

# GSI Trends and Challenges in the United States: National to Local



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# Philadelphia GSI efforts

## Philadelphia Water Department

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Reveal banner highlights

YOUR WATERSHED

WATERSHED ISSUES

WHAT WE'RE DOING

WHAT'S IN IT FOR YOU

## Green City, Clean Waters

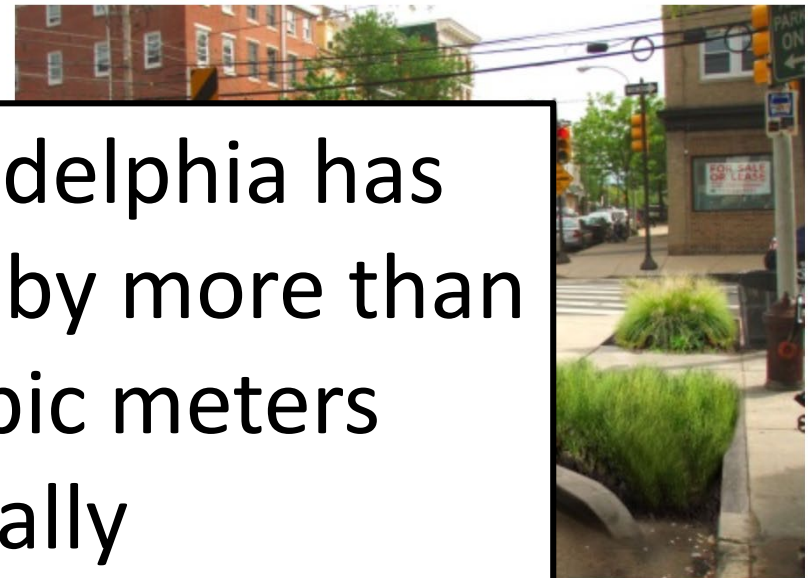
Green City, Clean Waters is currently entering our construction phase. Infrastructure.

Green City, Clean Waters is slowing, filtering, and collecting stormwater in Philadelphia. Green roofs, schools, parks, and public spaces are currently funneling stormwater into the ground, reducing the stormwater runoff.

That means rivers and streams are not overflowing, even in the heaviest rain.

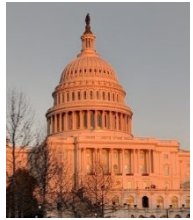
Since Green City, Clean Waters began, private developers have

To date, Philadelphia has reduced runoff by more than 600,000 cubic meters annually

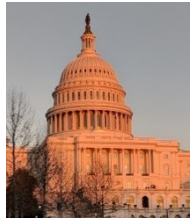


<https://e360.yale.edu/features/with-a-green-makeover-philadelphia-tackles-its-stormwater-problem>

# Washington, D.C.



# Washington, D.C.

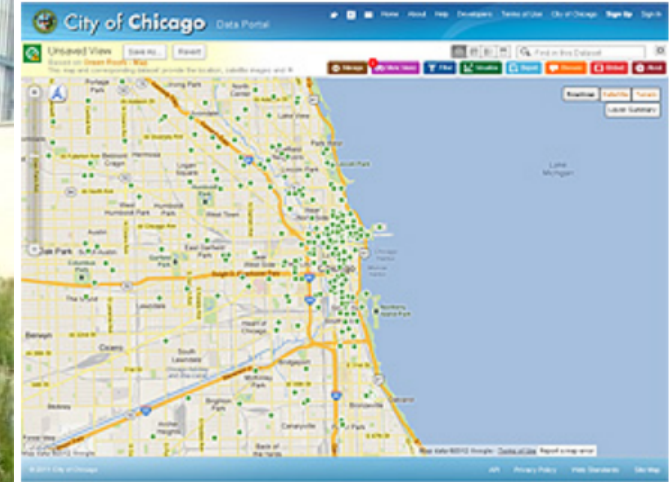


# StormCrete in New York City

- Modular, pre-cast pervious concrete



# Chicago Green Roofs



[View the map.](#)

- Over 500,000 square meters of green roofs installed!!

