation of LA reductions from non-point sources, and therefore, a reasonable assurance demonstration is not required. Successful reduction in non-point sources depends on the willingness and motivation of stakeholders to get involved and the availability of private, federal, state, and local funds.

Instream Reductions

The required fecal coliform and enterococci reductions for the Blackstone River Watershed are presented in Tables 5.1 and 5.2, respectively. They are calculated from observed concentrations at the instream stations. These values were then compared to the applicable portion of the water quality standard. The station having the largest violation relative to the state's pathogen standard was used to calculate the percent reduction for the segment containing that station and is shown in bold. The required fecal coliform reduction for each segment is the higher of the two reductions (geometric mean versus 90th percentile value). Enterococci reductions are predicated on the geometric mean value for each water body segment. Necessary reductions were calculated for the State-Line stations in the Blackstone, Mill, and Peters Rivers for the purposes of identifying reductions needed from the Massachusetts portions of the watershed to meet water quality standards in Rhode Island waters.

No pathogen TMDL is proposed for the lower portion of the Blackstone River (RI0001003R-01B) since the vast majority of stormwater in this segment discharges to the NBC CSO system. Since the NBC is currently implementing a CSO abatement plan, no TMDL allocations are made for this segment, at this time. Until CSO discharges are mitigated, it is difficult to determine whether reductions are necessary for any remaining separate discharges.

Table 5.1 Fecal Coliform (MPN/100ml) Expressed as Percent Reductions to Meet Concentration Criteria in Cherry Brook and the Blackstone, Mill, and Peters Rivers

Station	Geomean Value*	Geomean Criteria	% Reduction Geomean Value	90 Percentile Value*	90 Percentile Criteria	% Reduction 90 Percentile Value	Segment % Reduction
Blackstone River at Massachusetts - Rhode Island State Line							
W-01	*641*	*200*	*68.8%*	*6,050*	*400*	***93.4%***	*93%*
Blackstone River (RI0001003R-01A)							
W-21	437	200	54.2%	2,959	400	86.5%	88%
W-22	413		51.5%	2,607		84.7%	
W-17	759		73.6%	2,486		83.9%	
W-02	405		50.6%	3,300		**87.9%**	
W-03	328		39.0%	2,574		84.5%	
W-04	381		47.5%	2,640		84.8%	
P-04	150		-	548		27.0%	
W-25	310		35.5%	3,300		**87.9%**	
Mill River at Massachusetts – Rhode Island State Line							
W-11	*90*	*200*	-	*300*	*400*	-	-
Mill River (RI0001003R-03)							
W-12	1,131	200	82.3%	9,000	400	96.0%	97%
W-13	838		76.1%	10,500		**96.5%**	
Peters River at Massachusetts – Rhode Island State Line							
W-14	*1302*	*200*	84.6%	*18,700*	*400*	***97.9%***	*98%*
Peters River (RI0001003R-04)							
W-15	1,417	200	85.9%	18,700	400	**97.9%**	98%
W-16	2,460		91.9%	18,700		**97.9%**	
Cherry Brook (RI0001003R-02)							
W-31	2,127	200	90.6%	16,060	400	**97.5**%	98%

*Geomean and 90th percentile values include an additional 10% for the MOS

Table 5.2 Enterococci (CFU/100ml) Expressed as Percent Reductions to Meet Concentration Criteria in Cherry Brook and the Blackstone, Mill, and Peters Rivers

Station	Geomean Value	Geomean Criteria	% Reduction Geomean Value	Final Segment Reduction
Blackstone River at Massachusetts- Rhode Island State Line				
W-01	*79.4*	*54*	***32.0%***	*32%*
Blackstone River (RI0001003R-01A)				
W-21	<10	54	-	28%
W-22	<10		-	
W-17	14.6		-	
W-02	75.6		**28.4%**	
W-03	63.8		15.4%	
W-04	71.0		23.9%	
P-04	13.6		**-**	
W-25	<10		**-**	
Mill River at Massachusetts – Rhode Island State Line				
W-11	*25.3*	*54*	-	-
Mill River (RI0001003R-03)				
W-12	977.5	54	**94.5%**	94%
W-13	562.8		90.4%	
Peters River at Massachusetts – Rhode Island State Line				
W-14	*1041.2*	*54*	***94.8%***	*95%*
Peters River (RI0001003R-04)				
W-15	1,253.1	54	95.7%	98%
W-16	2,199.2		**97.5%**	
Cherry Brook (RI0001003R-02)				
W-31	622.6	54	**91.3%**	91%

*Geomean values include an additional 10% for the MOS

It is difficult to determine the scale of reductions specifically necessary for regulated stormwater discharges such that water quality criteria will be met during wet weather. However, the WLA assigned to stormwater for these municipalities will require that the Phase II mandated six minimum measures be fully implemented and following an adaptive management approach, that structural best management practices be constructed to treat priority stormwater discharges such that bacteria loads are reduced to the maximum extent feasible.

5.8 Wasteload Allocations by Waterbody Segment

A summary of wasteload allocations, by segment, is presented in the sections below.

5.8.1 Blackstone River (RI0001003R-01A)

The most significant source of fecal coliform and enterococci to this segment is from the Massachusetts portion of the watershed, requiring a 93% reduction for the 90^{th} percentile fecal coliform levels and a 32% reduction in the enterococci concentrations crossing the MA/RI State

Line. The Rhode segment requires a reduction of 88% for fecal coliform and 28% for enterococci, both of which are inclusive of a 10% margin of safety.

The BTMDL field study (Figure 3-75, Berger 2008) showed that approximately 41% of the weighted mean annual load observed at W-02 was accounted for at W-01. Figure 3-77 (Berger 2008) accounted for fecal loads in the reach from the MA/RI border to Manville Dam (W-02) for three dry weather surveys (DW-7, 9, 11) that sampled all the stations identified in the field study. Over the three surveys, the fecal load from MA averaged 107% of the load at Manville Dam. The wet weather contributions were even greater with approximately 130% of the fecal load crossing the RI/MA line (Figure 4-116, Berger 2008). Figure 4-34 and 4-35 (Berger, 2008) showed that the highest concentrations observed in the Blackstone River for three of the four BTMDL wet surveys were at W-01 in Millville, MA. The Branch River was another pathogen source to the Blackstone that averaged 109% of the load at W-02 for the three dry surveys but only averaged 14% of the load during three wet weather events. The other significant pathogen source to the Blackstone is the Mill River. The Mill's pathogen load contribution at W-02 averaged 70% during dry weather (Figure 3-77, Berger 2008), but only 11 % during wet surveys. Sources of enterococci are downstream between W-17 and W-04, with the highest geomean values about W-04.

MassDEP's Draft Pathogen TMDL for the Blackstone River contains the following language with respect to setting waste load allocations for sources of fecal pollution.

"*There are eight municipal WWTPs, one CSO, and other NPDES-permitted wastewater discharges within the Blackstone River Drainage Basin. NPDES wastewater discharge WLAs are set at the WQS. In addition there are numerous storm water discharges from storm drainage systems throughout the watershed. All piped discharges are, by definition, point sources regardless of whether they are currently subject to the requirements of NPDES permits. Therefore, a WLA set equal to the WQS will be assigned to the portion of the storm water that discharges to surface waters via storm drains.*

WLAs and LAs are identified for all known source categories including both dry and wet weather sources for Class A and Class B segments within the Blackstone River Basin. Establishing WLAs and LAs that only address dry weather indicator bacteria sources would not ensure attainment of standards because of the significant contribution of wet weather indicator bacteria sources to WQS exceedances. Illicit sewer connections and deteriorating sewers leaking to storm drainage systems represent the primary dry weather point sources of indicator bacteria, while failing septic systems and possibly leaking sewer lines represent the non-point sources. Wet weather point sources include discharges from storm water drainage systems (including MS4s), sanitary sewer overflows (SSOs) and combined sewer overflows (CSOs). Wet weather non-point sources primarily include diffuse storm water runoff. "

5.8.1.1 RIPDES (Rhode Island Pollutant Discharge Elimination System) Sources

The allocations for the Woonsocket WWTF are the same in dry or wet weather and, consistent with EPA policy, are set to meet the bacteria standards at the point of discharge. Since Rhode Island adopted recreational enterococci criteria in 2009, the Woonsocket WWTF RIPDES permit (which expires in October 2013) will be revised consistent with this wasteload allocation when it is reissued. The Class B/B1 enterococci criterion is a geometric mean concentration of 54 colonies per 100 mL.

Table 5.3 shows the current fecal coliform permit limits, geometric mean, and average discharge from 2005 through 2010 at the Woonsocket WWTF. While the re-issued permit will not include limits for fecal coliform, the plant will be required to continue its monitoring of fecal coliform.

Table 5.3 Woonsocket WWTF 2005-2010 Fecal Coliform Permit Limits and Observed Values

Woonsocket WWTF	Permit Limits (MPN/100ml)	Average Discharge MGD (ft^3/sec)	Average Values (MPN/100ml)	Geometric Mean (MPN/100ml)
Monthly Average	200	7.9 (12.2)	3.5	3.0
Daily Maximum	400	11.2 (17.3)	69.7	15.3

5.8.1.2 Stormwater

The previous sections describe the allowable loads for the Woonsocket WWTF as well as the reductions required by MA sources to meet applicable water quality criteria in the Blackstone River downstream of the State Line. As is the case for most pollutants, insufficient data exist to accurately differentiate between point and nonpoint sources of bacteria. In addition, there is no meaningful method to determine specific bacteria loading from multiple stormwater systems with hundreds of outfalls distributed through a large watershed such as the Blackstone. Therefore, a wasteload allocation of zero (0) is set for illicit discharges to storm drains, leaking sanitary sewer lines, and failing septic systems, and the remaining allowable load for this segment is allocated as a stormwater wasteload.

5.8.2 Mill River (RI0001003R-03)

With a 10% MOS included, the final segment reductions for the 90th percentile fecal coliform is 97% and 94% for enterococci. Significant increases in pathogen concentrations between Stations W-11 (above state line) and W-12 (located north of Social Street in Woonsocket at the culvert inlet) during both wet and dry weather conditions suggest that stormwater runoff and illicit connections and/or illegal discharges within this reach of the river and possibly wildlife are predominate sources of pathogens to the river. As shown in Table 4.2, Outfall 704 north of East School Street across from the Veterans Memorial Park is a likely candidate. As a source, stormwater runoff will receive 100% of the wasteload allocation. A wasteload allocation of zero (0) is set for illicit discharges to storm drains, leaking sanitary sewer lines, and failing septic systems.

5.8.3 Peters River (RI0001003R-04)

Tables 5.1 and 5.2 show that the reduction at the State Line station (W-14) is 98% for the 90th percentile fecal coliform, and 95% for enterococci. With the 10% MOS included for the Rhode Island portion of the Peters River, a final reduction of 98% is required for both the 90th percentile fecal coliform and enterococci. The most prevalent source of pathogens to this segment is stormwater runoff. Other possible sources include illicit discharges to storm drains, and wildlife.

Possible sources of pollutants, whether pathogens or metals are likely between stations W-14 (State Line) and W-15 (culvert entrance). There were eighteen outfalls identified in the BTMDL data report between these two stations, with several specifically noted in Table 4.2. These outfalls range in size from 24 to 72 inches and may drain large areas of impervious surfaces. As a source, stormwater runoff will receive 100% of the wasteload allocation. A wasteload allocation of zero (0) is set for illicit discharges to storm drains, leaking sanitary sewer lines, and failing septic systems.

5.8.4 Cherry Brook (RI0001003R-02)

With a 10% MOS included, the final segment reduction for fecal coliform is 98% while enterococci requires a 91% reduction. Evaluation of the data shows that pathogen sources within Cherry Brook are both dry weather and stormwater related. RIDEM staff did some follow up investigation in the watershed in 2009 and found that a significant source of fecal coliform bacteria is located west of Route 146A (Smithfield Road) between Pound Hill and Woonsocket Hill Roads. There is a dairy farm and an equestrian center located in this area that may be the source of pathogens. There also appears to be both a dry and wet weather source of bacteria discharging in the lower reach of Cherry Brook between the road crossing at CB-02 (Alice Avenue) and W-31 (Olo Street). As a source, stormwater runoff will receive 100% of the wasteload allocation. A wasteload allocation of zero (0) is set for illicit discharges to storm drains, leaking sanitary sewer lines, and failing septic systems.

5.9 Strengths and Weaknesses in the Technical Approach

Strengths

- The TMDL is based on extensive data and knowledge of the area
- The TMDL incorporates the findings of several of the many studies that have been completed on the Blackstone River
- An extensive field research program that covered the Rhode Island portion of the watershed was completed within the past five years and the actual data from that study was used in the analysis
- The phased implementation approach allows an emphasis on mitigation strategies rather than on modeling and more complex monitoring to keep the focus on source reduction

Weaknesses

- The watershed is extremely complicated with large tracks of rural and urban developments that have constantly evolved since the industrial revolution.

6.0 DISSOLVED METALS TMDL ANALYSIS

6.1 Applicable Water Quality Criteria

Freshwater aquatic life criteria for certain metals are expressed as a function of hardness because hardness can affect the toxicities of these metals. Increasing hardness has the effect of decreasing the toxicity of metals. The water quality standards for toxics, including dissolved metals, are set forth in Appendix B of Rhode Island's Water Quality Regulations (DEM December 2009). The chronic and acute fresh water aquatic life criteria of most metals apply to the dissolved form and are calculated using water hardness (in mg/l as CaCO3) based on equations in Table 2-Appendix B of Rhode Island's Water Quality Regulations. As described in Section 1.4.2 and Section 6.6 below, a range of hardness values were used to calculate chronic and acute criteria reflecting the actual hardness values observed under both dry and wet weather flow conditions and the varying frequency of sampling (dry vs. wet). This resulted in a range of water quality values being calculated for each waterbody for both dry and wet weather. Table 6.1 reflects the range of criteria that were utilized in determining the required reductions for this TMDL. This approach to determine which hardness values would be used to establish the criteria was necessary in order to be conservative enough to provide adequate protection under all flow conditions.

Table 6.1 Range of Water Quality Criteria for the Blackstone River Watershed

Hardness as $CaCO_3$ (mg/L)	Cadmium (µg/L)		Lead (µg/L)		Copper (µg/L)*	
	Acute Criteria	Chronic Criteria	Acute Criteria	Chronic Criteria	Acute Criteria	Chronic Criteria
5.00	0.11	0.03	1.80	0.07	0.80	0.69
30.00	0.62	0.11	17.0	0.66	4.32	3.20
50.00	1.03	0.15	30.1	1.17	6.99	4.95
70.00	1.42	0.19	43.7	1.70	9.60	6.60
90.00	1.82	0.23	57.6	2.24	12.2	8.18

* Site specific copper criteria have been adopted for the main stem of the Blackstone River; the criteria presented here are applicable to all other freshwaters in the watershed.

6.2 Water Quality and Resource Impairments

Data collected by RIDEM in the Blackstone Watershed confirm that the both segments of the Blackstone River, Peters Rivers, and Cherry Brook exceed certain dissolved metals aquatic life criteria as stated in Appendix B of the State's Water Quality Regulations. In this case, the impaired use is the protection of aquatic life.

6.3 Critical Conditions and Seasonal Variation

The Clean Water Act, Section 303(d)(1)(C) requires that TMDLs "be established at a level necessary to implement the applicable water quality standards with seasonal variations". The current regulation also states that determination of "TMDLs shall take into account critical conditions for stream flow, loading, and water quality parameters" [40 CFR 130.7(c)(1)].

Rhode Island Water Quality Regulations (RIDEM 2010) state the acute and chronic aquatic life criteria for freshwaters shall not be exceeded at or above the 7Q10 flow. A 7Q10 analysis was completed for all waterbody segments in order to quantify metals loadings during periods of minimal dilution. The range of flows surveyed included a low flow condition that closely approximates the calculated 7Q10 flow for each segment.

Elevations of metals concentrations occur throughout the year and under various flow regimes however wet weather concentrations are only slightly higher than dry weather concentrations. Seasonal variations in the data are not apparent. Critical conditions vary by station; therefore the TMDL analysis is inclusive of all seasons and all weather conditions.

EPA regulations at 40 CFR 130.7 (c)(1) requires TMDLs to take into account critical conditions for stream flow, loading, and water quality parameters. The intent of this requirement is to ensure that the water quality is protected during times when it is most vulnerable. Critical conditions are important because they describe the single or multiple factors that cause violations of water quality standards. In specifying critical conditions in the waterbody, an attempt is made to use a reasonable "worst-case" scenario condition.

Three hydrologic conditions were examined with respect to the aquatic life criteria for the metals of concern; wet weather storm flow conditions, dry weather baseflow conditions, and the statistically derived 7Q10 flow condition. These conditions were examined based on analysis of the data and knowledge of both existing and historic sources. Clearly, these three flow regimes account for a majority of hydrologic conditions experienced. The data used in this TMDL were collected under a wide range of stream flow conditions as shown in Figure 6.1.

Analysis of the data (located in Appendix B) for the Manville Dam and Roosevelt Avenue stations show that for dissolved cadmium, there is little variation between the average observed dry and wet weather concentrations. Dissolved lead concentrations do vary significantly when the averaged dry and wet concentrations are compared for the two stations. While dissolved cadmium averages 14% to 20% lower during the high flow/wet weather surveys as compared to low flow/dry weather surveys, lead has 82% to 91% higher concentrations during the high flow/ wet weather events. This is the period when metals are introduced into the water column via stormwater inflows and scour of streambank and streambed sediments.

Although fewer violations of the chronic criteria for dissolved lead occurred under the dry weather low flow condition, it is still the period where less dilution is available for point sources such as wastewater treatment facilities and other permitted discharges, as well as any nonpoint sources such as contaminated groundwater inflows.

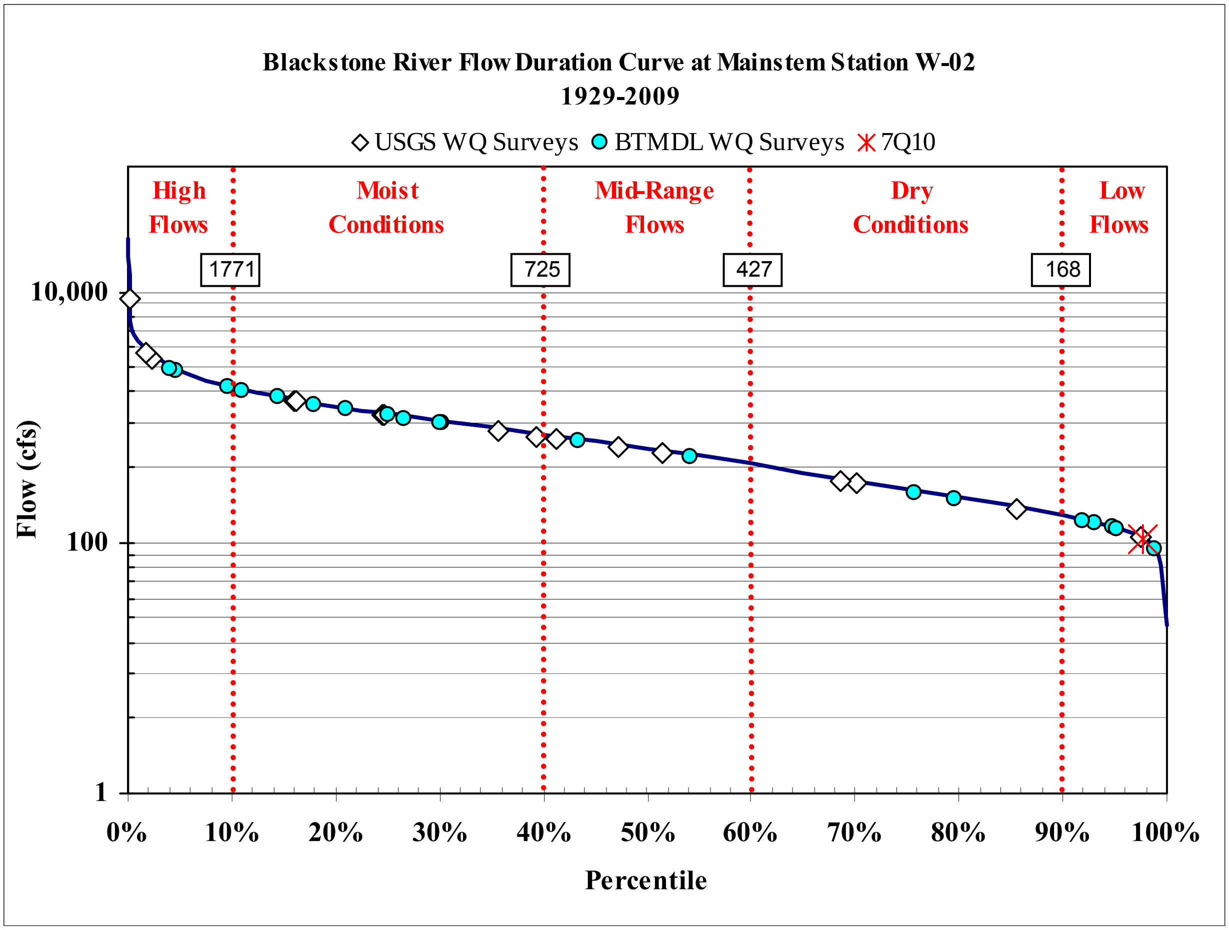

Figure 6.1 Flow Duration Curve for the Blackstone River at Manville Dam (W-02)

A 7Q10 loading analysis was completed for both segments of the Blackstone River mainstem in order to quantify metals loadings during this flow regime and to be consistent with NPDES permit development for point source discharges located in the watershed. Rule 17.11(b) of the Rhode Island RIPDES Regulations (1984) states that; "in-stream concentrations of discharged pollutants shall be determined using the 7Q10 flow of the receiving stream immediately upstream of the discharge. The 7Q10 specifies the minimum dilution at which the aquatic life criteria apply. In addition, Rhode Island Water Quality Regulations (RIDEM 2010) state that the ambient water quality criteria for aquatic life must be met at or above the 7Q10 flow. Accordingly, the 7Q10 condition was evaluated in this TMDL.

6.4 Margin of Safety

A margin of safety (MOS), designed to account for uncertainty in TMDL calculations, is a required element of a TMDL [40 CFR 130.33(b) 7]. The MOS can be expressed explicitly as unallocated assimilative capacity, or can be incorporated implicitly in the TMDL through the use of conservative assumptions when calculating the allowable load (EPA 1991). The TMDL must contain a margin of safety (MOS) to account for uncertainty in the analysis. Both implicit and explicit MOS are applied in this TMDL as further described below.

Blackstone River

The metals TMDLs for the Blackstone River are expressed in terms of the Load Duration Curves which were generated using the chronic criteria, (which is the more conservative of the two applicable criteria). Use of these daily average load duration curves represents a more stringent application of the chronic criteria since the chronic criteria as stated is a four day average (as opposed to one day), and allows for one exceedance every three years thus adding an implicit margin of safety.

Peters River / Cherry Brook

An explicit MOS was calculated for Peters River and Cherry Brook by taking 10 percent of the total loading capacity as determined by multiplying the applicable water quality criteria (generated from the equations in Table 1.2 (for dissolved Cu) using the sampled hardness concentration) and applicable flow value. This 10 percent amount is essentially reserved: it is not available for wasteload or load allocation and therefore makes the allocations smaller and thus, more protective. For example, if the calculated loading capacity for dissolved copper on a particular survey date is 10 lbs/day, then 10% or 1 pound would be allocated to the MOS. Therefore, the wasteload and load allocation would have to equal 9 lbs/day (10 lbs minus 1 lb).

Allowable metal loads are presented as a 'range' under each condition (dry and wet) as well as a maximum reduction. The TMDL requires that the maximum reduction for each metal be met. This ensures that the worst-case critical condition (i.e. the largest of the wet weather reductions) is used to drive implementation activities. This provides an additional implicit MOS.

6.5 Technical Analysis

The technical analysis for the Blackstone River metals TMDL included data collected during the BTMDL field investigation as well as that collected by the USGS at Millville, MA, Manville Dam (W-02) and Roosevelt Avenue Bridge. The analysis for Peters River and Cherry Brook metals used data collected during the BTMDL field investigation. Because the aquatic life criteria are required to be met under all flow conditions, wet and dry weather data were used to evaluate both the existing and allowable daily loads. The final analysis evaluated all samples together in determining the required reductions. The largest reduction from either the dry or wet weather analysis was used to set the required reduction for each waterbody segment. To ensure compliance during dry weather low flow conditions when wastewater treatment facility discharges exert their greatest influence on the river's water quality, a 7Q10 analysis was done to determine if the current permit for the facility protective of the Blackstone. A separate analysis was not done for the tributaries since there no waste water treatment facilities present on these waterbodies.

The technical approach used to develop the load based TMDLs consisted of:

- Use of the stage discharge data developed during the BTMDL Field Study, and stage measurements taken at the time of sample collection

- Evaluating the available hardness and discharge data to determine the applicable metals criteria under varying flow conditions including 7Q10, baseflow and stormflow conditions,

- Using these criteria to determine the loading capacities at each station for each survey and to develop a load duration curve for dissolved lead and cadmium at the three Blackstone River mainstem stations monitored by the USGS (Millville, MA, Manville Dam, and Roosevelt Avenue),

- Calculating existing metal loads for each flow condition using the instantaneous flows and WQ concentrations. This method was used because the daily average flows were not available at all the sampling locations.

- Comparing the existing loads to the allowable loading capacities at each station to determine the required load reductions.

- The Blackstone mainstem stations used the USGS dissolved metals data and the associated hardness values for each survey date to determine the applicable criteria. The hardness values for the two Rhode Island stations were averaged together to use a common hardness value for the RI portion of the Blackstone River (both USGS river stations).

Sufficient data was not available to develop load duration curves for the Peters River and Cherry Brook. The load based metals TMDLs for the Peters River and Cherry Brook used the BTMDL field survey data to determine the applicable criteria. The procedure followed is described in Section 1.4.2.

6.5.1 Establishing the Allowable Loading (TMDL)

EPA guidelines specify that a TMDL identify the pollutant loading that a waterbody can assimilate per unit time without violating water quality standards, with loads expressed as mass per time, toxicity, or any other appropriate measure (40 CFR§130.2).

Trace metal reductions are unique in that the TMDL endpoints (acute and chronic criteria) must be met during a range of flows in order for a waterbody to maintain water quality standards and meet its designated uses. Waterbodies dominated by point sources typically have the highest metal concentrations occurring during low flow conditions. Conversely, elevated nonpoint source pollutant loadings generally correspond to storm events. Consistent with EPA’s Technical Support Document for Water Quality-based Toxics Control (1991), this dissolved metals TMDL was evaluated under both steady state and wet weather conditions.

This TMDL is evaluated under conditions that reflect worst-case (critical) conditions for both point and nonpoint source loadings (i.e. low flow and high flow conditions). Determination of the TMDL under these two scenarios identifies the more stringent of the two loading capacities of the waterbody, thus ensuring protection of designated uses during critical conditions.

Loading capacity is the maximum amount of pollutant that a waterbody can assimilate while maintaining water quality standards. The loading capacity is a function of different hydrodynamic processes that affect the environmental fate and transport of dissolved metals as they move through the system. For this TMDL, the allowable load or loading capacity is expressed as a load duration curve developed using the established criteria concentration set equal to the applicable state water quality standard for each dissolved metal. This concentration is considered to apply daily, in that daily values are used to compare against the acute and chronic criteria. The allowable daily load is the criteria concentration times the flow in the receiving water.

The dissolved metals dataset used in this TMDL analysis contains a combination of data collected during low flow and high flow conditions. For acute criteria, EPA has established an averaging period of 1-hour and, for chronic criteria EPA has established an averaging period of 4 days.

6.6 Dissolved Metals Evaluation

The Blackstone River USGS dissolved metals samples for cadmium and lead were collected over a range of base flow conditions (dry weather) and are therefore assumed to be representative of water quality within any steady-state and low flow period bounded by runoff events, including a four-day period of time. During this sampling period, the mean daily flows observed at the Blackstone River USGS station in Woonsocket, RI ranged from 88 ft^3/sec to 323 ft^3/sec, which represents the 98.8 and 68.1 percentiles, respectively. By comparison, the observed flows at the USGS station in Woonsocket during the BTMDL dry weather surveys ranged from 76ft^3/sec to 2050 ft^3/sec, which represents the 99.4 and 6.5 percentiles, respectively.

Dissolved metal samples were also collected during high flow conditions and are considered to be representative of the water quality observed in the Blackstone River during those periods of wet weather and during those times where higher than normal flows occur. The observed flows at the Woonsocket gauge during the USGS surveys ranged from 556ft^3/sec to 8360ft^3/sec, which represents the 49.6 and 0.10 percentiles, respectively.

Cherry Brook and Peters Rivers dissolved metals samples were collected during the dry and wet weather field survey portions of the BTMDL. The observed range of flows for Cherry Brook at the sampling station (W-31) ranged from 0.03ft^3/sec to 0.62 ft^3/sec during the dry weather surveys. The observed range of flow at the confluence with the Blackstone River for the Peters River was 0.9ft^3/sec to 50.5ft^3/sec.

Cherry Brook and Peters River also had high flow sampling events conducted during the BTMDL field surveys. The observed storm flows for the Cherry Brook station (W-31) ranged from 0.25ft^3/sec to 7 ft^3/sec, while the storm flows for Peters River ranged from 7.4ft^3/sec to 90 ft^3/sec, as measured at the confluence with the Blackstone River. During the period when these wet weather surveys were conducted, the mean daily flows in the Blackstone River observed at the Woonsocket USGS station ranged from 207ft^3/sec to 3310 ft^3/sec, which represents the 82.5 and 1.7 percentiles, respectively.

6.6.1 Dry Weather –Low Flow Steady State Flow Analysis

Low flow conditions on the Blackstone River are defined as those flows that fall below the 60 percentile point on the flow duration curves developed from the long term data for the Woonsocket USGS station. All flows below 425ft^3/sec at Manville Dam and 460ft^3/sec at the Roosevelt Avenue Station were considered low flow. Being upstream of the three major Rhode Island tributaries to the Blackstone River, flow values less than or equal to 275ft^3/sec were used at the Millville, MA station to represent low flow conditions.

Analysis of the BTMDL data showed no exceedances for lead criteria for the river segments addressed in this TMDL and cadmium was not analyzed for during the BTMDL field surveys. Therefore, only the data collected by the USGS at the three Blackstone River mainstem stations was used in the TMDL analysis of dissolved cadmium and lead.

The mean hardness values from the USGS data for the Manville Dam and Roosevelt Avenue stations was used to calculate the acute and chronic criteria for the Blackstone River. The single hardness value for each survey date was used to calculate the criteria for the Millville, MA station which was used as the MA-RI State Line station for the Blackstone River. The Blackstone River allowable loads were calculated using the criteria and the flow measurements reported by the USGS at the time when the samples were collected at each station.

The Peters Rivers and Cherry Brook analysis for dissolved copper used the flows and hardness values from the dry weather surveys in the BTMDL field data report (Berger, 2008) to determine the allowable loads for each river segment. For the Peters River, the mean hardness from the RI stations (W-15 and W-16) by survey date was used to calculate both the acute and chronic criteria for each survey. The State Line station (W-14) used the single value associated with that station for each survey date. Similarly, Cherry Brook only had a single station (W-31) and the associated hardness value was used to calculate the acute and chronic criteria for each survey date. Once the criteria (acute and chronic) were calculated, an allowable load was calculated using the calculated criteria and the flow data from the BTMDL field report for Peters River and Cherry Brook. Table 6.2 shows the allowable load range of the waterbodies addressed in this TMDL.

The range of loads for the stations on the Blackstone River segments in Table 6.2 were taken from the load duration curves for the dissolved metals listed in the TMDL. The derivation of the load duration curves for the Blackstone River mainstem stations is explained below.

The load duration curves were calculated using mean daily flow obtained from the long term flow record at the Woonsocket USGS Station on the Blackstone River and the instantaneous flow data provided in the BTMDL field data report and that provided to RIDEM from USGS for the Millville, MA, Manville Dam, and Roosevelt Avenue stations on the days that those stations were sampled, The period of record for the mean daily flows on the Blackstone is from February 22, 1929 to February 1, 2012. The highest observed mean daily flow value of 25,900 ft^3/sec was recorded on August 20, 1955 and the lowest observed mean daily flow of 21 ft^3/sec occurred on August 11, 1934.

A flow-hardness relationship was derived using the hardness and flow data from the BTMDL field data report for the three mainstem stations. The resultant relationship was used with the period of record mean daily flows to calculate a hardness value for each day, and the hardness value was used to calculate the chronic criteria for each day. The calculated chronic criteria and calculated mean daily flows were used to calculate a mean daily load for the period of record. This mean daily load is the source data for the load duration curves for the TMDL. A curve for the acute criteria was not determined since the calculated acute loads would have been greater than the calculated loads for the chronic criteria.

Table 6.2 Range of the Allowable Loads in the Blackstone Watershed for Cadmium, Copper, and Lead

Parameter	Blackstone River			Peters River		Cherry Brook RI0001003R-02
	MA-RI State Line	RI0001003R-01A	RI0001003R-01B	MA-RI State Line	RI0001003R-04	
Copper (lbs/day)	NA	NA	NA	0.03 - 2.54	0.03 – 2.67	0.01 – 0.16
Lead (lbs/day)	0.17- 14.0	0.26 - 12.5	0.28 - 15.9	NA	NA	NA
Cadmium (lbs/day)	0.02 - 3.68	0.03 - 3.19	0.03 - 4.23	NA	NA	NA

Notes: Blackstone loads taken from the load duration curve data. *The copper loads for Peters River and Cherry Brook were calculated using the observed flows and the acute and chronic criteria. The lowest and highest loads are shown. A 10% MOS was subtracted from the allowable copper loads.

