# Stormwater Runoff Reduction Plan

## North Haven, Connecticut

June 6th, 2018


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UCONN | COLLEGE OF AGRICULTURE, HEALTH AND NATURAL RESOURCES

# PROJECT TEAM

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# SUMMARY

During the summer of 2018, a team of UConn students and Extension faculty performed an evaluation of potential stormwater enhancement opportunities in the Town of North Haven, CT. The process involved a desktop analysis and visits to the field to determine where potential green stormwater infrastructure opportunities existed on public parcels. Then, calculations were performed to determine the potential stormwater and pollution reduction benefits from each of the proposed installations. If all projects identified in the report were implemented, 259,107 sq ft of impervious cover will be disconnected from the stormwater drainage system. This means that 6,732,739 gallons of untreated stormwater, 49.48 pounds of nitrogen, and 9.14 pounds of phosphorus will be prevented from entering local streams annually.

# IN THIS REPORT...

Recommendations for green stormwater infrastructure practices at 8 sites are given. Each site has a varying amount of options for potential green stormwater infrastructure practices. The options are individual projects that can be done on one particular site. The first page of each site begins with an aerial photo. The second page is the site with all the options drawn out and labeled. In addition, the second page also contains broad information about the site.This includes location, impervious area that comprised of the drainage area for all options, and the subregional watershed. The soil type was assessed through the USDA web soil survey for the properties and qualities of broad guidelines most suitable for green infrastructure, but individual soil testing would be needed for further analysis at each site. On the following pages and for each option, there is a description of the recommended practice and a table which includes estimated reductions in runoff volume, and nitrogen and phosphorus pollution that would result from implementing the practice. These estimations were calculated from the drainage area, annual rainfall estimates, and literature export values.

# IMPERVIOUS SURFACES AND RUNOFF

Impervious surfaces are roads, buildings, parking lots, and other developments that have replaced the natural landscape. Natural landscapes absorb a significant portion of water that infiltrates native soils and eventually discharges into surface water bodies or recharges groundwater aquifers. When the natural landscape is replaced the water cycle is disrupted. As a result, infiltration decreases causing an increase in runoff that is often diverted into stormwater management systems and directly into the local streams. Runoff over impervious surfaces collects pollutants, and causes flooding and erosion that affect the water quality of local streams. To prevent a decrease in water quality, runoff over impervious surfaces needs to be disconnected from the stormwater management system. This can be done by implementing green infrastructure practices that reduce or convert impervious practices. For instance, downspouts and drainage areas can be connected to rain gardens bioretention areas, box planters, tree box filters, or rain barrels, while parking lots can be converted to pervious pavement.

