The Mystic River Watershed Alternative TMDL

Patrick Herron, Mystic River Watershed Association
Ivy Mlsna, EPA Region 1
Laura Schifman, MassDEP

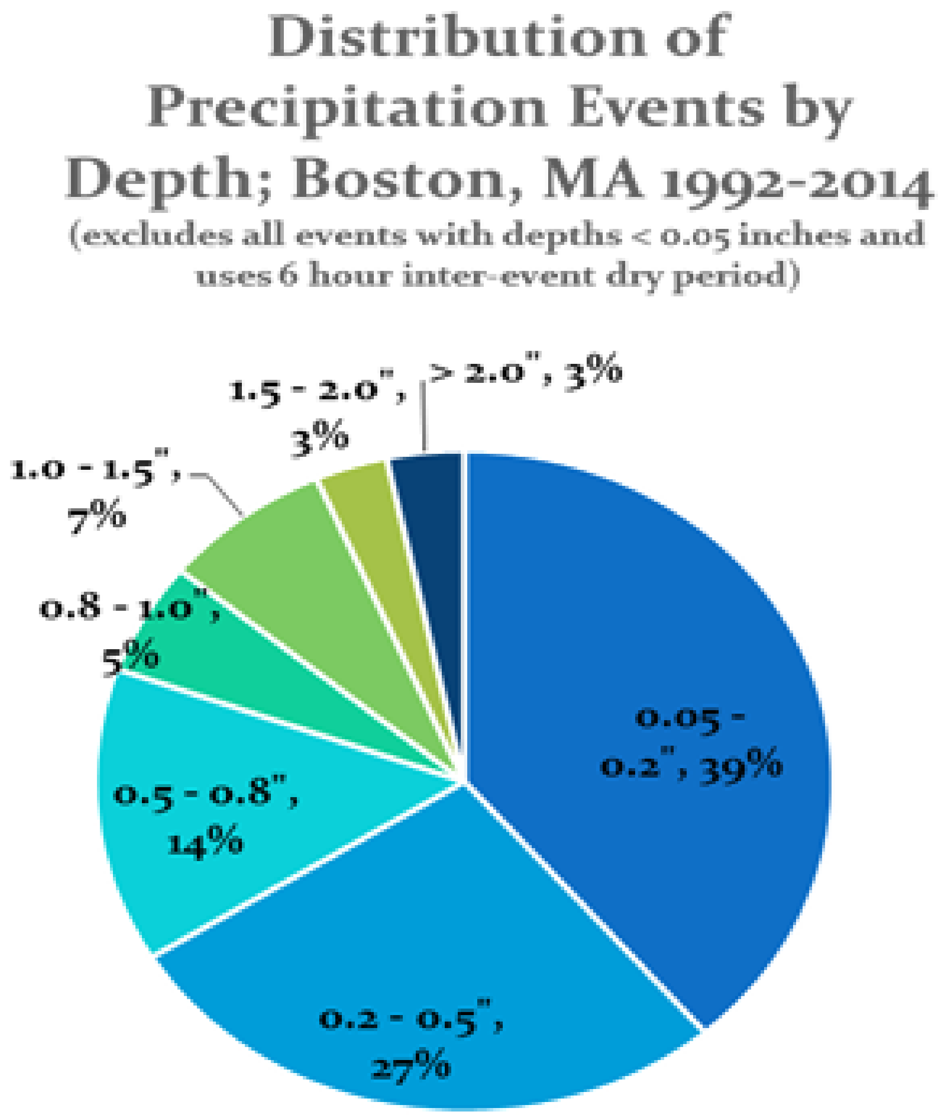
Outline

1. Background: Massachusetts and the Mystic River Watershed
2. Origin of the approach
3. How the science happened
4. Rollout and laying the groundwork for implementation
5. The Future

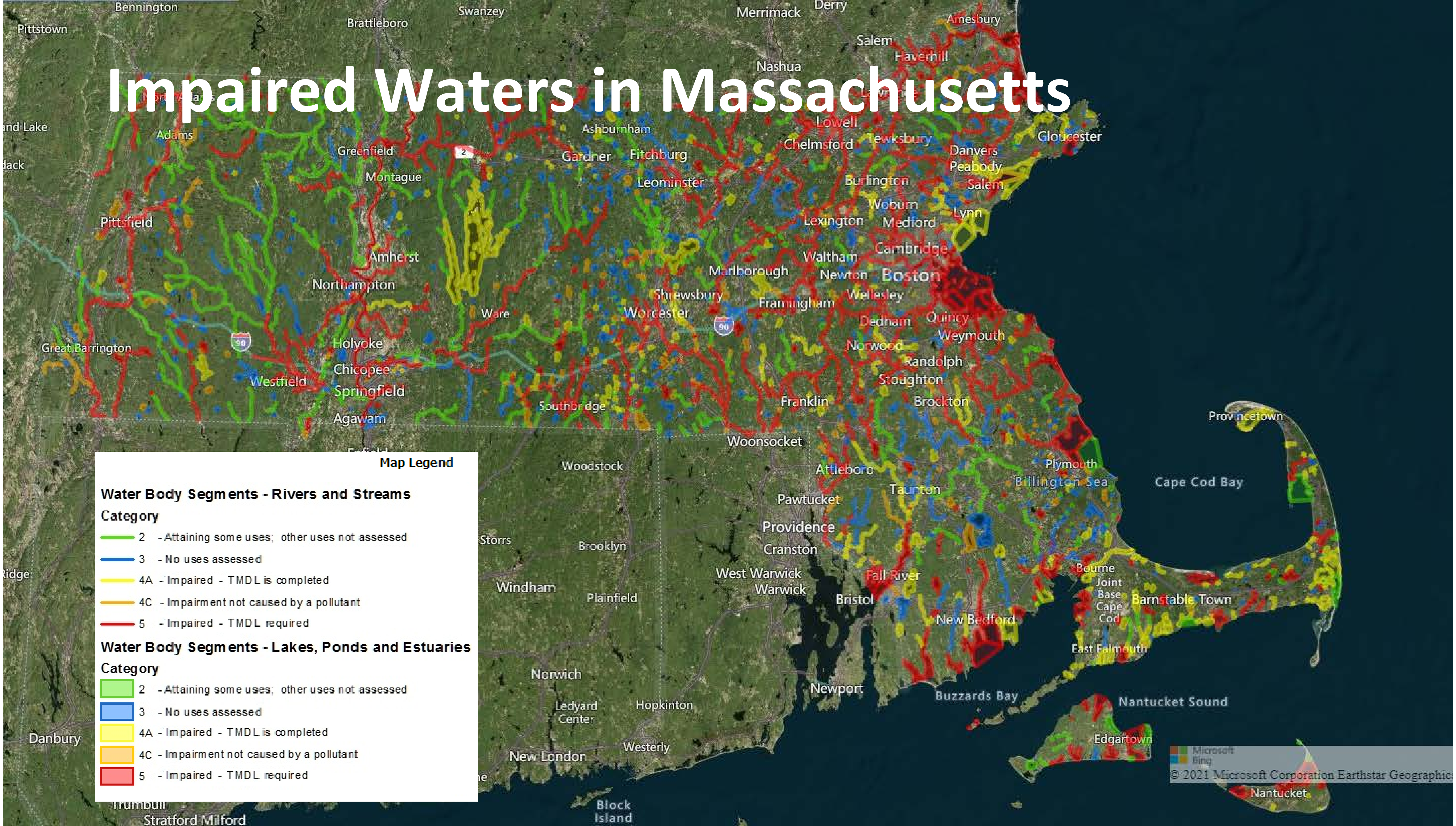
Background:
Massachusetts and the Mystic River Watershed

New England Region Rainfall Patterns Important Points

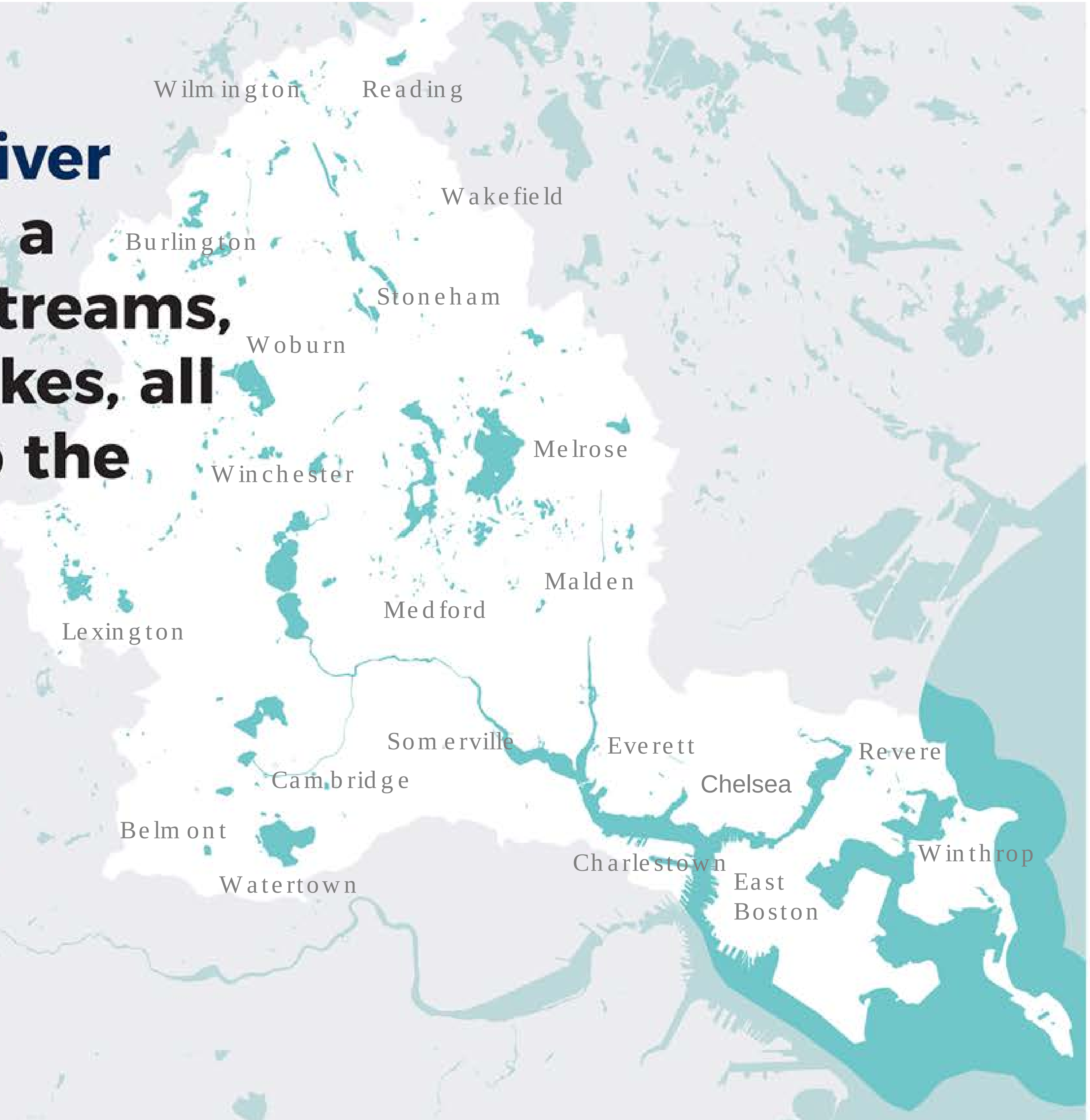
- Most rain events are small in size;
- Occur regularly (average about once every three days)
- The total volume and event size distribution are relatively consistent across New England Region
- Small sized events wash-off significant proportion of annual pollutant load from impervious surfaces



Impaired Waters in Massachusetts



The **Mystic River watershed** is a network of streams, rivers, and lakes, all draining into the Mystic River.



