Prioritizing Nature-based Stormwater Projects to Maximize Community Co-Benefits in the Buttonwood Brook Watershed

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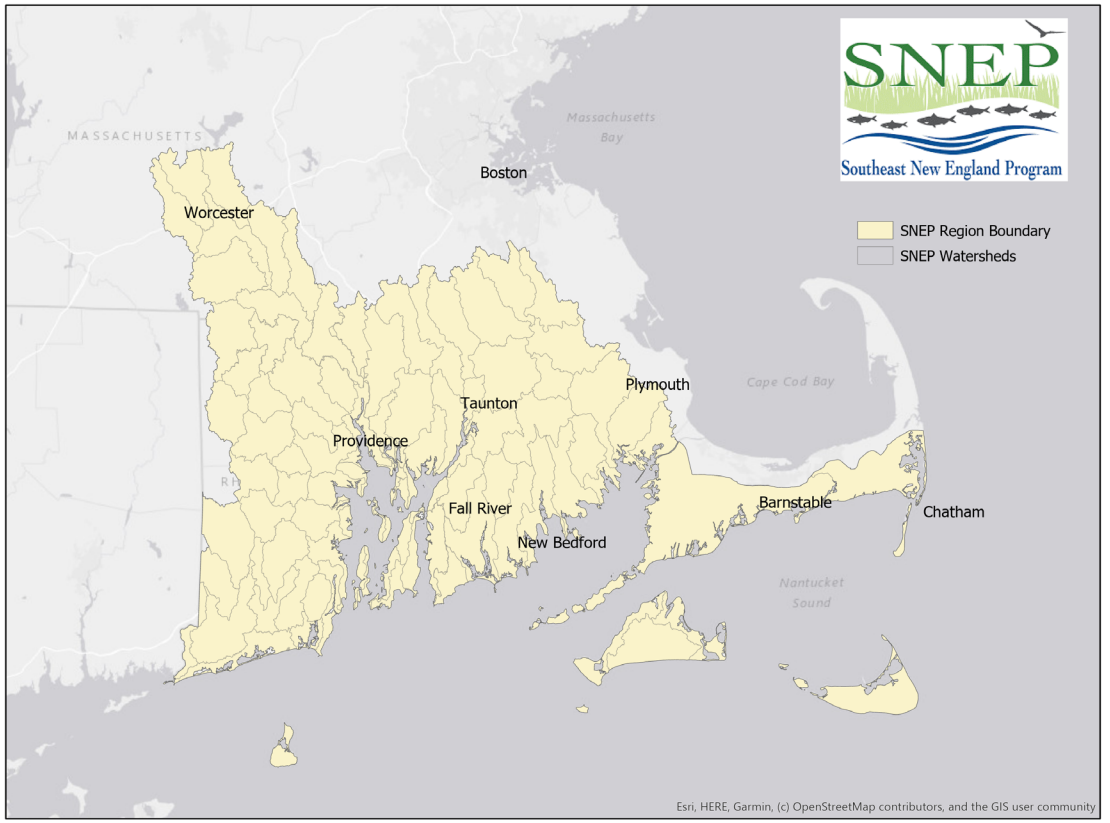
(Southeast New England Program Network)

The SNEP Network

SOUTHEAST NEW ENGLAND PROGRAM NETWORK

Training and Technical Assistance for Stormwater/Watershed Management

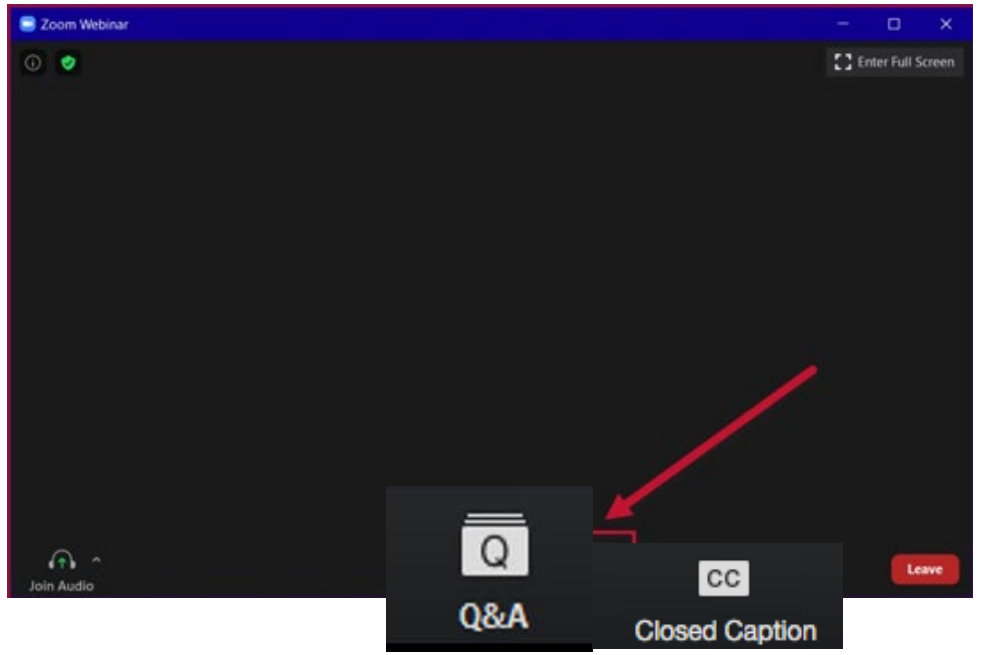


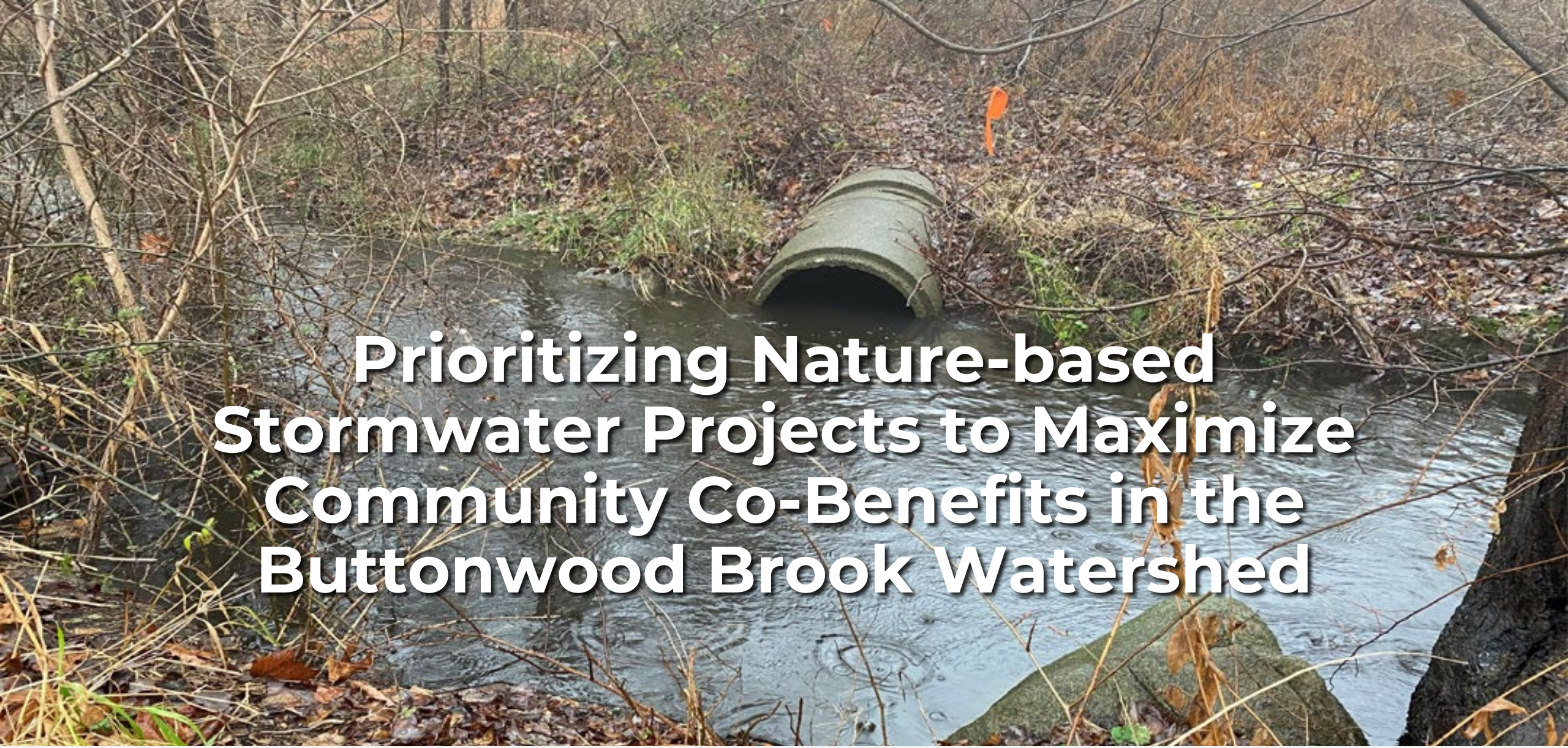
Boundary of the Southeast New England Program Region

New England neefc Environmental Finance Center

Zoom Logistics

- Attendees will be muted to ensure audio quality
- Type your questions into the **Q&A Box** at anytime
- In the chat, we will share links to resources
- We have closed captions available for the webinar. ***Please click the closed caption feature in the zoom control panel to view.***





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SNEP Network Webinar

July 31, 2024

Project Team

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buzzards BAY COALITION



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Project Overview

Dan Goulart

Buttonwood to Bay Project Manager

Buzzards Bay Coalition



SNEP Pilot Watershed Initiative
Buttonwood-to-Bay Project



Project Overview

Five Year Project: Focused on the restoration of a highly urbanized stream flowing through an EJ community

Grant Funding: $749,780

Match: $299,584 (50% BBC Private Fundraising)

Total Project: $1,049,364

Leveraged Funds: $6M+

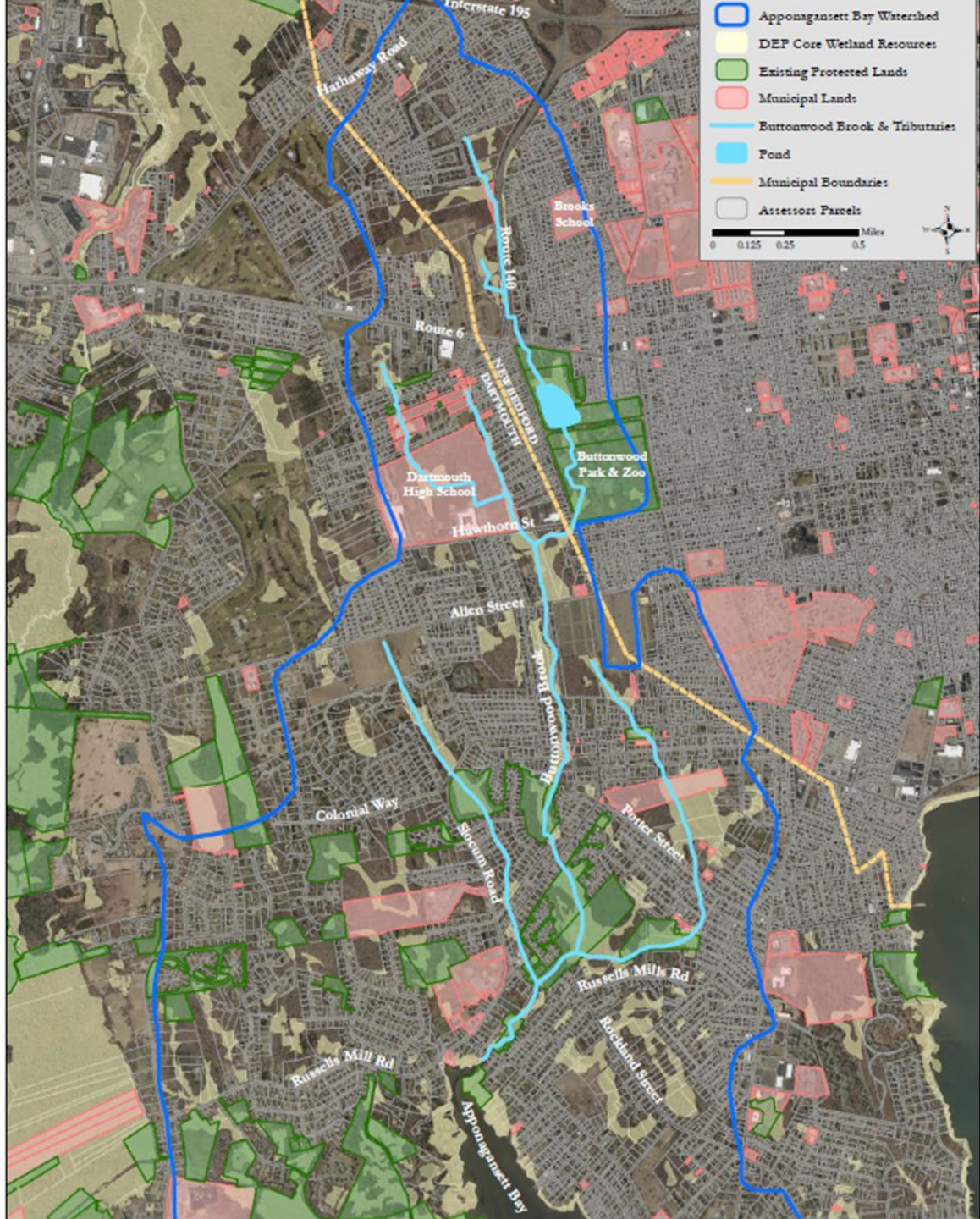
Approach:

