
# Green Stormwater Infrastructure

## Groton, CT

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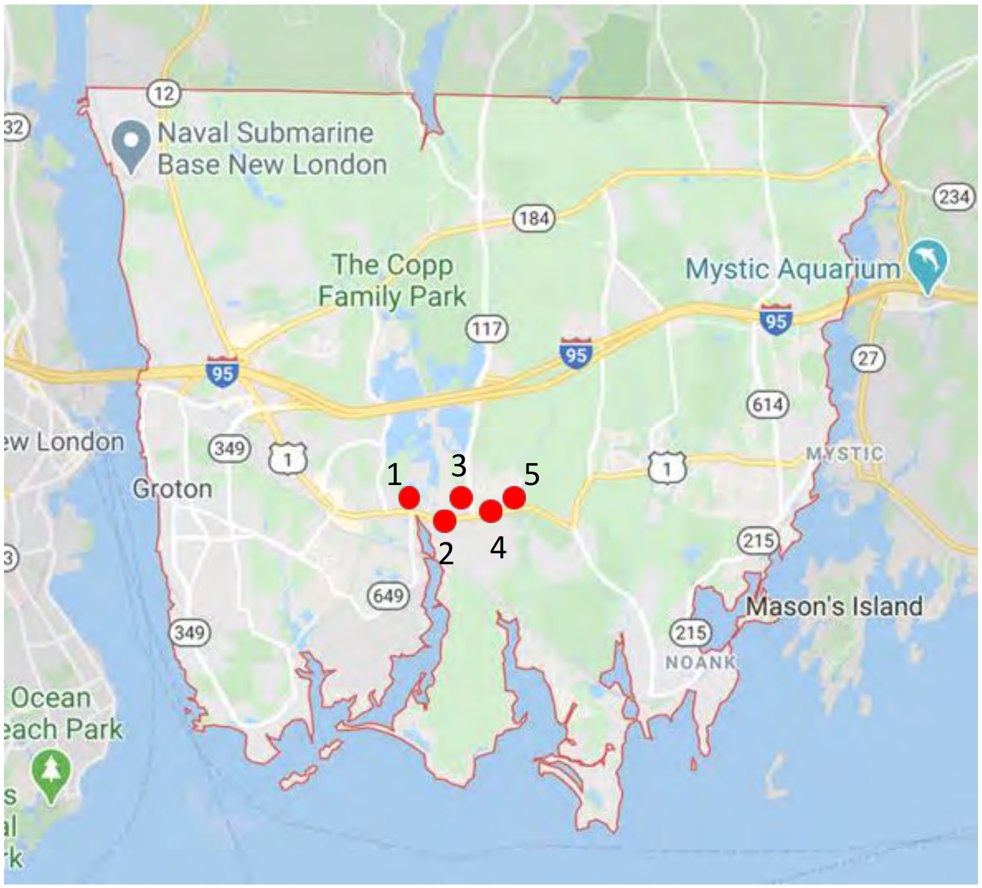
University of Connecticut Undergraduate Students

# Contents

# Map of Groton Sites



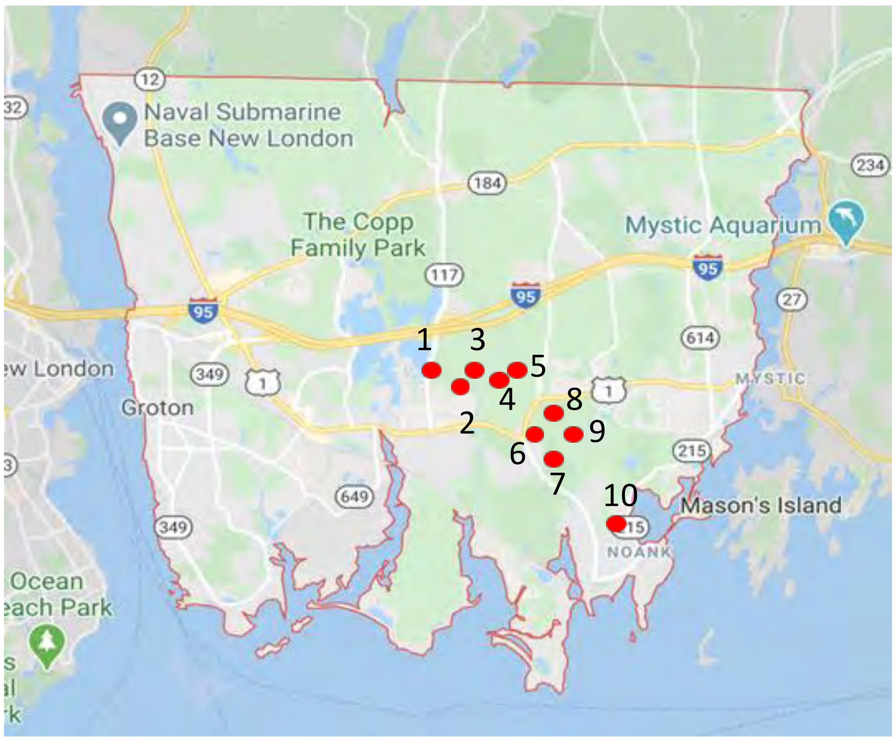

1. Groton Human Services
2. Groton Town Clerk/Community Center
3. Groton Public Library/Senior Center
4. Claude Chester Elementary School
5. Poquonnock Plains Park

# Summary

The following report created in early 2020 contains the evaluation of multiple locations in the town of Groton, CT for the potential implementation of green stormwater infrastructure. Each site discussed was evaluated using aerial imagery and field visits to determine where the infrastructure could be implemented most effectively. For each practice, the recommended location, size, and the calculations for the predicted runoff and pollution reductions are provided. If all practices were implemented, 64,250 square feet of impervious cover would be disconnected from the stormwater system. This would also prevent 1,412,972 gallons of runoff, 17.41 pounds of nitrogen, and 2.19 pounds of phosphorus from entering the stormwater system annually.