Mystic River WATERSHED ASSOCIATION

76
SQUARE MILES

44
LAKES & PONDS

21
COMMUNITIES

600,000
PEOPLE

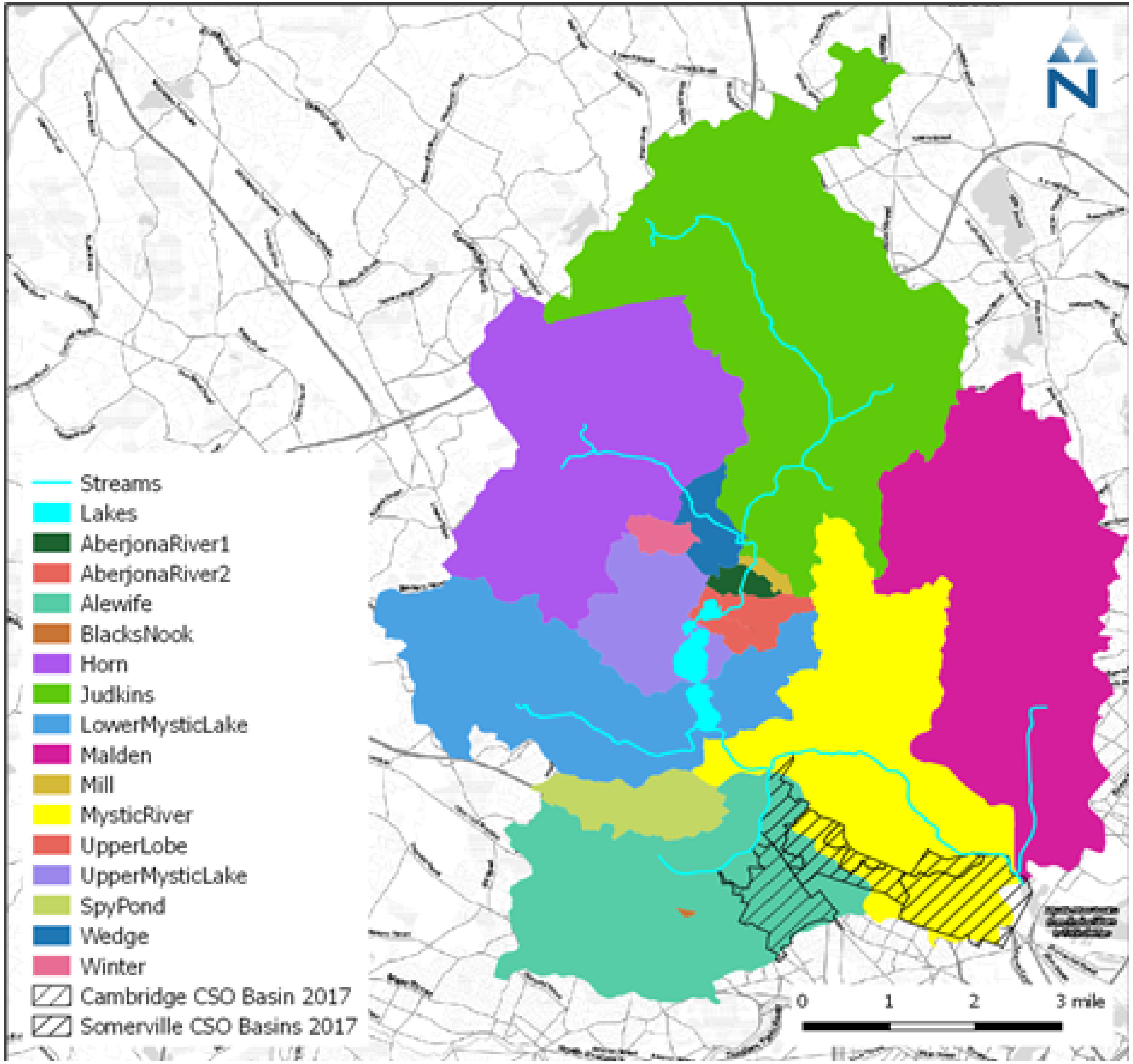
LEARN MORE
MYSTICRIVER.ORG

Symptoms of the built environment


Photo credit: David Mussina

Mystic River Watershed Summary

- 76 square mile watershed- 22 urban & suburban communities
- **Land Use:** 46% High Density Residential (HDR) and Medium Density Residential (MDR); 22 % Forest & 15% Commercial and Industrial
- **Extensive Impervious Cover (IC):** (e.g., 56% IC in HDR and MDR and 31% IC in Commercial and Industrial
- 15 Subwatershed Delineations according to watershed flow and pollutant routing to critical waterbody segments
  - 3 Critical WQS Attainment Segments
  - 5 ponds/lakes impaired by excessive nutrients



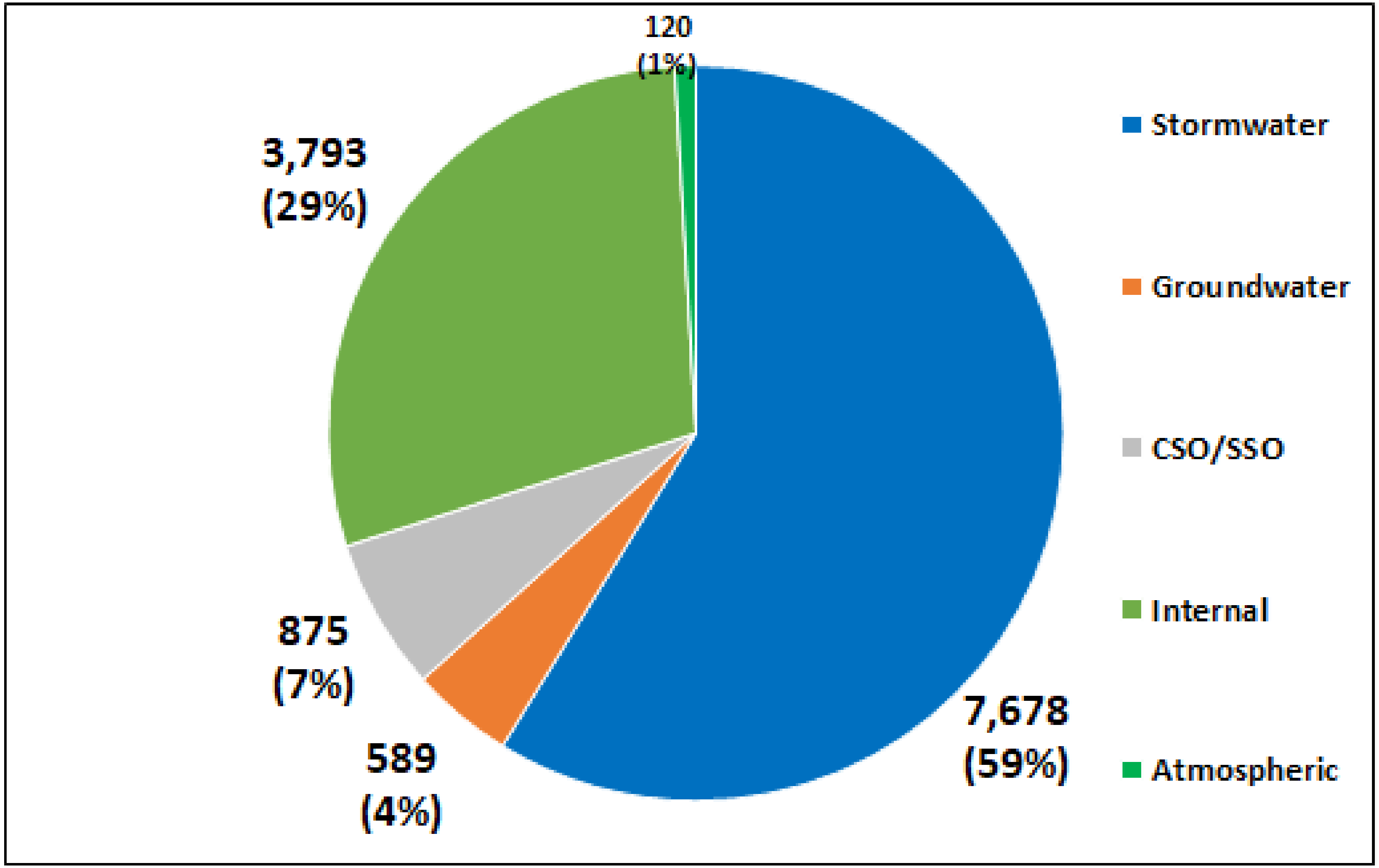
2016 Integrated List of Waters:

red = impaired

Mystic River Watershed
Source Contributions of Delivered Phosphorus Load (lbs./yr.)