# New Haven, CT

- Major bioswale effort underway



# UConn rain garden at dorm





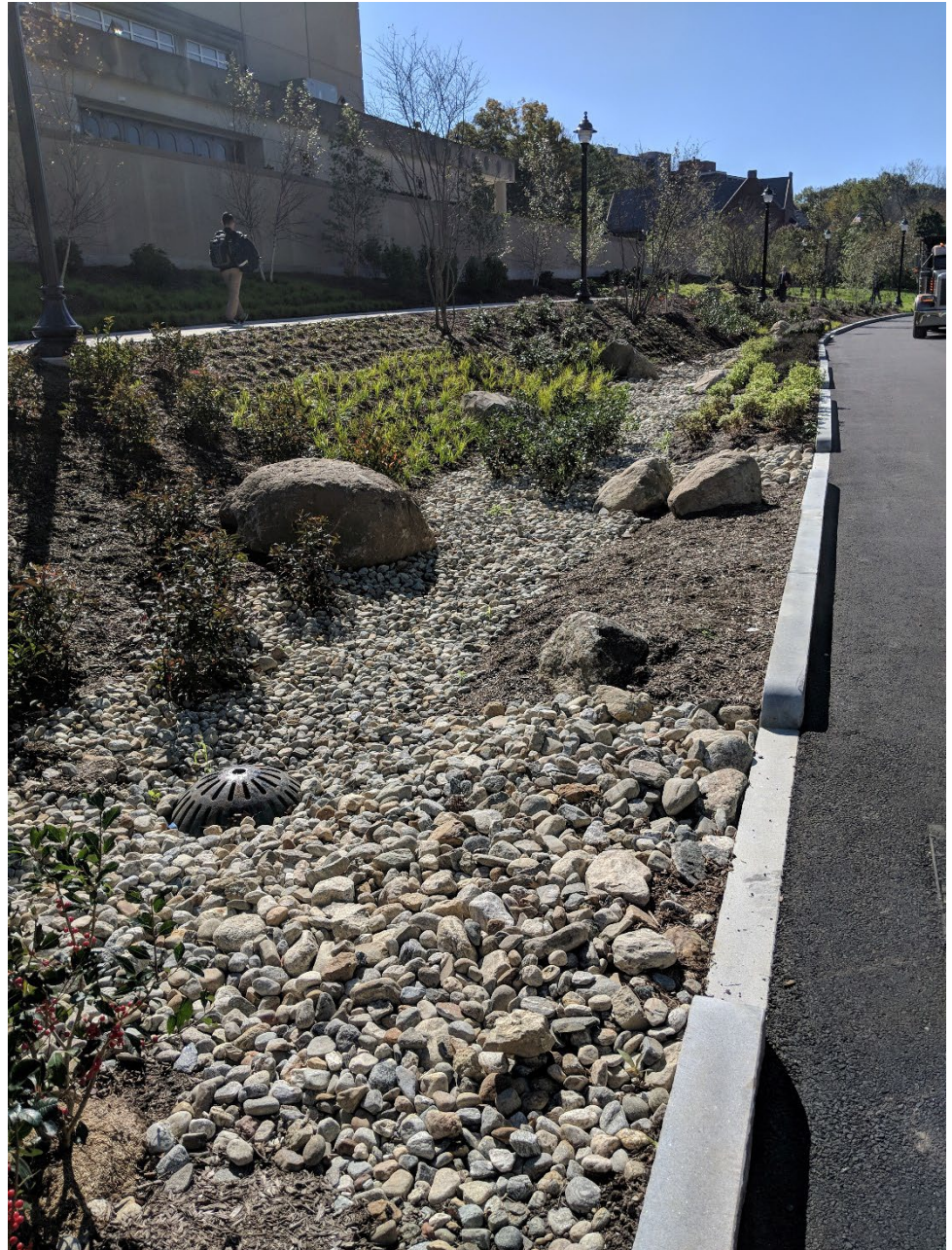


# Bioretention at UConn

- Linear bioswale in parking lot



# Bioretention swale at UConn



# UConn rain gardens/bioretention

- McHugh Hall
- Designed to contain 10-yr 24 hr storm (12.5 cm)



Maintenance is extremely important!

Examples of bioretention “bypass surgery” at UConn



2014

2004



# Turf dams – maintenance issue





# Over-mulching at UConn

- Storage depth was correct at installation...but...



You need to make sure it stays that way!