# Effect of COVID-19 on Project Scope

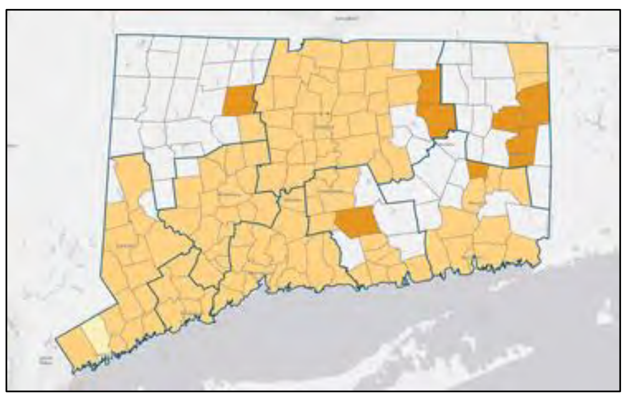
We originally identified 10 potential sites but were only able to do field confirmations for the first 5 due to COVID-related quarantine.

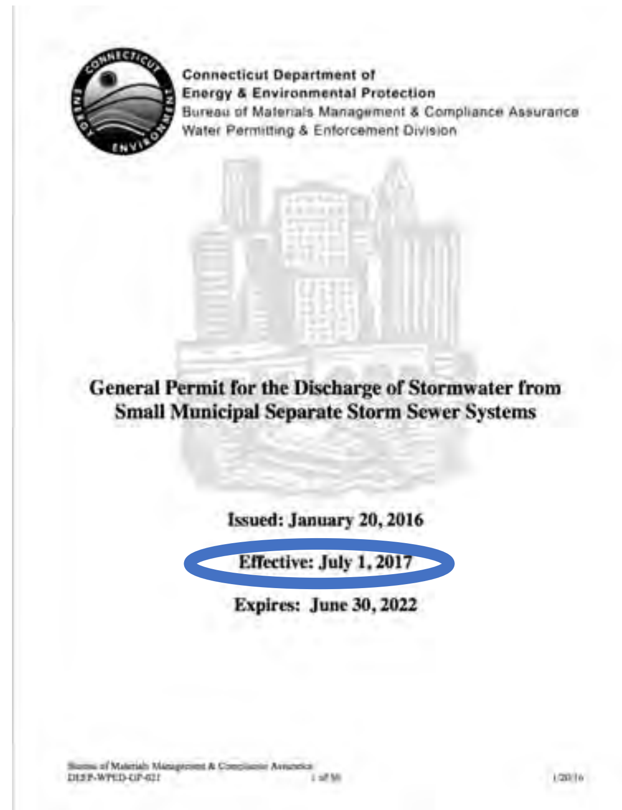



1. Groton Human Services
2. Groton Town Clerk/Community Center
3. Groton Public Library/Senior Center
4. Claude Chester Elementary School
5. Poquonnock Plains Park
6. Sutton Park
7. Robert E. Fitch Senior High School
8. New Groton Middle School
9. Groton Police Department
10. Tanglewood Park

# A New MS4 General Stormwater Permit

- MS4: Municipal Separate Storm Sewer System
- Part of CWA
- Address Nonpoint Source Pollution
- Updated in 2016, effective 2017





Connecticut Department of
Energy & Environmental Protection
Bureau of Materials Management & Compliance Assurance
Water Permitting & Enforcement Division