<u>Primary Watershed Source Categories of Nutrients:</u>

- Stormwater (SW),
- Combined Sewer Overflows (CSOs),
- Sanitary Sewer Overflows (SSOs),
- Natural Background (e.g., groundwater base flow)



Origin of the Approach

Charles River in Boston
Lower Charles Phosphorus TMDL 2007
Upper Charles Phosphorus TMDL 2011

EPA United States Environmental Protection Agency

Environmental Topics | Laws & Regulations | About EPA | Search EPA.gov

Mystic River Watershed

CONTACT US SHARE

- Mystic River Watershed Home
- About the Watershed
- Environmental Challenges
- **Watershed Initiative**
- Live Water Quality Data
  - Buoy Information
- Hurd Field Porous Pavement Project

The Mystic River Watershed Initiative

The Mystic River Watershed Initiative is a collaborative effort with a goal to improve water quality and environmental conditions as well as create and protect open space and public access to the Mystic River and its tributaries through safe public pathways and access points. The Initiative is guided by a steering committee composed of 22 organizations including not-for-profit community groups, local, state, and federal governmental agencies. To hear thoughts, perspectives, and insight from some of the not-for-profit and municipal Steering Committee members, play video below.

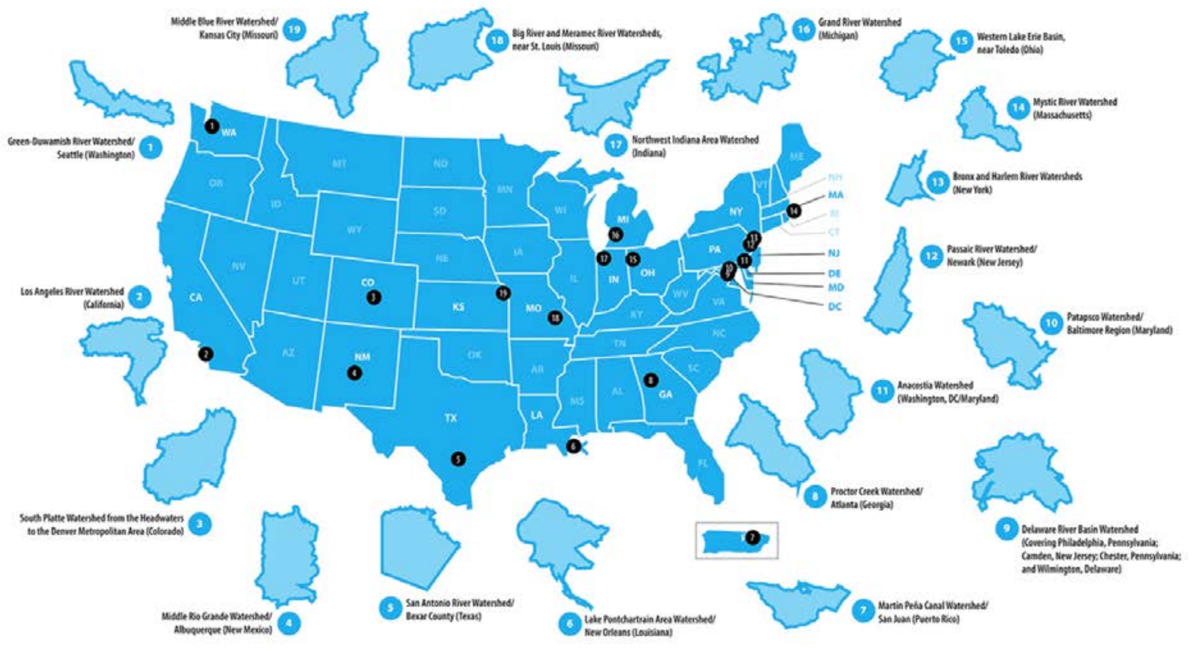
For questions or more information about this initiative, contact us.

Mystic River Watershed Initiative Video, May 2010 EXIT

On this page:

- Upcoming Meetings
- Past Meetings Archive

Urban Waters Federal Partnership Watershed Locations



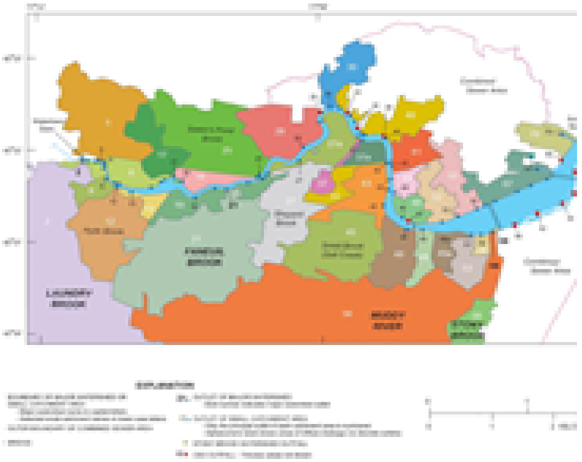
*Watersheds not to scale.

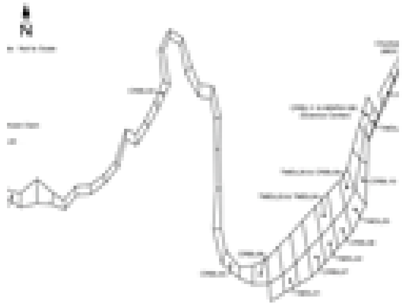
Some Background/Context

- 1990s: Many legal actions across the country jumpstarted TMDL development across the nation. SW and NPS pollution was a key driver
- Hundreds of TMDLs get done focused on SW and NPSs but with minimal specificity on sources
- 1st MS4 permits also lacked specificity to implement SW related load reductions encompassed in TMDLs
- Then the Lower Charles River Phosphorus TMDL came along
- Then more legal action this time focused on SW permitting
- Need for improved SW management tools became clear

Lower Charles River Phosphorus TMDL Charles River Watershed

- Highly rigorous and data rich study focused on cultural eutrophication in the lower basin
- SW predominant source of P based on comprehensive monitoring, gaging, modelling (land based and receiving water)
- P loads from other point sources (WWTFs and CSOs) had been already substantially reduced through NPDES and permit compliance actions.



Challenges of Charles TMDL → SW Permitting

- Translating TMDL watershed-based Waste Load Allocations (WLAs) and associated reductions into SW permitting requirements
- The need to breakout composite watershed load into distinct, representative SW runoff source loads (e.g., commercial IC, etc.)
- Separate Charles River baseflow loads (groundwater fed) from watershed loads
- WQ restoration efforts related to SW P load reduction is extensive (50+%) and will be costly. Must have technically strong and defensible record to support SW P load estimates and associated reductions through permit process.

EPA's CWA Section 303(d) Vision, Dec 2013

Alternatives Goal

- *By 2018, States use alternative approaches, in addition to TMDLs, that incorporate adaptive management and are tailored to specific circumstances where such approaches are better suited to implement priority watershed or water actions that achieve the water quality goals of each state, including identifying and reducing nonpoint sources of pollution*

Future MS4 Permits

Traditional Approach

1. TMDL Development
2. WLA Calculations
3. Numeric Reductions in MS4 Permit with Extended Schedule

Mystic Approach

1. Alternative TMDL Development
2. Watershed Reduction Targets
3. Iterative Requirements Every MS4 Permit Term

Traditional TMDLs vs. Alternative TMDLs

Traditional TMDL	Alternative TMDL
Slow	Fast
Expensive	Less Expensive
Inflexible	Flexible
Legally binding requirements	Adaptive management

How the Science Happened

- Sampling analysis plans, QAPP, SOPs
  - USGS: what flow data are needed
  - MWRA: financial support and technical support
- Collaboration with DEP and EPA
- EPA formed a Technical Advisory Committee, hired a project manager, hired subcontractors
- MyRWA carried out monitoring and data analysis

Project Partners - Technical Steering Committee (TSC)

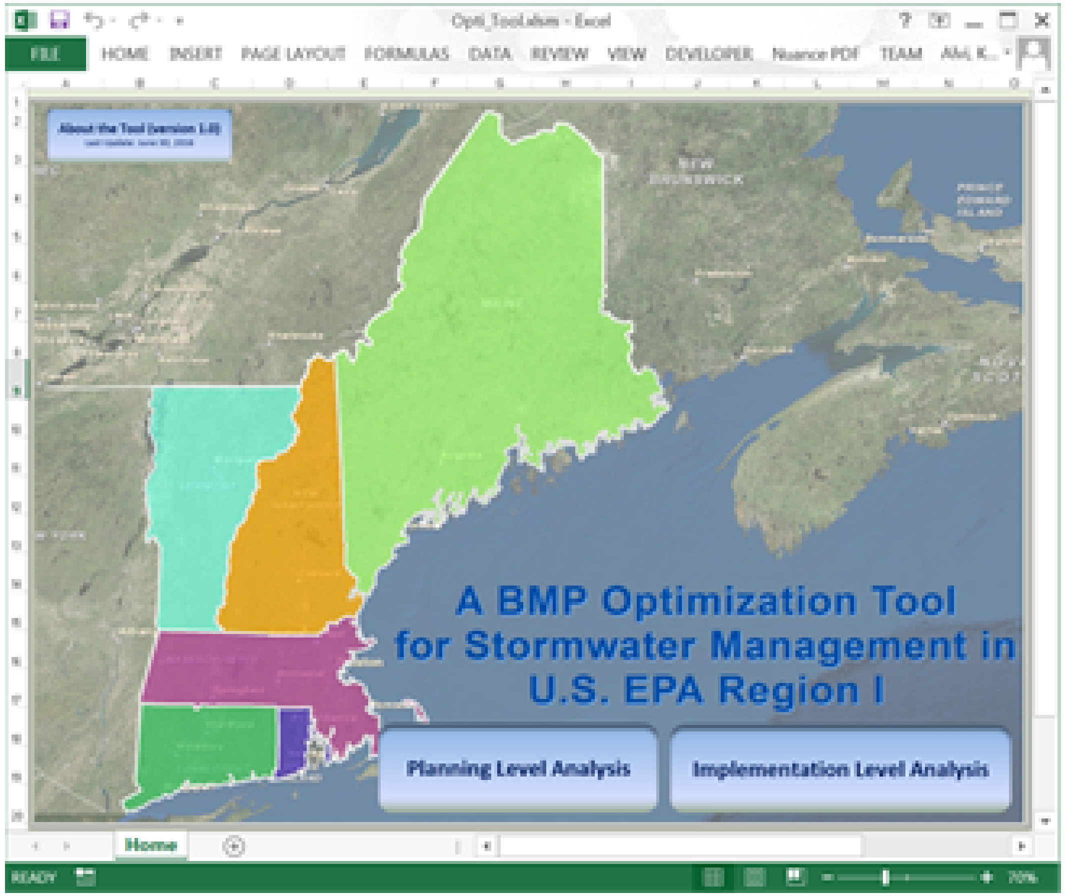
- **Mystic River Watershed Association (MyRWA)** - Water quality monitoring, USGS flow gaging project management, TSC
- **MWRA** - Water quality monitoring, financial support, TSC
- **MassDEP** -Technical and policy support, TSC, pond/lake phosphorus load reduction analyses
- **EPA Region 1** - EPA Contractor support, water quality monitoring, laboratory analyses, technical and policy support, TSC, pond/lake load reduction analyses
- **EPA's Contractor: Environmental Research Group (ERG)** - Team includes PG Environmental, Horsley Witten Group, & Paradigm Environmental - Overall technical support including data analyses, water quality endpoints, watershed and receiving water modeling