# Pervious asphalt at UConn

2009



2010



# Pervious concrete at UConn



# Problems with UConn pervious concrete



# New twist on pervious concrete

“StormCrete”



# Stormcrete

- Stormwater Compliance (Yarmouth ME)
  - 5' x 8' x 5" thick
  - Price: \$14/square foot delivered to site (E. U.S.)
  - Can be used on large jobs, but fills niche for small jobs such as driveways or sidewalks
  - <https://www.lidtech.com/precast-porous-concrete>

# Pervious concrete repair at UConn



“Flexipave” parking stall at  
UConn





# Partial pervious paving

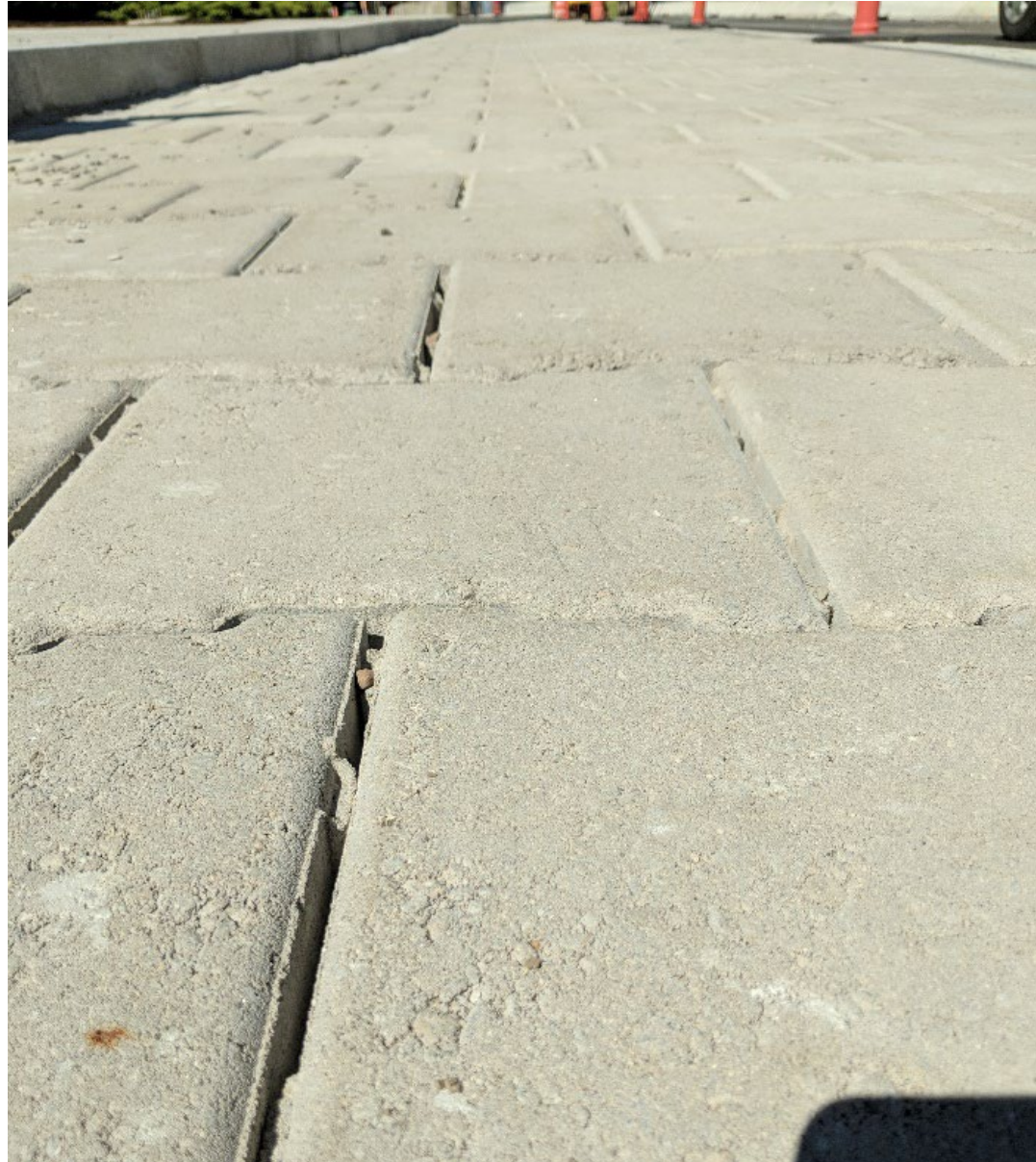


# Permeable Interlocking Concrete Pavers



# PICP bus stops on main road

- Permeable interlocking concrete pavers (PICPs)



NORTH ENTRANCE



2013  
Hillside Rd Snow Shelf

# How about winter performance?

- A properly designed and installed permeable pavement application functions well through the winter
  - Do NOT apply sand
- May not need as much deicing salt