**General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems**

**Issued: January 20, 2016**

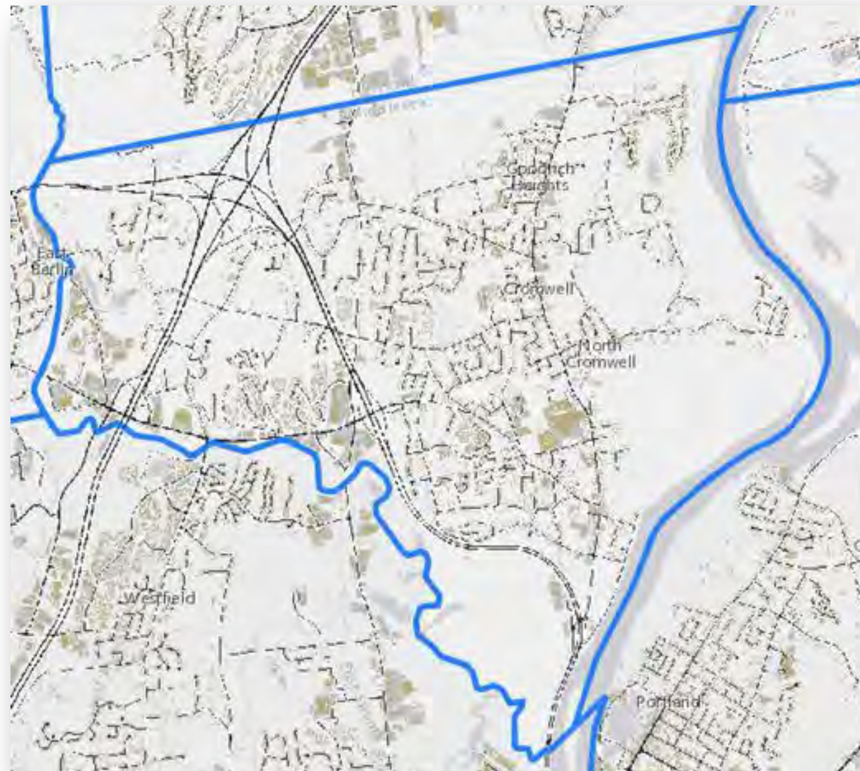
**Effective: July 1, 2017**

**Expires: June 30, 2022**


# Retrofit Program

Towns must:

- **reduce directly connected impervious area (DCIA) by 2% by 2022**
- develop a plan for meeting 2% goal
- track reductions & additions



# Considerations when looking for opportunities

The Stormwater Corps 2018

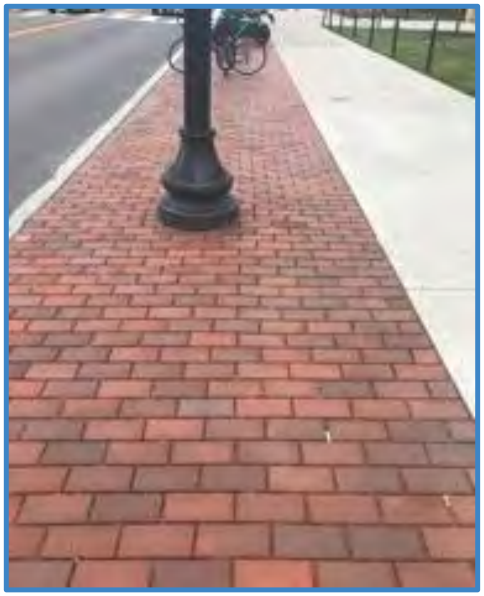
1. Town or other public properties
2. Large expanses of IC
3. Education / signage potential
4. Minimal infrastructure complications
5. Cost
6. Maintenance
7. The “RE” factor: renovations, redevelopment, repaving, reconstruction

# What is Green Stormwater Infrastructure?

Green stormwater infrastructure is a way of building that emulates natural processes to better manage stormwater on impervious surfaces. Impervious surfaces are areas that do not allow water to infiltrate through them such as rooftops, parking lots, and roads. When precipitation falls on these areas, there is an increased quantity of runoff. This runoff collects pollutants as it flows over impervious surfaces, causes erosion, and can lead to flooding. Green stormwater infrastructure works to reduce runoff by creating more pervious surfaces for water to infiltrate into, changing or reducing impervious areas. The stormwater will infiltrate into the ground where pollutants are naturally removed and the amount of runoff is reduced.

# Common Green Infrastructure Practices

Rainwater Harvesting



Pervious Pavement

Tree Boxes

Rain Garden and
Bioretention Systems

# Rain Garden

A rain garden is a shallow depression planted with vegetation to capture and absorb runoff. Rain gardens can collect water from a nearby impervious surface and divert it from entering a stormwater management system. They are usually built adjacent to the impervious area water is being diverted from and are about six inches deep. A variety of shrubs, perennials, and grasses suitable for an environment with standing water and high salt concentrations are used to aid in the efficient infiltration of water into the ground.

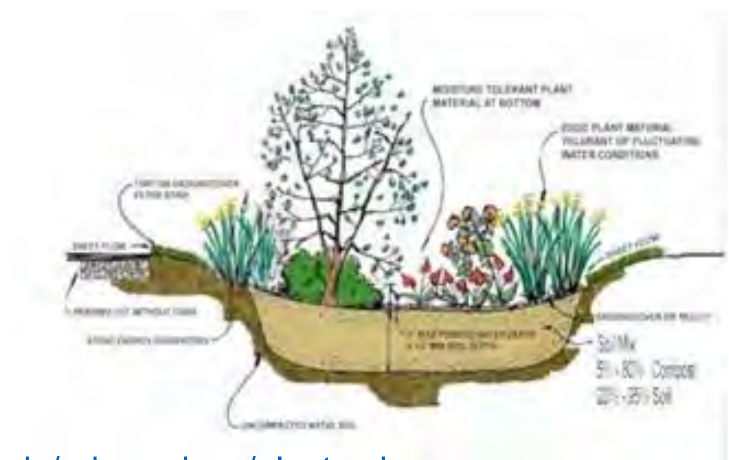
Depending on the source the runoff is being captured from, construction may vary. Rain gardens collecting runoff from parking lots and roads may require a section of the curb be removed to allow water to drain to the garden over a cobble or gravel path. Runoff collected from rooftops can be directed into a rain garden using gutters. A bioretention basin is an enlarged rain garden constructed to absorb a larger quantity of runoff.