Model Selection

- TAC involvement with model selection
- Nigel Pickering carried out modeling (fr. CRWA, Horsley Witten)
- OptiTool used to estimate P inputs (rather than loading), site Green Infrastructure to estimate costs
- BATHTUB model used to understand inputs and relationship between P and Chl-a □ report that established levels necessary to remove impairment
- Outside reviewer was trusted by all parties

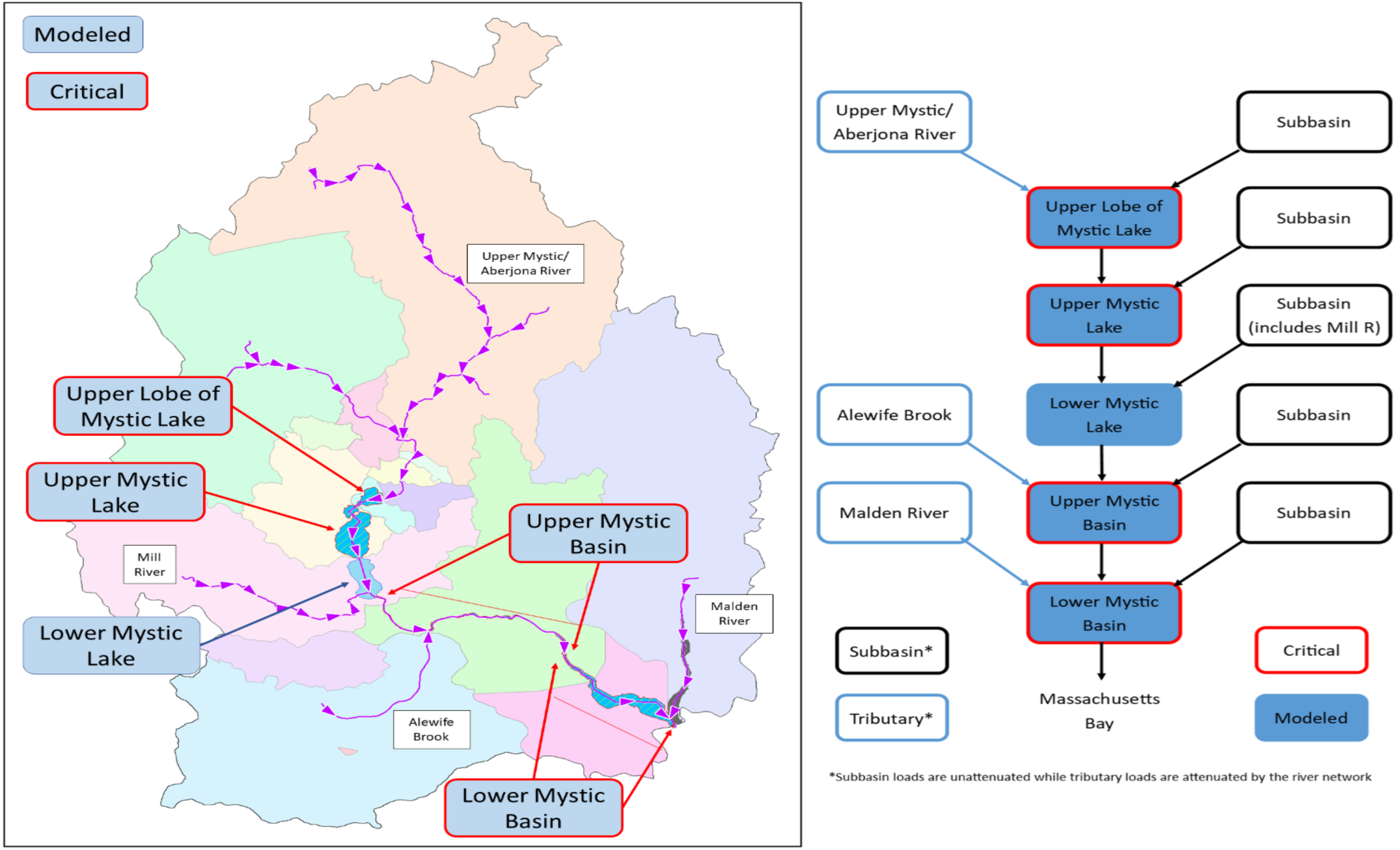
EPA Region 1 Opti-Tool

- A spreadsheet-based stormwater (SW) management optimization tool
  - Planning Level Analysis (EPA Region 1 SW Control Performance Curves)
  - Implementation Level Analysis (EPA SUSTAIN SW Control Simulation and Optimization Engine)
- Customized with calibrated SWMM HRU WQ and SCM models suitable for New England Region
- Suitable for Region 1 MS4 (MA & NH) permit compliance for nutrients



https://www.epa.gov/tmdl/opti-tool-epa-region-1s-stormwater-management-optimization-tool

Mystic River Watershed Sub-Basin Delineation and Schematic Diagram for Final BATHTUB Model



Mystic River Watershed Phosphorus (P) Load Reductions

Critical period of interest

- 10-year period from 2007 to 2016
- Includes 2 wet years (2008, 2011), 2 dry years (2015, 2016)

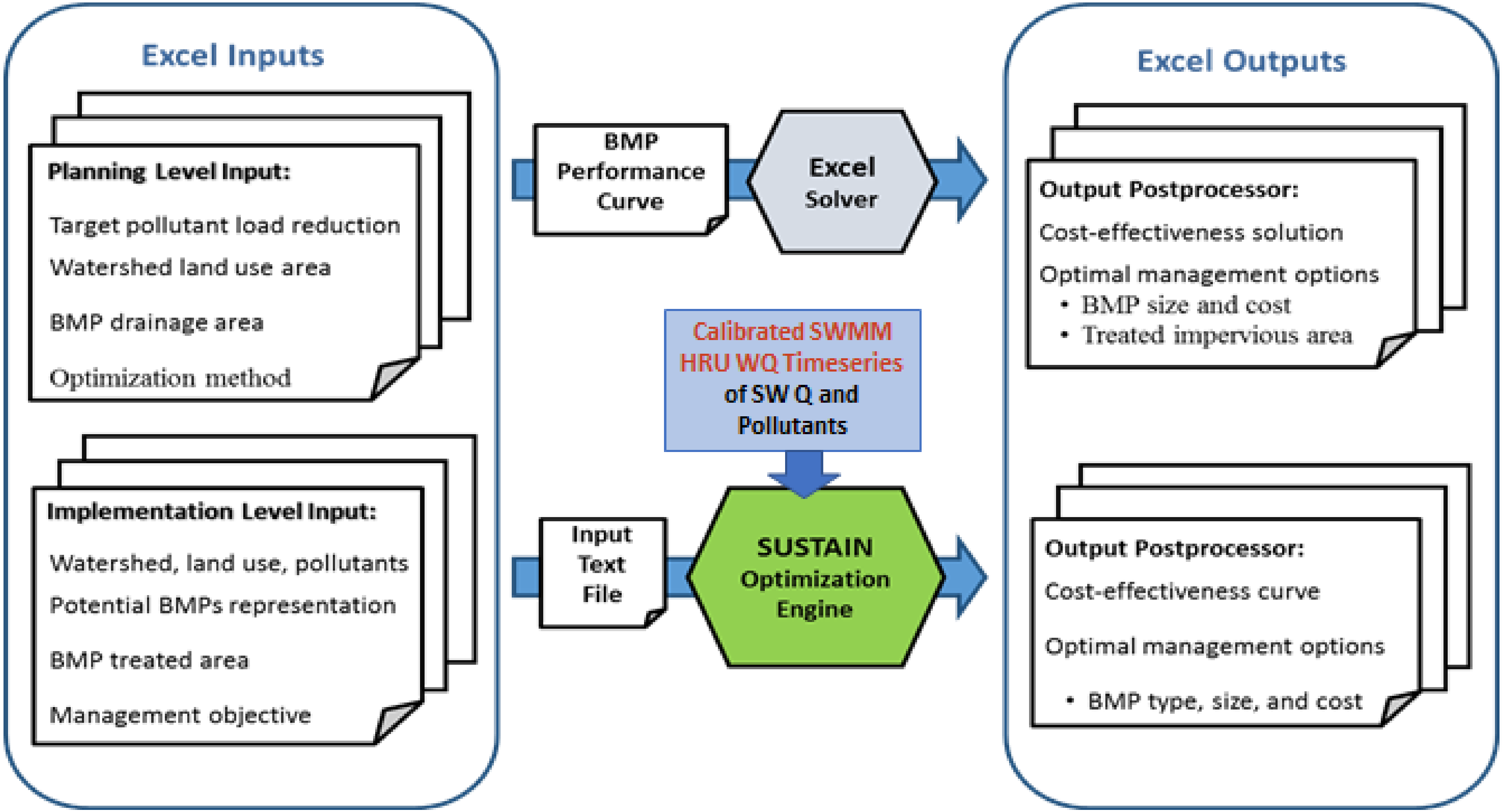
Annual phosphorus load reductions to attain targets for critical period

- **Stormwater:** 59% to 67% depending on amount of combined sewer separation
- **CSOs**: Consistent with level of control in MWRA approved Long-Term Control Plan
- **SSOs:** 50%
- **Internal nutrient cycling:** 30% to 34% assumed proportional to Watershed P load reduction