Using the same flow data and the observed dissolved metal concentrations, observed loads were calculated for each waterbody. The observed loads were compared against the allowable loads to determine the actual load reductions (in lbs/day) necessary to meet criteria under that flow/hardness condition. The actual load reductions were calculated for each sampling event and at each sampling location. Tables showing the data and calculations for the load reductions are included in Appendix B of this TMDL. Table 6.3 shows the range of the load reductions for each waterbody segment addressed in the TMDL. Under low flow conditions, the Blackstone River does not require any reductions for dissolved lead, but the MA-RI State Line, as well as both segments of the river does require reductions for dissolved cadmium. Comparing the observed and allowable trace metal loads in the appendix tables, neither Cherry Brook nor Peters River has a dissolved copper reduction requirement for dry weather, low flows.

Table 6.3 Range of Dry Weather –Low Flow Load Reductions (Below 60 Percentile Flows) for the Blackstone Watershed

Range of Required Load Reductions to Meet Chronic Criteria						
Parameter	Blackstone River			Peters River		Cherry Brook RI0001003R-02
	MA-RI State Line	RI0001003R-01A	RI0001003R-01B	MA-RI State Line	RI0001003R-04	
Copper (lbs/day)	NA	NA	NA	None	None	None
Lead (lbs/day)	None	None	None	NA	NA	NA
Cadmium (lbs/day)	0.08 - 0.23	0.01 – 0.11	0.01 – 0.13	NA	NA	NA

None implies no required reduction was necessary while NA (Not Applicable) is used to indicate that either there was not an impairment requiring a TMDL for this waterbody, or sampling was not conducted for the constituent.

6.6.2 Wet Weather - High Flow Analysis

Several of the USGS surveys evaluated for the Blackstone River TMDL were considered to be under wet weather conditions, however, only single grab samples were collected by the USGS at each of the three mainstem Blackstone River stations monitored. High flow conditions in the Blackstone River are defined as those flows above the 60 percentile point on the flow duration curves developed from the long term flow data for the Woonsocket USGS station.

For the Blackstone River, the high-flow, wet weather analysis used the USGS data, a single grab sample collected for each sampling event at Manville Dam (Segment RI0001003R-01A) and Roosevelt Avenue (Segment RI0001003R-01B). The USGS hardness values for Manville Dam and Roosevelt Avenue were averaged for each set of survey dates to get a mean value that was used to calculate acute and chronic criteria. The actual flow measured and reported by the USGS at the time of sample collection for each station and the calculated criteria was used to determine an allowable load at each station. For the MA-RI State Line, the single hardness value for the Millville, MA station at the time of sample collection for each survey was used to calculate the acute and chronic criteria. The USGS measured flow at the time the sample was collected was used to calculate the allowable load at the State Line. Since the chronic criteria are the more stringent criteria, it was used to calculate the allowable load for each station on the Blackstone.

The same flow used to calculate the allowable chronic load was used along with the observed metal concentration to calculate the observed load at each station for each survey. The observed load was compared against the chronic load for each Blackstone River USGS station and if an exceedance occurred, a reduction in the load was then determined.

The Peters River and Cherry Brook TMDL relied upon the BTMDL data which included four wet weather events in total. Each wet weather event included samples that were collected before, during, and after a rainfall event. The number of samples taken for each event ranged from 7 to 10 samples, which included a pre and /or post storm sample. The BTMDL wet weather samples were collected approximately 2 or more hours apart during the high-flow portion of the sampling event. Each data value collected under high-flow conditions is considered to be representative of a concentration in that waterbody for a period of one hour. Therefore, all individual data collected within the stormflow portion of the hydrograph are compared to the acute criteria and the maximum value is considered to conservatively represent existing conditions.

Appendix B of the State's Water Quality Regulations state that "the four-day average concentration of a pollutant should not exceed the chronic criteria more than once every three years on the average." The BTMDL wet weather surveys all covered a four-day period, with the exception of the Wet Weather 02, which focused on the Mill and Peters Rivers and covered two days. In order to satisfy the four-day chronic criteria requirement, RIDEM chose to evaluate the Cherry Brook and Peters River data available within the stormflow portion of the hydrograph, and conservatively assume that these conditions represented a four-day average.

The acute and chronic criteria were calculated differently for the wet weather surveys of the tributaries to the Blackstone River. The acute criteria used the mean hardness values of all the stations on a waterbody by run and for each storm. As with the dry weather calculations, the hardness values of all stations on a waterbody by run were used to calculate the mean. This mean value and the equations in Table 1.2 were used to calculate the acute criteria for each run for that particular wet weather event. The calculated acute criteria and the flow for each station at the time of sample collection were used to calculate an allowable acute load for that station. This was done for each run of each wet weather event. The observed load was calculated using the same flow and the observed dissolved metal concentration associated with each station. The allowable load was compared against the observed load, and if the observed value exceeded the criterion, a reduction was calculated for that sample. This was done for individual samples collected on all runs for each storm event.

The chronic criteria were calculated using the BTMDL observed event mean concentrations for hardness for each station on a waterbody for each storm. This event mean value was then used to calculate the chronic criteria using the equations listed in Table 1.2. Time weighted flows from the BTMDL report was used to calculate the allowable chronic load for each station for each storm. The same time weighted flow and the event mean concentration of the dissolved copper was then used to calculate an observed load. The observed load was compared against the chronic load and if an exceedance occurred, a reduction in the load was then determined. This procedure was followed for each station on the Peters River and for Cherry Brook and for each individual storm event.

Table 6.4 shows the range of acute and chronic load reductions required for each waterbody segment addressed in the TMDL. Tables showing the data and criteria used to determine the wet weather, high flow trace metal reductions can be found in Appendix B.

Table 6.4 Range of Wet Weather - High Flow Load Reductions for the Blackstone Watershed

Range of Required Load Reductions to Meet Acute Criteria						
Parameter	**Blackstone River**			**Peters River**		**Cherry Brook RI0001003R-02**
	MA-RI State Line	**RI0001003R-01A**	**RI0001003R-01B**	**MA-RI State Line**	**RI0001003R-04**	
Copper (lbs/day)	NA	NA	NA	0.12-0.50	0.04 -0.43	None
Lead (lbs/day)	None	None	None	NA	NA	NA
Cadmium (lbs/day)	None	None	None	NA	NA	NA
Range of Required Load Reductions to Meet Chronic Criteria						
Parameter	**Blackstone River**			**Peters River**		**Cherry Brook RI0001003R-02**
	MA-RI State Line	**RI0001003R-01A**	**RI0001003R-01B**	**MA-RI State Line**	**RI0001003R-04**	
Copper (lbs/day)	NA	NA	NA	0.08	0.16	0.03
Lead (lbs/day)	1.12-30.1	0.57-37.1	0.97-14.6	NA	NA	NA
Cadmium (lbs/day)	0.01-19.3	0.06-13.1	0.04-10.0	NA	NA	NA

None implies no required reduction was necessary while NA (Not Applicable) is used to indicate that either there was not an impairment requiring a TMDL for this waterbody, or sampling was not conducted for the constituent.

6.6.3 Range of Required Load Reductions for the Peters River and Cherry Brook

The final step to determine the final range of dissolved copper load reductions required for Cherry Brook and Peters River involved comparing the dry weather, low flow reductions in Table 6.3 against the wet weather, high flow reductions in Table 6.4. The final trace metal reductions that are required for each waterbody segment are the combined range of reductions from Tables 6.3 and 6.4. The ranges are based on the waterbody flow and concentrations from the observed data. Table 6.5 shows the final range of reductions required for the Peters River and Cherry Brook.

Table 6.5 Range of the Required Dissolved Copper Load Reductions for Peters River and Cherry Brook

Waterbody ID	Range of Load Reductions (lbs/day)	Range of Flows Associated with Required Reductions (ft^3/sec)
Peters River MA-RI State Line	0.08 - 0.50	24.9 – 37.0
Peters River RI0001003R-04	0.04 – 0.43	25.6 – 44.8
Cherry Brook RI0001003R-02	0.03	6.4

Note: Loads calculated using the observed flows and the chronic criteria, *A 10% MOS was subtracted from the allowable copper loads for Peters River and Cherry Brook. Cherry Brook reduction associated with an EMC flow.

6.6.4 Blackstone River Load Duration Curves

As discussed in the previous sections, the range of load reductions for the Blackstone River stations is significantly large for both dissolved cadmium and lead. The required cadmium reduction ranges from 0.01 to 19.3 lbs/day while the lead reduction ranges from 0.57 to 37.1 lbs/day. In view of this, load duration curves were developed for each dissolved metal and for each segment of the RI mainstem and for the State Line. The values along the load duration curves for each segment are the allowable TMDL loads for the river.

The process involved the generation of flow duration curves for each mainstem station using the mean daily flows for the period of record of the Woonsocket USGS station. The next step was to develop a relationship between the observed hardness and flow values at each main stem station using the hardness and flow data from the BTMDL and USGS surveys. The resultant equation is then used with the data from the flow duration curve to generate hardness values for each associated flow value. The hardness value is used along with the equations in Table 1.2 to generate criteria for each flow value. The criteria and flows are used to calculate a load for each flow. The load and flows are then used to generate a load duration curve. The chronic load duration curves are presented in Figures 6.2 through 6.5 below for cadmium and for lead for the upper segment (RI0001003R-01A) as represented by Manville Dam and the lower segment (RI0001003R-01B) as represented by the Roosevelt Avenue station.

6.6.5 Load and Waste Load Allocations

A TMDL is the combination of a wasteload allocation (WLA) that allocates loadings for point sources (stormwater and non-stormwater) , a load allocation (LA) that allocates loadings for nonpoint sources and background sources and a Margin of Safety (MOS). TMDLs can be expressed on a mass loading basis or as a concentration in accordance with provisions in federal regulations [40 CFR 130.2(1)]. For the Blackstone River Watershed, the metals TMDLs are expressed as loads. As discussed in Section 6.4, the MOS is implicit for the Blackstone River whereas an explicit MOS of 10% is applied to the Peters River and Cherry Brook TMDLs.

As discussed in detail in the following sections, permitted Rhode Island wastewater sources are given a wasteload allocation equal to their established permit limits. Nonpoint sources of pollution in the watershed including air deposition of metals, sediment resuspension and/or sloughing, and groundwater contributions, may or may not include anthropogenic sources. Insufficient data are available to differentiate between these nonpoint sources of metals and stormwater point source discharges regulated under the RIPDES permitting program. Therefore, this TMDL does not include a separate load allocation; all nonpoint sources are incorporated into the stormwater waste load allocation for these waters. Possible sources including illicit discharges to storm drains, illegal sources, and groundwater and sediment contamination receive a Wasteload Allocation of zero (0) since they are prohibited. For those waterbody segments receiving direct loading of metals from upstream portions of the watershed located in Massachusetts, a state line reduction is also included where indicated by available data. In implementing this TMDL, stormwater point and non-point source controls will be necessary in addition to reductions in the Massachusetts portion of the watershed in order to meet water quality goals.

USEPA guidance requires that in waters “impaired by both point and non-point sources, where a point source is given a less stringent wasteload allocation based on an assumption that non-point source load reductions will occur, reasonable assurance must be provided for the TMDL to be approvable” (USEPA, 2001a). This TMDL does not include less stringent WLAs for point sources based on anticipation of LA reductions from non-point sources, and therefore, a reasonable assurance demonstration is not required. Successful reduction in non-point sources depends on the willingness and motivation of stakeholders to get involved and the availability of private, federal, state, and local funds.

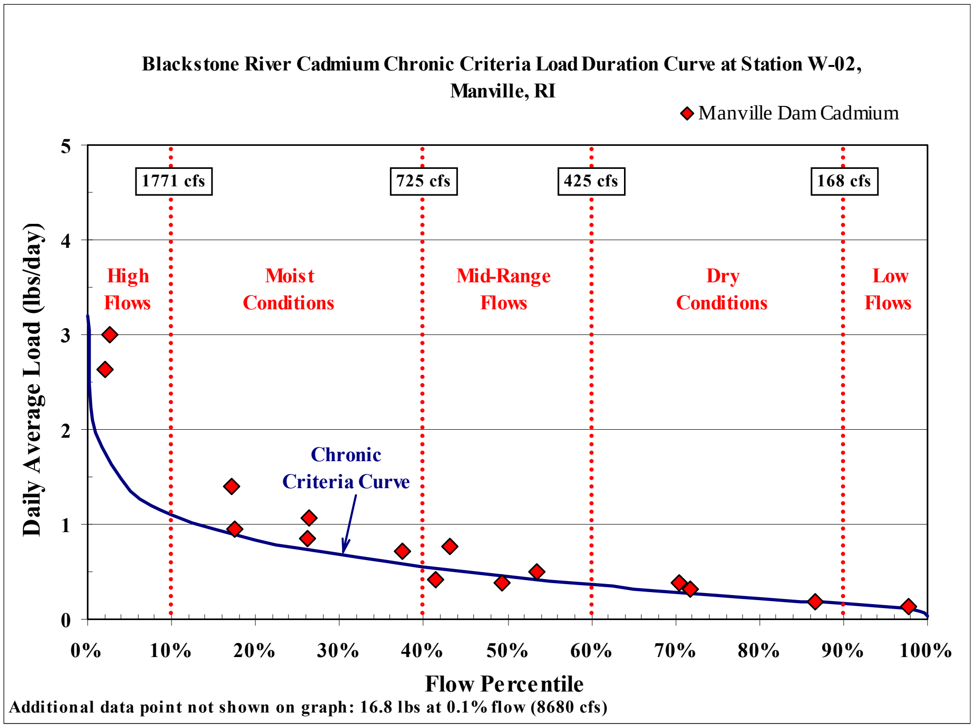

Figure 6.2 Cadmium Chronic Load Duration Curve for the Blackstone River (RI0001003R-01A) at Manville Dam

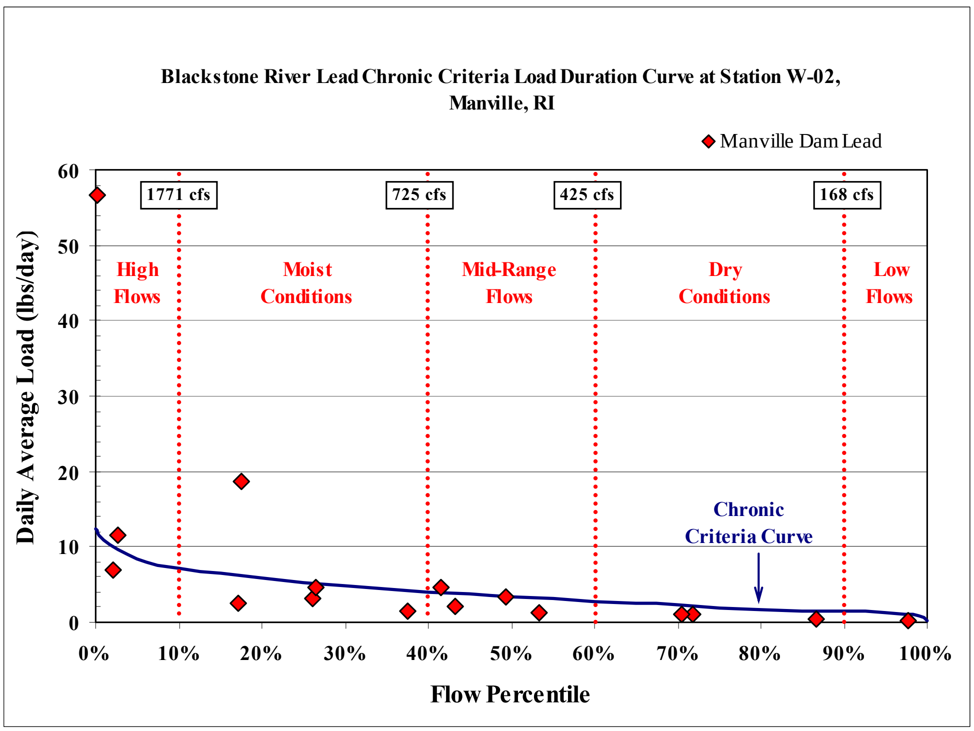

Figure 6.3 Lead Chronic Load Duration Curve for the Blackstone River (RI0001003R-01A) at Manville Dam

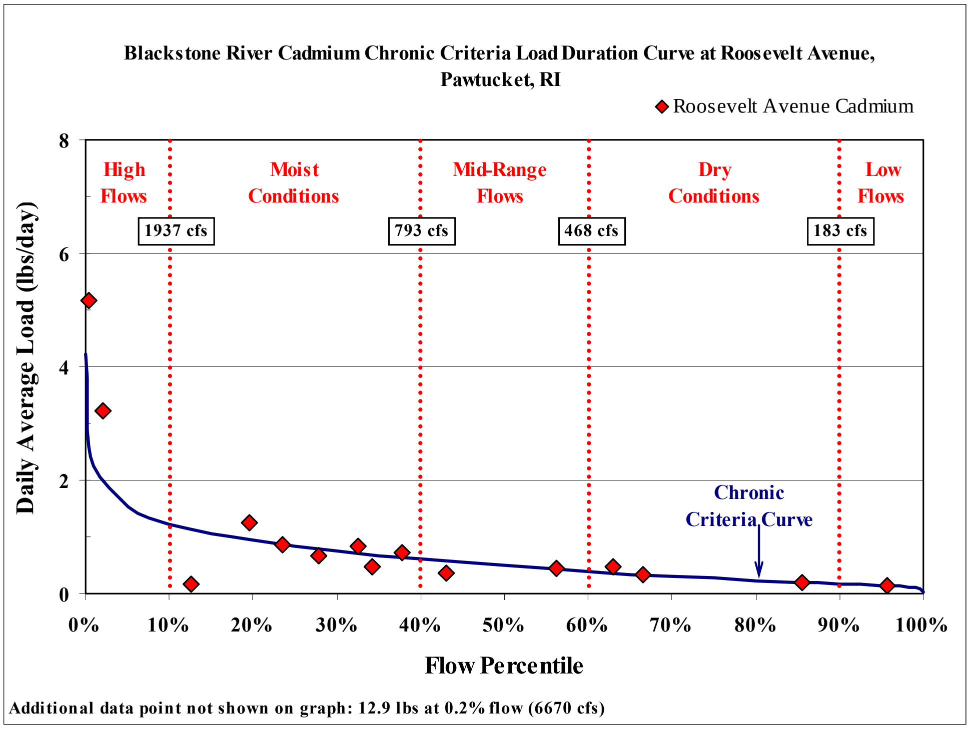

Figure 6.4 Cadmium Chronic Load Duration Curve for the Blackstone River (RI0001003R-01B) at Roosevelt Avenue

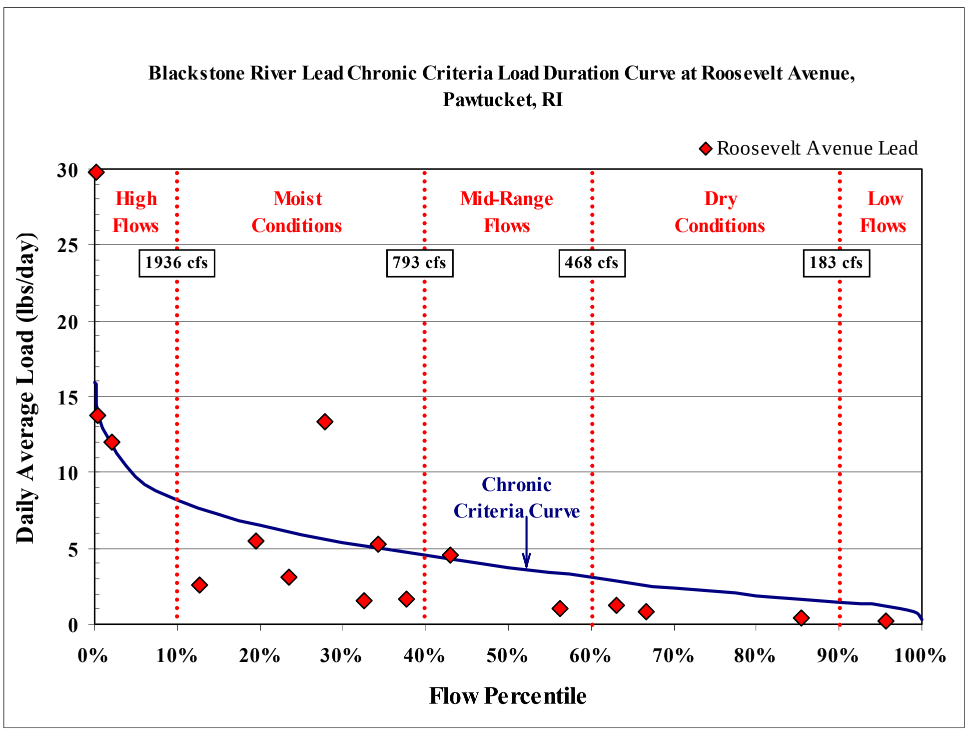

Figure 6.5 Lead Chronic Load Duration Curve for the Blackstone River (RI0001003R-01B) at Roosevelt Avenue

6.6.6 Wasteload Allocations by Waterbody Segment

The point sources discharging lead and/or cadmium to the Blackstone River are the RIPDES permitted municipal separate storm sewer (MS4) discharges, RIPDES permitted Multi-Sector General Permit (MSGP) industrial stormwater discharges, the Woonsocket WWTF (Segment RI0001003R-01A), and in the downstream segment (RI0001003R-01B), RIPDES permitted MS4 discharges and Narragansett Bay Commission owned combined sewer overflows. A summary of wasteload allocations, by segment, is presented in the following sections.

6.6.7 Blackstone River (RI0001003R-01A)

Lead

The observed loads in this segment range from 0.15 to 56.6 lbs/day and the required load reductions range from 0.57 to 37.1 lbs/day for dissolved lead. Although there were no exceedances of the lead criteria under dry weather/low flow conditions, the wet weather sources may ultimately be influencing dry weather conditions (from resuspension of settled particulates), and both wet and dry weather sources are discussed. The BTMDL shows the most significant source of lead to this segment is the Massachusetts portion of the watershed, since an average of 67.2% (Berger, 2008 Figure 3-77) of the lead load at Manville Dam (Station (W-02) came across the border during the dry weather surveys and 84% (Berger, 2008 Figure 4-121) of the wet load for Storm Three (the only storm where metals data were available). More recent data available from USGS show similar results. Fifteen of the nineteen surveys conducted by the USGS between 2007 and 2011 at Millville and Manville Dam occurred on or within a day of each other. Analysis of the data collected on those fifteen dates shows the average load at Millville, Massachusetts is 6.51 lbs/day as compared to 7.83 lbs/day at the Manville Dam station; as a percentage, the lead load from the Massachusetts portion of the watershed represents 83% of the load observed at Manville Dam. Further analysis of the data by flow condition reveals the low flow (below 275cfs) lead load at Millville Massachusetts averages 0.70 lbs/day versus 0.65 lbs/day at Manville (108% of load observed at Manville Dam), whereas high flow loads average 8.62 lbs/day at Millville versus 10.44 lbs/day at Manville (83% of load observed at Manville Dam). The data used for this analysis can be found in Appendix B. The next top two sources of dissolved lead to the Blackstone River include the Branch River with an average load contribution to W-02 for dry weather of 28.4% and 3.9% for wet weather, and the Mill River, contributing 9.4% for dry weather and 6% for wet weather. In addition to these, other watershed sources of lead would be the Woonsocket WWTF and urban stormwater. Table 4.2 identifies priority outfalls relative to the pollutants of concern addressed in this TMDL. Several of the outfalls sampled as part of the BTMDL study were found to contain lead. Downstream of Manville Dam (W-02), there appears to be a dry weather dissolved lead source located between stations W-02 and W-03. The mass load balances in the BTMDL field report showed that 55% of the observed load at W-04 was downstream from W-03.

Cadmium

The USGS data shows the observed cadmium loads in this segment range from 0.13 to 16.8 lbs/day, resulting in required load reductions ranging from 0.01 to 13.1 lbs/day for dissolved cadmium. The data from the fifteen common USGS surveys at Millville and Manville Dam shows that the average load at Millville, Massachusetts is 2.86 lbs/day as compared to 1.98 lbs/day at the Manville Dam station; as a percentage, the cadmium load from the Massachusetts portion of the watershed represents 144% of the average observed load at Manville Dam. The average dissolved cadmium load crossing the state line during low flow conditions was 0.29 lbs/day versus 0.26 lbs/day at Manville (115% of the load observed at Manville) and the high flow average load was 3.80 lbs/day versus 2.61 lbs/day at Manville (145% of the load observed at Manville). No sampling was conducted for cadmium during the BTMDL field investigation; therefore there are no data to assess cadmium loading from the Branch River or Mill River as was possible for lead. In addition to the Massachusetts portion of the Blackstone River, other sources of cadmium include the Woonsocket WWTF and urban stormwater. As mentioned above, Table 4.2 identifies priority outfalls of concern to the pollutants addressed in this TMDL. Though none of the outfalls were sampled for cadmium, it is likely that flows containing dissolved lead and copper would have cadmium as well.

6.6.7.1 Blackstone River at MA-RI State Line

Lead

As described above, the Massachusetts portion of the watershed is a significant source of metals to the Blackstone River in Rhode Island. In order to meet water quality criteria in the upper reaches of this segment (RI0001003R-01A), reductions in lead loads crossing the state line are necessary. There were five USGS survey dates that were common to both the Millville, MA and the Manville Dam sites. Examination of the data shows that the average observed dissolved lead load for all common surveys at Manville Dam was 13.4 lbs/day while the average load crossing the State Line was 15.6 lbs/day. The load coming across the State Line accounted for 61% of the observed dry load at Manville Dam, while the wet weather percentage increased to 119%.

The USGS data shows that there is a significant difference between the minimum and maximum dissolved lead loads crossing the MA-RI border, ranging from low of 0.23 lbs/day to a high of 38.4 lbs/day at Millville, MA. Following the same procedure as described in Section 6.6.4, a load duration curve was developed for the State Line as represented by the USGS station located at Millville, MA. The TMDL reductions are expressed as the difference between the observed load and the allowable load as shown in Figure 6.6, which is the load-duration curve for Millville, MA. The required load reductions for lead at the State Line range from 1.12 to 30.1 lbs/day and should address all conditions for dry or wet weather, low or high flows. The load duration curve was developed using chronic criteria which will ensure that the allowable loads are sufficiently protective for all applicable metals criteria under critical conditions.

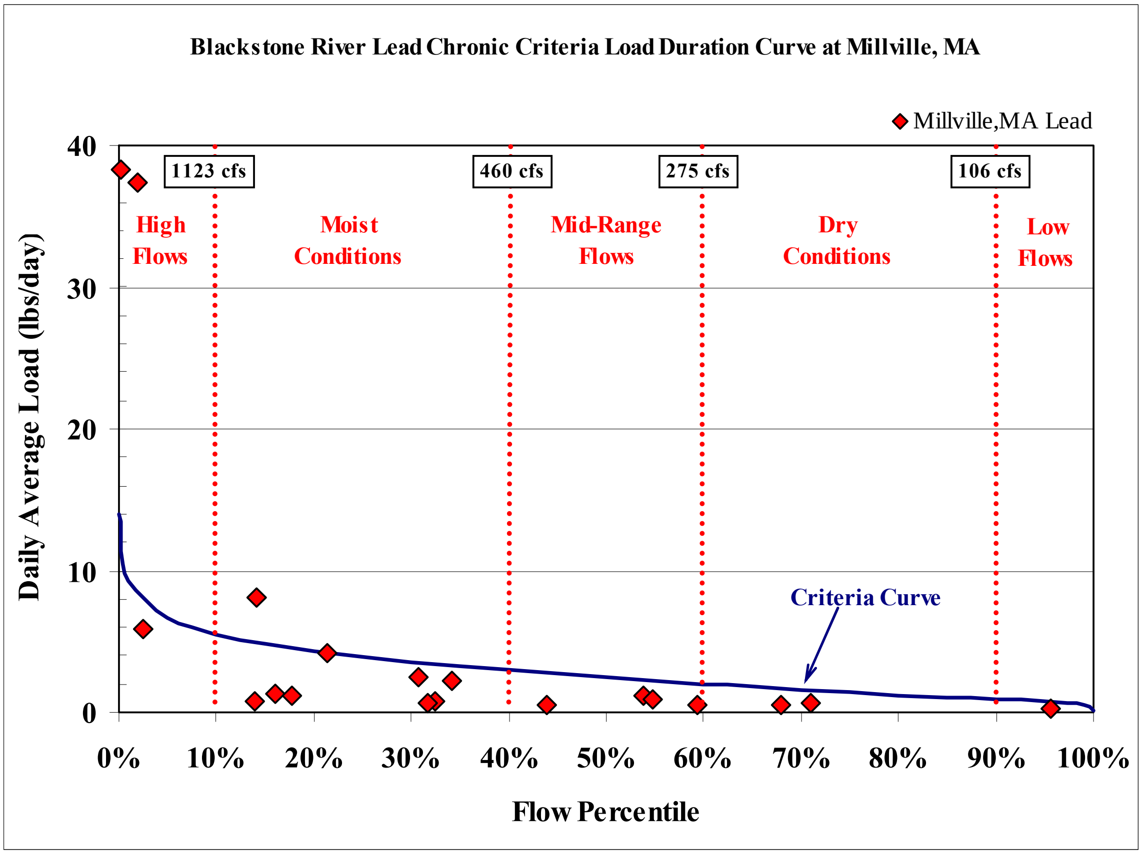

Figure 6.6 Lead Chronic Load Duration Curve for the Blackstone River at Millville, MA

Cadmium

The Massachusetts portion of the watershed is a significant source of cadmium to Rhode Island's Blackstone River as evidenced by the available data described above. A load duration curve for dissolved cadmium was created following the same procedure as described in Section 6.6.4 to represent reductions necessary at the State Line to meet water quality criteria in the upper reaches of this segment (RI0001003R-01A). Available USGS data show frequent violations of cadmium criteria at the Millville, MA sampling location, as evidenced by the fact that 17 of the 19 sampling surveys at this location exceeded the allowable load for dissolved cadmium. As with dissolved lead, the separation between the minimum and maximum observed load was significant, ranging from a low of 0.15 lbs/day to a high of 22.1 lbs/day. Analyses of the five surveys that share common dates show that Massachusetts contributes an average of 0.49 lbs/day during dry weather and 17.1 lbs/day during wet weather, which represent 91% and 176% of the observed cadmium load at Manville Dam.

The highest loads occurred during wet weather, high flow conditions. For this TMDL to sufficiently be protective of the waterbody, the dissolved cadmium chronic criteria were used to develop the load duration curve as shown in Figure 6.7. The required load reductions for dissolved cadmium at the State Line range from 0.01 to 19.3 lbs/day and should address all conditions for dry or wet weather, low or high flows. The load duration curve was developed using chronic criteria which will ensure that the allowable loads are sufficiently protective for all applicable metals criteria under critical conditions.

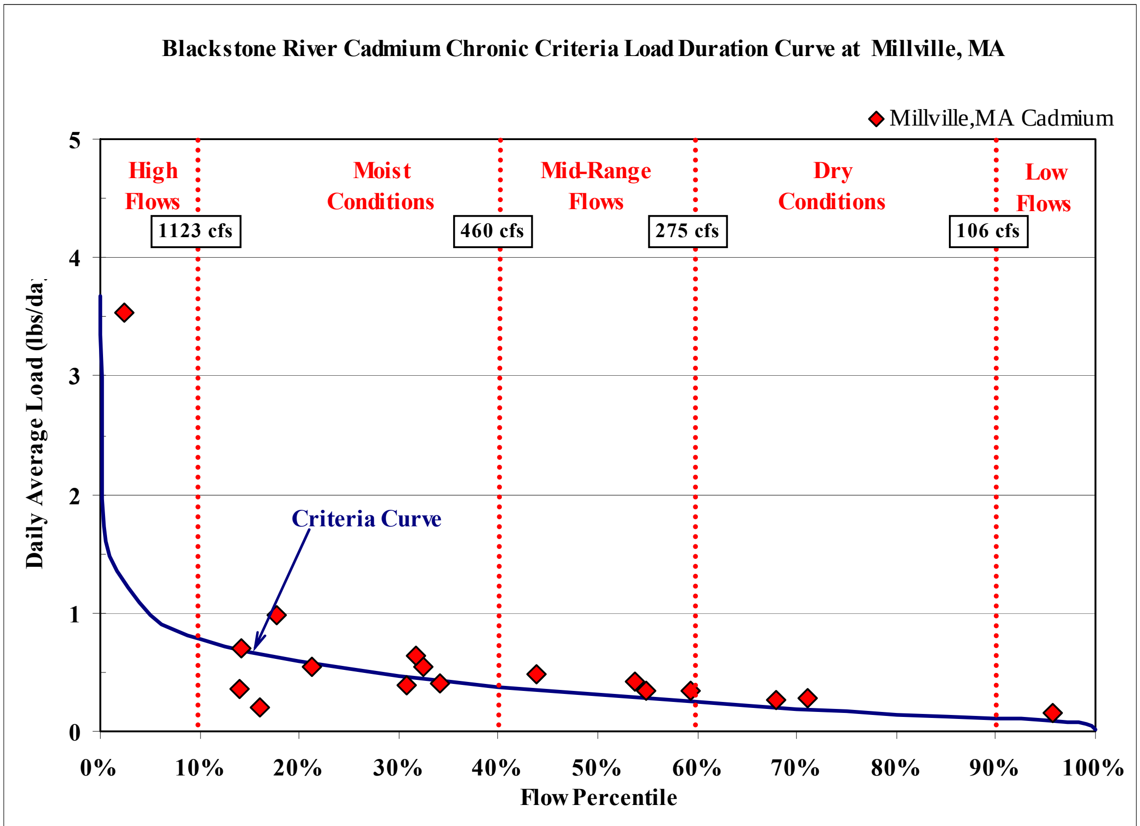

Figure 6.7 Cadmium Chronic Load Duration Curve for the Blackstone River at Millville, MA

6.6.7.2 Woonsocket Waste Water Treatment Facility

During 7Q10 low flow conditions, the Woonsocket WWTF is the most significant known source of metals discharging directly to this segment of the river along with groundwater, another potential source. As required, a 7Q10 loading analysis was completed for this waterbody segment in order to quantify metals loadings during this flow regime and to determine whether the existing permit is sufficiently protective under 7Q10 conditions, consistent with NPDES permit development for point source discharges. Table 6.6 shows the results of the 7Q10 dissolved cadmium and lead analysis for the Blackstone River and Woonsocket Wastewater Treatment Facility. The observed data from the USGS survey on September 21, 2010 where the flows observed at Millville, MA and Manville Dam were near 7Q10 conditions were used for this analysis.