# COMMON GREEN INFRASTRUCTURE PRACTICES

Rain Gardens and Bioretention System


Pervious Pavement

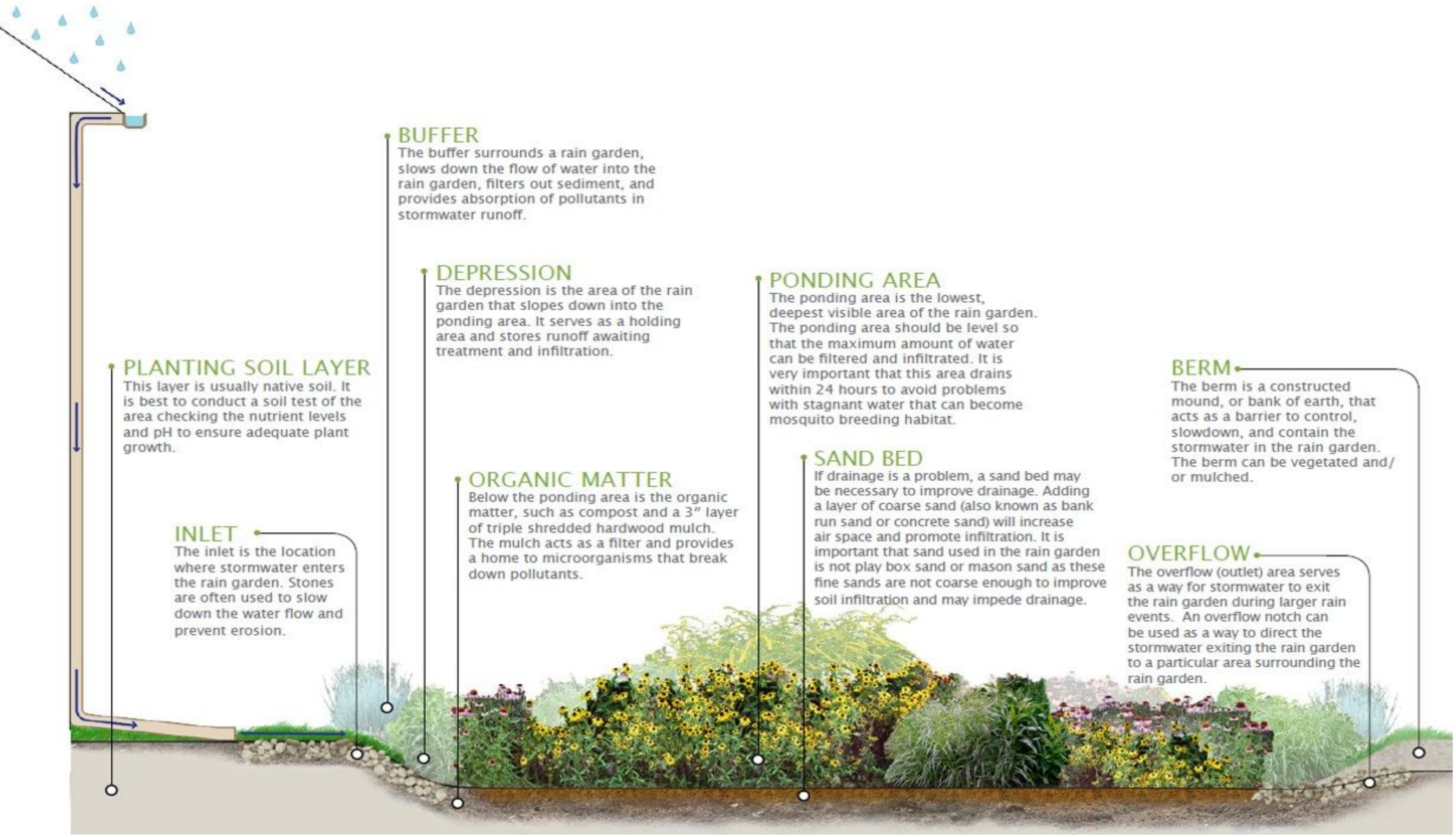
Tree Box Filters

Rainwater Harvesting

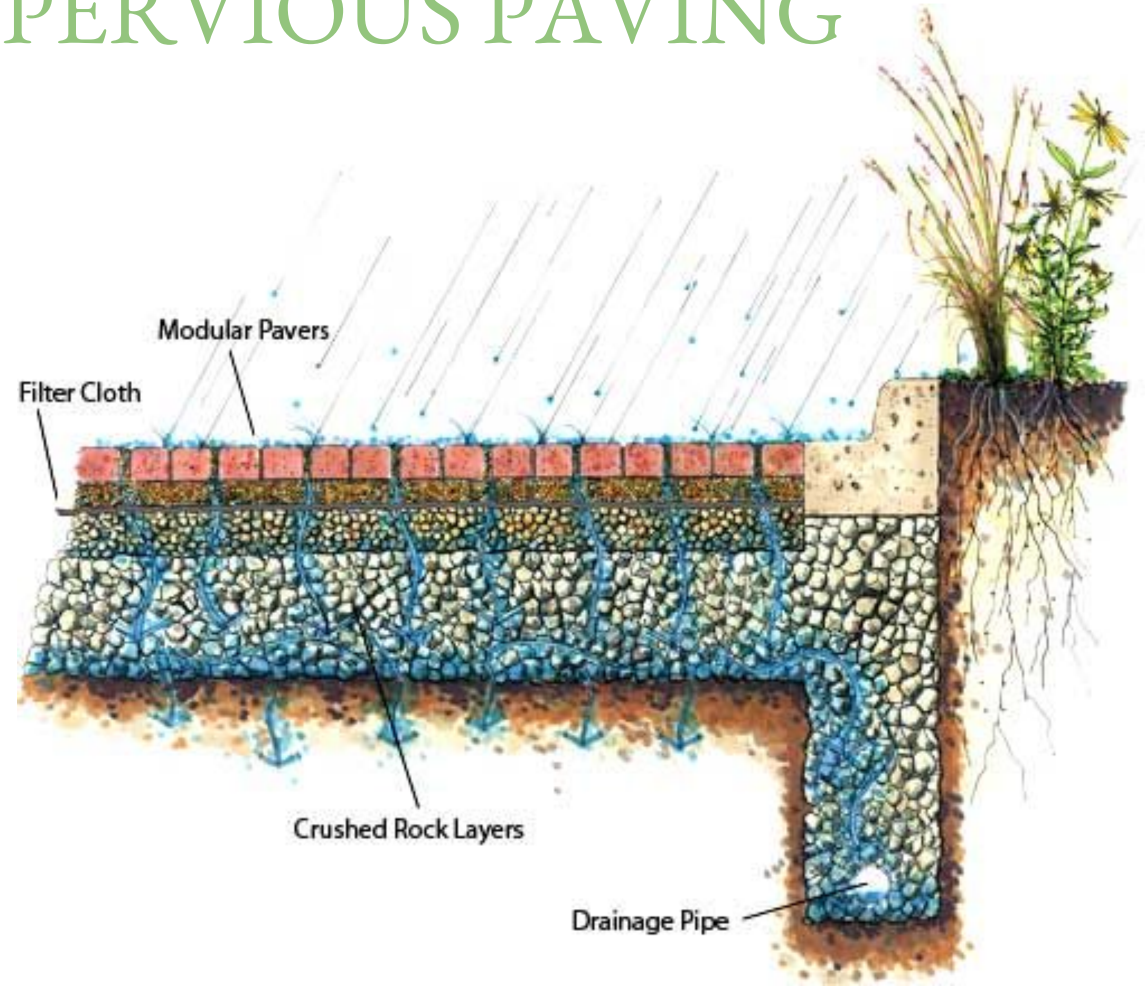
# RAIN GARDENS

A rain garden is a piece of green infrastructure designed to capture rain runoff water from an impervious area. By doing so, water is allowed to percolate into the ground rather than directly entering the storm drain system. Generally, they are built adjacent to the impervious area in question and are depressed about 6 inches or so depending on how much area is available. Rain gardens not only help to reduce pollution of local waters, but they also add to the aesthetic appeal and biodiversity of an area.

Generally, when built next to a parking lot; the curb is cut and water is directed through a path composed of cobble or gravel to minimize erosion. If implemented next to a building, gutters are generally led directly into the garden. From here, the water is either taken up by plants or enters the water table via percolation. The plants are generally shrubs or grasses that are tolerant to drought, flooding, and exposure to high salt concentrations. Ideally, these gardens are planted with hardy native perennials to minimize the need for maintenance.


BUFFER
The buffer surrounds a rain garden, slows down the flow of water into the rain garden, filters out sediment, and provides absorption of pollutants in stormwater runoff.
DEPRESSION
The depression is the area of the rain garden that slopes down into the ponding area. It serves as a holding area and stores runoff awaiting treatment and infiltration.
PLANTING SOIL LAYER
This layer is usually native soil. It is best to conduct a soil test of the area checking the nutrient levels and pH to ensure adequate plant growth.
PONDING AREA
The ponding area is the lowest, deepest visible area of the rain garden. The ponding area should be level so that the maximum amount of water can be filtered and infiltrated. It is very important that this area drains within 24 hours to avoid problems with stagnant water that can become mosquito breeding habitat.
BERM
The berm is a constructed mound, or bank of earth, that acts as a barrier to control, slowdown, and contain the stormwater in the rain garden. The berm can be vegetated and/ or mulched.
ORGANIC MATTER
Below the ponding area is the organic matter, such as compost and a 3" layer of triple shredded hardwood mulch. The mulch acts as a filter and provides a home to microorganisms that break down pollutants.
SAND BED
If drainage is a problem, a sand bed may be necessary to improve drainage. Adding a layer of coarse sand (also known as bank run sand or concrete sand) will increase air space and promote infiltration. It is important that sand used in the rain garden is not play box sand or mason sand as these fine sands are not coarse enough to improve soil infiltration and may impede drainage.
INLET
The inlet is the location where stormwater enters the rain garden. Stones are often used to slow down the water flow and prevent erosion.
OVERFLOW
The overflow (outlet) area serves as a way for stormwater to exit the rain garden during larger rain events. An overflow notch can be used as a way to direct the stormwater exiting the rain garden to a particular area surrounding the rain garden.

# PERVIOUS PAVING

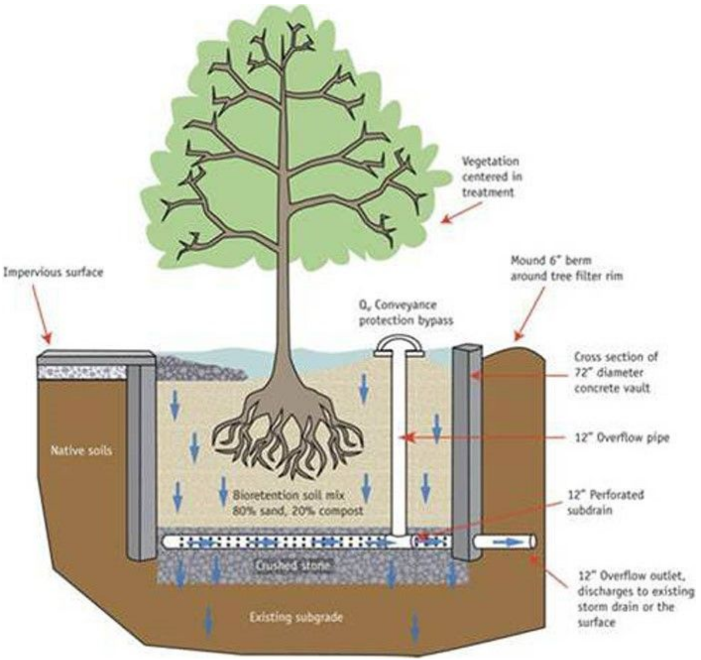



Pervious paving is an alternative to traditional asphalt or concrete, that allows for the infiltration of water. The ideal locations for pervious paving options are areas which are relatively flat and take on a fair amount of water from surrounding impermeable cover during storm events. Pervious asphalt generally needs to be replaced less often than traditional asphalt as well. As a result of it being porous, it is less susceptible to seasonal expansion and contraction than traditional asphalt. This causes it to crack less and prolongs its lifespan.

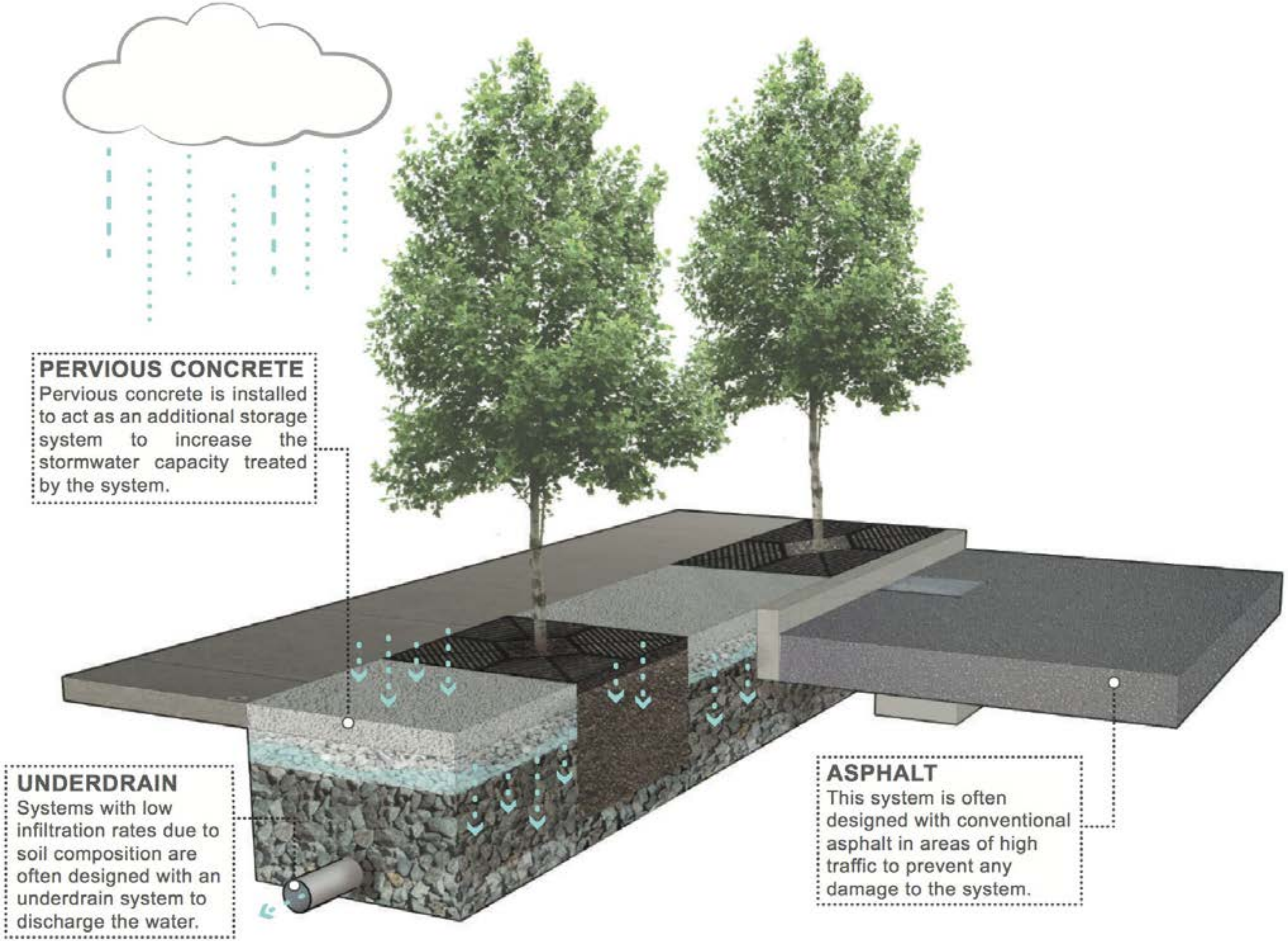
 

Pervious paving often reduces the need for snow removal as well. With traditional concrete and asphalt, water from melted snow cannot infiltrate so it often freezes into black ice or acts as runoff and takes salt with it. Pervious pavers allow this water to enter the ground, resulting in a decreased need for salting as well as less cost for snow removal maintenance. This not only puts less stress on the storm drain system, but on local aquatic ecosystems as well.