Years 1-2: Complete the science to inform restoration plans

Years 2-3: Engage stakeholders in site selection process

Years 3-4: Develop and demonstrate evidence-based restoration plans

Years 4-5: Implement at the most feasible sites with the greatest potential to improve water quality, habitat, and community resilience



Project Goals

Proceeding in parallel with separate objectives

Improve Water Quality

- Identify largest sources of pollution within the Buttonwood Brook Watershed
- Work with project partners and stakeholders to identify potential solutions
- Implement Green Infrastructure and Nature Based Solutions to remediate pollutions sources and restore habitat
- Ongoing Monitoring

Sustain Water Quality

- Conduct scientific studies and collect data that support the development of a Nutrient Threshold Report
- Submit findings and report to MassDEP and EPA for review
- Establish a Total Maximum Daily Load TMDL for Apponagansett Bay that supports regulatory management of nitrogen sources in the watershed

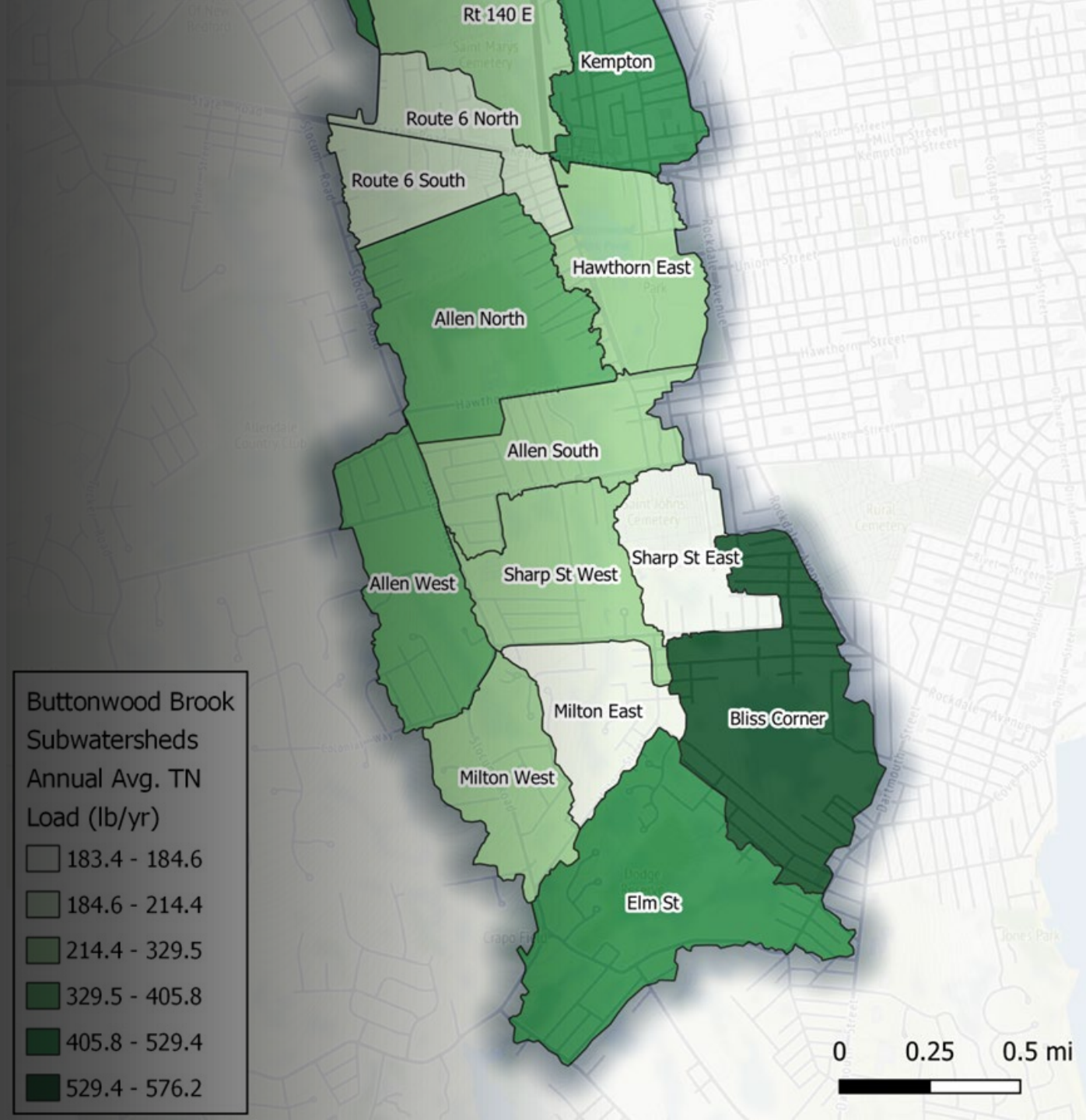
buzzards BAY COALITION

Identification of Pollutant Sources

Ben Bowes

Water Resources Engineer

Paradigm



Modelling Introduction

Purpose

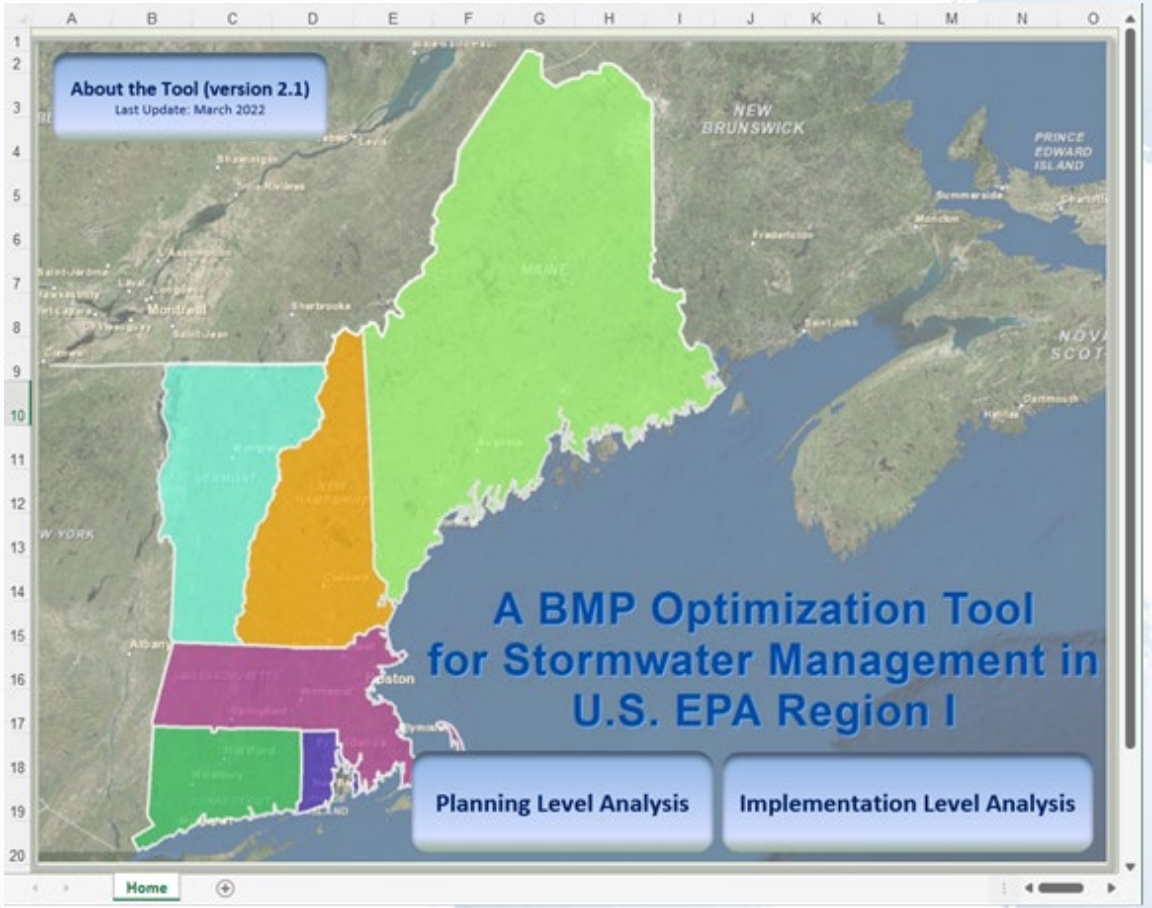
- Aid stormwater management, planning, and improvement efforts through high-resolution **watershed delineation** and **hot spot analysis** of stormwater runoff and pollutant loads at the source level (unattenuated)

EPA R1 Opti-Tool

- HRU Development
- Subwatershed Delineation
- Runoff and Pollutant Loading Analysis
  - **Summarize/visualize HRU distributions and pollutant loadings**

Opti-Tool Overview

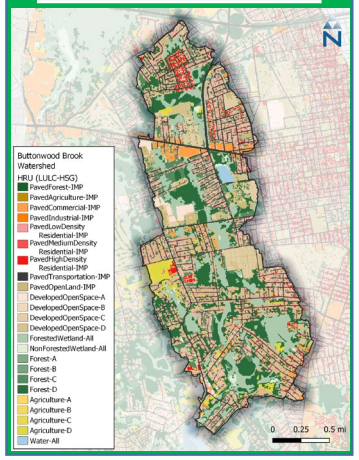
- Spreadsheet-based BMP optimization tool
  - **Provides planning level analysis**
  - **Provides detailed implementation level analysis using EPA's SUSTAIN model**
  - **Regionally-calibrated within EPA Region 1 for runoff, sediment, total nitrogen, total phosphorous, and bacteria**
- Additional information on the Opti-Tool is available from the EPA at https://www.epa.gov/tmdl/opti-tool-epa-region-1s-stormwater-management-optimization-tool