Table 6.6 The 7Q10 Analyses for the Blackstone River (RI0001003R-01A) at Manville Dam

	Cadmium (lbs/day)	**Lead (lbs/day)**
Observed River Load at Manville Dam (7Q10 flow of 106.5 cfs)	0.126	0.149
Expected Future Additional Load from WWTF at Design Flow (Permit load - Observed load)	0.067	0.680
Reduction Required at State Line (Observed Load at the State Line - Allowable Load at the State Line)	0.081	0.000
Expected Future River Load at Manville Dam ([Observed River Load at Manville Dam + Expected Future Additional Load from WWTF] – [Reduction Required at State Line])	0.112	0.829
Allowable River Load at Manville Dam	0.112	1.008
Required Load Reduction at Manville Dam from Rhode Island Sources (Expected Future River Load at Manville Dam - Allowable River Load at Manville Dam)	0.000	-0.179

The allocations for the Woonsocket WWTF are the same in dry or wet weather, consistent with EPA policy, and are set to the October 1, 2008 RIPDES permit (RI0100111) limits. Table 6.7 shows the current permitted limits for the treatment plant along with the reported monthly averages and the daily maximums for the pollutants of concern within this segment of the Blackstone River.

Table 6.7 Woonsocket WWTF Total Trace Metal Limits and Observed Averages from January 2005- December 2010

<table>
<tr><th rowspan="2">Year</th><th colspan="2">Permit Limits (µg/L)</th><th colspan="2">Average Discharge MGD</th><th colspan="2">Cadmium (µg/L)</th><th colspan="2">Lead (µg/L)</th></tr>
<tr><th>Monthly Average</th><th>Daily Maximum</th><th>Monthly Average</th><th>Daily Maximum</th><th>Monthly Average</th><th>Daily Maximum</th><th>Monthly Average</th><th>Daily Maximum</th></tr>
<tr><td>2005</td><td rowspan="4">Cadmium 2.7
Lead 5.4</td><td rowspan="4">Cadmium 7.3
Lead 139</td><td>8.4</td><td>12.4</td><td>2.53</td><td>5.93</td><td>1.72</td><td>4.00</td></tr>
<tr><td>2006</td><td>9.0</td><td>12.6</td><td>0.72</td><td>1.04</td><td>1.27</td><td>2.17</td></tr>
<tr><td>2007</td><td>7.1</td><td>9.7</td><td>1.35</td><td>1.83</td><td>2.68</td><td>6.08</td></tr>
<tr><td>Jan-Sep 2008</td><td>8.7</td><td>12.5</td><td>1.03</td><td>1.25</td><td>1.41</td><td>2.83</td></tr>
<tr><td>Oct 2008-2009</td><td rowspan="2">Cadmium 0.66
Lead 5.4</td><td rowspan="2">Cadmium 4.32
Lead 138</td><td>6.9</td><td>8.8</td><td>0.60</td><td>0.63</td><td>1.00</td><td>1.00</td></tr>
<tr><td>2010</td><td>7.6</td><td>11.3</td><td>0.48</td><td>0.50</td><td>1.00</td><td>1.00</td></tr>
</table>

6.6.7.3 Stormwater

The previous sections describe the allowable loads for the Woonsocket WWTF as well as the reductions required by MA sources to meet applicable water quality criteria in the Blackstone River downstream of the state line. As is the case for most pollutants, insufficient data exist to accurately differentiate between point and nonpoint sources of dissolved metals. In addition, there is no meaningful method to determine specific dissolved metals loading from multiple stormwater systems with hundreds of outfalls distributed through a large watershed such as the Blackstone. Therefore, the remaining allowable load for this segment is allocated as a stormwater wasteload.

6.6.8 Blackstone River (RI0001003R-01B)

Lead

As with the upper segment of the Blackstone River, the observed dissolved lead loads range from 0.18 to 29.3 lbs/day with the required load reduction ranging from a low of 0.97 lbs/day to a maximum of 14.6 lbs/day. The averaged load for all surveys is 6.0 lbs/day with dry weather loads averaging 3.9 lbs/day and the wet weather loads average at 15.4 lbs/day. Loads from the upper segment account for 104% (Dry Weather) to 207% (Wet Weather) of lead observed in the lower segment as evidenced by comparing the load at Manville Dam to Roosevelt Avenue. There are thirteen CSOs that discharge combined wastewater and stormwater into the Blackstone along this segment of the river. CSO discharges include a mix of domestic, commercial, and industrial wastewater and stormwater runoff, and contain a mix of human, commercial, and industrial wastes as well as pollutants washed from streets, parking lots, and other surfaces from the impervious areas of Pawtucket and Central Falls. Other sources of lead in this segment include runoff discharged directly from impervious surfaces in this very urbanized watershed. As mentioned previously, OSRAM Sylvania historically discharged lead to this segment of the Blackstone River, however no longer does. Therefore, no wasteload allocation for this facility is warranted.

Cadmium

The observed loads in this segment range from 0.15 to 12.9 lbs/day resulting in the reductions ranging from 0.01 to 10.0 lbs/day for dissolved cadmium. The data shows the average dry weather load is 0.71 lbs/day while the wet weather load averages 6.3 lbs/day. As with lead, the upper reach of the Blackstone accounts for 111% (Dry Weather) to 154% (Wet Weather) of cadmium observed in this lower segment. Potential sources of dissolved cadmium to the Blackstone River in this segment include CSO discharges and stormwater runoff from the large amount of impervious surfaces in Pawtucket and Central Falls.

6.6.8.1 Stormwater

The lower section of the Blackstone River will obviously benefit from reductions in dissolved metals achieved in the upper reaches of the river. There is no meaningful method to determine specific dissolved metals loading from any nonpoint sources of pollution, the thirteen combined sewer outfalls and multiple stormwater outfalls discharging to this section of the Blackstone

River. Other possible sources include illicit discharges to storm drains, illegal sources, groundwater and sediment contamination, and dry weather CSO discharges. These sources receive a Wasteload Allocation of zero (0) since they are prohibited. The entire WLA is allocated to RIPDES permitted stormwater sources, and wet weather CSO discharges consistent with Narragansett Bay Commission's approved Combined Sewer Overflow Control Facilities Program Concept Design Report Amendment.

6.6.9 Peters River (RI0001003R-04)

The required dissolved copper reduction for the Rhode Island segment of the Peters River is 0.38 lbs/day. Available data find no exceedances of dissolved copper criteria under dry weather conditions at any of the three sampling locations on the river. However, all stations exceeded both acute and chronic criteria during one (Storm 2) of the wet weather surveys conducted. A total of fourteen samples were collected during this wet weather event and 50% of the samples exceeded the allowable load for dissolved copper in the Peters River.

Data suggest that wet weather sources in both the Massachusetts and Rhode Island portion of the watershed must be addressed, since concentrations at all stations on the Peters River exceed criteria. Examination of the data for Storm 2 at the State Line shows that samples from four of the seven runs exceeded the acute dissolved copper criteria as well as the chronic criteria which are an average of all the samples collected at the station for the storm. In order to meet copper criteria in the upstream reaches of the Peters River in Rhode Island, a reduction of 0.49 lbs/day is required at the State Line as shown in Table 6.4. As stated previously, there were no dry weather exceedances of criteria, so the source appears to be wet weather related. The event mean load for Storm 2 at the State Line (W-14) was 94% of the event mean load at the downstream station (W-15). Though additional reductions are not necessary to meet the required dissolved copper reductions once MA source reductions are accounted for, available data indicate there may be RI based sources contributing to elevated copper levels in the RI portion of the river, as further described below.

While no wet weather exceedances occurred during Storms 3 or 4, the event mean storm dissolved copper concentrations showed an increase between stations W-14 and W-15 for Storm 3 and that the concentration remained constant even with stormwater dilution. The average event mean load at W-14 for Storms 3 and 4 was 2.40 lbs/day while the average for W-15 was 2.65 lbs/day, thus indicating a copper source within the Rhode Island reach.

There were four outfalls identified in the BTMDL Field Study between Stations W-15 and W-16 which discharge stormwater into the river. There was a three to four percent decrease in the event mean load between Stations W-15 and W-16 for Storms 2 and 3, which may indicate that the source could be upstream of the point where the Peters River enters the culvert before the confluence with the Blackstone River. These are likely locations that should be investigated in the future.

6.6.10 Cherry Brook (RI0001003R-02)

Cherry Brook requires a 0.03 lb/day load reduction for dissolved copper. Exceedances of copper occurred only during wet weather conditions. Since it is not possible to separate out nonpoint sources from point sources they are included in the WLA. An explicit MOS of 10% has been subtracted from the allowable load, therefore the TMDL equals the WLA. One hundred percent (100%) of the WLA is allocated to stormwater runoff. A potential source of wet weather copper during the sampling time period was the Fairmount Foundry Company (RIR50F001) on Second Avenue which is located approximately 200 yards up-gradient from Station W-31(Olo Street crossing). Fairmont Foundry is covered under a MSGP that has copper as one of the monitored parameters in the permit however has not submitted any data to RIDEM. It is our understanding that the company has since moved all industrial activities under cover and will be applying for a No-Exposure exemption from the general permit.

Other potential wet weather sources of dissolved copper include MS4 outfalls that drain South Main Street which parallels the brook prior to its confluence with the Blackstone River. This area east of Smithfield Road is high density residential with several warehouses and businesses that are located adjacent to the stream. Direct stormwater runoff from the streets and parking lots located in this part of the watershed are another potential source of copper as they are ten feet of less from the brook.

6.7 Strengths and Weaknesses in the Technical Approach

Strengths

- The TMDL is based on extensive data and knowledge of the area
- The TMDL incorporates the findings of several of the many studies that have been completed on the Blackstone River
- An extensive field research program that covered the Rhode Island portion of the watershed was completed within the past five years and the actual data from that study was used in the analysis

Weaknesses

- The watershed is extremely complicated with large tracks of rural and urban developments that have constantly evolved since the industrial revolution

7.0 IMPLEMENTATION

Actual and potential bacteria and dissolved metals sources exist in both the Rhode Island and Massachusetts portions of the Blackstone River watershed, as described in further detail below. This section describes implementation activities and next steps that should be taken towards the goal of restoring and maintaining water quality in these waters. Recommendations and requirements, where appropriate, are prescribed for pollution sources in both Rhode Island and Massachusetts. Implementation activities focus on stormwater, wastewater, and animal waste.

Available water quality and pollution source data indicate that point source and nonpoint source pollution mitigation activities must be pursued in both the Massachusetts and Rhode Island portions of the Blackstone River, Mill River and Peters River. More specifically, data indicate sources in Massachusetts are significant contributors of bacteria to the Blackstone River and Peters River during wet weather and to a lesser extent during dry weather. Whereas, Rhode Island sources are the primary contributors of bacteria impairments to the Mill River in both wet and dry weather. Rhode Island sources also contribute to localized increases in bacteria during dry and wet weather on the Blackstone River and wet weather on the Peters River.

Massachusetts' sources are significant contributors of lead to the Blackstone River during dry and wet weather, and though less significant, Rhode Island sources contribute to localized increases in lead during both wet and dry weather conditions. On the Peters River, Massachusetts sources are significant contributors of copper during both wet and dry weather whereas Rhode Island sources contribute to slight increases in copper in both wet and dry weather. The only current sources of cadmium data available at this writing are the two USGS monitoring locations in Manville and Roosevelt Avenue. Based upon the historic Blackstone River Initiative data collected in the late 1988 and 1989, MA sources contribute to elevated cadmium levels during both wet and dry weather conditions.

Implementation activities should focus on managing urban runoff/stormwater, wastewater, and animal waste. The large amount of impervious area within the Blackstone River Watershed produces large amounts of runoff and pollutants that enter the waterways during and immediately after wet weather events. As the extent of impervious area in a watershed increase, the peak runoff rates and runoff volumes generated by a storm increase because developed lands have lost much or all of their natural capacity to delay, store, and infiltrate water. Pollutants from streets, roofs, lawns, wildlife, and domestic pets quickly wash off during storm events and discharge into the nearby waterbodies. Achieving standards requires that both the *quantity* of stormwater and the pollutant concentrations and loads in that stormwater reaching the waterbodies addressed in this TMDL be reduced. Mitigation activities for stormwater should focus on urbanized stormwater runoff. Wastewater management activities include maintaining sewage collection and treatment systems to avoid sewage overflows, and adopting wastewater management ordinances in areas without sewers to ensure that OWTS are properly maintained and operated.

7.1 Stormwater Runoff

The watershed of the Blackstone River contains a mix of high density and rural areas. When possible, efforts by municipalities, land trusts and others to preserve open space should continue. As land is developed, it is critical that significant natural features be protected to maintain the area's unique characteristics and to prevent further degradation of water quality – as can be achieved through use of conservation development and LID techniques. Redevelopment projects represent opportunities to reduce the water quality impacts from the watershed's urbanized land uses by reducing impervious cover and/or attenuating runoff on-site. As described below, municipal ordinances must be reviewed and revised to make sure that future development projects do not add to water quality problems and that redevelopment projects reduce contributions to the water quality problems in the Blackstone River Watershed.

In 2007, Rhode Island adopted the Smart Development for a Cleaner Bay Act (General Laws Chapter 45-61.2), requiring RIDEM and CRMC to update the Rhode Island Stormwater Design and Installations Manual to: maintain groundwater recharge at pre-development levels, maintain post-development peak discharge rates to not exceed pre-development rates, and use low impact development techniques as the primary method of stormwater control to the maximum extent practicable. The revised manual, adopted January 2011, provides twelve minimum standards addressing LID Site Planning and Design Strategies, Groundwater Recharge, Water Quality, Redevelopment Projects, Pollution Prevention, Illicit Discharges, and Stormwater Management System Operation and Maintenance, among other concerns. This revised manual provides appropriate guidance for stormwater management on new development and redevelopment projects and, most importantly, incorporates LID as the "industry standard" for all sites, representing a fundamental shift in how development projects are planned and designed. The revised stormwater manual is available on-line at:
http://www.dem.ri.gov/programs/benviron/water/permits/ripdes/stwater/t4guide/desman.htm

A companion manual on LID site planning and design has also been prepared by RIDEM to provide Rhode Island-specific guidance regarding the site planning, design, and development strategies that communities should adopt to encourage low impact development. This manual is also available on-line at the above link. Rhode Island joins a growing number of states and localities including the Puget Sound area (http://www.psat.wa.gov/Programs/LID.htm) that rely heavily on LID techniques to protect and restore their waters.

Achieving water quality standards requires that both the *quantity* of stormwater and the pollutant concentrations in that storm water reaching waterbodies in the Blackstone River Watershed be reduced. Mitigation activities for storm water should focus on urbanized storm water runoff from downtown areas where large impervious areas are major contributors to stormwater runoff. Best Management Practices (BMPs) are effective, practical, structural, or non-structural methods which prevent or reduce the movement of pollutants from the land to surface or ground water. BMPs are designed to protect water quality and to prevent new pollution.

Structural BMPs are engineered constructed systems that can be designed to provide water quality and/or water quantity control benefits. The Rhode Island Stormwater Design and Installation Standards Manual (December 2010) contains detailed specifications for the design of these BMPs that can be used to meet water quality objectives. Common structural BMPs include the following:

Infiltration systems: designed to capture stormwater runoff, retain it, and encourage infiltration into the ground;
Detention systems: designed to temporarily store runoff and release it at a gradual and controlled rate (considered acceptable for flood control only);
Retention systems: designed to capture a volume of runoff and retain that volume until it is displaced in part or whole by the next runoff event (considered acceptable for flood control only);
Wet vegetated treatment systems: designed to provide both water quality and water quantity control; and
Filtration systems: designed to remove particulate pollutants found in stormwater runoff through the use of media such as sand, gravel or peat.

Non-structural BMPs are a broad group of practices designed to prevent pollution through maintenance and management measures. They are typically related to the improvement of operational techniques or the performance of necessary stewardship tasks that are of an ongoing nature. These include institutional and pollution-prevention practices designed to control pollutants at their source and to prevent pollutants from entering stormwater runoff. Non-structural measures can be very effective at controlling pollution generation at the source, thereby reducing the need for costly “end-of-pipe” treatment by structural BMPs. Examples of non-structural BMPs include maintenance practices to help reduce pollutant contributions from various land uses and human operations, such as street sweeping, road and ditch maintenance, or specifications regarding how and when to spread manure or sludge.

Structural and non-structural BMPs are often used together. Effective pollution management is best achieved from a management systems approach, as opposed to an approach that focuses on individual practices. Some individual practices may not be very effective alone, but in combination with others, may be more successful in preventing water pollution.

7.1.1 RIPDES Phase II Stormwater Management Programs – SWMPPs and Six Minimum Measures

Stormwater runoff is most often carried to waterways by publicly owned drainage networks. Historically, these storm drain networks were designed to carry stormwater away from developed land as quickly as possible to prevent flooding with little to no treatment of pollutants. In 1999, EPA finalized its Stormwater Phase II rule, which required the operators of small municipal separate storm sewer systems (MS4s) to obtain permits and to implement a stormwater management program as a means to control polluted discharges that is based on six minimum measures. Operators develop Stormwater Management Program Plans (SWMPPs) that detail how their stormwater management programs comply with the Phase II regulations. SWMPPs describe BMPs for the six minimum measures, including measurable goals and schedules. The implementation schedules include interim milestones, frequency of activities, and result reporting. Plans also include any additional requirements that are mandated for stormwater that discharges to impaired waters.

In Rhode Island, the RIDEM RIPDES Program administers the Phase II program using a General Permit that was established in 2003 (RIDEM, 2003a). The Cities of Central Falls, Pawtucket, and Woonsocket, the Towns of Cumberland, Lincoln, and North Smithfield and the Rhode Island Department of Transportation (RIDOT) are regulated under the Phase II program.

The six minimum measures are listed below.

- A public education and outreach program to inform the public about the impacts of stormwater on surface water bodies.
- A public involvement/participation program.
- An illicit discharge detection and elimination program.
- A construction site stormwater runoff control program for sites disturbing 1 or more acres.
- A post construction stormwater runoff control program for new development and redevelopment sites disturbing 1 or more acres.
- A municipal pollution prevention/good housekeeping operation and maintenance program.

In general, municipalities and RIDOT were automatically designated as part of the Phase II program if they were located either completely or partially within census-designated urbanized or densely populated area. Municipalities and RIDOT operate MS4s that discharge to the surface waters of the Blackstone River and its tributaries inside and outside of a densely populated area (RIDEM, 2003a). Densely populated areas have a population density greater than 1000 people per square mile and a total population greater than 10,000 people. The cities of Woonsocket, Central Falls, and Pawtucket are densely populated areas, while Cumberland, Lincoln and North Smithfield are not. These municipalities and RIDOT have submitted the required Stormwater Management Program Plans (SWMPPs) for those areas of the study that are located within the densely populated areas. In addition to the drainage structures owned by the MS4 operators, large areas of Central Falls and Pawtucket are serviced by combined sewer outfalls that are part of the Narragansett Bay Commission CSO service area as previously described in Section 4.3 of this TMDL.

7.1.2 Required SWMPP Amendments to TMDL Provisions

In Rhode Island, Part IV.D of the Phase II General Permit requires MS4 operators to address TMDL provisions in their SWMPP if the approved TMDL identifies stormwater discharges that directly or indirectly contain the pollutant(s) of concern (Part II.C3). Operators must comply with Phase II TMDL requirements if they contribute stormwater to identified outfalls, even if they do not own the outfall. Operators must identify amendments needed to their current SWMPP to comply with TMDL requirements. To avoid confusion and to better track progress, the SWMPP amendments should be addressed in a separate TMDL Implementation Plan (TMDL IP). The MS4 operators identified in this TMDL include Woonsocket, North Smithfield, Cumberland, Lincoln, Central Falls, Pawtucket, and RIDOT. Consistent with the 2003 RIPDES General Permit, the revisions (i.e. TMDL IP) must be submitted within one hundred and eighty (180) days of the date of written notice from RIDEM that the TMDL has been approved, as described in more detail below (RIDEM, 2003a).

It is common for state-owned and municipal-owned storm drains to interconnect. RIDEM encourages cooperation between MS4 operators when developing and implementing the six minimum measures and in conducting feasibility analyses and determining suitable locations for the construction of BMPs. Communities affected by the Phase II program are encouraged to cooperate on any portion of, or an entire minimum measure when developing and implementing their stormwater programs. An important first step in implementing this TMDL will be to confirm the ownership of the priority outfalls identified in Table 4.2 and to determine interconnections within these drainage systems to the priority outfalls.

7.1.3 TMDL Implementation Plan Requirements

The TMDL IP must address all parts of the watershed that discharge to the impaired water and all impacts identified in the TMDL. The TMDL IP must describe the six minimum measures and other additional controls that are or will be implemented to address the TMDL pollutants of concern. The operators must provide measurable goals for the development and/or implementation of the six minimum measures and additional structural and non-structural BMPs that will be necessary to address provisions for the control of storm water identified in this TMDL including an implementation schedule, which includes all major milestone deadlines including the start and finish calendar dates, the estimated costs and proposed or actual funding sources, and the anticipated improvement(s) to water quality. If no structural BMPs are recommended, the operator must evaluate whether the six minimum measures alone (including any revisions to ordinances) are sufficient to meet the TMDL's goals. As mentioned previously, these requirements apply to any operators of MS4s contributing stormwater to specifically identified outfalls, regardless of outfall ownership.

The TMDL IP must specifically address the following requirements that are described in Part IV.D of the RIPDES Stormwater General Permit (RIDEM, 2003a).

1. Determine the land areas contributing to the discharges identified in TMDL using sub-watershed boundaries as determined from USGS topographic maps or other appropriate means.
2. Address all contributing areas and the impacts identified by the Department.
3. Assess the six minimum control measure BMPs and additional controls currently being implemented or that will be implemented to address the TMDL provisions and pollutants of concern and describe the rationale for the selection of controls including the location of the discharge(s), receiving waters, water quality classification, shellfish growing waters, and other relevant information.
4. Identify and provide tabular description of the discharges identified in the TMDL including:
    a. Location of discharge (latitude/longitude and street or other landmark).
    b. Size and type of conveyance (e.g. 15" diameter concrete pipe).
    c. Existing discharge data (flow data and water quality monitoring data).
    d. Impairment of concern and any suspected sources(s).
    e. Interconnections with other MS4s within the system.
    f. TMDL provisions specific to the discharge.
    g. Any additional outfall/drainage specific BMP(s) that have or will be implemented to address TMDL provisions.

    h. Schedule for construction of structural BMPs including those for which a Scope of Work is to be prepared, as described below.

5. If the TMDL does not recommend structural BMPs, the TMDL IP must evaluate whether the six minimum measures alone (including any revisions to ordinances) are sufficient to meet the TMDL's goals. The TMDL IP should describe the rationale used to select BMPs.
6. With the exception of the lower reach of the Blackstone River (RI0001003R-01B) for pathogens, this TMDL has determined that structural BMPs are necessary in all waterbodies and reaches, the TMDL IP must describe the tasks necessary to design and construct BMPs that reduce the pollutant of concern and stormwater volumes to the *maximum extent feasible*. The TMDL IP must describe the process and the rationale that will be used to select structural BMPs (or LID retrofits) and measurable goals to ensure that the TMDL provisions will be met. In a phased approach, operators must identify any additional outfalls not identified in the TMDL that contribute the greatest pollutant load and prioritize these for BMP construction. Referred to as a Scope of Work in the current permit, this structural BMP component of the TMDL IP must also include a schedule and cost estimates for the completion of the following tasks:

    a. Prioritization of outfalls/drainage systems where BMPs are necessary. If not specified in TMDL, priority can be assessed using relative contribution of the pollutant of concern, percent effective impervious area, or pollutant loads as drainage area, pipe size, land use, etc. A targeted approach to construct stormwater retrofit BMPs at state and locally owned stormwater outfalls is recommended.
    b. Delineation of the drainage or catchment area.
    c. Determination of interconnections within the system and the approximate percentage of contributing area served by each operator's drainage system, as well as a description of efforts to cooperate with owners of the interconnected system.
    d. Completion of catchment area feasibility analyses to determine drainage flow patterns (surface runoff and pipe connectivity), groundwater recharge potentials(s), upland and end-of-pipe locations suitable for siting BMPs throughout the catchment area, appropriate structural BMPs that address the pollutants of concern, any environmental (severe slopes, soils, infiltration rates, depth to groundwater, wetlands or other sensitive resources, bedrock) and other siting (e.g. utilities, water supply wells, etc.) constraints, permitting requirements or restrictions, potential costs, preliminary and final engineering requirements.
    e. Design and construction of structural BMPs.
    f. Identification and assessment of all remaining discharges not identified in the TMDL owned by the operator contributing to the impaired waters addressed by the TMDL taking into consideration the factors discussed above.

7. If the TMDL determines structural BMPs are necessary, but has not identified or prioritized outfalls/drainage systems for BMP construction, the TMDL IP must first identify and assess outfalls owned by the operator discharging directly to the impaired

water or indirectly within 1 mile of the impaired water. The operator must then complete all tasks described in section f above.

In summary, the SWMPPs must be revised to describe the six minimum measures and other additional controls that are or will be implemented to address the TMDL pollutants of concern. The operators must provide measurable goals for the development and/or implementation of the six minimum measures and additional structural and non-structural BMPs that will be necessary to address provisions for the control of storm water identified in this TMDL including an implementation schedule, which includes all major milestone deadlines including the start and finish calendar dates, the estimated costs and proposed or actual funding sources, and the anticipated improvement(s) to water quality. If no structural BMPs are recommended, the operator must evaluate whether the six minimum measures alone (including any revisions to ordinances) are sufficient to meet the TMDL's goals.

7.1.4 Evaluation of Sufficiency of Six Minimum Measures

In areas where stormwater has been found to contribute to the impairment, but that structural BMPs are not specifically recommended, evaluation shall be conducted to determine whether the six minimum measures alone are sufficient to meet the TMDL goals for the pollutants of concern. Due to the limited geographic area contributing to the main stem of the Blackstone River in North Smithfield and the co-existence of combined sewer outfalls in Central Falls and Pawtucket, these communities fall into this category and should evaluate all mapped outfalls and all sampling data (collected by DEM and MS4s) for those discharging stormwater to the Blackstone River. Consideration shall be given to the percent effective impervious area of the catchment area and pollutant loads as indicated by drainage area, pipe size, land use, known hot spots, and/or any sampling data. If these evaluations and measures determine that six minimum measures are insufficient, the MS4 will be required to describe modifications to their six minimum measures and/or the need for structural BMPs. At a minimum, North Smithfield, Central Falls, and Pawtucket, are required to modify ordinances regulating post construction stormwater discharges consistent with provisions outlined in Section 7.2.3 below so as to prevent further degradation of these impaired waters. The modifications and/or structural BMPs must be specified along with a schedule for implementation, as part of the TMDL Implementation Plan. Alternatively if the evaluation determines that no structural BMPs are needed, then the requirements would be considered satisfied at that time.

7.2 Modifications to Six Minimum Measures

As described previously, MS4 operators must assess the six minimum control measure BMPs included in their SWMPPs for compliance with this TMDL plan's provisions and provide measurable goals in the TMDL IP for any needed amendments. The operator must also describe the rationale for the selection of controls including the location of the discharge(s), receiving waters, water quality classification, and other relevant information (General Permit Part IV.D.3.c). The following sections outline activities that towns and RIDOT should or must implement and/or consider when modifying their six minimum measures.

7.2.1 Public Education/Public Involvement

The public education program must focus on both water quality and water quantity concerns associated with stormwater discharges within the watershed. Public education material should target the particular audience being addressed, while public involvement programs should actively involve the community in addressing stormwater concerns.

An educational campaign targeted to residential land uses should include activities that residents can take to minimize water quality and water quantity impacts. Measures that can reduce bacteria contamination include proper septic system maintenance, eliminating any wastewater connections to the storm drain network, proper disposal of pet waste, proper storage and disposal of garbage, and not feeding waterfowl. For trace metals, measures that can reduce the quantity of water that runs off during a wet weather event can aid in preventing these pollutants from reaching impaired waterbodies. These include decreasing effective impervious area and by providing on-site attenuation of runoff. Roof runoff can be infiltrated using green roofs, dry wells, or by redirecting roof drains to lawns and forested areas. Reducing land runoff can be accomplished by grading the site to minimize runoff and to promote storm water attenuation and infiltration, creating rain gardens, and reducing paved areas such as driveways. Driveways can be made of porous materials such as crushed shells, stone, or porous pavement. Buffer strips and swales that add filtering capacity through vegetation can also slow runoff. Waterfront properties as well as those adjacent to hydrologically connected streams and wetland areas should establish and maintain natural buffers, planted with native plants, shrubs and/or trees to minimize impacts of development and restore valuable habitat.

Other audiences include commercial, industrial, and institutional property owners, land developers, and landscapers. In addition to the activities discussed above for residential land use, educational programs for these audiences could discuss BMPs that should be used when redeveloping or re-paving a site to minimize runoff and promote infiltration. Measures such as minimizing road widths, installing porous pavement, infiltrating catch basins, breaking up large tracts/areas of impervious surfaces, sloping surfaces towards vegetated areas, and incorporating buffer strips and swales should be used where possible. Section 6.2 discusses changes to the RI Stormwater Design and Installation Standards Manual (RIDEM and CRMC, 2010) that promote these measures using low impact development (LID) techniques.

The University of Rhode Island Cooperative Extension’s Storm Water Phase II Public Outreach and Education Project provides participating MS4s with education and outreach programs that can be used to address TMDL public education recommendations. This project is funded by RIDOT and has many partners, including RIDEM. More information may be found on the URI website http://www.ristormwatersolutions.org/.

In addition to the more generalized outreach and education efforts described above, Woonsocket, North Smithfield, Cumberland, Lincoln, and RIDOT must also provide targeted outreach to the owners/managers of highly impervious parcels (comprising 2 or more acres of impervious cover) discharging to their drainage systems. These parcels have been identified by RIDEM as part of work under a 104b3 grant, and are included in Appendix C. Though no direct evidence that these properties are contributing to the water quality impairments was documented, due to the extent of impervious cover, these property owners should be encouraged to undertake measures to reduce runoff volumes and pollutant loads. MS4 operators are required to provide public education materials to the highly impervious industrial, commercial, and institutional property owners informing them of good housekeeping and pollution prevention techniques, and other practices to reduce runoff volumes.

In the summer of 2010, the four Blackstone River municipalities were offered the opportunity to work in partnership with RIDEM, University of Rhode Island NEMO Program, Blackstone River Coalition, and Audubon Society of Rhode Island to disseminate public education materials to these highly impervious parcel owners. The Towns of Lincoln and North Smithfield participated in this effort and thus have met this outreach requirement. Over 60 businesses were contacted informing them of the importance of managing their stormwater onsite and of the availability of on-site technical assistance from the Blackstone River Coalition and the Audubon Society of Rhode Island – as part of their "In Business for the Blackstone" Program. The Blackstone River Coalition's "In Business for the Blackstone" is a well established voluntary program offering technical assistance to small and mid sized commercial and industrial property owners on good housekeeping practices that will minimize the pollution associated with stormwater from rain and snowmelt. The effort produced one brochure (that may be customized for each municipality in the Blackstone watershed) describing good housekeeping and other pollution prevention measures (see Appendix A) as well as a self inspection checklist for property owners with large impervious areas. More information about the Blackstone River Coalition's programs can be found on the following website:
www.zaptheblackstone.org/whatwedoing/In_Business_Program/In_Business.shtml

7.2.2 Illicit Discharge Detection and Elimination

Illicit discharges are any discharge to a MS4 that is not composed entirely of stormwater with some exceptions. OWTS or sewer line wastewater connections to a storm drain result in the discharge of untreated sewage to a waterbody. Sampling storm drains in dry weather can reveal illicit discharges.

It is not unexpected that illicit sewer connections may be found in storm drainage systems serving the older developed portions of the Blackstone River watershed. Illicit connections were found during field studies conducted in support of this TMDL. As discussed in the pollutant source section, one of the hot spots identified in the field study discovered that a stormwater outfall adjacent to the Ann & Hope warehouse in Cumberland had multiple sewer lines inadvertently connected, resulting in high pathogen counts whenever samples were collected. Through dye testing and source tracking back through the stormwater lines, the illicit connections were discovered and the individual sewer lines properly connected to the sewer collection mains. As a result of this effort, dry weather pathogen counts in discharges from this outfall have been significantly reduced to acceptable levels.

All municipalities and RIDOT must review the list of the RIDEM-identified outfalls included in Table 4.2 and confirm ownership of outfalls and known interconnections with other MS4s. Outfalls that contain storm water from the MS4 should be integrated into the MS4 outfall maps and illicit discharge detection program including the dry weather sampling data collected by the MS4 operator. They must review the results of Figure 5-17 of the Blackstone River Final Report

2: Field Investigations (Berger, 2008) and the dry weather surveys. Any outfall with sampling results greater than 2400 MPN/100ml for pathogens, and / or those with elevated trace metal (copper or lead) values and exhibiting a steady flow should be prioritized for further investigation to eliminate any illicit discharges.

7.2.3 Construction/Post Construction

MS4 operators are required to establish post construction storm water runoff control programs for new land development and redevelopment at sites disturbing *one or more acres*. Untreated storm water runoff contains high bacteria loads, which contribute significantly to the water quality problems in the Blackstone Watershed. Land development and re-development projects must utilize best management practices if the Blackstone River and its tributaries are to be successfully restored. Consistent with the revised RI Stormwater Design and Installation Manual (RIDEM and CRMC, 2010), local ordinances meant to comply with the post construction minimum measures (General Permit Part IV.B.5.a.2.) must require that applicable development and re-development projects use Low Impact Development (LID) techniques as the primary method of stormwater control to the maximum extent practicable and maintain groundwater recharge to predevelopment levels.