# Maintenance neglect leads to clogging



# Maintenance

- Permeable systems do require maintenance
  - Depends on type
  - Also depends on local environment
    - Lots of wind-blown fines?
    - Winter sanding?
- Best maintenance for PICPs, pervious concrete, pervious asphalt: vacuum suction





# Regenerative air sweeper













# Green Roofs at UConn



**Retained 51% of precipitation**

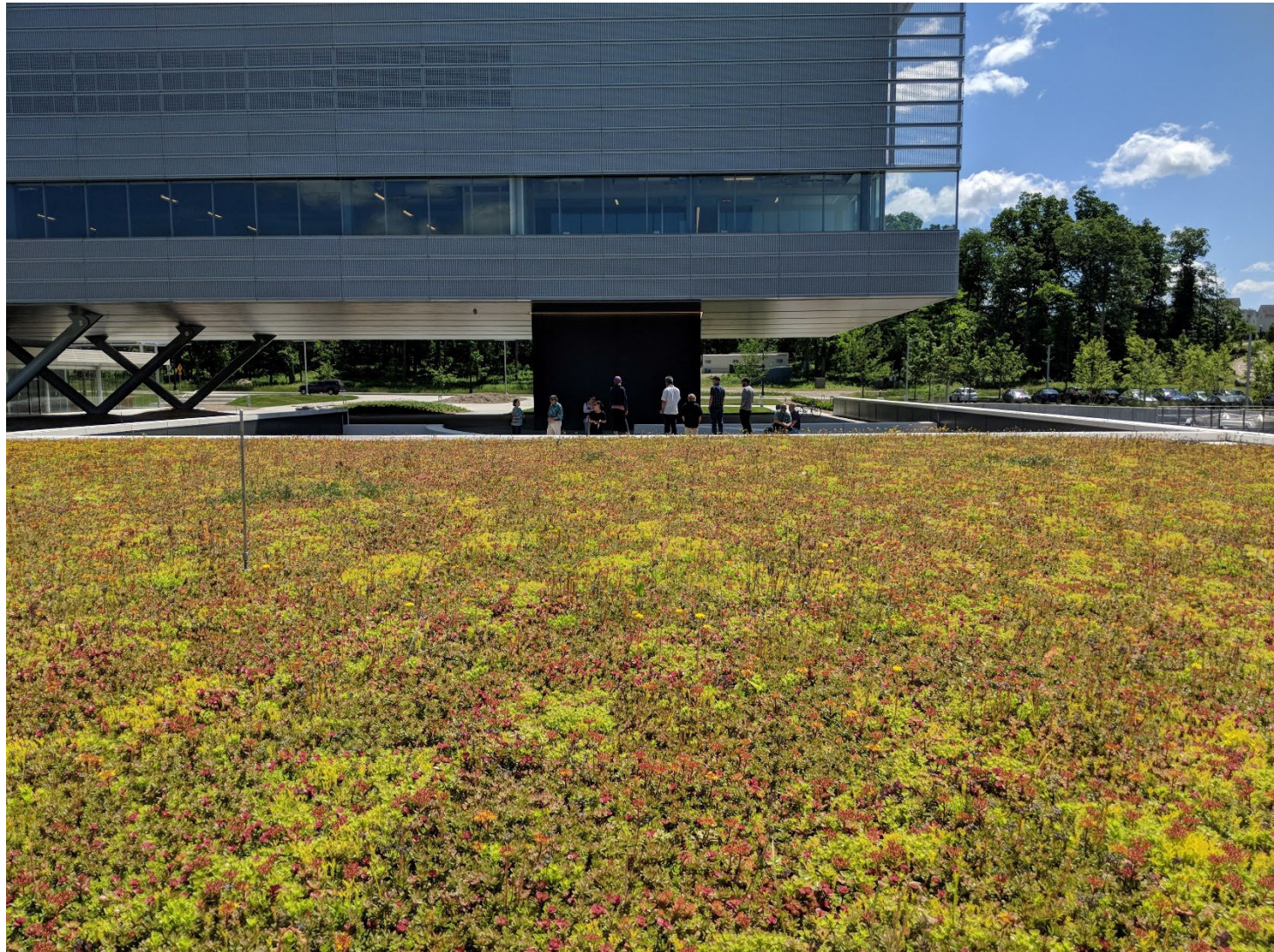


Gregoire, B., and J. Clausen. 2011. Effect of a modular extensive green roof on stormwater runoff and water quality. *Ecological Engineering*. Vol. 37, pp. 963-969.