SUSTAIN: System for Urban Stormwater Treatment and Analysis Integration

Opti-Tool Overview

Watershed Characteristics

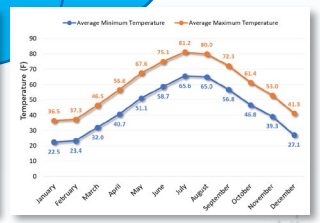


Climate Data

- New Bedford Airport

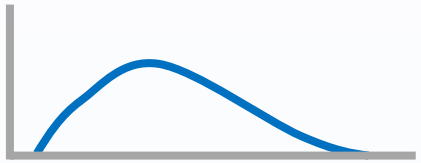


Precipitation



Temperature

Opti-Tool SWMM Model



Runoff and Pollutant Loading Time Series

Catchment Delineation

Hot Spot Analysis

Additional Opti-Tool Processes

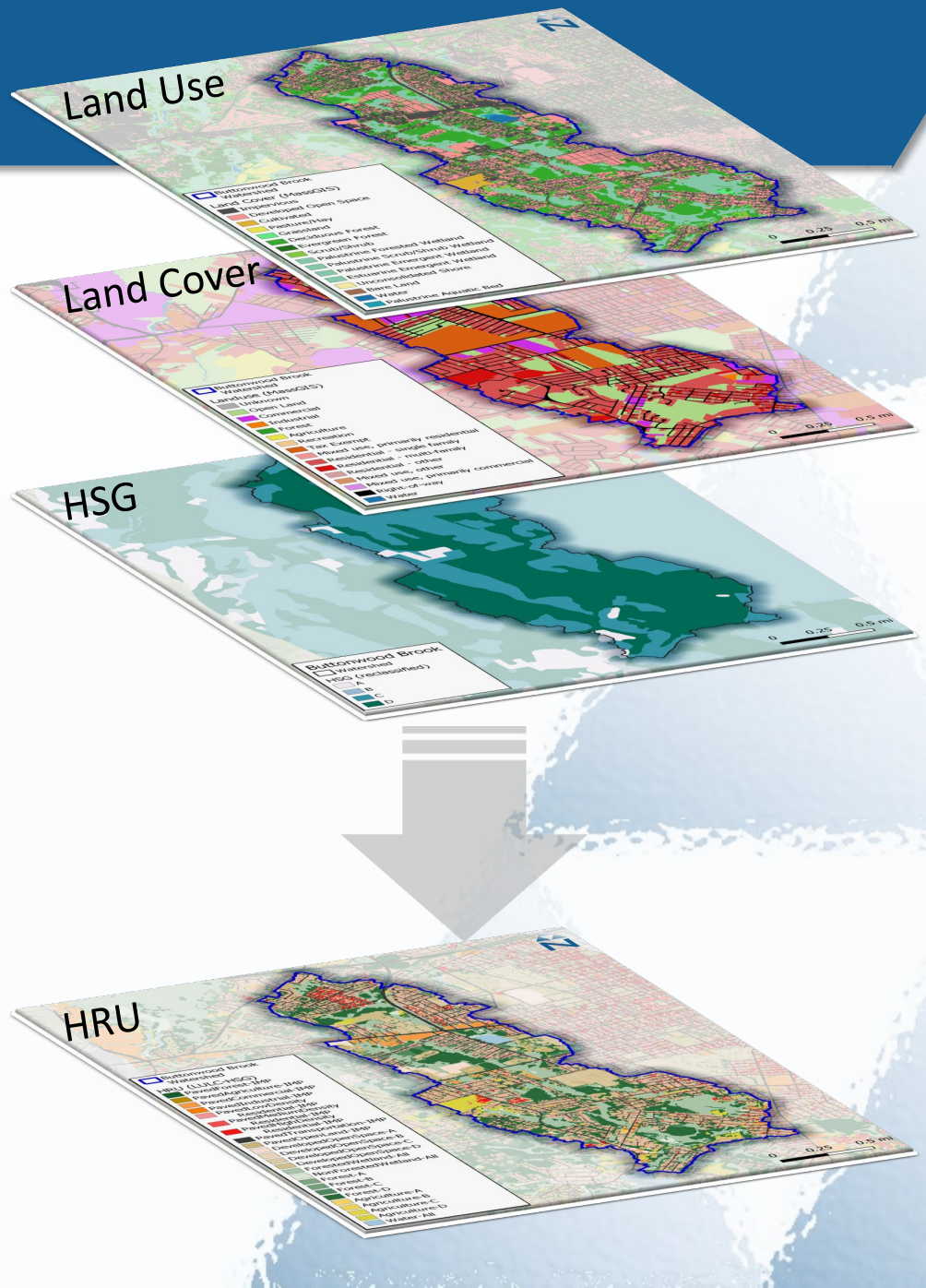
BMP Screening

Opti-Tool Optimization Engine

Suite of BMP Optimization Results

Hydrologic Response Units

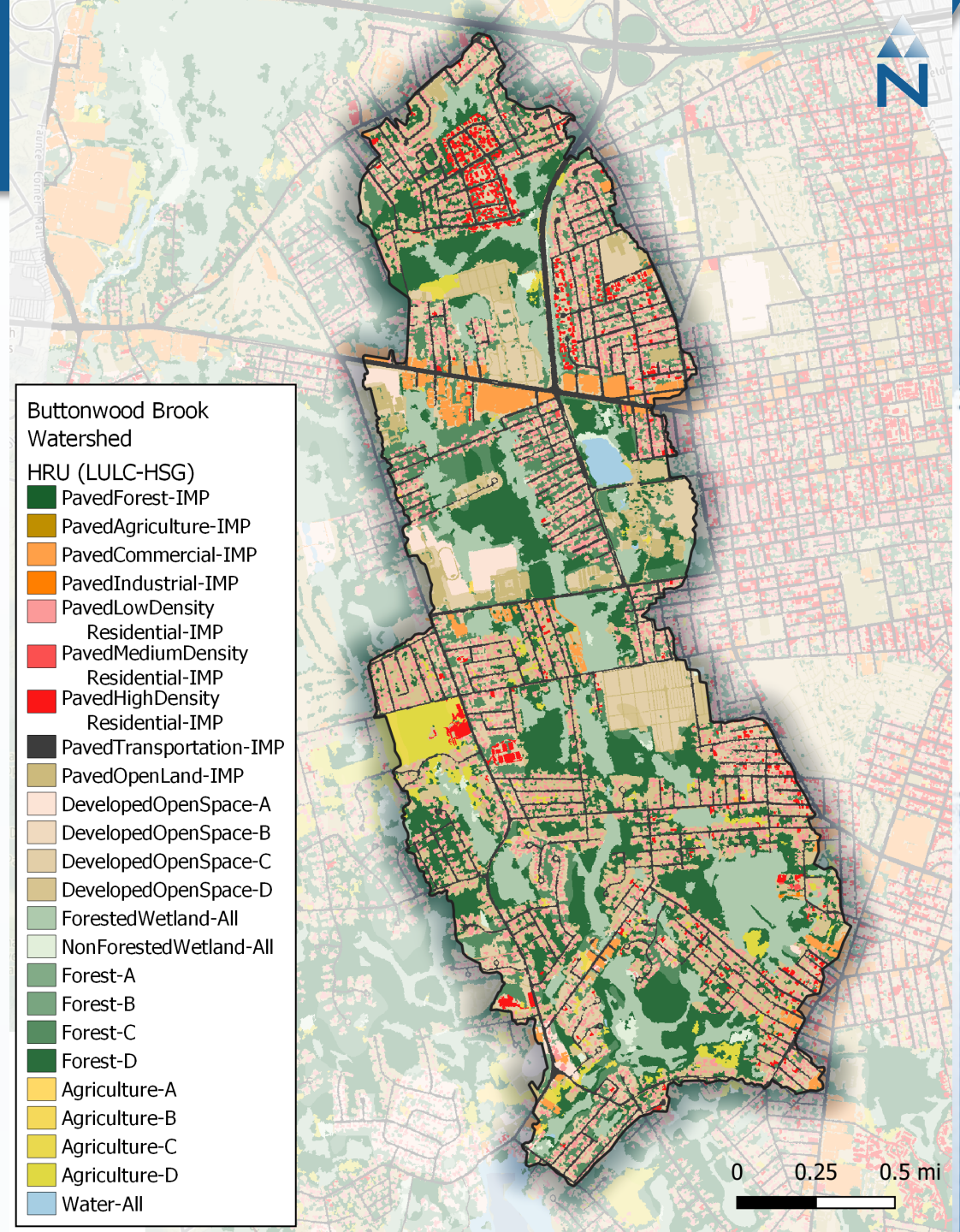
- Represents areas of similar physical characteristics attributable to core processes identified through GIS overlays
  - **Primarily land use – land cover (LULC) and hydrologic soil group (HSG)**
- All layers converted to 1-meter rasters
  - **Same extent and spatial alignment**
  - **Reclassified to appropriate categories consistent with the Opti-Tool**



HRUs

- Final HRU categories determined by unique combination of overlaid input layers
- 24 total:
  - **9 Impervious**
  - **14 Pervious stratified by HSG**
  - **1 Water**

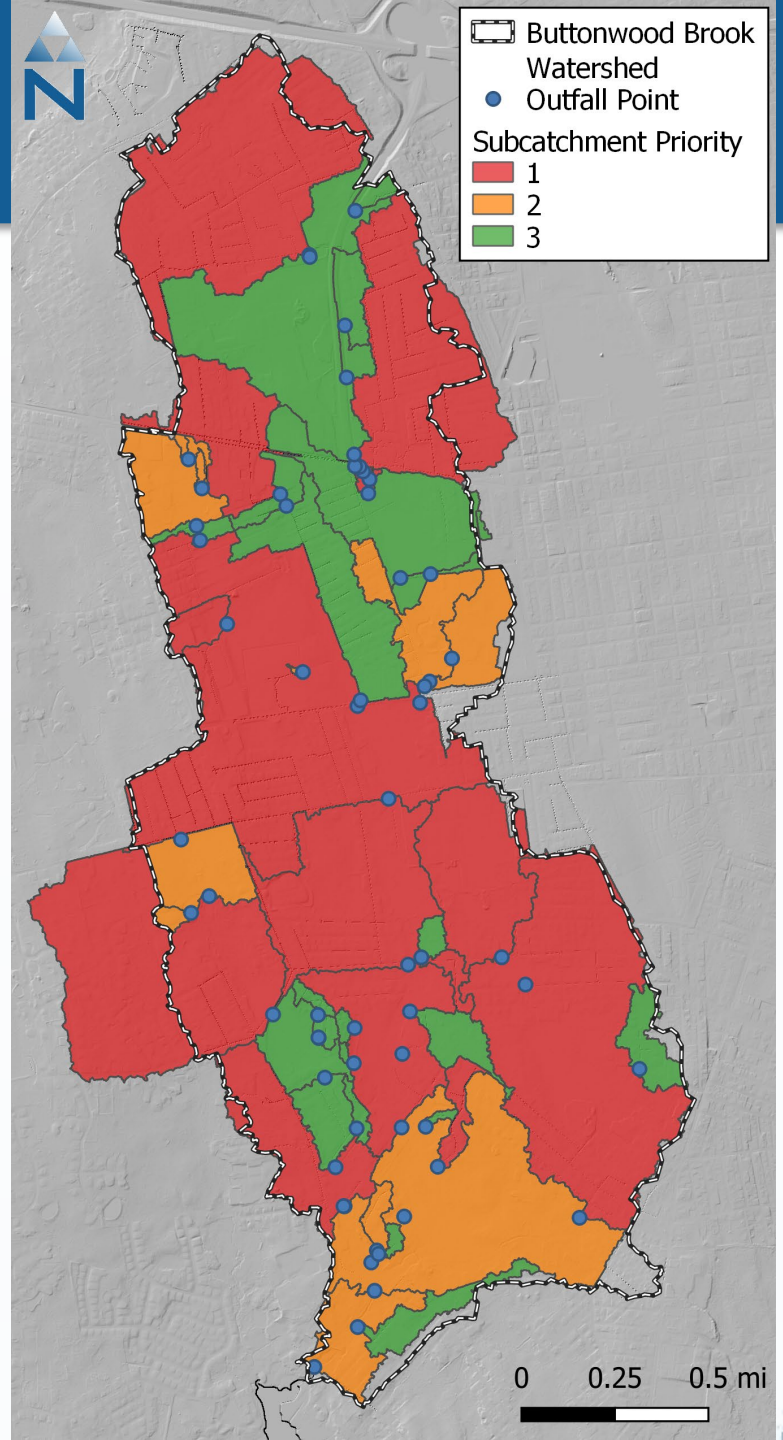
Major HRU Group	Area (ac)	Area (%)
Impervious	537.74	27.0%
DevelopedOpenSpace-A	26.17	1.3%
DevelopedOpenSpace-B	--	--
DevelopedOpenSpace-C	283.06	14.2%
DevelopedOpenSpace-D	249.16	12.5%
Forest	538.71	27.1%
Agriculture	57.80	2.9%
Wetland	288.30	14.5%
Water	10.48	0.5%
Total	**1,991.43**	**100%**