As mentioned previously, examples of acceptable reduction measures include reducing impervious surfaces, sloping impervious surfaces to drain towards vegetated areas, using porous pavement, and installing infiltration catch basins where feasible. Other reduction measures to consider are the establishment of buffer zones, vegetated drainage ways, cluster zoning or low impact development, transfer of development rights, and overlay districts for sensitive areas. The revised RI Stormwater Design and Installation Standards Manual (RIDEM and CRMC, 2010) contains detailed information on use of low impact development (LID) techniques.

To ensure consistency with the goals and recommendations of the TMDL, the TMDL IP must also address any revisions to local ordinances that are needed to ensure that:

- New land development projects employ stormwater controls to prevent any net increase in bacteria and trace metals pollution to the waterbodies in the Blackstone River Watershed, specifically:
    1. Blackstone River mainstem (RI0001003R-01A) - Pathogens, Cadmium, Lead.
    2. Blackstone River mainstem (RI0001003R-01B) – Pathogens[1], Cadmium, Lead.
    3. Cherry Brook (RI0001003R-02) - Pathogens, Copper
    4. Mill River (RI0001003R-03) - Pathogens
    5. Peters River (RI0001003R-04) - Pathogens, Copper

[1] Though this TMDL does not address the bacteria impairment in this reach, consistent with Rule 9A of RI's Water Quality Regulations, no person shall discharge pollutants into any waters of the State, or perform any activities alone or in combination which the Director determines will likely result in the additional degradation of water quality of the receiving waters or downstream waters which are already below the water quality standard assigned to such waters.

- Redevelopment projects to employ stormwater controls to reduce bacteria and trace metal pollution to the waterbodies in the Blackstone River Watershed (as detailed above) to the maximum extent feasible.

These runoff control programs also apply to MS4-owned facilities and infrastructure (General Permit Part IV.B.6.a.2 and Part IV.B.6.b.1).

Woonsocket, Lincoln, Cumberland, N. Smithfield, Central Falls and Pawtucket should also consider expanding these ordinances to include projects that disturb *less than 1 acre*. At a minimum the TMDL IP must assess the impacts of imposing these requirements on lower threshold developments. The TMDL IP should also assess and evaluate various enforceable mechanisms that ensure long-term maintenance of BMPs.

7.2.4 Good Housekeeping/Pollution Prevention

The Storm Water General Permit (see Part IV.B.6.a.2 and Part IV.B.6.b.1) extends storm water volume reduction requirements to operator-owned facilities and infrastructure. Similarly, municipal and state facilities could incorporate measures such as reducing impervious surfaces, sloping impervious surfaces to drain towards vegetated areas, incorporating buffer strips and swales, using porous pavement and infiltration catch basins where feasible. In addition, any new municipal construction project or retrofit should incorporate BMPs that reduce storm water and promote infiltration such as the before-mentioned measures.

The TMDL Implementation Plan should provide a list of municipally owned properties and any BMPs that may have been implemented to date, and/or where opportunities exist for future implementation. As part of their Good Housekeeping/Pollution Prevention requirements, municipal MS4 operators and RIDOT must investigate the feasibility of increased street sweeping and/or stormwater system maintenance to address pathogen loads to the stream systems. At least one street sweeping and storm drain cleaning should be conducted in the spring when the last reasonable chance of snowfall has past.

7.3 Municipality Specific Stormwater Measures

North Smithfield

North Smithfield (Permit RIR040013, Blackstone River Segment RI0001003R-01A and Cherry Brook RI0001003R-02) is authorized to discharge stormwater under the General Permit listed above. Upon notification by RIDEM of the US Environmental Protection Agency's approval of this TMDL, North Smithfield will have 180 days to amend its SWMPP consistent with Part IV.D of the General Permit. As detailed in Section 7.1.4, North Smithfield must evaluate the sufficiency of its six minimum measures to meet the TMDL water quality objectives and at a minimum must modify its ordinances related to post construction stormwater controls to prevent further degradation of these impaired waters, as detailed in Section 7.2.3 above. The evaluation of six minimum measures and all modifications and proposed BMPs must be documented in the TMDL Implementation Plan along with a schedule for implementation.

Central Falls

Central Falls (Permit RIR040041, Blackstone River Segment RI0001003R-01B) is currently authorized to discharge stormwater under the General Permit listed above. Due to CSOs located in the City of Central Falls that discharge to the Blackstone River, Central Falls has applied for a waiver from the Phase II permit requirements. To date, the City has not provided documentation in support of this waiver request, and therefore until such documentation is received, Central Falls is considered subject to the Phase II requirements.

Phase III of the Narragansett Bay Commission's CSO plan will address CSOs that discharge to the Blackstone River and will include the Pawtucket tunnel, CSO interceptors, and sewer separation. As sewer separation projects are completed and separate stormwater discharges are constructed, the responsible MS4 operators (RIDOT or Central Falls) must at a minimum apply the six minimum measures to these newly created separate stormwater discharges.

As noted above, the City of Central Falls must evaluate the sufficiency of its six minimum measures to meet the TMDL water quality objectives and at a minimum must modify its ordinances related to post construction stormwater controls to prevent further degradation of these impaired waters, as detailed in Section 7.2.3 above. A reasonable first step is for the City of Central Falls to coordinate with NBC and RIDOT to confirm outfall ownership (whether CSO or separate stormwater outfall) and system interconnections to determine whether a MS4 permit waiver can be supported, and to identify possible priority areas for runoff attenuation and/or treatment. Upon notification by RIDEM of the US Environmental Protection Agency's approval of this TMDL, Central Falls will have 180 days to amend their SWMPPs consistent with Part IV.D of the General Permit and these specific TMDL requirements.

Pawtucket

Pawtucket (Permit RIR040024, Blackstone River Segment RI0001003R-01B) is authorized to discharge stormwater under the General Permit listed above. Phase III of the Narragansett Bay Commission's CSO plan will address CSOs that discharge to the Blackstone River and will include the Pawtucket tunnel, CSO interceptors, and sewer separation. As sewer separation projects are completed and separate stormwater discharges are constructed, the responsible MS4 operators (RIDOT or Pawtucket) must at a minimum apply the six minimum measures to these newly created separate stormwater discharges.

As noted above, Pawtucket must evaluate the sufficiency of its six minimum measures to meet the TMDL water quality objectives and at a minimum must modify its ordinances related to post construction stormwater controls to prevent further degradation of these impaired waters, as detailed in Section 7.2.3 above. A reasonable first step is for Pawtucket to coordinate with NBC and RIDOT to confirm outfall ownership (whether CSO or separate stormwater outfall) and system interconnections, and to identify possible priority areas for runoff attenuation and/or treatment. Upon notification by RIDEM of the US Environmental Protection Agency's approval of this TMDL, Pawtucket will have 180 days to amend their SWMPP consistent with Part IV.D of the General Permit and these specific TMDL requirements.

Woonsocket

Woonsocket is authorized to discharge stormwater under the RIPDES Phase II Stormwater General Permit (RIPDES permit RIR040016, Blackstone River Segment RI0001003R-01A, Cherry Brook RI0001003R-02, Mill River RI0001003R-03, and Peters River RI0001003R-04). Upon notification by RIDEM of the US Environmental Protection Agency's approval of this TMDL, Woonsocket will have 180 days to amend their SWMPP consistent with Part IV.D of the General Permit. In addition to the modifications to the six minimum measures described above in Section 7.2, Woonsocket must also assess and prioritize drainage systems listed in Table 4.2 for the design and construction of BMPs that reduce the pollutants of concern and stormwater volumes to the *maximum extent feasible* as detailed in Section 7.1.3 above.

Table 4.2 lists thirty-one priority outfalls located in Woonsocket of which, the City of Woonsocket is the presumed owner of eighteen, and either RIDOT or Woonsocket the presumed owner of thirteen. As a preliminary step, Woonsocket must work with RIDOT to confirm ownership, to identify interconnections among the drainage systems to the priority outfalls, and to prioritize those with high pathogen levels and/or trace metals in their discharges based upon available information. Woonsocket should begin this assessment process by reviewing available information for priority outfalls listed in Table 4.2, as well as any other monitoring data collected by the city or others. Additional information about these and other identified outfalls is contained in Section 5 of the Blackstone Field Investigation Report (Berger, 2008) which has locations of all outfalls to the Blackstone Watershed that were identified at the time the study was conducted. Figure 5-17 of the Berger report provides the observed flow and water quality data from selected outfalls. Attention must be given to whether the data was collected under dry or wet weather conditions and thus whether priority ought to be given to illicit discharge detection and elimination, or construction of BMPs to reduce wet weather pollutant loads.

The outfalls discussed below are a subset of the priority outfalls listed in Table 4.2 and were chosen because of the high levels of pollutants of concern associated with the data reported in the Berger report, as well as the size of the impervious area draining to these outfalls. These should be considered a starting point for further investigations by Woonsocket. The outfalls below are identified using the same identification numbering system as found in the Blackstone Field Investigation Report.

- **Outfall 219** is located at the exit of Cherry Brook after it passes under Olo Street and continues to the Blackstone River and is one of the priority outfalls that should be investigated further. Cherry Brook is impaired itself and as discussed in this TMDL, also contributes both pathogens and metals to the Blackstone River. Areas to target for BMP implementation include the vicinity of the Wright Dairy Farm as well as the segment of the brook that runs from RT146A to Olo Street. The samples from the brook contained trace metals as well as high levels of pathogens.

- **Outfall 231** (also W-32) located at Front Street) is a 48-inch pipe with a large drainage area. The pipe carries a brook and has dry weather flow. The drainage area is largely residential and commercial. The outfall was investigated also as part of the dry and wet weather sampling program during the BTMDL field surveys. This outfall has high pathogen concentrations and trace metals in the dry and wet weather discharges to the Blackstone River downstream of the South Main Street Bridge. The wet weather sample contained lead concentrations that exceeded the freshwater chronic criteria.

- **Outfall 242** located on the north bank of the Blackstone River under the Court Street Bridge (RT126). This is a thirty inch outfall that had dry weather flows that contained both pathogens and dissolved metals. The wet weather flows had lead concentrations that exceeded the freshwater chronic criteria and fecal concentrations as high as 3000 MPN/100ml. This outfall is presumably owned by the city or RIDOT and discharges stormwater from Truman Drive.

- **Outfall 243** is a 48-inch pipe located on the north bank of the Blackstone River approximately three hundred feet downstream of Outfall 242. The outfall drains an area that contains two or more acres of impervious surfaces. No dry weather flows were observed but a wet weather sample had fecal coliform levels of 1,700 MPN/100ml and dissolved lead levels that exceeded the freshwater chronic criteria. This outfall is presumed to be owned by Woonsocket or RIDOT.

- **Outfall 247**, just upstream of the Mill River confluence with the Blackstone is 72-inch pipe and was shown to be discharging stormwater containing trace metals as well as pathogens. The pathogen concentrations were in excess of 16,000 MPN/100ml during wet weather while the dissolved lead concentrations exceeded chronic criteria.

- **Outfall 258** located upstream of the Hamlet Avenue Bridge is a 60-inch pipe that drained a large industrial area during wet weather events. Since the BTMDL surveys, the area that this outfall drains has been redeveloped with more open areas that allow some infiltration to occur, however, this is still an area of high priority that should be investigated further. The samples collected during the BTMDL surveys showed significant levels of pathogens as well as trace metals.

- **Outfall 263** is located across from the Woonsocket WWTF and was shown to have significant levels of pathogen concentrations when sampled during the BTMDL field surveys. The outfall is 36 inches in size and had dry and wet weather discharges of pathogens that exceeded the State's water quality criteria as well as trace metals in its discharges, of which dissolved lead violated the freshwater chronic criteria during wet weather events.

- Two outfalls in the Mill River watershed were identified as priority outfalls. The pathogen concentration of a wet weather sample collected at **Outfall 704** north of East School Street near the Veterans Memorial Park exceeded the State's pathogen criteria for freshwater, while the lead concentration violated the State's chronic criteria. The stormwater from 2 or more acres of impervious area drains through this outfall. Another outfall (**OF-703**) adjacent to an auto parts yard is 24 inches in size but was not sampled during the BTMDL surveys, however, it is a possible source with the auto parts yard being in such close proximity to the outfall.

The Rhode Island portion of the Peters River has four pipes that are listed in Table 4.2. During the BTMDL field surveys, two of the pipes had dry weather flows and three of the outfalls drain areas that have more than two acres of impervious surfaces. Two of the four are presumed to be owned by either the city or RIDOT.

- **Outfall 802** is a pipe draining the eastern section of Diamond Hill Road. The flow includes an open brook that originates in a wetland to the east of Linden Road. It was sampled twice during the field surveys and had a dry weather flow of approximately 1.5 ft^3/sec. While the pathogen concentrations were low, samples did contain trace metals. The area of this outfall contains two or more areas of impervious surfaces.

- **Outfall 804** is a 72-inch pipe in a concrete headwall. It is partially submerged in the Peters River and appeared dry (or had only very low dry weather flow) during the BTMDL surveys. The outfall drains part of East Hill Road, Salisbury Street and surrounding residential neighborhoods.

- **Outfall 815** is a large ribbed PVC pipe (24 inches in diameter) extending from the River Haven Condominiums. During the field survey work, it had a dry weather flow of approximately 0.1 ft^3/sec and samples contained dissolved metals. At the point of discharge there was white foam in Peters River, suggesting that the discharge from the pipe may have included domestic wastewater containing detergents.

Cumberland

Cumberland is authorized to discharge stormwater to the Blackstone River under the RIPDES Phase II Stormwater General Permit (RIPDES Permit RIR040035, Blackstone River Segment RI0001003R-01A). Upon notification by RIDEM of the US Environmental Protection Agency's approval of this TMDL, Cumberland will have 180 days to amend their SWMPP consistent with Part IV.D of the General Permit. In addition to the modifications to the six minimum measures described above in Section 7.2, Cumberland must also assess and prioritize drainage systems listed in Table 4.2 for the design and construction of BMPs that reduce the pollutants of concern and stormwater volumes to the *maximum extent feasible* as detailed in Section 7.1.3 above.

Table 4.2 lists fourteen priority outfalls located in Cumberland of which, the Town of Cumberland is the presumed owner of five, RIDOT the presumed owner of two, and either RIDOT or Cumberland the presumed owner of seven. As a preliminary step, Cumberland must work RIDOT to confirm ownership of those outfalls identified in the table, determine interconnections between the state and city owned drainage systems, and prioritize those with high pathogen levels and/or trace metals in their discharges based upon available information. Cumberland should begin this assessment process by reviewing available information for priority outfalls listed in Table 4.2, as well as any other monitoring data collected by the town or others. Additional information about these and other identified outfalls is contained in Section 5 of the Blackstone Field Investigation Report (Berger, 2008) which has locations of all outfalls to the Blackstone Watershed that were identified at the time the study was conducted. Figure 5-17 of the Berger report provides the observed flow and water quality data from selected outfalls.

Attention must be given to whether the data was collected under dry or wet weather conditions and thus whether priority ought to be given to illicit discharge detection and elimination, or construction of BMPs to reduce wet weather pollutant loads.

The outfalls discussed below are a subset of the priority outfalls listed in Table 4.2 and were chosen because of the high levels of pollutants of concern associated with the data reported in the Berger report, as well as the size of the impervious area draining to these outfalls. These outfalls below should be considered a starting point for further investigations by Cumberland. The outfalls below use the same identification numbering system as found in the Blackstone Field Investigation Report.

- **Outfall 302** is a flared, 36-inch concrete pipe located behind the parking area of the Panda Restaurant near the intersection of Mendon Road and Marshall Avenue. This outfall had observed flows for dry and wet weather surveys. The fecal coliform values for the dry and wet weather samples exceeded 16,000 MPN/100ml, while the wet weather dissolved lead concentrations exceeded the State's fresh water quality criteria. Additionally, the drainage area of this outfall includes impervious surfaces greater than 2 acres in size. Although the discharge is into a pond adjacent to the Blackstone, further investigation should be conducted due to the high dissolved metals observed in the stormwater coming from this location. The outfall is presumed to be owned by either Cumberland or RIDOT.

- **Outfall 304** is located on the north side of the Martin Street Bridge and may be the NPDES-permitted outfall from the Okonite facility. Although only a twelve-inch pipe, it had consistently high levels of pathogen concentrations in both the dry and wet weather discharges as well as dissolved copper and lead. The metal concentrations were highest during the wet surveys, nearly ten times the levels of the dry weather samples suggesting a wet weather source.

- **Outfall 311** is a 24-inch pipe that had high dry weather and significant wet weather pathogen levels when sampled during the field surveys. All samples analyzed also contained varying levels of trace metals as well. This outfall flows into Abbott Run Brook. It is located approximately 10 m (33 feet) from the southwestern corner of the Mill Street Bridge, discharging to Abbott Run Brook. It is located downstream of the Happy Hollow Pond. The outfall supposedly receives much of the drainage from High Street.

- **Outfall 317** (W-35 in the field report) is one of the pollutions hot spots identified in Section 4.5 of this TMDL. The outfall is 48 by 60 inches and had significant levels of fecal coliform and dissolved lead in the samples collected during the BTMDL Field Study. As noted earlier in this TMDL, RIDEM staff investigated this location in 2008 and 2009 and found thirteen direct sewer line connections to the stormwater lines draining this area. The sewer connections were corrected and a water quality survey done in November 2009 documented that dry weather discharges for pathogens were significantly reduced. However, a dry weather value of 2400 MPN/100ml fecal coliform was observed in the drainage system southwest of the intersection of Broad Street and

Ann and Hope Way – indicating the need for further dry weather evaluation. Given the size of the drainage system discharging to this outfall, it is also considered a priority for BMP construction to reduce wet weather discharges of both bacteria and dissolved lead to the Blackstone River.

- **Outfall 324** is located to the north of the Durham School Bus Service parking lot, along the John Dean Memorial Boulevard. The end of the pipe is badly corroded and appears to extend toward the industrial facilities along Ashton Park Way, located between Mendon Road and the railroad line. A metals finishing company occupy one of these buildings, and another is used for activities such as storage and car repair. This outfall had pathogen levels that exceeded the State's fresh water criteria, with the most significant violations occurring during wet weather. All samples contained trace metals with the highest concentrations of lead and copper occurring during dry weather surveys. One of the four dissolved lead concentrations exceeded the State's chronic criteria.

- **Outfall 325** is a concrete culvert is located at the southern end of the former Ashton Mill building. The culvert appears to be the conduit for Scott Brook. Scott Brook enters the subsurface just to the east of the intersection between Mendon Road and Scott Road. The former mill was undergoing redevelopment into apartments and the drainage system appeared to have been updated with all stormwater runoff discharging through OF325. The outfall had wet weather flows of 2 and 12 ft^3/sec with significantly high pathogen concentrations as well as trace metals.

- **Outfall 333** is located at the Albion Road crossing where it continues to the Blackstone River after passing under the bikeway. The flow for this outfall originates in Sneech Pond and flows through predominantly residential areas. Three samples were collected during the BTMDL field surveys consisting of one dry and two wet weather samples. All samples exceeded the State's fresh water quality criteria for fecal coliform and also contained detectable levels of trace metals in the wet weather samples. A new shopping are has recently been constructed upstream of the outfall which has a stormwater BMP for however, this area should be investigated for possible sources of pathogens that may have caused the high levels see during the surveys.

Lincoln

Lincoln discharges stormwater to the Blackstone River under the RIPDES Phase II Stormwater General Permit (RIPDES permit RIR040021, Blackstone River Segment RI0001003R-01A). Upon notification by RIDEM of the US Environmental Protection Agency's approval of this TMDL, Lincoln will have 180 days to amend their SWMPP consistent with Part IV.D of the General Permit. In addition to the modifications to the six minimum measures described above in Section 7.2, Lincoln must also assess and prioritize drainage systems listed in Table 4.2 for the design and construction of BMPs that reduce the pollutants of concern and stormwater volumes to the *maximum extent feasible* as detailed in Section 7.1.3 above.

Table 4.2 lists twelve priority outfalls located in Lincoln of which, the Town of Lincoln is the presumed owner of nine and either RIDOT or Lincoln the presumed owner of three. Six of the twelve exceeded the State's fresh water quality criteria for pathogen and/or trace metals, and three drain two or more impervious acres. As a preliminary step, Lincoln must work with RIDOT to confirm ownership, to identify interconnections among the drainage systems to the priority outfalls, and to prioritize those with high pathogen levels and/or trace metals in their discharges based upon available information. Lincoln should begin this assessment process by review ing available information for outfalls listed in Table 4.2, as well as any other monitoring data collected by the town or others. Additional information about these and other identified outfalls is contained in Section 5 of the Blackstone Field Investigation Report (Berger, 2008) which has locations of all outfalls to the Blackstone Watershed that were identified at the time the study was conducted. Figure 5-17 of the Berger report provides the observed flow and water quality data from selected outfalls. Attention must be given to whether the data was collected under dry or wet weather conditions and thus whether priority ought to be given to illicit discharge detection and elimination, or construction of BMPs to reduce wet weather pollutant loads.

The outfalls discussed below are a subset of the priority outfalls listed in Table 4.2 and were chosen because of the high levels of pollutants of concern associated with the data reported in the Berger report, as well as the size of the impervious area draining to these outfalls. These outfalls below should be considered a starting point for further investigations by Lincoln. The outfalls are listed by the same identification numbering system as that found in Section 5 of the Blackstone Field Investigation Report.

- **Outfall 435** is a granite block culvert 24 x 24 inches in size that is located across from Winter Street on the up gradient side of the railroad track. The culvert extends underneath Railroad Street and drains Winter Street and its vicinity in Manville. The BTMDL noted that there are several pipes that enter the culvert up gradient. One dry and one wet weather sample was collected during the surveys and both sets of samples exceeded the fecal coliform criteria of the State, and also have detectable levels of dissolved copper and lead. The higher concentration levels were the wet weather samples.

- **Outfall 428** consists of two flared concrete pipes, 24 inches in diameter, underneath the bike path. There was dry weather flow during each site visit, as the pipes appear to carry a brook. The wet weather sample was slightly higher that the State criteria for pathogens. Both the dry and wet survey samples contained detectable levels of trace metals, with higher wet weather concentrations for both copper and lead.

- **Outfall 448** is a pipe with a diameter of 21 or 24 inches, draining into the Blackstone River below the Manville Dam. On the landside of the railroad tracks, there is an open culvert that is accessible for sampling. The pipe discharges to the Blackstone River from a tall retaining wall downstream of the Manville Dam, approximately 4 m (13 feet) above the water surface. Two wet weather samples were taken during the BTMDL field surveys, and both exceeded the State’s fresh water quality criteria for pathogens. Both samples contained levels of trace metals that violated chronic criteria.

RIDOT

RIDOT is authorized to discharge stormwater under the RIPDES Phase II Stormwater General Permit (RIPDES Permit RIR040036, all segments of the Blackstone River Watershed). Upon notification by RIDEM of the US Environmental Protection Agency's approval of this TMDL, RIDOT will have 180 days to amend their SWMPP consistent with Part IV.D of the General Permit. In addition to the modifications to the six minimum measures described above in Section 7.2, RIDOT must also assess and prioritize drainage systems for the design and construction of BMPs that reduce the pollutants of concern and stormwater volumes to the *maximum extent feasible* as detailed in Section 7.1.3 above.

Table 4.2 lists twenty-three outfalls located in Woonsocket, Lincoln or Cumberland where RIDOT is identified along with the relevant municipality as the presumed owner of the outfall, and two outfalls located in Cumberland that RIDOT is the presumed owner. As a preliminary step, RIDOT must work with the municipalities in the watershed to confirm ownership of outfalls listed in Table 4.2, to identify interconnections among the state and local drainage systems to the priority outfalls, and to prioritize those with high pathogen levels and/or trace metals in their discharges based upon available information. RIDOT should begin this assessment process by reviewing available information for priority outfalls listed in Table 4.2, as well as any other monitoring data collected by the state or others. Additional information about these and other identified outfalls is contained in Section 5 of the Blackstone Field Investigation Report (Berger, 2008) which has locations of all outfalls to the Blackstone Watershed that were identified at the time the study was conducted. Figure 5-17 of the Berger report provides the observed flow and water quality data from selected outfalls. Attention must be given to whether the data was collected under dry or wet weather conditions and thus whether priority ought to be given to illicit discharge detection and elimination, or construction of BMPs to reduce wet weather pollutant loads.

The outfall discussed below is a subset of the priority outfalls listed in Table 4.2 and was chosen because of the high levels of pollutants of concern associated with the data reported in the Berger report. This outfall should be considered a starting point for further investigations by RIDOT. The outfalls are listed by the same identification numbering system as that found in Section 5 of the Blackstone Field Investigation Report.

- **Outfall 302** is located near the intersection of Marshall Avenue and Mendon Road, near the Panda Restaurant. It is draining into the southeastern part of the wetland to the northeast of the Peterson Puritan site and flows into New Pond. This outfall is one of the two considered to be the responsibility of RIDOT. A dry weather and two wet weather samples were collected during the field survey work and all exceeded the State's criteria with fecal coliform levels greater than 16,000 MPN/100ml. Trace metals were also present in the wet weather samples, with one of the wet weather values exceeding the State's Fresh Water Quality Criteria.

7.4 Stormwater from Industrial Activities

Stormwater discharges from facilities that discharge "stormwater associated with industrial activity" are regulated under the statewide general RIPDES permit prescribed in Chapter 46-12, 42-17.1 and 42-35 of the General Laws of the State of Rhode Island. As mentioned previously, stormwater is a major source contributing to the bacteria and metals impairments to the Blackstone, Mill and Peters Rivers, and Cherry Brook. Stormwater from industrial activities may be discharged to these waters directly or via MS4s and may contain bacteria and/or metal concentrations that contribute to the impairments. As part of the 104b3 grant project described in Pollution Source Section, RIDEM has confirmed that as of 2010, all industrial facilities subject to the MSGP requirements have either submitted the no exposure documentation exempting them from the general permit or have applied for application under the general permit.

In accordance with Part I.B.3.j of the RIPDES Multi-Sector General Permit (MSGP), permittees are required to demonstrate that the stormwater discharges are consistent with the TMDL once the TMDL has been approved. Permittees will have 90 days from written notification by RIDEM to submit this documentation including revised Stormwater Pollution Prevention Plan (SWPPPs) to RIDEM.

The owner/operators of facilities currently authorized to discharge directly to waters addressed in this TMDL (main stem Blackstone River, Cherry Brook, Peters River and Mill River) under a MSGP are listed below in Table 7.1.

Table 7.1 MSGP Facilities

Facility Name	Permit Number	Waterbody
Berger Recycling	RIR50N007	Blackstone River
Bill's Auto Parts, Inc.	RIR50M003	Blackstone River
Dean Warehouse Services	RIR50P027	Blackstone River
Healy Brothers Corporation	RIR50F007	Blackstone River
Hope Global (Martin St)	RIR50F011	Blackstone River
Lynch J H & Sons, Inc.	RIR50J001	Blackstone River
Murdock Webbing Company	RIR50V003	Blackstone River
OSRAM Sylvania, Inc.	RIR50E001	Blackstone River
Privilege Auto Parts	RIR50M007	Mill River
Woonsocket Auto Salvage	RIR50M012	Blackstone River

There are several facilities that discharge stormwater into this segment of the Blackstone Watershed that are currently covered under multi sector permits that list one of the pollutants of concern in this TMDL. Table M-1 of RIDEM’s MSGP document (http://www.dem.ri.gov/programs/benviron/water/permits/ripdes/pdfs/msgp.pdf), lists the sector-specific numeric limitations and benchmark monitoring requirements for automobile salvage yards for pollutants associated with this type of activity. The benchmark cutoff concentration for total lead is 81.6µg/L for stormwater discharges from these types of facilities. The permitted facilities located along the waterbodies addressed in this TMDL and are listed in Table 7.2, along with the receiving waterbody and the average concentration reported to RIDEM between 2008 and 2010.

Table 7.2 Industrial Storm Water Discharge Facilities with Monitoring Requirements for Pollutants of Concern.

Facility Name	RIPDES ID	Pollutants of Concern Monitored	Receiving Waterbody	Average Concentration (µg/L)
Bill's Auto Parts	RIR50M003	Lead	Blackstone River	0.07
Privilege Auto Parts	RIR50M007	Lead	Mill River	0.150
Woonsocket Auto Salvage	RIR50M012	Lead	Blackstone River	0.135

The SWPPP must identify the potential sources of pollution, including specifically the TMDL pollutants of concern, which may reasonably be expected to affect the quality of stormwater discharges from the facility; and describe and ensure implementation of practices, which the permittee will use to reduce pollutants in stormwater discharges from the facility. The SWPPP must address all areas of the facility and describe existing and/or proposed BMPs that will be used and at minimum must include the following:

- Frequent sweeping of roads, parking lots and other impervious areas
- Effective management (storage and disposal) of solid waste and trash
- Regular inspection and cleaning of catch basins and other stormwater BMPs
- Other pollution prevention and stormwater BMPs as appropriate

Where structural BMPs are necessary, as stated in Part IV.F.7 of the permit, selection of BMPs should take into consideration:

1. The quantity and nature of the pollutants, and their potential to impact the water quality of receiving waters.
2. Opportunities to combine the dual purposes of water quality protection and local flood control benefits (including physical impacts of high flows on streams - e.g., bank erosion, impairment of aquatic habitat, etc.).
2. Opportunities to offset the impact of impervious areas of the facility on ground water recharge and base flows in local streams.

For existing facilities, the SWPPP must include a schedule specifying when each control will be implemented. Facilities that are not currently authorized will be required to demonstrate compliance with these requirements prior to authorization. If the facility is redeveloped, stormwater controls must be employed to reduce pollutants of concern to the maximum extent feasible, consistent with minimum standard #6 of the RI Stormwater Design and Installation Standards Manual.

7.5 NBC's CSO Abatement Program

The combined sewer overflows into Narragansett Bay are a violation of the Federal Clean Water Act. In July of 1994, DEM approved a comprehensive Combined Sewer Overflow Control Facilities Program prepared by the Narragansett Bay Commission. The Program proposed the construction of six underground storage facilities and three deep rock tunnel segments at a cost of $467 million (1992 dollars). The underground storage tanks and tunnels would contain the sewage overflows during rain events so that the stored flows could be returned to the system for treatment after the storm. Subsequently, NBC reevaluated their CSO abatement plan and prepared an amended CSO Control Facilities Program that was approved by DEM in July of 1999. The amended Program replaced the underground storage facilities with a combination of CSO interceptors and sewer separation projects, and refined the sizing of the deep rock tunnels, with a total cost of $390 million (1998 dollars).

The entire CSO abatement project is being undertaken in three phases over the course of approximately 20 years. Phase I, which went online in November 2008, consists of a 3 mile long 26 foot diameter rock tunnel approximately 300 feet deep which stores approximately 62 MG of combined sewage that is pumped back to the Fields Point WWTF through a CSO Tunnel Pump Station. Phases II and III of the CSO plan address the remaining CSOs that discharge to the Woonasquatucket, Moshassuck, West, Seekonk, and Blackstone Rivers.

Phase II of the CSO plan focuses on the Woonasquatucket River and includes CSO interceptors to transport flows from remote CSOs to the main spine tunnel, separation of sanitary and storm sewers, and a constructed wetland treatment facility. The design for Phase II was completed in 2010, has been approved by RIDEM and is under construction with a proposed completion in 2014.

Phase III consists of a 13,000 foot long 26 foot diameter tunnel (referred to as the Pawtucket tunnel), CSO interceptors, and sewer separation projects. However, as stipulated in the Consent Agreement, NBC must review and evaluate water quality data and alternative technologies and modify the conceptual design approved in the Conceptual Design Report Amendment (CDRA), as necessary to meet the Federal Clean Water Act, USEPA CSO control policies and the Rhode Island Water Quality Regulations. The preliminary design must also include and be consistent with the results of the system evaluation of Phase II, identified in the approved CDRA. The final phase of the project is slated for completion by 2022 with submittal of the Phase III preliminary design report by January 2016. Throughout the entire project, NBC, with DEM's assistance, will continue to work with municipalities in the NBC service area to encourage them to take steps to reduce stormwater runoff. As sewer separation projects are completed and separate stormwater discharges are constructed, it is particularly important that NBC work closely with the responsible MS4 operators (RIDOT, Central Falls and/or Pawtucket) on the design of the separate stormwater discharges and any stormwater BMPs determined to be necessary to meet water quality objectives.

DEM issued a final permit (No.RI0100315) to the Narragansett Bay Commission on January 31, 2001. Section D of the Permit authorizes NBC to discharge from 15 CSOs providing the discharges comply with EPA and RIDEM CSO Policies and the discharges receive treatment at a level providing Best Practicable Control Technology Currently Available (BPT), Best Conventional Pollutant Control Technology (BCT) to control and abate conventional pollutants and Best Available Technology (BAT) to control and abate non-conventional and toxic pollutants. RIDEM and EPA have made a Best Professional Judgment (BPJ) determination that BPT, BCT, and BAT for combined sewer overflow include the implementation of Nine Minimum Controls (NMC) specified below and detailed further in Part I.D.2 of the Permit:

- Proper operation and regular maintenance programs for the sewer system and the combined sewer overflows.
- Maximum use of the collection system for storage
- Review and modification of the pretreatment program to assure CSO impacts are minimized.
- Maximization of flow to the POTW for treatment.
- Prohibition of dry weather overflows
- Control of solid and floatable materials in CSO.
- Pollution prevention programs that focus on containment reduction activities.
- Public notification to ensure that the public receives adequate notification of CSO occurrences and CSO impacts.
- Monitoring to effectively characterize CSO impacts and the efficacy of CSO controls.

As part of implementing a Best Management Practices Plan for Field's Point and Bucklin Point service areas, NBC is required to submit semi-annual reports detailing combined sewer overflow/regulator maintenance and repair, water quality monitoring, and total dry weather overflow discharge volumes. The goal of NBC's BMP implementation and sewer system maintenance and improvement strategies is to reduce or eliminate dry weather CSO discharges and inspect and maintain the approximately 105 miles (170 km) of interceptors. This is an important and ongoing component of the BMP implementation and maintenance program.