# Green roofs at UConn



# Summary of impacts

- Since 2004, more than 60 individual GSI practices have been installed on the UConn campus
- Disconnected 6.7 ha of impervious cover from local waterways
- In an average year, these systems treat roughly 81,700 m<sup>3</sup> of runoff!

# How about groundwater contamination?

- In most settings, pollutant concentrations are fairly low
- Most pollutants are adsorbed to soil and most are broken down over time
- Chloride can be a problem from deicing
  - UConn study (Dietz, Robbins, Angel, McNaboe)
- Avoid pervious pavements in areas with high potential contaminant loading
  - Gas stations, transfer stations, etc.

# Challenges

- MAINTENANCE!!!
  - Bioretention: lack of maintenance impeded proper function
  - Permeable pavements: clogging slowed infiltration rates
- Proper application for the setting
  - Plastic grid pavers not appropriate for high traffic area

# CT NEMO rain garden website

**Rain Gardens**  
A Design Guide for Connecticut & New England Homeowners

Home | Frequently Asked Questions | More Resources | Contact Us

UConn's NEMO Website | Save the Sounds's Reduce Runoff Website

**What is a Rain Garden?**

A rain garden is a depression (about 6 inches deep) that collects stormwater runoff from a roof, driveway or yard and allows it to infiltrate into the ground. Rain gardens are typically planted with shrubs and perennials (natives are ideal), and can be colorful, landscaped areas in your yard. [learn more](#)

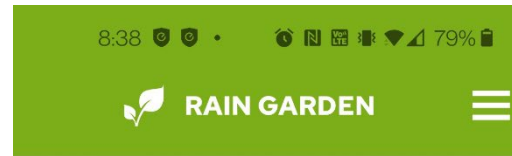
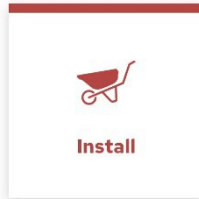
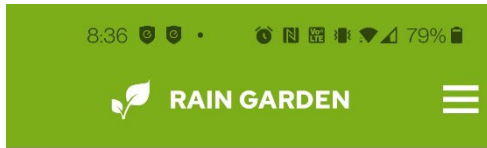
**Why a Rain Garden?**

Every time it rains, water runs off impervious surfaces such as roofs, driveways, roads and parking lots, collecting pollutants along the way. This runoff has been cited by the United States Environmental Protection Agency as a

**You Can Make A Difference!**

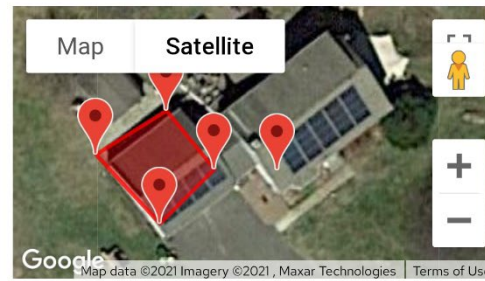
- <http://nemo.uconn.edu/raingardens>

# UConn Smartphone app for rain gardens!!



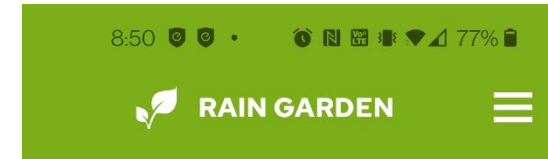
## SIZING MAP

Find address or place:



Measured Area: **510 sq. ft.**      Suggested Rain Garden Size: **85 sq. ft.**

Sizing is based on a 1 inch storm and 6 inch rain garden storage depth. To customize your size to a different depth, storm size or state, use the [sizing calculator](#).



## SIZING CALCULATOR

### Drainage Area

Width (ft.) 20

Length (ft.) 15

Drainage Area (sq. ft.) 300.00

Note: Drainage area can either be calculated by the length \* width or directly submitted

Select State  
Default Sizing: Connecticut

**50.00 sq. ft.**  
Recommended rain garden size

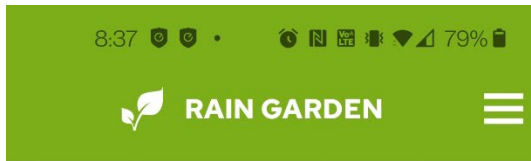
### Custom Design Storm and Storage Depth

