Pioneer Valley Green Infrastructure Plan

Promoting clean water.

Greening our streets and neighborhoods.

Prepared by

Pioneer Valley Planning Commission
60 Congress Street - Floor 1
Springfield, MA 01104-3419
pvpc.org

February 2014

Produced by the Pioneer Valley Planning Commission
with the support of the U.S. Department of Housing and Urban Development
Sustainable Communities Initiative Regional Planning Grant Program.

ACKNOWLEDGEMENTS

This project was funded through a Sustainable Communities Initiative grant from the U.S. Department of Housing and Urban Development (HUD), received by PVPC in partnership with the Capitol Region Council of Governments (CRCOG). PVPC would like to thank HUD and CRCOG for an outstanding partnership, and in particular acknowledge the efforts of the following staff:

Dwayne Marsh, U.S. Department of Housing and Urban Development (HUD)
Kate Dykgraaf, HUD
Lyle Wray, Capitol Region Council of Governments (CRCOG)
Mary Ellen Kowalewski, CRCOG

The work that provided the basis for this publication was supported by funding under an award with the U.S. Department of Housing and Urban Development. The substance and findings of the work are dedicated to the public. The author and publisher are solely responsible for the accuracy of the statements and interpretations contained in this publication. Such interpretations do not necessarily reflect the views of the Government.

Pioneer Valley Planning Commission Staff

Timothy Brennan	Executive Director
Christopher Curtis	Chief Planner and Project Manager/ Section Manager, Land Use & Environment
Patty Gambarini	Senior Environmental Planner
Danielle McKahn, LEED AP	Planner
Josiah Neiderbach, AICP	Planner
Gary Roux	Principal Planner/Transportation Section Manager
James Scace	Senior Planner/GIS Specialist
Todd Zukowski	GIS/Cartographic Section Manager

Pioneer Valley Green Infrastructure Committee

Daryl Amaral	MassDOT
Casey Berube	City of Westfield
Kurt Boisjolie	MassDEP
Todd Brown	Tighe & Bond
Kate Brown	City of Chicopee
Jeff Burkott	City of Holyoke
Kevin Chaffee	City of Springfield
Andrew Fisk	Connecticut River Watershed Council
Thomas Hamel	City of Chicopee
Joe Kietner	City of Chicopee
Richard Klein	Berkshire Design Group, Inc.
Meryl Mandell	MassDOT
Douglas McDonald	City of Northampton
Timothy Meyer	MassDOT
Dan Murphy	Town of South Hadley
Josh Schimmel	Springfield Water and Sewer Commission
Tom Shea	City of Chicopee
Matthew Sokop	City of Holyoke

Cover photo: The parking lot at River Valley Market in Northampton makes use of rain gardens- also known as bioretention areas- to capture and soak up stormwater flow from parking and sidewalk surfaces.
Photo by John Doherty.

TABLE OF CONTENTS

Chapter 3: Mapping for Green Infrastructure

Chapter 4: Analysis

Chapter 5: Recommended Strategies

Appendixes

Page left blank intentionally.

CHAPTER 1: INTRODUCTION

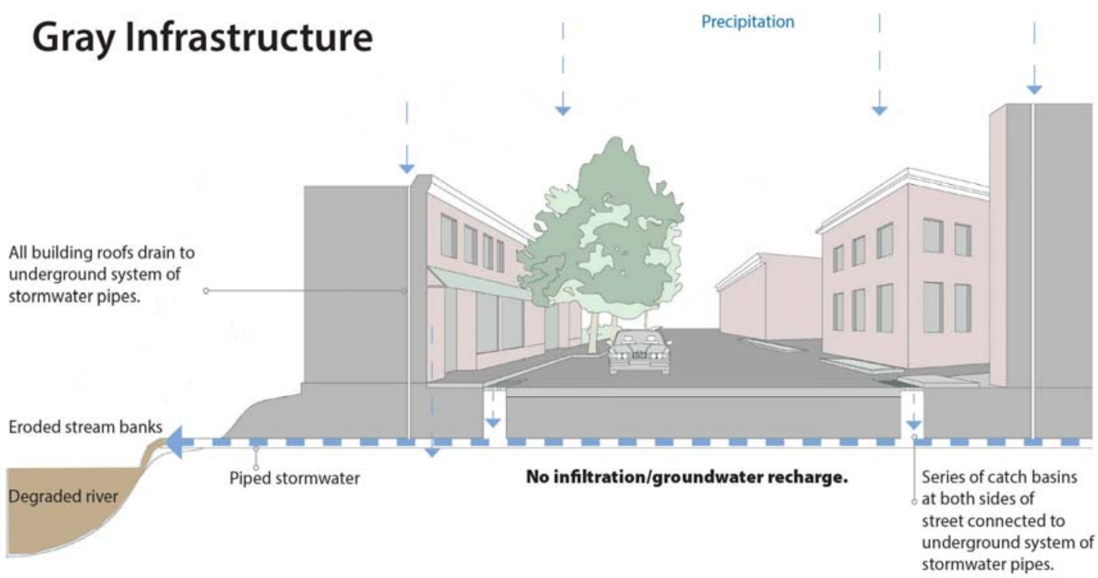
I. A TRANSFORMATION IN STORMWATER MANAGEMENT

Due to the persistence of polluted stormwater flows and forthcoming permit requirements, several Pioneer Valley communities are leading the region in transforming the approach to stormwater management. Through a variety of projects, communities are exploring strategies that promote capture and control of stormwater near to where it falls. This includes the use of natural or engineered systems —such as green roofs, rain gardens, or cisterns. In these facilities, stormwater can be cleansed as it moves through soils and the roots of plants, returned through soils to groundwater (infiltration), returned to the air (evapotranspiration), and/or captured to irrigate plants or flush toilets (reuse).
(See Figure 1.1 for images of several existing projects in the region.)

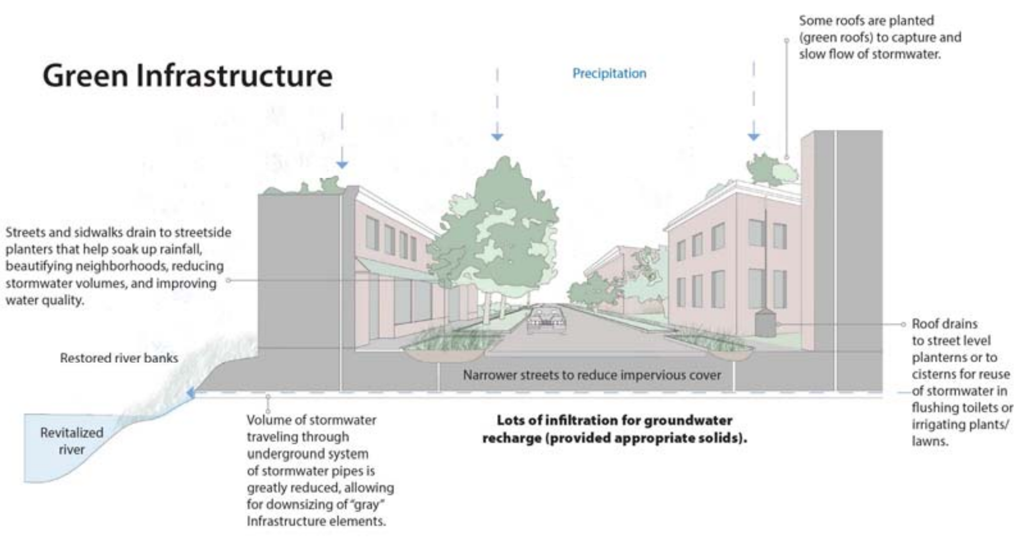
Because these facilities typically use plants to enhance and/or mimic natural processes, they are called "green infrastructure." These facilities are known as *structural practices*. Green infrastructure contrasts with traditional "gray infrastructure," which is typically built to convey rainfall from roofs, parking lots, and streets into catchbasins and pipes to outlet at the nearest waterway.

The use of green infrastructure stormwater management facilities in a pedestrian area.
Design research project for Springfield Water and Sewer Commission under direction of Professor Frank Sleegers and including Ryan Ball, Nathan Frazee, Pat McGeough, and Garrett Stone from the UMass Landscape Architecture and Regional Planning Program.

Figures 1.1 Gray versus Green Infrastructure



Traditional stormwater collection is built to convey rainfall from roofs, parking lots, and streets into catchbasins and underground tanks, and then travel in pipes to outlet at the nearest river.



Green infrastructure keeps rain close to where it falls, using structures to improve on-site infiltration, such as rain gardens and permeable pavements. These facilities can be used in combination with gray infrastructure to promote cleaner, slower, and smaller storm flows to nearby rivers and streams.

The move to improve stormwater management through green infrastructure also includes *non structural practices*. These involve policies, incentives, information, and regulations that promote management of rainfall near to where it falls, including better practices for site design, construction, and maintenance; protection of natural drainage systems; reductions of impervious cover (roads, parking lots, rooftops); and prohibitions on the use of harmful chemicals for lawns and deicing. The direct result of both these structural and non structural practices is that rain cannot accumulate and flow in large volume at high velocity, gaining erosive force to carry sediments and other pollutants into nearby surface waters. Runoff from rainfall and snowmelt and associated pollutants are essentially reduced at the "source."

This plan and its accompanying tools are intended to assist communities in the region as they continue the journey toward a more environmentally sustainable stormwater management program. The chapters within explore: the three existing infrastructures where green infrastructure stormwater management strategies might best be integrated (stormwater, combined sewer, and roads); criteria for mapping potential green infrastructure facility locations; the opportunities and challenges for implementing green infrastructure; and strategies for implementation. Key tools of interest within this plan include:

- Working maps to help with green infrastructure decision making in the 22 Hampden and Hampshire county communities regulated by the U.S. Environmental Protection Agency (EPA) for stormwater discharges (these are located in the Appendixes)
- Maps of potential green infrastructure locations for seven municipalities (these are located at the end of Chapter 3)
- Matrix of known existing green infrastructure locations in the region with in-depth descriptions for several of these (this is located in Appendix B)
- A checklist for reviewing local municipal regulations and the degree to which they allow/facilitate green infrastructure development. This checklist was developed with an eye toward the requirements of the forthcoming stormwater permit and using The Center for Watershed Protection's Code and Ordinance Worksheet (retrieved 2011); U.S. Environmental Protection Agency's Water Quality Scorecard (2009); and the Metropolitan Area Planning Council's Low Impact Development Toolkit Checklist for Regulatory Review (retrieved 2011) (this is located in the Appendixes)
- A listing of existing design resources and identification of which green infrastructure practices are addressed (within Chapter 4)

Green infrastructure is one of several aspects of regional sustainability planning for the Pioneer Valley now under way with funding from the Sustainable Communities Initiative of the United States Department of Housing and Urban Development. The planning focus areas of this broader effort include:

- Climate Action and Clean Energy
- Environment
- Food Security
- Housing
- Land Use
- Transportation (with an emphasis on transit oriented development)
- Workforce and Economic Development

Figures 1.2 Examples of Existing Green Infrastructure Facilities in the Pioneer Valley

A handful of green infrastructure projects are leading the way for the region, providing both inspiration and instructive lessons. These pioneer projects were done for a variety of reasons. Some projects were driven by a desire to learn, explore, and showcase what could be done with better design for stormwater management. Others are the result of site constraints and emerging local requirements. And yet other projects are in part motivated by the desire to receive certification from the Green Building Council's Leadership in Energy and Environmental Design (LEED) program, which includes criteria for better site design and stormwater management practices.

Clockwise from top left: Newly planted green roof at the Jones Ferry River Access Center, Holyoke; rain garden/bioretention area, Northampton Senior Center; porous paved parking lot, grass pavers, and rain garden at New England Environmental Inc. in Amherst; and porous asphalt parking lot at Columbia Greenway Rail Trail in Westfield. Northampton photo courtesy of Doug McDonald; NEE, Inc. photo courtesy of Kuhn Riddle Architects; and Westfield photo courtesy of Joseph Giffune.

A. THE NEED FOR A REGIONAL GREEN INFRASTRUCTURE PLAN

While there have been vast improvements in water quality since passage of the federal Clean Water Act 40 years ago, there are many Pioneer Valley streams, rivers, and lakes that do not meet fishable, swimmable standards.[1] The major culprit is stormwater flow from upland areas, including combined sewer overflows during major storm events.

The proposed *Massachusetts Year 2012 Integrated List of Waters,* identifies 76 waters in the Pioneer Valley deemed to be "impaired" for a variety of pollutants, including phosphorus, total suspended solids, and pathogens. According to MassDEP, the more urbanized section of the Connecticut River in Massachusetts, to which all rivers and streams are tributary, is impaired for Escherichia coli bacteria (E-coli) and total suspended solids (solid materials, including organic and inorganic, that are suspended in the water).[2] The Chicopee River and reaches within the Westfield River basin have similar impairments in their most urbanized stretches, and throughout the region many lakes and ponds are choked by plants due to excessive nutrients delivered by stormwater flow.

Stormwater from the Pioneer Valley also contributes to the estimated three million pounds of nitrogen flowing into the Connecticut River to Long Island Sound annually.[3] While moderate amounts of nitrogen support the growth of aquatic plants, these excessive discharges of nitrogen to Long Island Sound fuel algae blooms which when they die off and decay deplete water of oxygen. Low levels of oxygen result in a condition known as hypoxia, which makes it difficult for many fish species to survive.

Waters connect one community to the next at several scales. At the largest scale, the entire region is connected by the Connecticut River, but there are many smaller scale connections based on the myriad streams and other waters of the region. Problems thus require both local and regional action. Furthermore, there could be important cost savings as communities go developing policies, incentives, financing mechanisms, educational materials, and other resources, that can be shared with one another.

---

1 Point sources of pollution, specifically pipes delivering flow to surface waters where the first target under the Clean Water Act. These were somewhat easy targets for water pollution regulators. Non point sources, which refers to stormwater, however, have not been as easy to control because they are so diffuse and so numerous.

2 "Massachusetts Year 2012 Integrated List of Waters: Proposed Listing of the Condition of Massachusetts' Waters Pursuant to Sections 305(b), 314 and 303(d) of the Clean Water Act," Executive Office of Energy and Environmental Affairs

3 "An Evaluation of Potential Nitrogen Load Reductions to Long Island Sound from the Connecticut River Basin," Barry M. Evans, March 18, 2008. (Other nonpoint sources of nitrogen include agriculture, which delivers an estimated 3.8 million pounds annually, and point sources include municipal waste water treatment plants, which deliver an estimated 10 million pounds of nitrogen annually.)

Figure 1.3 A First for Western Massachusetts: Green Complete Street in Pittsfield

"Complete Streets" focuses on creating a street layout that is safe for all modes of transportation, including pedestrians and cyclists. In its work to improve the street experience in its downtown, the City of Pittsfield devised a street layout that combines complete street with green infrastructure stormwater management objectives. The result is safer and greener streets and neighborhoods with a pedestrian network of sidewalks that is complemented by stormwater management features. The images below show how the project transformed a section of North Street/Route 8.

A view on North Street in Pittsfield before the City undertook the street improvement project. Here, stormwater is conveyed along street curbs to nearby catch basins (and then piped to the nearest waterway).

The same view on North Street showing how the new bioretention planters that receive stormwater from the street support an improved experience for pedestrians.

Photos courtesy of Vanasse Hangen Brustlin, Inc.

B. METHOD

In developing the material of this plan, the Pioneer Valley Planning Commission worked with the guidance of the Western Massachusetts Green Infrastructure Advisory Committee composed of municipal and state officials, and professional design consultants. Committee members include: Kate Brown, Thomas Hamel, Joe Kietner, and Tom Shea from the City of Chicopee; Jeff Burkott and Matthew Sokop from the City of Holyoke; Douglas McDonald from the City of Northampton; Dan Murphy from the Town of South Hadley; Josh Schimmel from the Springfield Water and Sewer Commission; Kevin Chaffee from the City of Springfield; Casey Berube from the City of Westfield; Daryl Amaral, Meryl Mandell, and Timothy Meyer from MassDOT; Kurt Boisjolie from MassDEP; Richard Klein from Berkshire Design Group, Inc.; Todd Brown from Tighe & Bond; and Andrew Fisk from the Connecticut River Watershed Council.

Committee members helped define content and provided comment on draft material. They also identified personal concerns and practical barriers in moving forward with green infrastructure, but also pointed to initial strategies that are working, defined strategies for the longer term, and identified strategies for implementation in the coming year.

Because the region's communities are just beginning to explore green infrastructure strategies, this plan often uses examples from other places in the country that are further along and draws on related informational resources and studies. Early phone conversations with officials in Philadelphia and New York City to understand how related plans came together in those municipalities helped to make clear that the nature of this regional plan would be broader in scope. For example, while there are locations identified for potential location of green infrastructure facilities in this plan, these locations were offered by municipalities rather than selected through any specific ranking process. At the same time, it was clear the plan had to start in a place appropriate to where we stand in the region, addressing first steps and the questions that come with beginnings.

II. REGULATORY DRIVERS FOR GREEN INFRASTRUCTURE

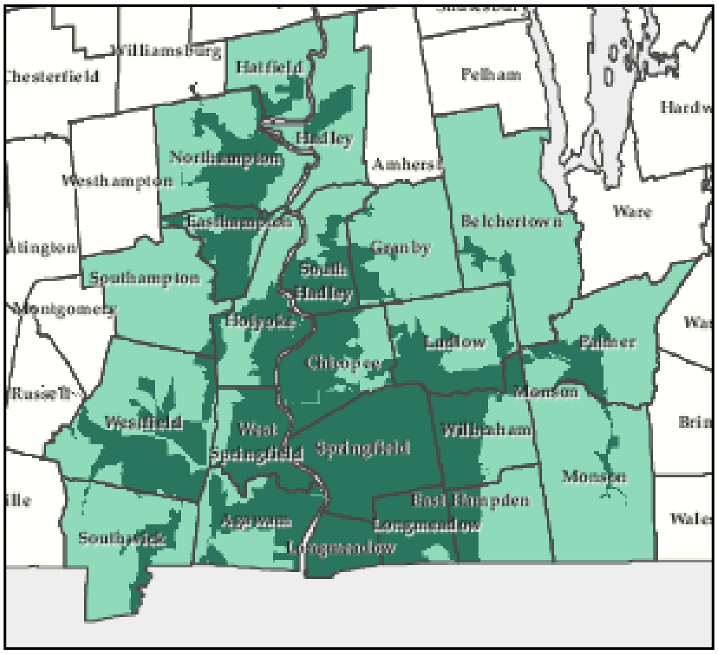
There are two major regulatory drivers under the Clean Water Act that require improved control of stormwater pollution, including overflows from combined sewer systems. The experience of communities in the nation that have already adopted green infrastructure strategies demonstrate its effectiveness in meeting these regulations.

A. MUNICIPAL SEPARATE STORM SEWER SYSTEM (MS4) PERMIT

Twenty-two Hampden and Hampshire county communities with "urbanized areas" are regulated by the U.S. Environmental Protection Agency (EPA) to control the amount of stormwater discharges from the Municipal Separate Storm Sewer System (MS4) to rivers, streams, lakes, ponds, and wetlands (referred to as "Waters of the United States").[4] (See map in figure 1.4.) Under the program's first permit issued to the region's communities in 2003, municipalities were required to meet six measures involving: public education and outreach, public involvement and participation, illicit discharge detection and elimination, construction site stormwater runoff control, pollution prevention, and good housekeeping in municipal operations.

4 Note that under the forthcoming stormwater permit, Amherst will be added to the list of regulated communities in the region, bringing the number to 23. This was announced by EPA at their December 6, 2012 conference called "Growing your Green Infrastructure Program," at University of Massachusetts, Amherst.

Figure 1.4 Municipalities Regulated for Stormwater Discharges



Dark green shows the 22 communities in the region that are in part or wholly regulated under the current EPA stormwater permit. The Town of Amherst will be added for the forthcoming permit.

Source: http://www.epa.gov/region1/npdes/stormwater/ma.html

A forthcoming new permit, expected to be issued by EPA in 2014, will expand stormwater management requirements. The first draft of this permit indicates that municipalities will need to meet several requirements associated with green infrastructure, including:

- Completing an inventory and ranking of MS4-owned property and infrastructure that may be retrofitted with practices designed to reduce the frequency, volume, and peak intensity of stormwater discharges
- Examining existing municipal policies for their ability to support green infrastructure options in new development and redevelopment
- Ensuring that stormwater discharges either reduce pollutant loading or do not cause or contribute to an exceedance of applicable water quality standards for receiving waters

Implementation of green infrastructure provides an important way to meet these requirements.

B. ADMINISTRATIVE ORDERS AND LONG TERM CONTROL PLANS FOR COMBINED SEWERS

Combined sewer systems carry flow from both sanitary sewage and stormwater to wastewater plants for treatment. During large storms, rainfall can overwhelm the capacity of wastewater treatment facilities so that untreated flow goes directly into nearby surface waters. In the late 1990s, EPA issued Administrative Orders under the Clean Water Act to

Agawam, Chicopee, Holyoke, Ludlow, Palmer, South Hadley, Springfield, and West Springfield, setting timelines and goals for abating combined sewer overflows (CSOs).

A total of 99 of the 163 CSO outfalls in the Pioneer Valley region have been eliminated to date, but the three largest communities (Chicopee, Holyoke, and Springfield) still face more than $446 million in costs to eliminate or abate flows coming from 64 remaining CSO outfalls. Each of these communities is working with EPA to finalize Long Term Control Plans that evaluate costs and alternatives and describe a phased implementation schedule for CSO work.

III. BENEFITS OF GREEN INFRASTRUCTURE

Stormwater management through green infrastructure facilities is an approach that thoughtfully combined with gray infrastructure, promises important benefits that extend far beyond improved water quality to include important secondary environmental, social, and economic benefits. These secondary benefits, key attractions of green infrastructure, have been articulated by New York City which estimates that:

> …for every fully vegetated acre of green infrastructure, there will be total annual benefits of $8,522 in reduced energy demand, $166 in reduced CO_2 emissions, $1,044 in improved air quality, and $4,725 in increased property value.[5]

For the Pioneer Valley, these benefits include: reducing costs for combined sewer separation; reducing runoff of polluted urban stormwater; increasing recharge to groundwater sources; mitigating flooding; enabling smarter, more visible investments; creating green jobs; and reducing energy costs. Described below, these benefits in particular seemed to resonate with participants in a February 13, 2012 Green Infrastructure Workshop for Municipal Officials (second workshop in a series) sponsored by PVPC and the Connecticut River Stormwater Committee at Holyoke Community College.

A. REDUCES THE COST OF SEWER SEPARATION PROJECTS

Several older municipalities across the country with combined sewer systems are turning to green infrastructure strategies to help cut the costs of sewer separation projects. Traditional sewer separation projects require the construction of separate systems of underground pipes, one for stormwater and another for sanitary waste, and including tanks and other underground storage facilities.

With green infrastructure, stormwater can be intercepted at the surface so that the scale of gray infrastructure facilities required can be reduced and the costs of treating combined

5 "The Value of Green Infrastructure for Urban Climate Change Adaptation," The Center for Clean Air Policy, February 2011, p. iv.

sewage volumes can be avoided. Municipalities in the vanguard of a green infrastructure approach include Portland, Oregon, and more recently Philadelphia, and New York City.

- New York City aims to manage runoff from 10 percent of the impervious surfaces in combined sewer watersheds through green infrastructure strategies over the next 20 years. Modeling done by the City shows that the green strategy will reduce CSO volumes from approximately 30 to 17.9 billion gallons a year at a cost of approximately $1.5 billion in public funds compared to what would be $3.9 billion for grey investments in the 20 year period, a savings of $2.4 billion.[6]
- In Philadelphia, new stormwater standards require new development and redevelopment that disturbs more than 15,000 square feet of earth to manage the first inch of stormwater runoff generated by the site.[7] The City estimates that these standards have reduced combined sewer inputs by a quarter billion gallons, saving the City $170 million. [8]
- Portland, Oregon, significantly reduced inflow to its combined system with green streets facilities retaining and infiltrating 8 billion gallons annually or 40 percent of the City's runoff. In one area where the City implemented a program called "Tabor to the River," such green infrastructure improvements helped to avoid $86 million in sewer separation costs.[9]

Given the track record of these and several other municipalities, EPA is now formally allowing communities to take a more integrated planning approach in meeting the various Clean Water Act permit and enforcement requirements for sanitary sewer, combined sewer, stormwater, and wastewater treatment plants. June 2012 guidance issued by EPA acknowledges the important integrating role that green infrastructure can play. The intent is

---

6 "NYC Green Infrastructure Plan: A Sustainable Strategy for Clean Waterways," Executive Summary, p. 9. Available at: http://www.nyc.gov/html/dep/pdf/green_infrastructure/NYCGreenInfrastructurePlan_ExecutiveSummary.pdf

7 Philadelphia Water Department website: http://www.phillywatersheds.org/whats_in_it_for_you/businesses/developers-guide-stormwater-management

8 EPA's document entitled, Green Infrastructure Case Studies from August of 2010, notes: "These savings are derived from the fact that one square mile of impervious cover has been redeveloped under Philadelphia's updated stormwater regulations, and the cost of storing that same volume of stormwater in a CSO tank or tunnel comes to $170 million in capital, not including operations and maintenance costs. After two years of effectively enforced stormwater regulations, the City now estimates that two square miles are using green infrastructure, saving about $340 million in capital." See: www.epa.gov/owow/NPS/lid/gi_case_studies_2010.pdf, p. 9.

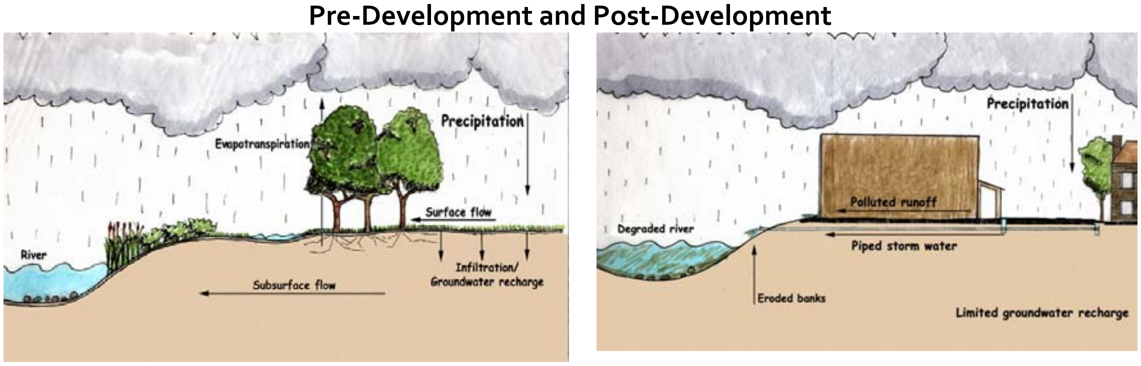
9 October 4, 2012, correspondence with Linc Mann, Public Information Officer for City of Portland Environmental Services.

to ensure that attention and financial resources are focused on addressing the most serious water quality and system issues first.[10]

B. REDUCES RUNOFF OF POLLUTED STORMWATER AND RECHARGES GROUNDWATER

Numerous studies show a direct correlation between the amount of impervious area—surfaces such as roofs, driveways, roads, and parking lots—and the quality of water in rivers, streams, and lakes receiving discharges from these areas. Stream health begins to decrease when a watershed's impervious surface exceeds 10 percent with severe impacts occurring when impervious cover in a watershed exceeds 25 percent. These hard surfaces prevent rainfall from soaking into soils and recharging groundwater. Instead, rainfall moves at higher velocities and collects in larger volumes, gathering pollutants along its way. During summer months stormwater flows are also heated by these surfaces. Delivered to nearby rivers and streams, this runoff can significantly degrade both physical and biological qualities.[11] (See Figure 1.5 below.)

Figure 1.5 How Water Moves:
Pre-Development and Post-Development



In natural systems, rainfall can be intercepted by trees for evaporation, or reach the ground where, soils permitting, most of it soaks in to recharge groundwater.

In developed areas, rainfall travels over paved surfaces, picking up many pollutants. Most rainfall is collected and conveyed by pipe (or runs directly over pavement) to surface waters.

By capturing rainfall close to where it falls, green infrastructure strategies reduce the impact of these impervious surfaces, providing volume control and preventing the transport of urban runoff to rivers and streams. Instead, rainfall has a short journey to facilities that can help

---

10 "Integrated Municipal Stormwater and Wastewater Planning Approach Framework" describes overarching principles and essential elements of an integrated plan, as well as considerations for implementation. See: http://www.epa.gov/npdes/pubs/integrated_planning_framework.pdf

11 The Center for Watershed Protection's impervious cover model, developed in 1994 and affirmed by many studies since, provides a framework for understanding that the more impervious surface in a watershed, the greater the impacts are to stream quality. See Chapter 3 on mapping under Impervious Cover for a more detailed discussion.

filter, absorb, or break down pollutants, either through proprietary devices or simply through microbial action in soils and plant roots. At the same time, the infiltration of stormwater into soils helps to recharge groundwater resources that are important in some communities for drinking water supply and are also essential to maintaining base flows for aquatic life in rivers and streams during the drier summer months. Urban trees already provide comparable services. In Boston, a study performed by the Urban Forest Coalition found that the existing tree cover reduces stormwater runoff by 314 million gallons per year, helping the city avoid capital costs of more than $142 million.[12]

C. MITIGATES FLOODING

The greater the impervious cover with urbanization, the greater the likelihood of flooding. One study, cited in a report by the American Society of Landscape Architects estimates that "...a flood event occurring once in 100 years in a watershed in the Maryland suburbs of Washington, D.C. could occur as frequently as once every five years in the same watershed if impervious area increased to 25 percent. Similarly, a total impervious cover of 65 percent in the same watershed could make this flood event occur every year."[13]

As a system of facilities deployed across the urban environment, green infrastructure facilities are intended to replicate the natural hydrology of the landscape, either intercepting rainfall for evapotranspiration, slowing and retaining it over a longer period of time, collecting it for reuse, or infiltrating it into the ground. In this way, green infrastructure prevents rainfall from most storm events from moving in large quantities to downstream locations where the influx of such volumes from a large urbanized area can be damaging.

Before and after images of a green alley project in Chicago. The alley at top shows pooling of water after a storm. Following the use of porous pavers that allow rainfall to filter into the soil, there is no pooling of water.

Source: The Chicago Green Alley Handbook

While the storm depth of major flood events typically exceeds the design threshold of green infrastructure facilities, there is increasing evidence that these facilities can provide important

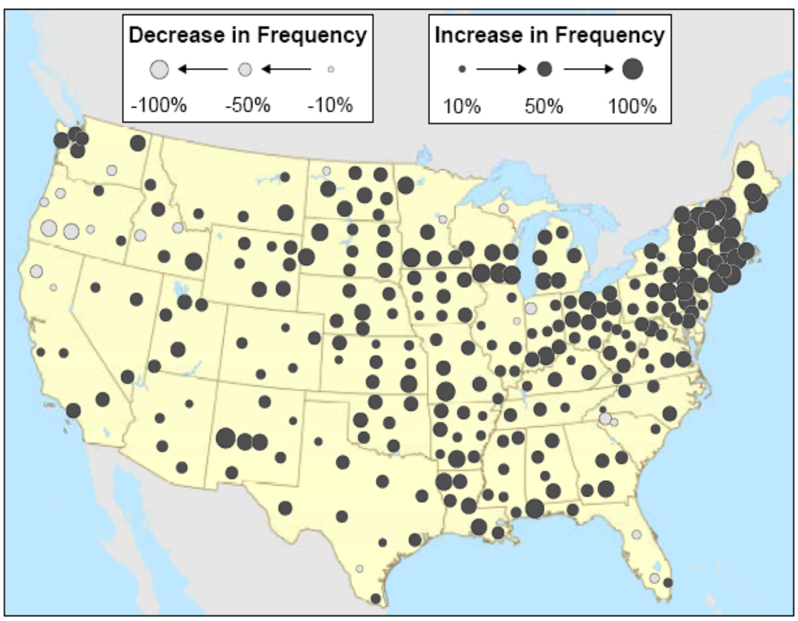
12 "Seeing the forest for the trees: Urban greenery can bring better health, more attractive neighborhoods, and even safer streets," Lord, C., Commonwealth, Summer 2008.

benefits even with larger storms. In a 2010 study, EPA reports that communities hard hit by major floods in 1998 and again in 2004 because traditional systems could not provide adequate flood protection, turned to green infrastructure approaches to provide additional flood protection during peak events. The study continues,

> Larger and older communities, including Chicago and Philadelphia, assume cost savings associated with green infrastructure for flood control and prevention. Chicago's Green Alley Program was started in large part as a response to homeowner complaints about flooding in alleys and adjacent basements.[14]

Mitigating flood events becomes urgently important in the face of the larger more frequent storm events. When compared to the rest of the nation, Massachusetts and other New England states are seeing the greatest change in frequency of these extreme events. A study examining global warming and extreme precipitation found that New England has experienced the greatest change, with intense rainstorms and snowstorms now happening 85 percent more often than in 1948. (See figure 1.6 below.) This study also found that the biggest rainstorms and snowstorms are getting bigger. Extreme downpours are more frequent *and* more intense.[15]

Figure 1.6: Extreme Downpours Have Become More Frequent Across Much of the U.S.



Source: Environment America Research & Policy Center, 2012

13 R.D. Klein, (1979), "Urbanization and Stream Quality Impairment," Water Resources Bulletin, 15(4): p.953. As cited in "Banking on Green: A Look at How Green Infrastructure Can Save Municipalities Money and Provide Economic Benefits Community-wide," a joint report by American Society of Landscape Architects, et al., April 2012, p. 21.
14 Green Infrastructure Case Studies, p. 12.
15 When it Rains, It Pours: Global Warming and the Increase in Extreme Participation from 1948 to 2011, Environment America Research & Policy Center, Summer 2012, p. 2.

D. ENABLES SMARTER, MORE VISIBLE INVESTMENTS

Through a green infrastructure approach municipalities can pursue construction projects that realize multiple benefits. Such a project might involve an enhanced streetscape that not only improves the roadway, but provides for stormwater infiltration, reduces sewer overflows, adds areas for walking and bikeways, and enhances aesthetic appeal. For such projects, interagency cooperation across a municipality is essential. Working together, departments can identify how and where stormwater investments can combine to best effect with investments in such projects as streets and sidewalks, sanitary sewers, and parks.

One public official from the Pioneer Valley region observed an added benefit: Because so much gray infrastructure work is underground, it is essentially invisible to the public and to ratepayers. Green infrastructure, in contrast, is above ground and highly visible, providing a much more apparent outcome for public investments.

Green infrastructure strategies can also be very cost effective in street reconstruction projects. Examples from both Chicago and Seattle are telling:

Chicago's experience with its Green Alleys programs has shown that investing in permeable pavements, downspout disconnection, rain barrels, and tree planting are estimated to be 3 to 6 times more effective in managing stormwater per $1,000 invested than conventional methods. The cost estimates vary depending on the type of technology deployed.[16]

Seattle Public Utility Natural Drainage Project in the Piper's Creek watershed showing a bioretention area.
Source: NOAA Northwest Fisheries Science Center

The Natural Drainage Projects in Seattle, Washington, replaced portions of aging public streets, incorporating drainage features to reduce the quantity and improve the quality of stormwater runoff while maintaining or improving amenities for both vehicles and pedestrians. Data from Seattle Public Utilities indicate that the designs incorporating green infrastructure cost $217,253 less than a conventional street in overall construction costs and yield a cost savings equivalent to $329 per square foot.[17]

16 Banking on Green, p. 13.

E. REDUCES ENERGY COSTS

Certain types of green infrastructure practices, such as green roofs and green walls, are integrated into the construction of a building and can increase building energy efficiency. Because the vegetation on green roofs in particular lowers absorption of solar radiation and thermal conductance, these roofs can substantially reduce annual energy consumption for interior heating and cooling. Data collected from the green roof on Chicago's City Hall indicates that reduced energy use produces annual savings of approximately $5,500 in heating and cooling expenses, an energy savings of $0.18 per square foot.[18] The green roof on FedEx's Main Sorting Facility at Chicago's O'Hare Airport provides a dramatic example. Covering nearly 175,000 square feet, the roof captures close to two million gallons of stormwater annually, and is projected to save the company an estimated $35,000 in energy costs per year. [19]

Street trees, when properly placed, can also reduce energy costs by shading buildings, providing evaporative cooling, and blocking winter winds. Street trees and trees planted along building exteriors can lower surface and air temperatures through shading and evapotranspiration, the return of moisture to the air by plants through transpiration. Shaded surfaces can be 20 to 40°F cooler than non-shaded surfaces, thus reducing electricity demand for cooling in summer. Street and landscaping trees also reduce wind speeds, slowing heat loss in winter.[20] The use of natural vegetation and limited paving in a Davis, California, development reduced the energy bills of the constructed homes by 33 to 50 percent when compared to the surrounding neighborhoods.[21]

Water harvesting and reuse, which involves the use of rain barrels and cisterns, can reduce energy use by saving on the need for highly treated drinking water for irrigation and other non potable uses such as toilet flushing.[22]

---

17 Changing Cost Perceptions: An Analysis of Conservation Development, Conservation Research Institute, 2005. Available online at <http://www.chicagowilderness.org/sustainable/conservationdesign/cost_analysis/Cost_Analysis_Exec_Summary.pdf>. as cited in "Banking on Green," p. 13.
18 "Green Infrastructure Case Studies," page 39.
19 "Banking on Green," p. 17.
20 Ibid, p. 16 and p. 19.
21 "Economics of LID, " Ed MacMullan, EcoNorthwest, Eugene, OR, 2007
22 "Banking on Green," p 20.

F. CREATES GREEN JOBS

Public investment in water infrastructure as a share of the economy is estimated to have fallen by over one-third since peak levels of investment in 1975. Yet investments in infrastructure are one of the most efficient methods of job creation.[23] Infrastructure investments create over 16 percent more jobs dollar-for-dollar than payroll tax holidays, nearly 40 percent more jobs than across-the-board tax cuts, and over five times as many jobs as temporary business tax cuts.

As estimated by the U.S. Environmental Protection Agency, over $188 billion in investment is needed to manage stormwater and preserve water quality across the country. Such an investment would generate nearly $266 billion in economic activity and create close to 1.9 million jobs in the United States. Approximately 45,000 to 54,000 of these new jobs would be created in Massachusetts.[24]

In addition to the raw job creation benefits of green infrastructure investment, there is the added benefit that these occupations do not require high levels of formal education (they typically require a high school degree plus some post-secondary education or training). This provides an opportunity to counteract income inequality by opening up new job opportunities with family-supporting wages for middle-skilled workers.[25]

---

23 "Water Works: Rebuilding Infrastructure, Creating Jobs, Greening the Environment," a report by Green for All. Emily Gordon, Jeremy Hays, Ethan Pollack, Daniel Sanchez, and Jason Walsh. 2011, p.2. Available at: www.pacinst.org

24 Ibid

25 Ibid

CHAPTER 2: INVENTORY & ASSESSMENT

I. GREEN INFRASTRUCTURE AND EXISTING INFRASTRUCTURES

Implementation of green infrastructure stormwater management practices can occur most effectively in terms of existing systems of infrastructure where stormwater must be better managed. These are chiefly:

- existing infrastructure for roadways, which typically account for 50 to 75 percent of impervious cover;
- combined sewer systems, which annually produce more than 700 million gallons of untreated overflow into the Connecticut River; and
- existing stormwater management infrastructure, which given current practices typically delivers storm runoff with associated pollutants to nearby surface waters.

Current and projected investments in the region for these existing infrastructures tally in the hundreds of millions of dollars. These investments are essential to regulatory compliance, as well as to fixing serious deficiencies within these systems. This state of affairs makes integration of green infrastructure a key consideration for upcoming projects. Green infrastructure can reduce the environmental impacts of these existing systems, but also provide important cost savings in many cases.

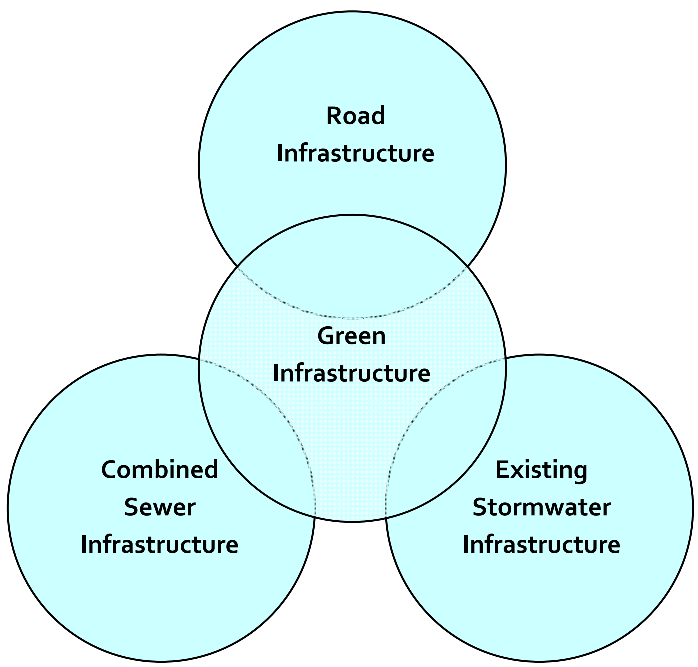


Figure 2.1: Green infrastructure can be integrated into most existing infrastructure projects that involve improved stormwater management.

This chapter focuses on these major existing infrastructures—stormwater, combined sewers, and roads— so as to understand the potential to integrate green infrastructure stormwater management strategies. The narrative here describes:

- Projected needs, costs, and funding for existing infrastructure
- Existing regulations, policies, and plans
- Current decision making about infrastructure

A. DATA SOURCES

Surveys of municipal officials, one-on-one interviews, and existing reports and plans provide the backbone for this inventory and assessment section. In particular, PVPC prepared two written surveys, one for stormwater management officials in the region's 22 regulated communities and the other for combined sewer managers in Chicopee, Holyoke, and Springfield. The surveys included questions about projected costs, decision making processes, and plans and tools currently in use. This chapter also draws on information from several roundtable discussions with municipal officials during a February 2012 event.

II. PROJECTED NEEDS, COSTS, AND FUNDING FOR EXISTING INFRASTRUCTURE

At roundtable discussions with Pioneer Valley municipal officials, needs and costs came up as a commonly cited "driver" for green infrastructure. Several officials indicated they were aware of the potential for green infrastructure to help offset the costs of traditional "gray" infrastructure projects. One municipal official noted that better asset management through projects that serve multiple purposes is an important incentive because with such limited resources, it is important to get the "best bang for the buck."

This section describes the magnitude of needs and costs within existing infrastructure throughout the region as a foundation for understanding the potential role of green infrastructure in mitigating project costs, but also meeting regulatory requirements (described in the next section of this chapter). Funding for existing infrastructure described in this section could in many cases be redirected from covering the costs of building traditional "gray" stormwater facilities to building green infrastructure stormwater management facilities.

A. STORMWATER NEEDS AND COSTS

Few Pioneer Valley municipalities in the region have methodically projected and quantified the likely long-term costs for maintenance of existing stormwater infrastructure, expansion of stormwater services, and compliance with the forthcoming National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer Systems (MS4) stormwater management permit.

In cases where a community has made future stormwater infrastructure and regulatory compliance cost projections, the picture is somewhat daunting.

- The City of Chicopee, for example, has estimated that over the next 50 years all stormwater pipes not replaced by the sewer separation projects should be replaced. This would entail replacement of 150 miles of storm drain pipe. In 2012 dollars, pipe replacement and associated road work cost is estimated at $1 million dollars per mile or an additional $150 million.
- The City of Northampton recently completed a study that indicates that an additional $402,695 to $466,834 will be required annually through 2016 for compliance with the new MS4 Permit; $258,000 to $452,000 will be required annually for additional "green design and construction" to meet NPDES best management practices requirements; $500,000 per year will be needed for drainage infrastructure maintenance, repair, and upgrades; and large capital projects will require nearly $4 million per year on average in debt service.[1]

Every community faces different challenges. Some communities have combined sewer infrastructure, some have older stormwater system infrastructure than others, and population size and density varies. These variables aside, existing budgeting efforts provide some indication of what the increased costs may be for compliance with the forthcoming NPDES MS4 permit. It is estimated by Northampton's study that if EPA issues the permit next year, the City will spend $427,219 *in addition to* the existing annual budget of $226,174 to operate the stormwater system and comply with the new permit. This is an increase of almost three times the existing costs.[2] The few other communities that are budgeting for the forthcoming

---

[1] The methodology from this study may be of interest to other municipalities in gauging future costs. Look for: "Stormwater and Flood Control System Assessment and Utility Plan," by CDM, May 2012.