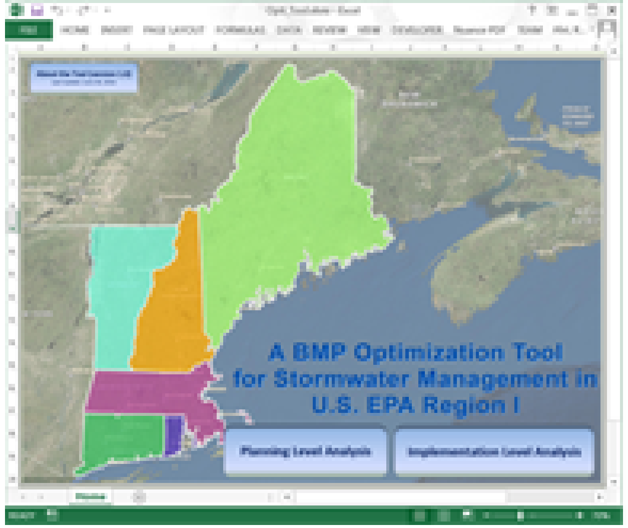
Table IX-6. Total Phosphorus Load Reductions for Scenario 2A

Item	SW	GW Base flow	CSO/SSO	Internal	Atm.	Total
Existing Conditions Total P Load (lb./yr.)	14,887	1,141	1,696	3,793	120	21,638
Scenario 2A P Load (lb./yr.	9,974	1,141	412	1,271	120	12,919
Reduction (%)	67%	0%	24%	34%	0%	60%

Opti-Tool Planning and Implementation Options



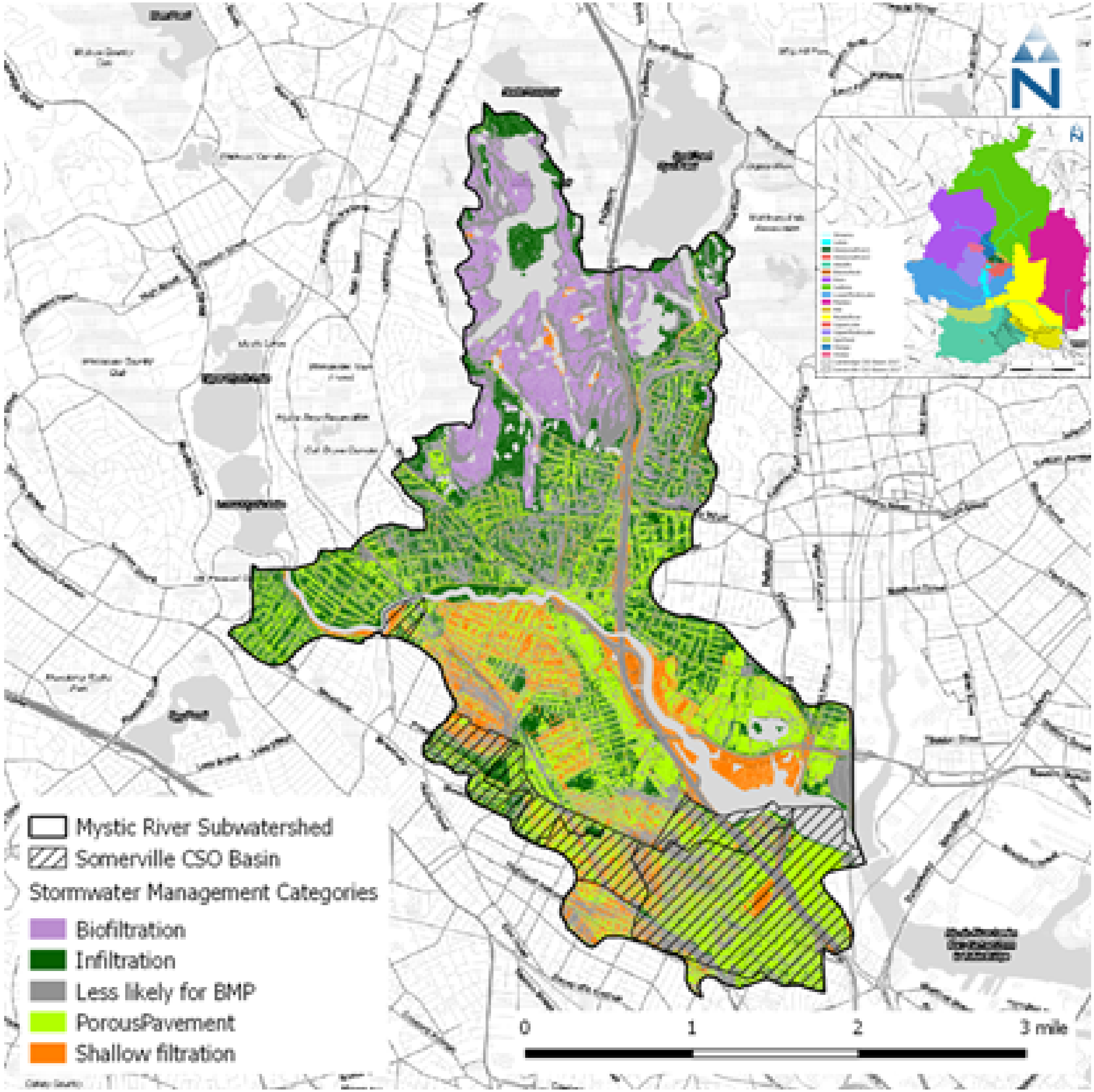
Goals of Mystic River Watershed Opti-Tool Demonstration Analysis



- Develop a step-by-step, high-level approach to inform cost effective SW managment strategies
  - Generalize approach
  - Treating impervious areas (up to 90% of Total Impervious Area)
  - Structural SCMs only
- Demonstrate cost-benefits of optimization at watershed scale
  - Cumulative reductions for all storm events (2007 – 2016)
  - Develop cost-effective curve for TP load reduction

Identifying Cost-Effective Stormwater Management Strategies w/Opti-Tool

- Pilot sub-watershed (5,151 acres - ~10% of entire watershed area)
- Models watershed and evaluates thousands of scenarios of applying most effective stormwater controls to treat impervious cover runoff
- Results demonstrate cost-benefits of optimization at watershed scale
  - Quantifies cumulative treatment performance for all precipitation events (2007 – 2016)
  - Developed cost-effective curve for P load reduction



Opti-Tool: Pilot Subwatershed Model Results

Phosphorus Reduction Cost-Effectiveness Curve
(Blue diamond line)

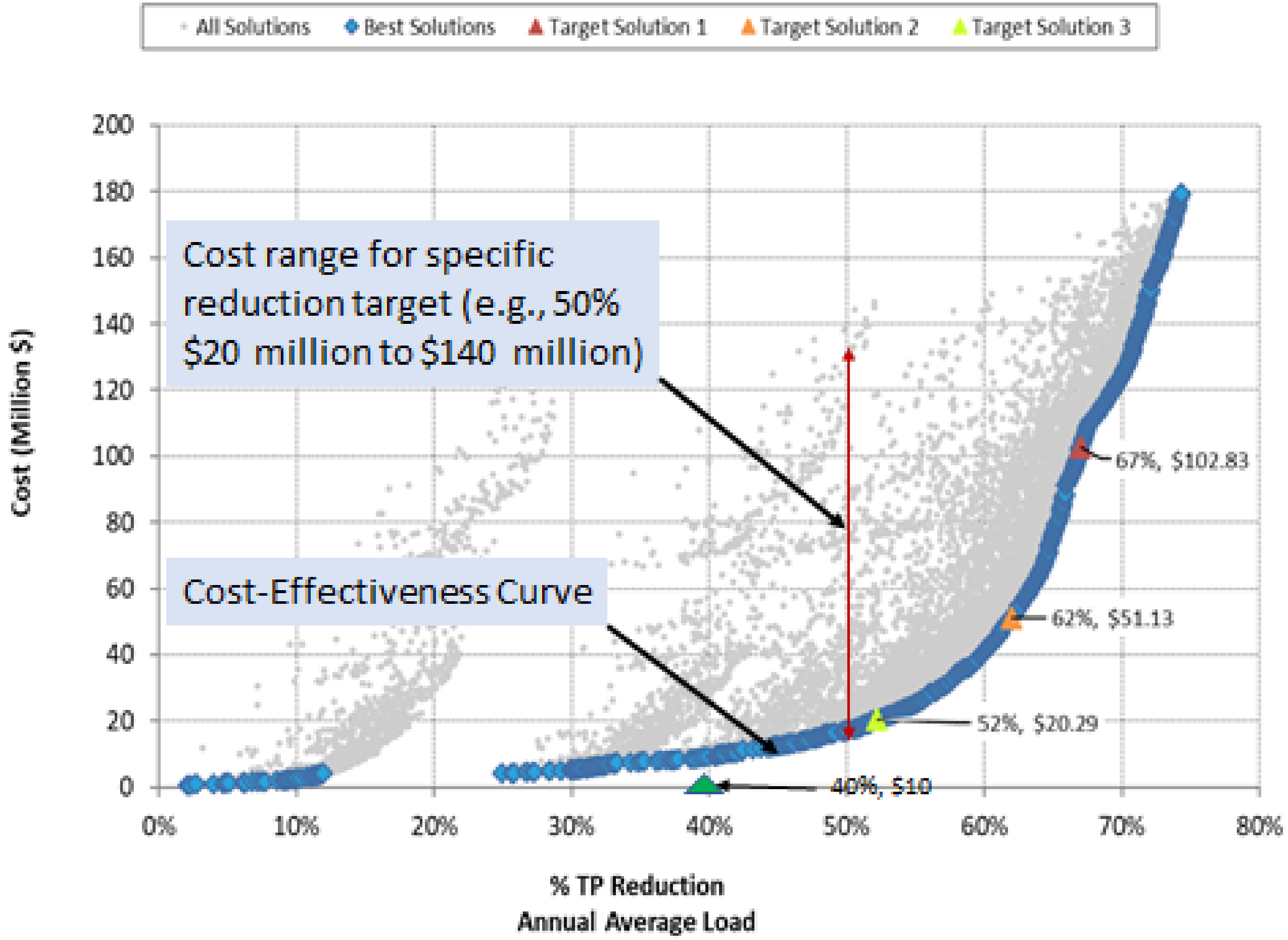
- Thousands of scenarios simulated with varying amounts of IC area treated and varying sizes of SW controls applied.
- Very large range in estimated costs!
  - Large range across reduction targets:

    40% - $10 million

    52% - $20.3 million

    62% - $51.1 million

    67% - $102.8 million
  - Large range for specific reduction target



Roll-Out – Piloting and laying the groundwork for implementation

Status of Mystic River Watershed Alternative TMDL Analysis for Eutrophication Management

1) Final Report of Alternative TMDL Technical Analyses completed January 2020
https://www.epa.gov/sites/production/files/2020-05/documents/mystic-phosphorus-tmdl-development.pdf