There are currently 15 active combined sewer overflows discharging to the Blackstone River between River Street and Slater Mill Dam. Of these 15, twelve are monitored for flows (six in Central Falls and 6 in Pawtucket). At these sites, flow meters monitor either volume of overflow or activity of the overflow. The flow monitoring results are used to determine if and when an overflow to the Blackstone occurs, monitor surcharging in the interceptor, and to develop a history of the flow data to better identify problem situations and improve efficiency.

The NBC Interceptor Maintenance Report on the CSO for the first half of 2012 indicated that there were no dry weather discharges observed at any of the Central Falls or Pawtucket CSOs that discharge to the Blackstone mainstem. Additionally, NBC maintains two sampling locations on the Blackstone mainstem, one at the Mendon Road/ Lonsdale Avenue bridge crossing of the Blackstone and one adjacent to the Slater Mill Museum site.

7.6 Onsite Wastewater Management

A properly designed and operating OWTS does prevent bacterial pollution from impacting the surrounding surface and ground waters. Inadequately treated wastewater from substandard and failed OWTS adds bacteria to waterbodies, contributing to water quality impairments. These sources can be mitigated through sewer extensions and tie-ins and, for those areas where sewers are not and will not be available, through replacement of sub-standard and/or failed systems.

Statewide, failed OWTS are required to be replaced under current onsite wastewater treatment regulations. In addition, new OWTS rules effective January 1, 2008 require the replacement of cesspools that serve commercial facilities or multifamily dwellings. The Rhode Island Cesspool Act of 2007 took effect on June 1, 2008, and was subsequently revised during the 2012 legislative session. It requires the replacement of cesspools located within 200 feet of all public wells, and within 200 feet of a water body with an intake for a drinking water supply by January 1, 2014. Cesspools located in communities with comparable or more stringent replacement requirements are exempt from the new state law (RIDEM, 2007b).

Burrillville, Cumberland, Lincoln, North Smithfield, and Woonsocket should work to create an Onsite Wastewater Management District to provide more comprehensive protection of surface and groundwater. Currently, none of the municipalities covered by this TMDL have wastewater management plan on file with RIDEM, although several inquiries about drafting such a plan was made in the past. RIDEM recommends that communities adopt ordinances for those areas where sewers are not planned to establish *enforceable* mechanisms to ensure that existing OWTS are properly operated and maintained. As part of the wastewater management planning efforts, communities should keep detailed records of which properties are not connected to the municipal sewer system, identify sub-standard systems through mandatory inspections, and adopt a schedule for replacement of those systems. Policies that govern substandard OWTS and cesspool replacement within a reasonable time frame should be adopted.

7.7 Waterfowl, Wildlife, and Domestic Pets

Past TMDL studies have shown that waterfowl, wildlife, and domestic pets contribute significantly to elevated bacteria concentrations in surface water. Pet waste left to decay on the sidewalk, or on grass near the street, may be washed into storm sewers by rain or melting snow and cause water quality impairments (MassDEP et. al., 2009).

Stormwater Phase II requirements include an educational program to inform the public about the impact of stormwater. Municipalities' education and outreach programs should highlight the importance of picking up after pets and not feeding birds. Pet wastes should be disposed of away from any waterway or stormwater system that discharges to the study area. The cities and towns in the Blackstone Watershed should work with volunteers to map locations where pet waste is a significant and a chronic problem. This work should be incorporated into the municipalities' Phase II plans and should result in an evaluation of strategies to reduce the impact of pet waste on water quality. This may include installing signage, providing pet waste receptacles or pet waste digester systems in high-use areas, enacting ordinances requiring clean-up of pet waste, and focusing educational and outreach programs in problem areas.

Towns and residents can take several measures to minimize bird-related impacts. They can allow tall, coarse vegetation to grow in areas along the shores of the Blackstone River that are frequented by waterfowl. Waterfowl, especially grazers like geese, prefer easy access to the water. Maintaining an uncut vegetated buffer along the shore will make the habitat less desirable to geese and encourage migration. With few exceptions, Part XIV, Section 14.13 of Rhode Island's Hunting Regulations prohibits feeding wild waterfowl at any time in the state of Rhode Island (2009a). Educational programs should emphasize that feeding waterfowl, such as ducks, geese, and swans, contributes to water quality impairments in the Blackstone Watershed and can harm human health and the environment. All municipalities should ensure that mention of this regulation is included in their SWMPPs.

7.8 Farms

Agricultural activities such as dairy farming, the raising of livestock (including cattle, hogs, fowl, horses, llamas, alpacas, and other animals), and crop farming can contribute to bacterial impairment of surface waters. Agricultural land uses with the potential to contribute to bacteria pollution include manure storage and application, livestock grazing, and barnyards.

When appropriately applied to soil, animal manure can fertilize crops and restore nutrients to the land. However, when improperly managed, animal wastes can pose a threat to human health and the environment. Pollutants in animal waste and manure can enter surface waters through a number of pathways, including surface runoff and erosion, direct discharges to surface water, spills and other dry-weather discharges, and leaching into soil and groundwater. These discharges of manure pollutants can originate directly from animals accessing surface waters, or indirectly from manure stockpiles and cropland where manure is spread (USEPA, 2003).

In Rhode Island, the Farmland Ecology Unit within the Division of Agriculture work with, and regulate, farmers to ensure agricultural activities do not negatively impact Rhode Island's valuable wetland and groundwater resources. This unit works with the USDA Natural Resource Conservation Services to implement Best Management Practices for farmers and conservation projects. Permits are issued through this program for improvements to farms for activities which may impact wetlands or nearby waterbodies. This unit works closely with RIDEM Freshwater Wetlands staff in the permitting process for activities such as constructing farm ponds, roads and agriculture waste runoff facilities (RIDEM, 2009d).

During the field investigation portion of the BTMDL, Cherry Brook was one of the tributaries to the Blackstone River that had significantly high pathogen levels during dry and wet weather surveys. Follow-up monitoring by RIDEM staff attempted to isolate the source of the pathogens in the watershed. Tables 4.7 and 4.8 show the results of those surveys. Wright Dairy Farm is adjacent to the stream at Station CB06 and drainage from the farm's cow hut area flows down hill in a northeast direction into the stream system. Uphill from Station CB05, a large manure pile was discovered that may also be a source fecal coliform during wet weather events. These observations have been shared with RIDEM's Division of Agriculture, who is working with the producer to resolve these potential pollution sources.

Other potential sources to be investigated include a small family farm located in Lincoln at the intersection of Carrington Street and Lonsdale Avenue. Runoff was observed to be flowing off the far side of the farm field into a catch basin at the corner of Lonsdale Avenue and Cook Street, near the Whipple Bridge. The farm has many animals including goats, sheep, cows and chickens. This flow from the farm area, which had a strong septic odor and contained suspended solids, is a likely source of pathogens to the Blackstone River and should be investigated further.

8.0 PUBLIC PARTICIPATION

RIDEM held a public meeting with the Louis Berger Group, Inc. on March 20, 2007 at the Lincoln, RI town hall to discuss the findings of the comprehensive water quality study conducted on the Rhode Island portion of the Blackstone River Watershed in 2005-2006. This study was performed as part of the development of Total Daily Maximum Loads (TMDL) for the watershed. Waterbodies included in the report consisted of the Blackstone River (impaired for biodiversity, pathogens and copper), Mill River (pathogens, lead), Peters River (pathogens, copper), Valley Falls Pond (biodiversity impacts, pathogens, phosphorus), and Scott Pond (excess algal growth, chlorophyll a, low dissolved oxygen, phosphorus). The draft document was presented and all parties had until April 7, 2007 to make comments. Several comments were received and the field study document was finalized in February 2008. This TMDL was developed using the data from the field study.

A second public meeting was hosted by RIDEM on November 7, 2012 at the Woonsocket Harris Public Library in Woonsocket, RI to present the completed draft water quality restoration study known as a Total Maximum Daily Load (TMDL) for the Rhode Island portion of the Blackstone River Watershed including the recommended strategies to addresses bacteria and trace metal related impairments that affect recreational and aquatic life uses of the Rhode Island portions of the Blackstone River, Cherry Brook, and the Mill and Peters Rivers. A notice of the November 7th meeting was emailed to over 130 individuals that included watershed council members and other environmental groups, city and town officials and elected representatives as well as the representatives from other state and federal agencies. The email included the RIDEM web address for the draft Blackstone TMDL document that was available for review. Additionally, notices of the meeting were posted in the town halls and public libraries of all the municipalities listed in the Blackstone River TMDL document. The meeting provided an opportunity for municipal officials and members of the community to hear the study's findings and recommended pollution abatement activities, and to provide RIDEM feedback on the study. Eleven people attended the scheduled meeting. Interested parties had until December 7, 2012 to submit comments on the completed document. Several written comments were received and are provided in their entirety, along with RIDEM's responses in Appendix D. The draft TMDL document was revised where necessary in response to these comments.

9.0 FUTURE MONITORING

The results of water quality monitoring will allow RIDEM to track compliance with the water quality objectives as the TMDL is implemented and remedial actions are accomplished. As part of the state's Ambient Rivers Monitoring Program, RIDEM will periodically conduct biological, chemical and physical monitoring of the Blackstone River and its tributaries to assess their overall condition as well as the success of pollution abatement activities.

The USGS, under an agreement with RIDEM is continuing to monitor three mainstem stations on the Blackstone River. The stations include Millville, MA for the MA/RI State Line, Manville Dam in Manville, RI for the Blackstone segment RI0001003R-01A, and the Roosevelt Avenue Bridge in Pawtucket, RI for the segment RI0001003R-01b. Annual data reports for all three stations are submitted to the RIDEM Office of Water Resources in Providence, RI.

Lastly, the Blackstone River Coalition and its partners have historically conducted monitoring of the watershed. They have monitored nineteen stations within the Rhode Island portion of the watershed since 2004. RIDEM encourages the coalition volunteers to continue monitoring these stations in the future. RIDEM will also seek to have the performance of BMPs monitored as they are installed throughout the Blackstone River watershed in order to assess the effectiveness of these controls.

10.0 REFERENCES

BBL (Blausland, Bouck & Lee, Inc.), 2003, RI/FS, Data Base Summary Report, Peterson/Puritan OU2. (December 2003).

BBL (Blausland, Bouck & Lee, Inc.), 2006, Revised Data Base Summary Report. Remedial Investigation and feasibility Study for the Peterson/Puritan Superfund Site, Operable Unit 2, Cumberland and Lincoln, Rhode Island (February 2006).

Berger (The Louis Berger Group, Inc.), 2004, *Water Quality – Blackstone River*. Final Report 1: Existing Data. Prepared for the Rhode Island Department of Environmental Management, Office of Water Resources, 2 volumes (January 2004).

Berger (The Louis Berger Group, Inc.), 2008, *Water Quality – Blackstone River*. Final Report 2: Field Investigations. Prepared for the Rhode Island Department of Environmental Management, Office of Water Resources, (February 2008).

Brown University, 2003, The Blackstone River. A comprehensive study of storm runoff and drainage on the Cumberland side between the Ashton & Pratt Dams. Center for Environmental Studies.
http://envstudies.brown.edu/classes/es192/2003/blackstone/projectoverview.htm

City of Central Falls, 2004, Flow Monitoring Areas – map. Provided by the Department of Public Works Office in July 2004.

Kerr, M., 1990, The Blackstone River. Rhode Island Sea Grant Fact Sheet. http://seagrant.gso.uri.edu/factsheets/blackstone_river.html.

King, J., et al., 1995, *A study of the sediments of Narragansett Bay. Volume 1: The surface sediments of Narragansett Bay*. Final Report submitted to the Narragansett Bay Project.

London & Co, 1953, *D. London and Company, Lonsdale, Rhode Island*. Site engineering map. Surveyed on December 3, 1953; revised from Department files on March 13, 1959. Provided by John Faile, Water Department, Town of Lincoln.

NOAA (National Oceanographic and Atmospheric Administration), 1977, Technical Memorandum NWS Hydro-35, U.S. Department of Commerce, Weather Bureau.

North Smithfield (Town of North Smithfield), 2003, North Smithfield Stormwater Outfalls (provided by the Town Planning Office).

Pawtucket (City of Pawtucket), 1975, Pawtucket Existing Sewerage Facilities (provided by the City's Engineering Office).

RIDEM (Rhode Island Department of Environmental Management), 2000, Water Quality Regulations. Promulgated July 2006; amended December17, 2009.

RIDEM (Rhode Island Department of Environmental Management), 2000, Blackstone River Watershed-specific Stormwater Permitting. Final Report. Submitted to the U.S. Environmental Protection Agency. December 2000.

RIDEM (Rhode Island Department of Environmental Management), State of Rhode Island 2010 Consolidated Assessment and Listing Methology for 305(b) and 303(d) Integrated Water Quality Monitoring and Assessment Reporting, June 2009.

RIDOT (Rhode Island Department of Transportation), 1963, Interstate Route 295, Mendon Road to Mass State Line, Grading and Drainage STA 234+00 to STA 246+50. Prepared by J.L. Hayden Consulting Engineers.

USACE (U.S. Army Corps of Engineers), 1997, *Blackstone River Watershed Reconnaissance Investigation Massachusetts and Rhode Island.* Main Report and Appendices, 2 volumes.

USEPA (U.S. Environmental Protection Agency), 1970, *Blackstone River Time of Travel, 1964 and 1970, Worchester, MA – Pawtucket, RI*. USEPA Region 1, Surveillance and Analysis Division, Needham Heights, MA.

Woonsocket (City of Woonsocket), 2004, *Storm Line Plans*. Department of Public Works. Updated January 2004 (provided by the City’s Engineering Office)

Wright, R.M., P. Nolan, D. Pincumbe, E. Hartman, and O.J. Viator, 2001, *The Blackstone River Initiative: Water Quality Analysis of the Blackstone River Under Wet and Dry Weather Conditions.* Prepared for the USEPA New England, Boston, MA.

Wright, R., Viator, O. and Michaelis, B., 2004, *Dry Weather Water Quality Sampling and Modeling Blackstone River Feasibility Study, Phase 1: Water Quality Evaluation and Modeling of the Massachusetts Blackstone River.* Prepared for the U.S. Army Corps of Engineers, University of Rhode Island, Kingston, RI.

APPENDIX A – Pollution Prevention Brochure

Being a Responsible Neighborhood Business Benefits the Environment

Top 10 Good Housekeeping Practices

If your business uses a dumpster, a loading dock, toxic materials, or simply a parking lot, you can lead the movement toward better stormwater management.

1. Break the connection to storm sewers by ensuring that spills, wastewater, or drains do not flow into a storm sewer.
2. Store hazardous materials properly, inside or under cover.
3. Train employees on spill handling and good housekeeping practices with a spill response plan, and clean-up kit.
4. Use a mop sink for cleaning floor mats and equipment.
5. Make sure dumpsters stay covered and leak – proof to prevent trash from escaping.
6. Maintain your fleet by fixing leaks and drips and washing vehicles at a commercial car wash.
7. Keep your parking lot and service areas clean by sweeping regularly and emptying trash.
8. Keep wetlands and shoreline areas clean and in natural condition.
9. Water wisely and limit fertilization.
10. Design your site to infiltrate, filter or detain runoff.

Self-Inspection Checklist

Use this checklist to find out if you are in compliance with the new Illicit Discharge Detection and Elimination Ordinance.

Discharges

What are Illegal Discharges?

1) Pipes, drains or ditches that lead to the stormdrain system from any of the following sources: sewers, process wastewater, wash water and any connections from indoor drains and sinks (even if they have been previously approved)
2) Any connections to the stormdrain system from a commercial or industrial land which has not been documented and approved. This means that all the catch basins on your site should be on plans or maps held by the municipality and they should be permitted.
3) When in doubt remember: Only Rain Down the Drain – only rainwater should flow into your on-site catch basins.

What are Legal Discharges?

1) Generally, uncontaminated waters that flow off your site when it rains.
2) The following items are also legal: wash water from washing vehicles if no soap is used, external building washdown when no detergents are used, dechlorinated pool discharges, air conditioning condensation, irrigation drainage, foundation or footing drains, roof runoff and sump pumps where flows are not contaminated with process materials such as solvents, or contaminated by contact with soils where spills or leaks of toxic or hazardous materials have occurred.

1. Break the connection to storm sewers.

- ☐ Make sure that spills or wastewater can't flow into a storm sewer by any sump pump, drain, or surface stormwater flow.
- ☐ Check internal drains for improper connections to storm sewers.
- ☐ Contact your city/town to see if clean water discharges to storm sewers are allowed.
- ☐ Grade and pave loading and unloading areas away from water courses and stormdrains for easy spill clean-up.

Hazardous Materials

2. **Store hazardous materials properly** (examples of hazardous materials include: process chemicals, pesticides, herbicides, cleaning materials, waste materials, oil and gasoline).

   Store hazardous materials and wastes:

   - ☐ Under cover to keep them out of the rain and snow.
   - ☐ In a secondary containment system large enough to contain the material if the container begins to leak. This can be as simple as putting it in a bucket or basin.
   - ☐ Away from any location where leaks could get into stormdrains or waterways (i.e. near sump pumps for groundwater removal, storage locations near streams, wetlands, rivers, etc.).

3. **Train employees on spill handling and good housekeeping practices.**

   - ☐ Make a spill response plan and clean up kit handy. Repeat training regularly.
   - ☐ Use "dry" methods for clean up and spills. Keep a broom, mop and absorbent material such as kitty litter or saw dust handy.
   - ☐ Never use water to rinse off a spill.
   - ☐ See DEM website (link to be included here) for more information on hazardous waste generators.

Housekeeping

4. **Use a mop sink for cleaning floor mats and equipment.**

   - ☐ Pour wash water down a mop sink, not outside. Do not allow wash water containing soaps and other contaminants to flow into stormdrains
   - ☐ Grease, oils and fats should be disposed of in a grease, oil and fat recycling container.

5. Make sure dumpsters stay covered and leak-proof.

☐ Keep them covered to prevent trash from escaping and to keep water out. Don’t have dumpsters placed next to stormdrains and keep the drain plugs in.

6. Maintain your fleet. Fix leaks and drips. Wash vehicles at a commercial car wash.

☐ If you must wash vehicles or equipment outdoors, use water only, or wash on grassy areas and divert soapy water away from stormdrains. It’s best to just bring the car/vehicle to the car wash so that the collected water is recycled.

7. Keep your site clean and free of trash.

☐ Be sure there are enough trash receptacles on your property. Regularly empty the trash receptacles.

☐ Sweep the parking lot at least annually to remove winter road sand, and as necessary throughout the year.

☐ Inspect catch basins annually and clean as necessary – when no more than 75% full.

8. Keep wetlands and shoreline areas clean and in natural conditions.

☐ Keep these areas free of trash, yard waste, and debris that can pollute or obstruct water flow.

☐ If possible, allow vegetation to grow into a natural buffer instead of mowing to wetland edges.

☐ All maintenance actions must be completed in accordance with RIDEM Freshwater Wetlands Act or other applicable laws or regulations.

9. Water wisely and limit fertilizer use.

☐ Keep water and fertilizer on the grass, not pavement.

- ☐ Consider replacing some lawn area with low-care plantings.
- ☐ Water your lawn no more than one inch a week and consider allowing your lawn to go dormant in the summer.
- ☐ Consider leaving grass clippings on the lawn instead of using fertilizer. If you must fertilizer, fertilize sparingly and during September.

10. Design your site to infiltrate, filter or detain runoff.

- ☐ Divert roof leaders, foundation drains, air conditioning condensation and other clean water to grassy areas.
- ☐ When it's time to renovate your site and parking lot, consider updating the drainage system and landscaping using new methods such as rain gardens and dry wells fro roof top runoff and landscaped parking lot islands that double as stormwater treatment systems.

Other Opportunities

If your business is located in the Blackstone River Watershed, schedule a visit with the Blackstone River Coalition to learn about the "In Business for the Blackstone" program. Participation includes education, technical assistance and public recognition. Contact Peter Coffin at 508-753-6087 or email info@zaptheblackstone.org; website: http://www.zaptheblackstone.org (See "In Business for the Blackstone" under "What we are doing") (RI Municipalities in the Blackstone River Watershed include: Burrillville, Glocester, N. Smithfield, Lincoln, Cumberland, Central Falls, Pawtucket and Woonsocket)

APPENDIX B – Data Tables

LOW FLOW - ALL DATA FROM USGS

CADMIUM Percent Reduction Calculations for Blackstone Mainstem

7Q10 = 68.6 cfs **Millville, Ma for Dissolved CADMIUM** Flow<275

Survey Date	Flow Percentile	Flow (cfs)	Hardness (mg/L)	Cadmium Chronic Criteria (µg/L)	Allowable Load (lbs/day)	Observed Conc (µg/L)	Observed Load (lbs/day)	Req Load reduction (lbs/day)
7/9/07	59.3%	235	57.1	0.17	0.21	0.27	0.34	**0.13**
10/22/07	53.8%	275	38.4	0.13	0.19	0.28	0.42	**0.23**
6/3/08	71.0%	170	56.6	0.17	0.15	0.30	0.27	**0.12**
9/15/09	54.8%	267	48.9	0.15	0.21	0.24	0.34	**0.13**
6/28/10	67.9%	186	59.0	0.17	0.17	0.27	0.27	**0.10**
9/21/10	95.7%	69	65.0	0.18	0.07	0.40	0.15	**0.08**

7Q10

7Q10 = 106.5cfs **Manville Dam, RI for Dissolved CADMIUM** Flow<425

Survey Date	Flow Percentile	Flow (cfs)	Hardness (mg/L)	Cadmium Chronic Criteria (µg/L)	Allowable Load (lbs/day)	Observed Conc (µg/L)	Observed Load (lbs/day)	Req Load reduction (lbs/day)
10/23/07	71.8%	301	45.2	0.14	0.23	0.20	0.32	**0.09**
9/15/09	70.5%	313	57.0	0.17	0.28	0.23	0.39	**0.11**
6/29/10	86.7%	188	58.9	0.17	0.17	0.18	0.18	**0.01**
9/20/10	97.8%	109	72.0	0.20	0.11	0.22	0.13	**0.01**

CADMIUM

Woonsocket permit load	Woonsocket Observed Load	% Contribution to Observed Load	% Contribution to Allowable Load
0.36	0.10	30.8%	43.5%
0.09	0.02	4.4%	6.1%
0.09	0.03	13.7%	14.5%
0.09	0.02	16.2%	18.3%

7Q10

7Q10 = 116.5 cfs **Roosevelt Ave Bridge for Dissolved CADMIUM** Flow<460

Survey Date	Flow Percentile	Flow (cfs)	Hardness (mg/L)	Cadmium Chronic Criteria (µg/L)	Allowable Load (lbs/day)	Observed Conc (µg/L)	Observed Load (lbs/day)	Req Load reduction (lbs/day)
10/24/07	66.6%	344	45.2	0.14	0.26	0.18	0.33	**0.07**
9/16/09	63.0%	380	57.0	0.17	0.34	0.23	0.47	**0.13**
6/30/10	85.5%	188	58.9	0.17	0.17	0.18	0.18	**0.01**
9/22/10	95.6%	125	72.0	0.20	0.13	0.22	0.15	**0.02**

7Q10

LOW FLOW - ALL DATA FROM USGS

LEAD Percent Reduction Calculations for Blackstone Mainstem

7Q10 = 68.6 cfs **Millville, Ma for Dissolved LEAD** **Flow<275**

Survey Date	Flow Percentile	Flow (cfs)	Hardness (mg/L)	Lead Chronic Criteria (µg/L)	Allowable Load (lbs/day)	Observed Conc (µg/L)	Observed Load (lbs/day)	Req Load reduction (lbs/day)
7/9/07	59.3%	235	57.1	1.36	1.72	0.38	0.48	
10/22/07	53.8%	275	38.4	0.87	1.30	0.76	1.13	
6/3/08	71.0%	170	56.6	1.35	1.23	0.65	0.60	
9/15/09	54.8%	267	48.9	1.15	1.65	0.65	0.93	
6/28/10	67.9%	186	59.0	1.41	1.41	0.51	0.51	
9/21/10	95.7%	69	65.0	1.57	0.58	0.63	0.23	7Q10

7Q10 = 106.5 cfs **Manville Dam, RI for Dissolved LEAD** **Flow<425**

Survey Date	Flow Percentile	Flow (cfs)	Hardness (mg/L)	Lead Chronic Criteria (µg/L)	Allowable Load (lbs/day)	Observed Conc (µg/L)	Observed Load (lbs/day)	Req Load reduction (lbs/day)
10/23/07	71.8%	301	45.2	1.05	1.70	0.64	1.04	
9/15/09	70.5%	313	57.0	1.36	2.29	0.60	1.01	
6/29/10	86.7%	188	58.9	1.41	1.43	0.39	0.40	
9/20/10	97.8%	109	72.0	1.76	1.03	0.26	0.15	

LEAD

Woonsocket permit load	Woonsocket Observed Load	% Contribution to Observed Load	% Contribution to Allowable Load
0.72	0.13	12.0%	7.3%
0.72	0.03	3.3%	1.4%
0.72	0.05	12.7%	3.5%
0.72	0.04	27.3%	4.0% 7Q10

7Q10 = 116.5 cfs **Roosevelt Ave Bridge for Dissolved LEAD** **Flow<460**

Survey Date	Flow Percentile	Flow (cfs)	Hardness (mg/L)	Lead Chronic Criteria (µg/L)	Allowable Load (lbs/day)	Observed Conc (µg/L)	Observed Load (lbs/day)	Req Load reduction (lbs/day)
10/24/07	66.6%	340	45.2	1.05	1.93	0.47	0.86	
9/16/09	63.0%	380	57.0	1.36	2.78	0.60	1.23	
6/30/10	85.5%	188	58.9	1.41	1.43	0.39	0.40	
9/22/10	95.6%	125	72.0	1.76	1.18	0.26	0.18	7Q10

HIGH FLOW -ALL DATA FROM USGS

CADMIUM Percent Reduction Calculations for Blackstone Mainstem

7Q10 = 68.6 cfs **Millville, Ma for Dissolved CADMIUM** **Flows >275**

Survey Date	Flow Percentile	Flow (cfs)	Hardness (mg/L)	Cadmium Chronic Criteria (µg/L)	Allowable Load (lbs/day)	Observed Conc (µg/L)	Observed Load (lbs/day)	Req Load reduction (lbs/day)
3/19/07	16.1%	747	30.90	0.11	0.44	0.05	0.20	
4/17/07	0.2%	5930	21.83	0.09	2.72	0.69	22.05	**19.33**
6/4/07	32.4%	463	47.34	0.15	0.36	0.22	0.55	**0.18**
7/28/08	14.2%	814	39.74	0.13	0.57	0.16	0.70	**0.13**
8/18/08	34.1%	449	43.64	0.14	0.33	0.17	0.41	**0.08**
12/15/08	2.4%	1900	33.38	0.11	1.17	0.34	3.53	**2.36**
3/24/09	31.7%	473	52.77	0.16	0.40	0.25	0.64	**0.24**
6/23/09	30.8%	483	47.87	0.15	0.38	0.15	0.39	**0.01**
12/7/09	14.0%	831	35.54	0.12	0.54	0.08	0.36	
3/23/10	2.0%	2055	29.73	0.11	1.17	1.10	12.18	**11.01**
1/5/11	43.8%	362	51.73	0.16	0.30	0.25	0.49	**0.18**
3/29/11	17.8%	702	49.91	0.15	0.57	0.26	0.98	**0.41**
6/28/11	21.3%	632	39.36	0.13	0.44	0.16	0.55	**0.11**

7Q10 = 106.52 cfs **Manville Dam, RI for Dissolved CADMIUM** **Flows >425** **CADMIUM**

Survey Date	Flow Percentile	Flow (cfs)	Hardness (mg/L)	Cadmium Chronic Criteria (µg/L)	Allowable Load (lbs/day)	Observed Conc (µg/L)	Observed Load (lbs/day)	Req Load reduction (lbs/day)	Woonsocket permit load	Woonsocket Observed Load	% Contribution to Observed Load	% Contribution to Allowable Load
3/20/07	17.1%	1360	32.94	0.11	0.83	0.19	1.39	**0.56**	0.36	0.04	2.7%	4.6%
4/17/07	0.1%	8680	20.27	0.08	3.79	0.36	16.84	**13.06**	0.36	0.03	0.2%	0.8%
4/22/08	43.2%	677	45.15	0.14	0.52	0.21	0.77	**0.25**	0.36	0.08	9.8%	14.5%
8/19/08	49.3%	583	40.15	0.13	0.41	0.12	0.38					
12/16/08	2.7%	2930	26.86	0.10	1.56	0.19	3.00	**1.45**	0.09	0.12	4.0%	7.7%
3/24/09	37.5%	779	43.68	0.14	0.58	0.17	0.71	**0.13**	0.09	0.05	7.4%	9.1%
6/24/09	41.5%	706	42.81	0.14	0.52	0.11	0.42					
12/8/09	26.1%	1,050	30.71	0.11	0.61	0.15	0.85	**0.24**	0.09	0.03	3.9%	5.4%
3/23/10	2.0%	3,250	23.40	0.09	1.57	0.15	2.63	**1.06**	0.09	0.05	2.1%	3.4%
1/5/11	53.4%	523	43.19	0.14	0.39	0.18	0.51	**0.12**	0.09	0.02	4.1%	5.4%
3/28/11	26.4%	1,040	43.49	0.14	0.77	0.19	1.07	**0.29**	0.09	0.04	3.9%	5.4%
6/27/11	17.5%	1,350	36.27	0.12	0.88	0.13	0.95	**0.06**	0.09	0.02	2.2%	2.4%

HIGH FLOW -ALL DATA FROM USGS

CADMIUM Percent Reduction Calculations for Blackstone Mainstem

7Q10 = 116.48 cfs Roosevelt Ave Bridge for Dissolved CADMIUM **Flows >460**

Survey Date	Flow Percentile	Flow (cfs)	Hardness (mg/L)	Cadmium Chronic Criteria (µg/L)	Allowable Load (lbs/day)	Observed Conc (µg/L)	Observed Load (lbs/day)	Req Load reduction (lbs/day)
3/20/07	12.6%	1540	32.94	0.11	0.94	0.02	0.17	
4/18/07	0.2%	6670	20.27	0.08	2.91	0.36	12.94	**10.03**
4/23/08	56.2%	463	45.15	0.14	0.35	0.18	0.45	**0.10**
8/19/08	43.0%	654	40.15	0.13	0.46	0.10	0.35	
12/16/08	2.0%	3140	26.86	0.10	1.67	0.19	3.22	**1.55**
3/25/09	32.5%	849	43.68	0.14	0.63	0.18	0.82	**0.19**
6/24/09	34.2%	813	42.81	0.14	0.60	0.11	0.48	
12/9/09	23.5%	1080	30.71	0.11	0.63	0.15	0.87	**0.24**
3/24/10	0.3%	6400	23.40	0.09	3.09	0.15	5.17	**2.09**
1/4/11	37.7%	745	43.19	0.14	0.55	0.18	0.72	**0.17**
3/30/11	19.5%	1210	43.49	0.14	0.90	0.19	1.24	**0.34**
6/29/11	27.8%	961	36.27	0.12	0.63	0.13	0.67	**0.04**

HIGH FLOW -ALL DATA FROM USGS

LEAD Percent Reduction Calculations for Blackstone Mainstem

7Q10 = 68.6 cfs **Millville, Ma for Dissolved LEAD** **Flows >275**

Survey Date	Flow Percentile	Flow (cfs)	Hardness (mg/L)	Lead Chronic Criteria (µg/L)	Allowable Load (lbs/day)	Observed Conc (µg/L)	Observed Load (lbs/day)	Req Load reduction (lbs/day)
3/19/07	16.1%	747	30.90	0.69	2.76	0.31	1.25	
4/17/07	0.2%	5930	21.83	0.46	14.65	1.20	38.36	**23.71**
6/4/07	32.4%	463	47.34	1.11	2.76	0.33	0.82	
7/28/08	14.2%	814	39.74	0.91	3.99	1.86	8.16	**4.17**
8/18/08	34.1%	449	43.64	1.01	2.44	0.91	2.20	
12/15/08	2.4%	1900	33.38	0.75	7.66	0.57	5.84	
3/24/09	31.7%	473	52.77	1.25	3.18	0.28	0.71	
6/23/09	30.8%	483	47.87	1.12	2.91	0.95	2.47	
12/7/09	14.0%	831	35.54	0.80	3.59	0.17	0.76	
3/23/10	2.0%	2055	29.73	0.66	7.28	3.37	37.33	**30.05**
1/5/11	43.8%	362	51.73	1.22	2.38	0.27	0.53	
3/29/11	17.8%	702	49.91	1.17	4.44	0.3	1.14	
6/28/11	21.3%	632	39.36	0.90	3.07	1.23	4.19	**1.12**

7Q10 = 106.52 cfs **Manville Dam, RI for Dissolved LEAD** **Flows >425** **LEAD**

Survey Date	Flow Percentile	Flow (cfs)	Hardness (mg/L)	Lead Chronic Criteria (µg/L)	Allowable Load (lbs/day)	Observed Conc (µg/L)	Observed Load (lbs/day)	Req Load reduction (lbs/day)	Woonsocket permit load	Woonsocket Observed Load	% Contribution to Observed Load	% Contribution to Allowable Load
3/20/07	17.1%	1360	32.94	0.74	5.40	0.35	2.57					
4/17/07	0.1%	8680	20.27	0.42	19.52	1.21	56.61	**37.09**	0.72	0.11	0.2%	0.5%
4/22/08	43.2%	677	45.15	1.05	3.83	0.59	2.15		0.72	0.08		
8/19/08	49.3%	583	40.15	0.92	2.89	1.10	3.46	**0.57**	0.72	0.06	1.7%	2.0%
12/16/08	2.7%	2930	26.86	0.59	9.26	0.73	11.53	**2.27**	0.72	0.11	1.0%	1.2%
3/24/09	37.5%	779	43.68	1.01	4.24	0.34	1.43					
6/24/09	41.5%	706	42.81	0.99	3.76	1.21	4.60	**0.84**	0.72	0.04	0.9%	1.1%
12/8/09	26.1%	1050	30.71	0.68	3.86	0.54	3.06					
3/23/10	2.0%	3250	23.40	0.50	8.77	0.40	7.01					
1/5/11	53.4%	523	43.19	1.00	2.81	0.41	1.16		0.72	0.04		
3/28/11	26.4%	1040	43.49	1.01	5.64	0.84	4.71					
6/27/11	17.5%	1350	36.27	0.82	5.98	2.58	18.77	**12.80**	0.72	0.25	1.3%	4.2%