[2] This estimate accounts for increased costs of collecting and mapping a large quantity of data; sampling 25 percent of Northampton's 287 drainage outfalls each year during both dry and wet weather; detecting and eliminating illicit discharges; implementing BMPs to achieve a 10 percent reduction in nitrogen to meet water quality standards; completing an inventory and priority ranking of City-owned property and infrastructure that may have the potential to be retrofitted with green infrastructure BMPs; pursuing BMP retrofit projects; meeting outreach and education requirements; inspecting and cleaning every catch basin such that no sump is more than 50 percent full (this may require cleaning catch basins more frequently than the current maintenance schedule of once per year); and finally, determining the outlet of every floor drain in municipal buildings within one year of the effective date of the permit.

permit anticipate between a two and four-fold increase in compliance costs. The Town of Granby's current permit costs, for example, are $5,000, and the town has budgeted $20,000 for Fiscal Year 2013. Similarly, the Town of Hadley has increased its anticipated compliance budget from $4,000 to $20,000, and Palmer is increasing its budget from $45,000 to $100,000.

B. STORMWATER FUNDING

Currently, most Pioneer Valley municipalities do not charge directly for public stormwater services, but instead use general municipal funds to pay for maintenance of the stormwater system. Several communities in the region assess stormwater permit fees to review and permit new development projects (Agawam, Northampton, and Wilbraham). While there is no direct connection between these permit fees and funds to maintain the stormwater system, stormwater permit fees are paid into general funds, and most communities pay for stormwater system maintenance from the general funds. In a sense, then, some part of these permit fees may help to cover some stormwater system maintenance costs. In addition, at least one community charges a fee for a property's initial connection to the stormwater system (Northampton), and some communities use sewer fees to pay for stormwater system maintenance. In at least one community (Wilbraham), the municipality directly charges property owners for repairs to the stormwater system when it can identify property owners who are responsible for nearby stormwater system impairments. (See Table 2.1 below.)

Table 2.1: Local Funding for Stormwater Infrastructure

Community	Sources for Stormwater Infrastructure Funding
Agawam	General Funds
Belchertown	General Funds
Chicopee	Stormwater Fee
East Longmeadow	General Funds
Easthampton	Sewer Enterprise Fund
Granby	General Funds
Hadley	General Funds
Hampden	General Funds
Hatfield	General Funds
Holyoke	State Funds (TIP), Grants, Sewer Enterprise Fund
Longmeadow	General Funds

Community	Sources for Stormwater Infrastructure Funding
Ludlow	General Funds
Monson	General Funds
Northampton	General Funds
Palmer	General Funds
South Hadley	General Funds
Southampton	General Funds
Southwick	Federal S319 Grants, Ch. 90 Funds, General Funds
Springfield	General Funds
West Springfield	General Funds
Westfield	Stormwater Fee
Wilbraham	General Funds and in one instance, a direct charge to a property owner responsible for a system impairment

Source: Survey of local municipal officials

In the Pioneer Valley, the cities of Chicopee and Westfield are currently the only municipalities with programs that collect fees explicitly for maintenance and upgrade of stormwater infrastructure. (See Table 2.2 below.) Chicopee instituted a stormwater fee in 1998, one of the first to do so in the state. The fee was established for the purpose of managing stormwater and assisting with combined sewer separation projects. Westfield instituted a stormwater utility in 2010 for the purpose of financing a stormwater management division, responsible for meeting federal requirements for stormwater monitoring and maintaining the City collection system. Agawam, Northampton, and Southwick are considering the possibility of establishing a stormwater fee.

To encourage ratepayers to reduce stormwater runoff from their properties, the City of Chicopee has just begun implementing a "Rain Smart Rewards" program. The program offers a stormwater fee reduction of up to 50 percent in exchange for implementation of improved stormwater management practices—such as drywells, cisterns, and rain gardens—that reduce storm flow to the City's infrastructure and local streams and rivers. The stormwater utility ordinance in Westfield establishes a credit program that allows stormwater fee reductions of up to 30 percent, but the program is not currently in effect.

Table 2.2: Stormwater Utilities in the Pioneer Valley

Community	Date Created	Equivalent Residential Unit (ERU)*	Fee	Annual Revenue
Chicopee	1998	2,000	Single family residential at $100 per year Multi family, industrial, commercial at $1.80 per 1,000 square feet, with a minimum charge of $100 per year and a maximum charge of $640 per year	$1,500,000
Westfield	2010	NA**	Residential at $20 per year Commercial properties at $.045 per 1,000 square feet up to a maximum of $600 per year	$560,000

*Residential customers are typically billed for stormwater runoff based on the Equivalent Residential Unit (ERU). An ERU is based on the amount of impervious surface area or percent impervious area found at the average single-family home within the municipality.
**Information not available

C. COMBINED SEWER NEEDS AND COSTS

Under Administrative Orders from the U.S. Environmental Protection Agency (EPA) to abate combined sewer overflows (CSOs) to the Connecticut River, communities in Western Massachusetts have been working for more than 15 years, eliminating 99 of the 163 CSO outfalls in the region.[3] Agawam, Ludlow, Palmer, South Hadley, and West Springfield no longer have any combined sewer outfalls, but Chicopee, Holyoke, and Springfield continue work to eliminate or abate overflows from remaining combined systems within their jurisdictions.[4] In April 2009, Chicopee completed a Final Long Term CSO Control Plan that has since been approved by EPA. The Springfield Water and Sewer Commission submitted their final plan to EPA for approval in May 2012. Both of these documents outline the plan of work to be pursued for CSO elimination and abatement over the next decades. Holyoke completed a draft long term control plan in 2000, and must submit a final long term control plan for approval by June 2014.

Chicopee's CSO work plan entails a strategic approach whereby drainage areas with no overflows remain combined and areas with overflows are separated or abated to overflow no more than 4 times per year. Chicopee currently has a 20-year plan, but would like to extend the time frame to 30 years. In Springfield's work plan, each CSO has a specific strategy developed to address overflows within a specific tributary area. The estimated costs of abating overflows at the remaining CSOs in the region are shown in Table 2.3.

Table 2.3: Estimated Costs for Abating Overflows at Remaining CSOs in the Pioneer Valley

	# of CSOs	Estimated cost to eliminate/abate[5]
Chicopee	28	$200 million
Holyoke	12	$110 million
Springfield	24	$136 million
TOTALS	64	$446 million

The City of Chicopee has learned that the actual cost of work is proving far greater than the estimates used for planning in the Long Term Control Plan. Unanticipated conditions in the field, such as replacement of failing drainage structures and road restoration, are translating into far higher costs. The estimated cost of Chicopee's approved work plan was $153 million

[3] This total includes 29 CSOs eliminated in Palmer, but it does not include the existing three outfalls in Montague just north of the region.
[4] Note that Springfield's wastewater treatment system is owned and managed by the Springfield Water and Sewer Commission, which is overseen by three city-appointed commissioners.
[5] Note that these costs tend to rise as projects move forward and field work reveals unanticipated complications associated with actual conditions.

and projected costs are now $200 million. The DPW Superintendent has said that it is not realistic for Chicopee to meet what is described in the Long Term Control Plan. City officials are conferring with EPA to determine how the plan might be revised so that there is a more integrated approach with stormwater and combined sewer work.

In working to eliminate or abate combined sewer overflows, wastewater managers have a tough balancing act. On the one hand managers face the regulatory demand to eliminate overflows, but on the other hand they struggle with the frequent crises that arise with an aged infrastructure. As one manager noted, the combined sewer work is important, but an infrastructure failure can have far greater environmental consequence than a combined sewer overflow. These failures also often have direct impacts on ratepayers.

In Springfield 20 percent of the CSO system is more than 100 years old. In Chicopee, officials note that age of pipe in their city is not necessarily an indicator of infrastructure condition. They have 100-year-old brick pipe that can look as good as new while 60-year-old unreinforced concrete pipe is crumbling. Chicopee officials note that when they lay new pipe for sanitary sewers in their CSO separation projects, they should also often be laying new pipe for stormwater conveyance. Due to financial constraints, however, they make use of the old CSO pipe, which can often be in poor condition.

Officials in all three CSO communities report that given the combination of limited resources and regulatory pressures, they need to find a sustainable balance between CSO and infrastructure improvements. Currently, they have only been able to attend to aged infrastructure in a very limited way by managing repairs and responding to crises. To avoid having infrastructure that is more than 100 years old would require systematic replacement of the oldest infrastructure at a rate of 1 percent per year. In Springfield this entails costs of $313 million in addition to the costs for CSO abatement work.

D. COMBINED SEWER FUNDING

SEWER RATES

Funding and financing CSO programs is a significant challenge for the region's CSO communities. While municipalities received approximately $20 million in federal monies over the past 15 years to help with CSO work, they have also relied heavily on existing revenues from rate payers, as well as on borrowing against future revenues. To date, communities have had to commit the following local dollars to cover CSO project costs: $88 million in Chicopee, $88 million in Springfield, and $23.5 million in Holyoke.[6] Chicopee has also committed indebtedness of $118.6 million to date for CSO treatment and separation.

With the disappearance of federal monies altogether, sewer rates are now essentially the only source of funding. The political reality of tough economic times makes it extremely difficult

[6] August 25, 2011 PVPC Media Release, "Clean-up of Connecticut River Hits Important Milestones."

to win public approval for raising rates to pay for combined sewer work. This is compounded by the problem of dealing with infrastructure needs that for the most part are buried below ground and as such not immediately visible to the public. Unless a sewer main collapses and a street must be closed to make the needed repairs or a resident is directly affected by a sewer back up, the troubles of an aging combined sewer system go largely unnoticed and unappreciated. In Holyoke, the City Council controls the sewer rates and rather than raise rates, they are exploring how they might pull resources from the general fund to help cover costs.

The major constraints on raising rates, however, are the very low per capita incomes and high poverty rates in CSO communities. Holyoke and Springfield's poverty rates, for example, are well above 20 percent, which is triple the rate for Massachusetts.[7] In developing Long Term Control Plans for CSO abatement, each community uses financial capability assessment guidelines established by EPA in 1997. These guidelines draw on information to help evaluate the burden on ratepayers/households through a residential indicator and on the CSO community/system as a whole through a series of six indicators, including current debt burden, ability to issue new debt, and property tax revenue collection rate. Comparison of these indicators is intended to provide a measure of how burdensome a CSO mitigation implementation schedule would be: low burden, medium burden, or high burden. The aim is to select an implementation plan that does not rely on wastewater rates that exceed 2 percent of median household income, which would result in a high burden in all CSO communities save for those that demonstrate strong financial capability in all other indicators.

Chicopee and Springfield's CSO control plans are based on a preferred alternative that is presumably within the affordability constraints of each municipality and on containing rates at or below the threshold of 2 percent of median household income. But as described above, the City of Chicopee has learned that as they move forward with projects, the costs are actually much higher than what was estimated in the approved EPA work plan. One CSO manager has noted, "The problem with CSOs is so much bigger than what a municipality our size can handle. The number of CSOs and the cost for abatement are out of proportion to the size of our population and household income is certainly not keeping keep pace with what the CSO work is costing." In Springfield the wastewater manager notes that the proposed plan not only pushes up against the 2 percent of median household income threshold, it also takes funding from all other infrastructure needs that in and of themselves are not affordable within a 20-year time frame.

[7] The Region's Comprehensive Economic Development Strategy (CEDS), 2011 Annual Report, Pioneer Valley Plan for Progress, page 22-23.

Sewer rates are based on the amount of water used as measured by meters. Chicopee has a two tiered wastewater rate and recently proposed raising the rate by 18 percent to help address mounting costs.[8] Businesses that have a high pollutant load of total suspended solids (TSS) and/or biochemical oxygen demand (BOD), of which there are currently five, must pay proportionally a higher rate based on a formula. The revenue stream helping to fund Chicopee's CSO work also includes the stormwater fee and this is factored into EPA's evaluation guidelines for the 2 percent of median household income threshold. With 30 percent of what the City is raising through the stormwater fee going toward loan payments on principal and interest, the DPW Superintendent notes, "If you translate that to a homeowner mortgage arrangement, that would not be considered sustainable."

Holyoke has one rate for both residential and commercial uses and Springfield has rates for multiple categories that are based on pollutant loading: residential and municipal; commercial and medical; industrial; and food service.

Raising rates to help cover CSO costs has many implications. In Chicopee, city officials note that two companies recently decided not to locate in Chicopee due to the rates they have for businesses with high pollutant loads. In Springfield, the CSO manager is concerned that rising rates may force critical commercial and industrial users to consider moving operations elsewhere to cities whose utilities are not financially burdened by CSOs. He notes that the commercial-industrial base are a significant source of revenue and any losses will impact operating costs and the overall rate structure.

The size of the problem with which CSO communities are grappling already appears to exceed the ability to cover costs through rates. Table 2.4 below shows projected increases in residential rates over a 25-year period.

[8] Chicopee's rate is meant to encourage water conservation. For the first 1,000 cubic feet of use, the rate is $4.45 per 100 cubic feet. Above, 1,000 cubic feet of use, the rate is $5.25 per 100 cubic feet.

Table 2.4: Projected Increases in Residential Sewer Rates over the Next 15 Years

	2010	2015	2020	2025	% change from 2010 to 2015
Chicopee	$4.00/100 cubic foot (cf) for the first 1,000 cf used; $4.25/100 cf thereafter	$5.40/100 cf for the first 1000 cf used then $6.20/100 cf thereafter	$6.60/100cf for the first 1000 cf used then $7.40/100 cf thereafter	$9.00/100 cf for the first 1000 cf used then $9.80/100 cf thereafter	125 % for the first 1000 cf used; and 130% for 100 cf thereafter
	Translates to annual fee of $722.00, which is 1.63 % of MHI	Translates to annual fee of $836.00, which is 1.9 % of MHI	Translates to annual fee of $980.00, which is 2.21 % of MHI	Translates to annual fee of $1,268.00, which is 2.86 % of MHI	
Holyoke	$5.40/1000 gallons	No projected increases have been calculated.			
	Translates to annual household bill of $485, which is 1.1 % of MHI				
Springfield*	$2.86/100 cf	$4.09/100 cf	$6.92/100 cf	$8.78/100 cf	43%
	Translates to annual household bill of $275, which is .78 % of MHI	Translates to est. annual household bill of $393, which is 1.01% of MHI	Translates to est. annual household bill of $664, which is 1.55% of MHI	Translates to est. annual household bill of $843, which is 1.78% of MHI	

**Source: CSO Managers in Chicopee, Holyoke, Springfield*

CLEAN WATER STATE REVOLVING FUND

The Clean Water State Revolving Fund (SRF), which provides low interest loans to a range of projects related to sanitary sewer and nonpoint source pollution abatement projects, has been the primary source of financial assistance for CSO communities, providing low interest loans for many of the region's projects. Within the SRF program, combined sewer work tends to score high in the evaluation process because such projects address both public health and environmental ranking criteria.[9] In addition, the SRF program has recently offered principal forgiveness for Environmental Justice (EJ) projects, those projects occurring in areas defined to be a neighborhood whose annual median household income is equal to or less than 65 percent of the statewide median or whose population is made up 25 percent Minority, Foreign Born, or Lacking English Language Proficiency. Nearly all CSO work in the region occurs in EJ areas.

The ranking process for SRF projects also includes criteria called "green projects," which based on a decision by the Patrick Administration targets energy efficiency and renewable energy. Currently green infrastructure for stormwater management is listed as a "qualifying green project," but it is only included in the application to help inform state officials in meeting the federal requirement that a percentage of grant amounts finance "qualifying green projects." In addition, while the SRF program is required to use a percentage of the grant amount to finance "qualifying green projects," the requirement does not apply to the recycled funds in the program as those were allotted to states prior to any green infrastructure requirements. As a result, the overall amount for green projects is a small percentage of monies.[10]

E. ROAD NEEDS AND COSTS

In considering roadway infrastructure needs and costs, it is important to understand that roads have different functional classifications that affect eligibility for federal funding. Functional classification is described as, "the process by which streets and highways are grouped into classes, or systems, according to the character of service they are intended to provide."[11] In Hampden and Hampshire counties, 26 percent or 1,128.2 miles of roadway are eligible for federal funding. These classifications include: Interstates, Urban Arterials, Rural Arterials, and Urban Collectors. (See Table 2.5 below.)

Note that some roads, Route 9 and portions of Route 20, are also part of the "National Highway System" and as such state projects for improvements to these roads can access additional funding through the Federal-Aid Highway Program.

For maintaining and upgrading the remaining 74 percent or 3,236.4 miles of roadway in the region, which fall under the functional classifications of Rural Collectors and Local Roads, municipalities must rely on more limited state and local sources of funding. (See narrative below under Road Funding.)

[9] 4/23/12 e-mail from Steve McCurdy, DEP Municipal Services Director
[10] 4/24/12 e-mail from Steve McCurdy, DEP Municipal Services Director
[11] FHWA Functional Classification Guidelines: Concepts, Criteria and Procedures. http://www.fhwa.dot.gov/planning/fcsec2_1.htm

Table 2.5: Miles of Roadway and Functional Classification in the Pioneer Valley

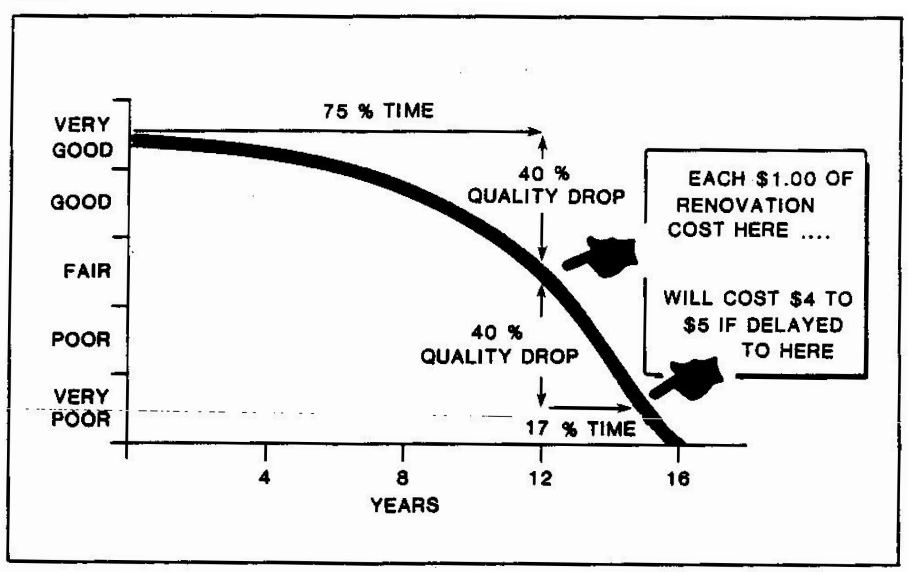
Functional Classification	Miles of Roadway	Eligible for Federal Funding?	Summary
Interstates (*e.g.*, I-90)	88.9	yes	1,128.2 miles or 26% of roads in region
Urban Arterials (*e.g.*, Route 9)	639.0	yes	
Rural Arterials (*e.g.*, Route 20)	133.9	yes	
Urban Collectors (*e.g.*, Route 66)	266.4	yes	
Rural Collectors	363.3	no	3,236.4 miles or 74% of roads in region
Local Roads	2,873.1	no	
Total Miles of Roads in Region	4,364.5		

Adapted from 2012 Regional Transportation Plan

Infrastructure needs and costs for each of these types of roads (federally eligible roads and non eligible roads) is different, but all face deteriorating conditions and an increasingly unsustainable future. PVPC's Principal Transportation Planner Gary Roux has noted, "Like other infrastructure, it is far less expensive to keep roads in good condition than to have them deteriorate. When you defer maintenance, projects involve far bigger fixes and as a result require far more money to cover costs."

The U.S. Department of Transportation illustrates this concept in an often used 1985 graphic showing the benefits of a systematic approach to maintenance. (See Figure 2.2.)

Figure 2.2 Pavement Deterioration / Rehabilitation Relationship



For federally eligible roads, the 2012 Regional Transportation Plan shows that no matter the degree to which monies are spent over the next couple of decades in three scenarios, there will be a significant decline in the overall condition based on the pavement index used by PVPC.[12] A fourth scenario that assumes a larger investment in roadway maintenance projects results in less dramatic declines.

For local roads that are not eligible for federal funding the situation is much the same. In Granby, for example, pavement condition has been on a steady decline, from a pavement condition index of 75 or "good" in 2003 to a pavement condition index of 45 or "poor" in 2009. Granby Highway Superintendent David Desrosiers attributes this decline to nearly parallel reductions in state aid in the early part of the past decade, which he notes was a critical time when revenues should have more than doubled just to keep pace with inflation. The cost of asphalt, in particular, more than doubled from 2000 to 2010.[13]

F. ROADS FUNDING

FEDERAL FUNDING SOURCES

Annual federal allocations for work on federally eligible roadways comes through federal surface transportation acts, the current version of which is known as Moving Ahead for Progress in the 21st Century (MAP-21). Federal allocations are made to each state based in part on population and road miles and require a 20 percent match from the state. The current fiscal year 2012 allocation to the region, including the state match, is approximately $15 million.[14] This is a figure that has remained more or less the same in the past several years, but looking further back there have been some dramatic changes. (See Table 2.6.) The decline in funding from the 1990s is in part a result of bridge projects no longer being included in the regional funding target. It is also due to the funding required for the Central Artery project in Boston.

Table 2.6: Federal Highway Dollars Allocated to Pioneer Valley Region

1990	$32,000,000
1995	$36,000,000
2000	$ 2,390,075
2005	$11,744,172
2010	$14,241,655

Source: Pioneer Valley Planning Commission

[12] PVPC uses a prepackaged Pavement Management software program "The PAVEMENT*View*" developed by Cartegraph Systems. The PAVEMENT*View* uses a Road Condition Index (RCI) as a measurement of roadway serviceability and as a method to establish performance criteria. Since the PVPC only collects pavement distress information, the Overall Condition Index (OCI) produced by PAVEMENT*View* was used for analysis purposes in the 2012 Regional Transportation Plan.
[13] "Infrastructure in Crisis: Documenting the Perfect Storm," a powerpoint presentation to the JTC by Granby Highway Superintendent David Desrosiers, April 2010.
[14] Because the federal transportation act expired September 30, 2009, requiring numerous extensions from Congress through 2012, it has been difficult to predict what allocations will be from year to year.

There are several programs under the federal allocation through which a road project might be constructed. These programs and the current funding they are providing as part of the total 2012 $15 million allocation are as follows: the Surface Transportation Program (STP), $12 million; Congestion Mitigation and Air Quality (CMAQ), $2 million; and Highway Safety Improvement Program (HSIP), $1 million. It should be noted that projects programmed using CMAQ and HSIP must also meet federal eligibility requirements.

These federal dollars *can only be used to cover construction costs*. Design costs must be covered through other sources. For these eligible roads under municipal jurisdiction, cities and towns must fund design costs through local sources, including "Chapter 90" funding. Chapter 90 funds come from transportation bond bills periodically enacted by the state legislature and appropriated to communities based on a formula that involves local road mileage, employment figures, and population estimates. If the rule of thumb holds true that design costs are generally 10 percent of construction costs, the resources required of municipalities to get to construction can be significant.

For the four-year period of 2013 to 2016, there are 20 projects eligible for federal funding that are "ready to go" at a total estimated cost of $79.7 million.[15] "Ready to go" means that projects are already at the 75 to 100 percent design phase. Between the estimated costs for these projects and the annual federal/state match allocation—assuming that it remains steady at $15 million over the next four years—there is a nearly $20 million funding shortfall. This does not include the TIP backlog of another 86 projects. The Regional Transportation Plan notes that this is a growing concern as the region's funding targets have not increased significantly while project costs continue to rise.[16]

Up until 2011, some funding for roadway projects also came from federal earmarks. Recent projects that received such funding included the Amherst intersection improvement at Route 116 and Bay Road (Atkins Farm).

STATE AND LOCAL FUNDING SOURCES

Chapter 90 monies combined with grants and other local sources are used by municipalities for much of the work on the 74 percent or 3,236.4 miles of roadway in the region that are not eligible for federal funding. The Massachusetts legislature enacted Chapter 90 of the General Laws in 1973 to entitle municipalities to reimbursement of documented expenditures on approved highway construction, preservation and improvement projects on town and county ways and bridges. Eligible projects include: bridges (structures greater than 20 feet in length), road resurfacing and related work, including preliminary engineering and construction, right-of-way acquisition, shoulders, intersections, guardrails, side road approaches, landscaping and tree planting, roadside drainage, sidewalks, foot bridges, berms and curbs, traffic

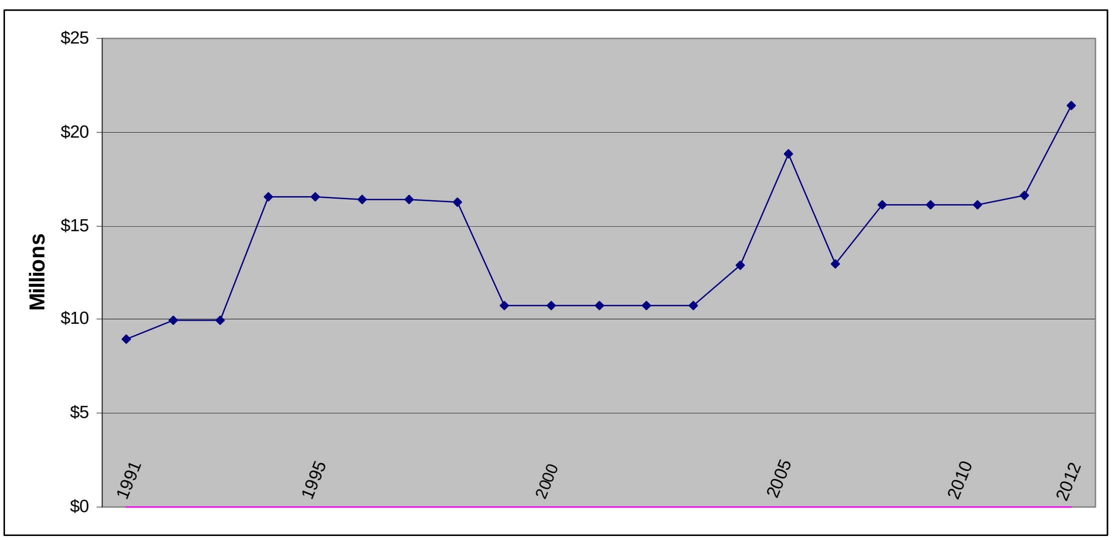
[15] "Status of Projects at the 75% and 100% Design," PVPC, May 2012.
[16] 2012 Regional Transportation Plan, page 257.

controls, street lighting, salt sheds, garages (construction and additions) for storage of road building equipment, bikeways and public use of off-street parking facilities related to mass transportation, a facility with bus or rail services, pavement management systems, development and maintenance. Culverts are only eligible if they are part of a larger road construction project.

In the early 1990s Pioneer Valley communities annually received a total of about $9.6 million. Funding increased for five years to about $16.4 million per year in the late 1990s before declining to $10.7 million in 2000. Since then, Chapter 90 monies to the region's 43 cities and towns have increased steadily to a total of $21.4 million in 2012. (See Table 2.7.)

This increase in the region mirrors a general trend for total Chapter 90 funding across the state from about $100 million to $200 million. For the coming year, the bond bill provides level funding for Chapter 90.[17] The Massachusetts Municipal Association has argued that the actual annual Chapter 90 need to maintain existing roadways is substantially more than $300 million a year.[18] The just issued 21st Century Transportation Plan from MassDOT and Transportation Secretary Richard A. Davey recommends an additional $100 million per year for Chapter 90 projects, which would bring funding to $300 million. The plan recommends increases in the 21-cent-per-gallon gas tax, payroll taxes, sales or income tax, among other strategies to pay for the Chapter 90 increase and other transportation investments described in the plan.

Table 2.7: Chapter 90 Funding to the Pioneer Valley 1991 to 2012



Source: Chart created by PVPC from spreadsheet provided by MassDOT Budget Office

---

[17] Note that communities across the Commonwealth added 96.9 miles of new roads so though the Chapter 90 program was level funded, the allocation formula which includes miles of roadways as a key factor in determining dollar amounts for each community, resulted in some communities seeing a slight decrease in funding and some communities, with new roads, seeing a slight increase in funding.

[18] Massachusetts Municipal Association letter, dated February 29, 2012 to The Hon. William M. Straus, House Chair, and The Hon. Thomas M. McGee, Senate Chair, of the Joint Committee on Transportation

To supplement Chapter 90 monies, communities typically draw on local sources of funding in a variety of ways. For example, the Town of Wilbraham is able to allocate about $350,000 to road projects from its own funds, providing an annual budget of $850,000 for road work. In South Hadley, however, there is no specific set aside for roadwork. Road design and inspection work, however, are covered through the Town Engineer's salary.

Other funding sources for roads include the Federal Emergency Management Agency, which is providing funding to many communities currently based on damage from Tropical Storm Irene in August 2011. In addition, there is the MassWorks Infrastructure Program, which requires that project designs be consistent with MassDOT's Complete Streets design guidelines.[19] In 2011, Pioneer Valley Communities received $4.24 million of a total of $65 million awarded by the program, and in 2012, Pioneer Valley communities received nearly $13.3 million of a total $38 million awarded by the program.

G. SUMMARY OF INFRASTRUCTURE NEEDS, COSTS, AND FUNDING

The challenges of meeting infrastructure needs in the region are overwhelming. Communities with remaining combined sewer systems—Chicopee, Holyoke, and Springfield—face astronomical costs in continuing to eliminate and abate CSOs as federal funding for sewer separation has disappeared and sewer fee increases are constrained by relatively low household incomes. Throughout the region, cities and towns face the costs of complying with water quality requirements set by the forthcoming new NPDES MS4 permit, as well as the costs to keep aging storm drain infrastructure in service. Managing these stormwater costs is complicated by the fact that residents and businesses in most municipalities have not been charged directly for these services and allocations to service stormwater infrastructure from general funds are not in keeping with the actual need. Funding for roads has also not kept pace with actual need and state officials are currently working to come up with a solution.

Generating revenue dedicated to stormwater management will likely become increasingly critical. As described above only a handful of regulated communities in the region have begun to plan for the costs of complying with the new NPDES MS4 stormwater permit. Projected to involve a 2.5 to 4-fold increase in current costs, the cost of compliance with the new permit will likely have significant impacts on local budgets throughout the region.

The combination of significant infrastructure needs with limited funding options means that municipalities will need to be ever more creative about project development and financing,

---

[19] The MassWorks program represents a consolidation of six former grant programs: Public Works Economic Development (PWED); Community Development Action Grant (CDAG); Growth Districts Initiative (GDI) Grant Program; Massachusetts Opportunity Relocation and Expansion Program (MORE); Small Town Rural Assistance Program (STRAP); and Transit Oriented Development (TOD) Program. See: http://www.mass.gov/hed/economic/eohed/pro/the-massworks-infrastructure-program.html

pursuing infrastructure projects with multiple benefits that tap into multiple funding sources. Projects to upgrade an aging road or improve pedestrian safety, for example, can be coupled with projects that improve stormwater management to meet water quality goals, and to improve quality of life (through new green spaces and landscaping). Such multi purpose projects can likely generate more support and utilize a range of funding sources – including "Chapter 90" monies, grants, and other federal, state and local funding sources. CSO abatement projects, too, may be coupled with other infrastructure investments in order to achieve multiple benefits and expand funding options. (See discussion in Analysis Chapter under Financing and Funding Green Infrastructure.) At the same time, communities will likely need to reevaluate the costs of infrastructure and have an honest public conversation about the true value of these services.

III. EXISTING REGULATIONS, POLICIES, AND PLANS

This section describes regulations, policies, and plans and identifies to what extent they promote or offer opportunities for green infrastructure stormwater management strategies.

A. STORMWATER MANAGEMENT REGULATIONS, POLICIES, AND PLANS

CLEAN WATER ACT – MUNICIPAL SEPARATE STORM SEWER SYSTEMS (MS4) PERMIT

Following the adoption of the federal Clean Water Act of 1972, the National Pollutant Discharge Elimination System (NPDES) was created to implement the Act by controlling the amount of pollution entering "waters of the United States."[20] The NPDES program began by requiring industrial facilities to obtain a permit and meet specified standards. As the program evolved, improved standards became required for discharges by publicly owned treatment works (POTWs) and discharges associated with stormwater runoff to receiving waters.

NPDES stormwater regulations were issued in two phases, Phase 1 for municipalities whose storm sewer system (formally known as Municipal Separate Storm Sewer Systems or MS4s) serves a larger population and Phase 2 for municipalities whose MS4s serves smaller populations.[21] For the MS4 permits, EPA uses census figures for total population and population density to define "urbanized areas." For the small MS4 permit at least, this means that some municipalities fall entirely within a regulated area while others have only discrete areas that are regulated under the permit.

[20] "Waters of the United States" is fairly all encompassing, including rivers, streams, lakes, ponds, wetlands, etc. For the current regulatory definition, see: 40 CFR 230.3(s).
21 Phase II of the NPDES stormwater program also regulated construction sites of one to five acres and previously exempted industrial facilities owned or operated by small MS4s.

2003 NPDES Permit

The first NPDES permit, issued by EPA to Pioneer Valley communities in 2003, was called the "General Permit for Storm Water Discharges From Small Municipal Separate Storm Sewer Systems." This first permit applies to 22 municipalities within the region, lays out a program for stormwater management and defines six minimum control measures. The key elements within the 2003 NPDES permit that relate to green infrastructure include, adopting regulations to control:

- construction site stormwater runoff erosion and sedimentation that apply to construction activities that disturb one or more acres of land
- post-construction runoff for such sites

Nearly all of the region's 22 regulated communities have adopted stormwater regulations that apply to construction activities and nearly all have adopted or are proposing stormwater regulations to address the water quality impacts of post-construction runoff from a development site. (See Table 2.8 for a summary of local regulations.)

- Most existing regulations explicitly apply to construction activities that disturb one or more acres of land.
- Most communities have procedures in place to consider construction water quality impacts during pre-construction site plan review (as indicated by requiring submission of a stormwater management plan).
- All of the region's existing and proposed stormwater regulations meet the 2003 NPDES requirement for an erosion and sediment control program at construction sites that includes appropriate BMPs.
- Most, but not all regulated communities in the region explicitly require that development plans minimize site disturbance and that construction activity wastes (e.g. building materials, chemicals, litter, etc.) are controlled.
- Regulations for post construction runoff include inspections and procedures to ensure long-term operation and maintenance of BMPs.
- Most but not all of the region's municipalities have established fines or other sanctions to ensure compliance and support enforcement of their stormwater regulations.

Table 2.8: Compliance with 2003 NPDES Regulatory Requirements

✓ = Successfully Implemented

☐ = Currently Adopting

N = Not in compliance and there are no current efforts to comply

Community	2003 NPDES Requirement												
	Stormwater Regulations for Construction Activities	Regulate Construction Activities that Disturb One or More Acres	Procedures in Place for Pre-Construction Site Plan Review	Require Erosion and Sediment Control Program and BMPs at Regulated Sites	Require Development Plans to Minimize Site Disturbance	Require Management of Construction Activity Wastes	Regulate Post-Construction Runoff	Procedures in Place for Inspections and Enforcement	Procedures in Place to Ensure Maintenance of BMPs	Sanctions Established to Support Enforcement	LID Specifically Mentioned in Stormwater Regulations	LID or LID Measures Actively Promoted in Stormwater Regs	LID Promoted in Subdivision Regulations
Agawam	✓	✓	✓	✓	N	N	✓	✓	✓	N	N	✓	N
Belchertown	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Chicopee	✓	✓	✓	✓	N	N	✓	✓	✓	✓	N	✓	N
East Longmeadow	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	N	✓	N
Easthampton	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	N
Granby	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	N*	☐	N*
Hadley	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	N	✓	N
Hampden	✓	N	N	✓	N	N	N	N	N	N	N	✓	N
Hatfield	✓	N	✓	✓	N	N	✓	✓	✓	N	N	✓	N
Holyoke	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	N	✓	N
Longmeadow	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	N	✓	✓
Ludlow	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	N	✓	N

Community	2003 NPDES Requirement												
Monson	✓	✓	✓	✓	N	N	✓	✓	✓	✓	N	✓	N
	Stormwater Regulations for Construction Activities	Regulate Construction Activities that Disturb One or More Acres	Procedures in Place for Pre-Construction Site Plan Review	Require Erosion and Sediment Control Program and BMPs at Regulated Sites	Require Development Plans to Minimize Site Disturbance	Require Management of Construction Activity Wastes	Regulate Post-Construction Runoff	Procedures in Place for Inspections and Enforcement	Procedures in Place to Ensure Maintenance of BMPs	Sanctions Established to Support Enforcement	LID Specifically Mentioned in Stormwater Regulations	LID or LID Measures Actively Promoted in Stormwater Regs	LID Promoted in Subdivision Regulations
Northampton	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	N	✓	N
Palmer	✓	N**	✓	✓	✓	✓	✓	✓	✓	✓	N	✓	N
South Hadley	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	N	✓	N
Southampton	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	N	✓	N
Southwick	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	N	✓	N
Springfield	☐	✓	✓	✓	☐	☐	✓	✓	☐	☐	☐	☐	N
West Springfield	N	N	N	N	N	N	N	N	N	N	N	N	✓
Westfield	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	N	✓	N
Wilbraham	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	N	✓	N

* Based on review of a draft regulation

** However, the regulations in effect in Palmer should capture any development that disturbs more than one acre, except in the unlikely event that a single family or duplex construction project disturbs this much land.

Forthcoming Permit

EPA is in the process of finalizing a new MS4 permit for the region's regulated communities. They issued a draft permit in 2010 and expect to issue a revised draft permit in 2014. The permit for this region is referred to as the "Interstate, Merrimack, and South Coastal Watersheds Small MS4 General Permit." The current draft of this new permit as of December 2012, available through EPA's website, shows several requirements that relate to green infrastructure. Moreover, since the last permit, EPA has formalized the use of green infrastructure approaches in meeting permit requirements. In 2011, EPA issued a "Strategic Agenda to Protect Waters and Build More Livable Communities through Green Infrastructure," which "outlines key near-term activities to help make green infrastructure an available tool for meeting Clean Water Act requirements. [22]

Permit requirements (in the 2010 draft) relating to green infrastructure include:

Non-Numeric Effluent Limitations –Receiving waters that are deemed to be "impaired" by MassDEP pursuant to section 303(d) of the Clean Water Act do not meet applicable state water quality standards. These include waters with approved Total Maximum Daily Loads (TMDL) and those for which TMDL development has been identified as necessary, but for which a TMDL has not yet been approved. (Section 2.2) A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards.[23] Requirements relating to these waters are more explicit in the new draft MS4 permit than in the 2003 permit.

In the region there are requirements for both phosphorus and nitrogen load reductions. Green infrastructure facilities could play a role in helping to meet these requirements.

- Four communities in the region (Granby, Hadley, Ludlow, and Springfield) must comply with phosphorous load reductions related to TMDLS for several local lakes and ponds. Required load reductions—to be achieved through the use of BMPs—are as low as 1 percent to as high as 60 percent. (Section 2.2.1 (d) and Appendix G of permit)
- At least 17 MS4 permittees must also maintain or decrease current nitrogen loads (*Section 2.2.1 (e)*). [24] According to the draft permit, communities that must comply with nitrogen requirements are: Agawam, Belchertown, Brimfield, Chicopee, Easthampton, East Longmeadow, Hadley, Hampton, Hatfield, Holyoke, Longmeadow,

[22] http://water.epa.gov/infrastructure/greeninfrastructure/upload/gi_agenda_protectwaters.pdf
[23] http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/index.cfm
24 While the Long Island Sound TMDL requires a 10 percent load reduction from urban and agricultural sources (both in basin and out of basin), this reduction is currently not required in the permit. Evidence suggests that actions undertaken by out of basin treatment plants (in MA, VT, and NH), which have been required by the TMDL to reduce nitrogen loading by 25 percent, may be sufficient to meet the total load reduction at the Massachusetts/Connecticut border. The draft permit notes, however, that this requirement may be modified if new information becomes available. See EPA's October 2010 Fact Sheet for the Small MS4 Draft General Permit for Massachusetts Interstate, Merrimack and South Coastal Watersheds (page 35).

Northampton, Southampton, South Hadley, Springfield, Westhampton, and West Springfield).[25]

Stormwater Management in New Development and Redevelopment – Requirements under this section build on the previous permit's requirements for post construction stormwater management. There are six requirements here that relate to green infrastructure.

- Develop a report assessing current street design and parking lot guidelines and requirements that affect the creation of impervious cover within 2 years of the effective date of permit. (Section 2.4.6.7)
- Develop a report assessing existing local regulations to determine the feasibility of making green infrastructure practices allowable within 3 years of the effective date of permit. (Section 2.4.6.8)
- Estimate number of acres of impervious area (IA) and directly connected impervious area (DCIA); report tabulated results and estimation methodology if baselines provided by EPA are not used. (Section 2.4.6.9 (a))
- Estimate the number of acres of DCIA added or removed to each sub-basin during the prior year, beginning with the second year annual report and in each subsequent annual report. (Section 2.4.6.9 (b)) See Table 2.9 below, which shows the baseline of impervious cover provided by EPA for regulated Pioneer Valley communities.
- Complete an inventory and priority ranking of MS4-owned property and infrastructure that may be retrofitted with BMPs designed to reduce the frequency, volume, and peak intensity of stormwater discharges to and from its MS4 within 2 years of the effective date of the permit. (Section 2.4.6.9 (c))
- Report on those MS4 owned properties and infrastructure that have been retrofitted with BMPs designed to reduce the frequency, volume, and peak intensity of stormwater discharges as well as their pollutant loadings beginning the third year annual report and in each subsequent annual report. (Section 2.4.6.9 (d))

Other requirements – The permit also requires permittees to evaluate physical conditions, site design, and best management practices to promote groundwater recharge and infiltration where feasible in the implementation of the permit. (Section 4.2)

Connected Impervious Cover

While the forthcoming NPDES MS4 permit is aimed at improving water quality, it could be more effective if it were to promote a watershed based approach. Most notably, the forthcoming permit uses the measure of connected impervious cover within the boundaries of each MS4, but not the watershed. The concept of percentage imperviousness and its relationship to water quality arose from studies based on the delineations of watersheds,

[25] Note that Monson, Wilbraham, Palmer, Southwick, and Westfield (all regulated communities) are not listed while Brimfield and Westhampton are listed.

specifically those of 1^{st} through 3^{rd} order systems, not political boundaries.[26] So while impervious cover provides a specific and measurable target, any actual reduction of impervious is somewhat abstracted from the waters the efforts seek to protect.

The National Academies of Science in a recent study noted the following:

> …the most likely way to halt and reverse damage to waterbodies is through a substantial departure from the status quo—namely a watershed permitting structure that bases all stormwater and other wastewater discharge permits on watershed boundaries instead of political boundaries.[27]

A watershed approach to the reduction of impervious surface could promote important collaborations across municipalities to more effectively improve the condition of surface waters. Such an approach would bring the picture of water quality together, including actions upstream that improve downstream conditions, and perhaps also provide more political leverage, tying stormwater improvements to specific watersheds and identifiable resources that people care about.[28]

It is worth noting that one challenge to watershed based impervious area mapping in Massachusetts is that current GIS watershed delineations do not correlate to 1st , 2nd, or 3rd order streams, the latter of which is the highest order in which the impervious cover model can be effectively applied. This is described at length in the Mapping chapter of this plan.