Rain Garden Cost Calculator: https://nemo.uconn.edu/raingardens/calculator.htm

# Suggested Rain Garden Vegetation

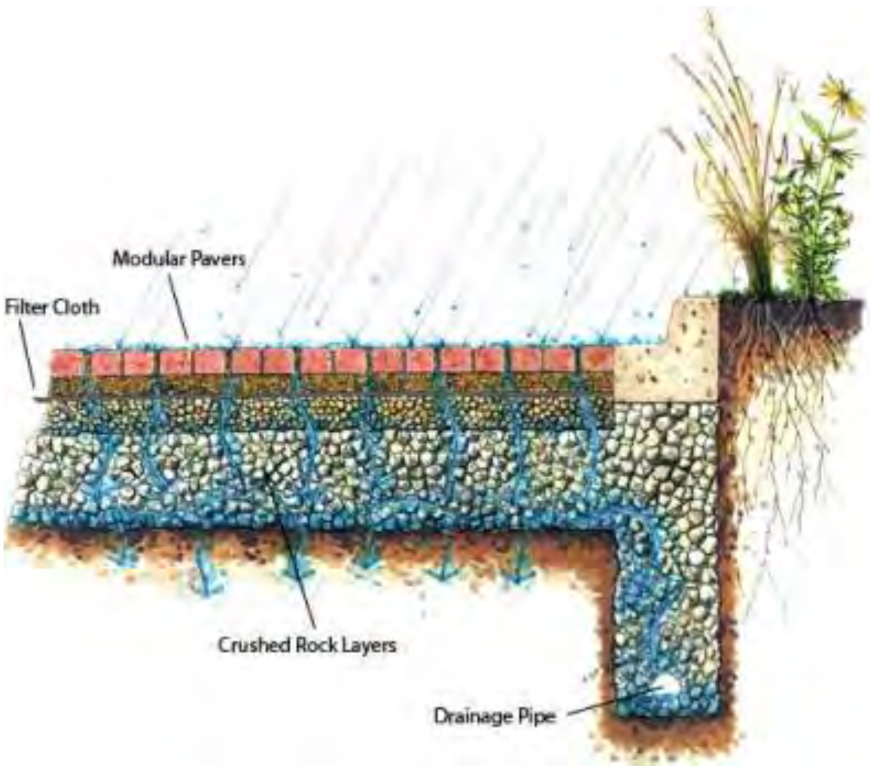
When selecting vegetation for a rain garden, the plants must be capable of withstanding fluctuating conditions. It is also beneficial to use vegetation native to the area to support local pollinators and wildlife. When choosing potential vegetation, we looked for plants with a variety of colors and heights to make the bioretention gardens as aesthetically pleasing as possible. We recommend the following options:

- Sweet Fern (*Comptonia peregrina*)
- Orange Coneflower (*Rudbeckia fulgida ‘Goldst*
- Lowbush Blueberry (*Vaccinium angustifolium*)
- Sweet Pepperbush (*Clethra alnifolia*)
- Red Chokeberry (*Aronia arbutifolia*)



For additional information on rain garden vegetation visit: https://nemo.uconn.edu/raingardens/plants.php

# Pervious Pavement




Pervious pavement is a replacement for traditional asphalt and concrete which allows for water infiltration. The porous pavement imitates the natural infiltration of water, trapping suspended solids and pollutants as the water filters through. Pervious pavement is best suited for flat areas that receive large quantities of stormwater from surrounding areas during storm events. To maintain optimal functionality, it requires cleaning through techniques such as vacuum sweeping and pressure washing to remove dirt and debris lodged in the pavement. Pervious pavement is less susceptible to seasonal expansion and contraction than traditional pavement and reduces the need for snow removal due to its permeability.

# Tree Box Filters

Tree boxes filters are a green infrastructure practice using the same techniques as rain gardens and bioretention areas. Stormwater runoff is directed to the filter through a grate, where it infiltrates through the soil and other substrates. The runoff acts as additional irrigation to the tree, and the tree root system and soil work to filter out any pollutants in the runoff. Tree boxes are often a great way to enhance the attractiveness of a sidewalk or road edge.


PERVIOUS CONCRETE
Pervious concrete is installed to act as an additional storage system to increase the stormwater capacity treated by the system.
UNDERDRAIN
Systems with low infiltration rates due to soil composition are often designed with an underdrain system to discharge the water.
ASPHALT
This system is often designed with conventional asphalt in areas of high traffic to prevent any damage to the system.

# Rainwater Harvesting

Rainwater harvesting is the process of diverting water from gutters and downspouts which would otherwise enter the municipal stormwater system. The roof runoff is retained in a container positioned adjacent to the building, where the water can then be used for a variety of purposes such as gardening and washing vehicles. Using rainwater can reduce water bills and reduce the demand on private wells and the local water supply.

The size of the retaining container is dependent on the size of the drainage area and the amount of water needed. PVC is suitable for small drainage areas containers, but larger areas may require steel or concrete containers.

# Site Selection and Approach

STEP 1: Use online imagery & data to identify possible options

- Before on site research, group members used the Town of Groton GIS, Google Maps/Street View, CT ECO and CLEAR MS4 Viewer to locate possible municipal sites to implement low impact development (LID) practices. We analyzed the data presented and developed LID plans that could be implemented.