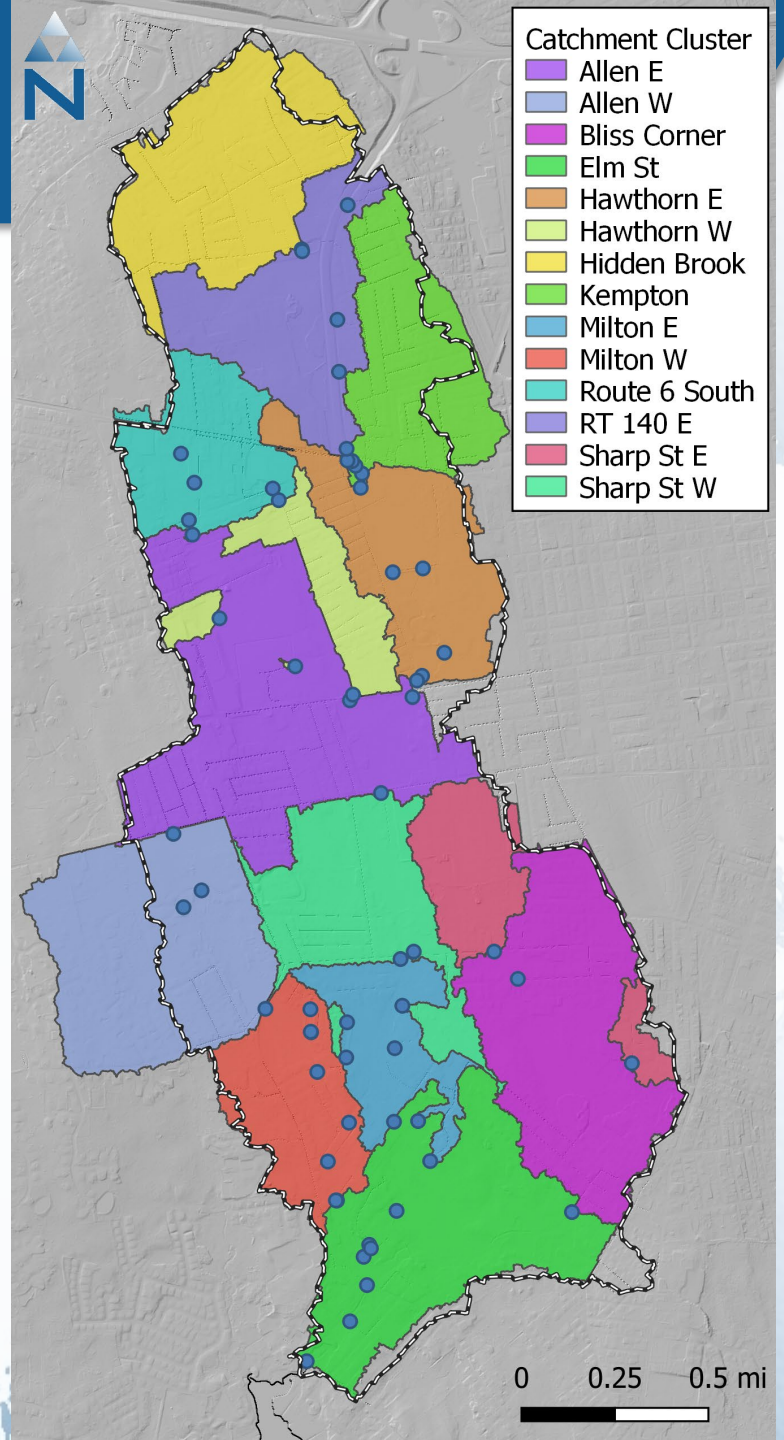


Catchment Delineation

GIS Processing

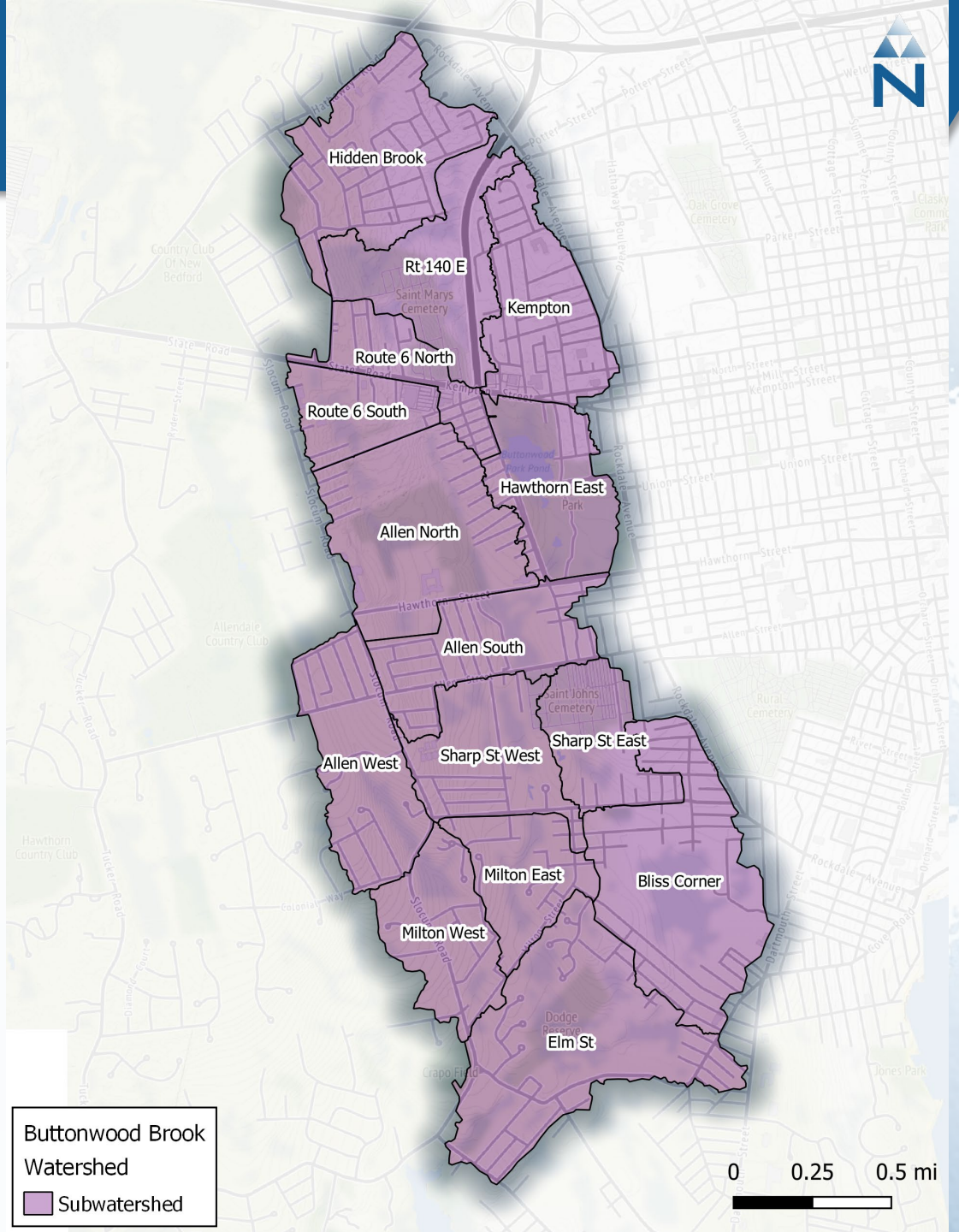
- High-resolution digital elevation model
- Stormwater pipe network
- 1 subcatchment delineated for each outfall point
- Subcatchments merged into 14 catchments
  - **Based on clusters provided by BBC**



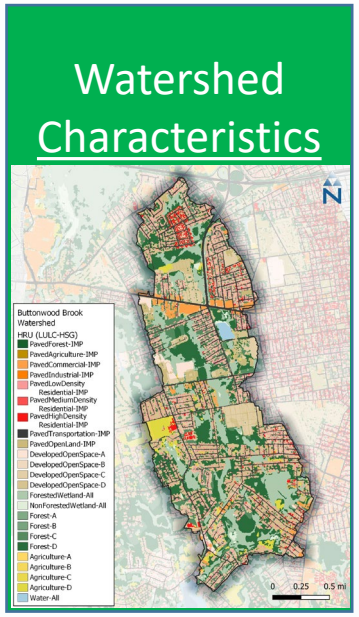


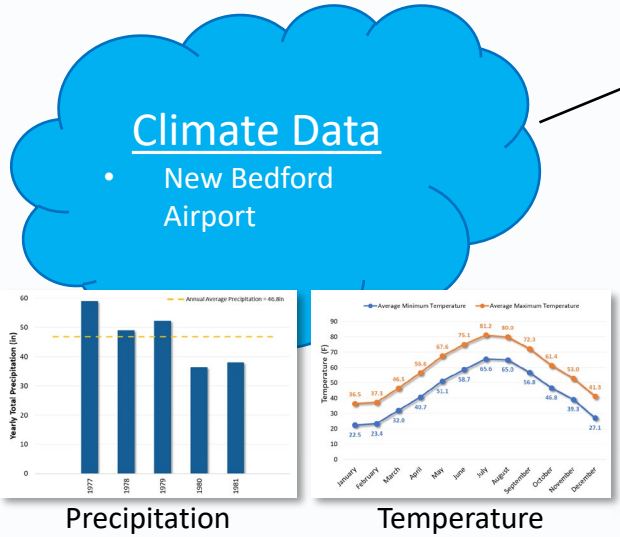
Final Delineated Subwatersheds

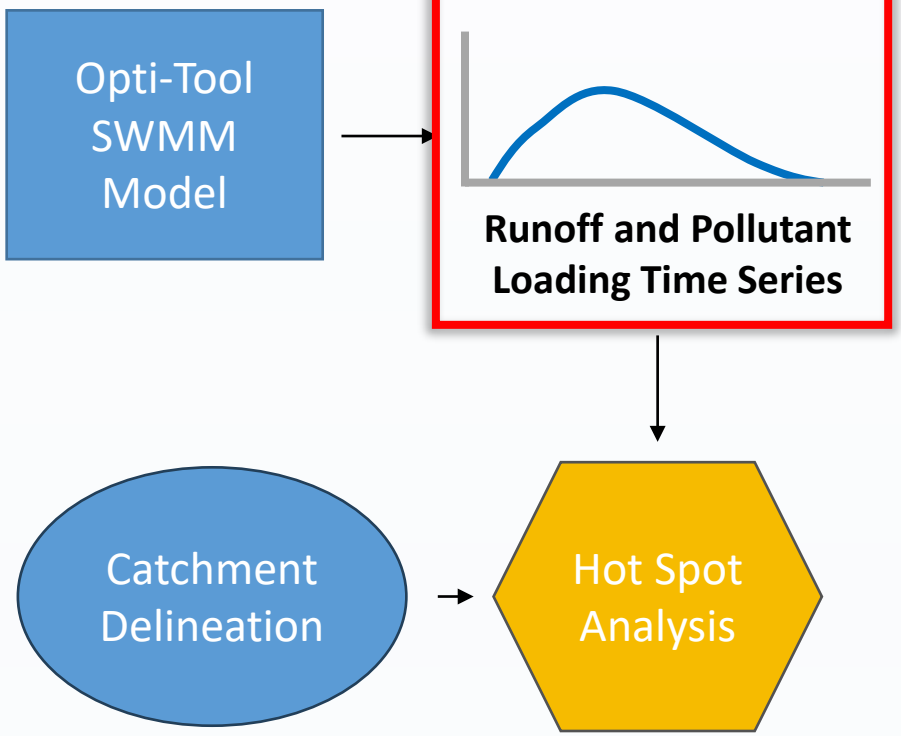
- QA/QC by BBC
  - **GIS and field verification**
  - **Manual edits to delineation**
- 15 subwatersheds



Unit Area Loading Analysis







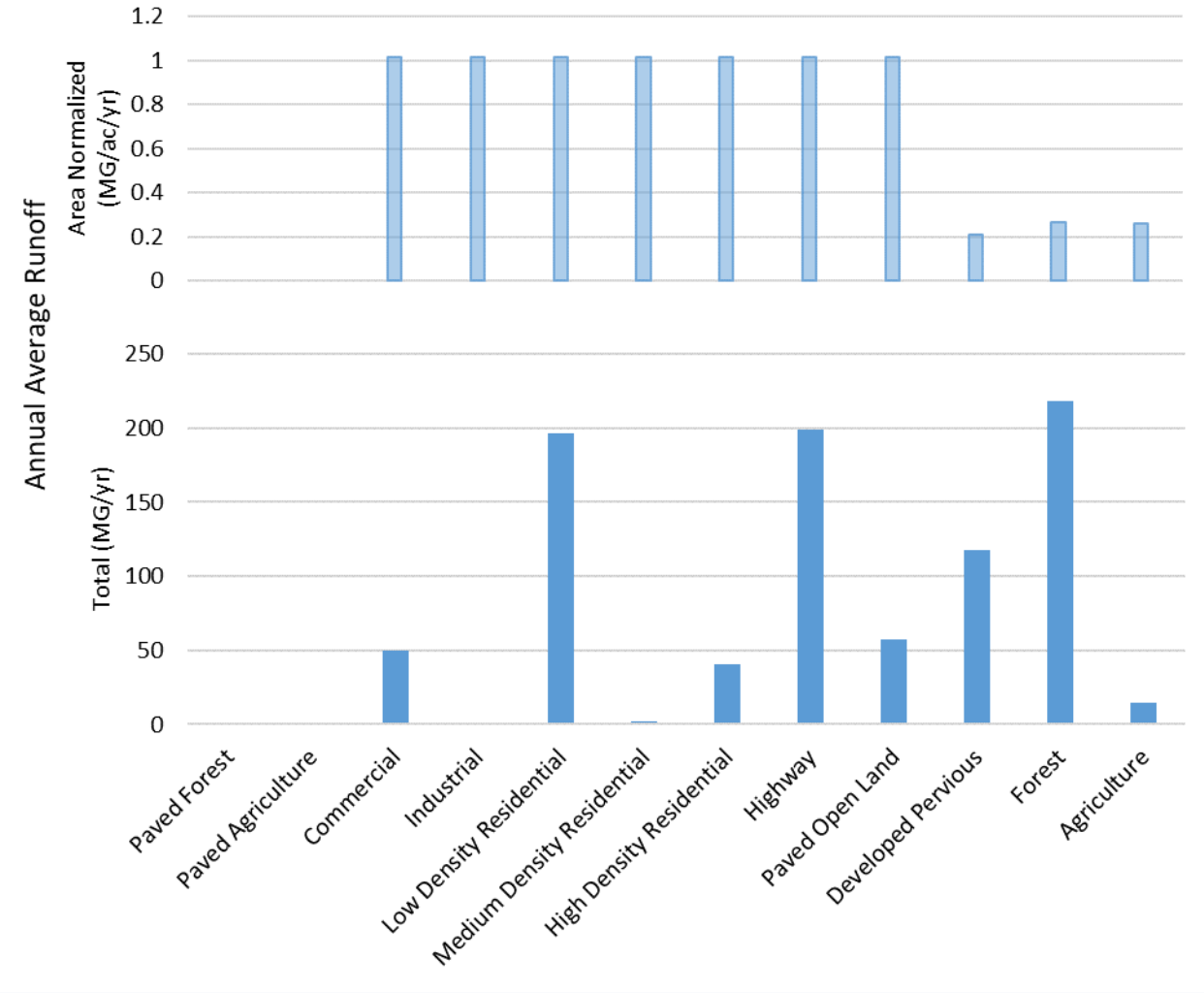
- Represents unattenuated, direct stormwater runoff and pollutant load
  - **Based on long–term continuous simulation**
  - **Useful for planning and prioritization purposes**
  - **Allows comparison of relative contributions from different source areas**

HRU and Loading Summaries

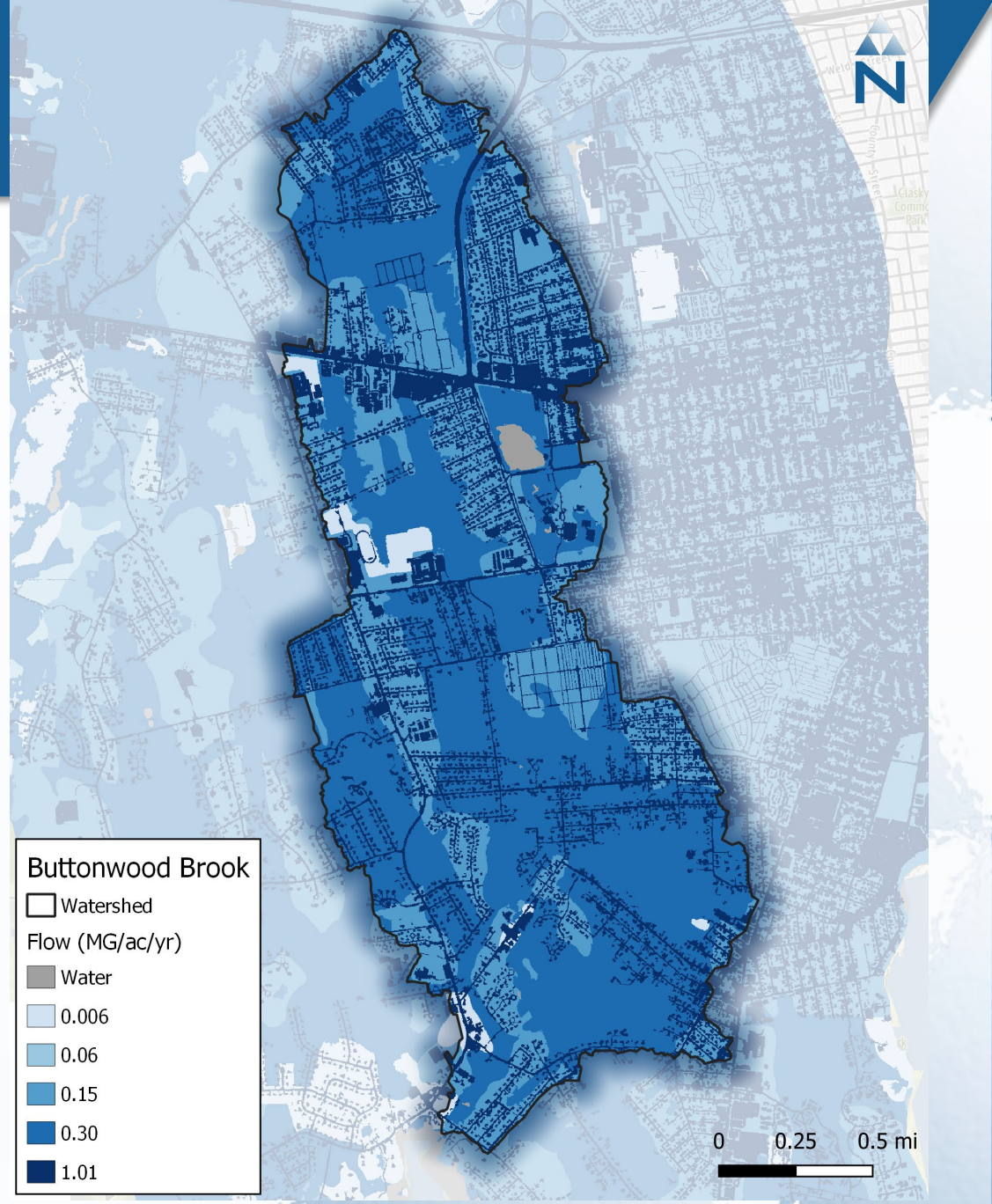
- Summary tables and maps for:
  - **Subwatersheds**
  - **Buttonwood Brook Watershed**