Table 2.9: 2012 EPA Impervious Cover Estimates for Pioneer Valley Regulated Communities

Municipality	Urbanized/Regulated Area Only			
	All Urbanized/ Regulated Area	Impervious Area (IA)	Directly Connected Impervious Area (DCIA)	
	Area (acres)	Area (acres)	Area (acres)	% of Urbanized/ Regulated Area
Agawam	8771.02	1884.91	1202.17	14%
Belchertown	1121.33	93.10	46.62	4%

[26] *Impacts of Impervious Cover on Aquatic Systems*, Center for Watershed Protection, March 2003, p. 2.
[27] *Urban Stormwater Management in the United States*, Committee on Reducing Stormwater Discharge Contributions to Water Pollution, National Research Council, National Academies Press, 2008.
[28] The DuPage River Salt Creek Work Group may provide some instructive examples and models for communities coming together on a watershed based approach. An official from the Illinois DEP noted that the communities in these basins, which banded together to address TMDL concerns, have learned that it is far more cost effective to work together rather than individually. See Work Group's website at: http://www.drscw.org/

Municipality	Urbanized/Regulated Area Only			
	All Urbanized/ Regulated Area	Impervious Area (IA)	Directly Connected Impervious Area (DCIA)	
	Area (acres)	Area (acres)	Area (acres)	% of Urbanized/ Regulated Area
Chicopee	10426.38	3661.35	2932.68	28%
East Longmeadow	7704.28	1389.60	866.93	11%
Easthampton	6659.99	1095.46	701.40	11%
Granby	2752.40	259.67	125.95	5%
Hadley	2105.92	254.50	129.83	6%
Hampden	3236.53	208.97	77.50	2%
Hatfield	1540.14	231.65	132.35	9%
Holyoke	6488.48	1931.34	1477.98	23%
Longmeadow	5798.36	1071.92	641.22	11%
Ludlow	8030.69	1428.10	889.73	11%
Monson	1005.49	211.12	146.18	15%
Northampton	8644.31	1724.38	1210.30	14%
Palmer	4144.16	697.69	494.70	12%
Russell	102.36	16.47	17.45	17%
South Hadley	6788.30	1136.62	684.98	10%
Southampton	475.67	61.61	33.19	7%
Southwick	3244.10	385.87	202.11	6%
Springfield	20865.13	8432.99	7058.35	34%
West Springfield	8789.93	2555.28	1958.99	22%
Westfield	13438.49	2581.00	1631.89	12%
Wilbraham	8484.96	1020.05	535.04	6%

Source: Adapted from impervious cover tables from U.S. Environmental Protection Agency

MASSACHUSETTS STORMWATER HANDBOOK

In early 2008, the state of Massachusetts issued updated stormwater regulations in accordance with revisions to the Wetlands Regulations, 310 CMR 10.00, and the Water Quality Regulations, 314 CMR 9.00. The 10 stormwater standards set forth in the regulations and in the *Massachusetts Stormwater Handbook* are applied in areas subject to the jurisdiction under the Massachusetts Wetlands Protection Act.[29] Through local bylaws, many municipalities are extending these standards to apply to upland areas where development will disturb one acre or more.

[29] The *Massachusetts Stormwater Handbook* can be viewed at: http://www.mass.gov/dep/water/laws/policies.htm#storm.

The Handbook notes that these standards require the implementation of a wide variety of stormwater management strategies, including environmentally sensitive site design and Low Impact Development techniques to minimize impervious surface and land disturbance, and source control and pollution prevention.[30] Standard three in particular promotes an LID or green infrastructure approach:

> Loss of annual recharge to groundwater shall be eliminated or minimized through the use of infiltration measures including environmentally sensitive site design, low impact development techniques, stormwater best management practices, and good operation and maintenance. At a minimum, the annual recharge from the post-development site shall approximate the annual recharge from pre-development conditions based on soil type. This Standard is met when the stormwater management system is designed to infiltrate the required recharge volume as determined in accordance with the Massachusetts Stormwater Handbook.

MASSDOT POLICIES

For roads within its jurisdiction MassDOT has recently launched the "Impaired Waters Program," a program through which Mass DOT seeks to reduce the impact of its facilities on water bodies that are classified by MassDEP as "impaired" (not meeting applicable state water quality standards). Under this program, MassDOT is: 1. installing BMPs along existing roadways where warranted to reduce water quality impacts to impaired waters (the "Retrofit Initiative"), and 2.incorporating additional structural BMPs into new construction projects where warranted to prevent further water quality impacts to impaired waters ("Programmed Projects Initiative").[31]

RAINWATER HARVESTING/WATER REUSE POLICIES

Use of cisterns to capture rainfall is an important green infrastructure strategy. Especially in highly urbanized locations where infiltration may be difficult, a cistern offers an approach to reduce the volume of flow through capture and reuse of stormwater for flushing toilets or irrigating gardens (after a storm event).

Because there are no provisions within the Massachusetts Uniform State Plumbing Code for rain water harvesting, projects proposing rainfall capture for flushing of toilets or irrigation are often subject to the state's reclaimed water/gray water permit program, 314 CMR 20.00. These regulations, set by the Board of State Examiners of Plumbers and Gas Fitters, are intended for reclamation of ***wastewater*** and require ***advanced treatment*** so that wastewater is contaminant free and can be reused safely for applications such as landscaping, irrigation,

[30] See Redevelopment section within Analysis Chapter for discussion about how Massachusetts Stormwater Handbook addresses redevelopment projects.

31 MassDOT brochure entitled, "MassDOT Stormwater Program: A Proactive Approach to Stormwater Management."

and toilet flushing. That means that when harvested rainwater is used for toilet flushing, it must be treated with either chlorine or ultra-violet light to prevent fecal coliform growth. To date, the state indicates it has not reviewed any applications for systems that harvest rainwater for use in landscaping so treatment requirements have not yet been determined for this use.[32]

Though requiring advanced treatment for harvested rainwater, which is relatively clean compared to wastewater, may present a barrier to rainwater harvesting, a state official has noted there are no plans to change this rule.[33]

For use of harvested rainwater in flushing toilets, state regulations also require that water be dyed and pipes be painted purple. These measures are designed to prevent accidental cross-connections with municipal water supply.

State code does allow for the direct plumbing of municipal water supply to rain water harvesting systems so that there is back up supply during dry times. An approved reduced pressure backflow preventer (RPBP), however, must be installed and included within the maintenance plan to ensure that rainwater does not back up into the treated municipal supply. There is a physical air gap internal to the device that separates the "unregulated" harvested water from the municipal supply. A standard model of an RPBP is approved by MassDEP for use in cross connections. Local plumbing boards, however, may impose higher requirements for a visible air gap. This typically means the harvesting system must be designed under a "cistern-refill" scenario where the back up water supply partially refills the cistern when the harvested rainfall supply is depleted. One engineering consultant has noted, "This adds unnecessary costs to the system and its operation since storage bought and paid for to be used for site water collection and storage must be permanently dedicated to municipal back up water in the cistern. This also increases energy costs since all water is now pumped via on-site pumping systems regardless of whether it is sourced from precipitation or the municipal back-up supply."[34]

LOCAL STORMWATER MANAGEMENT BYLAWS/ORDINANCES

As described above, local stormwater management bylaws and ordinances have had to comply with National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit requirements. Key provisions required under the 2003 permit are meant to control construction site stormwater runoff erosion and sedimentation for activities that disturb one or more acre of land and post construction runoff from such sites.

32 Taylor Roth, Senior Inspector, State Board of Examiners, December 6, 2012 phone conversation.
33 Ibid
34 2012 e-mail correspondence with Geosyntec Consultants.

For the forthcoming permit there are additional requirements that must be added to local regulations. Among these requirements is the development of a report assessing existing local regulations to determine the feasibility of making green infrastructure practices allowable.

Currently no local regulations refer to green infrastructure practices *perse*, though there is language that promotes "Low Impact Development (LID)." LID typically refers to stormwater management practices on undeveloped sites whereas green infrastructure refers to a system of stormwater management facilities on both developed and undeveloped sites.

In the Pioneer Valley region, only Belchertown and Easthampton have community-wide stormwater regulations (stormwater bylaws or ordinances) that specifically make mention of the term "Low Impact Development." Both Easthampton and Belchertown actively promote use of LID techniques in both new development and redevelopment projects by requiring stormwater permit applicants to demonstrate that they have considered the use of LID stormwater management techniques. For example, Easthampton requires environmentally sensitive site design and LID analysis demonstrating application of these principles where feasible, and all projects subject to the stormwater ordinance must consider a specific list of LID techniques. In addition, all of the region's existing and proposed stormwater regulations do promote LID approaches with regulatory language that states a preference for on-site infiltration of stormwater runoff when possible. Many local regulations also explicitly state that the most preferred stormwater management technique is on-site infiltration using swales or other decentralized strategies, followed by temporary detention basins, and then followed by permanent retention basins (least preferred).

In addition to town-wide stormwater regulations, subdivision regulations were reviewed for language that promotes LID practices as well. Only a few communities were found to have language in their subdivision regulations that promotes LID stormwater management approaches. (See Table 2.10.) It is worth noting that the subdivision regulations of many of the region's regulated communities are extremely out of date, a few to the point of actually contradicting the municipality's stormwater regulations (e.g. requiring that stormwater runoff be directly discharged into the nearest stream channel).

Table 2.10: Communities with Language in Regulations that Promotes Low Impact Development (LID)

✓ = Successfully Implemented

N = Not in compliance and there are no current efforts to comply

☐ = Currently Adopting

Community	LID Specifically Mentioned in Stormwater Regulations	LID or LID Measures Actively Promoted in Stormwater Regs	LID Promoted in Subdivision Regulations
Agawam	N	✓	N
Belchertown	✓	✓	✓
Chicopee	N	✓	N
East Longmeadow	N	✓	N
Easthampton	✓	✓	N
Granby	N*	☐*	N
Hadley	N	✓	N
Hampden	N	✓	N
Hatfield	N	✓	N
Holyoke	N	✓	N
Longmeadow	N	✓	✓

Community	LID Specifically Mentioned in Stormwater Regulations	LID or LID Measures Actively Promoted in Stormwater Regs	LID Promoted in Subdivision Regulations
Ludlow	N	✓	N
Monson	N	✓	N
Northampton	N	✓	N
Palmer	N	✓	N
South Hadley	N	✓	N
Southampton	N	✓	N
Southwick	N	✓	N
Springfield	☐*	☐*	N
West Springfield	N	N	✓
Westfield	N	✓	N
Wilbraham	N	✓	N

* Based on review of draft regulation

** Not present in the current regulations, which are in the process of being replaced by new updated regulations. The new draft regulations are not yet available for review.

B. COMBINED SEWER REGULATIONS, POLICIES, AND PLANS

CLEAN WATER ACT – LONG TERM CONTROL PLANS

In implementing the provisions of the Clean Water Act, EPA produced a Combined Sewer Control Policy in 1994, providing a framework for control of CSOs through the National Pollutant Discharge Elimination System (NPDES) permitting program. In March 1997, EPA issued administrative orders to several Pioneer Valley communities, including Chicopee, Holyoke, and Springfield, to abate combined sewer overflows. These communities are expected to develop long-term CSO control plans that provide for full compliance with the Clean Water Act, including attainment of water quality standards.

As mentioned above, Chicopee has an approved Final Long Term CSO Control Plan. Springfield has recently submitted their final plan for EPA approval, and Holyoke must complete a plan by June 2014. It is important to note that these plans follow years of work already done to eliminate combined sewer systems that yielded the largest overflows. (See Table 2.11 below.) The final plans address remaining combined systems and describe a preferred alternative, a work plan that balances water quality benefits with financial capabilities.

Table 2.11: CSO Abatement Work Since 2001 and Remaining Outfalls and Overflow Volume in 2011

	Total # CSO outfalls as of 2001	# CSO outfalls eliminated since 2001	Annual overflow volume reduction	Remaining CSO outfalls as of 2011*	Remaining overflow volume
Chicopee	33	4	318.8 million gallons/year	29	166.1 million gallons/year
Holyoke	15	1	432.2 million gallons/year	14	84.4 million gallons/year
Springfield	25	1	141.3 million gallons/year gallons/year	24	490 million gallons/year gallons/year

** Note that these remaining CSO outfall figures for 2012, as noted on page 20, are: 28 for Chicopee, 12 for Holyoke, and 24 for Springfield.*

Source: 2001 figures based on interviews with municipal public works superintendents. 2011 figures and overflow volume reduction and remaining overflow volume based on MADEP "Western Massachusetts CSO Status, as of June 24, 2011, Summary Sheet."

Chicopee – More than half of Chicopee's 200-mile sewer collection system involves combined sewers that lead to a total of 29 outfalls that directly impact either the Chicopee River or the Connecticut River. The City's work plan involves separating most of the combined sewers. Combined sewers that currently have no overflows and Drainage Area 7.1, in which a satellite treatment facility was constructed, remain combined. The plan includes a map and table that show how work will be phased. The estimated cost of Chicopee's work plan is $153 million, but projected costs are now $200 million. Implementation is slated to occur over a 20-year period, but the City hopes to extend the time frame of their work plan to 30 years.

Chicopee's plan recognizes the importance of "source control" as a way to reduce costs of other CSO abatement measures given its role in reducing stormwater flow volumes and pollutant loads from drainage areas into combined sewers. The plan describes such practices as zoning/development policies that minimize runoff volumes and rates of new development, porous pavement, and area drain and roof leader disconnection—all essentially strategies within a green infrastructure "toolbox"—as useful in controlling the quantity of stormwater that reaches the combined sewer system. These strategies, however, are not fully integrated into the plan of work, which focuses instead on separation of the combined system. City officials indicate they plan to meet with EPA officials to determine how the plan might be revised so that there is a more integrated approach that can help reduce costs.

Springfield – The Springfield Water and Sewer Commission's proposed Final Long Term Control Plan uses an integrated planning framework to comply with Clean Water Act requirements.[35] The Springfield plan notes that the age and condition of certain infrastructure, particularly sanitary sewer conduits that cross the river, must be addressed in tandem with CSO work to reduce risks to water quality and levels of service. The preferred alternative, which is consistent with the City's financial capability and water quality requirements, involves a 20-year CSO control plan and a 40-year wastewater capital improvements plan. The wastewater capital improvements plan is estimated to cost $313 million and the CSO control plan is estimated to cost $136 million. The plan notes that previous CSO abatement work to date has involved investments of $88 million.

Springfield's 24 combined sewer outfalls discharge during large storm events to the Mill River, Chicopee River, and Connecticut River. According to the plan, the preferred alternative will achieve a 65 percent flow reduction within the first 5 to 10 years of implementation and a reduction of 89 percent of flow (58.3 million gallons annually) at the end of 20 years with one to eight overflows per year. No existing combined sewer outfalls will be entirely eliminated. Work will proceed using an adaptive management approach that accommodates a 5-year cycle for periodic review of the plan and engagement of local stakeholders to evaluate plan progress and the implementation schedule.

The plan also identifies 140 acres in CSO drainage areas 012-Worthington Street and 013-Bridge Street for green infrastructure stormwater management facilities, possibly vegetated buffers, swales, filter strips, bioretention areas, and porous pavements. The CSO manager for Springfield Water and Sewer Commission reports that these areas will be further evaluated during the design phase to ensure that they provide the level of service required to meet CSO

[35] As noted in the Introduction, U.S. EPA published guidance in 2012 that allows a municipality to balance Clean Water Act (CWA) requirements in a manner that addresses the most pressing public health and environmental protection issues first. In this way, meeting the various CWA requirements for sanitary sewer, combined sewer, stormwater, and wastewater treatment plants, can be combined (and need not compete) so that attention and financial resources can be focused on addressing the most serious water quality and system issues.

control objectives and that they are economically feasible from a construction and operation and maintenance standpoint.[36]

C. ROAD REGULATIONS, POLICIES, AND PLANS

REGIONAL TRANSPORTATION PLAN

The Regional Transportation Plan sets the stage for all federally funded work in the region through the year 2035. As the first page of the 2012 plan reads, the Regional Transportation Plan,

> …concentrates on both existing needs and anticipated future deficiencies in transportation infrastructure, presents the preferred strategies to alleviate transportation problems, and creates a schedule of regionally significant projects that are financially constrained – in concert with regional goals and objectives and the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFTEA-LU) legislation.

The plan describes: planning process; regional profile; major considerations for transportation planning, including safety and security, the movement of people, the movement of goods, the movement of information, and sustainability; related needs; and describes future forecasts, finances, and the public participation process for the plan.

In terms of opportunities for green infrastructure, the plan acknowledges that transportation related uses, because they occupy so much land with impervious cover, have a significant impact on water quality due to polluted runoff. There are six strategies listed in the plan that promote green infrastructure stormwater practices. These include:

1. Divert highway runoff to stormwater Best Management Practices, such as rain gardens and dry swales.
2. Expand use of permeable pavements on sidewalks, paths, car-parks, minor roads.
3. Encourage use of materials such as pervious concrete, porous asphalt, paving stone, brick, tile, and gravel where appropriate.
4. Utilize narrower road widths for local roads where appropriate.
5. Mitigate the impacts of roadway salt and chemical usage during snow season.
6. Support urban forestry initiatives.[37]

---

[36] January 25, 2013 e-mail correspondence with CSO Manager Josh Schimmel.
[37] *2012 Regional Transportation Plan for the Pioneer Valley Metropolitan Planning Organization*, pages 210-213.

The plan recommends integrating these strategies as program improvement activities that will enhance the transportation system.

MASSDOT STREET DESIGN GUIDELINES

For numbered roads (state roads) in Massachusetts, the road width, shoulder width, and shoulder type are determined by the functional classification of the road, sight distance, traffic flow and volume, level of service, design speed of the road, topographical factors, and curvature. Based on the American Association of State Highway and Transportation Officials (AASHTO) "Green Book," these design guidelines can be found in the Massachusetts Project Development and Design Guidebook.

The width of the travel lane varies according to functional classification, traffic volumes, design speed, and specific roadway features. Travel lane widths range between 9 and 12 feet and shoulder widths can range between 2 and 10 feet. The shoulder is the portion of a roadway adjacent to a traveled way for accommodation of stopped vehicles, for emergency use, and for lateral support of base and surface courses. Shoulders can also serve as areas to support non-motorized travel, usually bicycling but also occasionally walking. There are three shoulder types:

- Paved shoulders - consisting of bituminous or concrete materials;
- Stabilized shoulders - consisting of bituminous material mixed with gravel to provide a compacted and relatively smooth surface;
- Unstabilized shoulders - consisting of slag, gravel, crushed stone, soil or grass, generally free of trees and other roadside obstacles.

State roads in Massachusetts must meet the design requirements, and cannot be narrowed by local authority. Design exceptions may be granted when there are geometric features that cannot be reasonably corrected or addressed due to engineering, or topographic or construction constraints. This is referred to as Context Sensitive Solutions or Context Sensitive Design.[38]

MUNICIPAL STREET DESIGN GUIDELINES

Better stormwater management principles call for reductions in paved areas to realize water quality benefits. Because streets and parking lots account for so much impervious cover, development standards are critically important. Street and parking lot development standards are typically described in two places:

For new private streets	Municipality's subdivision regulations
For municipally-owned roads	Department of Public Works (DPW) policies

[38] The approval process for CSS is described in Section 2.11 of *The Massachusetts Highway Department Project Development and Design Guidebook*.

Subdivision Regulations

In the Pioneer Valley region, many community regulations call for a minimum of 12-foot-wide travel lanes in new subdivisions with minimal vehicle traffic. However, some communities require 10- or 11- foot travel lanes. Reductions in roadway width have been used by some communities to help "calm traffic." Recommendations often call for 10- to 12-foot travel lanes on neighborhood streets, and a typical "yield street" that is intended to slow neighborhood traffic has 10-foot travel lanes. The required radius for a cul-de-sac also impacts the amount of impervious area. In the Pioneer Valley, minimum cul-de-sac radius requirements (at outer road edge) are typically set between 60 and 120 feet, and hammerhead turnarounds, which would greatly reduce impervious cover, are not typically allowed. Better stormwater management recommendations often call for cul-de-sacs to be designed with an outer road radius of 30 to 40 feet, as well as allowing for hammerhead turnarounds in lieu of cul-de-sacs.

DPW Policies

Local DPW road construction policies also determine the area of paved surfaces in a community. Depending on their use and traffic volume, travel lane widths can be as little as 9 to 10 feet. Local policies have generally not been updated to reflect better stormwater management or traffic calming principles. However, local residents and officials are increasingly aware of the need to narrow streets to achieve stormwater management and traffic

Emergency Vehicle Access

Emergency access considerations can have direct bearing on street width. Under the Massachusetts' fire marshal code, the minimum fire access lane width is 18 feet. Generally speaking, this can be met by two 9-foot travel lanes. The purpose of a fire access lane is to allow one fire truck to operate while allowing enough space for a second truck to pass by during the event of an emergency. Fire access lanes can be located on roads, but they must not be obstructed (i.e. by parked cars or snow).

While the state fire marshal code provides a minimum width, fire access lanes cannot be standardized across the state. Each community has different needs and fire apparatus that range in size. Communities may increase minimum fire access lane widths if required for their particular equipment. Alternatively, municipalities may select fire access equipment that allows for narrower lanes consistent with community design goals. Additional solutions to reduce lane widths and associated impervious cover may be permitted on a case-by-case basis in new developments.

One strategy to maintain adequate fire access while decreasing impervious surface area is to use permeable paving on part or all of a fire access lane. While some fire chiefs are reluctant to endorse alternative materials due to maintenance issues, a solid maintenance plan with assurances that fire lane access will remain open at all times may help to alleviate these concerns.

calming goals. One example of a comprehensive road narrowing policy is demonstrated by the City of Northampton's Traffic Calming program, which has been pursuing road narrowing projects that reduce travel lane widths from 12 to 10 feet where possible. This approach generally does not reduce total paved area, however, as the lane width reductions are often achieved by painting new street lines (over the same paved area) that create bike lanes and/or a wider shoulder area in order to create the narrower travel lanes. Traffic calming programs alone absent policies that target water quality outcomes will not necessarily reduce total paved area. In addition, proposals for new and redeveloped streets must consider both fire access and on-street parking needs (see discussion below).

D. SUMMARY OF EXISTING REGULATIONS, POLICIES, AND PLANS

The forthcoming NPDES MS4 permit and Administrative Orders to abate combined sewer overflows are major drivers for green infrastructure in the region. The new stormwater permit is explicit about several green infrastructure related requirements and the exorbitant cost of abating combined sewer overflows through large construction projects is making clear the importance of smaller source control projects (i.e., projects that reduce the flow of stormwater into the combined system). State and local policies could be improved to better support green infrastructure approaches, especially with regard to roadways, redevelopment projects, and the use of rainwater harvesting practices.

IV. CURRENT DECISION MAKING ABOUT INFRASTRUCTURE

Understanding how decisions are made can provide insights into processes, tools, and priorities as well as what approach might be taken to combine green infrastructure stormwater management strategies with ongoing projects to best effect.

A. STORMWATER DECISIONS

Most communities in the region make stormwater infrastructure decisions on an as-needed basis. This process is typically driven by citizen complaints or identification of a critical need by municipal staff or the Board of Public Works. Many municipalities are focused on crisis management rather than proactive management of infrastructure, as limited resources have forced municipal staff to address only immediate demonstrated needs as they occur. When infrastructure fails and a repair, replacement or upgrade is required, regular maintenance funds are used or, if needed, additional funds are identified at that time to allow the capital improvement project to occur. Municipal funds are very limited, so stormwater system maintenance and improvements often take a back seat to immediate pavement management and utility repair needs.

B. COMBINED SEWER DECISIONS

CSO managers say that much of the decision making about CSO infrastructure is essentially made by EPA through the administrative orders, consent decrees, and the draft and final long term control plan process. This process and resulting working plan identify where money must be invested. CSO managers say they are involved in the technical decisions required to meeting federal objectives and in apportioning resources so that other critical infrastructure work can be done.

CHICOPEE

In Chicopee officials observe that there is an ongoing tension between the City's efforts to alleviate problems suffered by ratepayers and EPA's goal of reducing combined sewer overflow volumes. While CSO managers are informed by history and operations of the system, they say that ongoing dialogue with the public is critical to making what infrastructure decisions it can as it moves forward with CSO project work. The DPW logs complaints, notes where there may be concentrations of complaints, and strives to respond to problems. They acknowledge that the City has had to make some significant compromises with EPA. The recent $17 million sewer separation work at Jones Ferry, for example, did little to alleviate problems for ratepayers, but did greatly reduce the volume of combined sewer overflow.

To manage its information about customers and wastewater infrastructure, the DPW uses Access software. This data base includes information about street flooding, basement flooding, and sewer backups. The City is adding new information about which customers are using shut off valves in their basements as a way to avert sewer back ups during times of heavy rainfall. The problem had remained somewhat hidden from City officials because older customers had adapted to living under such circumstances. As houses change hands, however, new homeowners clearly will not put up with such a routine.

HOLYOKE

Aside from the direction that has come out of negotiations with EPA over reducing combined sewer flow, decision making in Holyoke is based entirely on the institutional knowledge of the DPW's General Superintendent and his staff. Decisions are made based on history, where there are issues and where there are consistent problems. There is currently no data base or asset management software in use. With so few resources available, there is a general sense that there would be little use in investing in such a system.

SPRINGFIELD

Operation and management of wastewater facilities in Springfield is overseen by the Springfield Water and Sewer Commission. While the Commission coordinates with the City of Springfield on project work, it makes choices independently. Decision making on sewer projects draws from both institutional knowledge and information provided through asset management software. Two things are at play in decision making: conditions assessments and risk assessments.

C. ROAD DECISIONS

FEDERALLY ELIGIBLE PROJECTS

Accessing federal dollars for roadway construction is competitive and political. State and local project proponents submit proposals through a process outlined in Chapter 2 of the *Massachusetts Project Development and Design Guidebook* (2006). Proposed projects are reviewed by a committee at the state level to determine whether a project meets federal eligibility requirements. If a project is approved by the state committee, it gets assigned a project number.

Eligible projects are then reviewed and discussed by the Metropolitan Planning Organization (MPO), a forum for transportation decision making in the region, which annually develops, reviews, and endorses a planning work program. MPO members include the Secretary of MassDOT, the Administrator of MassDOT, Highways Division, the Chairman of PVPC, Chairman of the Pioneer Valley Transit Authority, and five chief elected local officials from the region. The Joint Transportation Committee (JTC), which represents both public and private interests, also provides comments and recommendations to the MPO on projects. As part of its review, the MPO scores projects based on four transportation criteria (condition, mobility, safety, and cost effectiveness) and on three other criteria (community effects and support, land use and economic development, and environmental effects). See Table 2.12 for the full matrix of criteria.

It is difficult for eligible projects in rural areas to score high as such projects typically receive zeros on several criteria. MassDOT is in the process of developing new scoring criteria in order to better mesh with its forthcoming statewide strategic multi-modal plan called, "weMove Massachusetts." One of the plan's stated philosophies is, "We need to develop a forward-looking, data-driven, decision-making methodology to assist MassDOT in implementing its priorities transparently and measurably."

Following review by the MPO and JTC, eligible projects are included within the Regional Transportation Plan and in turn put on the annual Transportation Improvement Plan (TIP), which identifies priority projects for implementation in the region over a four-year period. Projects advance on the TIP depending on project readiness (75 to 100 percent design) and cost/availability of dollars. In general, local projects tend to take five to seven years to reach implementation while MassDOT projects tend to advance more quickly. Some municipalities are having success with moving along their larger projects faster by splitting them into phases that better match the programming of available funding. The TIP is developed annually and is available for amendment and adjustment at any time.

Table 2.12: Transportation Evaluation Criteria for Roadways

Transportation Criteria				**Other Impact Criteria**		
Condition	**Mobility**	**Safety**	**Cost Effectiveness**	**Community Effects and Support**	**Land Use and Economic Development**	**Environmental Effects**
Magnitude of pavement condition improvement	Effect on magnitude and duration of congestion	Effect on crash rate compared to state average	Cost per Unit Change in Condition	Residential effects: right-of-way, noise, aesthetics, cut-through traffic, other	Business effects: right-of-way, access, noise, traffic, parking, freight access other	Air Quality /Climate effects
Magnitude of improvement of other infrastructure elements	Effect on travel time and connectivity / access	Effect on bicycle and pedestrian safety	Cost per lane Mile **$ -**	Effect on service to minority or low income neighborhoods - EJ	Sustainable development effects	Water quality/ supply effects; wetlands effects
	Effect on other modes using facility	Effect on transportation security and evacuation routes	Cost per AADT **$ -**	Other impact/ benefits to minority or low income neighborhoods	Consistent with regional land-use and economic development plans	Historic and cultural resource effects
	Effect on regional and local traffic		Cost per AADT per lane mile **$ -**	Public, local government, legislative, and regional support	Effect on job creation.	Effect on wildlife habitat and endangered species
				Effect on development and redevelopment of housing stock.		Effect on Green House Gas Emissions
Avg. Score (-3 to +3)	Avg. Score (-3 to +3)	Avg. Score (-3 to +3)		Avg. Score (-3 to +3)	Avg. Score (-3 to +3)	Avg. Score (-3 to +3)
0	**0**	**0**		**0**	**0**	**Total Score (-18 to +18)**

Source: Pioneer Valley Planning Commission, 2012

LOCAL PROJECTS DECISIONS

Decision making at the local level draws heavily on institutional knowledge. In Wilbraham, the DPW Director notes that other factors include the number of complaints received and an effort to spread monies/work across the Town from year to year. For most projects, it comes down to weighing the costs and benefits and making an effort to keep good roads in good condition. He says the Town goes through several iterations each year in creating a list of roads for work and that there are always many roads in need from which to choose. For roadwork in Granby, the Highway Department relies on pavement management software, traffic volume on a particular roadway, and the judgment of the Highway Superintendent to select the roadway repairs.

D. SUMMARY OF DECISION MAKING

While some communities have conducted infrastructure studies, very few municipalities are engaged in ongoing, systematic monitoring and evaluation of stormwater infrastructure to inform decision making. Stormwater infrastructure decisions in the region are typically based on institutional knowledge and citizen complaints (flooding, etc.). A more deliberate decision making approach to stormwater can help communities move from a reactive, crisis management mode of operating to a more proactive and cost effective mode of operating that connects stormwater management objectives to other objectives within a community, including attending to underserved neighborhoods and joining forces with other infrastructure projects such as street improvements.

Decision making for other infrastructures, particularly roadways and combined sewers is somewhat more developed.

Combined sewers - While EPA directives carry significant weight in decision making in the CSO communities of Chicopee, Holyoke, and Springfield, other sanitary sewer decisions are informed by ratepayer complaints (Chicopee tracks these along with other information about street flooding, basement flooding, and sewer back ups) to help in decision making, and asset management software (in Springfield) that compares condition assessments and risk assessments. Institutional knowledge is also important to informing decisions in all three communities.

Roads – Decision making for local roads projects may be informed by a mix of considerations that include pavement condition, traffic volume, and institutional knowledge all balanced by an effort to allocate monies across a municipal jurisdiction. Decision making on projects for roads that are eligible for federal highway monies is formalized by a competitive process that includes scoring based on transportation criteria (condition, mobility, safety), other criteria (community effects and support), land use and economic development, environmental effects), and cost effectiveness. This is done by the Metropolitan Planning Organization (MPO), a forum for transportation decision making in the region, which annually develops, reviews, and endorses a planning work program. This is essentially a *rank-based model* whereby projects are ranked from highest to lowest benefit based on established criteria. Investments are made in the highest ranked projects until the budget is expended (not necessarily examining what might be "good buys").

E. POSSIBLE DIRECTIONS FOR DECISION MAKING

The forthcoming stormwater permit for the region's urbanized areas includes at least two specific elements that are meant to measure progress toward objectives: directly connected impervious area and water quality. Directly connected impervious area (those areas connected hydraulically to a waterbody via continuous paved surfaces, gutters, drain pipes and other conventional conveyance) and additions and reductions to this area are a reporting requirement within the forthcoming permit.[39] Communities must also meet load reduction requirements for phosphorous in certain lakes and ponds and maintain or decrease nitrogen loads related to the Long Island Sound TMDL. As communities work to meet regulatory requirements through the implementation of green infrastructure, it makes sense that these indicators, along with cost considerations, help inform decision making. Where appropriate, decision making might also be informed by potential capacities for volume reduction in CSOs, flooding reduction , and/or increased groundwater recharge.

Additional data can help inform practical decisions about stormwater management as well as provide a more complete understanding of how stormwater investments intersect with other community objectives. This data, which is described in the next chapter, includes: delineations of watersheds, stormwater permitted areas, and combined sewer drainage areas, hydrologic soils groups, land ownership, delineation of environmental justice areas, identification of roads eligible for federal aid, and where other infrastructure projects may coincide.

How this information comes together may be different from one community to the next. Some communities may choose to work with only a subset of this data and yet others may identify even more data to inform decisions. This could include: frequency of flooding, ratepayer complaints, implementation of stormwater retrofit projects through private development, existing protected open space, and/or drinking water recharge areas, high value natural areas. A good decision making process can make for good economics and politics. The right tools combined with good information can provide a sound basis for building a more financially sustainable program as well as greater legitimacy and trust among rate payers and taxpayers.

There are emerging opportunities for communities to share the costs of new decision support technology. Communities enrolling in the Commonwealth Citizens Connect program, for example, can enable their citizens to report problems using the SeeClickFix smart phone

[39] Directly Connected Impervious Area definition is from EPA's Small MS4 Permit Technical Support Document, April 2011. See: www.epa.gov/region1/npdes/stormwater/ma/MADCIA.pdf

application and to provide municipal officials with a work order management system for staff to manage requests as they come in. The program provides the technology, training, and support for a three-year period free of cost. Specific problems with flooding, combined sewers, and storm drains, among others identified through this application, may help to better document the need for green infrastructure. The cities of Chicopee and Northampton are currently enrolled.

CHAPTER 3: MAPPING FOR GREEN INFRASTRUCTURE

I. DECIDING WHERE TO LOCATE GREEN INFRASTRUCTURE

Deciding where to locate green infrastructure stormwater facilities occurs at a variety of scales. At the site level, decisions are often made following better site design practices that first protect natural areas and minimize the use of impervious surfaces, and then locate facilities so that they support a functional relationship between land and water and human use. At redevelopment sites, the location of existing utilities, infrastructure, and other impacts already borne by the site from previous development are additional considerations.

At larger scales, emerging decision support tools account for many of these same site level factors along with other considerations to make analysis at this scale more comprehensible.

- The towns of Bellingham, Franklin, and Milford are using a cost optimization approach in development by EPA that seeks to aggregate benefits, and select "best buys" or projects with the greatest environmental value per dollar. These communities must meet federal compliance targets aimed at reducing phosphorous inputs so that the Upper Charles River can meet Massachusetts Surface Water Quality Standards. Cost optimization analysis has involved mapping information on land use categories, unit cost information for stormwater facilities, and pollutant loading export rates for each land use category.[1] The decision support tool emerging from this work is known as the System for Urban Stormwater Treatment and Analysis Integration Model (SUSTAIN). Because it is somewhat complicated to use, EPA is seeking funding to develop a simpler spreadsheet tool.[2,3] PVPC has proposed piloting a simplified tool for the Pioneer Valley related to reducing nitrogen loads and peak storm flow.

- For the Chesapeake Bay, the Maryland State Highway Administration, in tandem with EPA Region 3 and the U.S. Army Corps of Engineers, has been piloting a related decision making approach called the *Watershed Resources Registry*. A GIS based targeting tool, it integrates land use planning, regulatory and non regulatory decision making using the watershed approach. Driven by the Total Maximum Daily Load goals for the Chesapeake Bay, the Watershed Resources Registry will identify the best opportunities to protect high quality resources, restoration of impaired resources, and

[1] Such analysis has also been used to identify best investments for a CSO separation project in Washington D.C.'s Anacostia River watershed, and a federal redevelopment project at the Barksdale Air Force base in Louisiana to restore predevelopment hydrology. (TetraTech presentation with EPA at Pioneer Valley Planning Commission, December 17, 2012.)
[2] Mark Voorhees, Engineer, U.S. EPA, Region 1, conference call October 22, 2012.
[3] For a link to the SUSTAIN tool, see: http://www.epa.gov/nrmrl/wswrd/wq/models/sustain/

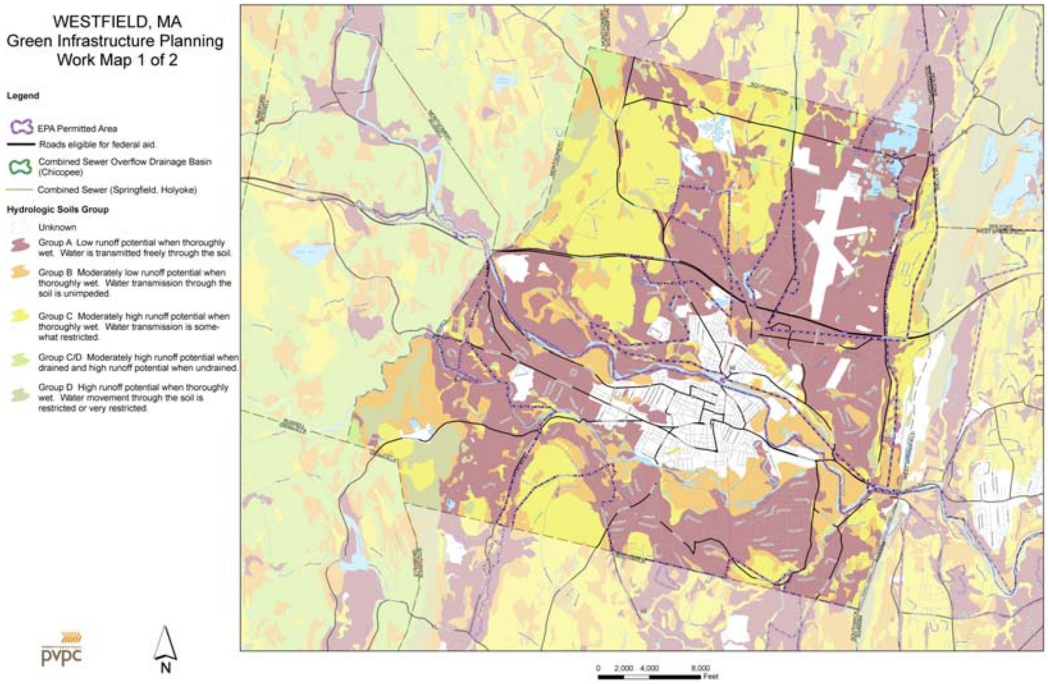
improvement of stormwater management.[4] Retrofits go beyond green infrastructure stormwater management to include, urban tree plantings, stream buffer plantings, wetland restoration, stream restoration, innovative methods, and improved operations (street sweeping, inlet cleaning).

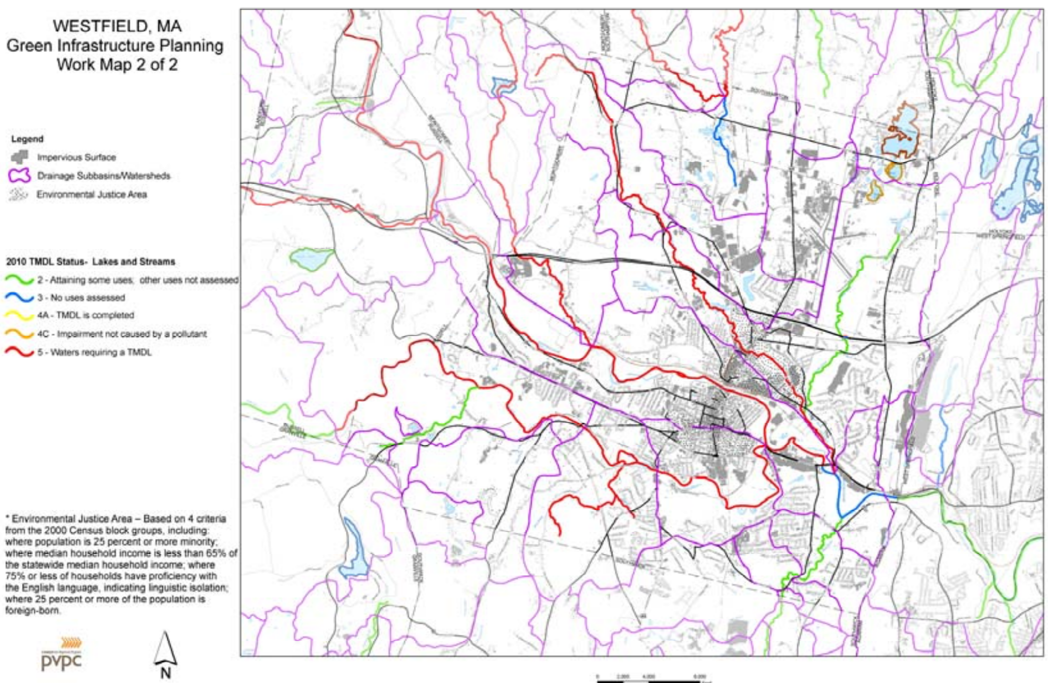
Until these methods become more widely understood, available, and practical, it makes sense to identify locations for green infrastructure facilities using a more simplified approach. A set of specific mapping criteria with an eye toward upcoming infrastructure projects provides an important first step. There is a broader discussion about the integration of green infrastructure into existing projects within the next chapter.

This chapter identifies mapping criteria of most importance to inform choices about best locations for green infrastructure investments. A set of two ***working maps*** showing these criteria and located in the Appendixes are focused on the 22 communities that are subject to regulations under the National Pollutant Discharge Elimination System (NPDES) Municipal Storm Sewer Systems (MS4) stormwater management permit.[5]

PVPC also did mapping for the Town of Huntington to provide an example of how a community, though not regulated for stormwater management by EPA, could think about implementation of green infrastructure stormwater management strategies as a way to protect an important natural resource; in this case, the Wild and Scenic designated Westfield River.

[4] www.watershedresourcesregistry.com and "Green Infrastructure and Transportation: Connecting the DOTs," Pedersen, Neil, Administrator Maryland State Highway Administration, February 23, 2011.
5 These 22 communities are: Agawam, Belchertown, Chicopee, East Longmeadow, Easthampton, Granby, Hadley, Hampden, Hatfield, Holyoke, Longmeadow, Ludlow, Monson, Northampton, Palmer, South Hadley, Southampton, Southwick, Springfield, West Springfield, Westfield, and Wilbraham. Note that EPA announced in December 2012 that under the forthcoming NPDES MS4 permit, Amherst will be added to the list of regulated communities in the region, bringing the number to 23. For a discussion of the NPDES MS4 program and permit, please see the preceding chapter.





The two working maps shown here for Westfield combine 8 mapping layers, providing key information to help begin decision making about locations for green infrastructure. Map #1 shows four of these criteria for consideration: EPA stormwater permitted area, roads eligible for federal aid, areas served by combined sewers (if any), and soils and their capacity to absorb stormwater. The second working map shows four additional criteria: impervious surfaces, drainage watersheds, environmental justice areas, and rivers, streams, and lakes with existing water pollution problems.

In addition to these working maps, this chapter includes ***maps showing existing and potential green infrastructure locations***, prepared with the help of municipal officials in communities that responded to PVPC's invitation for mapping. (These maps are located at the end of this chapter.) To define potential projects, municipal officials worked from the base maps provided by PVPC and used local knowledge about upcoming work and experience with problem locations. Municipalities that submitted information about existing and potential locations, are: Chicopee, Holyoke, Huntington, Northampton, South Hadley, Springfield, and Westfield.

II. WORKING MAPS AND CRITERIA FOR GREEN INFRASTRUCTURE LOCATIONS

The series of two working maps for each of the stormwater regulated communities combine 8 mapping layers, providing key information or criteria to help begin decision making about locations for green infrastructure. The first map shows: EPA stormwater permitted area, roads eligible for federal aid, areas served by combined sewers (if any), and hydrologic soils groups (an indication of the capacities of soils to soak up rainfall). The second working map shows four additional criteria: impervious surfaces, Environmental Justice Areas, and watershed delineations with Total Maximum Daily Load status (an indication of water quality problems). Following are the layers in list format.

Stormwater infrastructure	▪ EPA MS4 Permitted Stormwater Area ▪ Impervious Surface Coverage
Combined sewer infrastructure	▪ CSO Drainage Basin (Chicopee) ▪ Combined Sewer (Springfield, Holyoke)
Road infrastructure	▪ Roads ▪ Roads Eligible for Federal Aid
	▪ Hydrologic Soils Group ▪ Environmental Justice Area ▪ Watershed Delineations and TMDL Status

In developing this list of mapping layers, PVPC first reviewed the draft stormwater permit requirements and associated resources and then refined the list with the help of the Green Infrastructure Advisory Committee. Below is a description of the layers that are included on the working maps. Please note that the Drainage Subbasins/Watersheds layer is described together with the TMDL Status layer.