STEP 2: Field verification, determining drainage areas

- Once on site, we collected data such as elevation, waterflow direction and drainage area that were unavailable to us while searching online.

Local knowledge

Drain gazing

Slope checking

Note taking

# Stormwater & Pollutant Calculations

For each of the recommended practices, we calculated the reduction in runoff and pollutant loads using these calculations:

| Annual Gallons Treated | Annual Nitrogen Reduction (lb N/yr) | Annual Phosphorus Reduction (lb P/yr) |
|---|---|---|
| **Step 1**: drainage area ($ft^2$)<br>X 4 ft (avg. rainfall in a year)<br>= annual gallons runoff ($ft^3$)<br><br>**Step 2**: annual gallons runoff ($ft^3$)<br>X 0.88 (percent of storms treated)<br>= volume of water treated ($ft^3$)<br><br>**Step 3**: volume of water treated ($ft^3$)<br>X 7.48<br>= annual gallons treated | drainage area ($ft^2$)<br>X 0.00027388 lbs/$ft^2$<br>= annual N reduction (lb)<br><br>Note: based on 1991 paper by Charles Frink that summarizes CT research looking at nutrient concentrations by major type of land cover | drainage area ($ft^2$)<br>X 0.0000347 lbs/$ft^2$<br>= annual P reduction (lb)<br><br>Note: based on 1991 paper by Charles Frink that summarizes CT research looking at nutrient concentrations by major type of land cover |

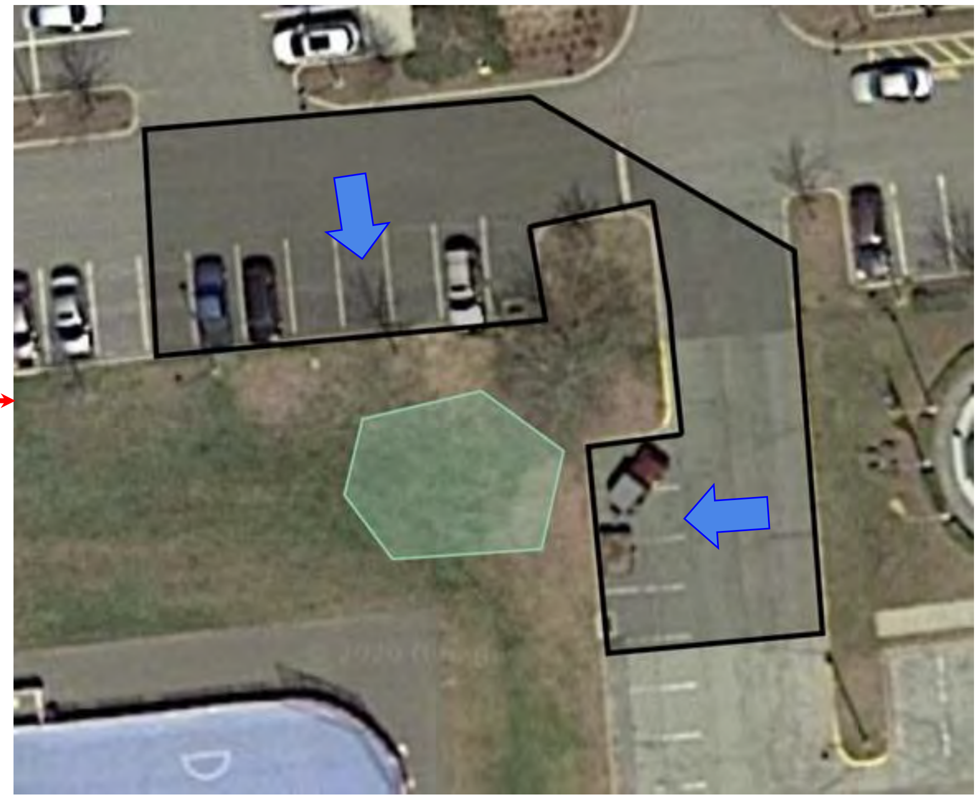
# Top Four Practices for Groton

The selection of the top four sites was based on the total impervious cover, maintenance, and education potential:

1. Groton Public Library/Senior Center
2. Groton Human Services
3. Poquonnock Plains Park
4. Groton Town Clerk/Community Center

If the above green infrastructure practices are all implemented, 42,078 square feet of impervious cover will be disconnected from the stormwater system. This would include preventing 1,107,892 gallons of treated water, 11.35 pounds of nitrogen, and 1.2 pounds of phosphorus from entering the stormwater system annually.

# Groton Public Library/Senior Center: Option 1

Direction of Water Flow

Drainage Area

Rain Garden / Bioretention Area

| Drainage Area (sq. ft.) | Suggested Green Infrastructure | Annual Gallons Treated | Annual Nitrogen Reduction (lb N/yr) | Annual Phosphorus Reduction (lb P/yr) | Suggested Practice Size (sq. ft.) |
|---|---|---|---|---|---|
| 5,793 | Rain Garden | 152,527 | 1.59 | 0.20 | 962 |

The photo to the right shows where the rain garden would go.

**Pros:** We chose this site as one of our top four sites because many people visit the senior center and public library. Therefore, it has a very high education potential. The location of the rain garden near the rink will help increase awareness of green infrastructure and will make the area more aesthetically pleasing. Also, a significant amount of impervious area will be reduced.