2) Phase 3 Facilitated Technical SW Management Support with 6 Pilot Communities

- Pilot process completed with Arlington and Winchester – March-September 2019
- Process expanded to work with 4 additional watershed communities, Cambridge, Lexington, Reading and Watertown – November 2019-September 2020

3) Rollout of Final Report

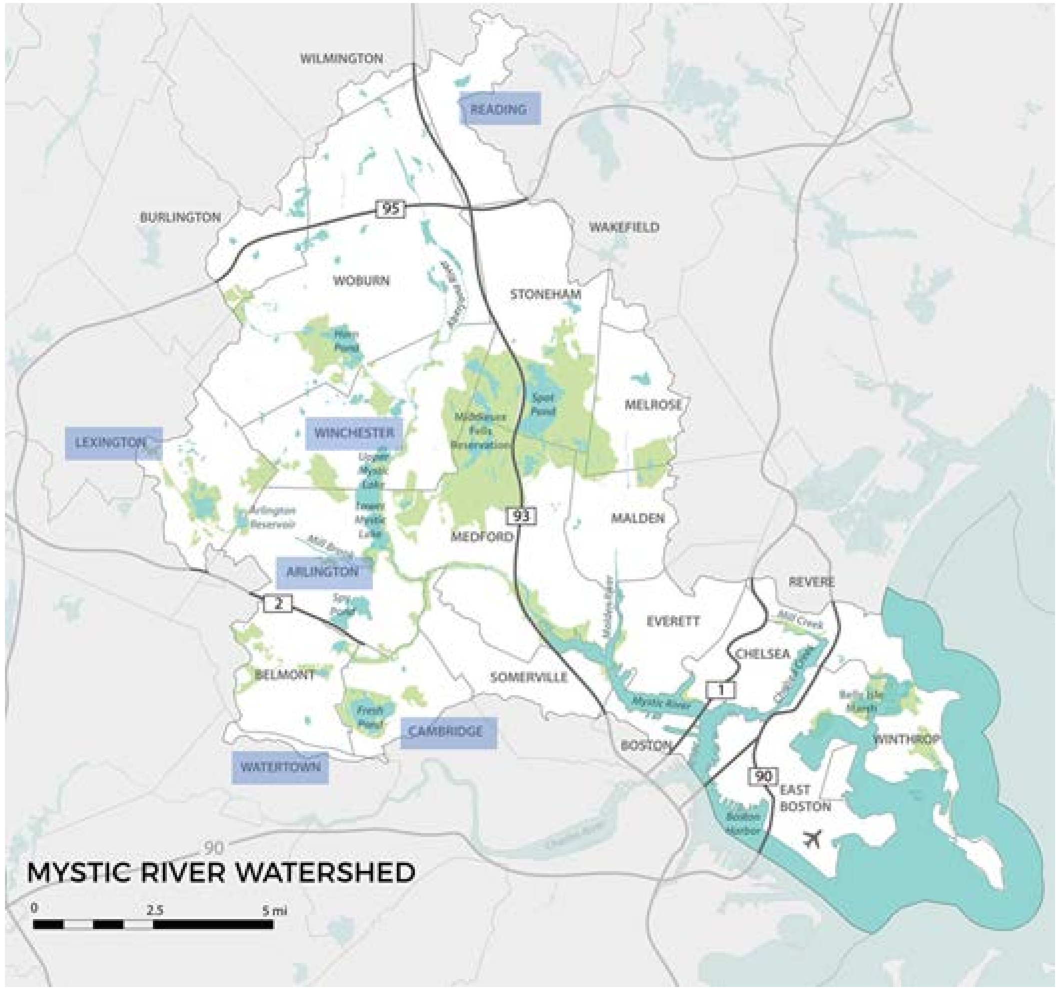
- EPA and MassDEP sent joint letter to watershed communities announcing release of the report and its significance to communities – May 28, 2020

  https://www.epa.gov/mysticriver/environmental-challenges-mystic-river-watershed#MysticAltTMDL
- Presentation of project results including Phase 3 work at Mystic Steering Committee Meeting today - June 4, 2020

4) EPA and MassDEP continue outreach to communities on Alt TMDL

Advancement of local stormwater management in response to eutrophication analysis: “Phase 3”

- Capacity building and technical assistance focused on P load reductions
- Goal is to make progress on nutrient management prior to TMDL permit implementation
- Phased work with small groups of municipalities in the watershed
- Collaboration between municipalities, MyRWA, EPA, MassDEP, UNHSC, consultants, and facilitators



Work to date in the Mystic River Watershed

Dec 2018 – Jun 2019

- Arlington and Winchester
  - Stormwater bylaw review for each town
  - 2 infiltration systems
  - Replicable small scale infiltration trenches
  - Stormwater management action plan

Dec 2019 – Sept 2020

- Cambridge, Lexington, Reading, Watertown
  - Stormwater bylaw review for each town
  - Self-certification process
  - Small-scale BMPs and redevelopment standards

Recent webinars and Future work:

- Phosphorus Reduction 101
- Trash Reduction in the Mystic
- Tracking and Accounting of pollutant reductions
- Funding a stormwater program

Infiltration Trenches

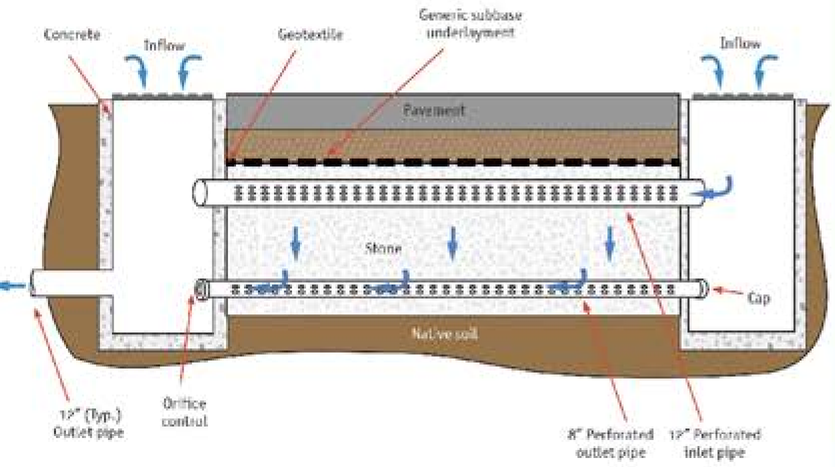
Dec 2018 – Jun 2019

- Arlington and Winchester
  - Stormwater bylaw review for each town
  - 2 infiltration system
  - Replicable small scale infiltration trenches
  - Stormwater management action plan

- Reduce footprint, provide design flexibility
- Construction efficiency
- Cuts costs compared to traditional methods
  - NO: Resetting curb, replacing sidewalk, stabilizing sites
- Arlington installed 11 trenches @ $2,500 each
  - Example
    - 170 cf Volume Reduction
    - 1.11 lbs P removed annually
    - 306 lbs TSS removed annually

SC STORMWATER CENTER

Generic Infiltration Trench Design Detail



Notes

1. Similar to subsurface gravel filters, infiltration trenches tend to be linear and are best used in narrow sites.
2. The storage layer (stone shown here) can be comprised of natural or manufactured materials to hold the design storage volume (DSV).
3. Locate the bypass to drain through the outlet pipe to existing drainage. The elevation may vary to meet existing infrastructure inverts, and flow is controlled through orifices and weirs.
4. Hydraulic inlets should drain by gravity where possible.
5. Surface cover may vary—pavement, grass, soil, or any combination of these can be used to meet end user needs and site requirements.
6. Add cleanouts and/or inlet protection, such as a snout or the Eliminator, as needed.

UNH Stormwater Center www.unh.edu/unhsc

Small residential stormwater management

Dec 2019 – Sept 2020

- Cambridge, Lexington, Reading, Watertown
  - Stormwater bylaw review for each town
  - Self-certification process
  - Small-scale BMPs and redevelopment standards

- Overview/Description with image
- Maintenance requirements/general schedule
- Bulleted list of key benefits provided by the practice
- Basic guidelines for sizing of the practice
- Key site conditions required /helpful in site selection
- Additional space for community to add information, such as contact information, town website, references, or permit information

- Dry Water Quality Swale*
- Biofiltration*
- Infiltration Trench*
- Non-Structural & Semi-Structural Approaches
- Dry Well
- Planters
- Permeable Pavers
- Rain Garden

* Identified in MS4 Permit App F, Section 3, w/ guidance for sizing & P load reductions

RAIN GARDEN

Description

Rain gardens are great for residential locations. A rain garden is a shallow depression dug into a yard or parking island that collects water when it rains. Rain gardens use the collected water to grow plants, but they also temporarily store that water and allow it to sink into the ground. This helps alleviate minor flooding in other locations and keeps some water from overwhelming the central drainage system in the street. They can be built in different sizes and shapes and can include a variety of plantings to suit your yard and your aesthetic tastes.

Maintenance

Follow the recommended maintenance summarized below to ensure your Rain Garden functions as designed:

- Regularly: Inspect your rain garden and remove trash and debris.
- Early Spring: Mow or prune your plants, remove dead vegetation and replace if needed, and mulch the bed.
- Fall: Mow or prune your plants.

Benefits

Your Rain Garden, when properly maintained, offers many benefits including:

- Provides habitat and attracts butterflies, birds, and other wildlife.
- Clean rainwater with the help of soils, plants, and beneficial microbes.
- Low maintenance systems That double as a garden.
- Help to reduce flooding and improve the quality of water in nature.

Sizing your Rain Garden

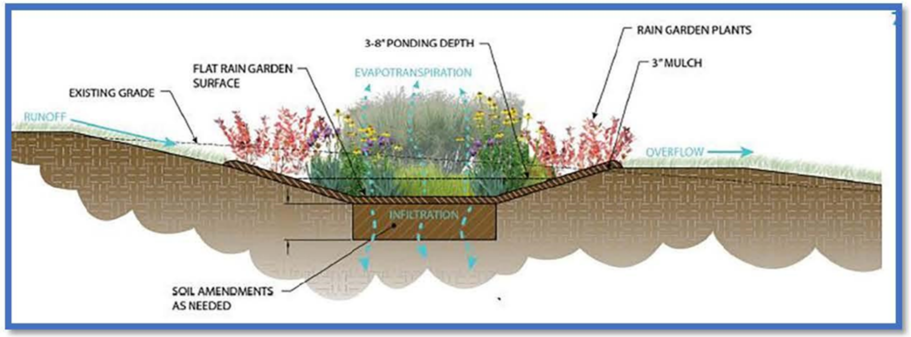
Your Rain Garden should be sized to handle the expected runoff from impervious cover on your property. Consider the following when sizing your Rain Garden:

- Rain gardens are filled with native New England plants that can grow and survive in both wet and dry conditions. Use gravel or pebbles at the inlet of the garden if water rushes in too fast and causes erosion.
- Rain gardens can be as large or small as needed. They generally do not need to be deeper than 1 foot. Don't be afraid to be creative with the plants and decorations. Colorful plants and features like stepping stones make rain gardens interactive and engaging.
- Avoid planting anything edible.
- See this link for a design guide: https://horsleywitten.com/wp-content/uploads/2020/06/Build-your-own-Rain-Garden_Final.pdf.