A. EPA PERMITTED MS4 STORMWATER AREA – MAP LAYER

This layer shows the areas regulated by the Small Municipal Separate Storm Sewer System (MS4) General Permit. EPA Region 1's GIS Center provided this data layer directly to PVPC. Regulated areas are based on population figures and specifically "urbanized areas" from the 2000 U.S. Census.[6] These areas may be updated to reflect the 2010 census, but EPA reports there is as of yet no official timeline for the update.[7]

In the Pioneer Valley region, seven communities (Chicopee, Holyoke, Longmeadow, Northampton, Springfield, West Springfield, and Westfield) are wholly within urbanized areas. Fifteen communities (Agawam, Belchertown, East Longmeadow, Easthampton, Granby, Hadley, Hampden, Hatfield, Ludlow, Monson, Palmer, South Hadley, Southampton, Southwick, Wilbraham) are partially within urbanized areas.

B. IMPERVIOUS SURFACE COVERAGE – MAP LAYER

The Impervious Surface layer for the base maps is from MassGIS, which uses information from the Sanborn Map Company, February 2007. This layer is the same used by EPA in the maps they provide on their website for the Massachusetts MS4 general permit. It includes rooftops, roads, drive ways, and parking lots, that prevent rainfall from soaking into soils and recharging groundwater.

EPA has also provided baseline estimates for impervious cover by municipality for compliance with the MS4 stormwater permit.[8] This information will be useful for communities in reporting reductions of impervious cover as they comply with permit requirements, but it will also be important to understand how these impervious cover reductions relate to specific watersheds, particularly where there are impaired waters. The impervious cover model developed by the Center for Watershed Protection in 1994 and affirmed through many studies since, correlates stream health to degree of imperviousness in a watershed. Although the model applies only to streams that are 3rd order or less, the model is often generalized to apply to larger watersheds. To understand which streams in the region are 3rd order or less, see Table 1. in *Gazetteer of Hydrologic Characteristics of Streams in Massachusetts—*

---

6 Urbanized areas involve a complex calculation used by the Bureau of the Census to determine the geographic boundaries of the most heavily developed and dense urban areas. It is generally defined as, "…a densely settled core of census tracts and/or census blocks that have population of at least 50,000, along with adjacent territory containing non-residential urban land uses as well as territory with low population density included to link outlying densely settled territory with the densely settled core."
7 March 30, 2012 e-mail correspondence with Thelma Murphy, Manager
Storm Water and Construction Permits Section at U.S. Environmental Protection Agency, Region 1.
8 The methodology used to develop the estimates in impervious cover can be found on EPA's website. The methodology provides an understanding of the basis for the estimates, but also facilitates any refinements where desired or needed. See:
www.epa.gov/region1/npdes/stormwater/draft_manc_sms4gp.html

Connecticut River Basin by S. William Wandle, Jr. of the U.S. Geological Survey, 1984. In using this Table, note that the Connecticut River itself is 6th order.[9]

C. COMBINED SEWERS (CHICOPEE, HOLYOKE, SPRINGFIELD) – MAP LAYER

As green infrastructure can play a critical role in helping to abate stormwater flow into combined sewers it is important to know the location of these systems in the three communities that have them: Chicopee, Holyoke, and Springfield. These cities are considering the potential for green infrastructure stormwater management strategies to help reduce the costs of what would otherwise be a more traditional sewer separation approach. It has been suggested that they might also consider implementation of green infrastructure to exceed targets in combined sewer areas where there is a planned level of control for several overflows per year.

In Chicopee, the City has a phased plan for implementation of combined sewer control projects and mapping information on the base maps within this plan shows the drainage areas for each system. For Holyoke and Springfield, the information on the base maps shows the combined sewer system itself with no delineation of the drainage areas. All layers for combined sewers were obtained directly from municipal officials in the respective communities and from the Springfield Water and Sewer Commission.

D. ROADS AND ROADS ELIGIBLE FOR FEDERAL AID – MAP LAYER

Road projects provide an especially important way to advance green infrastructure objectives in the region. Stormwater management as it pertains to road projects is an eligible expense within both the state Chapter 90 funding and federal funding that comes through surface transportation acts. This mapping layer helps to distinguish the respective funding sources available to given roads in the region.

Information for this layer comes from the MassDOT Roads layer available from MassGIS, dated October 2009. The official state-maintained transportation data set represents local and major roadways, including designation of interstate, state, and federal roads.

E. HYDROLOGIC SOILS GROUPS – MAP LAYER

Though there are thousands of soil types, soils have been grouped according to their runoff potential under similar storm and cover conditions. Group A type soils, for example, "…have low runoff potential and high infiltration rates even when thoroughly wetted. They consist of deep, well to excessively drained sand or gravel and have a high rate of water transmission

9 For more information, see: "The Importance of Imperviousness." Feature article from Watershed Protection Techniques. Center for Watershed Protection. 1994; and "Impacts of Impervious Cover on Aquatic Ecosystems." Center for Watershed Protection. March 2003.

(greater than 0.30 in/hr)." On the other end of the spectrum are the Group D soils, which "…have high runoff potential and very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very low rate of water transmission (0 to 0.05 in/hr)."[10]

The mapping layer for hydrologic soils groups provides some understanding of what the conditions may be at a site, but it is important to note that mapping is done at a scale that does not provide a fine level of detail or ensure accuracy. In developed areas the use of fill brought in from other locations may have altered the existing conditions and in heavily urbanized areas in particular, so much fill has been used that mapping provides no soils information for such areas other than to indicate "urban fill."

For the hydrologic soils group layer, PVPC used Natural Resources Conservation Service SSURGO Certified Soils data from MassGIS, November 2010. Hydrological soils group data is from the related table: Soils_poly_muggat.

F. ENVIRONMENTAL JUSTICE AREA – MAP LAYER

By explicitly mapping Environmental Justice Areas on the green infrastructure base maps it is hoped that decisions about green infrastructure implementation can be made with greater awareness and intention in meaningful involvement of all people and neighborhoods regardless of race, color, national origin, or income.

Base mapping information for Environmental Justice Areas relies on four criteria from the 2000 Census block groups. These criteria are as follows:

- where population is 25 percent or more minority
- where median household income is less than 65 percent of the statewide median household income
- where 75 perent or less of households have proficiency with the English language, indicating linguistic isolation
- where 25 percent or more of the population is foreign-born

PVPC obtained this data layer from MassGIS.

10 Part 630 Hydrology, National Engineering Handbook, Appendix A: Hydrologic Soil Groups. United States Department of Agriculture, Natural Resources Conservation Service. January 2009.

Origins of Environmental Justice

The concept of environmental justice had its genesis in 1982 with a poor, rural, and largely black community in Warren County, North Carolina, when the state government decided it was a good location for the disposal of 6,000 truckloads of PCB laden soil. Marches and protests by angry residents who were concerned about PCBs leaching into drinking water supplies and the more than 500 arrests that followed drew national attention. Though the state ultimately prevailed, the protests and legal challenges to fight the landfill in Warren County served as a watershed moment in the formation of a national movement for environmental justice.

By 1994, President Clinton issued an Executive Order directing every Federal agency to make environmental justice part of its mission by identifying and addressing the effects of all programs, policies, and activities on minority and low-income populations.

Sources: Natural Resources Defense Council website: http://www.nrdc.org/ej/history/hej.asp; and Executive Order 12898 of February 11, 1994: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (see: Federal Register, Vol. 59, No. 32, Wednesday, February 16, 1994).

G. WATERSHED DELINEATIONS AND TMDL STATUS – MAP LAYERS

Taken together, Total Maximum Daily Load (TMDL) status and watershed delineation is one important way of understanding where waters are impacted by human activity and which drainage areas contribute to these waters. The question here is: Where are the biggest water quality problems and hence where might there be the best opportunities to improve water quality through green infrastructure stormwater management strategies?

A TMDL establishes the amount of a particular pollutant that a water body can receive while still meeting water quality standards.[11] The TMDL status map layer identifies those waters that do not meet applicable state water quality standards. These waters are deemed to be "impaired" by MassDEP pursuant to section 303(d) of the Clean Water Act. These include waters with approved TMDLs and those for which TMDL development has been identified as necessary, but for which a TMDL has not yet been approved. (Section 2.2 of the draft permit)

There are six lakes and ponds in the region that must meet specific phosphorous load reduction requirements. Communities that must comply with phosphorous TMDL requirements are: Granby, Hadley, Ludlow, and Springfield).[12] Many MS4 permittees must

---

11 http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/index.cfm

12 Communities must meet planning load reductions for phosphorous within 3 years of the effective date of the permit and implementing load reductions within 7 years of the effective date of the permit. Section 2.2.1 (d)

also maintain or decrease current nitrogen loads (*Section 2.2.1 (e)*).[13] Communities that must comply with nitrogen requirements are: Agawam, Belchertown, Brimfield, Chicopee, Easthampton, East Longmeadow, Hadley, Hampton, Hatfield, Holyoke, Longmeadow, Northampton, Southampton, South Hadley, Springfield, Westhampton, and West Springfield).[14]

As part of the stormwater management program developed by municipalities for the upcoming MS4 permit, municipalities are required to identify: each waterbody that receives a discharge from the small MS4; the water quality classification applicable to that waterbody, and standards that are applicable to the water classification; and any identified impairments.[15] The aim is to ensure that discharges do not cause or contribute to an exceedance of applicable water quality standards for the receiving water. (Section 2.1.1 (a)(b) of the draft permit)

The TMDL status layers comes from MassGIS, which is derived from the *Massachusetts Year 2010 Integrated List of Waters*. Watershed delineations are also from MassGIS.

III. ADDITIONAL MAPPING CRITERIA

As communities zero in on locations to explore green infrastructure, there is other information that will add to the utility of these working maps. Combined with this other information, the working maps can help advance a local process of refining criteria for decision making, evaluating best locations for green infrastructure and making informed choices about where to spend monies.

Additional mapping information includes: land ownership, where other infrastructure projects coincide, and land use categories. Due to the detail of these layers, it was not possible to include them on the working maps. These mapping layers are better suited for use on larger scale maps of specific areas.

---

13 While the Long Island Sound TMDL requires a 10 percent load reduction from urban and agricultural sources (both in basin and out of basin), this reduction is currently not required in the draft permit. Evidence suggests that actions undertaken by out of basin treatment plants (in MA, VT, and NH), which have been required by the TMDL to reduce nitrogen loading by 25 percent, may be sufficient to meet the total load reduction at the Massachusetts/Connecticut border. The draft permit notes, however, that this requirement may be modified if new information becomes available. See EPA's October 2010 Fact Sheet for the Small MS4 Draft General Permit for Massachusetts Interstate, Merrimack and South Coastal Watersheds (page 35).

14 Monson, Wilbraham, Palmer, Southwick, and Westfield (all regulated communities) are not listed while Brimfield and Westhampton are listed.

15 Inland surface waters are assigned one of three classes, A through C, based on water quality. For more information on these classes, see the Massachusetts Surface Water Quality Standards.

A. LAND OWNERSHIP

Good parcel boundary information to understand land ownership is available through MassGIS for most communities in the region.[16] An understanding of land ownership, particularly the location of municipally owned land, including street right of ways, will be an important consideration moving forward to comply with MS4 stormwater permits. In meeting stormwater permit requirements, communities must complete an inventory and priority ranking of MS4 owned property and infrastructure, including public right of ways that may have the potential to be retrofitted with BMPs and that can help reduce the frequency, volume, and peak intensity of stormwater discharges to and from the MS4. The 2010 draft permit requires this inventory and ranking occur within two years of the effective date of the permit (Section 2.4.6.9(c)).

B. WHERE OTHER INFRASTRUCTURE PROJECTS COINCIDE

To promote green infrastructure construction projects that are multipurpose and result in multiple benefits (e.g., improved roadway, stormwater management, and neighborhood) one of the most important questions is: Where do we have investments to be made or being made through other infrastructure projects? In most cases, the answer comes from good dialogue among municipal departments, between municipalities, and with state agencies. Information from the following sources can also help to inform understanding about where there might be good opportunities to integrate green infrastructure objectives with upcoming projects.

- Capital Investment Plans (available in some municipalities)
- Regional Transportation Improvement Plan (available from PVPC)
- Other MassDOT Roadway Projects, such as projects from the Impaired Waters Program (available from MassDOT) – MassDOT's website has a list of projects under design
- MassBroadband 123 initative

A valuable next step in understanding where it makes the most sense to promote green infrastructure stormwater strategies includes amending the base maps produced for this plan to show the locations of major projects cited in these sources.

[16] Through what it calls Level 3 Assessors' Parcel Mapping, MassGIS is in the final stages of upgrading parcel information for the entire state. As of December 2012, municipalities in the region lacking good parcel data are: Pelham, Southampton, Springfield, and Williamsburg. See MassGIS website for updates: http://www.mass.gov/anf/research-and-tech/it-serv-and-support/application-serv/office-of-geographic-information-massgis/datalayers/l3parcels.html

C. LAND USE CATEGORIES

If communities decide to undertake cost optimization work as described in the beginning of this chapter, land use information is essential. Different land uses generate runoff with different pollutant loads. Identifying where you have the highest loading can thus help in understanding where you might make the best investments in stormwater management.

In the Pioneer Valley, the stormwater pollutants of major concern are nitrogen and phosphorous. Sources of nitrogen and phosphorous in urban stormwater include atmospheric deposition, lawns, deposited organic matter (leaves, pollen, pet waste, organic debris), stream bank erosion, and leaching septic systems. Table 3.1 below indicates the average concentration of these pollutants for major land uses averaged from a number of national studies. It is important to note that while the concentration of nitrogen and phosphorus from parking lots and streets is lower than lawns, the volume of runoff from these sources is significantly higher.[17]

Table 3.1: Nitrogen and Phosphorous Concentrations for Different Urban Land Covers

Urban Land Cover	Total N (mg/l)	Total P (mg/l)
Lawns	9.70	**1.93**
Highway	2.95	.60
Streets (med. and low use)	1.40	.50
Parking Lots	1.94	.16
Rooftops	1.50	.12
Average Stormwater Runoff	2	.30

Source: "Impacts of Impervious Cover on Aquatic Systems," Center for Watershed Protection, March 2003 and CSN Technical Bulletin No. 9: Nutrient Accounting Methods to Document Local Stormwater Load Reductions in the Chesapeake Bay Watershed[18]

[17] "Impacts of Impervious Cover on Aquatic Systems," Center for Watershed Protection, March 2003, p. 69.
[18] CSN Technical Bulletin No. 9: Nutrient Accounting Methods to Document Local Stormwater Load Reductions in the Chesapeake Bay Watershed can be retrieved at: http://chesapeakestormwater.net/2012/03/technical-bulletin-no-9-nutrient-accounting-methods-to-document-local-stormwater-load-reductions

In its cost optimization work to reduce phosphorous loads to the Upper Charles River, described on the first page of this section, EPA aggregated Mass GIS information on land use into 9 land-use categories. They then calculated annual phosphorus loads for each land use category distinguishing between impervious and pervious areas and multiplying the amount of area in each land-use category by the corresponding land use specific phosphorus load export rate (lbs/acre/yr.).[19] Adapting this method may be useful in watersheds where calculations of nitrogen loading may be of interest and possibly even for peak flow reduction.

IV. EXISTING AND POTENTIAL GREEN INFRASTRUCTURE LOCATIONS

PVPC invited all 22 MS4 stormwater regulated communities to use the working maps to identify locations of existing and potential green infrastructure stormwater management facilities. This exercise began with several municipalities in February 2012 that attended a workshop involving roundtable discussions with maps. Another invitation to participate was issued in June 2012. PVPC received information on existing and potential locations for green infrastructure from six stormwater regulated communities: Chicopee, Holyoke, Northampton, South Hadley, Springfield, and Westfield. As mentioned above, the Town of Huntington has also been included to show how a community, though not regulated for stormwater, could think about implementation of green infrastructure strategies as a way to protect an important natural resource.

Mapping of potential green infrastructure locations indicates the start of a process to evaluate where it may make sense from a municipal standpoint to introduce these stormwater management facilities. Potential green infrastructure locations may be municipally owned sites or significant privately owned sites with development or redevelopment potential. For a few of these sites, there has been some site analysis and there is momentum to pursue green infrastructure. For most of these sites, however, there has been only initial discussion. The indication of these sites on the maps is a preliminary step intended to promote broader conversations about green infrastructure across municipal departments, across the public and private sectors, and across neighborhoods throughout a municipality. In essence, the potential green infrastructure locations shown provide a current snapshot of green infrastructure improvements that may be possible in the near future.

The information on existing green infrastructure locations is important in several ways. It enables municipalities to see how upcoming projects might build on the stormwater management services provided by existing facilities and thus begin to develop a true system of green infrastructure. In addition, existing projects serve as important examples, providing

[19] Memorandum, August 9, 2011, from Mark Vorhees, EPA, Subject: Methodology for developing cost esitimate for structural storm water controls for preliminary residual designation sites and for Charles River watershed areas in the communities of Milford, Bellingham, and Franklin, Massachusetts.

a valuable knowledge base for municipalities and private developers as they move forward with similar projects in the region. In addition to maps showing existing green infrastructure locations, there is a table in Appendix B of known existing green infrastructure projects in the region. Descriptions of several select existing projects are also included in this appendix. It is hoped that these existing projects can help build understanding and know-how about green infrastructure.

Page is intentionally blank.

Chicopee MA - Green Infrastructure Locations

Existing Green Inrastructure Locations

1 Rainwater Harvesting, Jones Ferry Combined Sewer Treatment Facility

2 Stormwater Infiltrators, Upper Granby Road

Potential Green Infrastructure Locations

3 River Mills Redevelopment

4 Biofiltration, Infiltration, and Rainwater Harvesting, Older Adult Community Center

5 Tree Filter Boxes, Exchange Street

6 Call Street Area

7 Sheridan Street Area

8 Downtown Canal Walk

9 Navy Housing Redevelopment

10 Szot Park

11 Rivers Park

12 Nash Field

13 Chicopee Municipal Golf Course

14 Sarah Jane Sherman Park

15 Wastewater Treatment Plant

Roads Eligible for Federal Aid

Environmental Justice Areas

0 2,000 4,000 8,000 Feet

*Potential locations identified by site assessments, soil maps, and conversations with city officials

Catalyst for Regional Progress pvpc

N

Holyoke MA - Green Infrastructure Locations

Existing Green Inrastructure Locations

1 Catch Basins with Leaching Basins, Skinner Parking Lot

2 Green Roof, Jones Ferry River Access Center

3 Infiltrators, Holyoke Transportation Center

4 Infiltrators and Rainwater Reuse, Holyoke Senior Center

5 Infiltrators, Holyoke Public Library

6 Rain Gardens and Daylighted Brook, Community Field

7 Green Roof, Kittredge Center, Holyoke Community College

8 Rain Garden, Pulaski Park

9 Underground Infiltration, Veterans Park

Potential Green Infrastructure Locations

10 Underground Infiltration, Suffolk Parking Garage

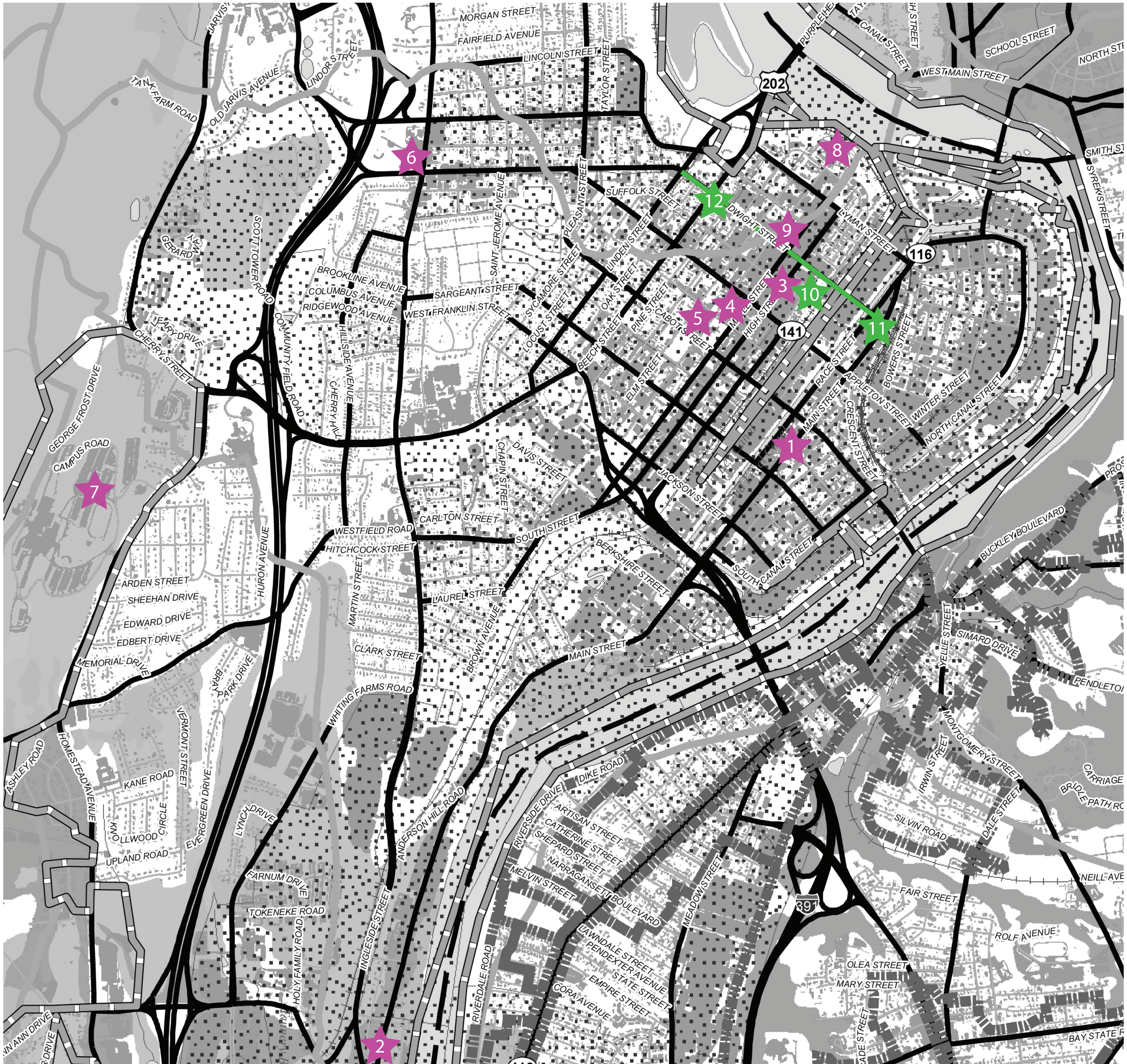
11 Depot Square Redevelopment

12 Dwight Street Transit Oriented Development District

Roads Eligible for Federal Aid

Environmental Justice Areas

*Potential locations identified by site assessments, soil maps, and conversations with city officials



0 2,000 4,000 8,000 Feet

N

Catalyst for Regional Progress pvpc

Huntington MA - Green Infrastructure Locations

Potential Green Infrastructure Locations

1 Downtown "Riverwalk" with Stormwater Best Management Practices between Federal Street and the Westfield River

2 Bioretention Swales, Route 112 South of Pond Brook Road (Rt. 66)

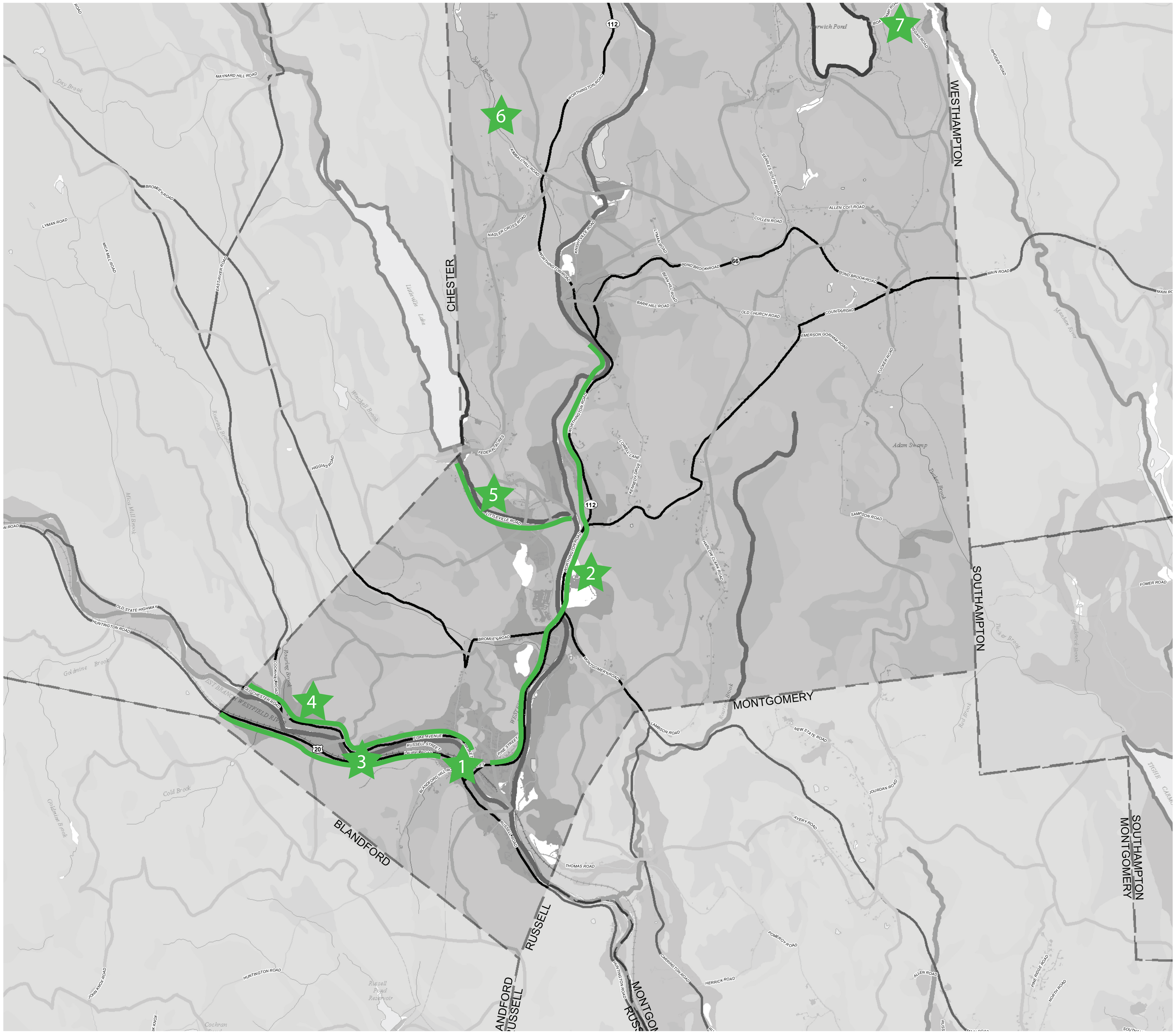
3 Bioretention Swales, Route 20 West of Route 112 Intersection

4 Bioretention Swales, Old Chester Road / Fisk Avenue

5 Bioretention Swales, Littleville Road

6 Bioretention Swales, Kimball and Goss Hill Roads

7 Swales in Roadway Right of Ways, Norwich Lake



Roads Eligible for Federal Aid

Environmental Justice Areas

0 2,000 4,000 8,000 Feet

N

*Potential locations identified by a previous study and conversations with town officials

Catalyst for Regional Progress pvpc

Northampton MA - Green Infrastructure Locations

Existing Green Inrastructure Locations

1 Infiltration Swale, Conz Street

2 Bioretention Area, Senior Center

3 Bioretention Area, Prince Street at L3-KEO (Kollmorgen)

4 Infiltration Swale, Musante Drive at Village Hill

5 Green Roof and Rainwater Harvesting, Ford Hall, Smith College, Green Street Area

6 Bioretention Area, River Run Condos, Damon Rd.

7 Infiltration Basin and Bioretention Areas, Northwood Development, Atwood Drive

8 Bioretention Areas and Rainwater Harvesting, River Valley Market

9 Bioretention Areas, KFC/Taco Bell

Potential Green Infrastructure Locations

10 Stormwater Planters and Tree Box Filters, Main Street

11 Infiltration Swale, North Street Reconstruction Project

12 Future Development at Village Hill

13 Infiltration Swale, Intersection of Bridge Street and Pomeroy Terrace

14 Smith Vocational and Agricultural High School

15 Upper and Lower King Street

16 Industrial Park

— Roads Eligible for Federal Aid

Environmental Justice Areas

*Potential locations identified by site assessments, soil maps, and conversations with city officials

0 2,000 4,000 8,000 Feet

Catalyst for Regional Progress pvpc

N

South Hadley MA - Green Infrastructure Locations

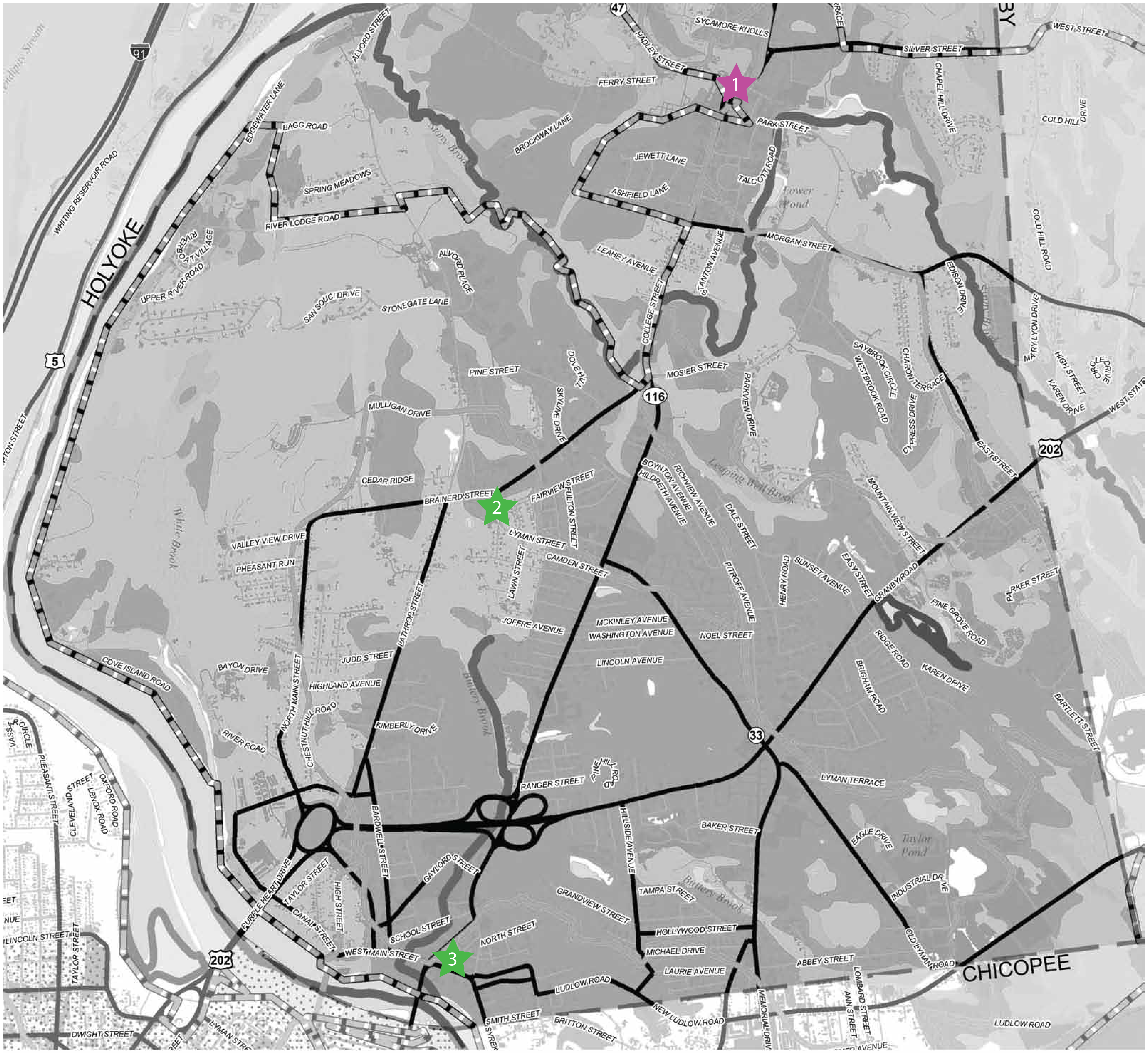
Existing Green Inrastructure Locations

1 Drywells, United States Post Office, 1 Hadley Street

Potential Green Inrastructure Locations

2 Bioretention Swale, Southwest Corner of Lyman Street and Brainerd Street

3 Bioretention Area, South Hadley Town Hall, 116 Main Street



— Roads Eligible for Federal Aid

Environmental Justice Areas

0 2,000 4,000 8,000 Feet

*Potential locations identified by site assessments, soil maps, and conversations with town officials

pvpc

N

Springfield MA - Green Infrastructure Locations

Existing Green Inrastructure Locations

1 Rainwater Harvesting and Infiltration Chambers, Putnam Regional High School

2 Rain Gardens, Johnny Appleseed Park (Shebbins Park)

3 Infiltration Chambers and Basins, F.W. Webb Industrial Development

4 Infiltration Chambers, Walmart

Potential Green Infrastructure Locations

5 Bioretention Area, Chapin Terrace / Washburn Street, Sewer Separation Project

6 Union Station, Future Intermodal Transportation Center

7 Springfield Plaza

8 York Street Jail Site, Potential Development Site

9 Smith and Wesson Industrial Park, Planned Future Expansion

10 (a,b) Swales, Filter Strips and Bioretention Areas, Worthington and Bridge Streets, Sewer Separation Projects

11 Chicopee Business Park, Planned Future Development Site

12 Eastfield Mall Parking Lot, Potential for Stormwater Improvements

13 Roosevelt Avenue at Island Pond, Future Road Construction Project

14 6 Corners, Hancock, Alden and Walnut, Future Road Construction Project

15 Allen Street and Bicentennial Highway, Follow up to Road Construction Project

16 Rain Garden, Smead Arena

17 Westinghouse Site

* Potential locations identified by site assessments, soil maps, and conversations with city officials

Roads Eligible for Federal Aid

Environmental Justice Areas

0 2,000 4,000 8,000 Feet

N

Westfield MA - Green Infrastructure Locations

Existing Green Inrastructure Locations

1 Porous Pavement, Columbia Greenway Rail Trail Parking Lot

2 Infiltrating Catch Basins, Marla Circle

3 Dry Vegetated Swale, Stieger/Falley Drives

4 Stormwater Wetland / Detention Basin, Big Y, Broad Street

5 Stormceptor and Wet Basin, Lowes

Potential Green Infrastructure Locations

6 Mass Transit Project, Elm Street Redevelopment

7 Rain Gardens, Stormceptor and Infiltration Galleries, Ashley Street School

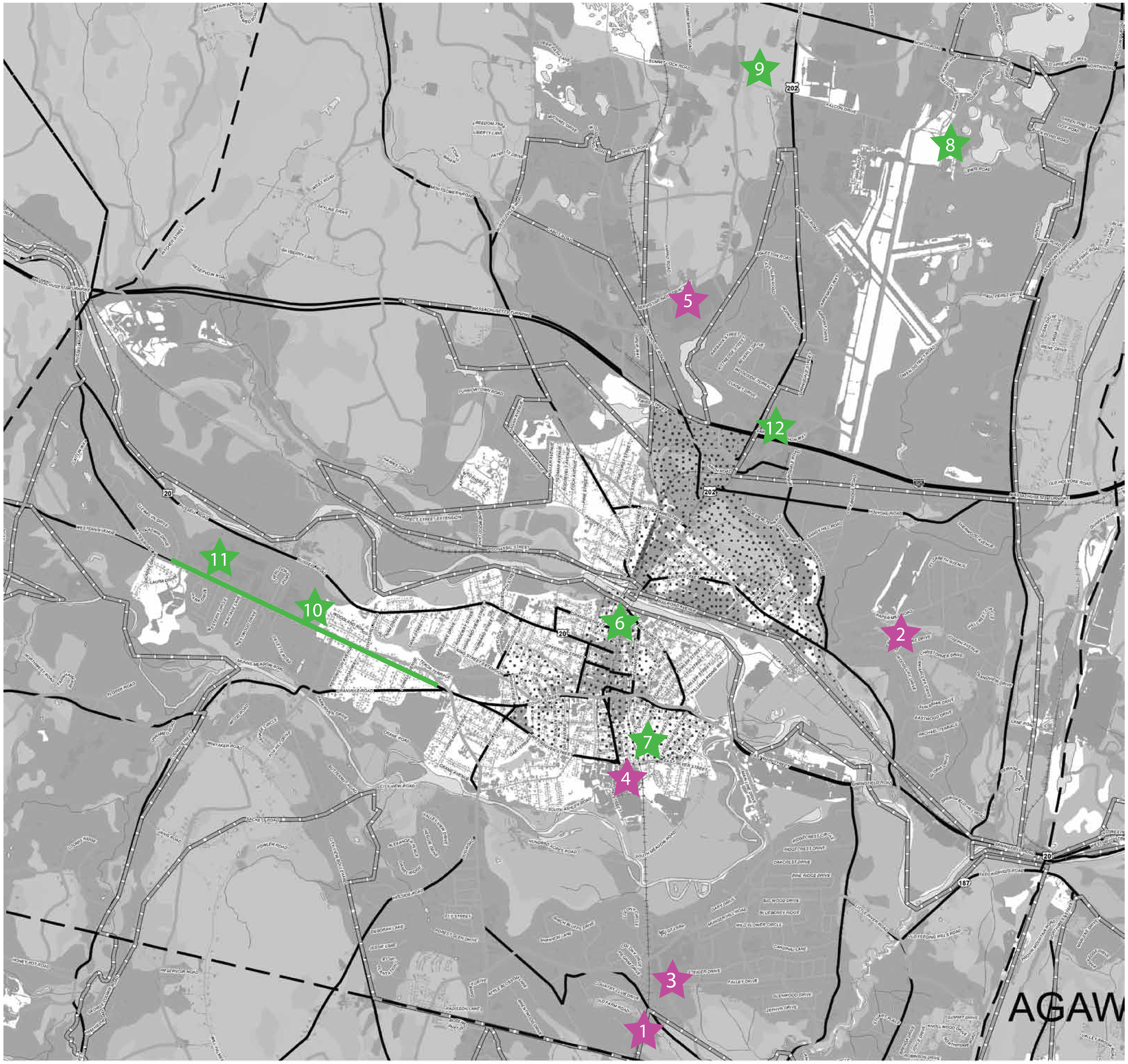
8 Stormceptor and Dry Detention Basins, Gulfstream Aerospace

9 Stormceptors and Infiltration Gallery, Armsbrook Village, Senior Living Facility

10 Western Avenue Roadway Improvements

11 New Construction Projects, Westfield State College

12 Vacant Lot at Turnpike Ramp



0 2,000 4,000 8,000 Feet

Roads Eligible for Federal Aid

Environmental Justice Areas

pvpc

N

*Potential locations identified by site assessments, soil maps, and conversations with city officials

Page left blank intentionally.

CHAPTER 4: ANALYSIS

I. KEY TOPICS TO GUIDE COMMUNITIES AND THE REGION

The field of green infrastructure stormwater management is rapidly evolving and consequently exploding with new information. This chapter explores select topics that seek to guide Pioneer Valley communities and the region in taking the next steps toward better stormwater management. These topics are:

- financing and funding green infrastructure
- building understanding and promoting engagement
- municipal policies and regulations
- redevelopment projects
- incentives
- design for green infrastructure facilities
- maintenance and inspections
- climate change mitigation

II. FINANCING AND FUNDING GREEN INFRASTRUCTURE

A. PUBLIC PROJECTS

Wherever there are considerations of stormwater management, as there are in most public development or redevelopment projects, there is a role for green infrastructure. Funding for green infrastructure work can come from a variety of sources already used to cover the costs of such projects, including roads, railways, sidewalks, and schools. The mix of funding sources might be further expanded by recognizing the many secondary benefits of green infrastructure. These include: ***social benefits***, such as avoided flooding and healthier neighborhoods; ***economic benefits***, such as job creation and increased property values; and ***environmental benefits*** such as cleaner waters and improved air quality. This more comprehensive accounting method is known as the "Triple Bottom Line" of green infrastructure used most notably by Philadelphia in their planning for green infrastructure. (For more information on the Triple Bottom Line approach, see Philadelphia's *Long Term Control Plan Update (2009).*) By integrating green infrastructure across the range of municipal projects while also accounting for all of the benefits to be derived, proponents can think more broadly and call on a far wider range of sources for project funding.

A national leader in green infrastructure, the City of Portland, Oregon, took a direct approach to integrating green infrastructure into projects as a way to abate stormwater flows into the combined sewer system. One strategy entailed adopting a green streets policy whereby all

City of Portland funded development, redevelopment or enhancement projects meeting the threshold in their stormwater management manual (of developing or redeveloping 500 square feet of impervious surface) must incorporate green street facilities.[1] This policy led to what EPA has described as, "…a formal process to overlay multi-bureau project plans and scheduled capital improvement projects to identify how public and private projects can achieve multiple community and environmental benefits through green infrastructure."[2] To cover the costs of green streets projects, Portland supplemented funds from general budget and capital improvement funds with innovation grants from EPA, revenue from a stormwater utility fee and from a one percent tax on construction projects that cannot meet the City's stormwater management regulations. What they learned, as did other case study communities examined by EPA, is that the increased investment necessary to include green infrastructure in large undertakings is typically a very small percentage of the total project costs. In addition, the use of green infrastructure elements can also decrease overall project costs, particularly with reductions in use of concrete or asphalt.[3]

Portland's story underscores how integrating or overlapping green infrastructure with street development, redevelopment, or enhancement can yield tremendous value. For Pioneer Valley cities and towns where might there be other possibilities of overlap that may be worth exploring? Figure 4.1 below identifies categories of projects where green infrastructure could be integrated. Projects identified in the diagram typically carry budgets funded by various sources.

The Knowledge Corridor New Rail Line and Stations

The new rail line and associated stations slated for Springfield, Holyoke, and Northampton, provide important opportunities to improve stormwater management in the urban core. While the Federal Railroad Administration allocation for rail corridor improvement does not include monies for drainage, supplemental funding sources could help to ensure that these projects attend to these important improvements. In the design of the rail platform at Depot Square, for example, the City of Holyoke is striving to include green infrastructure practices where possible. This work will be funded in part by a MassWorks Infrastructure Program grant.

[1] Exhibit A, Green Streets Policy, Portland, Oregon, April 2007. Available at: http://www.portlandonline.com/bes/index.cfm?c=44407

[2] "Green Infrastructure Case Studies: Municipal Policies for Managing Stormwater with Green Infrastructure." United States Environmental Protection Agency, 2010, p. 19.

[3] Ibid, p20.