Mapped HRU	HRU Description	SWMM HRU	Flow (MG/ac/yr)	TP (lb/ac/yr)	TN (lb/ac/yr)	TSS (lb/ac/year)	E. coli (mpn/ac/yr)
1000	PavedForest-IMP	Forest_I	1.01	1.36	10.40	840.07	3.49E+11
2000	PavedAgriculture-IMP	Agriculture_I	1.01	1.36	10.40	840.07	1.38E+11
3000	PavedCommercial-IMP	Commercial_I	1.01	1.63	13.84	495.30	1.16E+10
4000	PavedIndustrial-IMP	**Commercial_I**	1.01	1.63	13.84	495.30	1.16E+10
5000	PavedLowDensityResidential-IMP	LowDensityRes_I	1.01	1.36	12.95	576.09	2.37E+12
6000	PavedMediumDensityResidential-IMP	MedDensityRes_I	1.01	1.78	12.95	576.09	2.37E+12
7000	PavedHighDensityResidential-IMP	HigDensityRes_I	1.01	2.15	12.95	576.09	2.37E+12
8000	PavedTransportation-IMP	Highway_I	1.01	1.26	9.34	1,942.54	2.77E+07
9000	PavedOpenLand-IMP	OpenSpace_I	1.01	1.36	10.40	840.07	3.49E+12
10100	DevelopedOpenSpace-A	Pervious_A	0.01	0.01	0.06	1.45	1.06E+10
10200	DevelopedOpenSpace-B	Pervious_B	0.06	0.08	0.77	19.15	2.27E+11
10300	DevelopedOpenSpace-C	Pervious_C	0.15	0.19	2.11	51.98	6.90E+11
10500	DevelopedOpenSpace-D	Pervious_D	0.30	0.36	3.64	91.29	1.29E+12
11000	ForestedWetland-All	**Forest_D**	0.30	0.36	1.90	91.29	1.29E+11
12000	NonForestedWetland-All	**Forest_D**	0.30	0.36	1.90	91.29	1.29E+11
13100	Forest-A	Forest_A	0.01	0.01	0.03	1.45	1.06E+09
13200	Forest-B	Forest_B	0.06	0.08	0.39	19.15	2.27E+10
13300	Forest-C	Forest_C	0.15	0.19	1.07	51.98	6.90E+10
13500	Forest-D	Forest_D	0.30	0.36	1.90	91.29	1.29E+11
14100	Agriculture-A	Agriculture_A	0.01	0.02	0.13	1.45	4.21E+08
14200	Agriculture-B	Agriculture_B	0.06	0.29	1.70	19.15	8.99E+09
14300	Agriculture-C	Agriculture_C	0.15	0.70	4.64	51.98	2.74E+10
14500	Agriculture-D	Agriculture_D	0.30	1.36	7.90	91.29	5.11E+10
15000	Water-All	NA	--	--	--	--	--

Stormwater Runoff

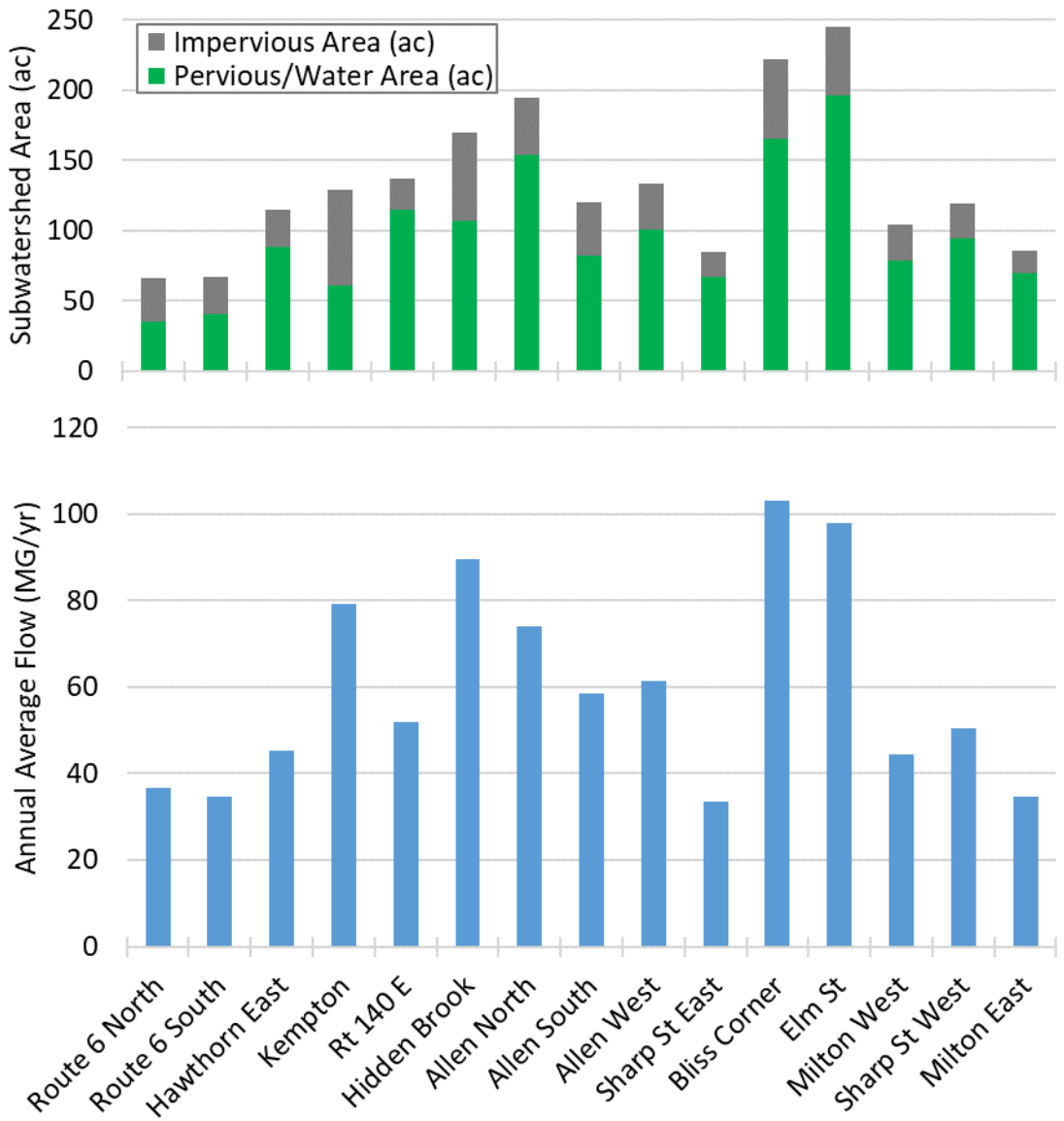


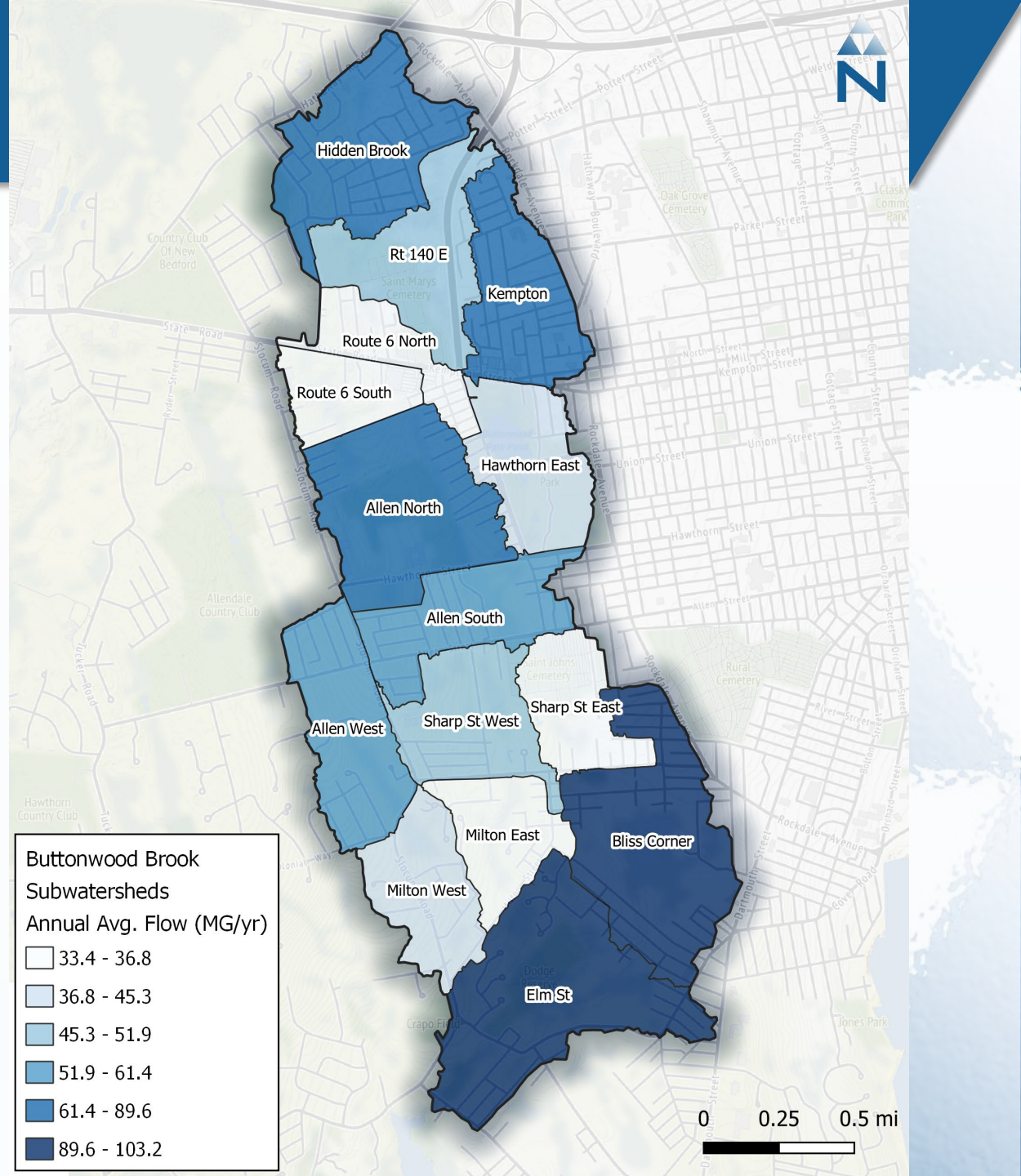
Runoff by HRU Group (pervious HRUs aggregated for all HSGs)