# TREE BOX FILTERS




Tree box filters are an aesthetically appealing green infrastructure practice that redirects stormwater runoff  through soil before entering municipal stormwater systems, which is often discharged directly into local bodies of water. Stormwater runoff flowing over impervious sidewalks and roads enter the tree filter box through a grate. Once inside the box, the water infiltrates through a special soil mixture, a mulch layer, and a shrub or tree root system that are specifically designed to filter out pollutants and contaminants.


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 diversion of water from gutters which would otherwise end up in the storm drain system. It is generally fed into large cisterns which retain the water until it can be used. This water can be re-purposed in several ways including garden watering, domestic use, as well as for fire protection. Not only does this aid in reducing runoff and the issues that come with that, it also reduces stress on well water or municipal water supplies. Generally these are situated beside buildings where gutters drain water from the roof. This in turn either puts less stress on the storm drain system or decreases the erosion associated with large amounts of water running over land.

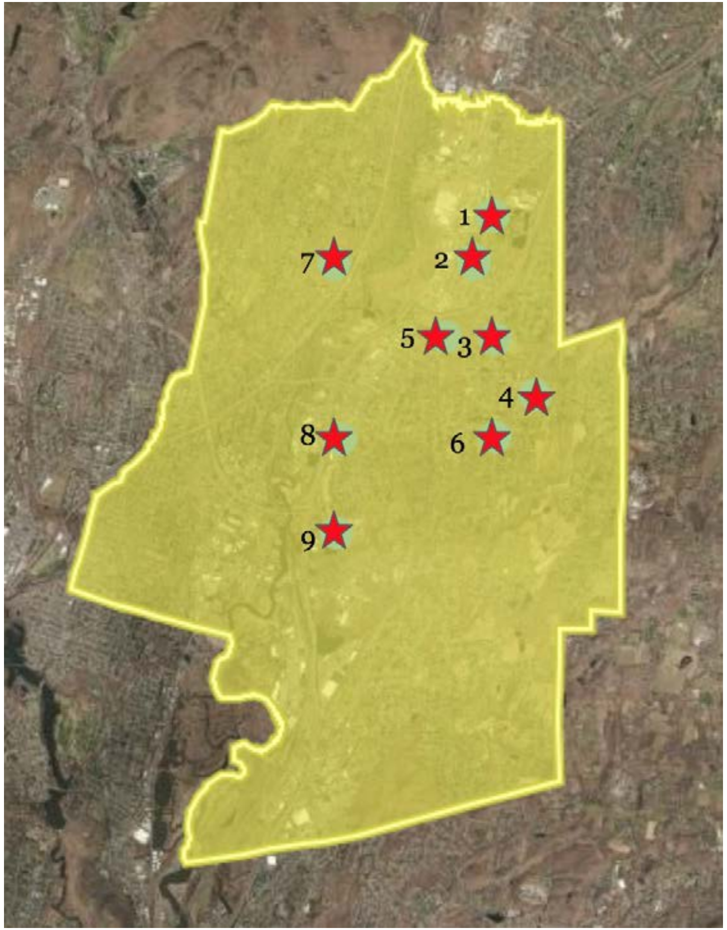
Both the amount of water needed as well as, the area of impermeable cover area are important to pay attention to when deciding how large a cistern to install. The size of the cistern also dictates what material it should be made of. For small drainage areas, PVC is appropriate, but as the size increases steel or even concrete may be necessary. Depending on the anticipated use of the water, a filter may be imperative to prevent contaminants from entering the cistern. Maintenance practices include relocating the cisterns inside to prevent them from freezing in the winter months.

# SITE SELECTION & APPROACH

Before visiting sites, team members used various aerial imagery tools to view locations within each town to determine possible sites suitable for green infrastructure practices.

On location, sites and site specific recommendations were selected based on suitability for implementation of green infrastructure practices.  Whether or not a site was suitable depended on factors such as slope of surrounding land, land available for use, location of existing storm drains, location of above ground and underground obstructions (large trees, pipes, utilities, etc.), hydric soil type, and whether or not some form of green infrastructure practice was already in place.

# SITES MAPPING




1. Quinnipiac North Haven Campus
2. ACES Village School
3. Gateway Community College & Cortland V.R. Creed School
4. Clintonville Elementary School
5. North Haven Housing Authority & Senior Center
6. ACES Mill Road School
7. Green Acres Elementary School
8. North Haven High School & Middle School
9. Recreational Center

# MAP KEY

- Rain Garden/Bioretention Area
- Permeable Pavement
- Drainage Area
- Location of Existing Storm Drains
- Location of Downspout
- Rain Barrel/Cistern
- Tree Box Filter
- Direction of Water Flow

- Contour Lines of Equal Elevation

- Roads
- Other Impervious
- Not Impervious
- Buildings
- Parcel Boundaries

# Site 1: QUINNIPIAC UNIVERSITY STUDENT PARKING LOT SOUTH, NORTH HAVEN CAMPUS


**Location:**

370 Bassett rd. North Haven, CT 06473

**Impermeable cover area:**

12,240 sq feet

**Subregional Watershed:**

5200; Quinnipiac River


Rain Garden/ Bioretention Area

Drainage Area

Direction of Water Flow

Roads

Buildings

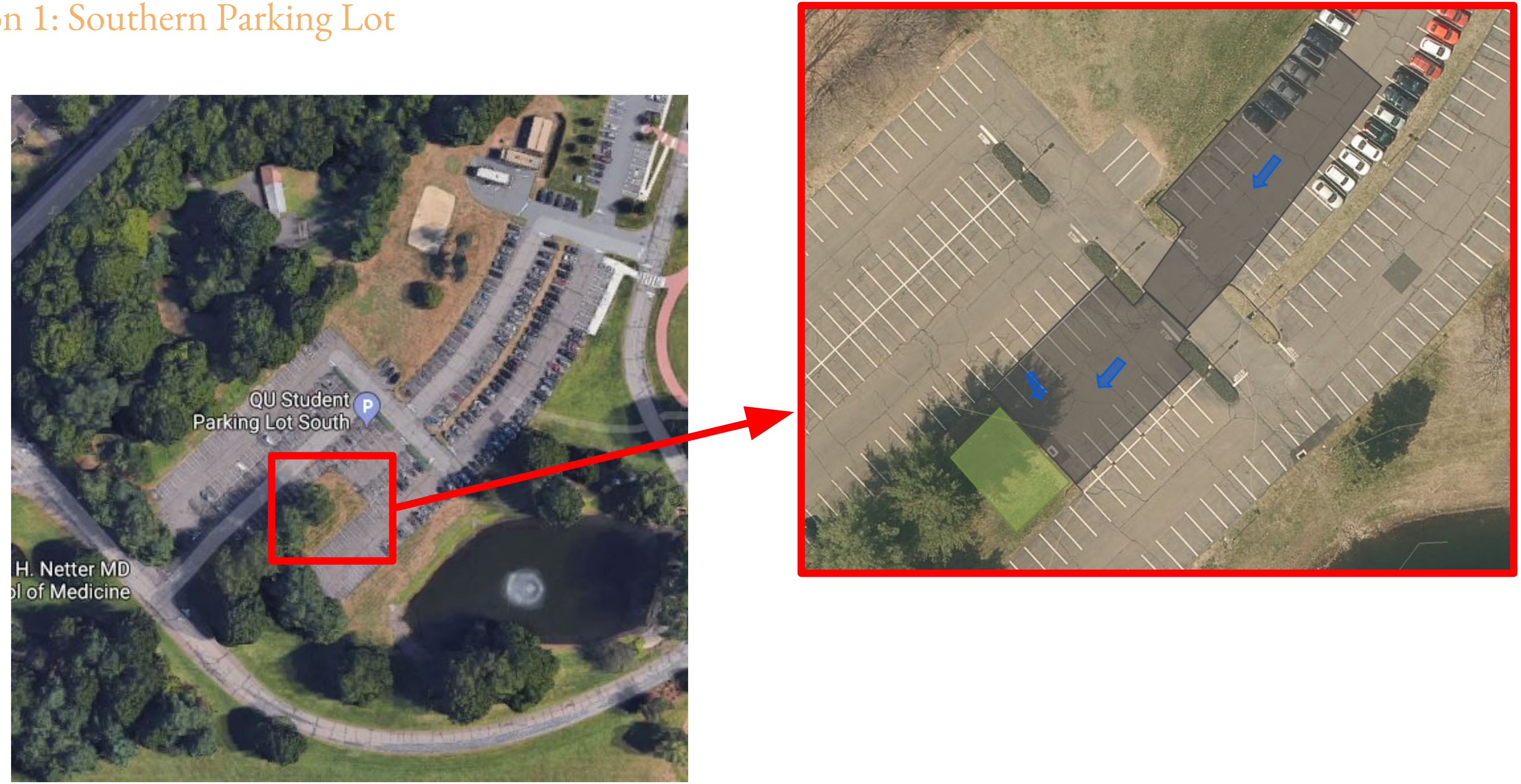
Other Impervious

Not Impervious

Parcel Boundaries

# QUINNIPIAC UNIVERSITY STUDENT PARKING LOT SOUTH, NORTH HAVEN CAMPUS

## Option 1: Southern Parking Lot



| 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) |
|---|---|---|---|---|---|
| 12,240 | Rain garden | 311,329 | 2.118 | 0.150 | 2,040 |