Figure 4.1: Opportunities for Integrating Green Infrastructure with Other Projects

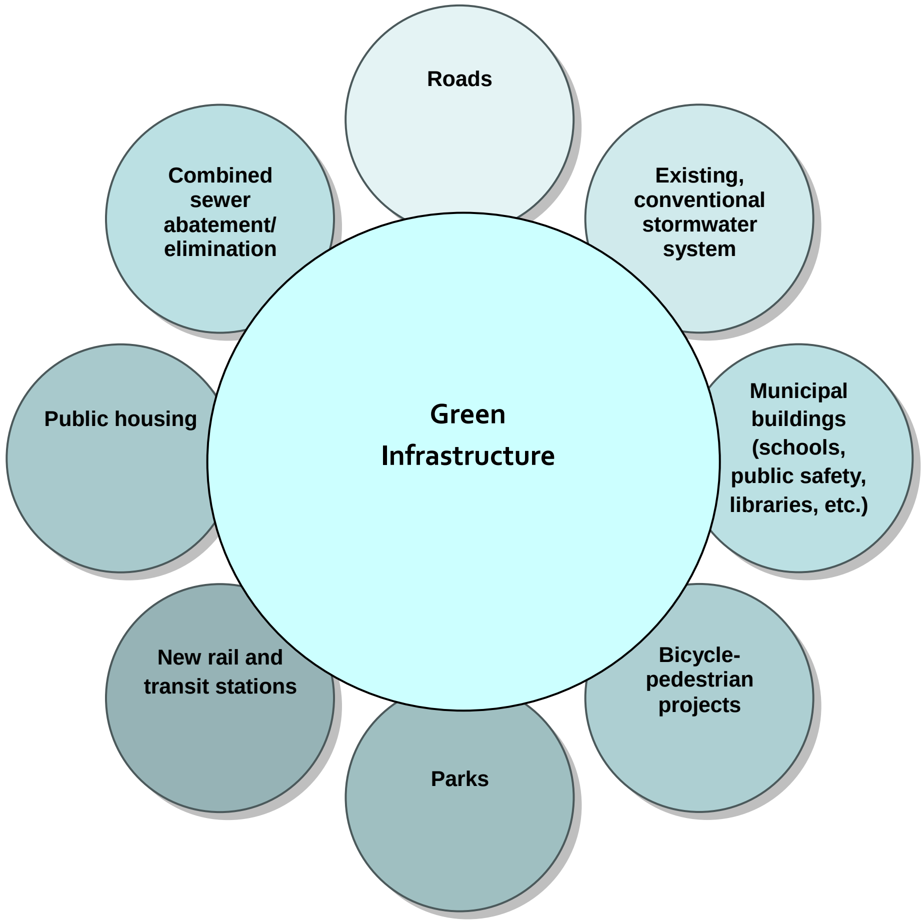


Table 4.1 below identifies the most common funding sources for various projects and identifies how funding might be enhanced to include green infrastructure, not only for design and construction, but for maintenance as well. The list here starts with the three major existing infrastructures explored in Chapter 2: roads, combined sewer, and stormwater, and then touches on most of the project types described in the diagram above.

Table 4.1: Potential Sources for Enhanced Project Funding

Types of projects	Typical funding source(s) for design, construction, maintenance	Potential sources of enhanced project funding with integration of green infrastructure
Roads - repairs and improvements on **interstates, urban and rural arterials, and urban collectors**	Federal surface transportation act with match from state (funds construction only) Chapter 90 and other state and local sources for design Hazard mitigation funding (where there is flood related damage)	1. Work with MassDOT to ensure that new project scoring criteria used by MPOs in evaluating projects for federal funding include points for managing stormwater through green infrastructure 2. Consult with officials from MassDOT's Impaired Waters Program to ascertain where there may be combined interests and possibly additional funds to improve stormwater management in specific locations that contribute to water quality problems. 3. Traffic calming strategies such as bump outs used to reduce vehicular speed can serve double duty to provide stormwater management functions as well. 4. Grants, particularly for innovative green infrastructure demonstration projects 5. Work to ensure that criteria developed for evaluating projects funded through the newly forming **Massachusetts Infrastructure Bank** give extra points to projects using green infrastructure stormwater management strategies.
Roads - repairs and improvements on **rural collectors and local roads**	Chapter 90 and general funds from municipalities (Note: MassDOT is seeking to increase Chapter 90 funding across the state by $100 million per year to help improve local roads and bridges.)	See numbers 3 through 5 in section above.
Combined sewer overflow elimination and abatement	Local sewer fees, loans from Clean Water State Revolving Fund (SRF), bonds	See numbers 2, 4, and 5 above. Also: 6. Work with congressional delegation to reinstitute federal funding promoting the improved cost effectiveness of green infrastructure solutions 7. Work with legislators to include within the state environmental bond bill specific CSO abatement work that includes green infrastructure projects 8. Work with MassDEP on Clean Water State Revolving fund project evaluation criteria to include points for green infrastructure stormwater

Types of projects	Typical funding source(s) for design, construction, maintenance	Potential sources of enhanced project funding with integration of green infrastructure
		management strategies on all projects, including those using recycled funds in the program. Also explore whether it may be possible to generate set aside funding (based on repayments or possibly through the Green Reserve program) that targets green infrastructure projects in CSO and MS4 areas.[4] 9. Work with MassDEP and EPA to promote use of Supplemental Environmental Projects funding for green infrastructure projects in CSO areas.
Repairs and improvements to **stormwater system**	General funds from municipalities, stormwater fees (Chicopee and Westfield), loans from Clean Water State Revolving Fund (SRF)	See numbers 4-5, and 9 above, and also: 10. Plan review and permitting fees for stormwater management plans 11. Tax on development projects that cannot meet stormwater requirements (Portland, OR, does 1%) 12. Corporate sponsorships
Parks	Municipal budgets; grants from Mass Department of Conservation and Recreation; Community Preservation Act (where it has been adopted locally)	13. Gateway City Parks Initiative 14. Massachusetts Parkland Acquisitions and Renovations for Communities (PARC) grants 15. Massachusetts Local Acquisitions for Natural Diversity (LAND grants) 16. Community Preservation Act funding
Public housing	Little to no funding available for construction of new public housing. Maintenance for existing housing is funded through rental income and potentially operating subsidies to housing authorities from Mass Department of Housing and Community Development	See 16 above. 17. Green Retrofit Program for Multifamily Housing (U.S. Housing and Urban Development) provided $250 million in loans and grants for energy and green retrofits in the multi-family assisted housing stock. The goal is to create green collar jobs; improve property operations by reducing utility expenses, and to benefit resident health and the environment. 18. Community Development Block Grant program. Projects would need to meet one of the three national objectives: assist low and moderate income persons; prevent or eliminate slums and blight; or meet an urgent community need where no other funding is available.

[4] The state of Illinois has run a program from such funds for the past three years with $5 million available each year for such projects.

Types of projects	Typical funding source(s) for design, construction, maintenance	Potential sources of enhanced project funding with integration of green infrastructure
Bicycle Pedestrian Projects	Massachusetts Chapter 90 program; Surface Transportation Program component to MAP-21; as well as: Congestion Mitigation Air Quality Program and the Transportation Alternatives Program, and Recreational Trails Program; The Massachusetts Department of Conservation and Recreation also funds project development through the Massachusetts Bond Issue. Many projects are also funded locally or included as part of a private developer's plan (the developer pays)	See numbers 3-5, and 13 above. 19. MassDOT's 21st Century Transportation Plan proposes $430 million in funding dedicated to constructing and improving bicycle and pedestrian facilities owned and managed by MassDOT and the Division of Conservation and Recreation.
Schools	School Building Grant Programs through the Massachusetts School Building Authority; local municipal budgets; and annual allocations from the state	20. The Massachusetts School Building Authority has instituted a Green Schools Program that promotes reduced energy and water consumption on all projects that they fund. Project proponents can follow the U.S. Green Building Council's LEED for Schools criteria or the Massachusetts Collaborative for High Performance Schools criteria. The MSBA may award a school district up to an additional 2 percent of a project's eligible costs if the project meets these criteria.
Libraries	Massachusetts Public Library Construction program; local municipal budgets; private donations	
Public Safety Complexes	Community Development Block Grants (if service area is >51% LMI); USDA low interest loan if population is less than 10,000; grant funds, and borrowing from the private sector	

MOVING TOWARD GREATER COORDINATION AND COLLABORATION

Many local public works officials conduct due diligence in order to ensure coordination for infrastructure projects. Promoting collaborations between municipal departments and other jurisdictions, however, can be more difficult. Capital Improvement Plans, which typically describe upcoming projects in a five year time-frame, can be one important tool, but an expanded plan review process and interdepartmental conversations may be most effective.

- In the City of Westfield, round table discussions are held on new development projects involving representative decision makers from each City department (i.e. Planning, Building, Engineering, Conservation, Water, Fire, Police, Gas & Electric, Health, Law, and Public Works). This clarifies for developers the requirements and expectations of each department, and allows City departments to address any concerns in an integrated fashion during the early stages of a project. While best stormwater management practices are written in the City's ordinance, these roundtable discussions ensure that practices are properly considered and implemented.
- In the City of Northampton, Department of Public Works (DPW) engineering staff review and provide feedback on the design of proposed infrastructure projects. These reviews led to conversations between the City's Stormwater Coordinator, the Transportation Engineer who manages the city's Traffic Calming Program, and other civil engineers about how projects might be combined to most effectively meet respective objectives. Following these initial discussions, opportunities to combine traffic calming/road narrowing with stormwater management objectives became apparent. The City is now beginning its second comprehensive road reconstruction project—the North Street Reconstruction Project—to combine "Complete Streets" objectives of creating roads that are safer for all modes of transportation with green infrastructure stormwater objectives.

B. PRIVATE DEVELOPMENT PROJECTS

With a focus on financial aspects of projects, private developers are primarily interested in ensuring a healthy bottom line. As part of a much larger project, stormwater management typically represents only a small percentage of the overall cost and green infrastructure approaches can often add value to projects. To finance projects, developers often rely on equity (personal and from investors) and construction loans. They can also draw on a wide array of grants and tax incentives (including brownfields programs, New Markets Tax Credits, low income housing incentives, etc.)

The cost of integrating green infrastructure into a project may depend on whether the development is occurring as a redevelopment in an urbanized location or as a new development in a more suburban or "greenfield" location. In developments on previously undeveloped sites, low impact development approaches, such as minimizing impervious cover and installing curb-and-swale infrastructure instead of curb-and-gutter infrastructure, can help to reduce overall development costs.

- In Pelham, New Hampshire, a subdivision that took a low impact approach to site development and used green infrastructure stormwater practices realized a 6 percent cost savings on the total cost of stormwater infrastructure. In addition to reducing the number of acres to be cleared, project proponents were able to avoid the use of 1,616 feet of curbing, 785 feet of pipe, 8 catch basins, 2 detention basins, and 2 outlet control structures.[5]
- A commercial development in Greenland, New Hampshire, produced a 26 percent savings on total cost of stormwater infrastructure by taking a low impact development approach and using green infrastructure stormwater practices. While paving costs for porous asphalt were considerably more expensive, there were total project savings of $930,000 based on reduced costs associated with earthwork and stormwater management.[6]

Conversely, a recent study found that for development projects where there is 65 percent existing impervious cover, green infrastructure facilities can cost up to 4 times more than in new development.[7] In some real estate markets, there is a favorable response to green infrastructure.[8] This can allow redevelopment projects to recoup construction costs through higher real estate values. LEED® Certification can help to sell development projects at a premium and to market a property's green infrastructure and other environmentally progressive features. (For a more complete discussion of costs for redevelopment projects see section on that topic within this chapter.)

Increased project costs, however, may have nothing to do with whether a project is a greenfield development or a redevelopment. During construction at L-3 KEO's Northampton facility, a failure of adequate oversight to ensure proper grading for drainage to parking lot bioretention areas resulted in untold costs to rectify problems.[9] Until municipalities, designers, and contractors become more practiced with developing these types of facilities, such problems may arise.

Municipalities can help to keep costs down for private development by ensuring that green infrastructure projects are supported within the existing code: zoning, subdivision regulations, and stormwater management ordinances or bylaws. The increased time and fees in the

[5] "Right Practice, Right Place: Green Infrastructure Technologies that Work in New England," Robert Roseen presentation at EPA's Growing Your Green Infrastructure Program, December 6, 2012.
[6] University of New Hampshire Stormwater Center, "Greenland Meadows LID Case Study: Economics," April 2011.
[7] Chesapeake Stormwater Network. "Stormwater Design for High Intensity Redevelopment Projects in the Chesapeake Bay Watershed. Version 2.0." CSN Technical Bulletin No. 5. January 5. 2011.
[8] EcoNorthwest. "Managing Stormwater in Redevelopment and Greenfield Development Projects Using Green Infrastructure: Economic Factors that Influence Developers' Decisions." 2011.
[9] Presentation by John Weatherwax, Manager, Maintenance/Environmental and Safety Officer, L-3 KEO, on Stormwater Management System: Lessons Learned, September 24, 2012

development approval process, particularly if variances and additional permitting time are required, increases the uncertainty and time in getting a project constructed, both of which can raise the project cost.[10]

C. FUNDING MECHANISMS/TOOLS

STORMWATER UTILITY/FEE

A stormwater utility or fee has been defined as, "...a dedicated and separate fund created to pay for stormwater management, planning, and outreach activities within a specified area." [11] A stormwater utility reinforces the notion that stormwater management—like sanitary sewer management and drinking water—is a public service. A fee can be collected on a separate bill, added to a water collection bill, or added to the property tax bill. Rates can be structured so that each property owner in a certain category (one family, multi family, commercial, etc.) pays the same rate or so that each property owner pays a dollar per unit cost based on the quantity of impervious surface on a property. Bellevue, Washington has one of the longest running stormwater utility programs in the United States (established in 1974). In Massachusetts, stormwater fees and utilities have been implemented in five cities and towns, as a means to raising the necessary funds to help with combined sewer overflow elimination and/or to meet federal stormwater requirements. (See text box at right.)

A guidance document prepared by the National Association of Flood and Stormwater Management Agencies notes, "The fundamental objective of a service fee/utility is attainment of equity. Service fee rate methodologies are designed to attain a

Stormwater Utilities In Massachusetts

There are two companion pieces of legislation that allow municipalities to set up stormwater utilities in Massachusetts: MGL Chapter 83 Section 16 and MGL Chapter 40 Section 1A.[12] The first, MGL Chapter 83 Section 16, is relatively new enabling legislation that allows municipalities to set up a stormwater management utility and charge utility fees for managing stormwater. The second, MGL Chapter 40 Section 1A, provides a definition of a district for the purpose of water pollution abatement, water, sewer, and/or other purposes. Together, these two pieces of legislation allow a municipality to set up an authority to manage stormwater and to charge utility fees for managing stormwater, just as utility fees are charged for managing and providing drinking water, sewering, and other public services. To date, there are five stormwater utilities in the state: Chicopee, Fall River, Newton, Reading, and Westfield.

---

[10] MacMullan, E. and S. Reich. "The Economics of Low Impact Development: A Literature Review." EcoNorthwest. 2007.

[11] University of Maryland Environmental Finance Center website: http://www.efc.umd.edu/SFOUfinoptions.html

[12] Stormwater Financing and Stormwater Utilities Frequently Asked Questions. Salem Sound CoastWatch website: http://www.salemsound.org/PDF/StormwaterFinancingFAQs.pdf

fair and reasonable apportionment of cost of providing services and facilities."[13]

According to a survey by Western Kentucky University, the proliferation of stormwater utilities within states appears to have a strong correlation with whether there is a supportive regulatory climate. In the states with the highest number of stormwater utilities, Florida, Minnesota, Washington, Wisconsin, and Texas, the right to enact stormwater utilities and assess fees is clearly defined in state law.[14] There are several benefits of a stormwater utility:

- Provides dedicated and stable source of funding for a stormwater management program
- Considered equitable because users pay for the stormwater services they receive, especially if the fee structure is based on variables such as the amount of impervious surface, property size, and land use type. Discounts or offsets can be provided to low-income residents, further ensuring the fee's equitability.
- Creates funding that can be leveraged to meet grant and bond requirements
- May enable municipalities to consolidate or coordinate responsibilities previously dispersed among several departments and develop programs that are comprehensive, cohesive, and consistent year to year
- Tax-exempt properties like universities, hospitals, and places of worship are required to pay the fee, so that they help cover the cost of services they receive
- Typically easier for the municipality to institute than other forms of funding. "In many communities, new taxes require a vote of approval by the public, while a fee is a charge that municipalities have the authority to leverage for the services they provide."[15]
- If a credit or reduction is offered, the fee can become an incentive for green infrastructure stormwater management on private property (see "stormwater fee discounts/credits" under Incentives section within this chapter).

To achieve desired objectives without causing harmful unintended consequences, several considerations should be taken into account when setting stormwater fees:

- Set rates so that the fee provides adequate revenue to achieve stormwater goals. If the fee is unreasonably high, it will not be supported. If it is too low, promised benefits will not materialize and public support is likely to erode.

[13] "Guidance for Municipal Stormwater Funding," National Association of Flood and Stormwater Management Agencies, January 2006.
[14] Western Kentucky University Stormwater Utility Survey, 2012. See: http://www.wku.edu/engineering/documents/swusurveys/swusurvey-2012.pdf
[15] US Environmental Protection Agency. *Managing Wet Weather with Green Infrastructure Municipal Handbook: Funding Options*, p. 2., 2009. See: http://water.epa.gov/infrastructure/greeninfrastructure/upload/gi_munichandbook_funding.pdf

- Start with a thoughtful outreach campaign that generates enthusiasm for the community's stormwater vision. No one wants new fees or taxes, but if residents understand the benefits they will receive they are more likely to support the fee.
- Be sure that the greatest costs are directed toward those who create the most runoff, particularly commercial and industrial facilities with large areas of impervious cover, rather than residential and other properties with low impervious cover.[16] At the same time, municipalities should be sensitive to where residents may already be paying stormwater management fees through homeowner associations.
- Ensure the fee does not harm low-income residents, as in Detroit, where an increase in stormwater fees caused some low-income residents to be unable to pay their water bill and have their water turned off. Sliding fee scales, bill discounts, crisis vouchers, and zero interest loans for qualified customers are options for offsetting the burden on lower income residents.[17]

BETTERMENTS AND MANAGEMENT DISTRICTS

- MGL Chapter 80 allows for the assessment of cost of public improvements by municipalities. Whenever a certain location or district receives exclusive benefit or advantage from a public improvement, betterments can be assessed in that area for the improvement. This could be the case where several neighborhoods in a town require improved stormwater infrastructure. The cost of improvements can be offset by charges to those properties located within that jurisdiction.[18]
- To implement the Long Creek Watershed Management Plan in Maine (the result of a citizen's lawsuit over impaired waters), landowners in four municipalities joined forces to create the Long Creek Watershed Management Plan District. The District collects fees from property owners and uses the money to restore Long Creek and install stormwater retrofits. The fee is $3,000 per acre of impervious surface per year.[19]

OTHER FEES

- Stormwater permit fees can be assessed for construction activities that disturb an existing site and could potentially discharge stormwater to surface waters. While these fees address potential stormwater impacts related to new construction, these fees are site specific and can be an unreliable source of funding when development slows.[20]

[16] Ibid.
[17] Ibid.
[18] "Funding Stormwater Management," Metropolitan Area Planning Council, Draft Presentation Handout, November 17, 2010.
[19] "The Pavement Proxy," *Landscape Architecture Magazine*, April 2012 by Lisa Owens Viani
[20] Ibid.

- The City of Westfield established a connection fee associated with new sewer hook ups aimed at helping to increase capacity at the wastewater treatment plant (where the City was reaching capacity), For every new gallon of sewage to be generated, the customer pays a fee equivalent to the cost of fixing 5 gallons worth of infiltration and inflow. It may be worth exploring whether this same strategy could be applied to stormwater whereby new connections to the system help to mitigate other flows into the system, thereby preserving capacity and avoiding the need for costly expansion projects.
- In 2007, the City of Portland, Oregon, began collecting one percent of the construction budget of any City of Portland funded development, redevelopment or enhancement project that is not subject to the requirements of the City's Stormwater Management Manual, but requires a street opening permit or occurs in the right of way. Money goes into the "1% for Green Fund," which supports construction of green street facilities to manage stormwater, enhance livability, and provide other environmental benefits.[21] This fee might be more broadly assessed to *all* redevelopment projects that cannot fully meet stormwater requirements.

Sustainable Financing: The Example of Lenaxa, Kansas

The City of Lenaxa, Kansas, established three financing mechanisms to help cover the various costs associated with stormwater management.

To help cover the capital costs of upgrading and repairing the existing stormwater system, voters approved in 2000 a 1/8th cent sales tax that would sunset within 5 years. The sales tax generated $7.2 million dollars and voters were apparently so pleased with the stormwater upgrades that they approved an extension for another 5 years.

To cover the long term operation and maintenance of the stormwater system, the City Council in 2000 approved a stormwater utility that collects approximately $66 annually from residential properties and a fee from commercial and non residential properties that is based amount of stormwater runoff generated by the property. The fee is collected as a special assessment on the Johnson County property tax bill.

To cover the costs for increasing services and capacity in the stormwater system, the City in 2004 implemented a one time fee "capital" development charge that developers pay when they apply for a permit. The idea is that "growth pays for growth."

Sources: http://www.lenexa.com/raintorecreation/about_us.html and December 6, 2012 presentation by Jennifer Cotting, Environmental Finance Center, University of Maryland.

[21] City of Portland Oregon, Green Street Policy, Approved April 2007. For more information, see also: http://www.portlandonline.com/bes/index.cfm?print=1&a=341452&c=44407

SPONSORSHIPS

Several communities have been able to tap into local businesses to provide donations and sponsorships for green infrastructure projects.

- In Portland, Maine, businesses helped to cover $20,000 of the $64,000 cost for a demonstration rain garden along the tidal Back Cove. The garden covers 2.5 acres of land adjacent to a popular recreational trail that is heavily used by walkers, joggers, and cyclists. The project's popularity led to the installation of a second rain garden adjacent to the trail's parking area, which was designed and funded by Stantec, a national engineering firm with local offices. Signage at the rain gardens highlights corporate sponsors.[22] This idea builds on the successful Adopt a Trail corporate sponsorship program run by Portland's local land trust.
- In Lynchburg, Virginia, a new corporate sponsorship program is drawing funding for the installation of demonstration rain gardens in prominent public places throughout the City. Each garden is sponsored by a local business, which is then credited with an attractive sign onsite. To date, this program has raised over $1.6 million and established 50 gardens.
- Virginia also has a related statewide program called Streetscape Appearance Green Enhancement (SAGE), a comprehensive roadside management program that has been in existence since 2006. Funded entirely by donations, but managed by municipalities, the program aims to beautify local streetscapes, boost civic and community pride, and facilitate future economic development. Municipalities manage the donations through a 501 (c)3 non-profit and contributions are organized so as to cover construction, maintenance, and renewal, typically after 5 years.[23]

D. CHALLENGES AND OPPORTUNITIES

CHALLENGES

1. Where once the federal government was the major source of funding for public infrastructure projects, the availability of federal dollars, particularly for water related infrastructure is gone. Communities across the region are suffering with constrained budgets that cannot come close to meeting the needs of aging combined sewer and stormwater systems.

2. Many communities—for a multitude of reasons—lack the political will to levy fees or taxes that could help promote improved stormwater management.

---

[22] http://www.pressherald.com/news/new-gardens-nurture-nature-naturally_2012-06-11.html?searchterm=back+cove Also: http://www.pressherald.com/life/homeandgarden/rain-garden-gives-city-a-green-way-to-stop-flow-of-pollution-_2010-07-04.html).

[23] http://www.sage-project.com

3. It is not easy to ascribe dollar value to some of the benefits of green infrastructure. Articulating the avoided costs that come with green infrastructure is also difficult. These values are further complicated in that they involve more expanded, longer term horizons, such as averting flooding, that are difficult to comprehend when there may be more immediate struggles with managing limited monies in the shorter term.

4. For inclusion of green infrastructure elements within larger infrastructure projects (such as road reconstruction), the main impediment is not necessarily cost (green infrastructure is typically a small portion of a road reconstruction project budget), but rather education and priorities. Many people are not familiar with green infrastructure concepts, and most communities do not have policies that call for systematic inclusion of green infrastructure within municipal construction projects.

5. Though green infrastructure implemented area wide could help to mitigate natural hazards and build community resiliency, grant programs out of the Massachusetts and Federal Emergency Management Agencies do not as of yet provide opportunities for funding of green infrastructure stormwater management projects. The Massachusetts Emergency Management Grant Program's State Hazard Mitigation Officer Richard Zingarelli notes:

> Standard hazard mitigation projects require a benefit-cost analysis that shows that the cost of the project is exceeded by the benefit as measured by direct reduction of damages from natural hazards. The difficulty is that it is difficult, if not impossible, to quantify a direct reduction in damage that results from measures like green roofs and porous pavement. As a result, any limited eligibility for funding in these programs would fall under the "5% Initiative" of the Hazard Mitigation Grant Program (HMGP), which allows for setting aside up to 5% of the total available HMGP funding for activities that are difficult to evaluate using traditional cost-effectiveness criteria.[24]

It is important to know that the use of the word "mitigation" in emergency preparedness means avoidance and preparation (resiliency) and is more closely linked to the concept of "adaptation" in climate change.[25]

OPPORTUNITIES

1. If municipalities, as with the example of Portland and green streets, can encourage cross departmental collaborations, there is a great possibility of producing more cost-effective multi-purpose construction projects. At the same time, capital improvement projects with multiple benefits can more easily tap into multiple funding sources.

2. The spread of "Complete Streets" concepts and growth of local traffic calming programs create a significant opportunity, as many communities are beginning to focus resources on

[24] November 1, 2012 e-mail correspondence with Richard Zingarelli,
[25] Northampton Emergency Management Coordinator Josh Shanley, phone conversation 10-19-12.

efforts to improve the street experience for pedestrians and bicyclists in neighborhoods and other developed areas. Because green infrastructure enhances the streetscape and helps create places that are more pleasant to walk and bike, it provides an important complement to traffic calming projects.

3. Westfield and Chicopee set good examples of communities where stormwater utilities/fees are providing an important revenue stream for stormwater work. If Northampton also adopts a similar program, it may become more politically palatable for other communities to move in this direction. Communicating the stories of each of these communities and making clear the dollars now available could be helpful.

4. The Massachusetts Infrastructure Bank, authorized in the March 2012 transportation bond bill, will leverage private investments in order to make loans for energy, transportation, and municipal development projects. There may be opportunities here to work with Mass DOT to ensure that green infrastructure is an integral component to projects funded through the bank.

5. Development of a simple spreadsheet tool that quantifies the degree to which the implementation of green infrastructure stormwater management facilities applied across a given area—perhaps converting x number of streets in a given subwatershed to green streets—mitigates damages from natural hazards could help to make the case for funding to FEMA and MEMA. A comparable tool is in development at EPA on cost optimization for green infrastructure investments as balanced with water quality benefits.

6. It may be worth exploring whether a water quality credits trading program can help municipalities better manage the oppressive financial burden of eliminating and abating combined sewers. Water quality trading is a market-based approach—an idea that has emerged from the energy market—that enables jurisdictions to achieve needed pollution controls through the purchase of credits for a particular pollutant. Landowners can produce water quality credits by implementing green infrastructure practices that reduce volume and pollutants, and typically at a much lower cost than a municipal treatment facility. EPA notes, "Through water quality trading, facilities that face higher pollutant control costs to meet their regulatory obligations can purchase pollutant reduction credits from other sources that can generate these reductions at lower cost, thus achieving the same or better overall water quality improvement. In most cases, trading takes place on a watershed level under a pollutant cap (the total pollutant load that can be assimilated by a waterbody without exceeding water quality standards) developed through the TMDL process or a similar type of water quality analysis that produces information on pollutant loadings and resulting water quality conditions."[26] For the Long Island Sound TMDL, the state of Connecticut adopted trading legislation. Public Act No. 01-180, which establishes the trading framework for a Long Island Sound Nitrogen Credit Exchange Program to be directed by a Nitrogen Credit Advisory Board

[26] *Water Quality Trading Assessment Handbook*, U.S. Environmental Protection Agency, 2004.

appointed by the General Assembly and the governor. EPA notes, "The Nitrogen Credit Exchange Program establishes a well-defined trading structure supported and regulated by limits mandated in state law. The state legislation specifies trading ratios (e.g., delivery and location ratios) and accounting methodologies to formalize all calculations used in trading."[27]

7. Many federal officials recognize the monumental challenges facing local communities given the decline of federal funding for projects. The Environmental Protection Agency, Housing and Urban Development, and Department of Transportation in particular are working to collaborate on projects where they have combined interests. Green infrastructure seems to be one such area of combined interest. The National Association of Regional Councils recently produced an online tool called, "A Roadmap to Green Infrastructure in Federal Agencies" that helps to navigate how each of these agencies as well as others value and support green infrastructure. See: http://narc.org/issueareas/environment/areas-of-interest/green-infrastructure-and-landcare/roadmap/

II. BUILDING UNDERSTANDING AND PROMOTING ENGAGEMENT

As a region, the Pioneer Valley is at the beginning of a learning curve with green infrastructure. This is true for most municipal officials who are just starting to consider and promote these new practices, as well as political leaders, businesses, developers, and local residents who may have little understanding of stormwater issues. At this nascent stage, there are also perceptions related to green infrastructure that can act as barriers (e.g., facilities are difficult to maintain and are not sustainable over the long term). The barriers created by these perceptions can be especially challenging to overcome during times of social and economic stress when human tendency is to stay with what is already known, with what is familiar.

Education and engagement, above all other possible strategies, are of paramount importance in advancing green infrastructure practices. Within this realm of education and engagement there are two fundamental needs:

1. developing good information about green infrastructure for our region and communities
2. finding effective ways to engage target audiences in the conversation about green infrastructure

[27] *Water Quality Trading Toolkit for Permit Writers*, U.S. EPA, August 2007, updated June 2009.

A. DEVELOPING GOOD INFORMATION

We are in a phase with green infrastructure during which it is important to draw together all that we learn and understand. These needs for information include the following:

- Good examples of green infrastructure facilities within the Pioneer Valley region that tell our own stories of success and lessons learned.[28] Some of the examples described within the pages of this plan provide a good starting place, but much more must be done. The region needs pilot and demonstration projects, particularly for practices that have not yet been implemented in the region, such as green streets or tree box filters.
- A clear articulation of current infrastructure needs and the costs that might be avoided with green infrastructure. Can green infrastructure solutions help the City of Chicopee avoid some of the $200 million plus costs of eliminating/abating combined sewer overflows and some of the $150 million cost associated with replacing storm pipes that are not being replaced by combined sewer projects? How might green infrastructure strategies help Northampton avoid the projected $400,000 to $1 million annual operating costs to address the City's stormwater and flood control systems? The analysis may require time and effort, but the answers to these questions could be instructive and provide firm direction.
- An analysis of how green infrastructure is helping to avoid costs by averting flooding. From Vermont there is a good example of how protection of open space and particularly a wetlands system along the Oyster River helped to avert devastation in downtown Middlebury during Tropical Storm Irene. See: http://action.clf.org/site/PageNavigator/hurricane_irene_anniversary.html
- Bolder lines that make the connection at the local level between: 1. the value of water (the work of bringing clean water to the tap); 2. rates (how little we actually pay for water); and 3. the importance of stormwater as a resource (keeping it clean to recharge groundwater and provide baseflow to rivers to lighten the burden of bringing clean water to the tap).

B. FINDING EFFECTIVE WAYS TO ENGAGE TARGET AUDIENCES

While there are many varied audiences in the Pioneer Valley region, there are five target audiences that are instrumental to advancing the work of green infrastructure. Perhaps the most effective approach will begin with these audiences in mind.

---

[28] Stories and examples of success from communities in other parts of the country, such as Portland, Oregon, or Chicago, Illinois, that are much further along with green infrastructure, while helpful, can be discounted as "not from around here."

1. Local residents and businesses, who can help provide support for initiatives at the local level and who can implement practices on their own properties. With this audience, it is important to understand that concerns about stormwater management and environment are likely not priorities. Concerns about finances, housing, education, transportation, employment, and health may take precedence.[29] Fortunately, stormwater management often has ties to these other concerns so being creative and aware of how to make these connections with a given audience will be important. The basics about stormwater, including the water cycle and where water goes when it falls, provide the best starting place.[30] Beyond that, there seem to be four questions that ought to be addressed in engagement activities: What does green infrastructure look like?[31] Why is green infrastructure important?[32] What can residents and business do to engage in supporting green infrastructure projects? What practices can residents and business implement on their property to help improve stormwater management? At the same time, local residents and businesses talking about the possibility of green infrastructure projects in their neighborhoods will likely have specific concerns. It is important to address these concerns with concrete examples. These might include: showing how the proposed installation of street trees and other green infrastructure features can enhance the attractiveness of local streets and boost clientele for local businesses; showing how mosquito production can be averted through proper design; or showing how proposed changes in local codes will translate into appealing and well functioning places.

2. Municipal officials who are involved in decision making, budgeting, constructing, maintaining and operating stormwater systems, as well as helping their bosses and constituents understand project proposals. Broadly, this audience needs to be equipped to understand the core issues related to green infrastructure, particularly: How do the costs of construction and maintenance compare to current practices? What are cost effective ways to go about prioritizing projects? What are good design and maintenance standards and lessons learned with each of the different types of facilities? What are effective strategies and regulations for ensuring that new development and retrofit development incorporate green infrastructure strategies (without discouraging development)? Workshops combined with

[29] In a Community Dialogues project associated with this plan, 176 people from the region provided their thoughts on housing, education, transportation, employment, health, and environmental issues. Environmental issues ranked lowest in terms of priority, but many astutely noted that by working on addressing other concerns, environmental issues would be addressed. Improved public transportation, for example, would result in fewer emissions.

[30] An EPA representative working with the City of Northampton on a green streets technical assistance program noted this as a valuable lesson following a public meeting in March of 2012.

[31] Providing a visual understanding, through images that show before and after examples, or through temporary demonstration projects where a parking lot or street are greened for a day-long event may be effective.

[32] Drawing on direct experience of some of the consequences of current stormwater management practices (flooding, polluted rivers and streams) may be most powerful in convincing people. Where appropriate it may also be useful to mention the need to better prepare for the more frequent larger storms that we are experiencing due to climate change and how a system of green infrastructure practices across a watershed could help mitigate these impacts.

peer to peer information sharing sessions may be the most productive form of engagement with municipal officials.

3. Developers and others in the private or non profit sector who are investing in, designing, constructing, and maintaining stormwater facilities. It is critical to acknowledge that this is a large and varied group with a variety of needs associated with their different roles. For those investing in green infrastructure, information about evolving regulations, incentives, and costs and benefits in the short and long term are important. For those designing, constructing, and maintaining stormwater facilities, there are some important lessons learned in the region to date that are instructive. There must be: 1. good communication between design consultants (engineers and landscape architects) on projects, 2. oversight during construction by someone who has the skills to ensure that green infrastructure facilities are built as designed and will function properly; and 3. clear instruction for those responsible for maintaining such facilities, including frequency of activities to ensure proper long term function and measures to be used in assessing proper functioning. Workshops and tours related to well designed and built facilities could be one important way to engage this audience. These could be most effective if coordinate with existing professional organizations.

4. Political leaders who provide direction and vision on major local initiatives such as green infrastructure, including commitments in funding and staffing. Answerable to their constituents, political leaders need to have a full picture of the issues related to green infrastructure, particularly what are the advantages and benefits and what are the challenges. It is also important for them to understand how green infrastructure might combine with ongoing initiatives, such as parks, combined sewer separation, and streetscape improvements, to transform neighborhoods and downtowns. Visualizations could be particularly helpful in this regard. For political leaders, green infrastructure projects will provide a much more apparent outcome for public investments than do traditional "gray" infrastructure projects, which are typically underground and essentially invisible.[33]

5. State officials and members of the Metropolitan Planning Organization, and Joint Transportation Committee who often have tremendous influence on direction and decision making in the region. The level of understanding about green infrastructure stormwater management strategies can vary greatly from one individual or one agency or group to the next. Within each of these agencies or groups, however, there is typically at least one person with expertise on the topic of green infrastructure. At MassDOT, for example, knowledge and expertise about best stormwater management practices is growing as the new Impaired Waters Program enters the implementation phase. Moving forward it is important to draw on this specialized knowledge, use existing forums, such as meetings or workshops, and supplementing information where needed.

[33] This is mentioned in the first chapter of this plan, but this important point seems worth mentioning again here.

C. CHALLENGES AND OPPORTUNITIES

CHALLENGES

With the concept of green infrastructure so new to the region, education and engagement is a key challenge. It is true that the ideas associated with enhancing or mimicking natural hydrology have been around for more than 10 years and the state and many Pioneer Valley municipalities have codes that require proposed developments to at the very least consider these stormwater management strategies. For many, the connection between stormwater management practices and the quality of water in our rivers and streams is also not new. What is new is the idea that for maximum effect these stormwater management practices and facilities ought to extend across a watershed's developed area to function as infrastructure. Taking this rather large step up from where we have been presents at least two major challenges:

1. Development of good information on green infrastructure that is meaningful to local communities

2. Overcoming perceptions that serve as barriers. For the region, municipal officials identified the following at a roundtable sessions in February 2012:

- green infrastructure costs more to build
- facilities are difficult to maintain and are not sustainable over the long term
- performance is not proven in our New England climate
- green infrastructure won't work in urban soils
- there is greater liability associated with these facilities
- the private sector is choosing not to do green infrastructure

There may be other perceptions that are yet to be identified. Within the communities of the region, there may also be perceptions that are based on cultural orientation. For example, immigrants from warmer climates where mosquito disease transmission of such diseases as Dengue Fever are common , could feel like bad neighbors if they were to use a rain barrel or allowed stormwater to pool in any way on their property. Likewise, there may be limitations based on economics. A person renting a property may not be as inclined to take up better stormwater management practices as would someone who owns a property. In the emerging conversations about green infrastructure, identifying and understanding these barriers will be important.

OPPORTUNITIES

There is an explosion of interest and information in the field of green infrastructure as federal agencies more fully promote these stormwater management strategies for meeting permit requirements and as "early adopter" communities of green infrastructure share their information and stories of success. There are also ongoing efforts in the region that could serve as important building blocks to a green infrastructure education and engagement program.

1. Massachusetts Think Blue is a consortium of 12 EPA regulated stormwater communities that have been collaborating for the past several years on stormwater education. They have done posters, radio ads, and educations campaigns to advance understanding and encourage practices that will lead to improved water quality.

2. The University of New Hampshire Stormwater Center conducts research and development of stormwater treatment systems and provides technical resources to stormwater managers, planners, and design engineers in New England and throughout the U.S. The Center offers technology demonstrations and workshops, as well as specialized training opportunities (e.g., porous pavements). They issue a range of publications, including a biannual data report on design and performance of BMPs at their field facility. Performance data released by the Center has been used in presentations by numerous other entities (e.g. EPA BMP DSS Model, EPA Green Infrastructure Webcast March 3, 2009), and as a basis for developing regulations and guidance in several states (e.g. MA, NH, RI). [34]

3. Bay State Roads is a cooperative program involving the Federal Highway Administration, MassDOT, and the University of Massachusetts at Amherst. The program provides technology transfer assistance to communities throughout the state, including regular transportation-related workshops of interest to municipal officials.

4. EPA, Region 1, Soak up the Rain Campaign is a recently launched program to encourage residents and businesses throughout New England to take up practices that soak up the rain and thereby reduce polluted runoff into streams, lakes, rivers and coastlines. For more information, see: http://www.epa.gov/region1/soakuptherain/ Through this program, EPA is working with Youth Build Boston, students from Central High School, and the Springfield Parks Department on a rain garden installation in front of the nearby skating rink in Springfield.

5. Existing green infrastructure projects in the region provide an important platform from which to expand understanding about such facilities and demonstrate the value of stormwater as a resource. They are also critical to building understanding about proper and effective maintenance. Capitalizing on these many opportunities throughout the region can be done through signage, brochures, and perhaps even more creative outreach strategies. In a recent article civil engineer and "eco-urbanist" Jonathan Ford notes that stormwater management solutions function best on a long term basis when benefits become apparent. He notes that they are best when they are: obvious (surface filters,

[34] http://www.unh.edu/unhsc/about

bioretention, tree filters, green roofs, pervious paving surfaces); simple (bioretention, vegetated swales, natural filtration systems and erosion control measures, roof downspout daylighting, rainwater harvesting); lovable (landscaping that provides double duty for stormwater management, green roofs); not needed in the first place (compact development, redevelopment/infill, shared parking and reduced parking requirements, appropriate width streets, minimized ornamental lawn).[35]

IV. MUNICIPAL POLICIES AND REGULATIONS

Policies and regulations are critically important to the success of green infrastructure. One illustration of this is a review of 2010 construction permits in New York State, which found that in the absence of a permit requirement, only 22 percent of development sites infiltrated stormwater, only 2 percent employed alternative green infrastructure practices, and few applicants proposed to maintain pre-development hydrology.[36] Under the new NPDES permit, regulated municipalities must assess existing local regulations to determine the feasibility of making green infrastructure practices allowable. Municipal regulations that affect stormwater runoff and associated water quality impacts fall into the following general areas:

- Municipal policies, which govern municipal road building, facility development, and stormwater infrastructure practices
- Stormwater regulations, which establish performance targets for private developments
- Overlay districts, which provide special protections to sensitive environmental resources
- Source reduction regulations, including bans on chemical fertilizer and pesticide use, as well as use of coal tar sealants
- Site development regulations that govern parking and driveways
- Subdivision Regulations, which govern the private development of new roads, and
- Zoning regulations, which govern how land used and developed, which in turn, has significant water quality implications

A. ROADS AND MUNICIPAL INFRASTRUCTURE

Existing road infrastructure typically accounts for 50 to 75 percent of impervious cover, and nearly 74 percent of all roads are municipally-owned. Municipal road development policies thus have enormous direct water quality impacts. At the same time, the approach to

[35] "Great Places in Balance with Nature," Jonathan Ford, Planetzin, January 30, 2012
[36] Shades of Green – Natural Concepts for Stormwater management. Karimipour, Shohreh. Fall 2011. Clear Waters.

municipal road building or rebuilding can set an example for others by modeling good stormwater management practices.

Reconstruction projects provide a significant opportunity to retrofit existing roads with green infrastructure measures that improve water quality. First and foremost, in many cases travel lane widths can be narrowed and total paved area can thereby be reduced. However, lane narrowing (e.g. from 12' to 10') is often accomplished by simply repainting lines (and therefore does not reduce the total impervious area), or is used to accommodate the addition of bike lanes. Still, lane narrowing can provide an effective green infrastructure strategy in locations with multiple lanes or in downtown locations where lane narrowing can allow for sidewalk widening with planters or green strips.

In addition to lane narrowing, road reconstruction projects can be designed with bioretention areas within the road right-of-way to detain, treat, and infiltrate stormwater runoff. This strategy is most easily applicable along roads in less developed areas where there is abundant roadside land and no storm drain infrastructure. However, many cities are demonstrating that bioretention areas can be effectively sited in urban areas as well. Neighborhoods and general business zones may be appropriate areas for using the right-of-way to selectively bring small amounts of impervious area "off-line" (i.e. redirecting runoff in that area from a storm drain to an infiltration basin). Also, instead of "curb and gutter" infrastructure, some road reconstruction projects may be able to accommodate larger paved areas being taken off-line through a "perforated curb and swale" approach.

A Green Streets Policy can be a valuable and comprehensive tool for promoting green infrastructure in both public and private development. As mapping for potential green infrastructure locations is taken to finer detail (see Mapping Chapter), it will be important to look specifically for opportunities within the street right of way. Municipalities may also want to inventory their streets to understand where it may be possible to go curbless and where curbs are essential based on traffic volume.

In addition to road building, municipalities may also establish policies that promote green infrastructure for other municipal facilities. Following are several ideas:

- Commit to green building, site development, and management practices for all new construction or upgrades involving schools, municipal buildings, athletic fields, and other municipal facilities. Municipal green site development efforts provide significant leadership and demonstrate improved development techniques.
- Promote green infrastructure within Open Space and Recreation Plans and parks and open space management policies
- Address downtown parking, constructing new on-street parking and municipal lots that enable downtown off-street parking requirements to be reduced or eliminated (resulting in a net decrease in areas required to be paved to provide parking). Also, when a municipality creates new on-street or lot parking, efficiently sized parking

spaces and some designated compact car spaces can help to reduce impervious area further.

- Establish municipal policies that call for any new purchases of fire emergency equipment to be consistent with the goal of minimizing roadway widths.
- Choose not to extend the storm drain system to new areas and instead promote lower density and Low Impact Development (i.e. infiltration) in outlying areas (see Zoning Regulations discussion below).

B. STORMWATER REGULATIONS

Stormwater ordinances and bylaws have been widely adopted in the region, and many of these regulations promote on-site infiltration of stormwater runoff when possible. However developments that disturb less than 1 acre are often not regulated (as this is not required by the NPDES permit), so there is room for improvement in regulating smaller development sites. For smaller developments, a municipality may establish stormwater management standards that improve water quality but are less burdensome than requirements for larger projects. Increasingly, municipalities throughout our region are adopting stormwater regulations for smaller developments.

Another significant area for regulatory improvement is to establish stormwater management standards that apply to redevelopment sites. In the case of a redevelopment site, the standards can be focused on improvement to existing conditions. For example, a redevelopment might be required to achieve a certain percentage reduction in runoff compared to existing conditions. For very small redevelopment sites, such as single family residential homes that are being renovated or expanded, a municipality may choose to promote certain practices (e.g. rain gardens) and to significantly simplify the process and requirements. See a more in-depth discussion of these issues in the Redevelopment section within this chapter.