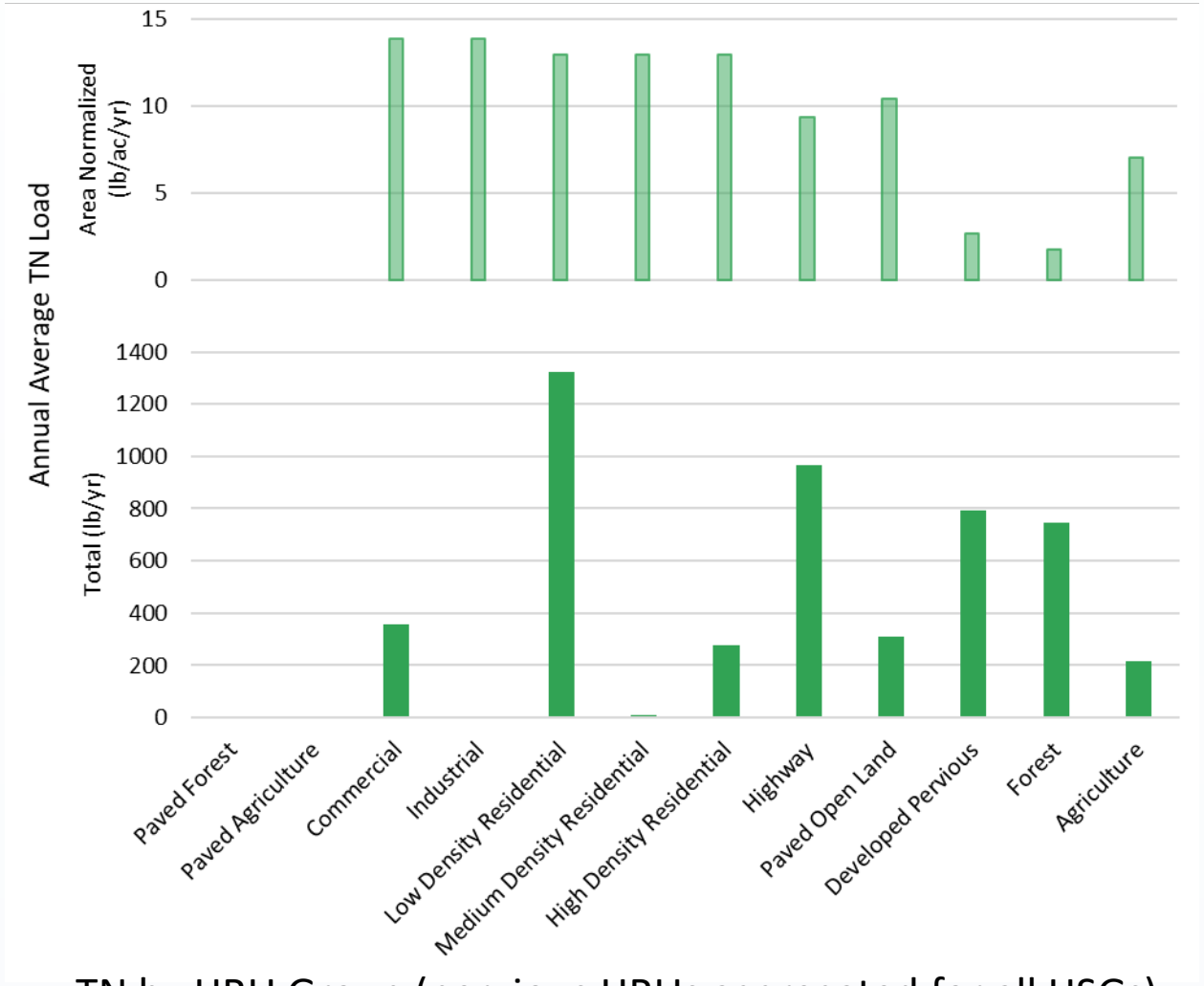
Unit area hotspot map

Flow Total by Subwatershed

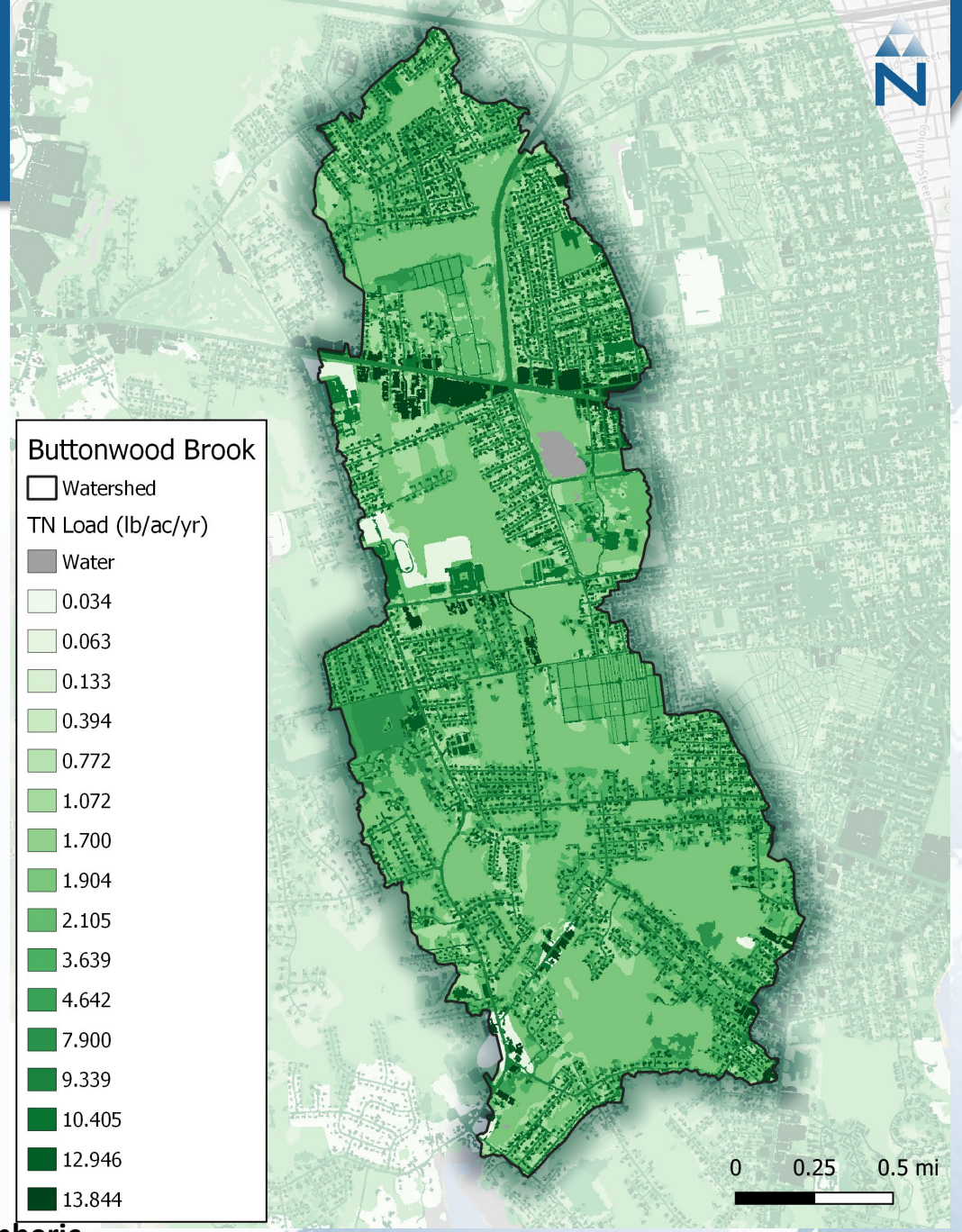




Total Nitrogen (TN)



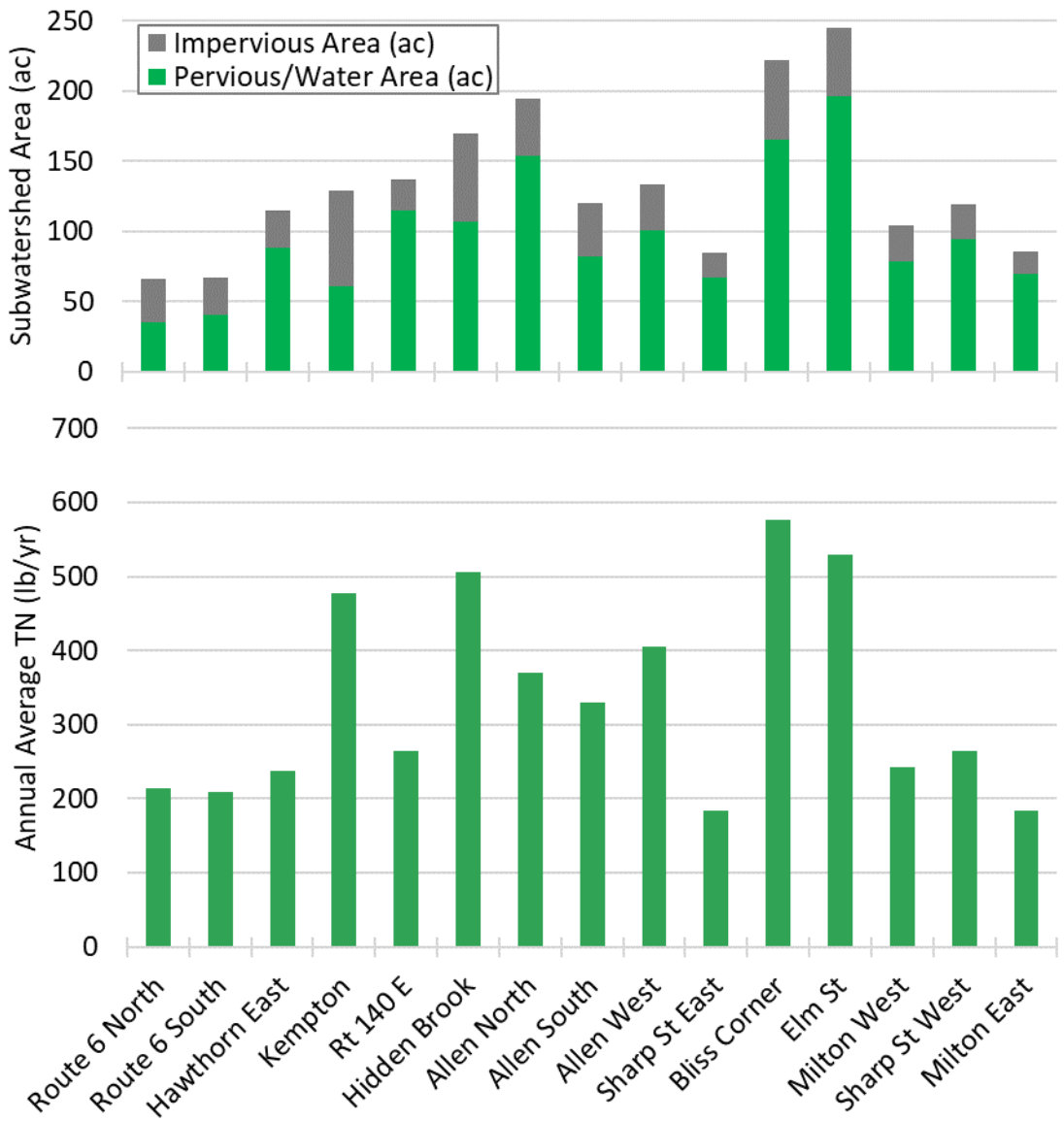
TN by HRU Group (pervious HRUs aggregated for all HSGs)

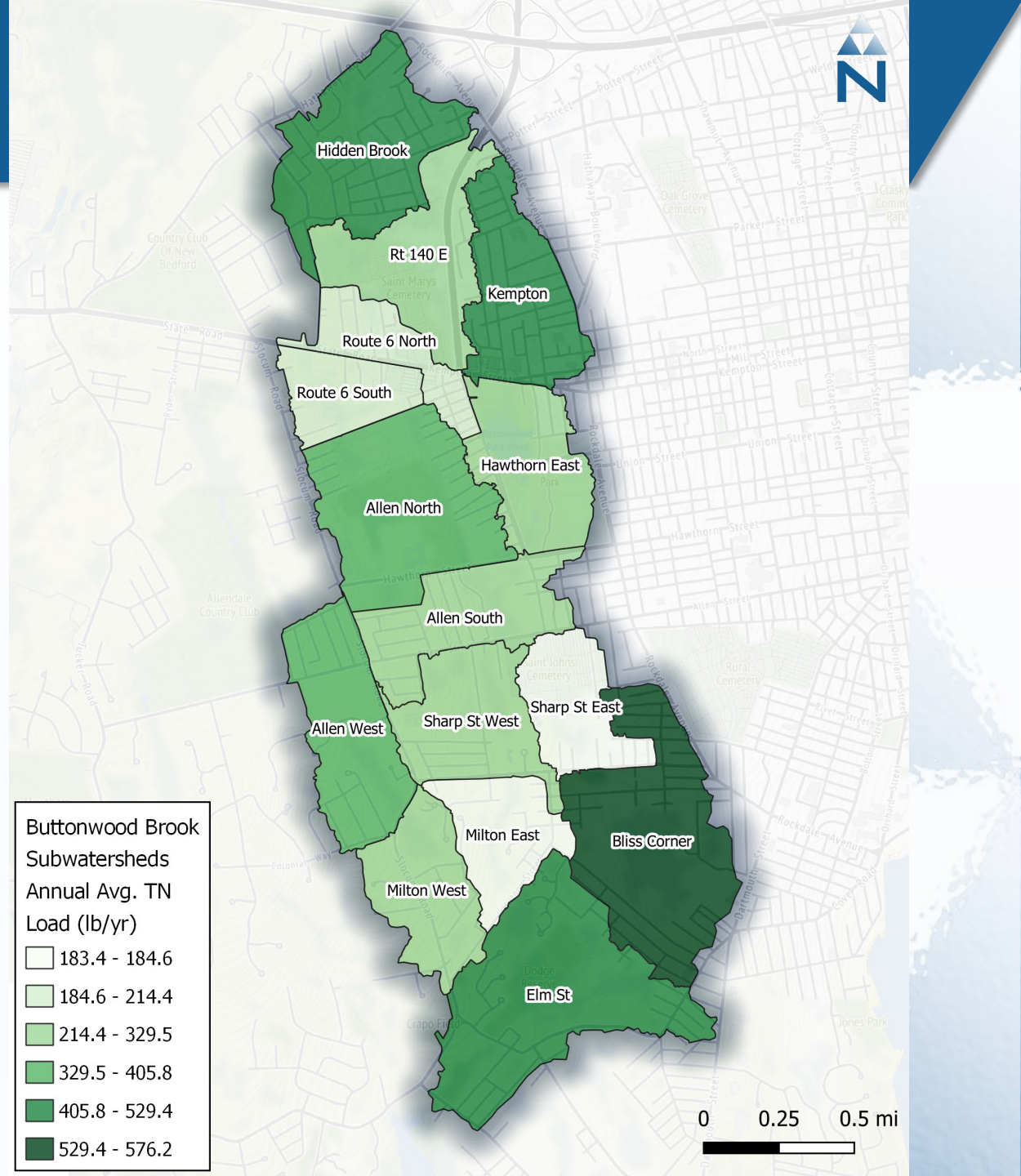


Unit area hotspot map

*** These are unattenuated values that may by lower than shown due to reductions in atmospheric deposition, however relative differences between loading rates would remain constant**