Appropriate Site Conditions

Rain gardens that are used in a residential setting should be located close enough to the home to catch roof runoff or within a lawn area to collect runoff from both the lawn and roof. When selecting a location for your Rain Garden, consider the following:

- Should be planned so that it can be incorporated into the yard/site with existing landscape.
- Should be located at least 10 feet from the house to prevent potential structural damage due to wetness or flooding.
- Should never be located directly over a septic system.
- Should not be installed in an area where water typically ponds.
- Should be built in full or partial sun to speed up evaporation and transpiration of captured water.
- Should be built in relatively flat areas of a yard, and not on or directly adjacent to steep slopes.



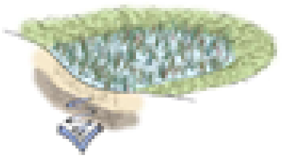
Phosphorus Reduction 101

Recent webinars and Future work:

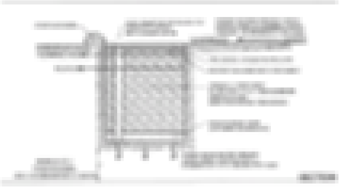
- Phosphorus Reduction 101
- Trash Reduction in the Mystic
- Tracking and Accounting of pollutant reductions
- Funding a stormwater program

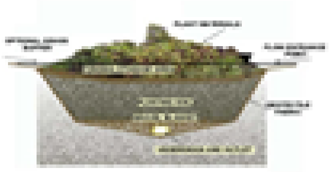
- Easy to Install and Maintain Green Infrastructure
  - Small scale controls - “every day counts”
- Effective Non-structural Practices
  - Successful street sweeping programs and associated crediting
- Funding Your Program
  - Stormwater Enterprise Funds - existing programs and lessons learned from implementation

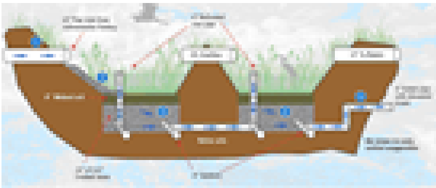
SW Control Types with Performance Curves

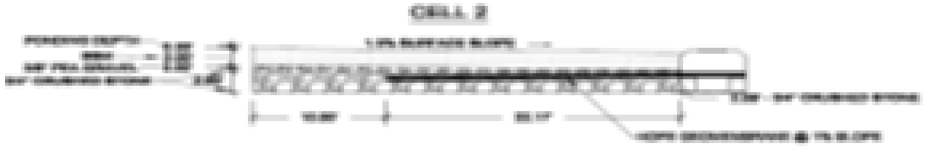


Pollutants: TP, TN, TSS, Zn

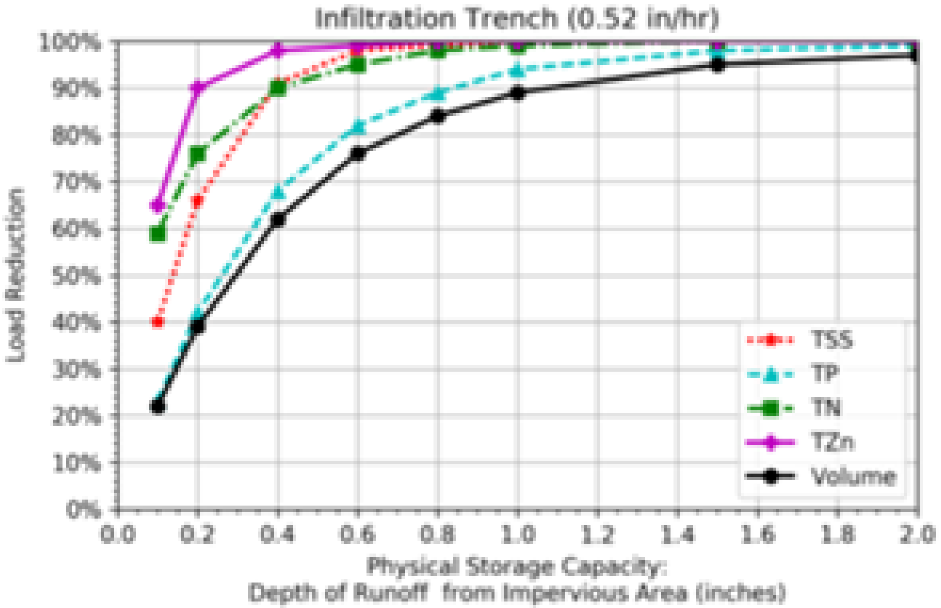








1. Infiltration Basin, Rain Gardens, Bioretention*
2. Subsurface Infiltration Systems*
3. Enhanced Bio-filtration w/ Internal Storage Reservoir (ISR) (enhanced for P sorption and N control)*
4. Gravel Wetland*
5. Porous Pavement with and without subsurface infiltration
6. Bio-filtration (currently using Chesapeake Bay curves for P and N)*
7. Sand Filter (currently using Chesapeake Bay curves for P and N)*
8. Wet Pond (currently using Chesapeake Bay curves for P and N)*
9. Extended Detention Dry Pond (currently using Chesapeake Bay* curves for N)
10. Grass WQ Swale w/detention (currently using Chesapeake Bay curve for N)*



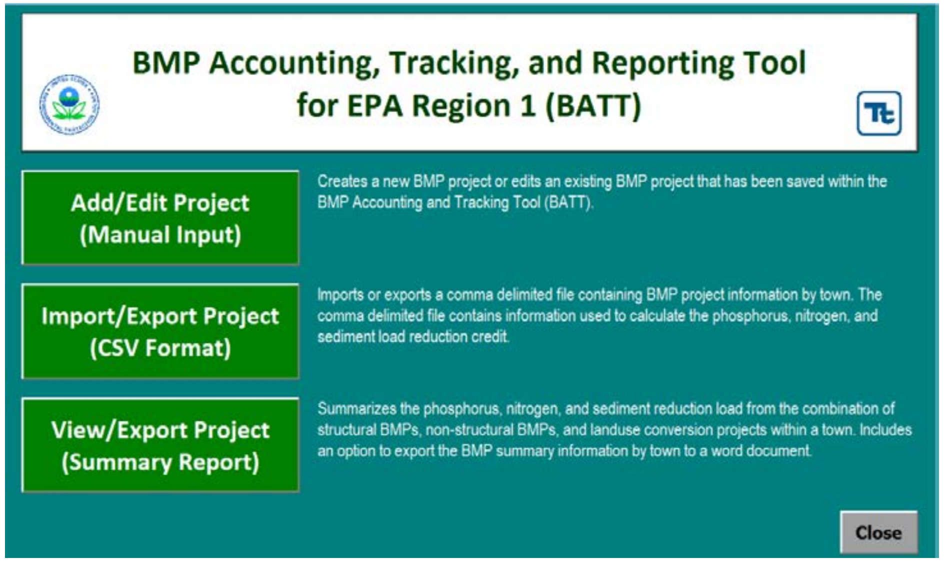
See Attachment 3 https://www3.epa.gov/region1/npdes/stormwater/nh/2017-appendix-f-sms4-nh.pdf

Tracking and Accounting of P load reductions

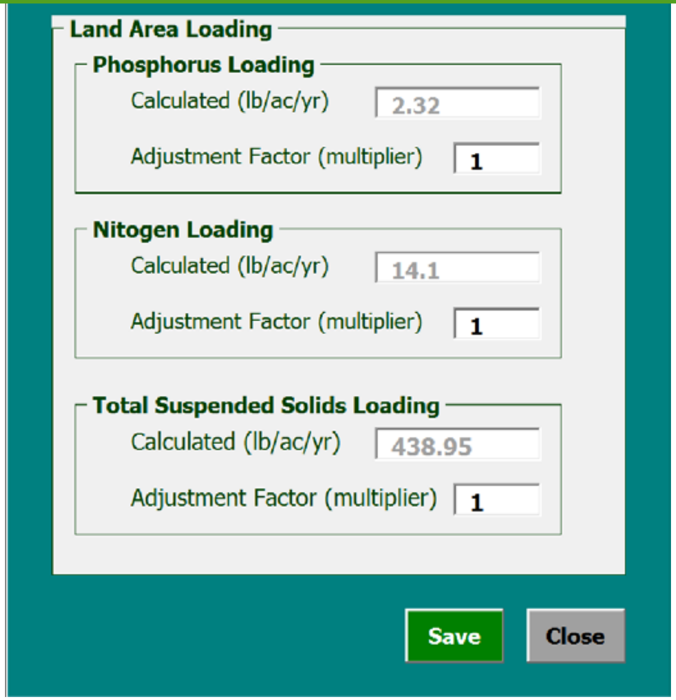
Recent webinars and Future work:

- Phosphorus Reduction 101
- Trash Reduction in the Mystic
- Tracking and Accounting of pollutant reductions
- Funding a stormwater program

- EPA Region 1 BMP Accounting and Tracking Tool (BATT)
- Spreadsheet based tool that facilitates watershed based nutrient accounting, tracking and reporting for the MS4 permit