C. OVERLAY DISTRICTS

Overlay districts are special zoning districts that limit development and establish extra protections near sensitive environmental resources. Many communities in the region have Floodplain Overlay Districts, and some communities also have special overlay districts for rivers, streams and wetlands. In addition to keeping district boundaries updated, municipalities can increase buffer requirements for sensitive resource areas (e.g. by establishing larger buffer zones than the minimums required by state law). Further, communities may specify how buffer zones are to be maintained, as well as acceptable types of vegetation to be planted in buffer zones. Design guidelines can also be provided for buffer zone vegetation.

D. SOURCE REDUCTION REGULATIONS

A powerful tool that municipalities and states have at their disposal is the adoption of regulations that reduce stormwater pollution at its source. One notable example of this is a ban on the use of phosphorus-based fertilizers. In Ann Arbor, Michigan, a study conducted several years after a municipal lawn fertilizer ban was adopted found that phosphorous levels in the town's river dropped by 28 percent.[37] In addition to municipal bans, a number of states have also adopted phosphorus-based fertilizer bans, including at least 12 states, including Illinois, Maine, Maryland, Michigan, New Jersey, New York, Vermont, Virginia, Washington, Wisconsin[38] - and now, Massachusetts (adopted August 2012).[39] The new Massachusetts law includes regulations to allow only low-phosphorus and phosphorus-free fertilizers to be used on lawns. Like many other states with similar bans, the Massachusetts law exempts agricultural applications, turf farms, and new lawns.

In addition to fertilizers, source reduction regulations can also restrict or ban the use of toxic pesticides, as well as the use of coal tar sealants. Coal tar sealants, which have been identified by studies as a major source of cancer-causing polycyclic aromatic hydrocarbons (PAHs), have been the target of many recent local bans.[40] Choosing to ban coal tar sealants may be the most cost-effective way for communities to limit the pollution impacts of these products.[41] In 2011, Washington became the first state to ban coal tar sealants.[42] The same year, the Minnesota Pollution Control Agency was awarded a grant from U.S. EPA's Great Lakes Restoration Initiative to promote the phase-out of coal tar-based seal coats in Minnesota and in partnering Great Lakes states through 2014. In 2012, the EPA issued a new Stormwater Best Management Practice fact sheet called Coal-Tar Sealcoat, Polycyclic Aromatic Hydrocarbons, and Stormwater Pollution, which describes notable state and municipal efforts to limit the use of coal tar sealants.[43]

---

37 Water Quality Improves After Lawn Fertilizer Ban, Study Shows. University of Michigan News Service. http://ns.umich.edu/new/releases/7272

38 State Laws Banning Phosphorous Fertilizer Use. Kristen L. Miller. 2/1/212. Connecticut General Assembly Website. http://www.cga.ct.gov/2012/rpt/2012-R-0076.htm

39 Law Limits Phoshorus in Lawn Fertilizers. The Beacon. October 2012. P.8

40 Actions to Restrict or Discontinue the Use of Coal Tar-Based Sealants in the United States. 8/29/2012. Minnesota Pollution Control Agency. http://www.pca.state.mn.us/index.php/view-document.html?gid=16180

41 Assessment of Water Quality of Runoff from Sealed Asphalt Surfaces. Environmental Protection Agency. 2011. http://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100ECC8.txt

42 State Bans Coal Tar Sealants in Big Win for Foes. NBC News. 5/5/11. http://www.msnbc.msn.com/id/42917004/ns/us_news-environment/t/state-bans-coal-tar-sealants-big-win-foes/#.ULe-IOTWKPw

43 Stormwater Best Management Practice: Coal-Tar Sealcoat, Polycyclic Aromatic Hydrocarbons, and Stormwater Pollution. USEPA. 11/2012. http://www.epa.gov/npdes/pubs/coaltar.pdf

E. PARKING AND DRIVEWAY REGULATIONS

Most communities do not allow for parking reductions that consider shared parking, availability of public or street parking, public transit, demographics, reduced parking needs for specific proposed uses, utilization of Transportation Demand Management programs, and other relevant considerations. In general, parking requirements should be established based on a better understanding of actual parking demand for certain uses. For example, a 1998 study by the Center for Watershed Protection found actual average parking demand for single family dwellings to be 1.1 parking spaces per dwelling unit, and actual average parking demand at shopping centers was found to be 3.97 parking spaces per 1,000 square feet.[44] To reduce excess parking, maximum parking space limits are sometimes proposed in lieu of minimum requirements.

Site development regulations, which are typically part of a zoning ordinance, govern off-street parking and driveways. Like road width requirements in subdivisions (see below), driveway width requirements are often larger than needed. Typically, a 10-foot wide driveway is more than sufficient for one vehicle or for stacked vehicles (parked one in front of the other), while a 20-foot driveway width is adequate when a two car garage is being accessed. Further, when a two car garage is being accessed, the entire length of the driveway need not be 20-feet wide; the driveway can become narrower as it approaches the street and still allow for two vehicles to pull in and out. Maximum driveway widths can be set to limit the paved area. For example, 15-foot and 24-foot maximum widths have been set in some Pioneer Valley communities. Another strategy to reduce impervious area is to promote common (or shared) driveways, which are allowed in many communities throughout the region.

Reducing the minimum area required for parking spaces and lots is an additional strategy to minimize impervious cover. A typical parking stall can be as small as 8.5 by 18 feet, while a parking space for a compact car can be as small as 8 by 16 feet. Regulations can minimize the back up and maneuvering area for parking spaces and parking lot lane widths. Landscaping requirements for parking lots can also help manage stormwater runoff and improve water quality.

Whenever revising site development regulations, check for consistency with existing design standards, site plan review regulations, and subdivision regulations. A helpful non-regulatory approach to support regulatory changes that promote green infrastructure is to provide design guidelines. A Design Manual can address green infrastructure at development sites as well as within street design.

[44] Center for Watershed Protection (CWP). 1998a. Better Site Design: A Handbook for Changing Development Rules in Your Community. Prepared for the Site Planning Roundtable. Elliot City, MD. 172 pp. For purchase/registration access: http://www.cwp.org

F. SUBDIVIVISION REGULATIONS

While many communities require 12-foot-wide travel lanes in new subdivisions, 10- or 11-foot travel lanes are appropriate on roads with minimal vehicle traffic and would reduce the total impervious area. In fact, depending on use and traffic volume, travel lane widths can be as little as 9 feet. Because the minimum required fire access lane is 18 feet, which can be met by two 9 foot travel lanes, fire truck access should not be an impediment to the narrower road widths called for by a Low Impact Development approach.

In addition, any requirements for curb and gutter infrastructure (i.e. requirements for new subdivisions to connect to storm sewer infrastructure) can be replaced with requirements for "perforated curb and swale" infrastructure, or simply roads without curbs where appropriate. Also in subdivision regulations, there are opportunities to reduce the required radius of a cul-de-sac (down to an outer road radius of 30 to 40 feet), and to allow hammerhead turnarounds. On dead-end streets, hammerhead turnarounds can provide a feasible way to reduce paved area while providing sufficient turnaround space for larger fire vehicles.

Another significant green infrastructure strategy for subdivisions is to allow (and promote) cluster development coupled with open space preservation. When development is clustered to a smaller portion of a site, less pavement is required overall. In addition, development can be clustered to the least environmentally sensitive areas on a site. Municipalities may also consider allowing Traditional Neighborhood Development (TND) subdivision in appropriate locations. TNDs have a more traditional neighborhood pattern that was used prior to the automobile, including small lots and homes with porches oriented toward the street. TNDs typically have narrow roads and on-street parking coupled with reductions in required off-street parking. Overall, cluster developments and TNDs create a more compact development pattern which, on the whole, reduces the amount of paved surfaces created for new development (see discussion of Smart Growth in Zoning Regulations section within this chapter).

G. ZONING REGULATIONS

A community's zoning regulations have a significant impact on water quality. Land use regulations that prescribe "suburban sprawl" development patterns, or ubiquitous single-use low density development (e.g. ½ or 1 acre single family home lots, roadside strip malls with single purpose parking lots, suburban office parks, etc.), result in loss of farms and natural areas, and require large amounts of impervious area per person. This is because in order to support a low density, single-use development pattern, automobiles are required to bring people to different destinations and an enormous network of roads and parking areas is required.

In contrast, "smart growth" is a concept that calls for development patterns that are more similar to traditional settlements that predated the car. Smart growth concentrates development in and around (often preexisting) city, town, village and neighborhood centers in order to create more densely populated and mixed-use pockets that bring residences, jobs, schools, shopping, and services within walking distance of each other. This type of development pattern is also more supportive of public transit, which requires certain minimum development densities to be cost effective. At the same time, outlying areas are preserved for agriculture and very low density uses (e.g. 5 to 10 acre minimum lot sizes).

Within a smart growth development pattern, there is generally a larger proportion of impervious surface area within the areas of concentrated development, but impervious surface area is significantly lower overall, reducing water quality impacts associated with overall imperviousness. It is important to note that while smart growth development reduces the overall scope of stormwater management and related water quality problems (by reducing total imperviousness), green infrastructure is still critical to managing stormwater runoff, particularly from roadways and in densely developed areas where paved surfaces cause localized water quality impacts.

While many cities and towns throughout the country as well as in our region are beginning to look to zoning reform to replace outdated zoning regulations that promote sprawl development, the challenge of making zoning amendments that promote smart growth development patterns should not be underestimated. Even seemingly small reforms to a single district (e.g. promoting appropriate infill within a downtown or village center district) take time to study and develop, require considerable public input and education, and often face significant opposition. Still, if the effort is undertaken, the rewards are many – from more vibrant communities where residents can walk to shops, community services, parks, schools, work and other destinations – to preserved rural and natural areas where people can access less developed landscapes – to improved water quality so that our residents can safely boat, fish and swim in our waterways.

H. CHALLENGES AND OPPORTUNITIES

CHALLENGES

1. The main challenge of the new NPDES permit is that by continuing to use political boundaries instead of a watershed permitting structure, funds for green infrastructure projects may not be spent where they can achieve the greatest water quality improvement per dollar spent. This makes it more difficult and costly to achieve water quality improvement goals. It may be that a watershed-based approach will be considered for the next NPDES permit update. In order to switch to a watershed-based approach, significant institutional and data challenges will need to be overcome. In the meantime, municipalities can make efforts to prioritize their own projects based on water quality impacts and cost effectiveness.

2. With regard to municipal legislation, even small regulatory changes can require a lengthy and sometimes difficult process. The comprehensive changes required to systematically

promote green infrastructure will therefore take time, and will sometimes face stiff opposition. For example, increasing regulatory requirements for stormwater management can draw criticism from businesses that believe that the new requirements will be too burdensome. Changing municipal policies can be equally challenging due to entrenched institutional practices, lack of knowledge about green infrastructure, and resistance to change by individuals.

3. Regulations and policies are not simply words on paper, but are often reflections of our values as a society. Therefore, education and discussion are required in order for policies and regulations to be changed in a way that prioritizes clean water and other benefits of green infrastructure. One example of this relates to fire access. When discussing green infrastructure strategies that reduce street widths, the issue of emergency access for fire trucks is often raised as a potential obstacle. In many cases, municipalities set fire access lane widths that are wider than required by state code. Absent any other goals for road design other than efficient vehicle travel and emergency access, the result is often requirements for very wide roads. However, the experience from many communities has shown that with education and discussion about other important road design goals – including reducing vehicle speeds and managing stormwater – compromises can be reached and policies can be ammended to meet multiple goals.

OPPORTUNITIES

1. The required review of existing municipal regulations under the new NPDES permit provides a significant opportunity to understand where there are barriers to green infrastructure development and to make improvements to local policies and regulations. In the appendixes of this plan, there is a checklist that identifies what to look for and how code might be improved to encourage the use of green infrastructure strategies. This checklist draws from several national checklists, but is further informed by local knowledge and the requirements in the forthcoming permit for the region.

2. Awareness about stormwater pollution and Low Impact Development (LID) is growing, making it increasingly possible to make changes to local policies and regulations that improve water quality outcomes. Some communities are integrating improved stormwater management within road reconstruction projects (i.e. piggybacking on traffic calming projects that require road reconstruction), providing successful examples of cost-effective green infrastructure improvements for other communities to emulate. At the same time, there are significant "low hanging fruit" opportunities for improvement. Subdivision Regulations are relatively easy for Planning Boards to change, and municipal road building policies can often be changed by the department and commissions or boards responsible for municipal roads (for example, the Department of Public Works and the Board of Public Works).

3. Significant improvements can be made to existing stormwater regulations by expanding regulation to small sites and redevelopment sites. This requires approval by elected officials or at Town Meeting, but many are already familiar with stormwater regulation and its goals due to existing regulations. At the same time, changes to site development regulations that reduce paving requirements for private roads, driveways and parking lots can reduce development costs, making the development community a potential ally in adopting such changes.

4. Recent trends supporting reinvestment in cities and walkable neighborhoods with nearby goods and services also support "smart growth" and related green infrastructure goals. When public investments in walkable centers are considered, there is an opportunity for green infrastructure to be included to provide both environmental and beautification benefits to the urban environment.

V. REDEVELOPMENT PROJECTS

A. COSTS

Costs of green infrastructure stormwater management strategies can depend greatly on whether implementation is occurring in an urban setting or a more suburban setting where new development is possible. For redevelopment projects—where an existing development is rehabilitated, restored, renovated and/or expanded—existing site conditions can translate into greater complexity. This includes the higher cost for land, many competing needs for space, and the need to work around many utilities and existing infrastructure. These present challenges that can add to costs.

Exactly how much more green infrastructure may cost in a redevelopment setting depends

The Why of Green Infrastructure in Redevelopment

While the cost of green infrastructure in an urban setting can be greater, the positive impacts of improved stormwater management here can be far greater than for a development occurring in a "greenfield." The main reason is that urban areas generate higher stormwater runoff volumes loaded with great concentrations of pollutants than suburban or rural lands. With good indications that we are trending toward greater redevelopment, improved stormwater management in urban areas can have a significant effect. A 2010 study by EPA finds a sharp increase in residential redevelopment projects in core cities and inner suburbs of major metropolitan areas, and the Brookings Institute estimates that 42 percent of land in the United States will be redeveloped by 2030.

(Text in this box is drawn from CSN Technical Bulletin No. 5: Stormwater Design for High Intensity Redevelopment Projects in the Chesapeake Bay Watershed.)

entirely on the complexity of the site and degree of imperviousness. Tom Schueler, Director of the Chesapeake Stormwater Network, notes in a recent study, "The cost to construct LID practices at high intensity redevelopment projects (85 % or more of impervious cover) can be 4 times more expensive than installing them at low density new development projects (25% of impervious cover or less)." This translates to around $191,000 per impervious acre for the high intensity scenario as compared to $46,600 per impervious acre for the suburban greenfield site.[45] In the same study, however, he also notes the following, "Stormwater practices are much easier and cost-effective to install at redevelopment projects with less than 65% impervious cover, since they have an abundant surface area where LID practices can be located."

Currently the state of Massachusetts stormwater management regulations and most local stormwater regulations tread lightly with respect to redevelopment projects. This is in part due to the great desire not to add barriers and discourage development, especially in tough economic times. Within the *Massachusetts Stormwater Handbook* redevelopment projects must meet requirements "only to the maximum extent practicable." Standard number 7 from the Handbook addresses redevelopment as follows:

> A redevelopment project is required to meet the following Stormwater Management Standards only to the **maximum extent practicable**: Standard 2 (design so that post-development peak discharge rates do not exceed pre-development peak discharge rates), Standard 3 (eliminate or minimize loss of annual recharge to groundwater through the use of infiltration measures), and the pretreatment and structural best management practice requirements of Standards 4 (80% removal of Total Suspended Solids, 5 (which pertains to land uses with higher potential pollutant loads), and 6 (which pertains to stormwater discharges within the Zone II or Interim Wellhead Protection Area of a public water supply, and stormwater discharges near or to any other critical area). Existing stormwater discharges shall comply with Standard 1 only to the maximum extent practicable. A redevelopment project shall also comply with all other requirements of the Stormwater Management Standards and improve existing conditions.

In at least one municipality within the region, there is some effort to present realistic and achievable standards for redevelopment projects. In addition to the regulations set forth in the Massachusetts Stormwater Handbook, the City of Holyoke's stormwater regulations set specific standards for redevelopment and large lot projects, including a 25 percent reduction in peak flow rate for the 2 year and 10 year 24-hour storms, and require the maximum use of infiltration techniques.[46]

---

[45] Chesapeake Stormwater Network. Technical Bulletin No. 5: Stormwater Design for High Intensity Redevelopment Projects in the Chesapeake Bay Watershed. May 2011, p. 12.

[46] City of Holyoke Stormwater Regulations. http://www.holyoke.org/images/stories/dept_public_works/Final_Stormwater_Regulations_May_17_2010.pdf. Accessed September 18th, 2012.

These requirements for redevelopment projects seem reasonable, especially considering a study conducted by EcoNorthwest that indicates for most redevelopment, the cost of green infrastructure is not a large part of a development's bottom line.[47] Additionally, there are many types of green infrastructure that can add to the ultimate value of a development. These two factors mean that if well organized and planned out, green infrastructure can be successfully incorporated as part of redevelopment. The following are suggested strategies drawn from Schueller to assure better stormwater management on redevelopment projects:

1. Define "redevelopment": Schueler acknowledges the importance of a much more specific operational definition of redevelopment. The State of Maryland, he notes, defines redevelopment as "any construction, alteration or improvement performed on sites where existing land use is commercial, industrial, institutional or multifamily residential and the existing site impervious area exceeds 40 percent."[48] The Model Low Impact Development Bylaw developed by the Massachusetts Executive Office of Energy and Environmental Affairs defines redevelopment simply as, "Any construction, alteration, transportation, improvement exceeding land disturbance of 5,000 square feet, where the existing land use is commercial, industrial, institutional, or multi family residential."

2. Distinguish between existing impervious cover and newly created impervious cover: Schueler further notes that the Maryland requirements also clearly distinguish between existing impervious cover and newly created impervious cover at a redevelopment site.

> Stormwater treatment requirements are reduced for existing impervious cover (compared to green-fields), and treatment credits are given if the project reduces the amount of existing impervious cover. The situation reverses if the redevelopment project creates more impervious cover than the predevelopment condition. In this case the new increment of impervious cover is subject to the higher stormwater treatment standards for new development. This creates a strong incentive to prevent creation of new or additional impervious cover at a redevelopment site.[49]

3. Develop a checklist for redevelopment projects: Given how different redevelopment projects can be from green-field development with respect to LID, Schueler notes that the stormwater design approach should be different. A checklist for redevelopers might help in this regard, but also aid municipal boards in better evaluating projects. This checklist could include many of the elements described in section 4 of Schueler's report, including watershed context, site history, identifying potential hotspot generating areas, identifying existing impervious cover and new existing impervious cover. There are many other elements within

---

[47] EcoNorthwest. Managing Stormwater in Redevelopment and Greenfield Development Projects Using Green Infrastructure: Economic Factors that Influence Developer's Decision. June 2011.
[48] As mentioned above, Shueller seems to identify a threshold of 65% impervious cover where redevelopment projects with less than 65% impervious cover are much easier and cost effective to install at redevelopment projects.
[49] Technical Bulletin No. 5: Stormwater Design for High Intensity Redevelopment Projects in the Chesapeake Bay Watershed, page 4.

this Section 4 and within Section 6 in selecting practices for high density redevelopment projects that could be converted into a guide for redevelopers. In addition, the *Massachusetts Stormwater Handbook* has a Checklist for Redevelopment Projects that may be useful. This includes an estimate of the proposed percent TSS removal performance and groundwater recharge volume that will be achieved by the proposed redevelopment project. See: http://www.mass.gov/dep/water/laws/v2c3.doc

<u>4. Offer incentives</u>: Incentives may be an important way to get developers to think about incorporating improved stormwater management practices into their projects. These might include an incentive for green roofs (e.g., increased floor area ratio [FAR] bonus, additional building height) and/or an incentive for reduced stormwater management requirements for a project that decreases total imperviousness on previously developed sites.

<u>5. Provide a "safety valve"</u>: The economics of redevelopment can be tricky especially as Schueler notes at high intensity urban sites where there is 85 percent or more impervious cover. As such, compliance cannot always be achieved due not only to space but feasibility constraints. A safety valve for high intensity redevelopment projects is essential to allowing such projects to proceed. Schueler notes that in these cases municipalities could charge a stormwater offset fee or provide options for off-site compliance. Section 8 of Shueler's report has more information on this topic. The Puget Sound Partnership has developed a document to guide local governments on when improved stormwater management practices should not be required. It provides specific information about parameters related to bioretention, permeable paving, among other practices, which could provide a good starting place for the development of such guidelines for Pioneer Valley communities. See:
http://www.psparchives.com/publications/our_work/stormwater/lid/2009_Local_Assitance/005_Appendices/Guidance%20for%20Determining%20When%20LID%20Should%20Not%20be%20Required.pdf

B. UTILITY LINES

Existing underground and overhead utility lines present a specific space-related challenge for redevelopment, since they may conflict with green infrastructure and are either impossible or potentially very expensive to move. Trees are particularly problematic, as they can often interfere with the operation of utility lines. For underground systems, roots can break and disrupt sewer and electrical conduits, and above ground trees can grow to the point where they disrupt power lines. Many municipalities require trees to be planted at least four to eight feet from sewers and electrical wiring, to avoid these issues. Utility lines can be relocated to places where green infrastructure does not interfere, such as under road edges. However, utility companies and municipalities are often concerned about how this will affect the cost and time required for repairs.

Strategies that can assist with challenges presented by sewers and utility lines are as follows:

- Develop a complete and thorough understanding of the street section. The City of Pittsfield, for example, used cross sections in their design analysis to understand the location of utilities and the relationship of these utilities to proposed bioretention facilities for installation along the downtown street edge. This analysis enabled project proponents to come up with some workable solutions, including a split sleeve conduit which meant the bioretention facility could be built around certain utilities.

- Know the canopy size and height of planted trees within green infrastructure facilities so as to ensure they will not interfere with utility lines when they mature.
- Use green infrastructure practices that are known to provide confined, yet adequate growing space for trees. One example is Silva Cell, a light frame that acts as a container for lightly compacted loam soil. The top of the Silva Cell system is provided with a deck that can be paved over for pedestrian walking surface.

C. CHALLENGES AND OPPORTUNITIES

CHALLENGES

1. The cost to construct green infrastructure stormwater management facilities in urban locations, where there is 85 percent or more of impervious cover, can be four times more expensive than installing such facilities at low density new development projects, where there is 25 percent or less impervious cover.

2. With so many competing demands for space in the urban environment, including sidewalks, utilities, and other infrastructure, there is limited space for green infrastructure stormwater management facilities.

3. Urban areas generate higher stormwater runoff volumes loaded with great concentrations of pollutants than suburban or rural lands.

4. Communities may be reluctant to establish meaningful stormwater management regulations for redevelopment projects so as not to discourage development.

OPPORTUNITIES

1. With redevelopment on the rise, there are tremendous opportunities to improve stormwater mangement in the urban landscape.

2. Regional standards for redevelopment projects may help to create a level playing field between one municipality and the next so that one community is not seen as more discouraging of redevelopment than the next.

3. Incentives could be an important way to get developers to think about incorporating improved stormwater management practices into their projects. It may be useful to develop a menu of potential incentives and work in concert with developers to make them meaningful and attractive and with municipal officials to make them practicable.

4. There are some good existing resources that describe stormwater management practices that are most suited to the urban environment. These could be drawn on for inclusion in a regional design manual along with standards for redevelopment.

VI. INCENTIVES

Understanding the benefits of green infrastructure may not always provide the impetus necessary for implementation. So it is that incentives can play an important role in moving projects to incorporate green infrastructure stormwater management strategies. This might be for private projects that involve new development or redevelopment where retrofits of green infrastructure can be integrated. This section describes: technical assistance, rebates, and grant programs; stormwater fee discounts/credits; and development incentives.

A. TECHNICAL ASSISTANCE, REBATES, AND GRANT PROGRAMS

- Portland Oregon has implemented a long-term compliance assistance program that offers reimbursement of up to $53 per disconnected downspout for property owners in targeted neighborhoods. The City's plumbing division works directly with homeowner, eliminating the need for a plumbing permit. The homeowner can arrange for the city to disconnect the downspout at no cost or have the work done themselves and apply for the reimbursement. Portland's program, conducted over an 18-year period, successfully disconnected over 56,000 downspouts, annually keeping 1.2 billion gallons of stormwater from entering the combined sewer system.[50]
- In South Hadley, Massachusetts, the Pioneer Valley Planning Commission worked with town officials under a grant from the Environmental Protection Agency to provide rebates to property owners who disconnected downspouts and sump pumps from the sanitary sewer system redirecting stormwater flow to gardens, lawns, and drywells. A total of 20 property owners participated, removing some 300,000 gallons annually from the system at a cost of $25,000.
- Though green roofs have comparable long term costs to conventional roofs as they typically have twice the lifespan, overcoming the significant initial costs of a green roof may be difficult. The City of Toronto has been running a program to help developers overcome this initial cost hurdle and to promote the use of green roofs. Begun in 2009, the program targets developers of existing and new commercial, industrial, and institutional buildings and existing and new Toronto Public and Separate School Board buildings offering grants of $50 per square meter of eligible roof area up to a maximum of $100,000. [51] Part of the City's Climate Change Action Plan which aims to reduce

[50] See: http://www.portlandonline.com/bes/index.cfm?c=54651
[51] See: http://www.toronto.ca/livegreen/greenbusiness_greenroofs_eco-roof.htm

Toronto's greenhouse gas emissions by 80 percent come 2050, the program has funded 24 green roofs to date.

- In Illinois, the state Environmental Protection Agency provides reimbursement grants to local units of government and other organizations to implement green infrastructure best management practices in Municipal Separate Storm Sewer System (MS4) or Combined Sewer Overflow areas. There are three program categories: CSO rehabilitation, stormwater retention and infiltration, and green infrastructure small projects. The grant program, in its third year, has approximately $5 million available each year and is funded through the "Green Project Reserve."[52] The Green Project Reserve is an EPA requirement under the Clean Water State Revolving Fund that states direct a portion of their capitalization grant toward projects that address green infrastructure, water efficiency, energy efficiency, or other environmentally innovative activities. Reportedly states have some flexibility in how they meet Green Project Reserve requirements. Massachusetts has been able to meet requirements through its regular programming.[53]

B. STORMWATER FEE DISCOUNTS/CREDITS

Local governments with stormwater utilities or stormwater fees can encourage better practices on private property by reducing fees in exchange for desired green infrastructure practices, which produce a reduced need for service by the system. Discounts and credits can be geared to promote impervious surface reductions, onsite management or volume reduction, or the use of specific practices, such as bioretention facilities, cisterns, or green roofs.

- The City of Chicopee has just begun to implement a "Rain Smart Rewards" ordinance that offers a stormwater fee reduction of up to 50 percent in exchange for implementation of improved stormwater management practices by property owners.
- In Minneapolis, Minnesota, 50 percent of the stormwater fee can be waived if the property owner can demonstrate that the runoff from a 10-year, 24-hour storm event can be managed on site. If a property owner can demonstate that the runoff from a 100-year, 24-hour storm event can be managed on site, the entire stormwater fee is waived. [54]
- Portland, Oregon's Clean River Rewards program provides stormwater utility fee discounts to encourage residential and commercial property owners to manage stormwater on site (35 percent discounts) and/or on the public right of way that serves their property (65 percent discounts). Partial credits are also given for ecoroofs, four

[52] http://www.epa.state.il.us/water/financial-assistance/igig.html
[53] 11/28/12 e-mail from Steve McCurdy, DEP Municipal Services Director
[54] "Managing Wet Weather with Green Infrastructure, Municipal Handbook, Green Infrastructure Retrofit Policies," Jennifer Bitting and Christoper Kloss for the Low Impact Development Center, December 2008, p. 6.

or more trees over 15 feet tall, and for properties with less than 1,000 square feet of imperviousness. There is a Residential Discount Calculator and a Commercial Discount Calculator on the program's website so that property owners can calculate what changes they might make to obtain certain savings.[55]

C. DEVELOPMENT INCENTIVES

Various incentives can be integrated into the framework of existing regulations and development codes to encourage private developers to implement green infrastructure practices in new or redevelopment projects.

Upgrades in zoning

- A Floor Area Ratio (FAR) Bonus in Portland, Oregon's Center City District, increases a building's allowable area in exchange for adding an ecoroof, which the city defines as a rooftop stormwater facility. Buildings with ecoroof coverage can earn from one to three square feet of additional floor area per square foot of ecoroof depending on the ratio between the eco-roof and building footprint. Combined with the Eco Roof Incentive Program, which provides grants of up to $5 per square foot for an ecoroof project, Portland has seen over $225 million in additional private development and more than 120 ecoroofs in the center city district.[56]

Reduced stormwater requirements

- In Knox County, Tennesee, developers and site designers may be granted stormwater credits to implement better site design practices that can reduce the volume of stormwater runoff and minimize the pollutant loads from a site. The credit system translates into cost savings by reducing the size of structural stormwater control and conveyance facilities. The Knox County Stormwater Management Manual reads,

> The basic premise of the credit system is to recognize the water quality benefits of certain site design practices by allowing for a reduction in the water quality treatment volume (WQv). If a developer incorporates one or more of the credited practices in the design of the site, the requirement for capture and treatment of the WQv will be reduced. Site designers are encouraged to utilize as many credits as they can on a site. Greater reductions in stormwater storage volumes can be achieved when many credits are combined (e.g., disconnecting rooftops and protecting natural conservation areas).[57]

Such credits based on limited impacts are used in Salem, Massachusetts as well. In Salem, there are five such credits: environmentally sensitive development, disconnection of rooftop

---

[55] http://www.portlandonline.com/bes/index.cfm?c=41976&a=390568
[56] "Managing Wet Weather with Green Infrastructure," page 4.
[57] *www.**knoxcounty**.org/.../5-2%20Water%20Quality%20Volume%20*

runoff, disconnection of non rooftop runoff, stream buffers, and grass channels.[58] These credits for non structural practices are also described in the Massachusetts LID Model Bylaw within the Smart Growth Smart Energy Toolkit. See page 17 and Appendix at: http://www.mass.gov/envir/smart_growth_toolkit/bylaws/LID-Bylaw.pdf

Expedited review/permitting

- Philadelphia has implemented an expedited review process, "Green Project Review," for redevelopment projects that disconnect 95 percent or more of the post construction impervious area from the combined or separate storm sewer. The Philadelphia Water Department reviews the stormwater management component of such project proposals within five business days. This is a low or no cost program for the City and provides the project with a time savings that usually also translates into a financial savings for project proponents.[59]
- Chicago's "Green Permit Program" offers applicants an expedited permit process—of 30 days instead of the 60 to 90 days normally required— when projects meet certain U.S. Building Council LEED® (Leadership in Energy and Environmental Design) criteria that include better stormwater management practices. Program applicants work with a menu of green strategies or green technologies provided by the City. Projects that display a high level of green strategy can also be eligible for waiving of consultant code review fees.[60]

Tax credits

- Building owners in New York City who install green roofs on at least 50 percent of available rooftop space can apply for a one-year property tax credit of up to $100,000. The credit is to $4.50 per square foot of roof area that is planted with vegetation or approximately 25 percent of the typical costs associated with the materials, labor, installation, and design of the green roof.[61] When the tax credit was passed by the state legislature in 2008, a board member of the New York City Soil & Water Conservation District noted, "Each 10,000 square foot green roof can capture between 6,000 and 12,000 gallons of water in each storm event. This is rainfall that will never enter the combined sewer. At the same time, the evaporation of this rainfall will produce the equivalent of between a thousand and two thousand tons of air conditioning, enough heat removal to noticeably cool ten acres of the City."[62]
- In Philadelphia, commercial building owners may claim a tax credit against the Business Privilege Tax of 25 percent of all costs associated with the construction of a

[58] "Urban Stormwater Management Guidebook, City of Salem, Massachusetts,"December 2005, pp 55-70.
[59] Managing Wet Weather, p. 7
[60]https://www.cityofchicago.org/city/en/depts/bldgs/supp_info/overview_of_the_greenpermitprogram.html
[61] www.**nyc**.gov/html/dob/.../pdf/**green_roof_tax_**abatement_info.pdf
[62] http://swimmablenyc.info/?p=54

green roof up to a maximum of $100,000. The tax credit, in place since 2007, is applied against the applicant's total business privilege tax liability for the tax year when verification of green roof completion is submitted and approved. Any unused credits may be carried forward until fully used.[63],[64]

D. CHALLENGES AND OPPORTUNITIES

CHALLENGES

1. There is little insight into what incentives might help the development community to overcome current barriers to green infrastructure and particularly where there is a higher cost to implementation in redevelopment projects (where existing impervious cover is 65 percent or more).[65] For example, incentives in Holyoke to use best low impact development practices as described in the *Massachusetts Stormwater Handbook* in exchange for waiving site plan review application fees, discounting the sewer entrance fee, and reducing parking requirements appear not to have been successful.

2. Running incentive programs can take additional municipal staff time, the allocation of which may be difficult when budgets are already tight and staff already managing a full slate of work.

3. To work well an expedited permitting program requires the attention of a dedicated review team the members of whom are knowledgeable about better site design and green infrastructure stormwater management practices. In some communities implementation of such a program might require hiring consultants, which would be a direct cost to the municipality if the incentive entails waiving the application fee.

4. It is not clear what opportunities there may be within state and local tax codes to provide credits for green infrastructure.

OPPORTUNITIES

1. If barriers to green infrastructure can be well identified in a community, there may be incentive programs that can be directed to addressing local needs and concerns. Such a

[63] www.phila.gov/revenue/pdfs/Internet_Summary_-_B.pdf
[64] http://www.phillywatersheds.org/whats_in_it_for_you/residents/green-roofs
[65] In the Redevelopment Projects section of this chapter, see discussion about costs, which describes finding from report: "Stormwater practices are much easier and cost effective to install at redevelopment projects with less than 65% impervious cover…"

program might begin as a pilot to test its effectiveness. If proven effective, it may be worth expanding and extending or even modifying the program.

2. The power of stormwater rebates and grants to save money has a stellar example from a program here in the region. The stormwater incentives program in South Hadley, which provided rebates to property owners who disconnected downspouts and sump pumps from the sanitary sewer system and redirected storm flow to gardens, lawns, and drywells, with an investment of $25,000 is now saving the town $3 million in avoided costs of wastewater treatment over a 10-year period. Such rebates and grants could help to target important savings in managing combined sewer flows, flooding, among other chronic problems in other communities

3. LEED® Certification is an important incentive for many long-term building owners and companies, as well as governmental entities and even some speculative developers. Local governments can strengthen this incentive further through programs like Chicago's, which confers expedited permitting benefits to LEED® Certified projects. The more recognition the LEED® Rating System gains, the greater the incentive for LEED® Certification becomes, leading to installation of more green infrastructure. However, perhaps even more importantly, LEED® Certification creates opportunities to demonstrate green infrastructure and push it toward greater use in all development, whether LEED® Certified or not. As examples of green infrastructure and its benefits become more common, green infrastructure will be increasingly taken up by individual property owners and developers, and will also be increasingly incorporated into local policies and development incentives and regulations.

4. The Data Base of State Incentives for Renewables and Efficiency may be a good starting place to understanding what tax credit strategies and other incentives may be possible for green infrastructure under existing Massachusetts law. See:
http://www.dsireusa.org/incentives/index.cfm?re=0&ee=0&spv=0&st=0&srp=1&state=MA

VII. DESIGN FOR GREEN INFRASTRUCTURE FACILITIES

A. KEY CONSIDERATIONS

While there is no design manual for green infrastructure specific to the Pioneer Valley Region, there are many readily available sources that provide good information. Mass DEP, in Volume 2, Chapter 2 of the *Massachusetts Stormwater Handbook*, and the University of New Hampshire Stormwater Center both have useful information on the pollutant removal efficiencies of numerous stormwater management facilities. Further afield, the Philadelphia Stormwater Manual, Version 2, 2008, at http://www.pwdplanreview.org/StormwaterManual.aspx, and the Portland, Oregon Stormwater Manual at http://www.portlandonline.com/bes/index.cfm?c=47952, have useful design information.

Critical to effective implementation of green infrastructure practices is the site inventory and analysis process itself, which should occur before any design work. Opportunities identified through site analysis may help to minimize impacts as well as the costs for stormwater management. The inventory process ought to identify existing features, soil, vegetation, structures (if any), existing drainage pathways, and ascertain opportunities to protect these features. Local permitting can reinforce a thoughtful process by defining planning steps. The Town of Franklin, Massachusetts, for example, recommends that developers use a four step process for site plan and subdivision applications that begins with an environmental "opportunities and constraints" map and an initial Planning Board meeting. The express purpose of this process is to expedite project review and the approval process and minimize the need for re-designs. This process might be modified where there are redevelopment projects in highly urbanized locations, but the early pre design meeting with local authorities seems an important starting place to produce projects with effective stormwater management.

Table 4.3 below lists design resources and identifies which green infrastructure stormwater management facilities are evaluated. Design resources in the matrix below that also address practices and techniques associated with site development or redevelopment are indicated in bold.[66]

[66] Another good resource is: "Rhode Island Low Impact Development Site Planning and Design Guidance Manual," Horsley Witten Group and RI DEP, March 2011.

Table 4.3: Green Infrastructure Design Resources												
	Bioretention System (Rain Garden)	**Drywell and/or Infiltration Trench**	**Green Roof**	**Infiltrators**	**Porous Pavement**	**Rainwater Harvesting**	**Tree Box Filter**	**Veg. Water Quality Swale**	**Veg. Filter Strip**	**Gravel Wetland**	**Constructed Wetland**	**Other**
Massachusetts Stormwater Handbook, Vol. 2, Ch. 2: Structural BMP Specifications, February 2008	√	√	√	√	√	√		√	√		√	Proprietary media filter, sand and organic filters, sediment forebay, wet basins, infiltration basin
New York DEP Guidelines for the Design and Construction of Stormwater Management Systems, July 2012			√									Storage vaults or tanks, gravel beds, perforated pipes, stormwater chambers, blue roofs
University of New Hampshire Stormwater Center 2009 Biannual Report	√				√		√	√		√		Retention ponds, filter berm swales, deep sump catchbasin, StormTech Isolator ROW

	Bioretention System (Rain Garden)	Drywell and/or Infiltration Trench	Green Roof	Infiltrators	Porous Pavement	Rainwater Harvesting	Tree Box Filter	Veg. Water Quality Swale	Veg. Filter Strip	Gravel Wetland	Constructed Wetland	Other
Rhode Island DEP Urban Environmental Design Manual, January 2005	√		√		√			√			√	Cisterns, stormwater planters
Maine Stormwater Best Management Practices Manual	√	√			√			√			√	Vegetated buffers, infiltration basin, sand filter, flow splitters and bypass, level spreaders, permeable road base
City of Salem, MA Urban Stormwater Management Guidebook, December 2005	√	√	√		√			√	√		√	Cisterns and rainbarrels, infiltration drainfields, retention basins
Tech. Memo. # 4: LID Guidelines and Standards (Partners for CT LID and Stormwater General Permit Evaluation), December 2010	√	√	√					√	√			Cisterns and rainbarrels

	Bioretention System (Rain Garden)	Drywell and/or Infiltration Trench	Green Roof	Infiltrators	Porous Pavement	Rainwater Harvesting	Tree Box Filter	Veg. Water Quality Swale	Veg. Filter Strip	Gravel Wetland	Constructed Wetland	Other
Philadelphia Stormwater Manual, Version 2	√	√	√	√	√	√	√	√	√			Filters, detention basins, berms and retentive grading
Portland (Oregon) Stormwater Management Manual	√ (Basin)	√ (Soakage Trench)	√ (Eco Roof)	√ (Sump)	√	√		√	√			Street tree, planter, pond

B. CHALLENGES AND OPPORTUNITIES

CHALLENGES

1. There is limited experience in designing and constructing green infrastructure facilities in the region

2. There are no green infrastructure design guidelines for municipal officials, developers, and designers to follow that are specific to the region

3. Regulations often do not support a project planning process that leads to good design for stormwater management

OPPORTUNITIES

1. There are many available design resources from which to draw, and it may be useful to develop design guidance specific to the Pioneer Valley Region that includes recommendations for the site planning process, BMP selection, design, and construction, as well as maintenance. The manual should also have recommended standards for redevelopment projects. See Redevelopment Projects below.

2. Municipal officials and developers are learning about green infrastructure design as they go. There are many important lessons being learned, from critical design details that make maintenance easier, to strategies that make it possible to devise green infrastructure solutions within the confines of existing utilities and other infrastructure. It is important to draw on this wealth of emerging information to inform upcoming design. Peer to peer presentations and dialogue should be encouraged and facilitated.

3. The forthcoming NPDES MS4 permit requires regulated communities to assess existing local regulations to determine the feasibility of making green infrastructure practices allowable within 3 years of the effective date of permit. (Section 2.4.6.8) With updates to regulations based on this assessment, there may be an opportunity to define a project planning process that will support improved stormwater management within all proposals.

VIII. MAINTENANCE AND INSPECTIONS

A. KEY CONSIDERATIONS

Proper maintenance of green infrastructure is critical to ensure that it continues to function as designed. First and foremost, new green infrastructure projects should have performance guarantees (for at least 2 years) once built, an operation and maintenance plan, a regular inspection schedule, and an annual maintenance budget.

Green infrastructure may be owned and maintained privately, owned by the public but maintained by a nearby private interest, owned privately but maintained by a public entity, or owned and maintained by a public entity (municipality, state agency, etc.). Creative solutions abound. For example, the City of Portland, Oregon, provides examples of neighborhood groups maintaining city-owned green infrastructure, as well as maintenance of green infrastructure by various city departments, including the public works and parks departments.

When a private entity agrees to maintain publicly owned green infrastructure, a maintenance agreement is established. This agreement may require a regular log of all maintenance activities to be kept, and may establish a schedule for periodic inspections of the infrastructure. There may also be a timeline for addressing maintenance issues identified during inspections.

Maintaining Green Infrastructure Facilities

Putting green infrastructure into practice requires a change not just in systems but in our approach to operations and maintenance (O&M) of stormwater systems. Properly functioning green infrastructure practices are premised on using natural processes rather than built systems, which requires a shift away from capital intensive, infrequent maintenance to less-invasive tasks that may be more frequent but less expensive overall. As grey infrastructure systems require increased operations and maintenance over time as equipment and materials wear down, green infrastructure practices are designed to increase in resilience and function as vegetation matures and adapts to local resource cycles. While green infrastructure solutions can become more effective over time, extending the infrastructure's life cycle and even performance level, it should be noted that performance may eventually diminish without proper maintenance.

(Source: "Banking on Green," p. 12.)

Generally, a municipality's public works department conducts inspections pursuant to green infrastructure maintenance agreements on municipal or private property. If green infrastructure is located on state property, the appropriate state agency is responsible for these inspections (this is most often MassDOT, but could also be other state divisions that have installed green infrastructure on state property, including DCR, etc.).

Municipalities face a number of considerations when permitting or installing new green infrastructure. For example, throughout the northeast, snow is a critical consideration in urban locations where there are limited snow storage options. Generally, snow should not be stored on infiltration BMPs. If this cannot be avoided, infiltration areas can be designed to hold a larger volume based on anticipated snow loads, to prevent snowplow damage, and to minimize snow blockages that cause stormwater to bypass infiltration and treatment BMPs. If bioretention areas are used for snow storage, maintenance can be much more complicated and costly if chloride based deicers and sand are not well managed. Where bioretention areas are used for snow storage, plants must also be limited to non-woody, salt tolerant species. These limitations can make green infrastructure solutions such as roadside swales more difficult to apply in urban locations.

Another consideration is whether new maintenance equipment will be required for new green infrastructure technologies and, if yes, how these equipment purchases will be funded. In some situations, it may be cost effective to hire private companies with the specialized equipment required to complete system maintenance. For example, it may be cost effective to hire private companies to maintain porous pavements, which require special vacuum cleaners that periodically clean out the pores in order to maintain system function.[67]

Some municipalities adopt standards to guide maintenance and inspection activities. Other management and enforcement strategies include maintaining a database of public and privately-owned BMPs and completed maintenance for each BMP, sending reminders to managers of private BMPs when regular maintenance is required, training municipal employees on proper maintenance techniques, and requiring maintenance logs for private projects that obtain stormwater permits.