Our recommendation here would be to have the water bypass the storm drain and run into a rain garden on this patch of grass. This would capture a very large quantity of water and be very visible. It may be important to look into the depth of the water table at this point as it could be rather shallow.

# Site 2: ACES VILLAGE SCHOOL

**Location:**

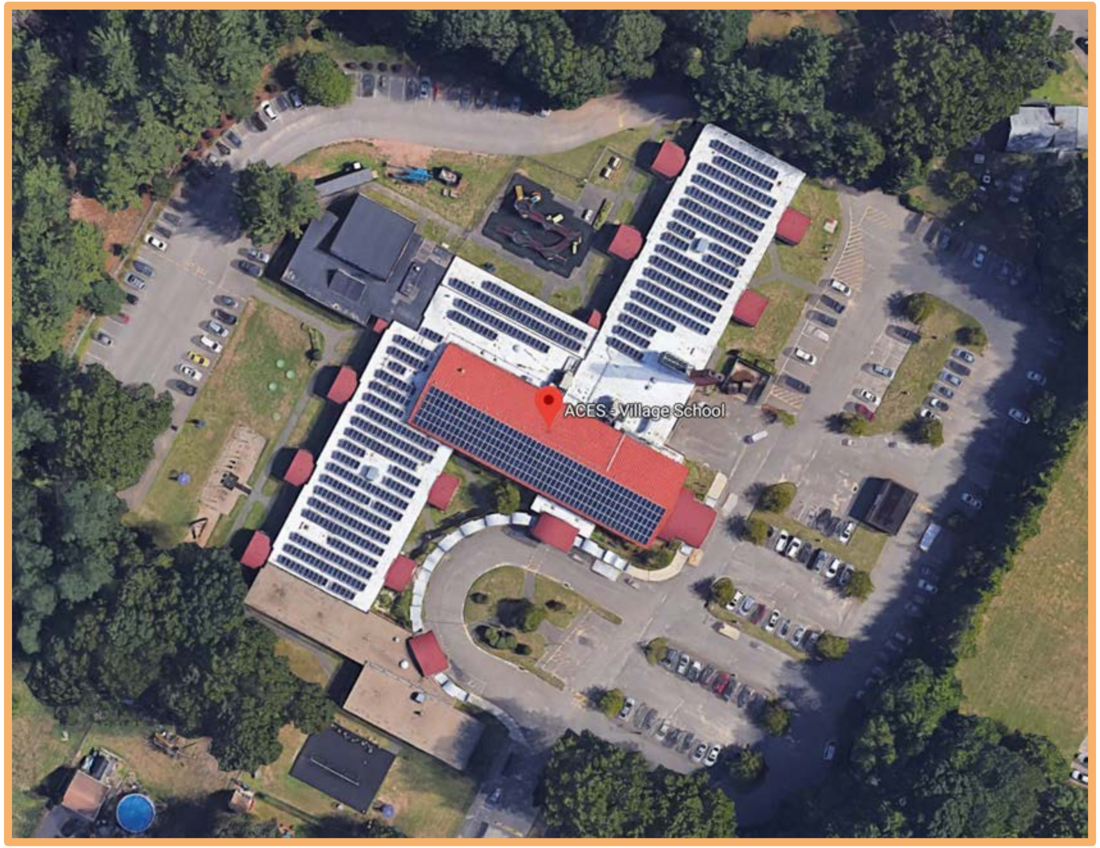
31 Temple Street, North Haven, CT 06473

**Impervious Area:**

32,882 sq feet

**Subregional Watershed:**

5200; Quinnipiac River




Rain Garden/ Bioretention Area
Location of Existing Storm Drains
Location of Downspout
Drainage Area
Direction of Water Flow
Rain Barrel/Cistern

Roads
Other Impervious
Parcel Boundaries
Buildings
Not Impervious

# ACES VILLAGE SCHOOL

## Option 1: Parking Lot on the NE side

| 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) |
|---|---|---|---|---|---|
| 8,389 | Rain Garden | 213,366 | 1.45 | 0.103 | 1,398 |

For this location, we recommend implementing a rain garden inside the barrier on the northeast side of the parking lot. The curb would be cut  to allow access into the rain garden since the water flows naturally to the area. Also, the existing drain would be raised for the bypass system. In order to maintain safety it is recommended that the area be fenced in to prevent anyone from entering the garden.

# ACES VILLAGE SCHOOL

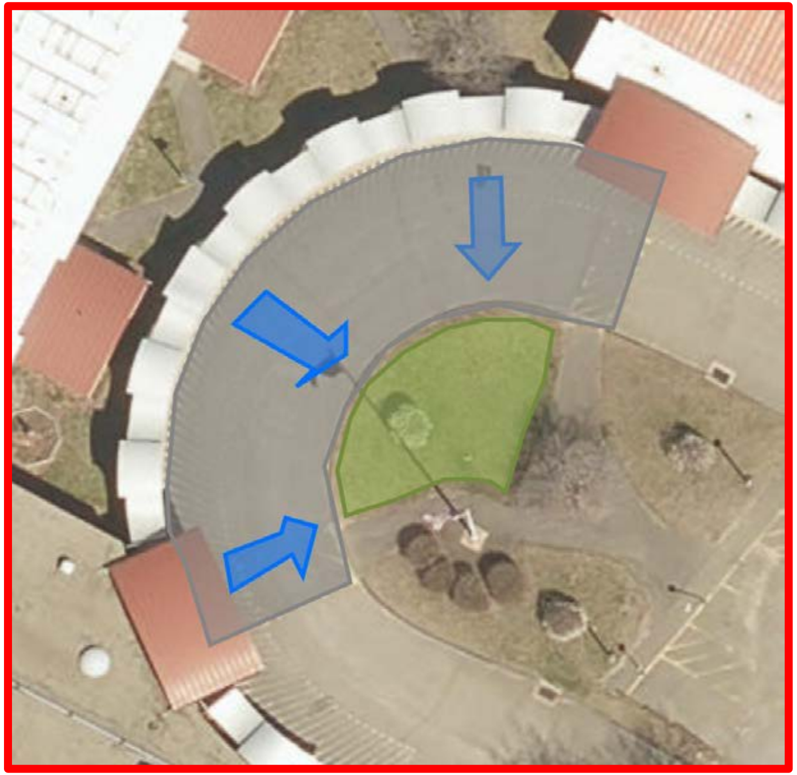
## Option 2: Entrance on the East side

| 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) |
|---|---|---|---|---|---|
| 441 | Rain Garden | 11,221 | 0.076 | 0.005 | 74 |

Here, we recommend placing a rain garden by the east entrance to collect the water running off the roofs. In addition, the rain garden would disconnect two downspouts from the storm water system. This would extend the rain garden further towards the school entrance.

# ACES VILLAGE SCHOOL

## Option 3: Entrance on the South side



| 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 (ft^2) |
|---|---|---|---|---|---|
| 3,170 | Rain Gardens | 80,619 | 0.54 | 0.04 | 528 |

Our recommendation here is to incorporate a rain garden in the middle section near the south entrance. The water around the bus loop flows to the center which would be captured using curb cuts. This would also add to the aesthetic appeal of the school since the rain garden would be at the main entrance. In addition, it could be an educational opportunity for the students to understand green infrastructure practices.

# ACES VILLAGE SCHOOL

## Option 4: Entrance on the West side

| 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 (ft^2) |
|---|---|---|---|---|---|
| 1,572 | Rain Garden | 39,981 | 0.27 | 0.019 | 270 |

At this location we recommend disconnecting three downspouts and having them drain into a rain garden. The area where the rain garden would be placed is about 400 sq ft, which is above the suggested practice size. We are showing the extra room to emphasize that the area is ideal for a rain garden since it has ample room and many options for a landscape design.