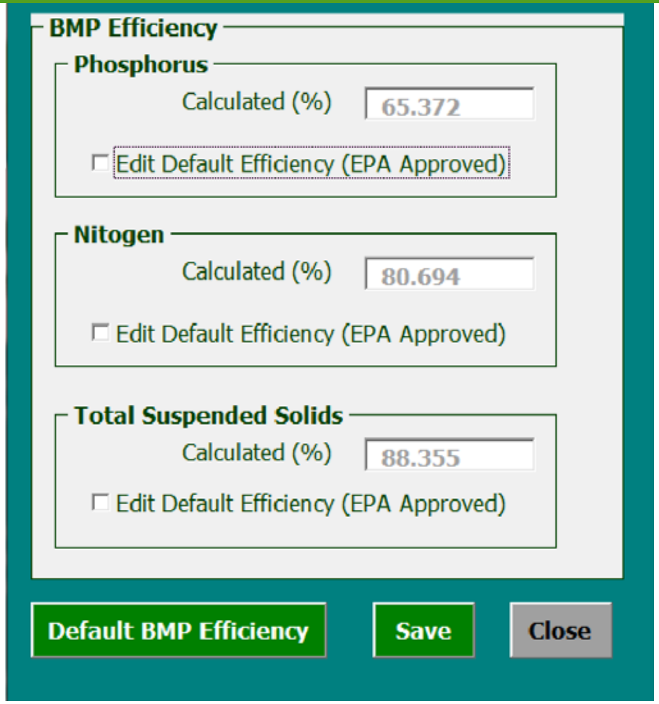
Land Use Loading Rate



Goal of Community Piloting

- Ensure BATT is user friendly
- Receive direct feedback on useability
- Improve BATT to promote community use

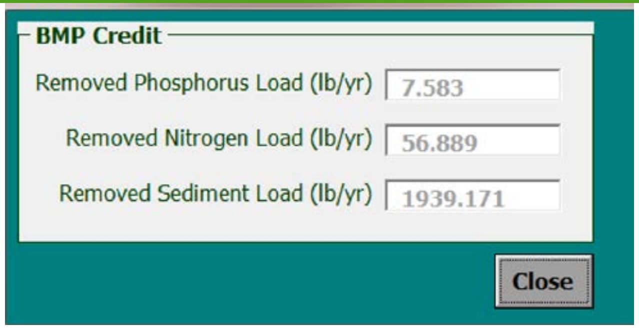
BMP Performance



Project Purpose

- Use green infrastructure and stormwater management to improve water quality and promote resilience
- Enable practitioners to account and track for pollution reduction

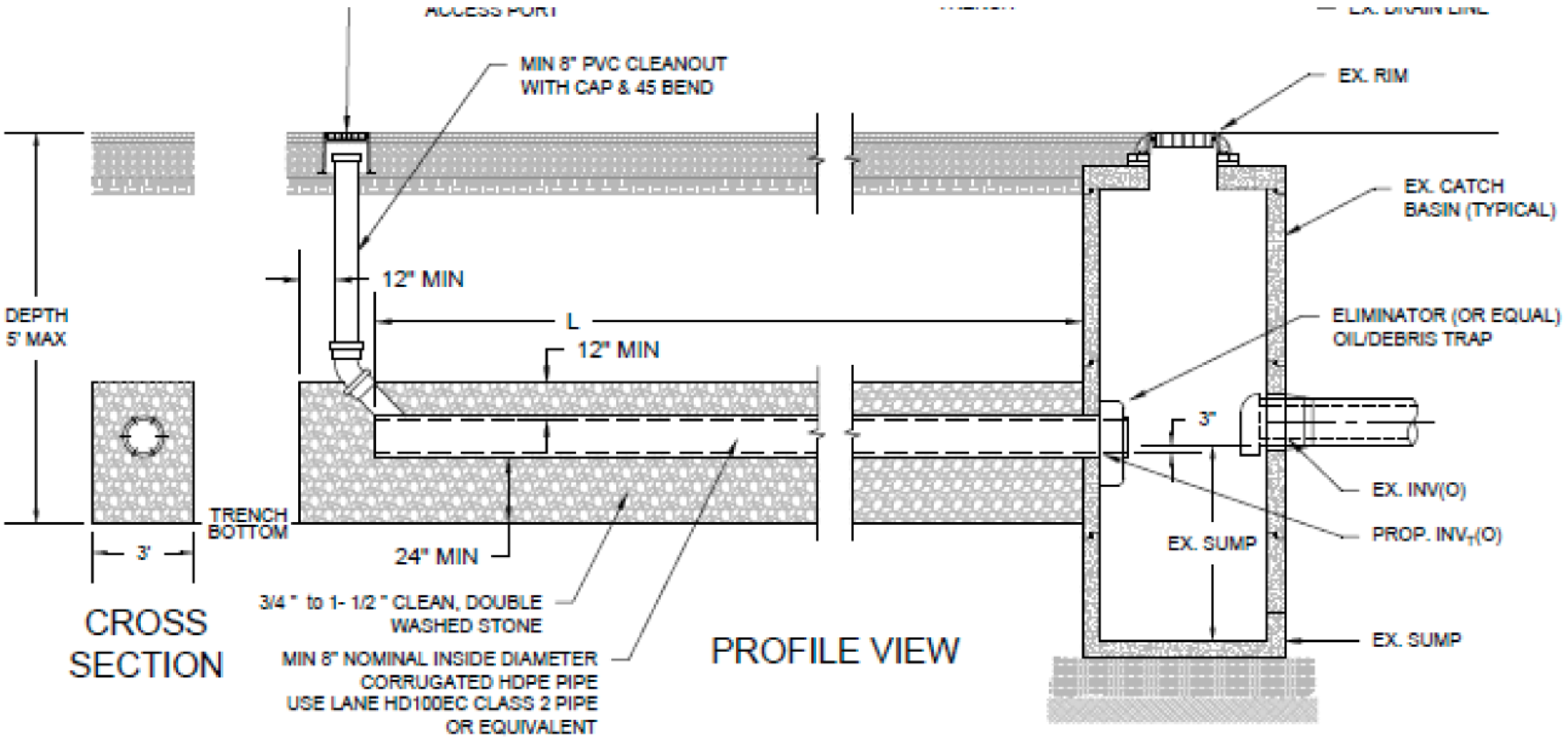
BMP Credit



The Future

- Communities haven’t moved forward w/ stormwater utilities (DEP and EPA collaborating on this)
- Funding mechanisms – reliable funding for communities (Municipal budgets are a challenge.)
- Actual integration into MS4 permit – regulatory requirements
- Equity – need to figure this out.
- Climate change and resilience
- Iteration – what comes next. When we will take another measure of the system? What’s the strategy? What strategy will EPA take with permits?

Small scale (but Mighty): Infiltration Trenches



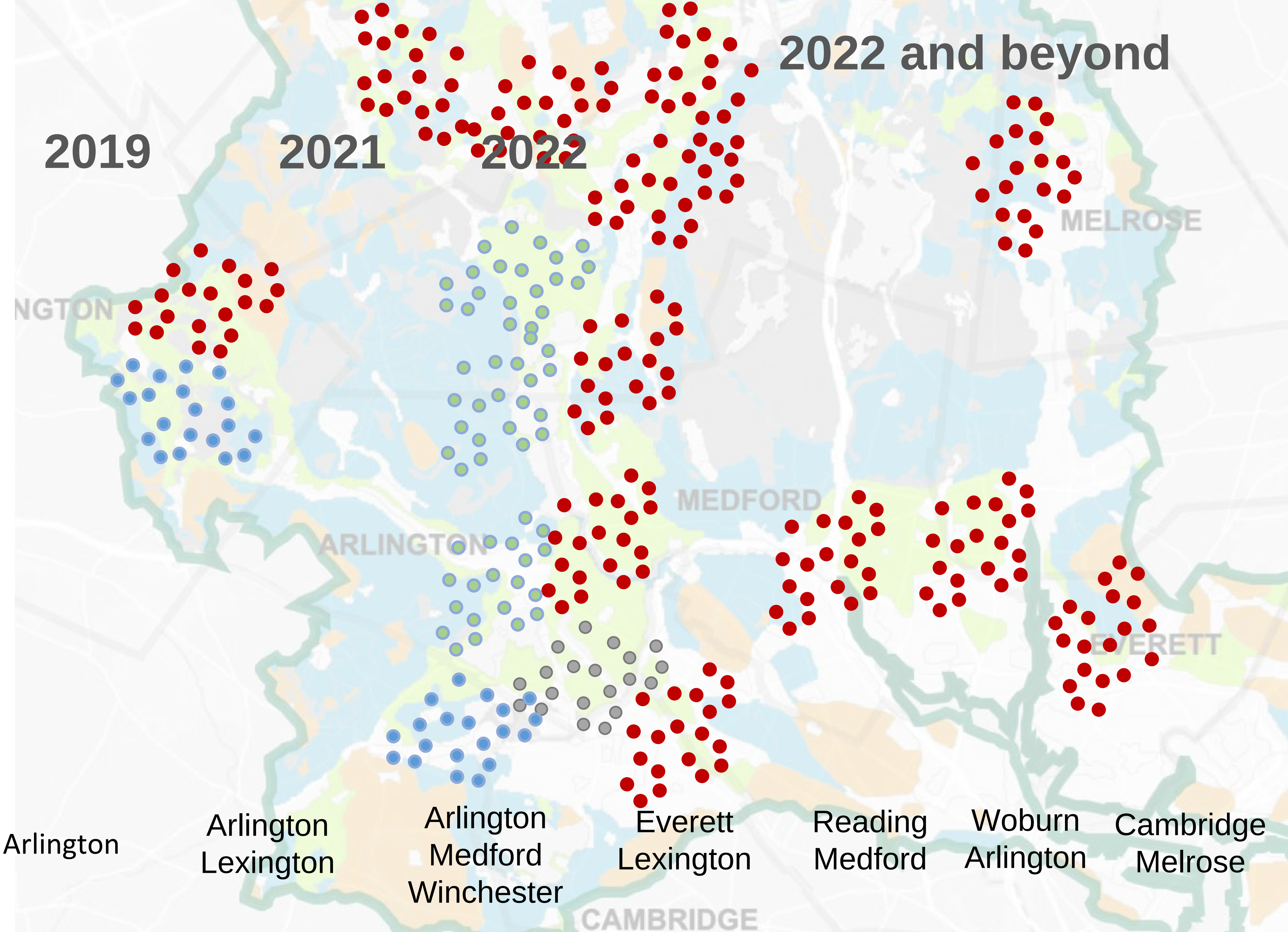
STANDARD PIPE TRENCH INFILTRATION SYSTEM

MODIFIED BY UNHSC, MAY 2019

MAR 2019	D-0014
NOT TO SCALE	
REVISION ①	

Taking a pilot project to scale

360 trenches



IMPLEMENTATION


…but, we won’t “raingarden” our way out of this

Patrick Herron: Patrick.Herron@mysticriver.org
Ivy Mlsna: Mlsna.Ivy@epa.gov
Laura Schifman: Laura.Schifman@mass.gov