# Groton Public Library/Senior Center: Option 2


Direction of Water Flow

Drainage Area

Rain Garden / Bioretention Area

| Drainage Area (sq. ft.) | Suggested Green Infrastructure | Annual Gallons Treated | Annual Nitrogen Reduction (lb N/yr) | Annual Phosphorus Reduction (lb P/yr) | Suggested Practice Size (sq. ft.) |
|---|---|---|---|---|---|
| 11,761 | Rain Garden | 309,662 | 3.22 | 0.41 | 1,952 |

**Pros:** We chose this site as one of our top four sites because many people use the senior center and the public library often on a regular basis. This site has very high education potential. The rain garden will help make the area more aesthetically pleasing. Also, a large amount of impervious area will be reduced.

**Cons:** Being near the hockey rink, it is highly likely that people may walk through or step on the rain garden.

# Groton Public Library/Senior Center

**Location:**

**52/102 Newton Rd, Groton, CT**

**Annual Gallons Treated per Year:**

**462,189**

# Groton Human Services

**Location:**

**2 Fort Hill Rd, Groton, CT**

**Annual Gallons Treated per Year:**

**364,720**

# Groton Human Services: Option 1


Direction of Water Flow

Drainage Area

Rain Garden / Bioretention Area

| Drainage Area (sq. ft.) | Suggested Green Infrastructure | Annual Gallons Treated | Annual Nitrogen Reduction (lb N/yr) | Annual Phosphorus Reduction (lb P/yr) | Suggested Practice Size (sq. ft.) |
|---|---|---|---|---|---|
| 3,528 | Rain Garden | 92,900 | 0.97 | 0.12 | 586 |

This photo to the right shows where we would put the rain garden.

**Pros:** This area has high education potential because it is next to a community garden. The rain garden would help reduce erosion and flooding in this corner of the parking lot.

**Cons:** Visibility could be better

# Groton Human Services: Option 2


Direction of Water Flow

Drainage Area

Rain Barrel/Rainwater Harvesting

| Drainage Area (sq. ft.) | Suggested Green Infrastructure | Annual Gallons Treated | Annual Nitrogen Reduction (lb N/yr) | Annual Phosphorus Reduction (lb P/yr) | Suggested Practice Size (sq. ft.) |
|---|---|---|---|---|---|
| 653 | Rain Barrel | 17,204 | N/A | N/A | 108 |

**Pros**: We think that putting in a rain barrel would help people reduce their water consumption by using the runoff water for the nearby community garden. The Groton Community Garden is a beautiful, safe, and peaceful place for Groton residents to cultivate flowers and vegetables.

**Cons:** The amount of impervious area reduced is not that large.

# Groton Human Services: Option 3


Direction of Water Flow

Drainage Area

Rain Garden / Bioretention Area

| Drainage Area (sq. ft.) | Suggested Green Infrastructure | Annual Gallons Treated | Annual Nitrogen Reduction (lb N/yr) | Annual Phosphorus Reduction (lb P/yr) | Suggested Practice Size (sq. ft.) |
|---|---|---|---|---|---|
| 5,881 | Rain Garden | 154,834 | 1.61 | 0.20 | 976 |

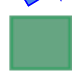
**Pros:** A significant amount of impervious area will be reduced.

**Cons:** Visibility and education potential are not the greatest.

# Groton Human Services: Option 4


Direction of Water Flow

Drainage Area



Rain Garden / Bioretention Area

| Drainage Area (sq. ft.) | Suggested Green Infrastructure | Annual Gallons Treated | Annual Nitrogen Reduction (lb N/yr) | Annual Phosphorus Reduction (lb P/yr) | Suggested Practice Size (sq. ft.) |
|---|---|---|---|---|---|
| 3,790 | Rain Garden | 99,782 | 1.04 | 0.13 | 629 |

This photo to the right shows the approximate location of where we would put the rain garden.