# ACES VILLAGE SCHOOL

## Option 5: Drainage on the West Side

| 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 (gallons) |
|---|---|---|---|---|---|
| 91 | Rain Barrel | 2,723 | 0.0157 | 0.001 | 55 |

In the same location there is another downspout that can be disconnected. The drainage area is small since the only source of runoff comes from a small awning. Although another rain garden is an option we suggest connecting the downspout to a rain barrel to collect the water since it's a small drainage area. The rain barrel would prevent 30 - 55 gallons of water from entering the stormwater system for each rain event.

# Site 3: GATEWAY COMMUNITY COLLEGE AND CORTLAND V.R. CREED HIGH SCH


**Location:**

88 Bassett Road, North Haven CT 06473

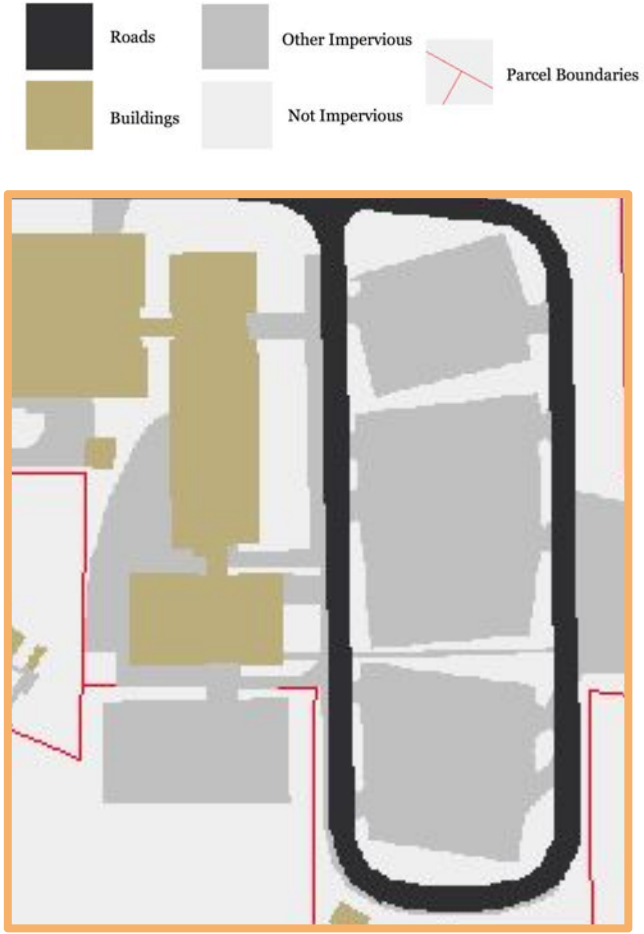
**Impervious Area:**

97,647 ft^2

**Subregional Watershed:**

5200; Quinnipiac River


1
2
3
Permeable Pavement
Drainage Area
Location of Existing Storm Drains
Direction of Water Flow
Tree Box Filter


Roads
Buildings
Other Impervious
Not Impervious
Parcel Boundaries

# GATEWAY COMMUNITY COLLEGE AND CORTLAND V.R. CREED HIGH SCHOOL

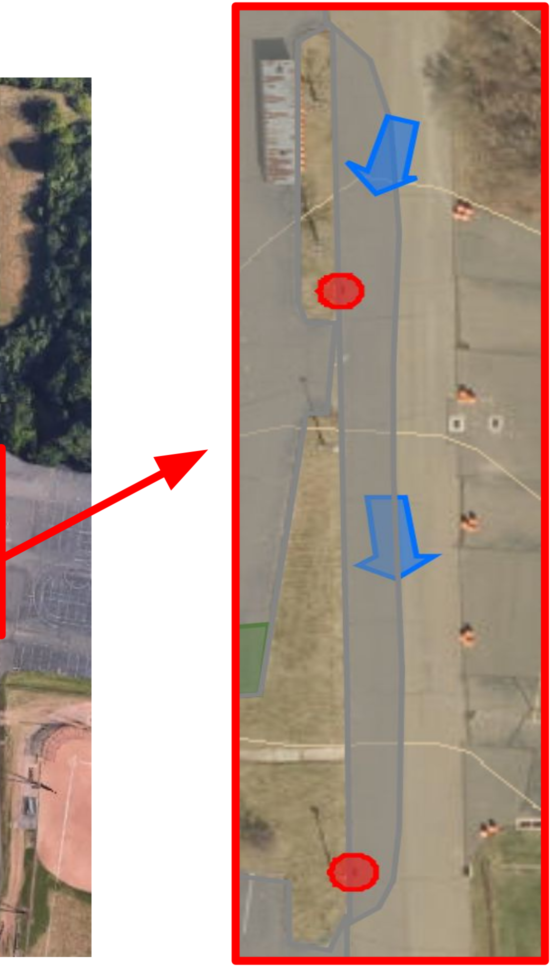
## Option 1: Middle Parking Lot West side

| 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 of permeable pavement) |
|---|---|---|---|---|---|
| 52,060 | Permeable Pavement | 1,323,990 *if the whole area was permeable pavement | 10.6 | 0.752 | 9,287 (3 rows of permeable pavement) |

At this location we recommend replacing the asphalt with permeable pavement. The most ideal area would be to replace the last row of parking. This row would infiltrate 75,154 gallons of water a year, if properly maintained. Other options include replacing the last three rows of parking which would infiltrate 236,197 gallons of water a year. If all the parking spots were replaced with permeable pavement then 608,630 gallons of water a year would infiltrate into the ground instead of entering the stormwater system.

# GATEWAY COMMUNITY COLLEGE AND CORTLAND V.R. CREED HIGH SCHOOL

## Option 2: Middle Parking Lot East side

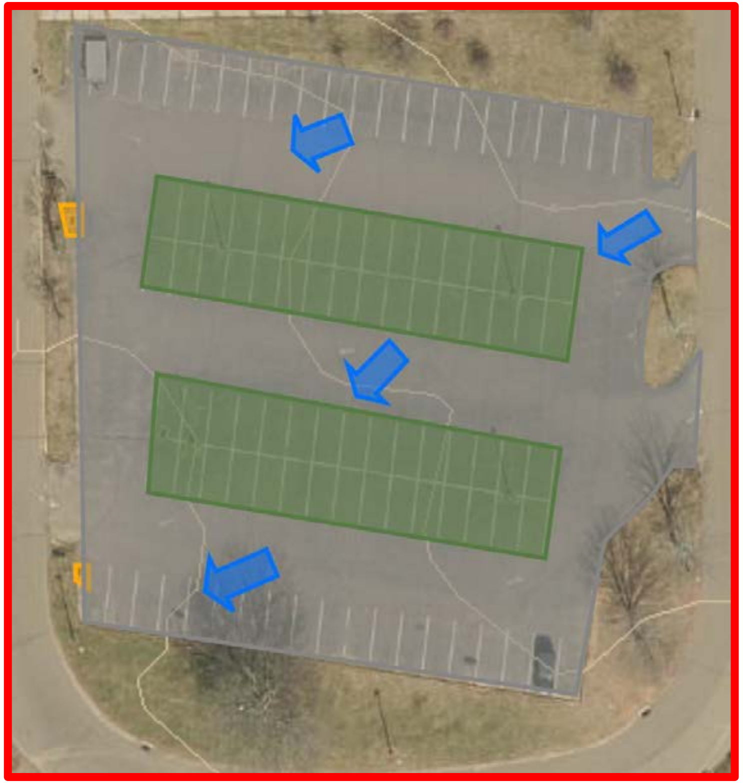


| Drainage Area (sq ft) | Suggested Green Infrastructure | Annual Gallons Treated | Annual Nitrogen Reduction (lb N/yr) | Annual Phosphorus Reduction (lb P/yr) | Suggested Practice Size (# Tree Box Filters) |
|---|---|---|---|---|---|
| 3,656 | Tree Box Filters | 92,979 | 0.63 | 0.045` | 2 |

In addition to the permeable pavement two tree box filters could be built to collect discharge coming from the east side of the parking lot. The tree box filters are ideal for this location because they would be easy to build since they would be located on top of current storm drains. Each tree box filter would infiltrate 46,489 gallons of water a year instead of entering the stormwater system.

# GATEWAY COMMUNITY COLLEGE AND CORTLAND V.R. CREED HIGH SCHOOL

## Option 3: South Parking Lot



| 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) |
|---|---|---|---|---|---|
| 37,283 | Permeable Pavement | 948,186 *if the whole area was permeable pavement | 8.25 | 0.585 | 10,432 (4 rows of permeable pavement) |

Our recommendation here is to install pervious pavement on the four inner rows of the parking lot. These spots were ideal since most runoff flows over these spots to enter into the storm drains on the other side. These spots would infiltrate 265,306 gallons of runoff a year and decrease the amount of water directed to the storm drains. If all the parking spots were replaced with permeable pavement then they would infiltrate 449,253 gallons of water a year.