HIGH FLOW -ALL DATA FROM USGS

LEAD Percent Reduction Calculations for Blackstone Mainstem

7Q10 = 116.48 cfs **Roosevelt Ave Bridge for Dissolved LEAD** **Flows > 460**

Survey Date	Flow Percentile	Flow (cfs)	Hardness (mg/L)	Lead Chronic Criteria (µg/L)	Allowable Load (lbs/day)	Observed Conc (µg/L)	Observed Load (lbs/day)	Req Load reduction (lbs/day)
3/20/07	12.6%	1520	32.94	0.74	6.04	0.31	2.54	
4/18/07	0.2%	6540	20.27	0.42	14.70	0.83	29.26	**14.55**
4/23/08	56.2%	463	45.15	1.05	2.62	0.40	1.00	
8/19/08	43.0%	654	40.15	0.92	3.24	1.29	4.55	**1.30**
12/16/08	2.0%	3140	26.86	0.59	9.92	0.71	12.00	**2.07**
3/25/09	32.5%	849	43.68	1.01	4.62	0.35	1.58	
6/24/09	34.2%	813	42.81	0.99	4.33	1.21	5.30	**0.97**
12/9/09	23.5%	1080	30.71	0.68	3.97	0.54	3.14	
3/24/10	0.3%	6400	23.40	0.50	17.27	0.40	13.80	
1/4/11	37.7%	745	43.19	1.00	4.01	0.41	1.65	
3/30/11	19.5%	1210	43.49	1.01	6.56	0.84	5.48	
6/29/11	27.8%	961	36.27	0.82	4.25	2.58	13.36	**9.11**

W-31 CHERRY BROOK DRY WEATHER COPPER EVALUATION

CHRONIC Copper Criteria Evaluation for Dry Weather Surveys

Dry Weather Survey No.	7	9	11
Flow (cfs)	0.62	0.24	0.03
Hardness by Run (mg/L)	43	85	84
Chronic Dry Wx Criteria (µg/L)	4.35	7.79	7.72
ALLOWABLE LOAD (lbs/day)	0.01	0.01	0.00
Allowable less 10% MOS	0.01	0.01	0.00
Observed Copper Conc (µg/L)	2.8	1.6	2.8
Observed Load (lbs/day)	0.01	0.00	0.00
REQ LOAD REDUCTION (lbs/day)			

W-31 CHERRY BROOK WET WEATHER COPPER EVALUATION

ACUTE Copper Criteria Evaluation For WW-3

WW-3 October 7-9, 2005	8-Oct		9-Oct
Run No.	2	5	7
Flow (cfs)	0.25	0.43	3.31
Hardness by Run (mg/L)	34	47	37
Acute Criteria for WW-3 (µg/L)	4.86	6.60	5.27
Allowable Load (lbs/day)	0.01	0.02	0.09
Allowable less 10% MOS	0.01	0.01	0.08
Observed Copper Conc (µg/L)	5.2	4.4	4.4
Observed Load (lbs/day)	0.01	0.01	0.08
REQ LOAD REDUCTION (lbs/day)			

CHRONIC Copper Criteria Evaluation WW-3

WW-3 October 7-9, 2005	
EMC Flow (cfs)	1.3
Average Hardness for WW-3 (mg/L)	39
Chronic Copper Criteria (µg/L)	4.03
Allowable Load (lbs/day)	0.03
Allowable less 10% MOS	0.03
Observed EMC Copper Conc (µg/L)	4.46
Observed Load (lbs/day)	0.03
REQ LOAD REDUCTION (lbs/day)	

ACUTE Copper Criteria Evaluation For WW-4

WW-4 October 22-25, 2005	22-Oct	23-Oct
Run No.	2	4
Flow (cfs)	5.85	7.00
Hardness by Run (mg/L)	36	32
Acute Criteria for WW-4 (µg/L)	5.13	4.59
Allowable load (lbs/day)	0.16	0.17
Allowable less 10% MOS	0.15	0.16
Observed Copper Conc (µg/L)	4.1	3.9
Observed Load (lbs/day)	0.13	0.15
REQ LOAD REDUCTION (lbs/day)		

Reduction = Observed Load - Allowable Load Less 10% MOS

4.0 Exceedance of Acute Criteria

CHRONIC Copper Criteria Evaluation WW-4

WW-4 October 22-25, 2005	
EMC Flow (cfs)	6.4
Average Hardness for WW-4 (mg/L)	34
Chronic Copper Criteria (µg/L)	3.56
Allowable Load (lbs/day)	0.12
Allowable less 10% MOS	0.11
Observed EMC Copper Conc (µg/L)	3.99
Observed Load (lbs/day)	0.14
REQ LOAD REDUCTION (lbs/day)	0.03

4.46 Exceedance of Chronic Criteria

PETERS RIVER DRY WEATHER COPPER EVALUATION

W-14 CHRONIC Copper Evaluation Peters River (MA/RI border)

Survey Date	Flow (cfs)	Hardness (mg/L)	Copper Chronic Criteria (µg/L)	Allowable Load (lbs/day)	Allowable less 10% MOS	Observed Conc (µg/L)	Observed Load (lbs/day)	Req Load reduction (lbs/day)
7/21/05	3.9	53	5.21	0.11	0.10	1.55	0.03	
8/11/05	0.8	74	6.92	0.03	0.03	0.50	0.00	
9/14/05	2.5	72	6.76	0.09	0.08	1.90	0.03	
10/7/05	3.8	63	6.03	0.12	0.11	2.10	0.04	
10/22/05	48.5	48	4.78	1.25	1.13	1.80	0.47	
12/22/05	26.6	53	5.21	0.75	0.67	2.00	0.29	

W-15 CHRONIC Copper Evaluation Peters River (pre-culvert entry)

Survey Date	Flow (cfs)	Average Hardness (mg/L)	Copper Chronic Criteria (µg/L)	Allowable Load (lbs/day)	Allowable less 10% MOS	Observed Conc (µg/L)	Observed Load (lbs/day)	Req Load reduction (lbs/day)
7/21/05	4.0	58	5.62	0.12	0.11	1.90	0.04	
8/11/05	0.8	74	6.88	0.03	0.03	1.80	0.01	
9/14/05	2.6	78	7.20	0.10	0.09	2.50	0.04	
10/7/05	3.9	65	6.16	0.13	0.12	2.90	0.06	
10/22/05	49.9	48	4.78	1.29	1.16	2.00	0.54	
12/22/05	27.4	53	5.21	0.77	0.69	1.20	0.18	

W-16 CHRONIC Copper Evaluation Peters River (confluence w/ BR)

Survey Date	Flow (cfs)	Average Hardness (mg/L)	Copper Chronic Criteria (µg/L)	Allowable Load (lbs/day)	Allowable less 10% MOS	Observed Conc (µg/L)	Observed Load (lbs/day)	Req Load reduction (lbs/day)
8/11/05	0.9	74	6.88	0.032	0.028	1.50	0.01	
9/14/05	2.7	78	7.20	0.10	0.09	2.00	0.03	
10/7/05	3.9	65	6.16	0.13	0.12	2.10	0.04	

Reduction = Observed Load - Allowable Load Less 10% MOS

PETERS RIVER COPPER EVALUATION for WET WEATHER-2 September 15, 2005

W-14 Peters River at (MA/RI border)

ACUTE Copper Evaluation For WW-2							
Run	1	2	3	4	5	6	7
Flow (cfs)	24.9	43.5	38.5	34.0	34.5	38.5	43.0
Hardness by Run (mg/L)	5	68	26	15	16	24	35
Acute Copper Criteria (µg/L)	0.74	9.34	3.78	2.25	2.39	3.50	5.00
Allowable Load (lbs/day)	0.10	2.19	0.78	0.41	0.44	0.73	1.16
Allowable less 10% MOS	0.09	1.97	0.71	0.37	0.40	0.65	1.04
Observed Copper Conc (µg/L)	4.4	2.4	4.0	3.3	3.3	3.0	2.5
Observed Load (lbs/day)	0.59	0.56	0.83	0.60	0.61	0.62	0.58
REQ LOAD REDUCTION (lbs/day)	0.50		0.12	0.23	0.21		

W-14 Peters River at (MA/RI border)

CHRONIC Copper Evaluation For WW-2	
EMC Flow (cfs)	37
AveWW-2 Hardness for W-14 (mg/L)	27
Chronic Copper Criteria (µg/L)	2.92
Allowable Load (lbs/day)	0.58
Allowable less 10% MOS	0.52
Observed EMC Copper Conc (µg/L)	3.05
Observed LOAD (lbs/day)	0.61
REQ LOAD REDUCTION (lbs/day)	0.08

W-15 Peters River (pre-culvert entry)

ACUTE Copper Evaluation For WW-2							
Flow (cfs)	25.6	44.7	39.6	34.9	35.4	39.6	44.2
Average Hardness by Run (mg/L)	21	17	40	28	20	17	23
Acute Copper Criteria (µg/L)	3.09	2.52	5.67	4.05	2.95	2.53	3.37
Allowable Load (lbs/day)	0.43	0.61	1.21	0.76	0.56	0.54	0.80
Allowable less 10% MOS	0.38	0.55	1.09	0.69	0.51	0.49	0.72
Observed Copper Conc (µg/L)	2.2	3.3	2.5	3.4	3.5	4.3	3.6
Observed Load (lbs/day)	0.30	0.79	0.53	0.64	0.67	0.92	0.86
REQ LOAD REDUCTION (lbs/day)		0.25			0.16	0.43	0.14

W-15 Peters River (pre-culvert entry)

CHRONIC Copper Evaluation For WW-2	
EMC Flow (cfs)	38
AveWW-2 Hardness for W-15 (mg/L)	24
Chronic Copper Criteria (µg/L)	2.62
Allowable Load (lbs/day)	0.53
Allowable less 10% MOS	0.48
Observed EMC Copper Conc (µg/L)	3.10
Observed LOAD (lbs/day)	0.63
REQ LOAD REDUCTION (lbs/day)	0.15

W-16 Peters River (confluence w/ BR)

ACUTE Copper Evaluation For WW-2							
Flow (cfs)	25.9	45.3	40.1	35.4	35.9	40.1	44.8
Average Hardness by Run (mg/L)	21	17	40	28	20	17	23
Acute Copper Criteria (µg/L)	3.09	2.52	5.67	4.05	2.95	2.53	3.37
Allowable Load (lbs/day)	0.43	0.61	1.22	0.77	0.57	0.55	0.81
Allowable less 10% MOS	0.39	0.55	1.10	0.70	0.51	0.49	0.73
Observed Copper Conc (µg/L)	3.5	2.0	2.9	2.9	4.7	3.4	3.2
Observed Load (lbs/day)	0.49	0.49	0.63	0.55	0.91	0.73	0.77
REQ LOAD REDUCTION (lbs/day)	0.10				0.40	0.24	0.04

W-16 Peters River (confluence w/ BR)

CHRONIC Copper Evaluation For WW-2	
EMC Flow (cfs)	38
AveWW-2 Hardness for W-16 (mg/L)	24
Chronic Copper Criteria (µg/L)	2.62
Allowable Load (lbs/day)	0.54
Allowable less 10% MOS	0.49
Observed EMC Copper Conc (µg/L)	3.14
Observed LOAD (lbs/day)	0.65
REQ LOAD REDUCTION (lbs/day)	0.16

Reduction = Observed Load - Allowable Load Less 10% MOS

4.0 Exceedance of Acute Criteria

3.1 Exceedance of Chronic Criteria

PETERS RIVER WET WEATHER-3 COPPER EVALUATION

W-14 Peters River at (MA/RI border)

ACUTE Copper Evaluation For WW-3				
WW-3 October 7-11, 2005	8-Oct			9-Oct
Run	2	3	5	7
Flow (cfs)	7.1	8.2	10.3	82.2
Hardness by Run (mg/L)	64	64	55	26
Acute Copper Criteria (µg/L)	8.83	8.83	7.65	3.78
Allowable Load (lbs/day)	0.34	0.39	0.42	1.67
Allowable less 10% MOS	0.30	0.35	0.38	1.51
Observed Copper Conc (µg/L)	2.1	3.7	2.2	2.1
Observed Load (lbs/day)	0.08	0.16	0.12	0.93
REQ LOAD REDUCTION (lbs/day)				

W-14 Peters River at (MA/RI border)

CHRONIC Copper Evaluation For WW-3	
EMC Flow (cfs)	33
AveWW-3 Hardness for W-14 (mg/L)	52
Chronic Copper Criteria (µg/L)	5.14
Allowable Load (lbs/day)	0.91
Allowable less 10% MOS	0.82
Observed EMC Copper Conc (µg/L)	2.23
Observed LOAD (lbs/day)	0.40
REQ LOAD REDUCTION (lbs/day)	

W-15 Peters River (pre-culvert entry)

ACUTE Copper Evaluation For WW-3				
Flow (cfs)	7.3	8.4	10.6	84.5
Average Hardness by Run (mg/L)	53	54	64	29
Acute Copper Criteria (µg/L)	7.39	7.52	8.83	4.19
Allowable Load (lbs/day)	0.29	0.34	0.50	1.91
Allowable less 10% MOS	0.26	0.31	0.45	1.72
Observed Copper Conc (µg/L)	2.5	2.7	2.3	2.8
Observed Load (lbs/day)	0.10	0.12	0.13	1.27
REQ LOAD REDUCTION (lbs/day)				

W-15 Peters River (pre-culvert entry)

CHRONIC Copper Evaluation For WW-3	
EMC Flow (cfs)	34
AveWW-3 Hardness for W-15 (mg/L)	51
Chronic Copper Criteria (µg/L)	5.04
Allowable Load (lbs/day)	0.92
Allowable less 10% MOS	0.83
Observed EMC Copper Conc (µg/L)	2.73
Observed LOAD (lbs/day)	0.50
REQ LOAD REDUCTION (lbs/day)	

W-16 Peters River (confluence w/ BR)

ACUTE Copper Evaluation For WW-3				
Flow (cfs)	7.4	8.5	10.7	
Average Hardness by Run (mg/L)	53	54	64	
Acute Copper Criteria (µg/L)	7.39	7.52	8.83	
Allowable Load (lbs/day)	0.29	0.35	0.51	
Allowable less 10% MOS	0.27	0.31	0.46	
Observed Copper Conc (µg/L)	2.6	2.6	2.7	
Observed Load (lbs/day)	0.10	0.12	0.16	
REQ LOAD REDUCTION (lbs/day)				

W-16 Peters River (confluence w/ BR)

CHRONIC Copper Evaluation For WW-3	
EMC Flow (cfs)	34
AveWW-3 Hardness for W-16 (mg/L)	56
Chronic Copper Criteria (µg/L)	5.43
Allowable Load (lbs/day)	1.00
Allowable less 10% MOS	0.90
Observed EMC Copper Conc (µg/L)	2.63
Observed LOAD (lbs/day)	0.49
REQ LOAD REDUCTION (lbs/day)	

Reduction = Observed Load - Allowable Load Less 10% MOS

PETERS RIVER WET WEATHER-4 COPPER EVALUATION

W-14 Peters River at (MA/RI border)

ACUTE Copper Evaluation For WW-3				
WW-4 October 22-25, 2005	22-Oct	23-Oct		
Run	2	4	6	7
Flow (cfs)	66.2	73.5	85.6	86.4
Hardness by Run (mg/L)	48	46	37	43
Acute Copper Criteria (µg/L)	6.73	6.47	5.27	6.07
Allowable Load (lbs/day)	2.40	2.56	2.43	2.83
Allowable less 10% MOS	2.16	2.31	2.19	2.54
Observed Copper Conc (µg/L)	3.5	3.1	2.1	1.9
Observed Load (lbs/day)	1.25	1.23	0.97	0.88
REQ LOAD REDUCTION (lbs/day)				

W-14 Peters River at (MA/RI border)

CHRONIC Copper Evaluation For WW-3	
EMC Flow (cfs)	80
AveWW-4 Hardness for W-14 (mg/L)	44
Chronic Copper Criteria (µg/L)	4.40
Allowable Load (lbs/day)	1.89
Allowable less 10% MOS	1.70
Observed EMC Copper Conc (µg/L)	2.58
Observed LOAD (lbs/day)	1.11
REQ LOAD REDUCTION (lbs/day)	

W-15 Peters River (pre-culvert entry)

ACUTE Copper Evaluation For WW-3				
Flow (cfs)	68.0	75.5	88.0	88.8
Average Hardness by Run (mg/L)	43	39	40	44
Acute Copper Criteria (µg/L)	6.07	5.53	5.67	6.20
Allowable Load (lbs/day)	2.22	2.25	2.69	2.97
Allowable less 10% MOS	2.00	2.03	2.42	2.67
Observed Copper Conc (µg/L)	3.9	2.8	1.8	2.1
Observed Load (lbs/day)	1.43	1.14	0.85	1.00
REQ LOAD REDUCTION (lbs/day)				

W-15 Peters River (pre-culvert entry)

CHRONIC Copper Evaluation For WW-3	
EMC Flow (cfs)	82
AveWW-3 Hardness for W-15 (mg/L)	42
Chronic Copper Criteria (µg/L)	4.22
Allowable Load (lbs/day)	1.86
Allowable less 10% MOS	1.67
Observed EMC Copper Conc (µg/L)	2.57
Observed LOAD (lbs/day)	1.13
REQ LOAD REDUCTION (lbs/day)	

Reduction = Observed Load - Allowable Load Less 10% MOS

Common Surveys at Millville, MA and Manville Dam, RI - All USGS Data

Millville, MA Dissolved Cadmium for 15 Common Surveys

Date	Flow Percentile	Flow (cfs)	Hardness (mg/L)	Observed Conc (µg/L)	Observed Load (lbs/day)	Cd Chronic Criteria (µg/L)	Allowable Load (lbs/day)	Req Load reduction (lbs/day)	
3/19/07	16.1%	747	30.90	0.05	**0.20**	0.109	0.44		
4/17/07	0.2%	5930	21.83	0.69	**22.05**	0.085	2.72	19.33	**W**
10/22/07	53.8%	275	38.37	0.28	**0.42**	0.126	0.19	0.23	
8/18/08	34.1%	449	43.64	0.17	**0.41**	0.138	0.33	0.08	
12/15/08	2.4%	1900	33.38	0.34	**3.53**	0.115	1.17	2.36	
3/24/09	31.7%	473	52.77	0.25	**0.64**	0.158	0.40	0.24	
6/23/09	30.8%	483	47.87	0.15	**0.39**	0.147	0.38	0.01	
9/15/09	54.8%	267	48.91	0.24	**0.34**	0.150	0.21	0.13	
12/7/09	14.0%	831	35.54	0.08	**0.36**	0.120	0.54		
3/23/10	2.0%	2055	29.73	1.10	**12.18**	0.106	1.17	11.01	**W**
6/28/10	67.9%	186	58.97	0.27	**0.27**	0.170	0.17	0.10	
9/21/10	95.7%	69	64.99	0.40	**0.15**	0.182	0.07	0.08	
1/5/11	43.8%	362	51.73	0.25	**0.49**	0.156	0.30	0.18	
3/29/11	17.8%	702	49.91	0.26	**0.98**	0.152	0.57	0.41	
6/28/11	21.3%	632	39.36	0.16	**0.55**	0.129	0.44	0.11	

W = Wet Weather Surveys

2.86	**Millville, MA Average Load for Common Surveys**
0.29	**Millville, MA Average Load for Flows below 275 cfs**
3.80	**Millville, MA Average Load for Flows above 275 cfs**

Manville Dam, RI Dissolved Cadmium for 15 Common Surveys

Date	Flow Percentile	Flow (cfs)	Hardness (mg/L)	Observed Conc (µg/L)	**Observed Load (lbs/day)**	Cd Chronic Criteria (µg/L)	Allowable Load (lbs/day)	Req Load Reduction (lbs/day)	
3/20/07	17.1%	1360	32.94	0.19	**1.39**	0.114	0.83	0.56	
4/17/07	0.1%	8680	20.27	0.36	**16.84**	0.081	3.79	13.06	**W**
10/23/07	71.8%	301	45.23	0.20	**0.32**	0.142	0.23	0.09	
8/19/08	49.3%	583	40.15	0.12	**0.38**	0.130	0.41		
12/16/08	2.7%	2930	26.86	0.19	**3.00**	0.098	1.56	1.45	
3/24/09	37.5%	779	43.68	0.17	**0.71**	0.138	0.58	0.13	
6/24/09	41.5%	706	42.81	0.11	**0.42**	0.136	0.52		
9/15/09	70.5%	313	57.02	0.23	**0.39**	0.166	0.28	0.11	
12/8/09	26.1%	1,050	30.71	0.15	**0.85**	0.108	0.61	0.24	
3/23/10	2.0%	3,250	23.40	0.15	**2.63**	0.089	1.57	1.06	**W**
6/29/10	86.7%	188	58.93	0.18	**0.18**	0.170	0.17	0.01	
9/20/10	97.8%	109	71.96	0.22	**0.13**	0.196	0.11	0.01	
1/5/11	53.4%	523	43.19	0.18	**0.51**	0.137	0.39	0.12	
3/28/11	26.4%	1,040	43.49	0.19	**1.07**	0.138	0.77	0.29	
6/27/11	17.5%	1,350	36.27	0.13	**0.95**	0.121	0.88	0.06	
W = Wet Weather Surveys					**1.98**	**Manville Dam Average Load for Common Surveys**			
					0.26	**Manville Dam Average Load for Flows below 425 cfs**			
					2.61	**Manville Dam Average Load for Flows above 425 cfs**			

Millville, Ma Dissolved Lead for 15 Common Surveys

Date	Flow Percentile	Flow (cfs)	Hardness (mg/L)	Observed Conc (µg/L)	**Observed Load (lbs/day)**	Pb Chronic Criteria (µg/L)	Allowable Load (lbs/day)	Req Load reduction (lbs/day)	
3/19/07	16.1%	747	30.90	0.31	**1.25**	0.686	2.76		
4/17/07	0.2%	5930	21.83	1.20	**38.36**	0.458	14.65	23.71	**W**
10/22/07	53.8%	275	38.37	0.76	**1.13**	0.875	1.30		
8/18/08	34.1%	449	43.64	0.91	**2.20**	1.010	2.44		
12/15/08	2.4%	1900	33.38	0.57	**5.84**	0.748	7.66		
3/24/09	31.7%	473	52.77	0.28	**0.71**	1.247	3.18		
6/23/09	30.8%	483	47.87	0.95	**2.47**	1.119	2.91		
9/15/09	54.8%	267	48.91	0.65	**0.93**	1.146	1.65		
12/7/09	14.0%	831	35.54	0.17	**0.76**	0.803	3.59		
3/23/10	2.0%	2055	29.73	3.37	**37.33**	0.657	7.28	30.05	**W**
6/28/10	67.9%	186	58.97	0.51	**0.51**	1.410	1.41		
9/21/10	95.7%	69	64.99	0.63	**0.23**	1.570	0.58		
1/5/11	43.8%	362	51.73	0.27	**0.53**	1.219	2.38		
3/29/11	17.8%	702	49.91	0.3	**1.14**	1.172	4.44		
6/28/11	21.3%	632	39.36	1.23	**4.19**	0.900	3.07	1.12	

W = Wet Weather Surveys

6.51	**Millville, MA Average Load for Common Surveys**
0.70	**Millville, MA Average Load for Flows below 275 cfs**
8.62	**Millville, MA Average Load for Flows above 275 cfs**

Manville Dam, RI Dissolved Lead for 15 Common Surveys

Date	Flow Percentile	Flow (cfs)	Hardness (mg/L)	Observed Conc (µg/L)	Observed Load (lbs/day)	Pb Chronic Criteria (µg/L)	Allowable Load (lbs/day)	Req Load Reduction (lbs/day)	
3/20/07	17.1%	1360	32.94	0.35	**2.57**	0.737	5.40		
4/17/07	0.1%	8680	20.27	1.21	**56.61**	0.417	19.52	37.09	**W**
10/23/07	71.8%	301	45.23	0.64	**1.04**	1.051	1.70		
8/19/08	49.3%	583	40.15	1.10	**3.46**	0.920	2.89	0.57	
12/16/08	2.7%	2930	26.86	0.73	**11.53**	0.586	9.26	2.27	
3/24/09	37.5%	779	43.68	0.34	**1.43**	1.010	4.24		
6/24/09	41.5%	706	42.81	1.21	**4.60**	0.988	3.76	0.84	
9/15/09	70.5%	313	57.02	0.60	**1.01**	1.358	2.29		
12/8/09	26.1%	1050	30.71	0.54	**3.06**	0.682	3.86		
3/23/10	2.0%	3250	23.40	0.40	**7.01**	0.501	8.77		**W**
6/29/10	86.7%	188	58.93	0.39	**0.40**	1.409	1.43		
9/20/10	97.8%	109	71.96	0.26	**0.15**	1.756	1.03		
1/5/11	53.4%	523	43.19	0.41	**1.16**	0.998	2.81		
3/28/11	26.4%	1040	43.49	0.84	**4.71**	1.006	5.64		
6/27/11	17.5%	1350	36.27	2.58	**18.77**	0.821	5.98	12.80	
W = Wet Weather Surveys					**7.83**	**Manville Dam Average Load for Common Surveys**			
					0.65	**Manville Dam Average Load for Flows below 425 cfs**			
					10.44	**Manville Dam Average Load for Flows above 425 cfs**			

APPENDIX C – Impervious Parcel Listing

Woonsocket Parcel Ownership

MAP LOT	Street #	Street Name	Ownership	Business type	Imp Acres	% Imp
5-4	300	Avenue A	Education Department	Schools	**4.9**	82
49-107	0	Aylsworth Avenue	Public Works Director	Parking Lot	**2.9**	51
58-31	101	Brookhaven Lane	Gillooley James F	Condos	**4.8**	25
40-7	0	Cass Avenue	Public Works Director	Vacant Land	**4.9**	10
49-15	0	Cass Avenue	State of R I	Schools	**2.0**	70
37-1	115	Cass Avenue	Southern New England Rgnl	Hospitals	**10.6**	76
37-61	186	Cass Avenue	Wellington Retail LLC	Medical Office	**3.0**	93
49-4	777	Cass Avenue	Education Department	Schools	**5.3**	81
22-38	245	Clinton Street	RI Economic Development Corp	Office Bldg	**2.2**	83
22-180	401	Clinton Street	Zhang Jun Yong Et Al	Store	**3.7**	96
41-1	105	Cumberland Hill Road	Water Treatment Plant	Office Bldg	**11.9**	42
41-149	433	Cumberland Hill Road	Timpany Roderic R	Service Shop	**2.0**	41
41-29	560	Cumberland Hill Road	Oakland Grove Assoc L P	Nursing Home	**2.8**	41
42-7	840	Cumberland Hill Road	SRW Realty Corp	Garage/Office	**3.0**	91
42-8	846	Cumberland Hill Road	Cumberland Hill Realty LLC	Warehouse	**3.0**	81
36-10	68	Cumberland Street	Primco Woonsocket LLC	Office Bldg	**2.3**	74
51-18	0	CVS Drive	RI Economic Development Corp	Parking Lot	**4.3**	49
51-2	1	CVS Drive	RI Economic Development Corp	Office Bldg	**11.0**	65
42-4	45	Dawes Street	Lefebvre Leo E	Service Shop	**4.0**	67
46-11	1666	Diamond Hill Road	RD Woonsocket Associates LP	Bowling/Arena	**3.0**	99
46-29	1500	Diamond Hill Road	RD Woonsocket Associates LP	Shopping Ctr	**14.6**	93
46-3	1500	Diamond Hill Road	RD Woonsocket Associates LP	Department Str.	**4.0**	85
52-6	1919	Diamond Hill Road	Walmart Real Estate Bns Trust	Dpt. Str.	**9.7**	73
52-1	2000	Diamond Hill Road	WP Woonsocket Associates LLC	Shopping Ctr	**21.6**	88
52-20	2010	Diamond Hill Road	SFFGA RHODE ISLAND LLC (Lowe's)	Shopping Ctr	**12.2**	60
52-10	2168	Diamond Hill Road	Lacroix Realty Inc	Office Bldg	**2.7**	86
61-6	2491	Diamond Hill Road	Four Seasons North Apts LLC	Apartments	**4.2**	49
20-23	308	East School Street	First Base Space LLC	Mill.Bldg.	**2.8**	74
11-209	80	Fabien Street	State of R I	Offices	**2.3**	36
8-97	84	Fairmount Street	Hanover Capital (Blackstone) LLC	Mill.Bldg.	**4.1**	63
8-24	85	Fairmount Street	Tech Industries Inc	Mill.Bldg.	**6.4**	83
6-118	229	First Avenue	Seville Associates	Industrial bldg.	**2.5**	50
43-9	50	Fortin Drive	MFR Properties LLC	Office Bldg	**4.7**	95
43-32	55	Fortin Drive	RI REIT LLC	Auto Sales Rpr	**3.2**	100
43-16	114	Fortin Drive	Carriage Way Associates LTD	Auto Sales Rpr	**3.5**	92
43-29	194	Fortin Drive	Laxmiji LLC	Motel	**2.5**	91
43-30	205	Fortin Drive	Glenn Craft Corp	Industrial	**2.0**	83
43-19	100	Founders Drive	Blackstone Street Realty LLC	Industrial	**4.3**	74
43-33	200	Founders Drive	Flock Tex	Industrial	**3.1**	71
43-31	220	Founders Drive	Front Street Realty Corp	Warehouse	**2.3**	91
43-1	400	Founders Drive	RI Economic Development Corp	Warehouse	**9.5**	80
43-3	400	Founders Drive	RI Economic Development Corp	Industrial	**5.4**	69
50-5	100	Goldstein Drive	RI Industrial Facilities Corp	Industrial	**2.5**	46
27-165	138	Hamlet Avenue	City of Woonsocket	Schools	**2.0**	64

Woonsocket Parcel Ownership (Continued)

MAP LOT	Street #	Street Name	Ownership	Business type	Imp Acres	% Imp
28-12	153	Hamlet Avenue	The 153 Hamlet Avenue Realty Tr	Mill.Bldg.	**6.0**	90
24-303	0	Logee Street	Education Department	Schools	**3.3**	30
23-62	800	Logee Street	Mt. St. Charles Academy	Schools	**8.3**	44
42-354	119	Madison Avenue	Lefebvre Leo E	Service Shop	**3.6**	90
3-35	108	Mason Street	RI Economic Development Corp	Mill.Bldg.	**2.2**	62
54-6	976	Mendon Road	Education Department	Schools	**2.1**	18
55-2	1148	Mendon Road	St. Joseph Church	School	**2.9**	52
49-6	1265	Mendon Road	Beaudoin Leo J Jr	Mill.Bldg.	**5.4**	95
35-115	100	Mill Street	Riverhaven Condominium Association	Condos	**5.9**	63
20-75	755	North Main Street	Privilege Park Assocoates LLC	Warehouse	**2.3**	32
18-2	1400	Park Avenue	ALM Supermarkets Three LLC	Shop Center	**4.1**	91
11-91	1409	Park Avenue	Roman Catholic BishopP	School	**4.6**	59
50-51	300	Park East Drive	Technic Inc	Industrial	**3.6**	30
56-18	475	Park East Drive	RI Economic Development Corp	Office Bldg	**2.4**	64
59-13	1026	Park East Drive	CVS Pharmacy Inc	Office Bldg	**2.7**	37
59-14	1246	Park East Drive	Java Realty LLC	Office/Wrhs	**2.6**	78
59-16	1275	Park East Drive	Summer Infant Inc	Wrhs/office	**2.1**	39
39-8	260	Poplar Street	Woonsocket Nursing Center	Nursing Home	**2.6**	33
5-48	667	Providence Street	Lachapelle Donald & Michael A	Warehouse	**2.0**	62
49-246	115	Ricard Street	Hetu Donna Trustee	Mill.Bldg.	**2.0**	58
7-33	0	River Street	City of Woonsocket	Garage	**2.7**	99
8-36	784	River Street	Lambert Bernard J Inc	Mill.Bldg.	**2.4**	52
7-20	1112	River Street	Lebeaux Robert A Trustee	Industrial bldg.	**2.0**	60
7-36	116	Singleton Street	K & S Realty Inc	Mill.Bldg.	**2.8**	81
7-37	153	Singleton Street	The First Republic	Mill.Bldg.	**2.3**	30
22-1	191	Social Street	Boucher Properties LLC	Office Bldg	**2.3**	97
22-51	263	Social Street	Arvanigian Gary M & Janis C	Shopping Ctr	**2.8**	86
42-507	0	St. Augustin Street	RI Economic Development Corp	Parking Lot	**2.3**	79
42-403	171	St. Augustin Street	171 Food Services Woonsocket	Cold Storage	**2.0**	84
27-113	0	Villa Nova Street	Education Department	Schools	**2.5**	89
53-3	0	Village Road	Plaza Village Group	Apartments	**5.2**	22
36-136	250	Winthrop Street	Education Department	Schools	**2.5**	23
36-136	250	Winthrop Street	Education Department	Schools	**2.3**	41