**Pros:** This rain garden would help reduce erosion, including a large amount of impervious area.

**Cons:** Visibility and education potential are not the greatest.

# Poquonnock Plains Park

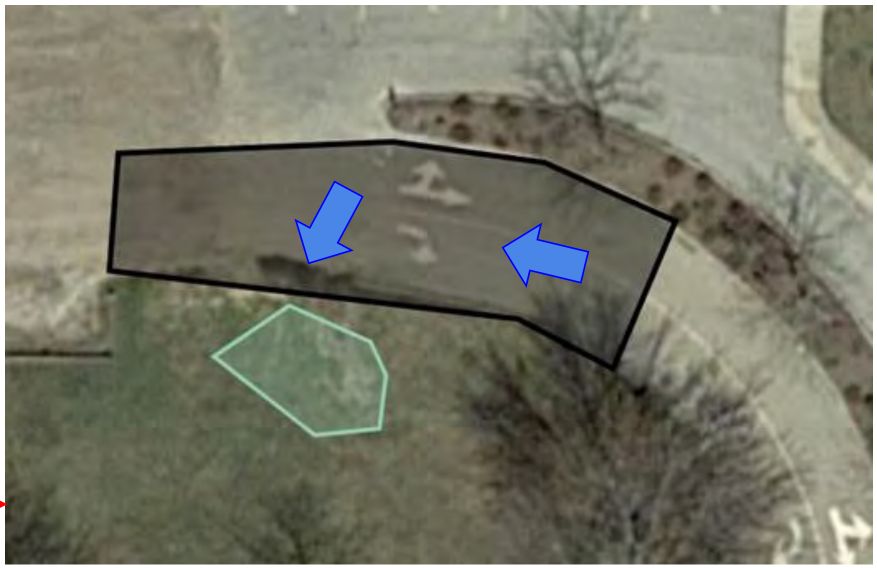
**Location:**

**1 Central Ave, Groton, CT**

**Annual Gallons Treated per Year:**

**56,187**

# Poquonnock Plains Park

Direction of Water Flow

Drainage Area

Rain Garden / Bioretention Area

| Drainage Area (sq. ft.) | Suggested Green Infrastructure | Annual Gallons Treated | Annual Nitrogen Reduction (lb N/yr) | Annual Phosphorus Reduction (lb P/yr) | Suggested Practice Size (sq. ft.) |
|---|---|---|---|---|---|
| 2,134 | Rain Garden | 56,187 | 0.58 | 0.07 | 354 |

The photo to the right shows where the rain garden would go (in the grass near the big puddle).

**Pros:** This site has great education potential because many people use the park for recreational activities. The rain garden could help increase awareness of green infrastructure.

**Cons:** The amount of impervious area reduced will not be that large.

# Groton Town Clerk/Community Center

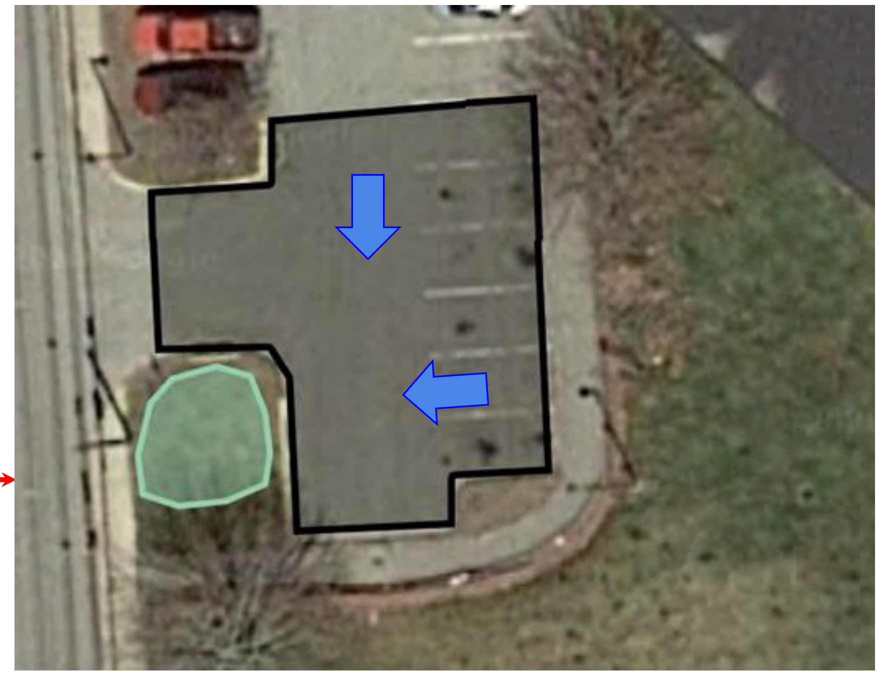
**Location:**

**45/61 Fort Hill Rd, Groton, CT**

**Annual Gallons Treated per Year:**

**224,796**

# Groton Town Clerk/Community Center: Option 1

Direction of Water Flow

Drainage Area

Rain Garden / Bioretention Area

| Drainage Area (sq. ft.) | Suggested Green Infrastructure | Annual Gallons Treated | Annual Nitrogen Reduction (lb N/yr) | Annual Phosphorus Reduction (lb P/yr) | Suggested Practice Size (sq. ft.) |
|---|---|---|---|---|---|
| 3,267 | Rain Garden | 86,019 | 0.90 | 0.11 | 542 |

This photo to the right shows the corner of pervious area where we would put a rain garden.

**Pros:** It will reduce a significant amount of impervious area.

**Cons:** This area has very low visibility, meaning that many people will not see it on a frequent basis. Education potential is low.

# Groton Town Clerk/Community Center: Option 2


Direction of Water Flow

Drainage Area

Rain Garden / Bioretention Area

| Drainage Area (sq. ft.) | Suggested Green Infrastructure | Annual Gallons Treated | Annual Nitrogen Reduction (lb N/yr) | Annual Phosphorus Reduction (lb P/yr) | Suggested Practice Size (sq. ft.) |
|---|---|---|---|---|---|
| 5,271 | Rain Garden | 138,777 | 1.44 | 0.18 | 875 |