B. CHALLENGES AND OPPORTUNITIES

CHALLENGES

1. When privately or municipally maintained, green infrastructure gives new responsibilities to municipal governments, and these new responsibilities must be accounted for in municipal budgets. If the infrastructure is municipally maintained, there will be new inspection and maintenance costs, possibly including new costs for specialized equipment needed to perform the required maintenance. If the infrastructure is privately maintained, there will be new costs associated with inspections, as well as enforcement actions when required maintenance is not performed.

2. Maintenance challenges are also caused by snow accumulation and plowing, which can affect both the short- and long-term performance of green infrastructure. Particularly in

[67] New England Environmental, Inc. currently hires a private contractor to vacuum its porous parking lot in Amherst.

urban environments where space is at a premium, green infrastructure installations may provide the only feasible locations for snow storage if bike lanes and sidewalks are to be kept clear. Snow storage on green infrastructure installations may result in increased maintenance requirements, reduced effectiveness, or a shorter lifespan prior to replacement.

3. Finally, green infrastructure is relatively new, and the technology is rapidly changing. As a result, there are many unknowns. Maintenance schemes will need to be adapted to different conditions and individual experiences in order to maintain the performance of installed green infrastructure.

OPPORTUNITIES

1. The greatest maintenance opportunity offered by green infrastructure is that it can reduce the significant municipal costs required to maintain storm drain infrastructure. As a cost effective long-term investment, green infrastructure can win public support.

2. In addition, the introduction of green infrastructure can help organize the municipal street system in a cost effective manner that allocates different purposes to different streets. That is, not every street needs to serve every purpose. Green infrastructure – as well as other uses – can be located where it is most needed as well as where it is most cost effective to accommodate and maintain.

3. Finally, well-maintained green infrastructure has multiple benefits. It not only serves water quality functions, but also continues to beautify the built environment as it matures, and continues to create a human environment that reduces stress and improves health and safety.

IX. CLIMATE CHANGE

Changes to the earth's climate due to greenhouse gas (GHG) emissions may have profound impacts on the Pioneer Valley over the next few decades. Increased flooding, drought, and other extreme weather will negatively affect agriculture, wildlife, air and water quality, and human development.

Green infrastructure presents one strategy for addressing climate change, both by reducing the amount of greenhouse gas in the air (mitigation) as trees and plants absorb CO_2 and by accommodating the predicted effects that climate change will have (adaptation) as facilities reduce storm flow volumes. This section discusses in more detail the specific benefits of green infrastructure as it relates to climate change.

A. REDUCTIONS IN GREENHOUSE GAS

Due to the amount of GHG already released into the atmosphere from human activity, the scientific community believes that global temperatures will increase by two degrees Farenheit (F) in the next 50 years regardless of what actions are taken in the future to reduce emissions.

However, if GHG emissions continue to increase unabated, projections indicate that temperatures will rise several more degrees. These scenarios make reductions in emissions critical.[68] Green infrastructure can assist in accomplishing this goal, since trees and vegetation provide carbon sequestration that removes GHG from the atmosphere. One study conducted at Drexel University in Philadelphia indicates that for a given neighborhood in New York City, the implementation of green infrastructure will result in a reduction of GHG emissions of 0.4 metric tons.[69]

The Massachusetts state Clean Energy and Climate Plan for 2020, published in 2010, sets goals for the reduction of GHG statewide by 2020. Specifically, the plan sets a state requirement to limit GHG emissions between 10 and 25 percent below 1990 levels by 2020, and an 80 percent reduction in emissions by 2050. Levels from 1990 are estimated to have been 94 million metric tons of Co2 statewide.[70]

In order to achieve this statewide goal, it will be important that each region participates in reducing a share of the GHG reduction. One recommended strategy to reduce GHG within the state plan is the planting of new trees, which reduces energy usage from building heating and cooling and promotes carbon sequestration. Though the Pioneer Valley represents a relatively small percentage of the statewide population, the region could play a meaningful role by planting significant quantities of new trees and other vegetation. Green infrastructure facilities for improved stormwater management could be an integral part of this GHG gas reduction strategy.

The reduction of GHG and adaptation to climate change is discussed in far greater detail within the Pioneer Valley Planning Commission's Climate Action and Clean Energy Plan.

B. FLOODING IMPACTS

With more frequent larger storms predicted to occur due to climate change, the design capacity of existing stormwater management infrastructure will likely be exceeded more frequently. In addition, it is expected that the area currently designated as flood plain will be expanded with more existing development becoming part of land that is susceptible to a 100-year flood. In the Pioneer Valley, areas of concern for expansion of the 100-year flood are Westfield adjacent to the Westfield River and in Hadley near the Connecticut River.[71] (See discussion under Introduction of this plan under Benefits of Green Infrastructure in subsection called Mitigates Flooding.)

[68] Northeast Climate Impacts Assessment. Confronting Climate Change in the US Northeast: Science, Impacts, and Solutions. July 2007.
[69] Spatari, Sabrina; Yu, Ziwen; Montalto, Franco. Life cycle implications of urban green infrastructure. Environmental Pollution. 2011 Aug-Sep 159(8-9):2174-9.
[70] Clean Energy and Climate Plan for 2020, State of Massachusetts.
[71] Pioneer Valley Planning Commission, Regional Transportation Plan, 2011.

Because green infrastructure practices, such as vegetated stormwater management practices and porous pavements, allow for greater infiltration of rainfall on-site, they can reduce the amount of stormwater runoff that flows downstream and that can overwhelm stormwater infrastructure and/or waterways. For example, when properly constructed porous pavement can reduce runoff volume by 70-90 percent.[72]

A reduction in climate change flooding will also have tangible financial benefit, in that it reduces the need for installation of alternative, very expensive flood control mechanisms. For example, a project in Seattle called the Viewlands Cascade reduced its stormwater runoff by 75-80 percent by utilizing green infrastructure practices. For the 72-acre project, the total cost was only $850,000.

C. HEAT ISLAND EFFECT

Urban heat island effect describes the tendency of urban areas to have higher annual average temperatures than surrounding rural areas. In large cities, the increased temperature can be between 2 to 5 degrees F during the day, and up to 22 degrees F at night.[73] The cause of heat island effect is the higher concentration and quantity of materials in urban areas that absorb heat, such as asphalt and dark building roofs. While the increased temperatures of climate change will affect both rural and urban areas, the effect will be more significant in urban areas, where the highest temperatures already exist and residents are most likely to be affected by heat-related illness.

Green infrastructure can provide significant relief from heat island effect, through the replacement of hard, heat-absorbing surfaces with vegetation. For example, a study by the Center for Clean Air Policy states that in some cases green roofs can reduce ambient air temperatures by 9 degrees F. Studies conducted in New York City and Toronto estimate that installation of green roofs on 50 percent of roofs across those cities could result in an almost full 1 degree F reduction in temperature.[74]

The City of Chicago has been a national leader in green roofs for over 15 years, with several incentive programs dedicated to promoting the construction of green roofs. One such program is the Green Roof Improvement Fund, which provides a 50 percent grant match for the cost of a green roof in a portion of the central business district. For residential and smaller commercial projects, grants of $5,000 are available.[75] One of the purposes for the City's programs is to reduce urban heat island effect. For example, in a study conducted by the EPA,

---

[72] The Center for Clean Air Policy. The Value of Green Infrastructure for Urban Climate Adaptation. February 2011.
[73] US EPA. http://www.epa.gov/hiri/. Accessed September 14th, 2012.
[74] The Center for Clean Air Policy. The Value of Green Infrastructure for Urban Climate Adaptation. February 2011.
[75] US Department of Energy. Building Energy Codes Program – Green Roof Improvement Fund (Chicago, IL 2006). http://www.energycodes.gov/resource-center/policy/green-roof-improvement-fund-chicago-il-2006 . Accessed September 18th, 2012.

the green roof located on Chicago's City Hall measures approximately 80F degrees cooler than a neighboring conventional roof. The temperature nearby air temperature was over 7 degrees cooler than on a neighboring green roof.[76]

D. AIR QUALITY

The emission of greenhouse gas results in poor air quality and adverse impacts for human health such as asthma. As discussed above, green infrastructure – particularly trees – has the ability to reduce GHG quantities and accordingly improve air quality through carbon sequestration. Additionally, trees absorb existing air pollutants, including particulate matter, carbon monoxide, sulfur dioxide, nitrogen oxides and ground-level ozone. The production of ozone is also reduced through the lessening of the urban heat island effect and sunlight reflection, two factors responsible for the creation of ozone. A study conducted in New York City found that increasing the number of trees throughout the city by 10 percent would reduce ground-level ozone by 3 percent. The City of New York estimates that its trees remove or avoid 129 tons of ozone annually.

As discussed below, buildings that incorporate green infrastructure reduce energy use for heating and cooling. This reduction in energy use means that utility companies can generate less power and accordingly, generate less greenhouse gas. This emission of less GHG improves air quality. The EPA estimates, for example, that the use of trees and vegetation for stormwater management could result in anywhere from a 1.5 to 5 percent reduction in carbon emissions in American cities.[77]

E. ENERGY COSTS

There are two primary ways in which green infrastructure is able to reduce energy costs. First, the reuse of stormwater for purposes of irrigation and restroom facilities, either utilizing a blue roof, cistern, or rain barrel, means that less water must be used by individual property owners. This not only reduces the amount of water that must be provided and treated from the utility, but also limits the energy required to heat the additional water within the building. Both of these benefits reduce greenhouse gas emissions. The financial and emission savings from water reuse are significant. The Center for Neighborhood Technology estimates that in California, it requires between 955 and 1911 kWH of electricity to treat 1 million gallons of stormwater using a blue roof, whereas it would require 12,700 kWh to treat the same amount of fresh drinking water by a water utility company.

Second, energy costs are reduced from trees, which generate increased shade and reduce the heat generated from light hitting buildings directly. The Center for Clean Air Policy estimates

[76] Department of Energy 2004. Federal Technology Alert: Green Roofs. DOE/EE-0298, Washington, D.C.
[77] EPA Heat Islands Compendium (October 2008): Trees and Vegetation

that trees absorb approximately 70 to 90 percent of sunlight in the summer and 20 to 90 percent in the winter. The EPA has estimated that the surface temperature of buildings can be reduced by 20 to 45 degrees F through tree shade. Additionally, this study found that planted trees can have cooling savings of 1 percent per tree, and heating savings of 2 percent per tree.[78]

F. GROUNDWATER RECHARGE

Increased irregularity in weather patterns due to climate change will result in more extreme weather, including floods and droughts. This irregularity will translate into less consistency and extremes in the flow volumes of the region's rivers and streams, causing severe erosion during times of extreme large flows, and adversely impacting many of the region's aquatic wildlife during times of extreme low flows. These extreme low flow events may have particularly severe impacts on river ecology. River organisms typically rely on being able to travel continuous stream systems for their food and to regulate their temperature by finding cooler and deeper refuges during warmer dryer months. Extreme low flows can segment a stream system, leaving some sections without any water. An effective strategy for ensuring more consistency in stream flow is the replenishment of groundwater, which makes installation of facilities that promote infiltration of stormwater for groundwater recharge (aka green infrastructure practices) a critical part of the solution.

G. CHALLENGES AND OPPORTUNITIES

CHALLENGES

1. Aside from the damage caused by Tropical Storm Irene in 2011 and more recently Tropical Storm Sandy, the consequences of climate change are not immediately apparent. Climate change is an abstract and complex problem that seems to lack any simple solution, making it very difficult to accept and comprehend the dangers that we face with global warming.

2. These barriers to comprehension and easy solutions tend to limit action and response. At the same time, the seemingly small solutions with such strategies as implementation of green infrastructure stormwater management, which can include more trees and other vegetation to sequester carbon, may seem inconsequential in the face of such a massive problem.

OPPORTUNITIES

1. Understanding about climate change—the threat it poses to global security and our way of life—is growing. As more people understand these dangers, more will engage in action. The State of Massachusetts has already set goals for reduction of GHG statewide by 2020, objectives that can help move cities, towns, and individuals to respond.

[78] Ibid.

2. EPA has developed a cost optimization method for stormwater management of phosphorous in the Upper Charles River Watershed. A similar decision support tool that quantifies the potential reduction in natural hazard damage from flooding based on green infrastructure implementation could be invaluable as more frequent larger storms lead to increased flooding. The question to be answered would be: Where might green infrastructure investments best be made to help avoid the cost of damages?

3. The identification of parts of the City of Westfield along the Westfield River and parts of the Town of Hadley near the Connecticut River as areas where the 100-year flood plain will likely expand into existing development, provides important impetus to take preventive action. This could begin with some analysis and then implementation of a suite of strategies that might include extensive implementation of green infrastructure stormwater management practices in upstream locations.

Page left blank intentionally.

CHAPTER 5: RECOMMENDED STRATEGIES

I. MOVING FORWARD WITH GREEN INFRASTRUCTURE

While green infrastructure can help meet multiple community objectives, including reducing polluted runoff of stormwater into nearby rivers and streams, mitigating flooding in developed areas, reducing the costs of combined sewer separation projects, and promoting improved public and environmental health, each community will likely find its own way to implementing improved stormwater control practices. This will depend on understanding and engagement within a municipality, regulatory push from state and federal agencies, political palatability, and financial ability. Some communities may choose to start with initial steps and then move forward gradually to more advanced green infrastructure practices while others may choose to start somewhere in the middle.

This chapter offers a range of strategies for advancing implementation of a green infrastructure program to realize benefits at the local and regional level. Strategies are divided into eight categories:

Strategies for Financing and Funding Green Infrastructure

Strategies for Building Understanding and Promoting Engagement

Strategies for Policies and Regulations

Strategies for Decision Making

Strategies for Redevelopment

Strategies for Incentives

Strategies for Design

Strategies for Maintenance and Inspections

A. CROSS CUTTING STRATEGIES

Green infrastructure strategies described here often tie into the focus areas of one or more of the eight other plans developed for the Sustainable Communities Initiative of the United States Department of Housing and Urban Development. Icons are used in this strategies section and in the strategies section of other plans to denote where a strategy involves other plans. The system of icons is shown in Table 5.1. To learn more about the cross cutting strategy as it may pertain to the topics and analysis in the cross cutting Element Plan, visit www.SustainableKnowledgeCorridor.org .

Table 5.1: Icons Identifying Strategies that Tie into other Sustainable Communities Initiative Plans

FOOD SECURITY	LAND USE	CLIMATE ACTION
GREEN INFRASTRUCTURE	TRANSPORTATION	ECONOMIC DEVELOPMENT
HOUSING	BROWNFIELDS	ENVIRONMENT

II. ELEMENT PLAN STRATEGIES

A. STRATEGIES FOR FINANCING AND FUNDING GREEN INFRASTRUCTURE

To establish a program that is financially sustainable

STRATEGY	DESCRIPTION	SUGGESTED LEADERSHIP
Create a toolkit on funding green infrastructure	This toolkit would include: ▪ An update to the stormwater utility toolkit produced by PVPC in 1998 that draws on the recent experience of Chicopee,Westfield, and other Massachusetts communities. ▪ Fact sheets on each of the different types of fees that could be raised under Massachusetts law to help cover costs for green infrastructure projects. This might include fees akin to the traffic mitigation fees charged by several municipalities. ▪ Information about community outreach on rates and making clear the connection at the local level between: 1. the value of water (the work to bring clean water to the tap); 2. rates (how little we actually pay for water); and 3. the importance of stormwater as a resource (keeping it clean to recharge groundwater and provide baseflow to rivers to lighten the burden of bringing clean water to the tap), which brings it all full circle. This information should also make the connection to recreation and habitat values.	PVPC with project partners
Couple "complete street" with "green street" projects	Promote dialogue on how municipal stormwater managers can collaborate with their colleagues tasked with improving the street experience for	Interested municipalities with assistance

STRATEGY	DESCRIPTION	SUGGESTED LEADERSHIP
	pedestrians and bicyclists to produce projects that result in "complete green streets."	from PVPC
Hold regular municipal cross departmental roundtable discussions to encourage the integration of green infrastructure in all projects involving stormwater management	Encourage cross departmental discussions with regular roundtable meetings to promote projects that bring funding sources together and help to achieve multiple objectives. For example, a combined sewer abatement project might find ways to combine objectives with a road project as well as a parks department project, integrating green infrastructure stormwater management work to abate flow into the combined system. This could lead away from single purpose construction projects to more cost effective projects that serve multiple purposes.	Interested municipalities with possible support available from PVPC
Promote Massachusetts Infrastructure Bank funding for projects that incorporate green infrastructure	Ensure that criteria developed for evaluating projects funded through this newly formed tool, give extra points for managing stormwater through green infrastructure	State legislature with support from PVPC and interested municipalities
Coordinate with MassDOT's Impaired Waters Program to reduce peak flow in CSO communities	Provide information to MassDOT's Impaired Waters Program about locations where runoff from MassDOT roads such as I-91 contributes to combined sewer flows and where municipalities have great interest in managing stormwater for peak flows. Conduct a follow-up meeting to talk about where these local interests may combine with MassDOT interests in managing flow to impaired waters.	Interested municipalities with assistance from PVPC
Seek funding through Environmental Bond Bill for CSO abatement work that includes green infrastructure projects	Work with legislators to include in the bond bill specific CSO abatement work that includes green infrastructure projects	PVPC with municipalities

STRATEGY	DESCRIPTION	SUGGESTED LEADERSHIP
Promote changes to the Clean Water State Revolving Fund so that projects that include green infrastructure are more actively supported	Include points for green infrastructure stormwater management strategies in ranking projects, including the preponderance of projects financed through the use of the program's "recycled" funds. Also, explore whether it is possible to generate set aside funding (based on repayments or possibly through the Green Project Reserve Program) that targets green infrastructure projects in Combined Sewer Overflow (CSO) and Municipal Separate Storm Sewer System (MS4) areas. See State of Illinois for program set up that prioritizes green infrastructure in CSO communities.	MassDEP and EPA
Explore corporate sponsorship programs for green infrastructure	Identify local business leaders who may be interested in a corporate sponsorship program to fund installation of demonstration rain gardens in prominent public places	Interested municipalities with support from PVPC
Seek Supplemental Environmental Project funding for green infrastructure	Provide project ideas to MassDEP and EPA for use of SEP monies on green infrastructure projects in CSO areas	PVPC and interested municipalities
Target specific funding sources and local authorities to ensure that all projects involving stormwater management use green infrastructure strategies	Work with representatives from: ▪ Massachusetts Department of Housing and Community Development and U.S. Housing and Urban Development relative to all Community Development Block Grant funded projects ▪ EPA, HUD, and DOT to encourage conversations with the Economic Development Administration relative to all projects that they fund ▪ Local redevelopment authorities in the region relative to all projects they direct	PVPC and interested municipalities
Explore effectiveness of water quality credits trading programs to alleviate financial	Research Long Island Sound Nitrogen Credit Exchange Program and possibly other programs in the country to understand how such programs are implemented and how effective they are in alleviating financial burdens on municipalities while providing incentives to landowners to implement	PVPC perhaps with help from UMass

STRATEGY	DESCRIPTION	SUGGESTED LEADERSHIP
burden on municipalities of meeting water quality requirements	green infrastructure practices. In these credit exchange programs typically facilities that face higher pollutant control costs to meet regulatory obligations can purchase pollutant reduction credits from landowners who are more easily able to reduce volume and pollutants through green infrastructure.	
Incorporate green infrastructure practices into publically funded projects across the region	Support local officials in their efforts to implement green infrastructure practices in publically funded projects. These can include: the Connecticut Riverwalk Project and the Older Adult Community Center in Chicopee, and possibly current MassWorks funded projects in Easthampton, Holyoke, Springfield, and Westfield.	Interested municipalities with support from PVPC

B. STRATEGIES FOR BUILDING UNDERSTANDING AND PROMOTING ENGAGEMENT

Promote understanding about stormwater management and green infrastructure solutions with residents, businesses, the development community, political leaders, and municipal officials

STRATEGY	DESCRIPTION	SUGGESTED LEADERSHIP
Seek funds for pilot/demonstration projects that transform "gray" streets into "green" streets	Seek funds to support and promote pilot/demonstration projects and highlight existing projects in the region, collecting data, measuring results, demonstrating the potential for cost savings in avoiding costly gray infrastructure projects, and showing effectiveness, benefits, and lessons learned. Capitalize on the visibility of green streets projects through signage, brochures, and creative outreach strategies. This can also include temporary transformation of streets, using the occasion of local street festivals to convert a local street into a green street and using the help of local nurseries and design students.	Municipalities and MassDOT with help from PVPC
Promote citizen-built rain gardens and related projects	Support local efforts to build rain gardens and other such projects. This work can include: ▪ Collaborating with EPA and city partners to conduct a rain garden workshop in Springfield Technical High School that results in a constructed facility; ▪ Facilitating EPA's work to conduct rain garden trainings in other parts of the region for other	PVPC in collaboration with EPA and coordinating with citizen groups and municipalities

STRATEGY	DESCRIPTION	SUGGESTED LEADERSHIP
	young people to develop these skills. Other locations to conduct a similar program might include the Smith Agricultural and Vocational High School in Northampton, Dean Technical High School in Holyoke, or Chicopee Comprehensive High School.	
Develop a green infrastructure educational toolbox	The toolbox should contain information about what green infrastructure is, what it looks like, and why it is important. It should describe green infrastructure strategies to be adopted by residents and businesses on their properties, and include fact sheets, how-to guides, and a short film or powerpoint presentation.	PVPC
Conduct a series of workshops for municipal officials, design professionals, and others in development community	For municipal officials conduct workshops on: A. green infrastructure stormwater management approaches and planning; B. methodologies for quantifying the range of benefits associated with green infrastructure; C. use of EPA's cost optimization tool to identify the most effective stormwater controls based on watershed conditions; D. design and maintenance guidance for green infrastructure practices; E. incentives and credits for green infrastructure (to be included in local codes); and F. site plan review for green infrastructure stormwater management. Also promote peer to peer events where officials take with their peers about their experience with green infrastructure projects and issues. For design professionals and others in the development community conduct workshops on: A. alternative models for site design that incorporates Low Impact Design/Green Infrastructure, especially for infill/retrofit situations; B. cost benefits of green infrastructure and the mitigating costs in infill/retrofit projects; C. how to ensure effective construction oversight of green infrastructure stormwater management facilities	PVPC in collaboration with state and federal agencies and grant funding sources
Train municipal staff tasked with facilities management (parks, schools grounds, and athletic fields) about green site management practices to reduce stormwater	Promote green site management practices to reduce erosion and stormwater runoff, as well as pollutant loading from fertilizers and pesticides. The Northeast Organic Farming Association (NOFA) offers training in organic land care through their Accredited Organic Land Care Professional (AOLCP) program. Work with the Connecticut River Stormwater Committee to offer scholarships to Stormwater Committee members to trainings, as well as other programming offered through the Ecological Landscaping Association.	PVPC in collaboration with state and federal agencies and grant funding sources

STRATEGY	DESCRIPTION	SUGGESTED LEADERSHIP
pollutants		
Promote narrower roads necessary to reducing stormwater flows	Work with municipal emergency services representatives to define a strategy for meeting both public safety and green infrastructure objectives, drawing from good examples in other communities. Explore standards for truck sizes and revising road width standards (for subdivision regulations). Develop graphics to show how public safety objectives can be met with green infrastructure facilities.	Municipal officials with assistance from PVPC
Design and install interpretive signage at key existing green infrastructure facilities in the region	Highlight existing green infrastructure projects in the region to promote awareness and build greater understanding and appreciation for these types of facilities. This could begin at the Jones Ferry River Access Center where there is a green roof that is largely invisible to the many people who use the Center throughout the rowing center. This is an especially good location because the rowers who use the facility will immediately get the connection between the green roof and water quality in the Connecticut River.	PVPC with willing landowners
Establish annual awards program	Recognize and promote good green infrastructure projects by municipalities, private developers, and the State of Massachusetts	PVPC
Add green infrastructure projects from the Pioneer Valley to the LID (Low Impact Development) Atlas developed by the Nonpoint Education for Municipal Officials (NEMO)'s National Network	Work with NEMO's existing LID/green infrastructure interactive mapping tool to help build understanding about existing projects in the region. Add specific information on design, costs, funding sources, and lessons learned to help build the knowledge base in the region and beyond. Make extensive use of before and after images. See atlas at: http://clear2.uconn.edu:8080/lidmap/index_original.php	PVPC
Work with existing education programs to further develop programming about green infrastructure	Organize a tour for municipal officials of the green infrastructure facilities at the University of New Hampshire Stormwater Center. Work with Bay State Roads to conduct a workshop on making complete streets green streets. Collaborate with EPA, Region 1's, Soak up the Rain Campaign to conduct more rain garden trainings.	PVPC

STRATEGY	DESCRIPTION	SUGGESTED LEADERSHIP

C. STRATEGIES FOR POLICIES AND REGULATIONS

To create a suite of regulations that as a whole promote/facilitate/require projects that reduce imperviousness and utilize green infrastructure strategies for stormwater management

STRATEGY	DESCRIPTION	SUGGESTED LEADERSHIP
Provide technical assistance to develop policies and regulations that promote green infrastructure	Work with one to three municipalities to develop policies and regulations that include provisions to promote green streets, green civic buildings, as well as stormwater, zoning, and subdivision regulations that incentivize green infrastructure in private development.	Interested municipalities with help from PVPC
Assess existing local policies and regulations that impact green infrastructure and make recommendations for improvements	Use the PVPC Green Infrastructure Checklist (see Appendixes) to review to what extent local policies and regulations make green infrastructure practices allowable	PVPC with interested municipalities
Bring together impervious cover reduction requirements in proposed MS4 stormwater permit with impervious cover reductions that better target improved water quality	Identify and map 3rd order streams in Municipal Separate Storm Sewer System (MS4) regulated communities so that municipalities can measure impervious cover connections in relation to the watersheds of these streams rather than measuring impervious cover reductions in terms of municipal boundaries. (Note: the Impervious Cover Model, which made the connection between degree of imperviousness and degree of stream degradation, applies only to 1st through 3rd order streams.)	PVPC in collaboration with EPA and municipalities

STRATEGY	DESCRIPTION	SUGGESTED LEADERSHIP
Amend road building practices to better reduce total impervious area and to manage stormwater runoff from roads	Update municipal road building policies and Subdivision Regulations to reduce impervious areas. This should include: ▪ Reduced cul de sac dimensions and street lane widths (which can also help meet traffic calming goals) ▪ Porous pavements in new and reconstructed roads where appropriate ▪ Use of roadside green infrastructure facilities wherever possible Encourage discussions across departments – between staff responsible for stormwater management and those responsible for emergency response – to promote supportive attitudes that ensure new fire trucks and other equipment purchases are compatible with municipal road narrowing policies and green infrastructure goals. Capitalize on lane narrowing in urban locations to introduce roadside planters and other small-scale green infrastructure.	Interested municipalities
Create a detailed Green Infrastructure Opportunities Map for each municipality	Inventory all municipal streets and planned road construction projects to identify green infrastructure opportunities within the road right of way, and where it may be possible to go "curbless" (e.g. with perforated curb and swale infrastructure, or with only swale infrastructure). Identify future municipal and private development projects that may offer opportunities to implement green infrastructure. PVPC has started this process with several municipalities within this plan (see Mapping Chapter). PVPC has also created green infrastructure base maps for all Municipal Separate Storm Sewer System (MS4) permitted communities in the region that are in the Appendixes of this plan.	Municipal stormwater management staff
Adopt municipal tree bylaws/ordinances or other regulations that minimize removal of large trees and encourage planting of new	Trees have great capacity to take up water, and therefore provide significant stormwater management benefits. Tree Ordinances or Site Plan Review standards are sometimes established to limit removal of mature trees, and to promote planting of new trees.	Interested municipalities with assistance from PVPC

STRATEGY	DESCRIPTION	SUGGESTED LEADERSHIP
trees		
Adopt stormwater regulations that promote green infrastructure on smaller sites and redevelopment sites	Establish regulations that promote best stormwater management practices at small development sites (in addition to large sites), and at redevelopment sites. For small sites, requirements should improve water quality but should be less burdensome than requirements for large projects. For all new developments on previously undeveloped sites, require that post-development runoff be no greater than pre-development runoff. For redevelopment sites, the standards can be focused on improving existing conditions.	Interested municipalities with assistance from PVPC
Establish reduced and more flexible off-street parking requirements to reflect actual parking demand	Reduce off-street parking requirements, introducing greater flexibility for considerations of shared parking, availability of transit, etc. In downtown areas, siting new municipal parking lots can support reduction or elimination of off-street parking requirements. Where developers are pushing for allowances of more parking, it may be worth considering a parking mitigation fee (akin to the traffic mitigation fees already in place in some communities)	Interested municipalities with assistance from PVPC
Amend municipal zoning and subdivision regulations that require excess pavement in driveways and parking lots	Revise site development regulations to ensure that driveway widths, parking space dimensions, and parking lot designs minimize paved area to the greatest extent feasible. In addition, landscaping requirements for parking lots can help manage stormwater runoff, improve water quality, and improve the pedestrian experience.	Interested municipalities with assistance from PVPC
Revise Subdivision Regulations to promote green infrastructure	Subdivision Regulations can support green infrastructure by allowing or requiring perforated curb and swale infrastructure and, where appropriate, curbless roads with roadside swales. Cluster development provisions coupled with open space	Interested municipalities with assistance from PVPC

STRATEGY	DESCRIPTION	SUGGESTED LEADERSHIP
	preservation improve water quality by creating less paved area overall, and by allowing more environmentally sensitive portions of a site to be preserved.	

D. STRATEGIES FOR DECISION MAKING

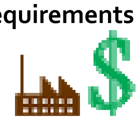
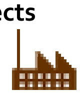
To develop more coordinated, collaborative, and cost effective approach

STRATEGY	DESCRIPTION	SUGGESTED LEADERSHIP
Explore the use of a cost optimization tool, that aggregates the benefits and selects "best buys" or projects with the greatest environmental value per dollar	Work within a subwatershed or community to use EPA's cost optimization method to develop a tool that targets where the best green infrastructure investments would be for reduction of Nitrogen in storm flow (given the Long Island TMDL and Municipal Separate Storm Sewer System permit requirements for nitrogen reduction), and possibly peak flow reduction as well.	PVPC with EPA, pending a Conservation Innovation Challenge grant for this work)
Promote Federal Highway funding for projects that incorporate green infrastructure	Ensure that new project scoring criteria used by the Metropolitan Planning Organization in evaluating Transportation Improvement Program (TIP) projects include points for managing stormwater through green infrastructure. To promote better coordination between projects, also establish ranking criterion for TIP projects that provides additional points to projects that are also eligible for Clean Water State Revolving Fund monies.	MPO with support from PVPC
Seek to advance green infrastructure practices within MassWorks funded projects	Work with MassWorks grant administrators, possibly in tandem with other interested regional planning agencies, to explore revisions in ranking criteria that would promote projects that incorporate green infrastructure.	PVPC with MassWorks administrators and perhaps other RPAs
Establish a structured decision making approach for green infrastructure	Encourage municipalities to hold a strategy-setting meeting to assess how decisions are currently made for roads, stormwater, and CSO infrastructure, and how decision making can be improved. Establish a deliberate and systematic approach that considers needs and costs. Develop reporting systems across municipal departments to ensure that potential	Interested municipalities with support from PVPC

STRATEGY	DESCRIPTION	SUGGESTED LEADERSHIP
	opportunities for green infrastructure do not inadvertently slip through the cracks.	
Track the condition of stormwater infrastructure, possible locations for green infrastructure retrofits, and other valuable decision support information	Develop a local GIS-based decision support database and/or use asset management software. Track the condition of all stormwater and CSO infrastructure, as well as possible locations for new green infrastructure. Track degree of impervious, water quality, flooding locations, infrastructure cost estimates, etc. to support decision making.	Interested municipalities with support from PVPC
Enable citizens to report problems with stormwater, CSO and road infrastructure, along with other issues	Enroll in Commonwealth Citizens Connect program, or other emerging opportunities to share the costs of decision support tools. The Citizens Connect program enables citizens to report problems using the SeeClickFix smart phone application and to provide municipal officials with a work order management system for staff to manage requests as they come in. Specific problems with flooding, combined sewers, and storm drains, among others, may help to better document the need for green infrastructure.	Interested municipalities
Establish a regional agreement to promote a common purpose around green infrastructure	Develop a regional agreement on implementation of green infrastructure so that upstream and downstream communities understand that they are working toward a common purpose in reducing polluting stormwater flows. Maybe include specific performance measure from the MS4 permit.	Interested municipalities

E. STRATEGIES FOR REDEVELOPMENT

To assure better stormwater management in these critically important urban locations

STRATEGY	DESCRIPTION	SUGGESTED LEADERSHIP
Create a good operating definition of "redevelopment" within existing stormwater regulations	A good definition of redevelopment will help to ensure more effective management of stormwater in urban locations. See the five core elements to a good definition in Tom Schueler's report entitled, "Stormwater Design for High Intensity Redevelopment Projects."	Interested municipalities with help from PVPC
Develop a checklist for redevelopment projects 	Guide developers and assist municipal governments in reviewing projects and evaluating metrics with checklists. A checklist could include elements within Section 4 and Section 6 in Schueler's report and in the Checklist for Redevelopment Projects within the *Massachusetts Stormwater Handbook.* See: http://www.mass.gov/dep/water/laws/v2c3.doc	Interested municipalities with help from PVPC
Offer incentives for projects to go beyond requirements 	Incentives could include an incentive for green roofs (e.g., increased floor area ratio [FAR] bonus, additional building height) and/or an incentive for reduced stormwater management requirements for a project that decreases total imperviousness on previously developed sites. See Strategies for Incentives in this chapter.	Interested municipalities
Promote some flexibility in regulations 	For projects where compliance cannot be achieved, particularly in high intensity urban sites where there is 85% or more impervious cover, provide options for off-site compliance or charge a fee to help offset stormwater inputs on public properties. Such a fee is especially important in areas where the stormwater system is limited in its capacity to accommodate additional peak flow.	Interested municipalities
Develop a preferred practices list with technical specifications for redevelopment projects 	A preferred practices list of green infrastructure strategies could be included in a green infrastructure stormwater manual. This list of practices could include design schematics and maintenance information for such strategies as removal of existing impervious cover with soil restoration, green roofs, rainwater harvesting, foundation planters, and permeable pavements.	Interested municipalities with possible assistance from PVPC

F. STRATEGIES FOR INCENTIVES

To devise a most sensible route forward in terms of economic, social, political, and environmental reasons for projects on private property

STRATEGY	DESCRIPTION	SUGGESTED LEADERSHIP
Develop a toolkit of effective incentives for green infrastructure	Establish a toolkit based on specific incentives tested in conversations with developers. These could include: ▪ Floor area ratio bonuses and reduced parking requirements in exchange for green infrastructure, particularly green roofs and water harvesting systems ▪ Expedited review/permitting policy, based on qualifying criteria (e.g., projects that meet LEED stormwater criteria, or redevelopment projects that "disconnect" stormwater flow from a certain percentage of impervious cover into the municipal storm sewer system). ▪ Rebate programs	PVPC with guidance from municipalities and development community
Provide guidance for downspout disconnect compliance programs	Based on programs to date in the region, review lessons learned, successes to date, and develop a guidance tool for municipalities	PVPC, and interested partners in South Hadley, Holyoke, and Springfield
Define and develop effective messaging around green infrastructure initiatives	Identify community specific stormwater problems with municipal officials and explore solutions that might lend themselves to theme-based programs to help address problems. Chicago, for example, tackled flooding problems with the Green Alleys program. Portland, Oregon, reduced inflow into their combined sewer system with a Green Streets program and Eco-Roof program.	PVPC with interested municipalities
Explore opportunities within state and local tax codes to provide credits for green infrastructure	Look to other tax credit programs to devise programs for green infrastructure. The Data Base of State Incentives for Renewables and Efficiency may be a good starting place to understand what may be possible under existing Massachusetts law. See: http://www.dsireusa.org/incentives/index.cfm?re=0&ee=0&spv=0&st=0&srp=1&state=MA	PVPC

G. STRATEGIES FOR DESIGN

To promote understanding and practice with green infrastructure facilities

STRATEGY	DESCRIPTION	SUGGESTED LEADERSHIP
Develop a green infrastructure stormwater manual for the region	Draw from existing manuals and additional research to develop a manual of standards for use by interested communities. This manual can include: green infrastructure/low impact development standards, standards for redevelopment, an application process that supports a green infrastructure/low impact development approach to site design, and technical guidance on design, construction, and maintenance, including design and maintenance for snow storage. For ease of use, the manual might include a menu of best management practices (BMPs) based on whether the project is occurring on a high density urban site or new development on a green field and based on the type of project: street, street with sidewalk, parking lot, residential, commercial. Development on the manual can draw on existing documents from MassDEP and the University New Hampshire Stormwater Center on pollutant removal capabilities of practices. Further development of the manual will require review and revision by a qualified engineer to ensure that design guidelines and specifications are fully appropriate to the region.	PVPC with guidance from interested municipalities
Overcome barriers to rainwater harvesting	Promote state plumbing code changes to include requirements specific to rainwater harvesting. Also work with local plumbing boards to better understand appropriate safeguards for cross connections in rainwater harvesting projects.	MassDEP
Seek and share information about new best management practices throughout the region	As green infrastructure practices evolve, information about new approaches to design, construction, and maintenance is constantly emerging. An innovative bioretention system being tested by the UNH Stormwater Center, for example, could be an important new development for communities seeking to meet TMDL nitrogen reduction targets. There is good emerging information at the local level too, such as the analysis by City of Northampton of reducing impervious surfaces at intersections.	PVPC

STRATEGY	DESCRIPTION	SUGGESTED LEADERSHIP
Facilitate procurement of materials and facilities	Support and develop markets for materials, particularly porous pavement and bioretention soil mixes. Also provide guidance about procurement regarding proprietary BMPs and with elements, like water quality swales, that are not "quantities."	PVPC with interested municipalities

H. STRATEGIES FOR MAINTENANCE AND INSPECTIONS

To ensure proper long-term functioning of green infrastructure facilities and systems

STRATEGY	DESCRIPTION	SUGGESTED LEADERSHIP
Adopt standards to guide maintenance and inspection activities	Ensure that green infrastructure maintenance for both private and public projects will be adequate by adopting standards for maintenance and inspection activities. Such standards will also help to inform developers and site managers and could be useful to maintenance agreements that municipalities may establish with private entities, such as neighborhood groups to care for town or city-owned green infrastructure (a common practice in Portland, Oregon).	Interested municipalities with possible help from PVPC
Require green infrastructure installations to have a maintenance plan and budget	For new privately owned green infrastructure, require developers to submit a maintenance plan and budget, and to demonstrate how annual maintenance will be funded as part of the stormwater management permitting process. The format of this plan could be standardized. For publicly owned green infrastructure, establish a maintenance plan and annual budget, and identify the maintenance funding source. All maintenance plans should identify any specialized equipment that will be needed for infrastructure maintenance and provisions for snow storage that safeguard the functionality of the green infrastructure facility.	Interested municipalities
Require Performance and Maintenance Bonds for new privately-owned green infrastructure	Require two-year performance and maintenance bonds for green infrastructure to guarantee performance and to protect a municipality against design defects, failures in workmanship, and inadequate maintenance.	Interested municipalities
Establish a	Whether privately or municipally owned, establish a	Interested

STRATEGY	DESCRIPTION	SUGGESTED LEADERSHIP
regular inspection schedule for all green infrastructure	regular municipal inspection schedule for green infrastructure to ensure that maintenance is being conducted according to the maintenance plan and that green infrastructure is working as designed. Require that a log of maintenance activities be kept for all facilities, private and public, and submitted annually to the permitting authority.	municipalities
Maintain a database of public and privately-owned green infrastructure	Municipal databases are used to inventory and track green infrastructure. Databases can track completed maintenance, as well as future inspection and maintenance dates. Some municipalities send reminders to owners of private green infrastructure when regular maintenance is required.	Interested municipalities
Develop adequate enforcement measures for green infrastructure maintenance	Establish timelines for addressing maintenance and repair issues identified during inspections. For privately maintained green infrastructure, establish penalties that apply when required maintenance is not completed.	Interested municipalities
Provide training to municipal employees regarding maintenance and inspection techniques	Ensure that municipal employees are knowledgeable about green infrastructure design, maintenance and inspection in order for the municipality to be able to fulfill its oversight role and ensure that green infrastructure continues to function as designed.	Interested municipalities with help from PVPC
Highlight details of green infrastructure facilities that will help make maintenance easier	Broadcast information about green infrastructure design details that provide savings of time and money in maintenance. Bioretention facilities designed for North Street in Pittsfield, MA, for example include an important solution: concrete splash pads that allow sediment to drop out of stormwater coming into bioretention facilities are designed to accommodate the width of one shovel, making it far easier to remove sediment.	PVPC

Page left blank intentionally.

CHAPTER 6: IMPLEMENTATION PROJECTS

Implementation projects described in this chapter are one-year projects that have tangible, measurable outcomes. PVPC drew together a list of potential implementation projects from the preceding Strategies chapter based on prospective funding and achievability within a one-year time frame. Green Infrastructure Advisory Committee members further refined the list through a ranking process in which they were asked to prioritize strategies based on importance to their municipality or agency. Projects preceded by an infinity ∞ symbol were among the five highest ranked projects. Note that several projects listed here are based on current available opportunities to advance green infrastructure and several projects listed here will require additional funding.