North Smithfield Parcel Ownership

MAP LOT	Street #	Street Address	Ownership	Business Type	Imp Acres	% Imp.
003-117	14	Canal Street	A & G Realty	Office Bldg	**2.0**	46.5
013-150	408	Eddie Dowling Hwy	408 Eddie Dowling RI LLC	Office Bldg	**2.5**	21.6
017-074	1195	Eddie Dowling Hwy	Rustic Acquisition LLC	Store	**6.5**	71.5
004-237	110	Graham Drive	Poly top Corp	Ind/ Comm	**3.9**	51.3
006-002	501	Great Road	Please see attached spread*		**2.6**	30.3
005-064	582	Great Road	Sam – Man Realty Corp	Mill Bldg	**11.9**	77.8
005-479	590	Great Road	Sam – Man Realty Corp	Ind/ Comm	**5.7**	13.2
005-029	765	Great Road	ATP Realty Inc	Ind/ Comm	**3.1**	10.6
009-599	76	Greenville Road	Narragansett Electric Co.	Ind/ Comm	**2.1**	42.7
012-298	231	Greenville Road	Narragansett Electric Co.	Ind/ Comm	**4.2**	40.3
015-044	412	Greenville Road	N Smithfield Jr – Sr High School	Schools-Public	**5.9**	46.6
017-169		Incl in 17/250	DRF Arena LLC	Vacant Land	**2.4**	36.8
007-059		Incl in 7/62	U S Government	Vacant Land	**2.2**	37.4
005-078		Incl in 8/300	Pound Hill Real Estate Company, LLC	Vacant Land	**2.3**	7.4
005-421	70	Industrial Drive	RI Port Authority 7 Economic Dev. Coro	Warehouse	**3.7**	57.8
005-073	100	Industrial Drive	JED Realty Associates LLC	Ind/ Comm	**7.8**	75.2
005-478	150	Industrial Drive	R I Industrial Facilities Corp #886	Ind /Comm	**18.5**	54.1
016-008	955	Iron Mine Hill Road	C & B Scrap LLC	Vacant Land	**2.9**	55.7
016-006	1115	Iron Mine Hill Road	Ferra Ralph F & Muriel J	Ind/ Comm	**6.6**	12.7
004-009		Main Street	Town of North Smithfield	Vacant Land	**4.0**	24.9
006-062	395	Mendon Road	Lantern House Partners	Apartments	**2.7**	31.1
006-009	400	Mendon Road	The Frassati Residence	Asst Living	**2.8**	21.3
006-305	403	Mendon Road	Gatewood Limited Partnership	Apartments	**2.2**	42.2
004-290	115	Mt. Pleasant Road	Laramee Emile & Lorraine M	Residential	**2.3**	20.2
010-085	274	Old Oxford Road	US Government Air National Guard	Other Federal	**3.7**	54.4
009-150		Pound Hill Road	Geer Daniel E Jr & Debra Morgan	Vacant Land	**2.2**	11.1
005-360	20	Providence Pike	Edgcomb Metals Co	Ind/ Comm	**3.0**	60.4
005-385	100	Providence Pike	Providence Realty LLC	Ind/ Comm	**7.7**	46.6
001-016	229	Quaker Hwy	Laliberte Leon Trustee	Ind/ Comm	**2.5**	84.1
021-004	61	Reservoir Road	Ronci Fernando F Trustee	Residential	**3.5**	6.2
006-334	10	Rhodes Avenue	St. Antoine Residence	Nursing Home	**6.1**	33.8
005-004	60	School Street	Village Associates	Apartments	**3.0**	37.3
005-423	90	School Street	V-H Inc	Restaurant	**2.1**	83.2
009-794	595	Smithfield Road	Northbud Realty Co Inc	Supermarket	**6.3**	93.5
003-243	190	St. Paul Street	Deerfield Common Associates LP	Apartments	**2.9**	34.4
005-422	9	Steel Street	C & C Terra Holdings L.P	Ind/ Comm	**2.6**	54.1
005-417	21	Steel Street	Praxair Distribution Inc	Ind/ Comm	**2.2**	26.4
003-002	135	Tupperware Drive	Blackstone Smithfield Corp	Apartments	**14.7**	29.2
001-310	900	Victory Hwy	Wally Realty LLC	Shop Center	**7.6**	43.9
009-851	229	Woonsocket Hill Road	Wrights Dairy Farm Inc	Ind/ Comm	**2.3**	37.4
005-019					**3.3**	12.5
004-041					**5.9**	42.9
005-414					**3.7**	58.8
021-098					**3.7**	94.2

Lincoln Parcel Ownership

MAP LOT	Street No.	Address	Ownership	Business Type	Imp Acres	% Imp
41-007			No information provided		**32.7**	84
28-041	1	Albion Road	Albion Crossing LLC	Industrial/ Other	**10.7**	41
28-039	24	Albion Road	Lincoln Corp Center LLC	Comm/ Other	**4.6**	64
31-176	25	Amica Center Blvd.	Amica Mutual Insurance Co	Office General	**3.2**	70
31-178	50	Amica Way	Amica Mutual Insurance Co	Comm/ Other	**5.6**	60
31-168	100	Amica Way	Amica Mutual Insurance Co	Office General	**4.7**	22
30-061	10	Blackstone Valley Place	Autocrat Inc	Warehouse	**2.5**	47
30-059	13	Blackstone Valley Place	Original Pizza Crust Co	Warehouse	**3.3**	78
30-065	14	Blackstone Valley Place	Lincoln Business Center LLC	Manufacturing	**2.5**	55
30-062	15	Blackstone Valley Place	Cathedral Corp	Warehouse	**3.2**	56
30-606	20	Blackstone Valley Place	Amica Mutual Insurance Co	Office General	**2.6**	45
31-150	25	Blackstone Valley Place	Howland Assoc Inc Et Al	Office General	**4.5**	70
28-114	8	Court Drive	Caliri Realty Assoc LLC	Warehouse	**1.9**	59
10-340	10	Franklin Street	Lincoln Housing Authority	Federal Building	**3.6**	49
10-058	10	Franklin Street	Lincoln Housing Authority	Federal Building	**2.5**	33
10-059	172	Front Street	Risko James R Living Tr	Retail Shopping Ctr	**3.1**	100
41-059	606	George Washington Highway	Crown Enterprises Inc.	Warehouse	**3.6**	26
28-012	617	George Washington Highway	Overnight Transportation Co	Warehouse	**2.8**	30
28-055	625	George Washington Highway	Band Rhode Island	Office General	**2.1**	73
30-049	670	George Washington Highway	RI Economic Development Corp	Office General	**12.3**	73
30-054	676	George Washington Highway	Manderville Reality LLC	Warehouse	**2.3**	53
30-032	678	George Washington Highway	Lincoln (Tax sale property)	Tax Sale Property	**2.0**	38
30-013	680	George Washington Highway	State of Rhode Island	State	**2.4**	86
29-290	695	George Washington Highway	River Place Venture LLC	Office General	**4.5**	47
29-300	701	George Washington Highway	SNH Medical Office Properties Trust	R & D Facility	**2.7**	49
29-304	707	George Washington Highway	Cullen Inc.	Storage	**2.0**	23
29-151	713	George Washington Highway	Werchandlo Charles E.	Warehouse	**2.1**	63
30-042	7	Hood Drive	Crest Mfg Company	Manufacturing	**2.0**	66
05-052	1775	Lonsdale Avenue	State of Rhode Island DEM	State Rec Facility	**4.7**	13
28-149	23	New England Way	Windmoeller & Hoelscher	Manufacturing	**2.3**	41
34-184	315	New River Road	Town of Lincoln	School, Public	**3.3**	17
30-007	135	Old River Road	Town of Lincoln	School, Public	**10.4**	23
31-023	208	Old River Road	Kirkbrae Country Club	Swim Club	**4.1**	55
39-004	30	Sayles Hill Road	Holiday Retirement Home	Nursing Home	**3.5**	54
32-048	2	School Street	Albion Mills Co, Inc.	Other/ Improv Land	**5.0**	53

Cumberland Parcel Ownership

MAP LOT	Street #	Address	Ownership	Business Type	Imp Acres	% Imp
054-0173-000					**4.8**	78
054-0182-000					**8.4**	46
054-0032-000					**17.0**	50
058-0057-000					**2.2**	90
001-0108-000	51	Abbott Street	3J Corporation	Industrial	**2.3**	100
011-0159-000	100	Ann & Hope Way	Realty Associates Inc	Comm/Ind	**10.9**	79
026-0017-000	15	Arnold’s Mills Road	Community School	School	**2.0**	28
021-0816-000	156	Bear Hill Road	Bear Hill Limited Partnership	Apts	**3.9**	37
017-0010-000	160	Bear Hill Road	Dean Acquisition	Comm/Ind	**6.8**	40
052-0366-000		Biltmore Avenue, Rear	RI Economic Development Corp	Vacant	**4.9**	67
034-0223-000	44	Cray Street	Forty Four Cray Street Associates	Comm/Ind	**3.5**	81
035-0002-000	140	Crossing Drive	Lincoln Property Co	Apts	**10.2**	23
019-0363-000	290	Curran Road	JF Realty LLC	Comm/Ind	**10.3**	37
006-0150-000	275	Dexter Street	Narragansett Electric Co	Utility R/R	**2.0**	46
016-0632-000	1364	Diamond Hill Road	Garvin School	School	**2.2**	65
020-0024-000	1460	Diamond Hill Road	St. Aidan Church Corporation	Church	**2.3**	20
020-0001-000	1464	Diamond Hill Road	Cumberland Public Library Senior Center	Libraries	**6.3**	6
021-0491-000	2077	Diamond Hill Road	Pasqua Realty Trust	Comm/Ind	**2.6**	86
036-0020-000	3655	Diamond Hill Road	Mary Vianney Church	Church	**2.2**	43
059-0015-000	4097	Diamond Hill Road	Diamond Hill Baseball Field Rec Dept	OFFICE	**5.2**	4
004-0094-000	11	Fatima Drive	Church of Our Lady of Fatima	Church	**2.3**	30
058-0041-000	1	Front Street	J & W Realty Holdings LLC	Comm/Ind	**2.5**	80
058-0040-000	51	Front Street	FC Ashton Mill Lessor LLC	Apts	**2.5**	56
052-0358-000	100	Highland Corporate Drive	JDS Lot 1 LLC	Industrial	**2.6**	29
052-0359-000	300	Highland Corporate Drive	Cintas Corporation No. 2	Offices	**4.4**	36
021-0806-000	5	Industrial Road	Msnks Realty Cumberland LLC	Comm/Ind	**10.2**	77
021-0755-000	35	Industrial Road	Cumberland Business Center LLC	Industrial	**5.1**	92
021-0844-000	55	Industrial Road	TNT Red Star Express Inc	Industrial	**7.8**	79
024-0289-000	60	Industrial Road	Dean Leasing Corp	Industrial	**5.4**	79
024-0331-000	70	Industrial Road	Berkeley Acquisition Corp	Industrial	**3.3**	41
024-0097-000	80	Industrial Road	OLD DOMINION FREIGHT LINE INC	Inndustrial	**6.2**	79
034-0234-000	65	John C Dean memorial Blvd	Berkeley Acquisition Corp	Vacant	**4.6**	97
034-0254-000	75	John C Dean memorial Blvd	Berkeley Acquisition Corp	Vacant	**3.5**	58
034-0052-000	50	Lynch Place	Lynch J.H. & Sons INC	Comm/Ind	**6.8**	21
034-0092-000	50	Lynch Place	Lynch J.H. & Sons INCC	Vacant	**2.1**	3
054-0220-000	205	Manville Hill Road	J. J. McLaughlin Cumberland Hill School	School	**3.6**	19
051-0052-000	100	Maple Ridge Drive	Cumberland Properties LLC	Industrial	**6.8**	41
051-0057-000	300	Maple Ridge Drive	Tiffany and Company	Industrial	**9.4**	38
034-0100-000	25	Martin Street	Berkeley Acquisition Corp	Comm/Ind	**9.8**	58
034-0188-000	30	Martin Street	Saylesville Properties Inc	Industrial	**4.5**	83
034-0138-000	45	Martin Street	Okonite Company	Industrial	**8.3**	63
034-0139-000	50	Martin Street	RI Industrial Facilities	Comm/Ind	**11.8**	49
002-0004-000	30	Meeting Street	Cadillac Mills LLC	Industrial	**2.7**	83
002-0017-000	32	Meeting Street	AYN Wardo Realty LLC	Comm/Ind	**2.4**	68
012-0006-000	1	Mendon Road	Cumberland Housing Authority	Comm/Ind	**2.1**	51
012-0008-000	70	Mendon Road	Inland American Cumberland LLC	Comm/Ind	**13.9**	41

Cumberland Parcel Ownership (Continued)

MAP LOT	Street #	Address	Ownership	Business Type	Imp Acres	% Imp
012-0018-000	120	Mendon Road	Cumberland Town of by Tax Sale	Comm/Ind	**3.3**	65
034-0211-000	1041	Mendon Road	Donaldson Realty LLC	Vacant	**2.0**	33
058-0056-000	1226	Mendon Road	Berkeley Acquisition Corp	Industrial	**3.6**	39
039-0024-000	1595	Mendon Road	Narragansett Electric Co	Utility R/R	**6.8**	20
039-0068-000	1725	Mendon Road	Sabre Development Company LLC	Comm/Ind	**2.0**	84
058-0053-000	1800	Mendon Road	1800 Mendon Road LLC	Comm/Ind	**3.1**	70
033-0393-000	2000	Mendon Road	524 Commonwealth Avenue LP	Comm/Ind	**5.4**	65
035-0161-000	2065	Mendon Road	Cumberland Place LP	Apts	**3.1**	20
055-0008-000	2600	Mendon Road	Cumberland High School	School	**8.3**	35
038-0004-000	2675	Mendon Road	Cumberland High School	Vacant	**4.5**	4
052-0321-000	3751	Mendon Road	Cumberland Village Associates	Comm/Ind	**3.6**	47
045-0022-000	60	Nate Whipple Hwy	Four Horsemen Realty LLC	Comm/Ind	**2.8**	41
043-0012-000	400	Nate Whipple Hwy	North Cumberland Middle School	School	**2.9**	9
027-0004-000	10	Old Diamond Hill Road	HCP HB2 Emerald Bay Manor LLC	Nursing Home	**3.4**	34
016-0628-000	9-21	Old Mendon Road	Pascale Jane B.	Comm/Ind	**3.3**	40
051-0040-000	200	Scenic View Drive	RB Highland Holdings LLC	Offices	**2.2**	25
039-0124-000	96	Scott Road	Narragansett Electric Co	Utility R/R	**5.9**	42
039-0184-000	130	Scott Road	Ashton Elementary School	School	**3.0**	21
048-0007-000	11	Summer Brown Road	Sisters of Mercy	Church	**2.7**	6
048-0054-000		Wrentham Road	Sisters of Mercy	Church	**3.2**	27
033-0430-000					**3.1**	36

APPENDIX D - Response to Comments

Response to Comments

The following comments were received by RIDEM during the public comment period for the draft document, Total Maximum Daily Load Analysis for Blackstone River Watershed. The complete text of all comments received is on file in the Office of Water Resources at RIDEM.

Donald E. Pryor - Center for Environmental Studies, Brown University

Comments
1. Good work
This TMDL provides specific, actionable recommendations based on substantial data and information. It could a real guide to improving the river. I especially like the notion of asking for TMDL Implementation Plans -- specific responses not buried in other things.

2. Current requirements/transparency
I have concerns about adding more requirements without assessing how current ones are working.
a. MS4 requirements: Have municipal plans and progress reports been assessed? The TMDL does not so indicate. Have outfalls been mapped as required? There doesn't seem to be any indication in the TMDL. Are catch basins cleaned and any BMPs maintained? Indeed, are any BMPs in place in areas covered by the TMDL? Are illicit discharges being investigated? Are ordinances affecting new development being enforced? The TMDL implies not -- only one new shopping center in Cumberland draining to outfall 333 is mentioned and that mention is vague about how well it is performing. Very little detail is given about any actions by RIDOT under the MS4 permit. Have they made any progress in this area?

RIDEM Response:
Municipalities, RIDOT and other owners of municipal separate stormwater sewer systems (MS4) report on their progress in implementing their RIPDES Phase II General Permit required Stormwater Management Program Plan elements through their annual reporting to the RIDEM Office of Water Resources. Assessing municipalities' compliance with these permit requirements is beyond the scope of the TMDL document. The MS4 Annual Reports are kept on file in the RIDEM Office of Water Resources and are available for public review, upon request.

b. MSGPs: The TMDL provides apparently contradictory information. Table 4.5 lists 4 facilities but Table 7.1 lists only 3 -- 2 of which are included in Table 4.5 plus another unmentioned there, Privilege Auto Parts. Several of the facilities in Table 7.1 would seem to require MSGPs that cover metals and/or pathogens. Where discharge concentrations are reported they appear to be remarkably low. Based on data from comparable facilities elsewhere these would be expected to be significant contributors.

RIDEM Response:
Thank you for pointing out this inconsistency in the document. Since Table 4.5 and Table 7.2 are largely duplicative, we have decided to delete Table 4.5 in the document. As for the inconsistencies between the tables, Table 4.5 lists those facilities with MSGPs that include pollutants of concern (POCs) for the impairments addressed by this TMDL. At the time that

sampling was conducted on Cherry Brook, Fairmount Foundry was operating under a MSGP, and thus was included in the list, however it subsequently submitted a request for a "No Exposure Exclusion". A condition of no exposure exists at an industrial facility when all industrial materials and activities are protected by a storm resistant shelter to prevent exposure to rain, snow, snowfall, and/or runoff. This was verified and approved by RIPDES staff, which resulted in the Foundry being removed from the list of MSGP with monitoring requirements in Table 7.2. The other inconsistency is Advanced Auto Recycling which was included in Table 4.5 but not Tables 7.1 or 7.2 – since it discharges into Abbott Brook and not directly to the Blackstone River it was dropped from the list.

The average concentrations of the POC shown in Table 7.2 are as reported by the MSGP holder. RIDEM Office of Water Resources maintains a database containing these monitoring results; these monitoring data may be made available to the public upon request.

c. Transparency: MS4 SWPPPs, progress reports and evaluations should be available to the public. Similarly with MSGPs and monitoring data, EPA provides most of this on the web for MA so it can be done without enormous effort.

RIDEM Response:
As noted above, RIDEM maintains paper copies of the MS4 Stormwater Management Program Plans and annual reports. These documents are available for public review upon request. We will look into the feasibility of posting this information on DEM's website.

3. Unbalanced pressure on municipalities
The TMDL gives the impression of leaning heavily on municipalities without calling for other entities to do their share. It seems like lawyers wrote some of the sections. Cooperation is required but could be difficult if perceptions about treatment are uneven. Some of this is simply due to the sequence of presentation -- municipalities are discussed first and given more detailed direction. RIDOT is given very gentle treatment. Municipalities are presumed to have ownership in possibly joint outfalls but not the other way around. RIDOT in other documents (such as the current draft TIP) seems to acknowledge very little responsibility for stormwater. Some projects, reportedly, don't do stormwater measures because "the money ran out". Similarly NBC is called on to do very little. Even when their preferred solution is sewer separation, there appears to be no partnership with municipalities to maintain such infrastructure. Instead municipalities are directed to plan for such responsibilities -- despite the fact that the CSO consent agreement calls for maximizing flow to the treatment plant. DEM also does not fully acknowledge its responsibilities. These include not only guiding, assisting and evaluating municipalities and making information public but also committing to deal with upstream contributions -- in this case particularly from the Branch River. It is acknowledged to contribute substantial amounts of pathogens and lead but, as far as I can tell, does not have a commitment for reduction as does the MA upstream areas. MA contributions are harder to deal with but responsibility for RI upstream contributions should be clear. The TMDL should lay out a more even playing field so that real cooperation is possible.

RIDEM Response:
We respectfully disagree with your assertion that RIDOT is given gentle treatment. The TMDL document clearly states that RIDOT is identified along with the relevant municipality as the presumed owner of the twenty-three outfalls listed in Table 4.2, Furthermore, RIDOT is specifically directed to work with the municipalities in the watershed to confirm ownership of outfalls listed in Table 4.2, to identify interconnections among the state and local drainage systems to the priority outfalls, and to prioritize for further BMP implementation, those with high pathogen levels and/or trace metals in their discharges based upon available information.

The CSO abatement program is described in Section 7.5 of the TMDL which lists the plans and requirements for NBC. As stated, EPA and RIDEM require NBC to comply with CSO discharge policies, and to submit semi-annual reports detailing the maintenance, repair, monitoring and discharge reporting requirements for the CSOs that discharge into the Blackstone. To date, NBC has complied with all requirements, and the reports can be made available for review upon request. RIDEM so notes the need for coordination between NBC and municipalities as NBC proceeds with design and construction of facilities as part of Phase III – particularly, where sewer separation is the recommended alternative. Language has been added to the TMDL document to reflect requirements for NBC to review available technologies and water quality data to determine whether modifications to the Phase III facilities are necessary to meet requirements of the Clean Water Act and RI Water Quality Regulations, and to reinforce the importance of coordination between NBC and responsible MS4 operators, particularly on sewer separation projects

Relative to the Branch River's contributions of lead and pathogens to the Blackstone River, RIDEM will further evaluate the sources of lead and pathogens and needed reductions to meet both Branch River and Blackstone River water quality standards as part of the TMDL investigation, scheduled to be completed for the Branch River and its tributaries by 2020. A note to this effect has been added to Section 4.10 of the TMDL document.

4. Nit
Site specific copper WQ standards are referred to on pp. 16-20 but not given, as far as I can find.

RIDEM Response:
Site specific criteria for Copper are found in the current version of the RI Water Quality Standards in Appendix B, on page B-6. The link to the regulations is;
http://www.dem.ri.gov/pubs/regs/regs/water/h20q09.pdf
The site specific criteria applicable to the Blackstone River (RI0001003R-01A and RI0001003R-01B) and other wastewater dominated rivers have been added to the footnote to Table 1.2.

Steve Winnett - Regional TMDL/listing coordinator, U.S. EPA Region 1, New England

5. Section 1.1, 2nd paragraph: "Given the significance of the WWTFs as sources of TP to the Blackstone River..." Is this documented somewhere?

RIDEM Response:
The Blackstone River Initiative (BRI, Wright, et al, 2001) documented the significance of WWTFs as sources of nutrients (nitrogen, phosphorus) as did the White Paper: Approaches to TMDL Development (Berger, 2009).

6. Page 2, second paragraph discusses MassDEP's listed impairments for the Blackstone watershed's rivers within Mass, including priority organics, turbidity, suspended solids, and taste/odor/color. Is there any indication that these same rivers within RI are impaired for the same things? Have they been assessed for these pollutants?

RIDEM Response:
The Blackstone River impairments do include priority organics, but do not include turbidity, suspended solids nor taste/odor/color. In RI, taste and odor are considered observed effects (as defined by EPA's ADB guidance and in RIDEM's CALM) and are indicators associated with drinking water use. Since the Blackstone River and all other rivers addressed in this TMDL are not designated for drinking water use, no data exists within RI for taste and odor on these waterbodies. RI does not have numeric criteria for color nor suspended solids (TSS). No data exists for color on these waterbodies. TSS data collected at the USGS gaging stations on the Blackstone River is reviewed for compliance with the state's general narrative criteria during the assessment process, and has been found to be within the average values observed in rivers throughout the state, therefore, meeting the state's general narrative criteria. RI does have a numeric criterion for turbidity. Turbidity data collected on the Blackstone River is reviewed for compliance during the assessment process and has been found to meet the criteria.

7. Page 18, paragraphs 2 and 3 both end with the phrase "calculating a percent reduction." I think you mean, "calculating a TMDL." Recall that the percent reduction isn't the TMDL.

RIDEM Response:
Text changed to say required reduction. Percent reduction was deleted in both paragraphs.

8. Page 19, First sub-bullet under bullet number 2: Is the acute criteria discussed here associated with wet weather surveys as are the chronic criteria in the bullet that follows? It doesn't say. If not, please explain.

RIDEM Response:
The text was changed to read:
Acute criteria: The average hardness of all stations on a waterbody segment by run was used to calculate the criteria for wet weather events.

9. Section 5.7, first sentence, "EPA guidance requires that load allocations be assigned..." Suggest you mean "allowable loads" or "loading capacity," both of which refer to the entire TMDL load, whereas "load allocation" only applies to the NPS portion.

RIDEM Response:
Load allocations changed to ‘allowable loads’.

10. In the Implementation section 7.3, where the various general permits are identified, it would be helpful to know which river segment(s) each permitted facility/MS4 area discharges to. The same applies to the NBC CSO permit and its discharge area.

RIDEM Response:
Water body segment ID numbers inserted where applicable in section 7.3.

Allison Hamel - Environmental Scientist/Storm Water Program Coordinator, RIDOT

This letter constitutes RIDOT's written comments regarding the Blackstone River Watershed TMDL report. RIDOT has reviewed the report, attended the November 7, 2012 Public Meeting, and offers the following:

11. Page 21, paragraph 3: The 2004 Louis Berger Group document *Water Quality – Blackstone River, Final Report 1: Existing Data, Volume I & II* should be made available electronically, and posted on the RIDEM TMDL webpage for easy reference and review, as are other TMDL-related documents are. The 2008 LBG document *Water Quality – Blackstone River, Final Report 2: Field Investigations* should also be made available electronically. This is particularly important because each of the Priority Outfalls in Section 7.3 – Municipality Specific Stormwater Measures references the report for Outfall Identification.

RIDEM Response:
A link to the 2008 LBG report is located on page 29 of the TMDL document. Additionally, a link to the Existing Data, Volumes I & II was added to the document on page 21. The TMDL and the reports listed above can be found on the following two web pages for RIDEM.

http://www.dem.ri.gov/programs/benviron/water/quality/rest/index.htm

http://www.dem.ri.gov/programs/benviron/water/quality/rest/reports.htm

12. Page 113, paragraph 2: It should be noted who should/will be investigating the other potential sources – RIDEM Division of Agriculture or the MS4.

RIDEM Response:
The MS4s are expected to investigate and identify sources of pollution to their drainage systems. Any potential sources from farms identified by the MS4s should be referred to the RIDEM Division of Agriculture for follow-up.

13. Page 114, Section 8.0 – Public Participation: This section should include the Public Meeting held on November 7, 2012 and the current Public Notice period.

RIDEM Response:
The date and location of the November 7, 2012 public meeting was added. The draft document did not have that information available for insertion at the time it was made available on the RIDEM website.

14. Additionally, RIDOT would like to offer the following information:
RIDOT outfall data has been provided to the RIDEM Supervising GIS Specialist as part of RIDOT's MS4 Annual Report. Town/Site specific-RIDOT outfall data is also available upon request.

RIDEM Response:
So noted.

15. RIDOT, RIDEM, and the URI Cooperative Extension are currently developing a second multi-year agreement for URI to provide stormwater public education and outreach support and materials to participating MS4s. Targeted public education regarding illicit discharges, pet waste, motor vehicle repair/maintenance waste, etc. are all anticipated to be addressed through this Agreement. The RIDEM TMDL Program has been asked to review and comment on the proposed agreement.

RIDOT is currently developing a consultant RFP to develop a state-wide, 5-year TMDL Implementation Plan Strategy for RIDOT. RIDOT will request RIDEM review of proposal to seek comments and suggestions. RIDOT anticipates this 5-year Implementation Plan Strategy to encompass all approved TMDLs, including the Blackstone River Watershed TMDL for pathogens and Trace Metals.

RIDOT will continue to work with the Office of Water Resources and interconnected MS4s in both the Storm Water Retrofit Program and the Storm Water Management Program. RIDOT will also implement each of the 6 Phase II Minimum Measures within the Blackstone River TMDL area, to the maximum extent practicable, and will report on progress in the RIPDES Annual Report.

RIDEM Response:
So noted.

Kimberly Groff, Ph.D. - TMDL and Water Quality Standards Section Chief, MassDEP

16. Page 12, paragraph 2. The information provided in this paragraph with respect to the impairment listings for Massachusetts were based on the draft 2010 integrated list. The final 2010 list has been approved by EPA and the impairment listings for these segments are provided below. The final 2010 Integrated list can be found at this link. (http://www.mass.gov/dep/water/resources/10list6.pdf)

RIDEM Response:
The link was updated in the TMDL document.

17. The RIDEM report should be corrected to reflect the current 2010 approved listings for the adjoining Massachusetts assessment units. We have also included the draft 2012 listings for the segments for your information.

Blackstone River (MA51-06) 2012 proposed list	**Blackstone River (MA51-06) 2010 approved list**
(Other flow regime alterations*) Cadmium Copper DDT Lead PCB in Fish Tissue Phosphorus (Total) Total Suspended Solids (TSS)	Lead Phosphorus (Total) Fecal Coliform Turbidity Total Suspended Solids (TSS) Taste and Odor (Low flow alterations*) Copper PCB in Fish Tissue Cadmium

Peters River (MA51-18) 2012 proposed list	**Peters River (MA51-18) 2010 approved list**
Copper Escherichia coli Lead	Fecal Coliform Copper Lead

Mill River (MA51-10) 2012 proposed list was split into two segments (MA51-35 and MA51-36) so the downstream segment (MA51-36) 2012 proposed list	**Mill River (MA51-10) 2010 approved list**
(Non-Native Aquatic Plants*) Aquatic Plants (Macrophytes) Escherichia coli Other	Aquatic Plants (Macrophytes) PCB in Fish Tissue (Non-Native Aquatic Plants*) Other

It should also be noted that the evaluations of water quality conditions for Clean Water Act Sections 305(b) and 303(d) reporting, the assessment methodologies and subsequent listing decisions do vary slightly between Massachusetts and Rhode Island. However, both states have identified metals (i.e., cadmium, lead, and/or copper) and pathogens (*E. coli*, *Enterococci* and/or fecal coliform bacteria) as being problematic in the Blackstone and Peters Rivers. Elevated bacteria (E. *coli*) has also recently been identified as a problem in lower segment of The Mill River before it flows into Rhode Island. A draft bacteria TMDL for pathogens has been prepared by MassDEP, however it has not yet been finalized or approved by EPA. The 2012

Massachusetts Consolidated Assessment and Listing Methodology (CALM) Guidance Manual can be downloaded from the MassDEP website at http://www.mass.gov/dep/water/resources/2012calm.pdf.

RIDEM Response:
The above paragraph has been added on page 12 of the TMDL.

18. As part of the on-going watershed management process the MassDEP analysts will be reevaluating water quality conditions with the most recently validated water quality data collected in these river segments according to the state's Consolidated Assessment and Listing Methodology (CALM) guidance manual. Pollutant budgets (TMDLs) designed to restore the health of these waterbodies will be developed as needed.

RIDEM Response:
No response required

19. Page 15, Section 1.4. – RIDEM established the loading capacity expressed as concentrations that are equal to the water quality standard. Since EPA guidance does not allow consideration for dilution when considering the impacts from bacteria, Massachusetts has adopted the same approach in the establishment of watershed pathogen TMDLs.

A summary of the numeric bacteria standards for MA and RIDEM is shown below. As shown below Massachusetts Water Quality Standards no longer contain a criterion for fecal coliform and the state revised its standards in 2007 to include e-coli and enterococcus. The previous DRAFT MA Pathogen TMDL for the Blackstone River Basin used a similar approach to RIDEM in developing the TMDL. Therefore, it is not anticipated that there will be significant conflicts between the measures that will be taken between the two states to address bacteria impairments. However, it would be helpful to provide a comparison of the Massachusetts-RI water quality standards, since the load reductions required for bacteria between the two states may not be directly comparable due to difference in the two states water quality standards.

Massachusetts Applicable Surface Water Quality Criteria			
	Primary Contact Recreation		
Waterbody Class	Geometric Mean	90th percentile	Single Sample Maximum**
B	<126 E. coli	Not available	235 E. coli
	<33 enterococci	Not available	61 enterococci
Rhode Island Applicable Surface Water Quality Criteria			
	Primary Contact Recreation		
Waterbody Class	Geometric Mean	90th percentile	Single Sample Maximum
B/B1	<200 Fecal coliform	<400 Fecal coliform	Not available
B/B1	<54 enterococci	Not available	<61 enterococci
** Used for the purposes of public swimming beach closure.			

RIDEM Response:
RIDEM has maintained fecal coliform criteria in the state's water quality standards not only to cover a transition to Enterococci for primary contact recreation use, but also to allow for an evaluation of freshwaters that discharge/flow into salt waters where the shellfish consumption use may be affected. RIDEM has incorporated the comment, including a table showing a

summary of the numeric bacteria standards for MADEP and RIDEM, at the end of Section 1.0 in the TMDL.

20. Pg 18, Paragraph 6 – RIDEM averaged the individual water hardness values from the two USGS Blackstone mainstem stations to use in calculating the chronic and acute freshwater criteria for metals. However, other data sets used the individual hardness values collected on a given date for calculating the chronic and acute freshwater criteria for metals. Comparing data that used hardness associated with the samples collected for each survey date and the data where hardness was averaged may be problematic. An explanation of any noted differences between the two approaches is warranted.

RIDEM Response:
The determination of whether to use individual hardness values or average hardness values for each survey was consistent across all comparisons presented in the TMDL and was based upon consideration of: whether multiple stations were sampled on a specific waterbody, whether there was significant variability between stations on a given waterbody and whether there were multiple samples collected at each station during a sampling period.

When evaluating compliance with cadmium and lead criteria for the Blackstone River at state line, DEM determined that it was most appropriate to use only the data collected at the Millville MA station and not to average this data with additional data collected further upstream or downstream. Therefore the Millville MA station data was used to establish single hardness and flow values for each survey date. However, for the RI portion of the Blackstone River, samples were collected at two stations on the mainstem and DEM evaluated the factors listed above to determine whether to evaluate each station separately or whether to average sample results for each survey were appropriate. The difference in hardness values at the two RI stations during each of the 15 USGS surveys ranged from less than 1 to 6 mg/L and averaged 2.9 mg/L – resulting in an insignificant difference in criteria. This approach was used initially to assess any exceedances in applicable criteria and then to estimate required pollutant reductions. As noted in Section 6.6.4, the TMDL is based on the separate load duration curves for Millville, MA, Manville Dam, RI and Roosevelt Avenue, RI is based upon individual hardness values for each station.

For Cherry Brook only one station was available to establish the hardness and applicable criteria for each survey date. The Peter's River is similar to the main stem of the Blackstone, in that a single station was deemed representative of the state line and two stations were located on the RI portion. Again, for the RI portion the factors above were evaluated to determine whether evaluation of each station separately or evaluation of average sample results for each survey were appropriate. The difference in the BTMDL hardness values at the two RI stations for a given survey ranged from 1 mg/L to 5 mg/L and averaged 2 mg/L in dry weather and in wet weather from less than 1 mg/L to 4.7 mg/L and averaged 2.3 mg/L.