TN Total by Subwatershed





Summary

- HRUs were created for the Buttonwood Brook Watershed consistent with the U.S. EPA Opti-Tool and represent the non-point sources for stormwater runoff and pollutant loads
- Subwatersheds were delineated from high-resolution LiDAR datasets
  - Final subwatersheds developed through field verification by BBC
- Unit area flow and pollutant loading rates were created using the Opti-Tool SWMM model and local meteorological datasets
  - Represent the unattenuated loads at the source level and do not account for any delivery loss due to existing interventions (e.g., LID, downspout disconnection, run-on from IC to pervious cover)
- HRU/Loading summaries and maps were created to aid hot spot analysis and planning efforts

Site Prioritization Framework

Danica Belknap

Environmental Planning Manager

SRPEDD

Project Feasibility			Habitat Potential				Climate Resilience & Co-benefits				
...ated ...t Cost	Maintenance Burden	TOTAL PROJECT FEASIBILITY SCORE	Wetland Function-Connectivity	Habitat Restoration Opportunity	Groundwater Recharge Potential	TOTAL HABITAT POTENTIAL SCORE	Environmental Justice	Community Priority	Climate Adaptation - Resilience	TOTAL CLIMATE RESILIENCE CO-BENEFITS SCORE	OVERALL SCORE
2	2	5	3	3	2	7	3	2	3	8	39
1	1	4	0	2	3	5	3	3	3	9	37
3	3	9	1	3	1	5	3	2	1	6	36
2	1	6	3	3	0	6	2	2	2	6	33.5
1	2	5	2	3	1	6	2	2	1	5	33
1	2	4	3	3	2	8	1	1	2	4	33
2	2	6	0	2	2	4	2	2	1	5	32.5
1	2	5	2	3	1	6	1	1	2	4	32
3	2	8	1	3	1	5	1	2	1	4	32
1	2	4	3	2	1	6	1	1	2	4	32
1	2	4	3	2	2	7	1	1	2	4	32
1	1	3	3	2	1	6	2	2	2	6	31.5
3	2	8	1	2	1	4	1	2	1	4	31
1	1	4	0	0	2	2	3	2	2	7	30.5
2	2	6	0	2	1	3	3	3	1	7	30
2	2	6	2	2	0	4	1	2	2	5	29.5
1	2	4	3	2	1	6	1	1	2	4	29
2	2	6	3	3	2	8	1	1	2	4	28
1	2	5	0	2	1	3	3	3	1	7	28
2	1	5	0	1	2	3	1	2	2	5	28
2	1	5	0	1	1	2	2	2	2	6	28
3	2	8	0	1	0	1	1	2	2	5	27.5
1	2	4	0	1	0	1	2	3	1	6	27.5
2	2	6	2	2	1	5	1	2	2	5	27.5
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1	2	5	1	3	1	5	1	1	2	4	27
2	2	6	0	1	2	3	1	1	1	3	26.5
2	3	7	1	0	0	1	2	2	3	7	26.5
1	3	6	3	1	0	4	1	2	3	6	26.5
2	1	5	0	1	1	2	1	1	2	4	26
3	3	9	0	1	1	2	1	1	1	3	25.5
1	1	3	0	1	2	3	1	2	1	4	25
2	1	5	0	1	1	2	1	1	1	3	25
2	1	5	0	1	2	3	1	1	1	3	25
2	1	5	0	1	2	3	1	1	1	3	24.5
2	2	7	0	1	2	3	1	1	2	4	24
1	1	4	0	2	2	4	1	1	2	4	24
2	2	7	0	1	1	2	1	1	1	3	24
2	2	6	2	2	0	4	1	1	2	4	24

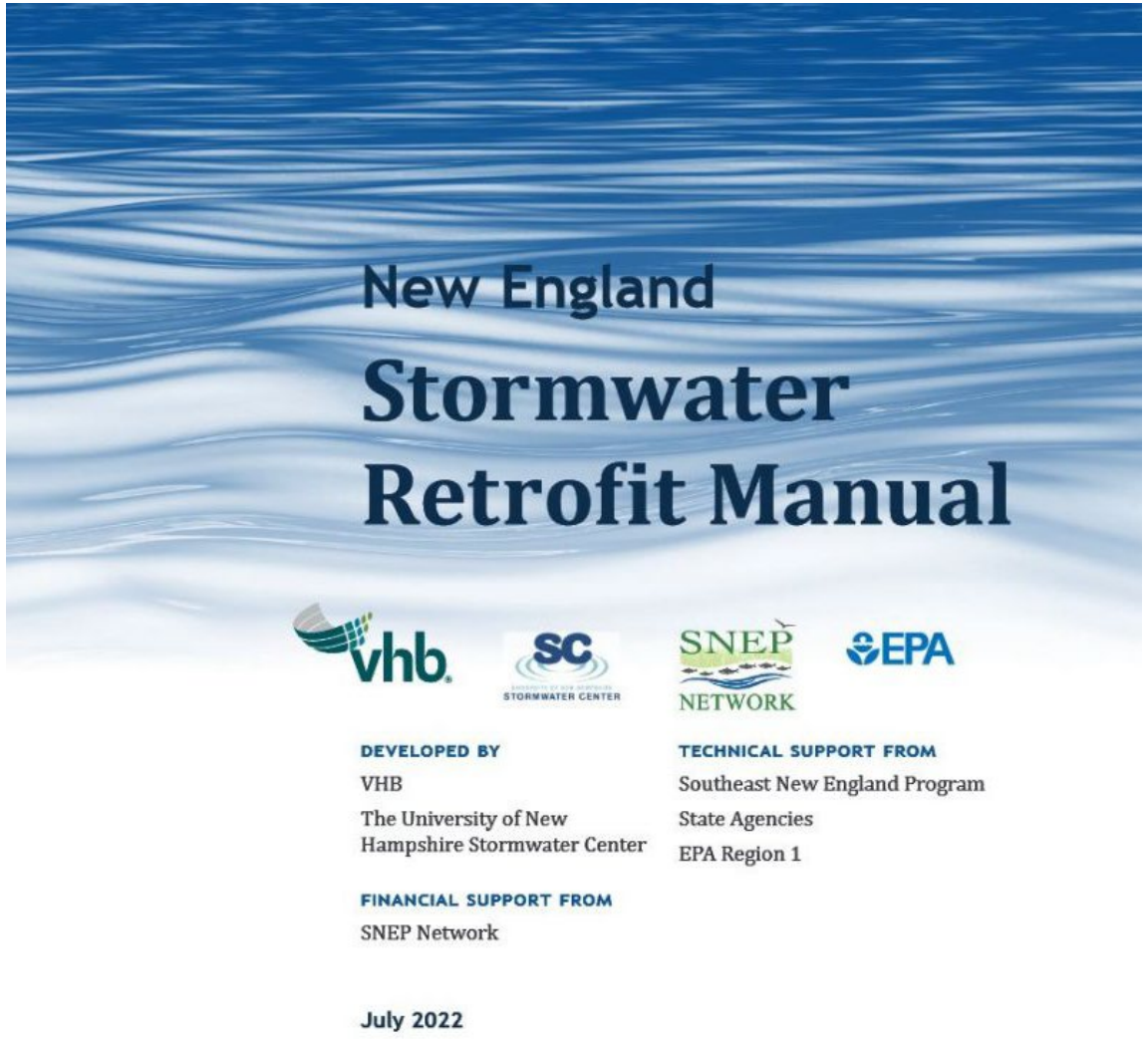
Pick the right technique for the right site & problem

Stormwater Control Measures, SCMs (AKA Best Management Practices, BMPs):

- Structures or systems that capture and remove pollutants from stormwater runoff
- Examples: detention ponds, bioretention basin, permeable pavement, gravel wetland…
- Come in many types & sizes to fit any situation / site

Learn more about SCM options at:

https://snepnetwork.org/stormwater-retrofit-manual/



Site Suitability Considerations

Topography & hydrology

- How is the slope controlling runoff? Use gravity to your advantage!
- Does soil infiltrate water?
- What is the depth to bedrock? Groundwater?
- What is the overall area available for your SCM?

Ownership

- Is the site owned by the municipality or project proponent?
- If not, is the owner a willing partner?

Infrastructure & other constraints

- Are there underground utilities on site? Any other buried pipes or infrastructure?
- Is the site in a sensitive groundwater area (aquifer / drinking water supply area)?
- What are the regulatory / zoning setback requirements? Is there existing infrastructure to avoid?

Project Feasibility Considerations

SCM compatibility

- Can the site accommodate the desired SCM?
- Will the SCM interfere with other uses of the site?
- Permitting constraints?

Estimated project costs

- Are construction costs prohibitive? Are the benefits worth the costs?
- Can you take advantage of already planned site work to reduce costs?

Maintenance burden

- Do you have the capacity, expertise and equipment to perform the necessary maintenance for the selected SCM?
- Is there suitable site access for the required maintenance & associated equipment?







Green Infrastructure

Nature-based SCMs provide co-benefits!

- Habitat for birds, pollinators, other wildlife
- Green space, streetscape improvements
- Flood capture / storage
- Neighborhood cooling, storm protection

What Co-Benefits Will the Project Provide?

Water quality (pollutant reduction potential)

- How well will the SCM reduce your pollutant of concern?
- How well will the SCM reduce the volume of stormwater entering nearby waterways?
- Is the site located within a pollutant loading “hot spot” area?

Habitat potential

- Can the project improve or provide wildlife habitat (particularly in urban areas)?
- Will the SCM increase groundwater recharge in highly developed areas?
- Will the project restore or improve functionality of wetlands? Will it help connect wetlands?

Climate resiliency & other community co-benefits

- Will the project provide social, environmental or health benefits in an area otherwise lacking greenspace?
- Will the project provide benefits to an EJ or other priority community?
- Will the project improve a priority site for the local community?

Site	SCM Option(s)	Site Suitability				Habitat Potential				Climate Resilience & Co-benefits				OVERALL SCORE
		Topography & Hydrology	Ownership	Existing Infrastructure	TOTAL SITE SUITABILITY SCORE	Wetland Function-Connectivity	Habitat Restoration Opportunity	Groundwater Recharge Potential	TOTAL HABITAT POTENTIAL SCORE	Environmental Justice	Community Priority	Climate Adaptation - Resilience	TOTAL CLIMATE RESILIENCE CO-BENEFITS SCORE	
Hidden Brook Wetland Restoration		3	1	3	7	3	3	2	7	3	2	3	8	39
Kempton Corridor NB Distributed BMP		2	3	2	7	0	2	3	5	3	3	3	9	37
Hidden Brook Outfall Remediation		3	1	3	7	1	3	1	5	3	2	1	6	36
Buttonwood Pond Wetland Restoration		3	3	2	8	3	3	0	6	2	2	2	6	33.5
Buttonwood Zoo Channel Restoration		3	3	2	8	2	3	1	6	2	2	1	5	33
Hawthorn-Allen Wetland Restoration		2	1	2	5	3	3	2	8	1	1	2	4	33
Buttonwood Zoo Surface Runoff		2	3	2	7	0	2	2	4	2	2	1	5	32.5

Site Prioritization Tool

- Excel-based scoring tool for comparing sites & SCMs
- Assign a score for each consideration
- Customize criteria and category weights
- Rank sites by total score

Access tool and additional stormwater planning resources at : https://snepnetwork.org/network-resources/

Data Collection

Before scoring, gather the following data, preferably in GIS or MassMapper

**Confirm site details before moving forward with a project*



Property tax parcels (for ownership) – MassGIS



1 ft elevation contours - MassGIS



NRCS SSURGO-Certified Top 20 soils data: hydrologic soil group, depth the water table - MassGIS