# Site 4: CLINTONVILLE ELEMENTARY SCHOOL

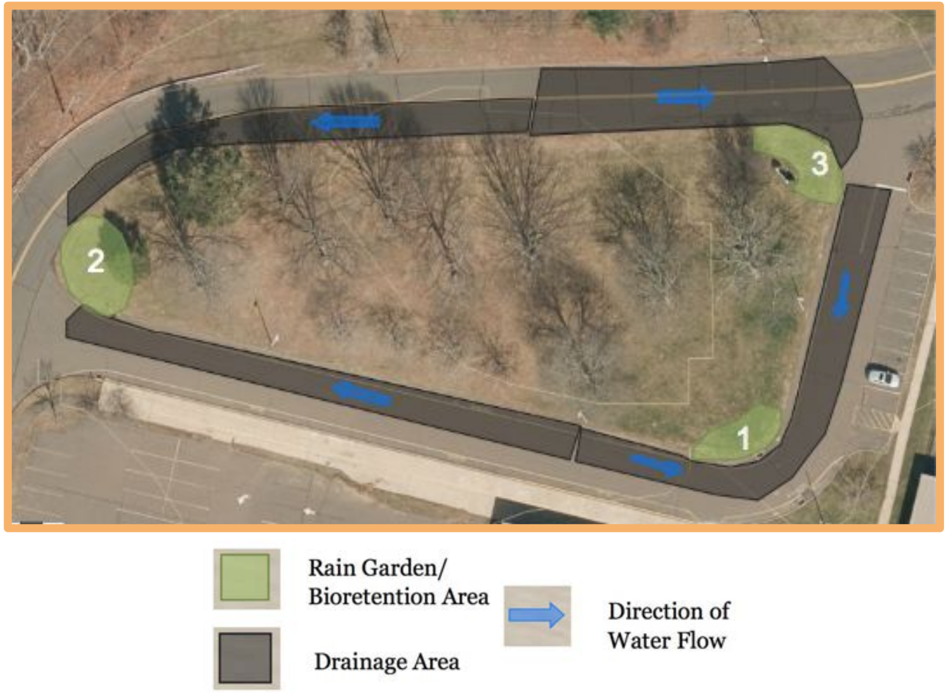
**Location:**

456 Clintonville Rd, North Haven, CT 06473

**Impervious Area of Interest:**
13,878 ft^2

**Subregional Watershed:**

5200; Quinnipiac River



2
3
1
Rain Garden/
Bioretention Area
Drainage Area
Direction of
Water Flow


Roads
Buildings
Other Impervious
Not Impervious
Parcel Boundaries

# CLINTONVILLE ELEMENTARY SCHOOL

## Option 1: SE Corner Front Entrance


| 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) |
|---|---|---|---|---|---|
| 3,403 | Rain Garden | 86,545 | .589 | .042 | 570 |

We recommend installing a rain garden behind the storm drain and design it in a way that redirects storm water away from the existing drain. Due to this location's high visibility, not only would a rain garden beautify the front entrance of the school, but would be a fantastic opportunity to educate the students, faculty, and surrounding community on the importance of LID.

# CLINTONVILLE ELEMENTARY SCHOOL

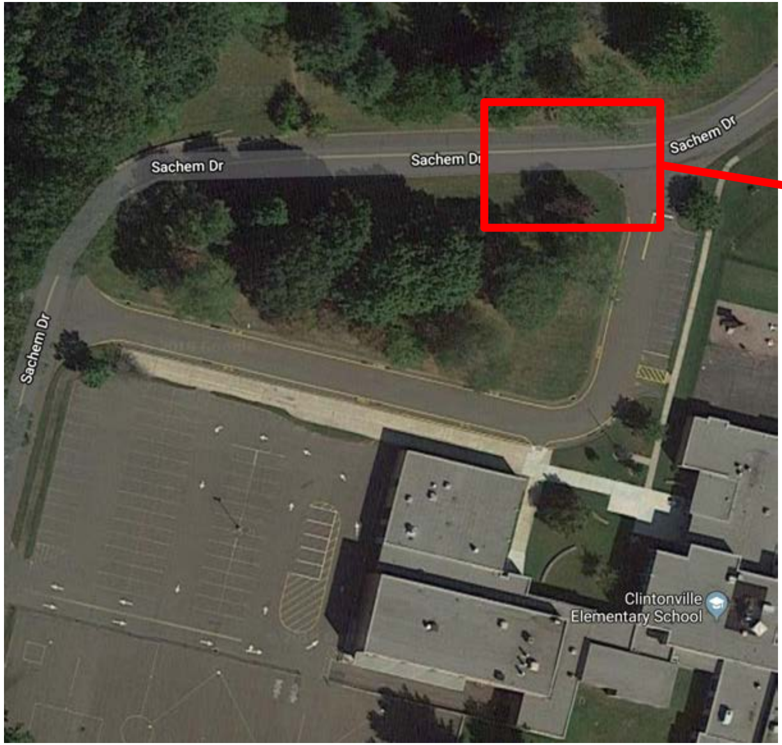
## Option 2: West Corner Front Entrance Rain Garden

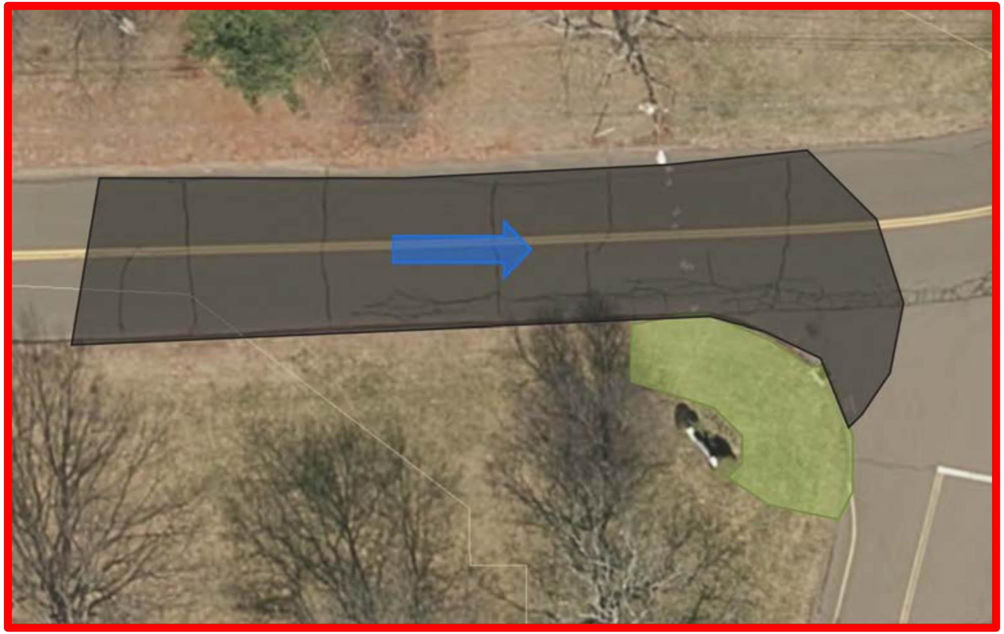

| Drainage Area (sq ft) | Suggested Green Infrastructure | Annual Gallons Treated | Annual Nitrogen Reduction (lb N/yr) | Annual Phosphorus Reduction (lb P/yr) | Suggested Practice Size (sq ft) |
|---|---|---|---|---|---|
| 6,244 | Rain Garden | 158,797 | 1.08 | .077 | 1,041 |

This location receives the most water per year out of the 3 options. We recommend either building one large bioretention area to accommodate the 2 existing storm drains on this corner, or building 2 smaller rain gardens.

# CLINTONVILLE ELEMENTARY SCHOOL

## Option 3: NE Corner Front Entrance Rain Garden



| Drainage Area (sq ft) | Suggested Green Infrastructure | Annual Gallons Treated | Annual Nitrogen Reduction (Ib N/yr) | Annual Phosphorus Reduction (Ib P/yr) | Suggested Practice Size (sq ft) |
|---|---|---|---|---|---|
| 4,231 | Rain Garden | 107,603 | 0.732 | 0.052 | 705 |

In this location, water from a small but significant portion of Sachem Drive tends to flow into the storm drain directly in front of the school's entrance sign. A small rain garden here to redirect storm water from flowing into the storm drain would be highly visible from the road, and would complement the areas current landscaping. Again, due to this locations high traffic, visible LID areas would be of great benefit to the surrounding community.