21. Page 19. Paragraph starting with Table 1.3, suggested edit "averaged to ~~two~~ represent …."

RIDEM Response:
Change made in the document.

22. Page 21. 3rd Paragraph. Is an electronic copy of the "Water Quality – Blackstone River, Final Report 1: Existing Data, Volume I and II" available. If so can a link to this report be added to the TMDL report?

RIDEM Response:
The report is on our website at the following location;
http://www.dem.ri.gov/programs/benviron/water/quality/rest/pdfs/blackwq2.pdf

23. Page 26. 2nd paragraph. Were any comparisons done of the data results between the BTMDL and NBC? Were the NBC data considered in the TMDL analysis?

RIDEM Response:
The NBC data was reviewed and although comparable, the data was not used in the TMDL analysis.

24. Page 32. The value of 279 for Station W-16 in Table 3.7 should not be in bold.

RIDEM Response:
Change made in the table.

25. Page 33. Last Paragraph. It is stated that Station W-04 has a geomean concentration of 244 CFU/100ml, however, Table 3.8 indicates a value of 247.3 CFU/100ml. It is also stated that the geomean at Station W-01 is 250 CFU/100ml while Table 3.8 indicates a value of 230.9 for that station.

RIDEM Response:
Correction to the text was made to match the table, which is correct.

26. Page 37. Section 3.2.2. It would be helpful to have the flow information presented in a table format.

RIDEM Response:
The flow data used in the TMDL report is available from the USGS web site and from the data available in the BTMDL Field Data Report (Berger, 2008).

27. Page 37. Section 3.2.3 should present the calculated criteria or indicate that it can be found in Section 6.1 and Appendix B.

RIDEM Response:
Text added to this section to indicate where the criteria are reported.

28. Page 39. 3rd Paragraph. It is stated that Cherry Brook had one acute and one chronic exceedance, however, Table 3.13 only indicates a chronic exceedance. Consider indicating all the exceedances on this table. The same is true for the Peters River.

RIDEM Response:
In response to the comment, the table has been revised to show the number of occurrences and condition under which criteria were exceeded.

29. Page 39. 4th Paragraph. It is stated that station W-02 had the highest mean dissolved cadmium value, but there are no values for cadmium presented for that station in Table 3.13.

RIDEM Response:
Deleted W-02 and clarified that this was the USGS data set for cadmium.

30. Page 40. Section 3.2.4, first sentence. Please state where the calculations can be found.

RIDEM Response:
Added that the calculations can be found in Appendix B.

31. Page 40. Section 3.2.5. Please specify in this section how the information from the past water quality surveys was used in this TMDL?

RIDEM Response:
Text added to TMDL to explain how past reports were used.

32. Page 57, 1st Paragraph. RIDEM should consider indicating the following on Table 3.13 even though they are state line stations.
It is stated the Mill River did have a single chronic criteria exceedance at Station W-11. This is not indicated on Table 3.13.
It is stated the Peters River had chronic and acute exceedances for dissolved copper at the state line. These are not indicated on Table 3.13.

RIDEM Response:
Table 3.13 was changed for the state-line stations to indicate that they did have exceedances of the criteria. However, as noted above, only the maximum values were used in reference to the type and condition of the exceedances.

33. Page 64. Last Paragraph, 1st sentence please specify that the percent reductions are for the 90th percentile fecal coliform.

RIDEM Response:
Text added to the TMDL to indicate that the percent reductions are for the 90th percentile values.

34. Page 66, Last Paragraph 1st sentence please specify that the percent reductions are for the 90th percentile fecal coliform.

RIDEM Response:
Text added to the TMDL to indicate that the percent reductions are for the 90th percentile values.

35. Page 66, 3rd Paragraph 1st sentence please specify that the percent reductions are for the 90th percentile fecal coliform.

RIDEM Response:
This is redundant from above comment. The referenced paragraph is the same for both comments.

36. Page 65. 2nd Paragraph. Where do the percentages of loads come from? It would be helpful if this information were presented in a table or appendix.

RIDEM Response:
The percentages listed can be found in the BTMDL Field Data Report (Berger 2008) in Figures 3-75, 3-77, 4-34, 4-35, and 4-116. These references were added to the text.

37. Page 70. 1st Paragraph. Where is the data that supports this analysis? Is it from the data presented in Table 3.13? If so, it would be helpful to indicate that in the text.

RIDEM Response:
The percentages were calculated using the average concentrations from the low and high flow data sets in Appendix B for the Blackstone River USGS stations at Manville Dam and Roosevelt Avenue. The text was corrected in this section to indicate that the data is in Appendix B.

38. Page 70. 2nd Paragraph. It is stated there are few violations of the chronic criteria. Is this for all the parameters?

RIDEM Response:
Added that this is for lead

39. Page 75, Table 6.2. What variable determines the upper and lower bounds of the load shown in this table? Are these acute and chronic criteria or ranges in flow for a particular acute or chronic target. It is not clear where this number came from. Can you direct the reader to the Appendix and the specific calculations upon which these ranges were derived?

RIDEM Response:
The upper and lower bounds for the lead and cadmium are taken from the load duration curves. They represent the lowest and highest values from the curves using the range of observed flows in the Blackstone River. The ranges for the Peters River and Cherry Brook are from the tables that can be found in Appendix B.

40. Pg. 76, Paragraph 6. An additional comment regarding the use of a mean hardness value of all stations on a waterbody by run and for each storm was used in the high flow analysis to calculate acute criteria for metals. The chronic criteria were calculated using observed event mean concentration for hardness for each station on the waterbody for each storm. An explanation of any noted differences between the two approaches is warranted.

RIDEM Response:
Paragraph 5 on page 76 stated that the chronic criteria as calculated for the wet weather, high flow analysis was considered a four day average of the samples collected on the Peters River and Cherry Brook. The Event Mean Concentrations (EMCs) represented the mean values for each storm for all constituents analyzed. The EMCs also represent the averaged contribution of pollutants of concern under the storm hydrograph. Assuming they represent the four day average, this allows for more conservative criteria to be used to calculate the allowable loads.

41. Page 78. 1st Paragraph. It should be made clear that the information presented here is for copper.

RIDEM Response:
Change made in document to reflect that the information was for dissolved copper.

42. Page 78, Section 6.6.4, 1st paragraph, which flow frequency do these load reductions correspond to.

RIDEM Response:
No single flow frequency can be used as the table represents the range of load reductions. The range of flows for Millville, MA was from the 0.1 percentile to the 98th percentile. For Manville Dam, the range was from 0.1 to the 97.4 percentile, and the range at Roosevelt Avenue was from 0.2 to 95.7 percentile.

43. Page 82, 1st and 2nd Paragraph. It is not clear how the contributing loads from Massachusetts were derived. Please provide more explanation or a link to the appropriate reports that are the source of this information.

RIDEM Response:
The loads were calculated from the USGS data located in Appendix B. Nineteen surveys were conducted by the USGS at Millville, MA while sixteen were at Manville Dam, RI. When reviewing the data for this comment, it was determined that only fifteen surveys occurred within one day of each other. These fifteen surveys were compared resulting in changes in the percent contributions from MA for both cadmium and lead. Appropriate changes were made to the document and the data used for the analysis of the fifteen surveys was added as additional tables in Appendix B of the TMDL.

44. Figures Pages 78 to 84. Please include error bars on the data points plotted in the figures to show the uncertainty associated with these calculations. In MassDEP experience, under the best of circumstances uncertainty can range up to +/- 30%. This uncertainty should be discussed in the analysis and depicted in the figure.

RIDEM Response:
There is acceptable variability in all analytical methods as described in the Quality Assurance Project Plans for the monitoring programs, and error bars could be added. The data used to

establish allowable loads have gone through a rigorous quality assurance process, and we believe is a reasonable representation of existing conditions. We have opted not to add error bars to the graphed data.

45. Section 7.0 Implementation. A brief overview of the types of funding programs that are available would be helpful in this section.

RIDEM Response:
A section on funding sources has been added to the Appendices of the TMDL document.

Roy P. Giarrusso - Giarrusso Norton Cooley McGlone, PC – Trial Attorneys for the Performing Party Group and the P/P Superfund Site Joint Defense Group

Comments to the RIDEM Total Maximum Daily Load (TMDL) Analysis for the Blackstone River, Draft Report October 2012 and a Limited Summary of Historical Activities on the Blackstone River and Their Impacts to Soil and Sediment Chemistry Peterson/Puritan, Inc. Superfund Site – Operable Unit 2 Cumberland and Lincoln, Rhode Island

46. The purpose of this paper is to highlight the well-known industrial use of the Blackstone River for the past two hundred and fifty years. These activities have had a significant adverse impact on the sediment and water quality of the River. This fact has been repeatedly recognized in numerous authoritative studies and discussions focused on the Blackstone River, and the existence of these contributing sources should be included into the current October 2012 draft of the TMDL analysis report for the Blackstone River Report-Pathogens and Trace Metal Impairment.

As the *Remedial Investigation Report* and Feasibility Study for the Peterson/Puritan, Inc. Superfund Site, Operable Unit 2 (OU-2) located in Cumberland and Lincoln, Rhode Island (Peterson/Puritan) is in the process of finalization, it is important to note that certain chemicals (including polychlorinated biphenyls [PCBs], polycyclic aromatic hydrocarbons [PAHs], and heavy metals, including lead) have been found in elevated concentrations in well documented reports in the Blackstone River over the past thirty years well upstream of Peterson/Puritan, extending upstream into Massachusetts. The TMDL Report overemphasizes the potential role of the Peterson/Puritan Site as a Waste Source in Section 4.8 on the one hand and yet on the other neglects to provide any discussion of the numerous and well documented historical contaminant sources in the Basin.

One recent example is the Fisherville EPA Emergency Response Site along the River in Grafton MA. The Fisherville Site was contaminated with petroleum, chlorinated volatile organic compounds (VOCs), asbestos and heavy metals. In the late 1990's, the Mass. Dept. of Environmental Protection (MassDEP) installed a groundwater treatment system to remediate the petroleum and trichloroethylene (TCE) contaminated groundwater. In August 1999, there was a major multiple-alarm fire at the Fisherville Mill building that destroyed the entire complex including MassDEP's treatment system. EPA conducted an emergency response action to address all offsite properties that had been impacted by the asbestos-containing fire debris. Further information can be found at http://www.epa.gov/region1/removal-sites/FishervilleSiteRemovalAction.html There are many other locations in the Basin similar to Fisherville and many other sources of contamination.

This paper discusses the impact of lead and other metals in sediments and floodplain soils from the many identified and unidentified sources, including, but not limited to, the historic textile industry. Any cleanup to achieve the Rhode Island Department of Environmental Management (RIDEM) Direct Contact Standard (DCS) of 150 milligrams per kilogram (mg/kg) for lead will be greatly hindered by the large volume of lead-contaminated sediments in up-gradient basin ponds and pools demonstrated by previous investigations in the Blackstone River. These sediment deposits become future sources through downstream transport from sediment resuspension and embankment sloughing, as noted in your Section 4.7 of the TMDL Report. These ubiquitous contributors will make achieving the 150 mg/kg RIDEM DCS technically impracticable at the OU-2 Site as these upstream sediments are transported downstream to OU-2 and beyond during future high water flooding events.

The sampling of metals in the soils at the Quinnville Well Field as part of the remedial investigation (RI) at the OU-2 Site indicated elevated concentrations of the seemingly ubiquitous constituents of lead over 150 mg/kg; dieldrin (over 400 micrograms per kilogram [µg/kg]); PCB-1260 (over 500 µg/kg); and other metals noted in samples LQW-010, LQW-011 and LQW-12 appear to be unrelated to the OU-2 Site activities, and are more likely related to the former textile manufacturing in the Quinnville area and/or other industry along the Blackstone River Valley as identified below. These constituents have been detected in floodplain soils and river sediments at similar frequencies and concentrations for miles within the Blackstone River and its discharge to the Narragansett Bay.

Some of the relevant historical industrial use of and along the Blackstone River resulting in significant sources of contamination, including heavy metals, for centuries, is highlighted below:

<u>Textile Mill Waste –</u>

- The intense industrial usage of the Blackstone River left a legacy of pollution. Textile manufacturers discharged dyes; metal-working plants discharged heavy metals; and wood-working companies discharged varnish, solvents, and paints. Many of these pollutants can still be found in the river's sediments today, over 100 years after they were released. These pollutants continue to influence water quality and overall health of the Blackstone River's ecosystem. (Kerr, 1990). (http://seagrant.gso.uri.edu/factsheets/blackstone_river.html)

- Benjamin Walcott erected the first mill in Cumberland in 1802. By the end of the War of 1812, there were 99 cotton mills with 76,000 spindles in or near Providence. (http://www.cs.arizona.edu/patterns/weaving/books/wp_1925-3.pdf)

- The Olney Manufacturing Company was a business that operated from at least 1828 to 1835, engaged in manufacture of thread and yarn. According to local historian Albert T. Klyberg, Granville Olney also ran a small machine shop, although none of these records seem to survive. All of these industrial sites were located in what was then Ashton Village in Smithfield on the west side of the Blackstone River. The village west of the Blackstone River has since been renamed Quinnville, and that part of Smithfield has been set off as the Town of Lincoln. (Walton, 1912) (http://www.cs.arizona.edu/patterns/weaving/books/wp_1925-3.pdf).

- Olney and Whipple leased space at the Smithfield Cotton and Woolen Manufacturing Company (in Ashton), popularly known as "Sinking Fund Mill," which had been founded in 1809. In 1809, Simon Whipple, upon whose farm the Kelly House is located, entered into an agreement with six others to dam the Blackstone River at Pray's Wading Place (Ashton Mill) and built a small textile mill under the leadership of George Olney. By 1850, the Woonsocket area was full of factories, mostly textile mills, and these mills were served by the Providence & Worcester Railroad. Woonsocket is less than 5 miles upstream of the site.

- Dye vats were common components of any textile mill to color the fabrics. Mordant dyes were applied only with a fixing agent, or mordant. The fixing agents are often salts of heavy metal compounds, such as chromium, aluminum, tin, copper, titanium, and bluestone (copper sulfate) (Application of Dyestuffs to Textiles, Paper, Leather and Other Materials; Matthews, 1920, pg 168). Lead was also commonly used to add color to cotton and wool in the textile mills. Mineral pigment dyes were colored compounds of various metals formed by the precipitation in the fiber of suitable metal salts, such as chrome yellow, which was formed by the precipitation of lead acetate and potassium bichromate usually in cotton materials (Matthews, 1920, pg 158). Chrome yellow pigment dye also historically consisted of lead chromate (Matthews, 1920, pg 169). Another technique for adding color was to impregnate the fiber with the salt solution of lead acetate and then treating with another chemical, such as yellow chrome to add the color (Matthews, 1920, pg 174).

- All of the chemicals used for coloring and mixing in the vats would contribute heavy metals when discharged to the Blackstone River and adsorb to the sediments. Direct discharge to the river was the primary method of disposal without treatment. The dye colors often contained cadmium (red and yellow), chromium (green), lead chromate and ferric cyanides (green), copper (blues and greens), and lead carbonate and zinc (whites). The dyes were rinsed out of the cloth releasing the various metals and giving the river a noticeable color temporarily. As mentioned earlier, chromium was important in mordant dying. Cadmium, chromium, copper, lead, and mercury have also been important pigments, and when used, their manufacture can lead to releases of toxic metal ions into the environment. (Matlack, 2001)

- As a result of textile manufacturing changing, lead chromate and white basic lead carbonate were subsequently replaced by less toxic materials, including yellow bismuth vanadate (Introduction to Green Chemistry; Matlack, 2001).

- A 1928 article in the *Sewage Works Journal*, Vol. 1, No. 1, pp 77-79 titled “Improvements in the Operation of a Textile Wastes Treatment Plant”, described the character of the waste at one of the American Woolen Companies in Rhode Island and Massachusetts. The article gives some description of the waste water. The mill was discharging 450,000 GPD of spent dye liquors, washer wastes and rinse waters as highly colored, exceeding turbid and containing considerable amounts of soluble solids, soap, dirt, wool fiber and oils. This was the waste being treated by Metcalf and Eddy in the study but it is clear that the legacy of these discharges remains in the basin sediments and flood plain soils and should be further described in your report. With such a reservoir of heavy metals, PAHs from the mills in basin sediments and floodplains in upper Rhode Island and Massachusetts, remedial efforts will not be effective until containment of these materials is achieved.

The historic textile mill waste embedded in the river sediments of the Blackstone moves downstream and is re-deposited on downstream riverbanks, causing present day issues. That this mechanism is occurring in the Blackstone is not novel, and has been written about extensively.

Heavy metals, including cadmium and copper, and PCBs remain trapped in the river sediments, especially in the former millponds. Despite the deindustrialization that has taken place with the collapse of the region's textile, electroplating, and shoe industries, their historic pollutants remain trapped in the sediments of the millponds. Major rain events have the potential to stir up these sediments. Thus a major focus in the basin has been to repair the dams at the abandoned mill factories to prevent a new cycle of scour that would send these "trapped" pollutants downstream and ultimately into the sea. The result is a legacy of degradation that has been inflicted on the current generation. Johnson, Douglas L. and Lewis, Laurence A., *Land Degradation: Creation and Destruction*, at p. 100 (2007).

Sewage Treatment Plant Waste –

- In 1999, an article published by Bryant College (Bryant.edu/-langlois/ecology/pollution.html), also highlights impacts of the sewage discharges and CSOs. The Upper Blackstone Water Pollution Abatement District (UBPAD), serving the City of Worcester, the second largest city in Massachusetts, can discharge 56 million gallons per day of treated sewage. This volume can actually exceed the flow of the River. The plant, at that time, accounted for 77 to 96 percent of the cadmium, copper, chromium, nickel and zinc discharged to the river. While the Woonsocket Plant is discussed in your report, no attention is paid to the largest historical discharger (UBPAD) of cadmium, copper and lead located in Massachusetts.

Fisherville Mill Site –

- The TMDL report discusses only one waste site specifically- the Peterson/Puritan Site. There is no mention of the hundreds of other identified wastes site in the BR basin both in Massachusetts and Rhode Island. There are many notable source areas including the Fisherville EPA Emergency Response Site along the BR in Grafton MA. The site was contaminated with petroleum, chlorinated volatile organic compounds (VOCs), asbestos and heavy metals. In the late 1990's, the Mass. Dept. of Environmental Protection (MassDEP) installed a groundwater treatment system to remediate the petroleum and trichloroethene (TCE) contaminated groundwater. In August 1999, there was a major multiple-alarm fire at the Fisherville Mill building that destroyed the entire complex including MassDEP's treatment system. EPA conducted an emergency response action to address all off-site properties that had been impacted by the asbestos-containing fire debris. It would seem the history of Fisherville and many other sites are a far more serious consequence to the health of the Blackstone River than Peterson/Puritan. Specifically identifying only the Peterson/Puritan Site misleads the public. A review of the soil and groundwater data collected at the Site would make abundantly clear that its inclusion in the TMDL Report is misplaced.

Contamination Is Ubiquitous to Blackstone River –

- In a study performed by Metcalf & Eddy (M&E) for the United States Environmental Protection Agency (USEPA) in 2002, M&E collected extensive soil data at the Mackland Farms/Kelly House land located in the floodplain of the Blackstone River approximately ½ mile upstream of OU-2. M&E published the results of this investigation in 2003. Table 1 presents the results of the 20 M&E surface soil samples, as well as with the three RI Mackland Farm surface background samples collected at the southern tip of the Mackland Farms area, plus eight split samples collected by ARCADIS representing a third party in the Mackland Farms M&E 2002 study (see inset on Figure 4-34). The 95% upper confidence limit (UCL) concentration for lead was calculated using ProUCL at 439 mg/kg for all the data, while the 95% UCL for lead from 0 to 2 feet samples only was calculated to be 596 mg/kg.

- Similarly, certain RI sediment lead results from samples collected upstream of Mackland Farms and upstream of the Ashton Dam had results of 300 mg/kg (T05BL-004) and 450 mg/kg (T05BL-003) (see RI draft Figure 4-57). Such values and the pattern and locations of detections are indicative of potential historic widespread impacts from the past industrialization and, in particular, textile mill manufacturing that flourished in the Blackstone River Valley.

- As early as 1981, the Massachusetts Department of Environmental Protection completed a major state effort to address the issue of contaminated sediments at several Blackstone River sites. The resulting report, entitled *A Sediment Control Plan for the Blackstone River* (commonly known as the 1981 McGinn report), describes metal concentrations, locations of sediment accrual, sediment volumes, impacts of the sediment on river ecology, and alternatives available to eliminate or mitigate the associated adverse impacts (United States Army Corps of Engineers [USACE], 1997). The data evaluated indicated elevated concentrations of both metals and PAHs.

- There is also an extensive sediment chemical dataset collected by Battelle on behalf of the USACE as part of an assessment of the Blackstone River in the vicinity of some of the former textile mills. As shown in Table 2 of the Draft Final Feasibility Study/Ecological Risk, November 2002, one of the Blackstone River impoundments (Fisherville Pond) upstream of the site had an average lead concentration that was 709 mg/kg, chromium concentration of 506 mg/kg, arsenic concentration of 52 mg/kg, copper concentration of 778 mg/kg, and zinc concentration of 568 mg/kg. Results were similar in the two other ponded areas investigated (Singing Pond and Lake Wildwood). In summary, arsenic, nickel, lead, zinc, cadmium and copper all exceeded sediment quality guidelines except at one location (pg 4-1). These studies corroborate the RIDEM TMDL data showing elevated copper, lead and cadmium well upstream of the Peterson/Puritan Site extending to the Massachusetts border. The USACE report also documented previous river studies where elevated metals, PAHs, and PCBs were documented. (http://www.nae.usace.army.mil/projects/ma/blackstone/04-TaskDFinal.pdf)

- A 1998 United States Geological Survey (USGS) sampling of sediment reported in Trace Elements and Organic Compounds in Streambed Sediment and Fish Tissue of Coastal New England Streams indicated a range of lead concentrations from 240 mg/kg to 590 mg/kg in samples collected in the Blackstone River near Woonsocket and associated tributaries. A follow up study by the USGS (WRI Report 02-4179) in 2002 titled Trace Elements and Organic Compound in Streambed Sediment and Fish Tissue of Coastal New England Streams found some of the highest concentrations of trace metals in the Blackstone River at

Manville, RI sediments when compared to other New England industrial rivers such as the Charles, Aberjona, Kennebec, Androscoggin and Merrimack Rivers. Cadmium was measured at 18 ug/kg at Manville which was more than twice as high as the next highest elevated sample at the Aberjona River near Woburn MA at 7.3 ug/kg. Lead and copper were measured at 240 and 270 ug/kg respectively which were also elevated.

- An analysis of OU-2 RI onsite surface soil samples along the northern banks of the Blackstone River had several samples above 250 mg/kg for lead, with the highest at 344 mg/kg at SO-028-LF. These impacts are not likely the result of landfill runoff, but are more likely the result of historic river flooding. This area is also adjacent to the Quinnville portion of the site, which is on the southern bank where lead was detected as high as 460 mg/kg. The Quinnville impacts are either the result of past Quinnville on-site activities (which could include historic mill activities in the area) or was transported to Quinnville through deposition of river sediment. Based on river hydrology, particularly during flooding conditions when deposition is most likely to occur, it is highly unlikely that the Quinnville soil impacts could have come from landfill activities.

CONCLUSION

In summary, the long and intense industrial usage of the Blackstone River to provide transportation, power, and wastewater disposal has left behind a legacy of regional pollution that includes pesticides, PCBs, metals, and PAHs both in the sediments, as well as the floodplain soils. The anthropogenic background concentration of many metals and PAHs is elevated. To not include this well documented river history in the TMDL Report simply ignores the legacy of over two centuries of contamination embedded in Blackstone River sediments and soil which are re-suspended during flooding events and major storms. For the Report to fail to even mention what has been characterized by experts to be a source of 77% to 96% of the cadmium, copper, chromium, nickel and zinc discharged to the Blackstone River is incomprehensible. For the TMDL Report to have any validity, this sewage treatment plant in Massachusetts (UBPAD) serving the City of Worcester, along with the remaining CSOs above the Rhode Island border, require recognition in the Report and discussion. To be sure, without full or partial abatement of these active Massachusetts sources, attainment of the goal for a cleaner Blackstone River will be incredibly difficult.

Moreover, including the Peterson/Puritan Site as the only Waste Source in the TMDL Report is simply factually inaccurate and is grossly misleading to anyone reading the Report. At a minimum, the reference to the Peterson/Puritan Site in the Report should be eliminated or the TMDL Report sufficiently expanded to more accurately frame the historical presence of numerous historical contributors of contamination to the River.

RIDEM Response:
RIDEM acknowledges the legacy of waste sites and contaminated sediments resulting from the watershed's long history of industrial activities. It is described in various sections of the document including Section 2.2 which describes the pollution contributed by the textile mills and the leather and metal-working industries that discharged dyes, paints, solvents, and heavy metals

into Blackstone River, much of which can be found in the historic sediments that were deposited behind the dams built to harness the hydraulic power of the river.

Section 4.8 of the report generally notes the presence of many other waste sources in the Blackstone River Watershed in addition to the Peterson-Puritan site. A review of existing data that included waste sites was completed as part of the preliminary TMDL development documents. The TMDL document has been revised to reference Section 2.9.6 of the report "Water Quality-Blackstone River, Final Report 1: Existing Data: Volume I: Data Summary" which includes a more detailed list of waste sites.

By inclusion of your letter in its entirety, the Limited Summary of Historical Activities on the Blackstone River submitted by Roy P. Giarrusso *(Giarrusso Norton Cooley McGlone, PC – Trial Attorneys for the Performing Party Group and the P/P Superfund Site Joint Defense Group)* is also made publically available. It should be noted that RIDEM Office of Water Resources has not verified the information included in the letter.

Given the fact that the Peterson/Puritan Site extends for 2 miles along both banks of the Blackstone River, and that elevated levels of metals of concern addressed in the TMDL have been observed at the site, it was felt that it was appropriate to specifically mention this site in the TMDL document.

As for comments related to the Upper Blackstone Water Pollution Abatement District (UBWPAD), Section 4 of the TMDL discusses the pollution sources from Massachusetts and specifically, UBWPAD treatment facility in Worcester, MA. Section 4.9 discusses the findings of the Blackstone River Initiative (Wright, et al, 2001) and the source rankings for cadmium and lead to the Blackstone River, which included the UBWPAD. Zinc was not discussed as it is not one of the impairments addressed in this TMDL document.

APPENDIX E - Funding and Community Resources

Funding and Community Resources

Funding assistance for pollution abatement and other watershed management projects is available from various government and private sources. This section provides an overview and contact information for financial assistance programs offered by the State of Rhode Island. Information here is subject to change, so please contact the appropriate agency to learn more about the programs. Grant funding information for water quality, infrastructure, and agricultural improvements is provided below.

Water Quality Improvement Grants

Section 319 Non-Point Source Implementation Grants

Section 319 Grants are available to assist in the implementation of projects to promote restoration of water quality by reducing and managing non-point source pollution in Rhode Island waters. These grants are made possible by federal funds provided to RIDEM by the USEPA under Section 319 of the Clean Water Act.

Eligible applicants: Statewide, including municipal, state, or regional governments, quasi-state agencies, public schools and universities, and non-profit watershed, environmental, or conservation organizations.

Online at: http://www.dem.ri.gov/programs/benviron/water/finance/non/index.htm

Contact: RIDEM's Office of Water Resources, 235 Promenade St., Providence, RI 02908. (401) 222-6800

Infrastructure Improvement Loans and Grants

Clean Water State Revolving Fund Loans

The Clean Water State Revolving Fund is a federal/state partnership designed to provide low cost financing for the cost of infrastructure needed to achieve compliance with the Clean Water Act. The program is available to fund a wide variety of water quality projects including: 1) Traditional municipal wastewater treatment projects; 2) contaminated runoff from urban and agricultural areas; 3) wetlands restoration; 4) groundwater protection; 5) brownfields remediation; and 6) estuary management. Funds to establish or capitalize these programs are provided through federal government grants and state matching funds (equal to 20% of federal government grants). The interest rate charged to the Clean Water State Revolving Fund is one-third off the borrower's market rate.

Eligible applicants: Statewide, including municipal, state, or regional governments, quasi-state agencies. Assistance will be offered and awarded to projects based on ranking of environmental benefits of the project, readiness to proceed, and availability of funds.
Online at: http://www.dem.ri.gov/programs/benviron/water/finance/srf/index.htm

Contact: RIDEM's Office of Water Resources, 235 Promenade St., Providence, RI 02908. (401) 222-4700
Rhode Island Clean Water Finance Agency, 235 Promenade St., Suite 119, Providence, RI 02908. (401) 222-4430

Community Septic System Loan Program/State Revolving Fund

The Community Septic System Loan Program (CSSLP) allows homeowners in participating communities low interest loans to repair or replace failed, failing, or sub-standard onsite wastewater treatment systems. These individual loans are funded from a Clean Water State Revolving Fund loan to a community and are administered locally by Rhode Island Housing. CSSLP loans to homeowners are offered at 2% interest rate with a 10-year term.

Eligible applicants: Statewide. Application requires RIDEM approval of an onsite wastewater management plan. Assistance will be offered and awarded to projects based on ranking of environmental benefits of the project, readiness to proceed, and availability of funds.

Online at: http://www.dem.ri.gov/programs/benviron/water/finance/srf/index.htm

Contact: RIDEM's Office of Water Resources, 235 Promenade St., Providence, RI 02908. (401) 222-6800

Rhode Island Clean Water Finance Agency, 235 Promenade St., Suite 119, Providence, RI 02908. (401) 222-4430

Pump-out Station Grants

This program awards grants to promote the development and maintenance of boater waste disposal facilities in Rhode Island marine waters in conformance with the mandatory Federal "No Discharge" designation. To maintain this designation for the state's marine waters, RIDEM must assure pump-out facility infrastructure is in sound operating condition. Through this ongoing grant program, RIDEM and participating marinas have successfully reduced a significant source of bacterial contamination to Rhode Island's coastal waters, including waters in close proximity to shellfish harvesting and swimming areas.

Eligible applicants: Owners of any Rhode Island marina may apply for grants for projects located at the owner's marina. A non-owner operator may apply for such a grant, but only if the owner co-signs the application and grant award. City and Towns may apply through their Harbor Departments.

Online at: http://www.dem.ri.gov/programs/benviron/water/shellfsh/pump/index.htm

Contact: RIDEM's Office of Water Resources, 235 Promenade St., Providence, RI 02908. (401) 222-6800

Community Development Block Grants (CDBG)

Title 1 of the Housing and Community Development Act of 1974 authorized the Community Development Block Grant (CDBG) program. The program is sponsored by the US Department of Housing and Urban Development (HUD) and the Rhode Island program is administered through the State of Rhode Island Office of Housing and Community Development. These grants include water and sewer system improvements.

Eligible applicants: Municipalities.

Online at: http://www.hrc.ri.gov/CDBG-R.php

Contact: Division of Planning, Office of Housing and Community Development, 1 Capitol Hill, 3rd Floor, Providence, RI 02908, (401) 222-7901

Rhode Island Statewide Planning Challenge Grant Program

This grant program, funded by the Rhode Island Statewide Planning Program, provides money for innovative solutions to address land use and transportation issues faced by Rhode Island communities. Past projects have included improving bike paths to promote sustainable transportation and increasing access to public transportation.

Eligible applicants: Statewide.

Online at: http://www.planning.ri.gov/misc/pcgrants.htm

Contact: Rhode Island Division of Planning, Rhode Island Statewide Planning Program, 1 Capitol Hill, Providence, RI 02908, (401) 222-7901

Agricultural Grants

Department of Agriculture Natural Resources Conservation Service Environmental Quality Incentives Program (EQIP)

This program is a voluntary conservation grant program designed to promote and stimulate innovative approaches to environmental enhancement and protection, while improving agricultural production. Through EQIP, farmers and forestland managers may receive financial and technical help to install or implement structural and management conservation practices on eligible agricultural and forest land. EQIP provides for additional funding specifically to promote ground and surface water conservation activities to improve irrigation systems; to convert to the production of less water intensive agricultural commodities; to improve water storage through measures such as water banking and groundwater recharge; or to institute other measures that improve groundwater and surface water conservation. EQIP payment rates may cover up to 75 percent of the costs of installing certain conservation practices.

Eligible applicants: Any person engaged in livestock, agricultural production, aquaculture, or forestry on eligible land.

Online at: http://www.ri.nrcs.usda.gov/programs/eqip/EQIP.html

Contact: USDA NRCS – RI State Office/Service Center, 60 Quaker Lane, Suite 46, Warwick, RI 02886, (401) 828-1300.

Additional Resources and Other Programs

Stormwater Utilities

Stormwater utilities operate on the principle that polluters must contribute to the cost of fixing the problems they cause by controlling the environmental impacts of land development. The utilities collect fees from those that use the municipal storm sewer system. The funding source that is created by the stormwater utility can provide programmatic stability, allow for long-term planning and facilitate NPDES permit compliance. Nationwide, stormwater utility funding is used for a variety of projects, including projects that correct flooding, erosion, or other water quality problems. Funding is also used for ongoing maintenance. While stormwater utilities are most common in the Pacific Northwest and the Southeast, they are located in all regions through the country including a growing number of utilities in New England.

In Rhode Island, the Rhode Island Stormwater Management and Utility District Act of 2002 authorizes municipalities to create stormwater management districts, empowering them to charge fees, providing that the “fee system shall be reasonable and equitable so that each contributor of runoff to the system shall pay to the extent to which runoff is contributed.” The Rhode Island law exempts the state from the fee system (RI General Law 45-61).

USEPA Funding Website

The USEPA recognizes that committed watershed organizations and state and local governments need adequate resources to achieve the goals of the Clean Water Act and improve our nation’s water quality. To this end, the USEPA has created the following website to provide tools, databases, and information about sources of funding to practitioners and funders that serve to protect watersheds:

Online at: http://www.epa.gov/owow/funding.html