Rainfall Depth (in) 1.00

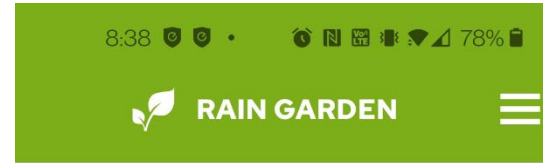
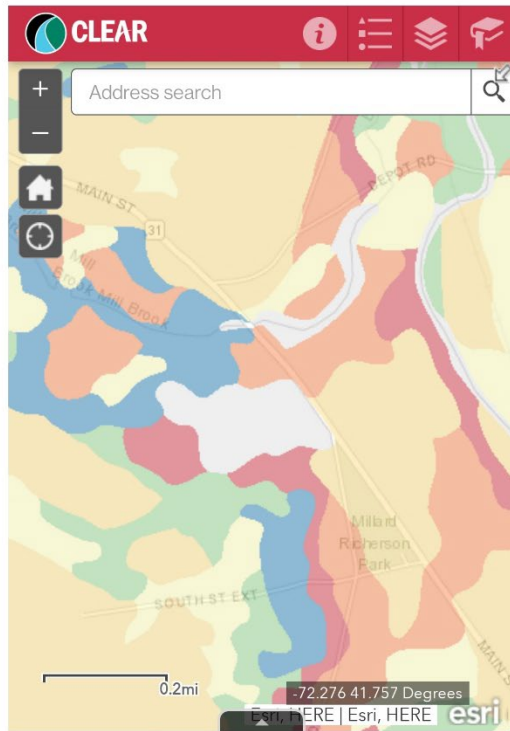
Storage Depth (in) 6.00



# rgapp.nemo.uconn.edu



## SOILS MAP



## YOUR RESULTS IN CONNECTICUT

Image	Name	Height	Width	Bloom Time	Notes
	<b>Serviceberry</b> <i>Amelanchier arborea</i>	>10	15-25	Early spring	Small purple fruits; wildlife benefit
	<b>Shadbush</b> <i>Amelanchier canadensis</i>	>10	0	Early spring	Edible purple berries; wildlife benefit
	<b>Allegheny Serviceberry</b> <i>Amelanchier laevis</i>	>10	15-25	Early spring	Edible black fruits; wildlife benefit
	<b>Bearberry</b> <i>Arctostaphylos uva-ursi</i>	<2	0	Spring	Ground cover; red berries in autumn
	<b>Swamp Milkweed</b> <i>Asclepias incarnata</i>	4-5	1-2	Fall	No notes for this plant.
	<b>Butterfly Milkweed</b> <i>Asclepias tuberosa</i>	2-6	2	Summer	Attracts butterflies
	<b>Astilbe</b> <i>Astilbe sp.</i>	1-3	0	Early summer	No notes for this plant.
	<b>Bluejoint</b> <i>Calamagrostis canadensis</i>	4-5	0	Late spring	No notes for this plant.
	<b>Common Buttonbush</b> <i>Cephalanthus occidentalis</i>	2-6	3-6	Summer	Blooms all summer
	<b>Sweet</b>				



# Rain garden certification course



Green Stormwater Certification Course  
2021-01

Stream

Classwork

People

Grades



Green Stormwater Certification Course  
2021-01

Stream

Classwork

People

Grades

+ Create



Google Calendar



Class Drive folder

All topics

Introduction to cour...

Stormwater backgro...

Rain gardens: site s...

Rain gardens: sizing

Rain gardens: plant ...

Rain gardens: install...

Rain gardens: maint

## Introduction to course



How to do this training course

Posted Feb 19



## Stormwater background



Stormwater background/introduction

Posted Jun 23, 2020



Stormwater background quiz

Due Jul 10, 2020, 2:00 PM





# Conclusions

- Bioretention, pervious pavements, green roofs have been shown to perform well in a variety of applications and climates
- Proper design and installation are critical to ensure proper performance
- Maintenance is critical to keep up long term performance

# Research (recent)

- Volume reductions from bioretention, permeable pavements well documented
- Modifications/additives to media target specific pollutants
  - Internal water storage zone for nitrogen processing
  - Water treatment residuals for phosphorus capture
- Switch away from high compost content in bioretention media
  - High potential to export phosphorus

# References

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- Tirpak et al. 2021. Conventional and amended bioretention soil media for targeted pollutant treatment: A critical review to guide the state of the practice. *Water Research*, Vol. 189, pp. 2-17.

Thank you!  
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