# Site 5: NORTH HAVEN HOUSING AUTHORITY/SENIOR CENTER

**Location:**

191 Pool Rd, North Haven CT 06473

**Impervious Area of Interest:**

2,020 ft^2

**Subregional Watershed:**

5200; Quinnipiac River


Rain Garden/ Bioretention Area

Drainage Area

Location of Downspout

Direction of Water Flow

Rain Barrel/Cistern

Roads

Buildings

Other Impervious

Not Impervious

Parcel Boundaries

# NORTH HAVEN HOUSING AUTHORITY/SENIOR CENTER

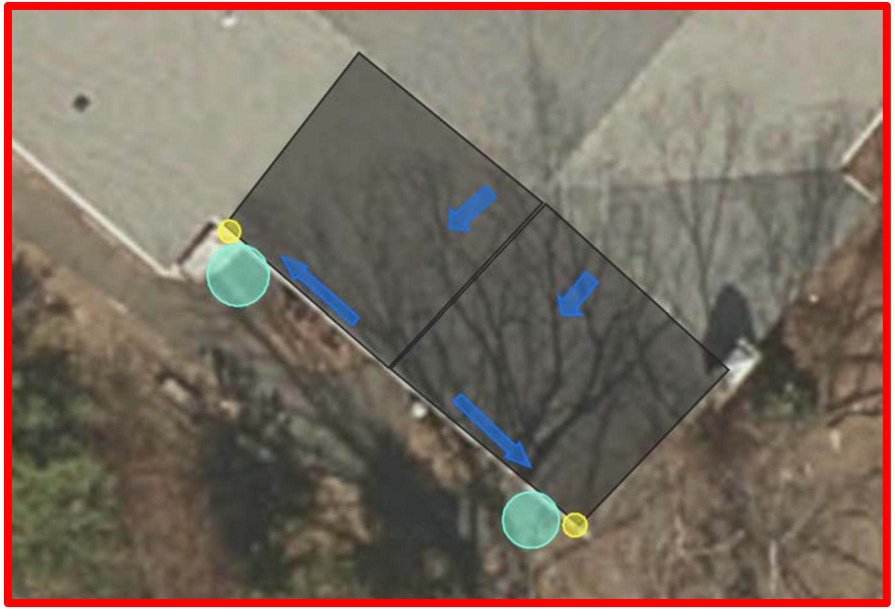
## Option 1: Front Side of Senior Center Building

| 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) |
|---|---|---|---|---|---|
| 1,220 | Rain Garden | 31,027 | .211 | .015 | 203 |

For this location, we recommend disconnecting the two front downspouts, diverting the water they collect from the storm water system. The water can be directed into a landscaped rain garden within the mulched area. This would reduce the need for use of the existing underground sprinkler system. This area is mostly shady, so shade tolerant plants would be selected for this rain garden.

# NORTH HAVEN HOUSING AUTHORITY/SENIOR CENTER

## Option 2: Side Garden 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) |
|---|---|---|---|---|---|
| 400 for each downspout drainage area | Rain Barrel or Cistern | 10,173 for each downspout drainage area | .069 | .005 | 67 |

Both downspouts in this area drain the same quantity of water. Depending on the amount of water demanded by the small existing garden beds, either one or both downspouts can be disconnected from the storm water system and directed into a small cistern or rain barrel.

# Site 6: ACES MILL ROAD SCHOOL

**Location:**

295 Mill Rd, North Haven, CT 06473

**Impervious Area of Interest:**

10,422 ft^2

**Subregional Watershed:**

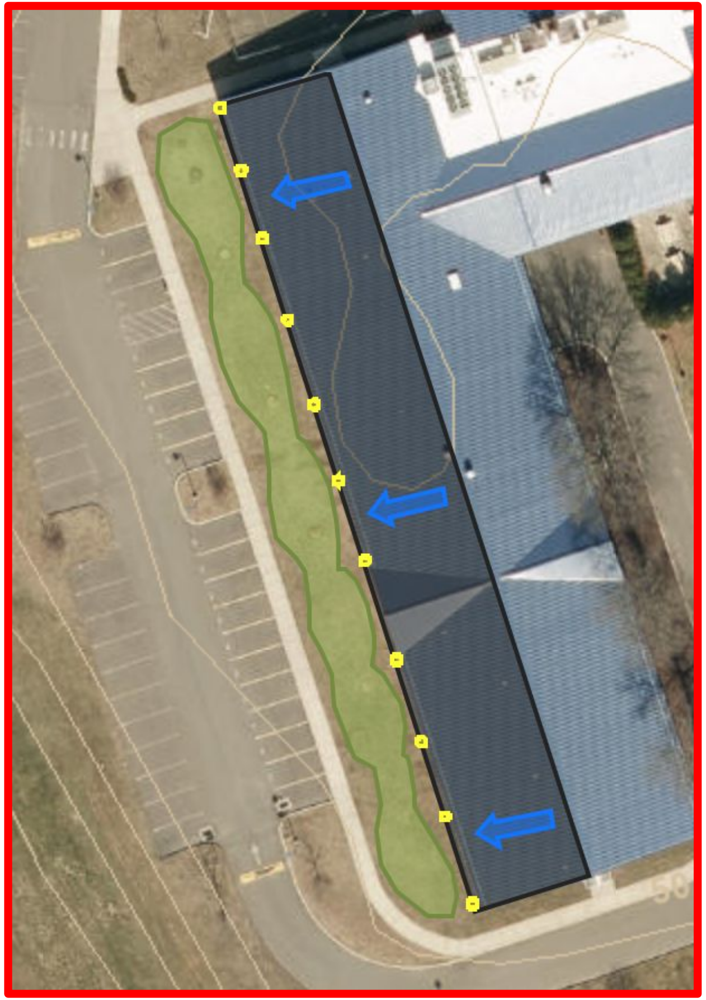
5200; Quinnipiac River


50
Rain Garden/
Bioretention Area
Location of
Downspout
Drainage Area
Direction of
Water Flow


Roads
Other Impervious
Parcel Boundaries
Buildings
Not Impervious

# ACES MILL ROAD SCHOOL

## Option 1:West Facing Land Strip Between Building and Parking Lot



| 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) |
|---|---|---|---|---|---|
| 10,422 | Rain Garden | 265,052 | 1.80 | .128 | 1,737 |

There are 11 downspouts located on the side of the building, all of which direct rooftop runoff into the stormwater detention basins. If these downspouts are disconnected from the system, the water can be directed into a large bioretention area, or several smaller rain gardens and allow for infiltration into native soils, in addition to adding aesthetic appeal. We believe that a rain garden at this location would add significant value to the current student education and experience on this campus.

# Site 7: GREEN ACRES ELEMENTARY SCHOOL

**Location:**

146 Upper State Street

**Impervious Area of Interest:**

51,279 sq. ft.

**Subregional Watershed:**

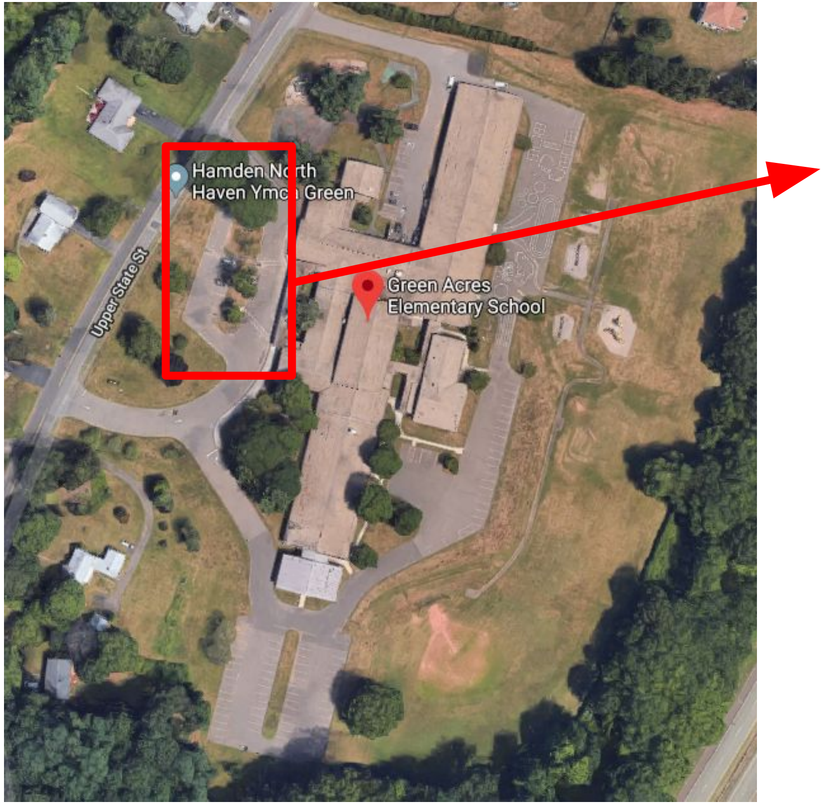
5200, Quinnipiac River


1
2
3
4
5
6
Rain Garden/ Bioretention Area
Location of Existing Storm Drains
Drainage Area
Direction of Water Flow