Land cover – MassGIS



Utility infrastructure – municipal survey data or utility companies



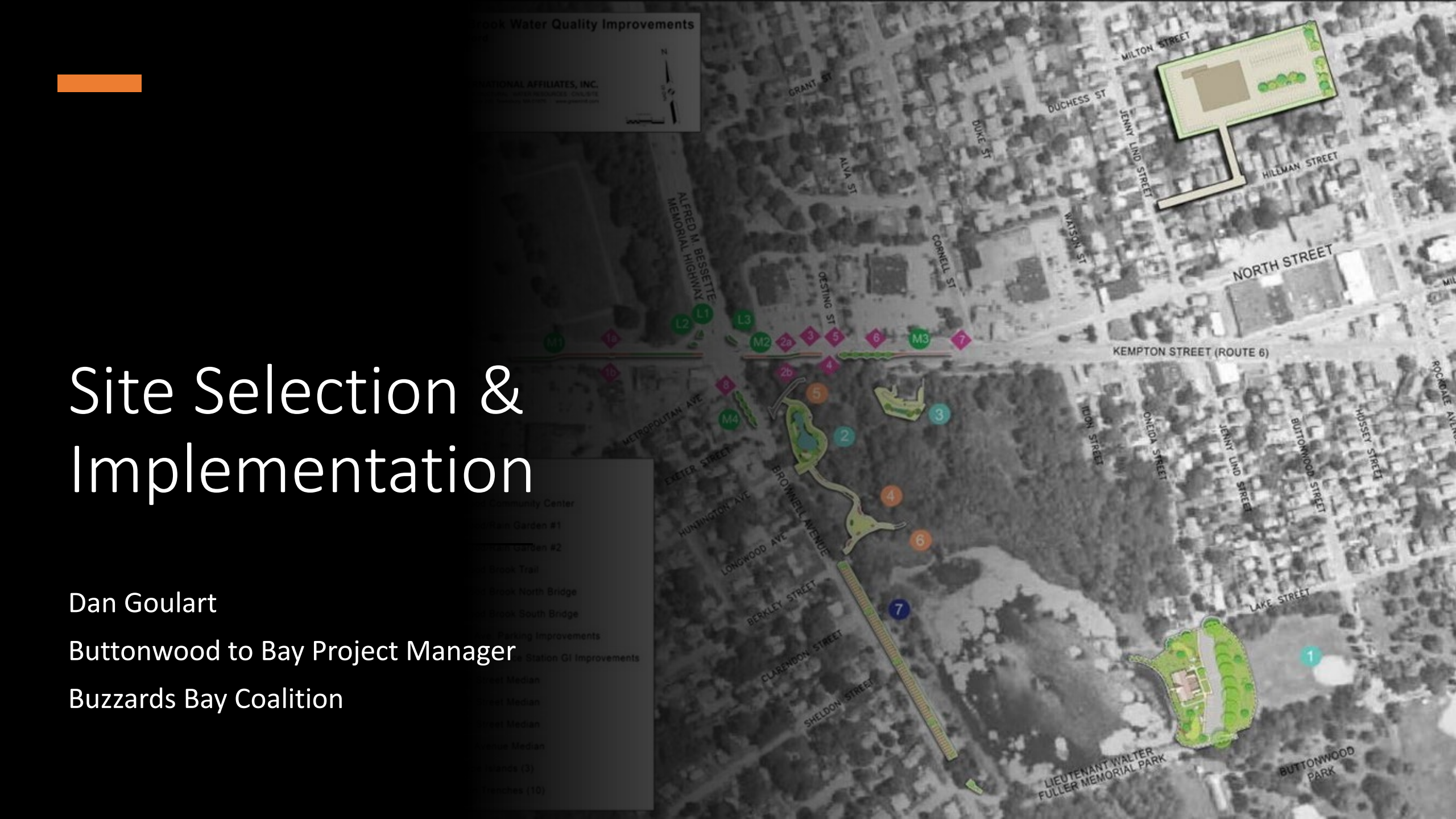
MassDEP Wellhead Protection Areas, Surface Water Supply Protection Areas - MassGIS

Site Selection & Implementation

Dan Goulart

Buttonwood to Bay Project Manager

Buzzards Bay Coalition



Watershed Assessment

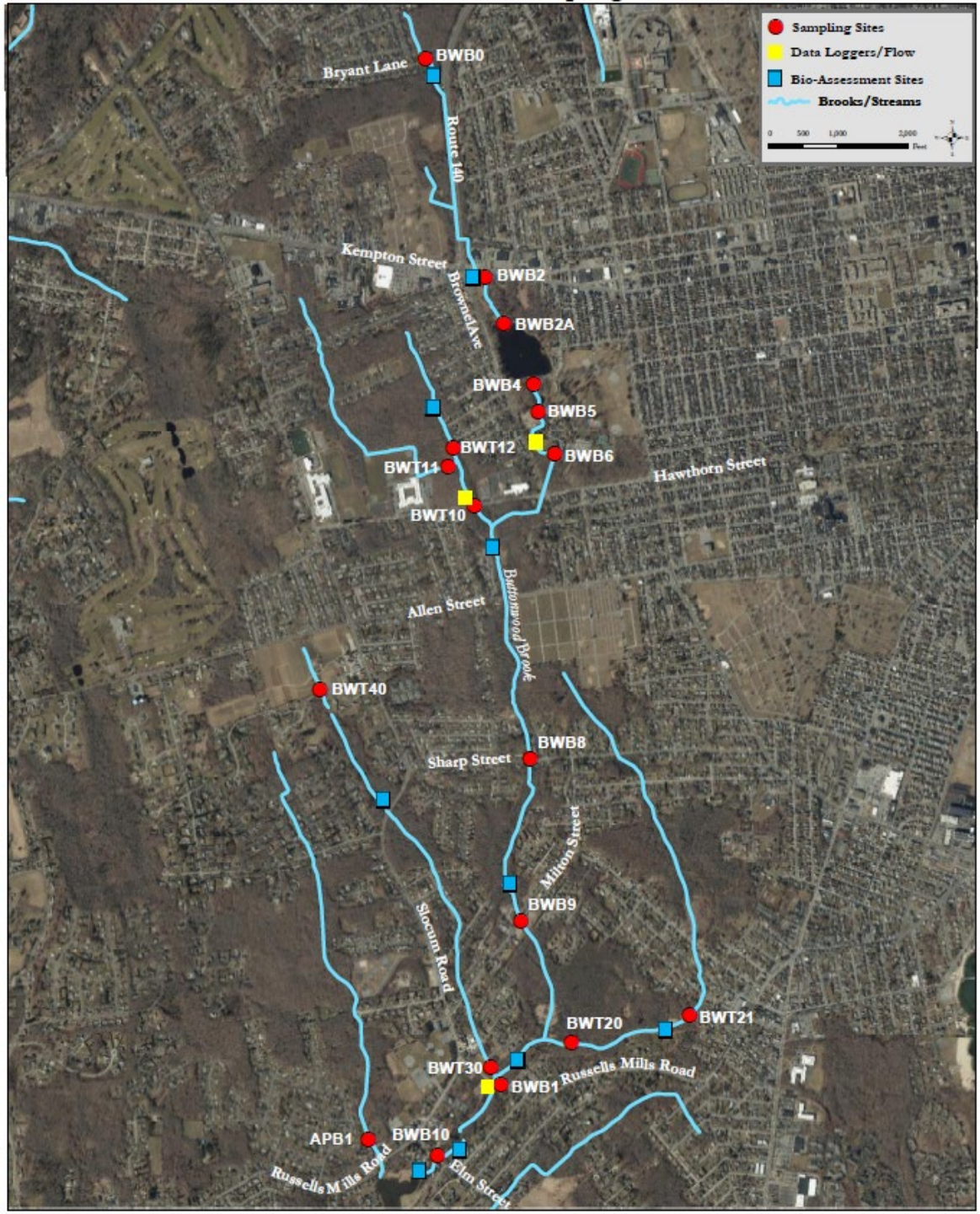
<u>Buttonwood Brook</u>

18-month adaptive testing program to characterize water quality and identify pollution sources

- Land Use Analysis and Pollutant Modeling
- Data Loggers: Conductivity & Hydraulics
- Discharge Measurements at Logger sites
- Ability to Model Annual Flow and Loading
- Dimensional Analysis at 42 sites
- Habitat and Bio-Assessment at 10 sites

<u>Apponagansett Bay</u>

- Data sensors deployed at 4 sites
- Baywatchers Sampling at 6 sites



Buttonwood Site Selection Process

Stream Walks
Stream Visual Protocol
Historical Studies and Data
Partner-Stakeholder Inputs

Water Quality Sampling
Data Logger Deployments
Discharge Measurements
GIS Mapping (Sewer & SW)
SNEP Site Matrix

Macro-Invertebrate and Habitat Assessment
Pollutant Load Modeling Study

Tighe&Bond



Ecological Restoration
Vs.
Green Infrastructure

Top Sites Vetted

Watershed Scale Analysis
Refined Ranking Criteria
Stream Dimensional Analysis
Engineer Field Surveys
Cost-Benefit Analysis

buzzards BAY COALITION

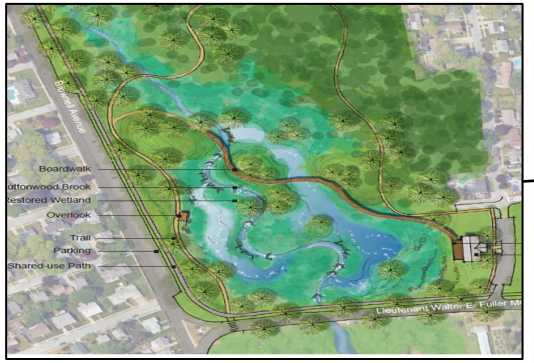
Current Projects

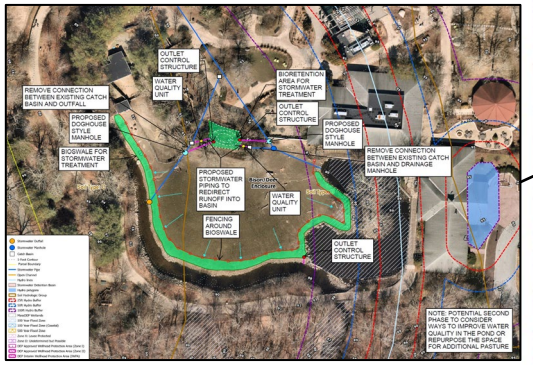
- Kempton Stormwater Remediation
- Buttonwood Pond Dam Removal
- Zoo Stormwater Remediation
- Lower Buttonwood Dams-Culverts
- Septic to Sewer incentive

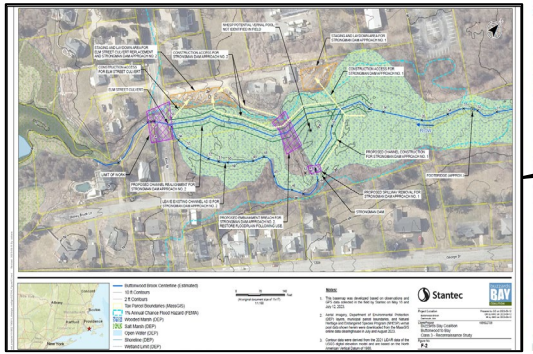
Key Takeaways

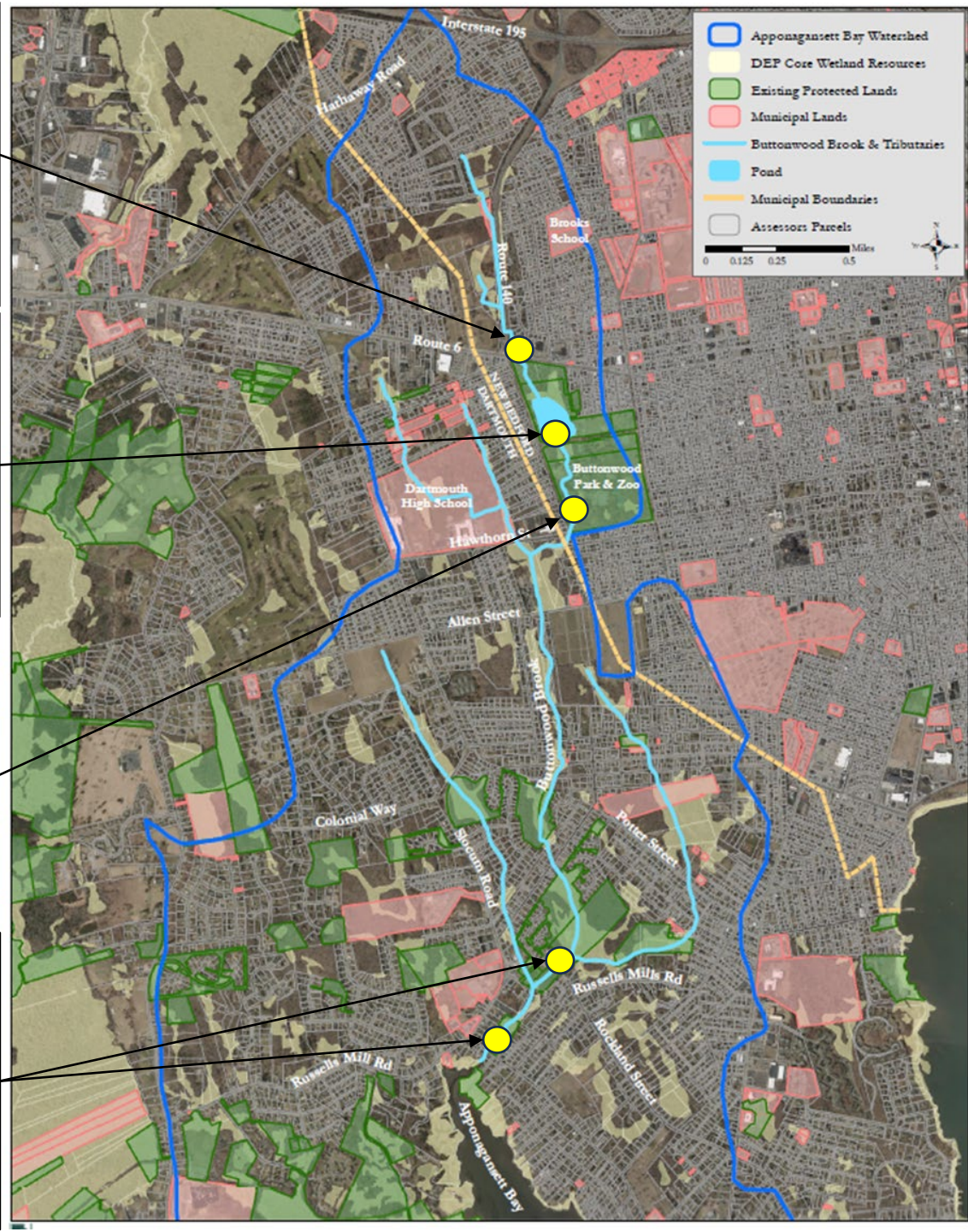
- Looking at an entire watershed and prioritizing sites is difficult
- Multiple criteria and equities to consider and weight
- Loading analysis complemented our sampling and helped prioritize sites
- Enabled deeper engagement with municipalities and stakeholders
- Increased motivation to apply for grant funding and take action
- Still a few gaps for the model













Thank you!

Any Questions?