**Pros:** A significant amount of impervious area will be reduced.

**Cons:** This area does not have the greatest visibility.

# Claude Chester Elementary School

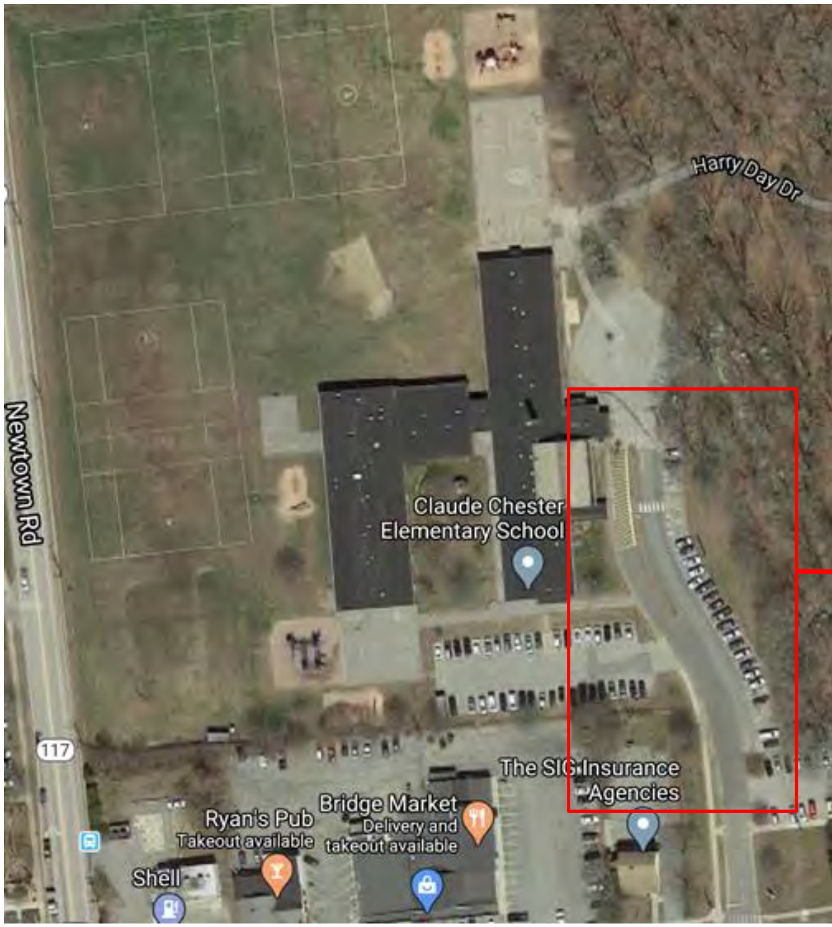
**Location:**

**1 Harry Day Dr, Groton, CT**

**Annual Gallons Treated per Year:**

**583,780**

# Claude Chester Elementary School: Option 1





Direction of Water Flow

Drainage Area

Rain Garden / Bioretention Area

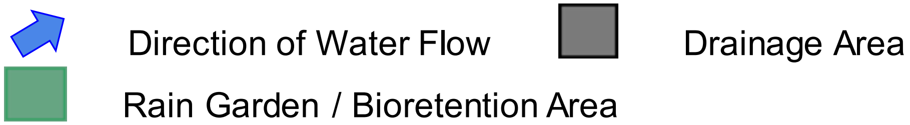
| Drainage Area (sq. ft.) | Suggested Green Infrastructure | Annual Gallons Treated | Annual Nitrogen Reduction (lb N/yr) | Annual Phosphorus Reduction (lb P/yr) | Suggested Practice Size (sq. ft.) |
|---|---|---|---|---|---|
| 6,708 | Rain Garden | 176,619 | 1.84 | 0.23 | 745 |

The photo to the right shows where the rain garden would go.

**Pros:** A large amount of impervious area would be reduced and the rain garden would help reduce erosion of the parking lot border.

**Cons:** We did not pick this as one of our top four sites because the town is closing Claude Chester Elementary School soon. Therefore, putting in a rain garden may not be worth the cost.

# Claude Chester Elementary School: Option 2

| Drainage Area (sq. ft.) | Suggested Green Infrastructure | Annual Gallons Treated | Annual Nitrogen Reduction (lb N/yr) | Annual Phosphorus Reduction (lb P/yr) | Suggested Practice Size (sq. ft.) |
|---|---|---|---|---|---|
| 15,464 | Rain Garden | 407,161 | 4.24 | 0.54 | 2,567 |

We had to make the rain garden have a depth of nine inches instead of the standard six inches because the pervious area is not large enough.

**Pros:** A large amount of impervious area will be reduced and the rain garden would help reduce erosion.

**Cons:** We did not choose this site as one of our top four sites because the town will be closing Claude Chester Elementary School soon. If the school was not closing, then it would have a very high education potential.

# Contact Information

This project was conducted by two UConn undergraduates under the guidance of Chet Arnold and Dave Dickson from the UConn Center for Land Use Education and Research (CLEAR). It is part of the independent study portion of the "Climate Corps," a course of instruction that includes a semester of classroom education followed by an independent study working on projects to assist Connecticut towns. The Climate Corps, in turn, is part of a larger initiative at UConn called the Environment Corps, which now includes courses on climate, brownfields redevelopment, and stormwater management.


For more information on this report

→ Chet Arnold (chester.arnold@uconn.edu) or Dave Dickson (david.dickson@uconn.edu)

For more information on the Climate Corps

→ Juliana Barrett (juliana.barrett@uconn.edu) or Bruce Hyde (bruce.hyde@uconn.edu)

For more information on the Environment Corps

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