FINANCE AND FUND GREEN INFRASTRUCTURE

PROJECT NAME	SUGGESTED LEADER
Promote changes to the Clean Water State Revolving Fund (SRF) to support green infrastructure Include points for green infrastructure stormwater management strategies in ranking projects, including the preponderance of projects financed through the use of the program's "recycled" funds.	MassDEP and EPA
Explore a new state green infrastructure grant program Explore whether it is possible to generate set aside funding (based on repayments or possibly through the Green Project Reserve Program) that targets green infrastructure projects in Combined Sewer Overflow (CSO) and Municipal Separate Storm Sewer System (MS4) areas. See State of Illinois for program set up that prioritizes green infrastructure in CSO communities. Seek funds to support and promote pilot projects that demonstrate the potential for cost savings in avoiding costly gray infrastructure projects, and showing effectiveness, benefits, and lessons learned.	MassDEP and EPA

Seek funds for pilot/demonstration projects that transform "gray" streets into "green" streets	Local municipalities and MassDOT with assistance from PVPC

BUILD UNDERSTANDING AND PROMOTE ENGAGEMENT

Conduct workshops for municipal officials, design professionals, and others in the development community Provide workshops to help expand understanding about green infrastructure stormwater management approaches and engagement with green infrastructure planning. PVPC conducted a workshop series in January and February 2012. PVPC also held a meeting with EPA for municipal officials to learn about current cost optimization work relative to green infrastructure. For 2013, PVPC will collaborate with EPA on a series of workshops aimed at addressing common barriers to green infrastructure. The workshop audience will be expanded to include designers/engineers/developers and construction and maintenance contractors. Projects from within the region will be featured to help build peer to peer relationships on learning from green infrastructure projects.	PVPC in partnership with EPA
Promote citizen-built rain gardens and related projects Support local efforts to build rain gardens and other such projects. This work can include: ▪ Collaborating with EPA and city partners to conduct a rain garden workshop in Springfield Technical High School that results in a constructed facility; ▪ Facilitating EPA's work to conduct rain garden trainings in other parts of the region for other young people to develop these skills. Other locations to conduct a similar program might include the Smith Agricultural and Vocational High School in Northampton, Dean Technical High School in Holyoke, or Chicopee Comprehensive High School.	PVPC in collaboration with EPA, citizen groups and municipalities

Design and install interpretive signage at key existing green infrastructure facilities in the region Highlight existing green infrastructure projects in the region to promote awareness and build greater understanding and appreciation for these types of facilities. This could begin at the Jones Ferry River Access Center where there is a green roof that is largely invisible to the many people who use the Center throughout the rowing season. This is an especially good location because the rowers who use the facility will immediately understand the connection between the green roof and water quality in the Connecticut River.	PVPC with willing landowners

DEVELOP POLICIES AND RESOURCES

Assess existing local policies and regulations that impact green infrastructure and make recommendations for improvements Use the PVPC Green Infrastructure Code Review Checklist developed as part of the Green Infrastructure Plan to identify how existing code might better facilitate green infrastructure practices	PVPC in collaboration with Ludlow and Chicopee, and possibly other interested municipalities
∞ Develop a model green infrastructure policy Develop a model policy that includes various components that can be used by municipalities to promote green infrastructure. These components can include: ▪ Incentives for green infrastructure in private development to be included in stormwater, zoning, and subdivision regulations. ▪ A "Green Streets Policy" to ensure that green infrastructure is included in all new road and road reconstruction projects. ▪ Committing new municipal buildings to achieve certain stormwater criteria, perhaps those laid out in the LEED (Leadership in Energy and Environmental Design Green Building Certification) program or the Sustainable Sites Initiative developed by the American Society of Landscape Architects.	PVPC

Provide technical assistance to municipal partners to develop policies and regulations that promote green infrastructure Work with one to three municipalities to develop policies and regulations that include provisions to promote green streets, green civic buildings, as well as stormwater, zoning, and subdivision regulations that incentivize green infrastructure in private development.	Interested municipalities with support from PVPC
Identify funding to develop green infrastructure stormwater manual for the region Identify funding that would enable PVPC, an engineering firm, and a roundtable of municipal partners to work on the development of a green infrastructure stormwater manual for the region, drawing from existing manuals and additional research. This manual can include: green infrastructure/low impact development standards, standards for redevelopment, an application process that supports a green infrastructure/low impact development approach to site design, and technical guidance on design, construction, and maintenance, including design and maintenance for snow storage. For ease of use, the manual might include a menu of best management practices (BMPs) for consideration based on whether the project is occurring on a high density urban site or new development on a green field and based on the type of project: street, street with sidewalk, parking lot, residential, commercial. Development on the manual can perhaps draw on existing documents from MassDEP, MassDOT, and the University New Hampshire Stormwater Center on pollutant removal capabilities of practices. Engineering expertise will be critical to ensuring that design guidelines and specifications are fully appropriate to the region.	PVPC

SUPPORT DECISION MAKING

Promote Federal Highway funding for projects that incorporate green infrastructure Ensure that new project scoring criteria used in evaluating Transportation Improvement Program projects include points for managing stormwater through green infrastructure.	PVPC and CRCOG with MassDOT, CT DOT, and possibly other RPAs
Incorporate green infrastructure practices into publically funded projects across the region Support local officials in their efforts to implement green infrastructure practices in publically funded projects. These can include: the Connecticut Riverwalk Project and the Older Adult Community Center in Chicopee, and possibly current MassWorks funded projects in Easthampton, Holyoke, Springfield, and Westfield.	Interested municipalities with support from PVPC
Seek to advance green infrastructure practices within MassWorks funded projects Work with MassWorks grant administrators, possibly in tandem with other interested regional planning agencies, to explore revisions in ranking criteria that would promote projects that incorporate green infrastructure.	PVPC with MassWorks administrators and perhaps other RPAs
∞ Coordinate with MassDOT's Impaired Waters Program to reduce peak flow in CSO communities Provide information to MassDOT's Impaired Waters Program about locations where runoff from MassDOT roads such as I91 contributes to combined sewer flows and where municipalities have great interest in managing stormwater for peak flows. Conduct a follow-up meeting to talk about where these local interests may combine with MassDOT interests in managing flow to impaired waters.	Cities of Springfield, Holyoke, and Chicopee with support from PVPC

Page left blank intentionally.

APPENDIX A

GREEN INFRASTRUCTURE WORKING MAPS FOR 22 STORMWATER REGULATED COMMUNITIES (IN ELECTRONIC VERSION OF PLAN ONLY)

Page left blank intentionally.

APPENDIX B

EXISTING GREEN INFRASTRUCTURE PROJECTS IN THE REGION

1. List of Known Existing Projects

2. Detailed Descriptions of Eight Existing projects

Bioretention areas (rain gardens)

- University of Massachusetts, Amherst
- Senior Center, Northampton
- Johnny Appleseed Park, Springfield

Street edge vegetated swale

- Conz Street, Northampton

Porous asphalt

- New England Environmental, Inc., Amherst
- Columbia Greenway Rail Trail, Westfield

Rain water harvesting

- Putnam Regional High School, Springfield

Green roof

- Jones Ferry River Access Center

EXISTING - Green Infrastructure Projects in the Pioneer Valley

(may not have captured all projects in region, but these are those projects known to PVPC at date of publication)

	Bioretention System (Rain Garden)	Drywell and/or Infiltration Trench/Basin	Green Roof	Infiltrators	Porous Pavement	Rainwater Harvesting	Tree Box Filter	Vegetated Swale	Constructed Wetland	Other
Agawam										
School Street Park	X				X					
Amherst										
New England Environmental Inc.	X				X					grass pavers
University of Massachusetts	X									
Chicopee										
Jones Ferry CSO Treatment Facility						X				
Upper Granby Road sewer separation project				X						
Granby										
Florence Savings Bank	X									
CVS	X									
U.S. Post Office	X									
Hadley										
Valley Bike and Ski Werks	X									
Central Rock Climbing Center	X									
Holyoke										
Skinner Parking Lot										Catch basins with leaching basins
Jones Ferry River Access Center			X							

	Bioretention System (Rain Garden)	Drywell and/or Infiltration Trench/Basin	Green Roof	Infiltrators	Porous Pavement	Rainwater Harvesting	Tree Box Filter	Vegetated Swale	Constructed Wetland	Other
Holyoke Transportation Center				X						
Holyoke Senior Center				X		X				
Holyoke Public Library				X						
Community Field	X									
Kittredge Center, Holyoke Community College			X							
Longmeadow										
Longmeadow High School	X							X		
Northampton										
Conz Street								X		
Northampton Senior Center (LEED Silver)	X									
L3-KEO parking lot (formerly Kollmorgen)	X									
Musante Drive at Village Hill								X		
Ford Hall, Smith College (LEED Gold)			X			X				
River Run Condos, Damon Road	X									
Northwood Development, Atwood Drive	X	X								
River Valley Market	X					X				
KFC/Taco Bell (LEED Gold)	X									
South Hadley										
U.S. Post Office		X								
Blanchard Campus Center Addition, Mt. Holyoke College (LEED)	X									

	Bioretention System (Rain Garden)	Drywell and/or Infiltration Trench/Basin	Green Roof	Infiltrators	Porous Pavement	Rainwater Harvesting	Tree Box Filter	Vegetated Swale	Constructed Wetland	Other
New Residence Hall, Mt. Holyoke College (LEED Gold)	X									
Carr Laboratories, Mt. Holyoke College (LEED)	X									
Springfield										
Putnam Regional High School				X		X				
Johnny Appleseed Park (Shebbins Park)	X									
F.W. Webb Industrial Development				X						
WalMart, Boston Road				X						Stormceptor Catch Basins
Westfield										
Parking lot for Columbia Greenway Rail Trail					X					
Marla Circle										Infiltrating Catch Basins
Stieger/Falley Drives								X		
Big Y, Broad Street									X	
Lowes										Stormceptor and Wet Basin

Bioretention Area/Rain Garden
Studio Arts, UMass Amherst

To capture stormwater flow from a nearby parking lot, UMass constructed a 150-foot long, 20-foot wide, and 18-inch deep rain garden. Designed as a flow-through system, the facility uses a series of four 12-inch by 12-inch weirs that help to maximize capacity. Weirs range in length from 10 to 14 feet . Stormwater enters through one of two entry points, infiltrates with excess waters moving downgradient through the series of basins to outlet ultimately into a catch basin that had previously received all flow prior to construction of the rain garden. The system also includes 450 native wetland plants.

Purpose: To capture a large volume of stormwater from the adjacent parking lot, allowing wetland plants to absorb water and filter contaminants.

Designers: UMass faculty Jack Ahern, Max Cohen, and Mike Davidsohn

Stormwater Capacity: 3,000 to 4,000 gallons

Permitting: None

Construction Costs: Extensive use of recycled materials, including concrete slabs, stone, boulders, plants and other materials, making construction costs very inexpensive (estimated to cost between $50,000 and $100,000 if had gone out to bid)

Funding Source(s): UMASS Amherst; donated parts and labor by UMASS Construction Services

Lessons Learned:

- Importance of accurate site data including soils and slopes.
- Need to provide management of flow during project development and with project completion.
- Having the right plants and soil for infiltration is critical. Native plants should be considered.
- Having a plan to maintain the raingarden is essential, including pruning, weeding, etc.
- It is critical to have at least one person on the ground overseeing every aspect of construction from setting grade stakes and excavation to planting and mulching.

Decision Makers: Designers, UMASS Construction Services

Completed: 2010

Bioretention Areas/Rain Gardens
Senior Center, Northampton, MA

To ensure that as much stormwater remains on site as possible the City of Northampton installed a series of two rain gardens, infiltration trenches, and underground detention at the new Senior Center. The rain gardens, which receive storm flow from 15,682 square feet of parking lot, enable water to get taken up by plants or infiltrate into onsite soils. The 3,750 cubic foot underground detention system captures stormwater from part of the parking lot and a portion of the roof and discharges to the City's drainage system. Another portion of the roof drains to infiltration trenches along the building. The overall project achieved a silver rating from the National Green Building Council's Leadership in Energy and Environmental Design (LEED) program.

Purpose: Reduce impervious cover and increase on-site infiltration so as to limit the amount of stormwater draining from the City's stormwater system to local surface waters

Designers: Juster Pope Frazier LLC and Berkshire Design Group, Inc

Stormwater Capacity: Designed for the 25-year storm event. Overflows during heavier rainfall events are directed to a closed drainage system.

Permitting: Site plan review, stormwater permit, Notice of Intent

Construction Costs: The construction costs vary depending on the extent of planting and subsurface drainage infrastructure required. Existing site conditions such as high ground water result in higher costs than do those sites with well draining soils.

Funding Source(s): Northampton City Bond in the amount of $3.9 million for design and construction. Mayor committed $2.5 million in current and future Community Development Block Grant (CDBG) funds for interest and principal payments on the approved borrowing. The remainder of the funding was covered by local tax dollars.

Lessons Learned: Raingardens do require maintenance to function correctly. This includes removal of any collected debris, weeds, and periodic sediment removal.

Decision Makers: City of Northampton in collaboration with design firm

Completed: August 2007

Rain Gardens
Johnny Appleseed Park, Springfield, MA

Major renovations to the 4.77-acre Johnny Appleseed Park, which borders the Mill River in Springfield, includes a series of two rain gardens to manage stormwater flow from the pathway and basketball court.

Each of the rain gardens consists of a 4-½ foot deep rain garden infiltration medium with several layers, including 12 inches of crushed stone, 6 inches of peastone, 6 inches of sand, and 30-inches of an engineered soil mixture. The rain gardens are planted with drought tolerant plants species that can sustain periods of wet soils, such as inkberry, winterberry, asters, black-eyed susans and coneflowers.

Purpose: To provide an aesthetically pleasing, but also innovative approach to stormwater management, promoting groundwater recharge, and reducing runoff to the Mill River.

Designers: GZA GeoEnvironmental, Inc.

Stormwater Capacity: The raingardens are designed to receive stormwater from relatively small impervious areas. For very large storm events overflow and underdrain structures are connected to an existing stormwater drainage system that discharges to the Mill River.

Permitting: Conservation Commission NOI and Order of Conditions as the project is located within 100 feet of the Mill River

Construction Costs: Approximately $9 per square foot or $5,500 for the 2 rain gardens

Funding Source(s): Renovations to the park were funded by the Parkland Acquisitions and Renovations for Communities "PARC" Program and a Community Development Block Grant

Lessons Learned:

- Careful installation of engineered soil medium should avoid compaction and oversight by the design professional during this phase of work is recommended.
- Make sure the area chosen drains properly by removing sediment that may clog the site
- Make sure grading supports drainage of stormwater to the rain garden

Decision Makers: The City of Springfield's Department of Capital Asset Construction

Completed: December 2010

Vegetated Water Quality Swale
Conz Street, Northampton, MA

As part of a road reconstruction project on Conz Street, the City installed a vegetated water quality swale along 110 feet of the street edge to capture, filter, and convey stormwater moving off the road through three curb cuts. The swale also allows for infiltration of some stormwater, helping to mitigate peak flows. The swale is currently planted with grass due to vehicle site distance requirements, but shrubs, trees and other deeper rooted vegetation may be added at some point. Soil in this facility is composed of 40 percent sand, 40 percent compost and 20 percent topsoil.

Because part of the swale grade involved the property of the Daily Hampshire Gazette, the City worked with newspaper representatives to obtain permissions and to ensure that the project addressed concerns.

Purpose: To mitigate peak flows from the roadway during storm events. Also, to test how to best integrate a green infrastructure stormwater management solution into an existing road reconstruction project and develop a design template to use green inftrastructure for future road development.

Designers: Northampton Department of Public Works (Felix Harvey, Engineer, and Doug McDonald, Stormwater Coordinator)

Stormwater Capacity: The project receives stormwater from 8,300 square feet of pavement.

Permitting: No permitting involved (voluntary project)

Construction Costs: $7,000 estimated cost for water quality swale

Funding Source(s): Chapter 90 transportation funding

Lessons Learned:
- Simpler than DPW thought it would be to build
- Project bid as lump sum, not itemized like other projects
- Soil mix had to be prepared on site by the contractor. Local sources of the correct soil mix would make it easier to construct these facilities.

Decision Makers: Director of Public Works (City of Northampton)

Completed: August 2011

Porous Asphalt Parking Lot
New England Environmental, Inc., Amherst, MA

As part of developing a new Leadership in Energy and Environmental Design (LEED) platinum rated office building, New England Environmental, Inc. (NEE) used porous asphalt for all travel lanes (about a 10,000 square foot area) in their parking lot. Grass pavers were used for parking stalls. The porous asphalt has been in place since 2008 and is reportedly performing beyond expectations with vacuuming occurring twice each year to remove sediment and fines.

Purpose: NEE undertook the entire project to provide a showcase, demonstrating that sustainable building and landscape design is aesthetically pleasing, can be utilized in cold weather climates, and can reduce the impact of development on the environment.

Designers: Kuhn Riddle Architects, Doucet & Associates, New England Environmental, Inc.

Stormwater Capacity: The porous asphalt parking area is set on a two foot base of aggregate. This base is used for added strength and to provide a reservoir that drains runoff away from the asphalt, minimizing heaving during a freeze-thaw cycle. The asphalt mixture is the limiting factor on how much water can move through the surface (larger aggregate size will allow for larger voids, allowing for a faster drain, but the large aggregate also makes for a weaker surface). NEE used a ¾" aggregate and has been able to drain all rainfall and snowmelt through the asphalt to the reservoir.

Permitting: Request for Determination of Applicability (received negative determination), Site Plan Review, and a stormwater management permit

Construction Costs: Porous asphalt component of parking lot: $25,000.00. Cost for the parking lot as a whole was less than the cost of a conventional parking lot with attendant stormwater management facilities.

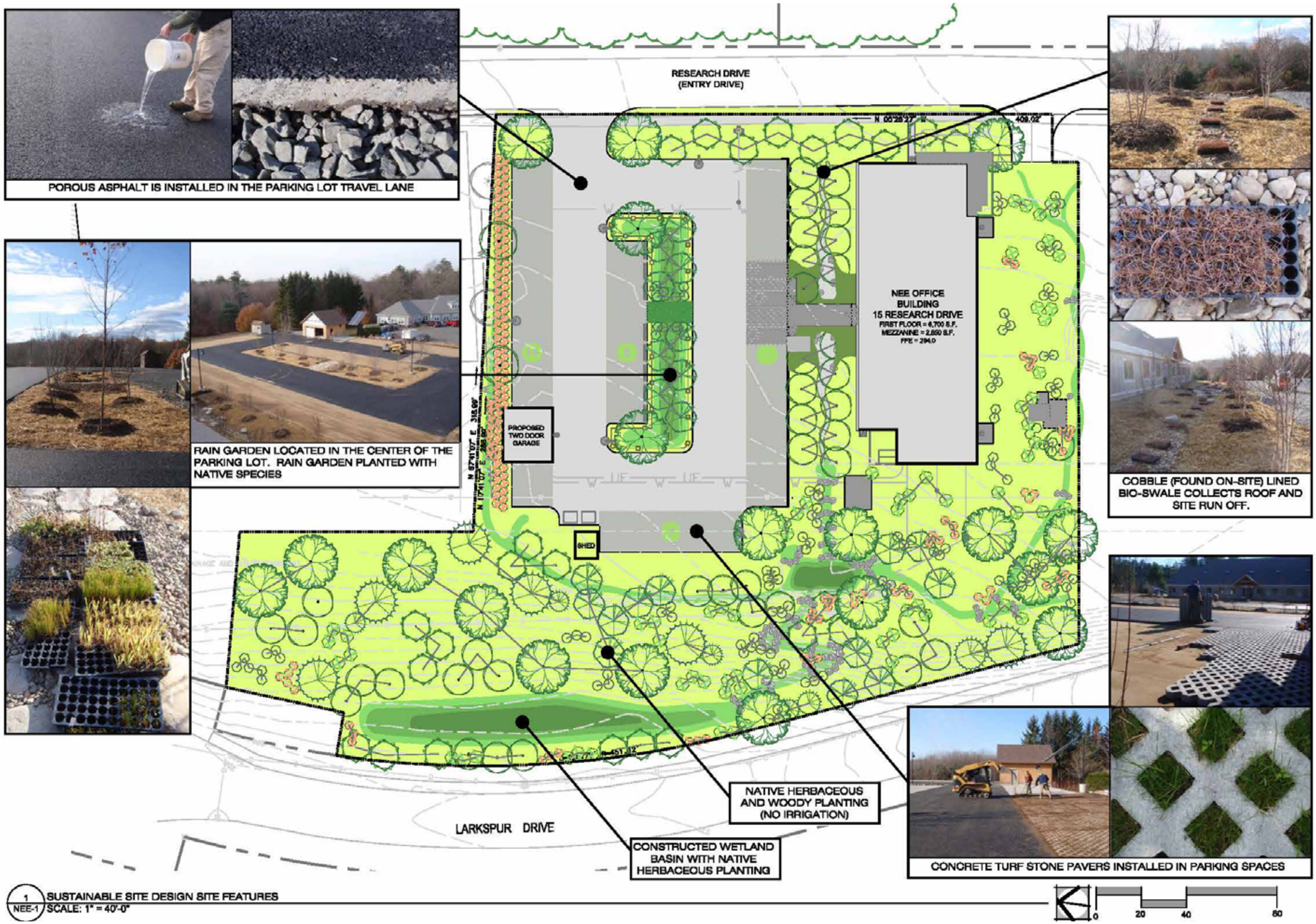
Funding Source(s): Privately funded

Lessons Learned:

- Asphalt plant needs to be cleaned before producing mixture for porous asphalt project to ensure that no fines (sand) are included in this special mixture.
- Coordinate with the asphalt plant to make sure that the mixture passes all tests prior to delivery on site.
- Provide detailed information to maintenance crew and remind them not to use sand
- Do not use grass pavers in combination with porous asphalt as the pavers are too easily damaged with winter plowing

Project Completed: January 2009

Other Stormwater Management Strategies
New England Environmental, Inc., Amherst, MA



Porous Asphalt Parking Lot
Columbia Greenway Rail Trail, Westfield, MA

The City of Westfield employed porous asphalt for a parking lot associated with a new rail trail segment. The parking lot, which accommodates 60 cars, used a specification that consists of the following layers: surface course of 2.5 inches of hot mix porous asphalt; a choker course of 4 inches of crushed stone; a filter course of 1 foot of gravel borrow over 3 inches of pea stone gravel; and a reservoir course of 6 inches of crushed stone. The project also includes several vegetated swales and a bioretention basin.

Goal: To implement Low Impact Design (LID) techniques, promote stormwater recharge, and reduce impacts to bordering vegetated wetlands, while providing parking.

Designers: Vanasse Hangen Brustlin, Inc.; Plan it Green

Stormwater Capacity: 7,250 cubic feet (or 54,000 gallons) of stormwater, which is equivalent to the volume of a 25-year storm event

Permitting: Compliance with Federal/NEPA Categorical Exclusion; ENF filed for MEPA Certification; NOI filed with Westfield Conservation Commission and MassDEP

Construction Costs: $135,000 including site clearing, excavation, bituminous curbing in some locations, striping, etc. (approximately $78,000 more than what a traditional parking lot would have cost)

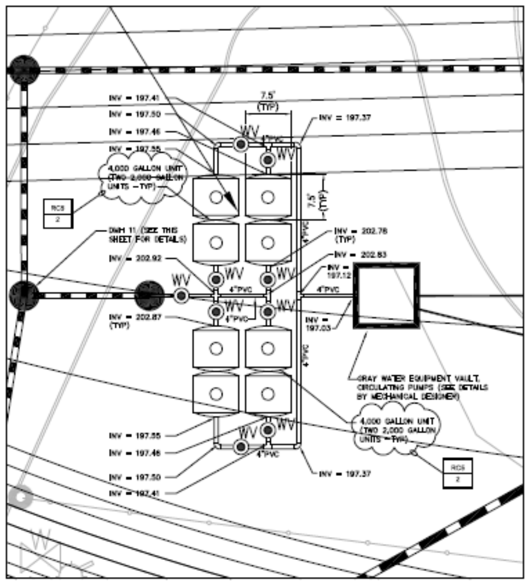
Funding Source(s): Gateway Cities Grant from Mass Executive Office of Energy and Environmental Affairs (for southern phase of the rail trail project)

Lessons Learned:

- Perform subsurface testing to determine soil type, composition and compaction requirements; sub-base material and compaction of various stone layers is important
- Review/approval of the job mix formula from the pavement contractor takes time
- Asphalt material testing at the plant is required on the day of paving
- Timing and sequencing of porous paving needed to prevent impacts/rutting from large vehicles during remainder of construction activities
- Porous paving material needs more time to "set-up" (harden) than traditional parking lot pavement. Material could be goopy and tracked by vehicles off-site.
- Pay attention to voids in crushed stone filled by smaller aggregate during material layering

Completed: Summer 2012

Rainwater Harvesting System
Putnam Regional High School, Springfield, MA



Detail of Graywater Reclamation Sysytem Scale = 1" = 10'

At the Roger L. Putnam Regional High School, stormwater runoff from a section of rooftop will be captured in a series of cisterns for use in flushing all toilets and urinals. Roof drainage will be collected in four 4,000 gallon underground tanks that direct flow to the school's gray water plumbing system. The project also includes a raingarden, grass swale, and a series of infiltrators. These facilities are capturing stormwater from the parking area.

Purpose: To provide a well functioning grey water plumbing system that uses harvested rainwater. The construction of this new school facility (which replaces an older facility) is following the Massachusetts Collaborative for High Performance Schools (MA-CHPS) Green Schools Guidelines. Two major components of these guidelines include a rooftop rainwater reclamation system and infiltration system.

Designers: Drummey Rosane Anderson, Inc.; Vanasse Hangen Brustlin, Inc.

Stormwater Capacity: The rainwater harvesting system is designed for a total storage capacity of 16,000 gallons. When tanks are full, water will be directed to the normal disposal system, including discharge to the city stormwater system. The system was not sized for a particular storm event, but rather for the capacity needed to make the recycle system work properly.

Permitting: The project required permitting through the Springfield Conservation Commission (NOI), Planning Department, and Engineering Department.

Construction Costs: $185,500

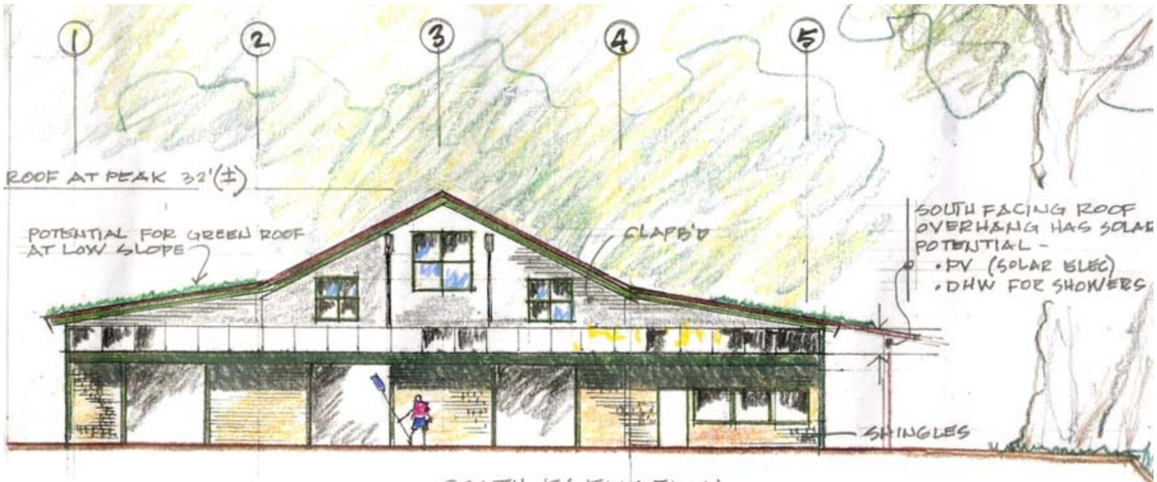
Funding Source(s): The project is funded with a grant from the Massachusetts School Building Authority as well as the City, which is required to provide match to the grant.

Lessons Learned: One item to consider in building these systems is connection to a dedicated water supply should this system run out of water in summer months due to drought. This can be done through the use of a float system that switches over to a domestic water supply, an approach that has been incorporated in the Putnam School Project.

Decision Makers: School Department; Architect

Completed: 2013 (estimated completion date)

Green Roof
Jones Ferry River Access Center, Holyoke, MA



This green roof project involves a 13,000 square-foot area with a 25 percent slope. Design includes sturdier roof framing, a thick waterproof membrane to protect the roof, and four inches of bio-engineered growth media that is planted with eight varieties of Sedum to reduce stormwater runoff from the roof. In addition to capturing rainfall, the roof improves energy efficiency within the building, lowering heating and cooling costs.

Purpose: To provide a rowing/kayaking facility with boat storage, locker rooms, and a meeting room for the community. In the design process it became evident that energy conservation strategies, renewable energy and stormwater retention would help make for a good demonstration project at this important site on the Connecticut River.

Designers: C. Stuart White, Jr., Banwell Architects, Lebanon, NH, and Carlisle Roofing.

Construction Costs: $85,000 total installation cost

Funding Source(s): EPA Targeted Watershed Initiative Grant through Pioneer Valley Planning Commission

Lessons Learned:

- Forward thinking on the part of the City of Holyoke provided important project support.

Decision Makers: City of Holyoke and the Holyoke Rows

Completed: 2009

Page left blank intentionally.

APPENDIX C

GREEN INFRASTRUCTURE CHECKLIST FOR REVIEWING LOCAL MUNICIPAL REGULATIONS

Green Infrastructure Code Review Checklist **NDPES MS4 Community: ________________________**

Y/N	Checklist Item	Notes (include location in code and any standards)
	Stormwater Management Program (NPDES Draft permit 1.10)	
	Is there an adequate funding source for the implementation of the stormwater management program (adequate funding means that a consistent source of revenue exists for the program)?	
	Illicit Connections (NPDES Draft Permit 2.4.4)	
	Is there an ordinance/bylaw that prohibits all non stormwater discharges into the MS4? See allowable exemptions in part 1.4 of draft permit. (NPDES Draft permit 2.4.4)	
	Erosion and Sediment Control/Construction Site SW Runoff Control (NPDES Draft permit 2.4.5)	
	Is there an ordinance/bylaw for construction site erosion and sediment control to reduce pollutants in any stormwater runoff discharged to the MS4 from construction activities that result in a land disturbance of greater than or equal to one acre (disturbances less than one acre if that disturbance is part of a larger common plan of development or sale).	
	Does the regulation have provisions for smaller development projects under 1 acre?	
	Does the regulation require the use of sediment and erosion control practices at construction sites?	
	Does the regulation include written procedures for site inspections and enforcement of sediment and erosion control measures at construction sites, including who is responsible for site inspections and who has authority to implement enforcement procedures?	
	Does the regulation require sediment and erosion control program where land disturbance activities result in stormwater discharges to the MS4 (program shall include BMP appropriate for the conditions at the construction site. May include references to BMP design standards in state manuals. Examples of appropriate sediment and erosion control measures for construction sites include local requirements to: i. minimize the amount of disturbed area and protect natural resources; ii. stabilize sites when projects are complete or operations have temporarily ceased; iii. protect slopes on the construction site; iv. protect all storm drain inlets and armor all newly constructed outlets; v. use perimeter controls at the site; vi. stabilize construction site entrances and exits to prevent off-site tracking; vii inspect stormwater controls at consistent intervals; and viii. size stormwater controls to control or manage a specific volume of runoff (e.g. design sediment and erosion control measures to manage 1 inch of runoff or a specific rain event such as the 2 year 24-hour rain event)	
	Does the regulation include requirements to control wastes, including but not limited to discarded building materials, concrete truck wash out, chemicals, litter, and sanitary wastes (these wastes may not be discharged to the MS4)?	

Y/N	Checklist Item	Notes (include location in code and any standards)
	Does the regulation include written procedures for ***site plan review*** . Site plan review shall include a review by the permittee of the site design, the planned operations at the construction site, planned BMPs during the construction phase, and the planned BMPs to be used to manage runoff created after development. The review procedure shall incorporate procedures for the consideration of potential water quality impacts; procedures for pre-construction review; and procedures for receipt and consideration of information submitted by the public. Site plan review procedure shall include evaluation of opportunities for use of low impact design and green infrastructure. When the opportunity exists, the permittee shall encourage project proponents to incorporate these practices into the site design.	
	Post Construction Stormwater Management/Stormwater Management in New Development and Redevelopment (NPDES Draft Permit 2.4.6)	
	Is there an ordinance/bylaw that addresses post construction stormwater runoff from new development and redevelopment projects that disturb one or more acres and discharge into the MS4 (disturbances less than one acre if that disturbance is part of a larger common plan of development or redevelopment)?	
	What are the provisions for redevelopment of existing properties?	
	The following are amendments that will be required with new permit. Do these currently exist?	
	a. For new development projects that disturb one or more acres and upon completion results in two or more acres of impervious surfaces, the MS4 shall require compliance with Standards 3, 4, 5, and 6 of the Massachusetts Stormwater Management Standards, regardless of the proximity to resource areas or their buffer zones under the Massachusetts Wetlands Protection Act. (The standards presented below are not exact wordings of the state standards. The standards are summarized at: http://www.mass.gov/dep/water/laws/strmreg.pdf and available at: http://www.mass.gov/dep/water/laws/310c10p.pdf and http://www.mass.gov/dep/water/laws/314c9p.pdf.)	
	i. Standard 3 – Loss of annual groundwater shall be eliminated or minimized through the use of infiltration measures including environmentally sensitive site design, low impact development techniques, stormwater best management practices, and good operation and maintenance. At a minimum, the annual recharge from the post-development site shall approximate the annual recharge from pre-development conditions based on soil type. In an effort to facilitate implementation of the requirements in Part 2.4.6.8, and Parts 2.2.1(c), (d), (f) and (g), if applicable, and the goal of this standard, the permittee is encouraged to require the capture of at least the 1 inch (90th percentile) storm event. The term “capture” includes practices that infiltrate, evapotranspire, and/or harvest and reuse rainwater. This means that 100 percent of the volume of water from events less than or equal to the 90th percentile event shall not be discharged. In Massachusetts, the 90th percentile storm event is a 1 inch storm event.	
	ii. Standard 4 – Stormwater management systems shall be designed to remove 80 percent of the average annual post construction load of Total Suspended Solids.	

Y/N	Checklist Item	Notes (include location in code and any standards)
	iii. Standard 5 – For land uses with higher potential pollutant loads, source control and pollution prevention shall be implemented to eliminate or reduce the discharge of stormwater from such land uses.	
	iv. Standard 6 – Stormwater discharges within the Zone II or Interim Wellhead Protection Area of a public water supply, and stormwater discharges near or to any other critical area, require the use of the specific source control and pollution prevention measures and the specific structural stormwater practices determined by MassDEP to be suitable for managing discharges to such areas.	
	b. For redevelopment projects that upon completion results in two or more acres of impervious surfaces, the permittee shall require compliance with Standard 7 of the Massachusetts Stormwater Management Standards ***regardless of the proximity to resource areas*** or their buffer zones under the Massachusetts Wetlands Protection Act as follows:	
	i. Redevelopment of a previously developed parcel with two or more acres of impervious surfaces, which upon completion does not increase the amount of impervious surface must meet the Stormwater Standard 3 and the pretreatment and structural stormwater best management practices of Standards 4, 5 and 6 only to the maximum extent practicable[1] and improve existing conditions.	
	ii. Redevelopment of a previously developed parcel which upon completion contains two or more acres of impervious surface and results in an increase in the area of the site covered by impervious surfaces must fully meet Standards 3 through 6 of the Massachusetts Stormwater Standards with regard to the increase in impervious surfaces and must meet the requirements of Part 2.4.6.4.b.i above with regard to the total area of the impervious surfaces that are undergoing redevelopment and that existed prior to the start of redevelopment. For pre-existing impervious surfaces, there must be an improvement of existing conditions.	
	c. For projects that are exempt from the MassDEP stormwater standards, the permittee's ordinance or other regulatory mechanism may apply the Massachusetts Stormwater Standards to the "maximum extent practicable", as defined in the Massachusetts Stormwater Management Standards.	
	Are there procedures to ensure that any stormwater controls or management practices for new development and redevelopment will prevent or minimize impacts to water quality. These procedures may include:	
	requirements to avoid development in areas susceptible to erosion and sediment loss; requirements to preserve areas in the municipality that provide important water quality benefits; requirements to implement measures for flood control; and requirements to protect the integrity of natural resources	
	Requires submission of as-built drawings within 90 days of completion of construction projects (See more detail under *2.4.6.6*) The as-built drawings must depict all on site controls, both structural and nonstructural, designed to manage the stormwater associated with the completed site (post construction stormwater management)	

Y/N	Checklist Item	Notes (include location in code and any standards)
	Requires procedures to ensure long-term operation and maintenance of stormwater management practices that are put in place after the completion of a construction project. (May include the use of dedicated funds or escrow accounts for development projects or the acceptance of ownership by the permittee of all privately owned BMPs. May also include development of maintenance contracts between the owner of the BMP and the permittee. Maintenance contract shall include verification of maintenance practices by the owner, allow the municipality to inspect the maintenance practices and perform maintenance if inspections indicate neglect by the owner. Alternatively, these procedures may include the submission of an annual certification documenting the work that has been done over the last 12 months to properly operate and maintain the stormwater control measures. Procedures to require submission of as-built drawings and ensure long term operation and maintenance shall be a part of the SWMP.)	
	Street Design and Parking Lot Guidelines (NPDES Draft permit 2.4.5) Perform assessment of current street design and parking lot guidelines and other local requirements that affect the creation of impervious cover. This assessment shall be used to provide information to determine if changes to design standards for streets and parking lots can be modified to support low impact design options. (Document cited by EPA: http://www.mapc.org/resources/lowimpact-dev-toolkit/roadway-lot-design)	
Street Standards in Subdivision Regulations		
	Please report the town's street requirements on the Street Standards sheet	
	Roadway Width and Length	
	Is paved roadway width standard set for LID purposes in low density residential developments with less than 500 daily trips? (LID standard: 18-22 feet)	
	At higher densities are parking lanes allowed to also serve as traffic lanes (i.e., queuing streets)?	
	Do street standards promote the most efficient street layouts so as to reduce the overall street length?	Identify how you would do this (frontage requirements, etc.)
	Right of Ways	
	Is the minimum right of way width less than 45 feet for a residential street?	
	Does the code allow utilities to be placed under the paved section of the ROW?	
	Does the code allow utilities to be placed immediately adjacent to the paved section of the ROW?	
	Do the regulations limit clearing within the right-of-way to the minimum necessary?	
	Do regulations require clearing and grubbing of entire right of way?	
	Are street trees required for new streets?	
	If yes, is this shown in the street cross section that may be provided?	
	Do street standards permit LID stormwater management approaches (i.e. allow swales or other such BMP instead of curb and gutter) or are curbs and gutters REQUIRED improvements?	
	Where curbs are necessary/required, are perforated curbs that allow runoff into swales or other stormwater BMPs allowed?	
	Does the town have criteria for design of roadside swales?	

	Where curb and gutter systems are installed, are inlets / drains required to have a notice regarding discharge to receiving waters?	
	Sidewalks	
	Where curb and gutter streets are required, are sidewalks required to be disconnected from the stormwater system (e.g. by a green strip)?	
	In low density neighborhoods, are sidewalks permitted on only one side of the road?	
	Is sidewalk width standard set for LID purposes? (LID standard 4 feet or less)	
	In low density neighborhoods, can alternate pedestrian networks be substituted for sidewalks (e.g. trails through common areas)	
	Cul de Sacs	
	Are dead ends discouraged by the regulations? (e.g. by encouraging or requiring connected streets or one-way loop streets)?	
	Is minimum radius for a cul de sac set for LID purposes (LID standard: 35 feet)?	
	Is curbing required for cul de sacs?	
	Is a landscaped island permitted for cul-de-sacs?	
	Are alternative turnarounds such as hammerhead allowed on short streets in low density residential developments?	
	Other	
	Are there provisions indicating that roadways ought to be located so as to protect important natural features, avoiding low areas and steep slopes?	
	Are developers required to rehabilitate soils that have been compacted by construction vehicles?	

Parking Requirements in Zoning Regulations

	Please report the town's parking requirements on the Parking Standards sheet	
	Are parking maximums used in any instances (to prevent too much parking)?	
	Does town require <u>more than</u> 3 off street parking spaces per 1,000 sq. ft. of gross floor area for office uses?	
	Does town require <u>more than</u> 4.5 off street parking spaces per 1,000 sq. ft. of gross floor area for shopping centers?	
	Does town vary parking requirement by zone to reflect places where more trips are on foot or by transit?	
	Does town have reduced off-street parking requirements for its downtown zoning district?	
	Does the town have lower parking requirements for properties near transit stops?	
	Does the town allow reduced parking requirements for properties within walking distance to multiple services?	
	Does the town have lower parking requirements for properties in the more densely developed residential districts?	
	Does town require <u>more than</u> 2 off-street parking spaces per residential unit?	
	Does town require 2 off-street parking spaces per residential unit?	
	Does town require <u>less than</u> 2 off-street parking spaces per residential unit?	
	Does town require more than 1 off-street parking space for an accessory dwelling unit?	
	Does the town have lower parking requirements for smaller residential units?	

	Does the town have provisions allowing for shared parking to reduce parking requirements?	
	Are the town's shared parking provisions by right?	
	Does the town provide model shared parking arrangments for private use?	
	Does the town allow alternative measures such as custom parking demand calculations, transportation demand management or in-lieu payments to reduce required parking?	
	Does the town allow for common driveways?	
	If yes, are they allowed by right?	
	Is requirement for standard parking lot stall consistent with LID purposes? (LID Standard: 9 feet or less by 18 feet or less)	
	Is requirement for residential driveway width consistent with LID purposes? (LID Standard: 9 feet wide for one lane / 18 feet wide for two lanes)	
	For larger commercial parking lots, are there provisions requiring compact car spaces?	
	If yes, are at least 30% of parking spaces required to have smaller dimensions for compact cars?	
	Is there a minimum perncentage of a parking lot required to be landscaped?	
	Do commercial landscaping requirements for parking areas allow for vegetated areas with bioretention functions?	
	Do commercial landscaping requirements for parking areas encourage vegetated areas with bioretention functions?	
	Is the use of bioretenion islands and other stormwater practices within landscaped areas or setbacks allowed (versus requirement for curb and gutter)?	
	Is the use of bioretenion islands and other stormwater practices within landscaped areas or setbacks encouraged?	
	Can porous surfacing materials be used for parking stalls, spillover parking areas, shoulders, etc.?	
	Is the use of porous surfacing materials for parking stalls, spillover parking areas, shoulders, etc encouraged?	
	Local Regulations and Feasibility of Green Infrastructure (NPDES Draft permit 2.4.6.8)	
	Are the following practices allowable when appropriate site conditions exist:	
	i. Green roofs;	
	ii. Infiltration practices such as rain gardens, curb extensions, planter gardens, porous and pervious pavements, and other designs to manage stormwater using landscaping and structured or augmented soils; and	
	iii. Water harvesting devices such as rain barrels and cisterns, and the use of stormwater for nonpotable uses.	
	If no, please describe impediments: ____________________________________	
Development Policies in Subdivision Regulations		

	Are regulations that govern stormwater within the subdivision code consistent with the Stormwater Management/LID ordinance/bylaw? (see controlling standards, drainage, and other relevant sections)	
	Do the site development standards explicitly permit LID stormwater management approaches?	
	Do planning processes encourage an LID approach? (preliminary plans)	
	Do regulations address context sensitive development measures? (indicate all that apply)	
	Reducing Cut and Fill	
	Minimizing disturbanc to hillsides and/or ridgelines	
	Requiring or encouraging preservation of natural vegetation or topography?	
	Do landscaping regulations promote the planting of street trees in private and public development projects?	
	Are there any regulations requiring limits to disturbance on a construction site?	
	Are there any regulations controlling tree clearance or removal of mature trees / forest stands?	
	Does the town have a tree protection or landscaping ordinance (If yes, please get copy)	
Development Policies in Zoning Regulations		
	Please report the municipality's dimensional standards on the Dimensional Standards Worksheet	
	Are regulations that govern stormwater within the zoning code consistent with the Stormwater Management/LID ordinance/bylaw?	
	Do planning processes encourage an LID approach? (site plan approval)	
	Are bioretention areas, rain gardens, filter strips, swales and constructed wetlands allowed in setback areas?	
	Does language on screening and buffers indicate that these areas could be used for stormwater management?	
	Are there any special districts or regulations that permit cluster development?	
	Is open space (cluster) development permitted by right?	
	Are the submittal or reeview requirements for open space / cluster developments greater than for conventional development?	
	Are there any flexible site design regulations that permit reductions in dimensional requirements to allow cluster development?	
	Are there any regulations that permit reductions in dimensional requirements to increase flexibility in building placement?	Note: Reductions in frontages would allow for reduced road length/paved area, perhaps where appropriate such as in open space residential developments, at the outside sideline of curbed streets, and around cul de sacs
	What counts towards meeting open space requirements? (indicate all that apply)	
	Stormwater management areas (e.g. bioretetention areas)	
	Wetland aras and water bodies	
	Green roofs	
	Can open space requirements be reduced if improved stormwater management facilities /open spaces are provided?	

Board of Health Bylaw and Regulations		
	Do regulations exceed Title 5 requirements, requiring oversized septic systems or larger setback distances?	Note: They should not require additional setbacks or classify stormwater structures so as to increase minimum setback distances (e.g. some towns require dry wells and bioretention areas to meet the same setbacks as a septic system)
	Do regulations require reserve septic fields to be cleared at the time of development?	
Wetlands Bylaw and Regulations		
	Do regulations permit the use of low impact stormwater structures (e.g. bioretention areas) within the buffer zone of wetland resource areas?	Note: Projects under 1 acre in jurisdictional areas would be regulated here for stormwater management.
	Do regulations increase the required buffer above beyond the 50' required by state law (e.g. to 100 feet or more)	
Municipal Policies and Programs		
	Does the municipality have a plan for water efficiency or reuse?	
	Does the town have a program to address stormwater runoff and/or LID?	
	Does town provide information brochures / manual for homeowners describing rainwater harvesting and stormwater management techniques?	
	Notes:	
	Does the town have any LID demonstration projects? (please list)	
	Does the town have policies that promote complete streets or LID considerations within capital improvement plans or in ranking road construction projects?	
	Do town policies require new street trees as part of road reconstruction projects?	
	Do capital improvement plans include tree planting as part of project budgets?	
	Has there been any review of emergency services policies or building and fire regulations to ensure that they allow LID techniques?	
	Has there been any review of local building codes to ensure that they permit LID techniques (e.g. permeable paving) and use of harvested rainwater for interior non-potable uses?	
	Who manages stormwater BMPs after construction?	If the town has responsibilities, how are dollars secured for long-term maintenance? If the developer or the new property owner has the responsibilities, has the DPW established mechanisms for enforcement of maintenance agreements for stormwater facilities (e.g. fines)?

Page left blank intentionally.