Roads
Buildings
Other Impervious
Not Impervious
Parcel Boundaries

# GREEN ACRES ELEMENTARY SCHOOL

## Option 1: West Parking Lot Center Island

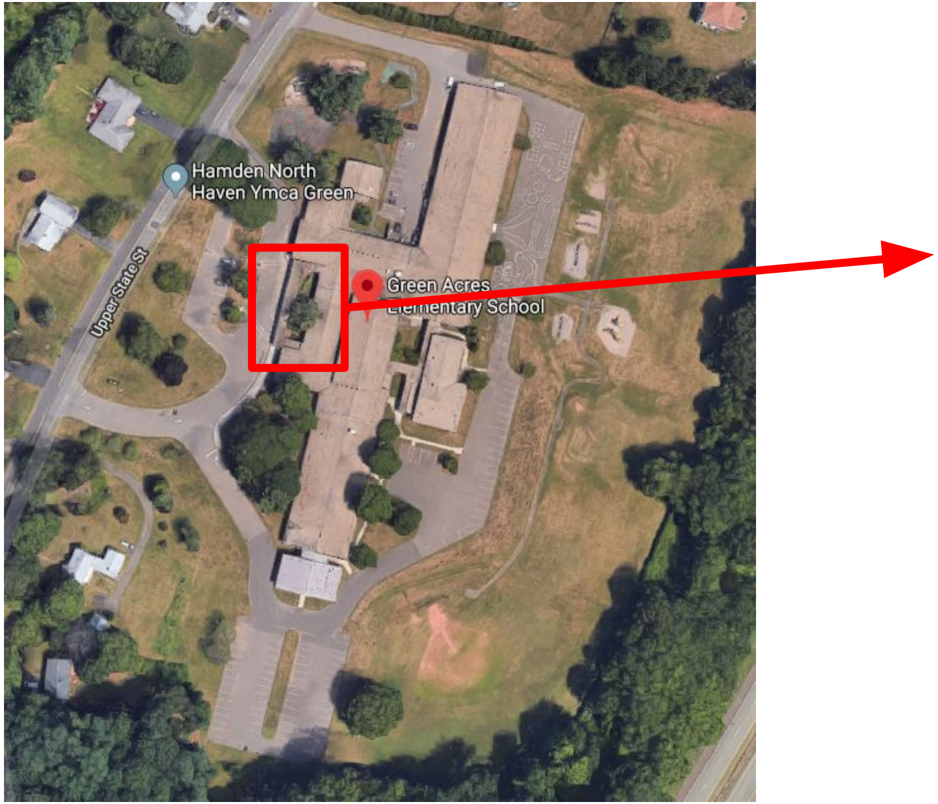



| Drainage Area (sq ft) | Suggested Green Infrastructure | Annual Gallons Treated | Annual Nitrogen Reduction (lb N/yr) | Annual Phosphorus Reduction (lb P/yr) | Suggested Practice Size (sq ft) |
|---|---|---|---|---|---|
| 1,245 | Rain Garden | 31,662 | 0.22 | 0.15 | 208 |

The first recommendation for this site is to build a rain garden in the front of the small parking lot. The water from the northern entrance of the school falls down to the area close to the sidewalk eroding the grass. Implementing a rain garden with the already cut curb would help to infiltrate the water and improve the aesthetics of this front area.

# GREEN ACRES ELEMENTARY SCHOOL

## Option 2: Front Terrace Entrance




| 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) |
|---|---|---|---|---|---|
| 2,682 | Rain Garden | 68,208 | 0.46 | 0.33 | 447 |

Our recommendation here is to disconnect the middle downspout from the overhead walkway cover to feed into a rain garden in the open grassy area of the front. There is already a disconnection from the 4 downspouts on the building that would also contribute to feeding the garden. The vegetation of the rain garden would help infiltrate the water into the natural soil. This spot in front of the school would be a good spot for educational examples.

# GREEN ACRES ELEMENTARY SCHOOL

## Option 3: Driveway to South Parking Lot


| 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) |
|---|---|---|---|---|---|
| 6,204 | Rain Garden | 157,780 | 1.07 | 0.76 | 1,034 |

The curb here currently directs all the stormwater to a storm drain. Our recommendation is to cut the curb alongside this driveway to feed a rain garden next to the drain. This will help infiltrate the water and will create an aesthetically pleasing garden in front of the school.

# GREEN ACRES ELEMENTARY SCHOOL

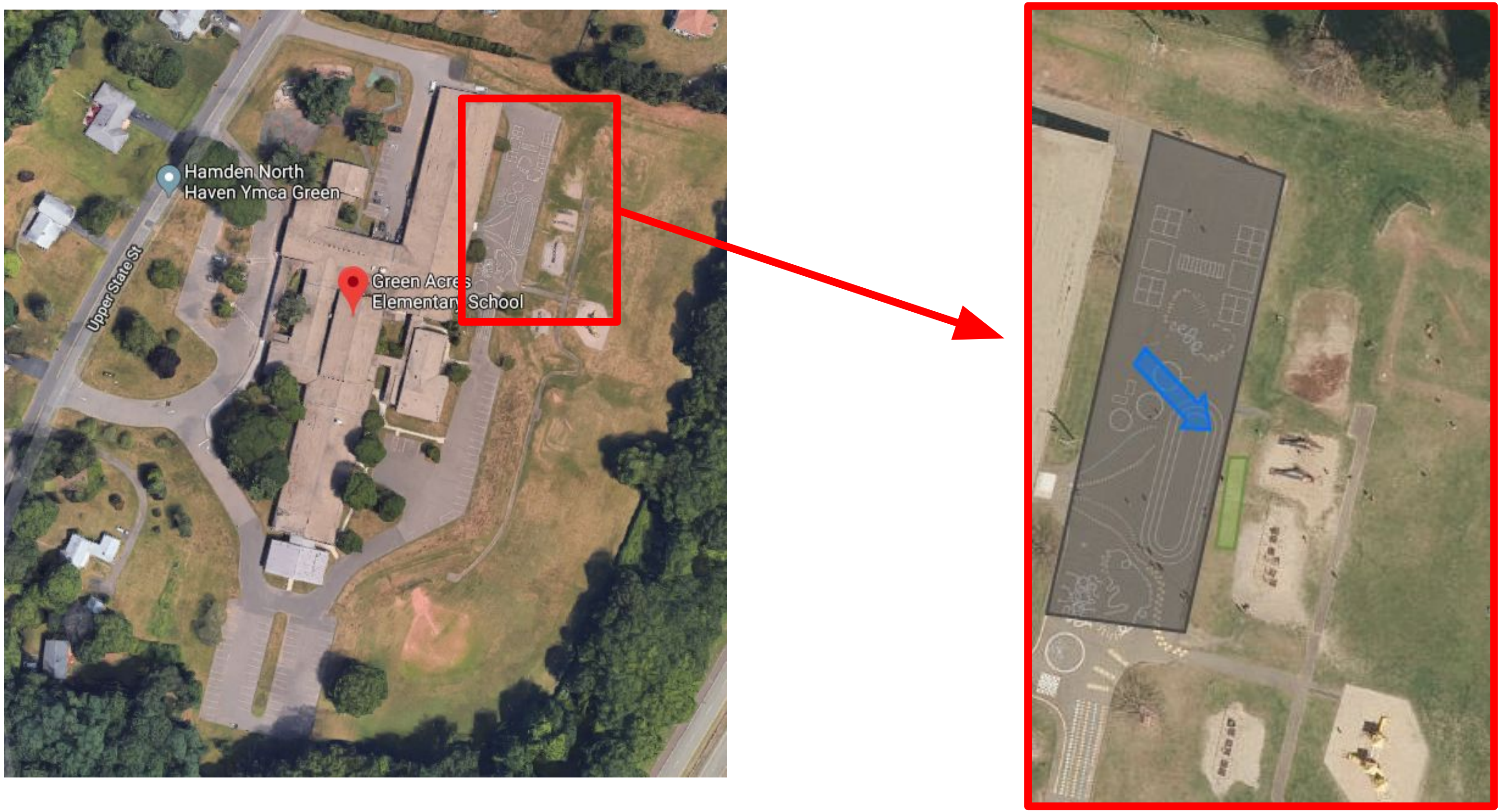
## Option 4: South Parking Lot


| 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) |
|---|---|---|---|---|---|
| 28,149 | Rain Garden | 715,888 | 4.87 | 3.45 | 4,692 |

Our recommendation here is to create a rain garden along the southern end of this parking lot. The entire area of the parking lot drains to the two storm drains along the curb. If the curb were to be cut along this side, the water could be directed into a rain garden area to infiltrate native soils.

# GREEN ACRES ELEMENTARY SCHOOL

## Option 5: Western Playground



| Drainage Area (sq ft) | Suggested Green Infrastructure | Annual Gallons Treated | Annual Nitrogen Reduction (Ib N/yr) | Annual Phosphorus Reduction (Ib P/yr) | Suggested Practice Size (sq ft) |
|---|---|---|---|---|---|
| 12,999 | Rain Garden | 330,590 | 2.56 | 1.59 | 2,167 |

This site seems to be already implemented as a bioretention area, but the drainage should be elevated for maximum catchment. This location may already be a vegetated swale and would be a difficult area to catch much water as there may be foot traffic with the children.

# Site 8: NORTH HAVEN HIGH SCHOOL & MIDDLE SCHOOL

**Location:**

221 Elm Street, North Haven CT 06473

**Impermeable cover area:**

50,617 sq feet

**Subregional Watershed:**

5200; Quinnipiac River


Rain Garden/ Bioretention Area

Drainage Area

Direction of Water Flow

Roads

Buildings

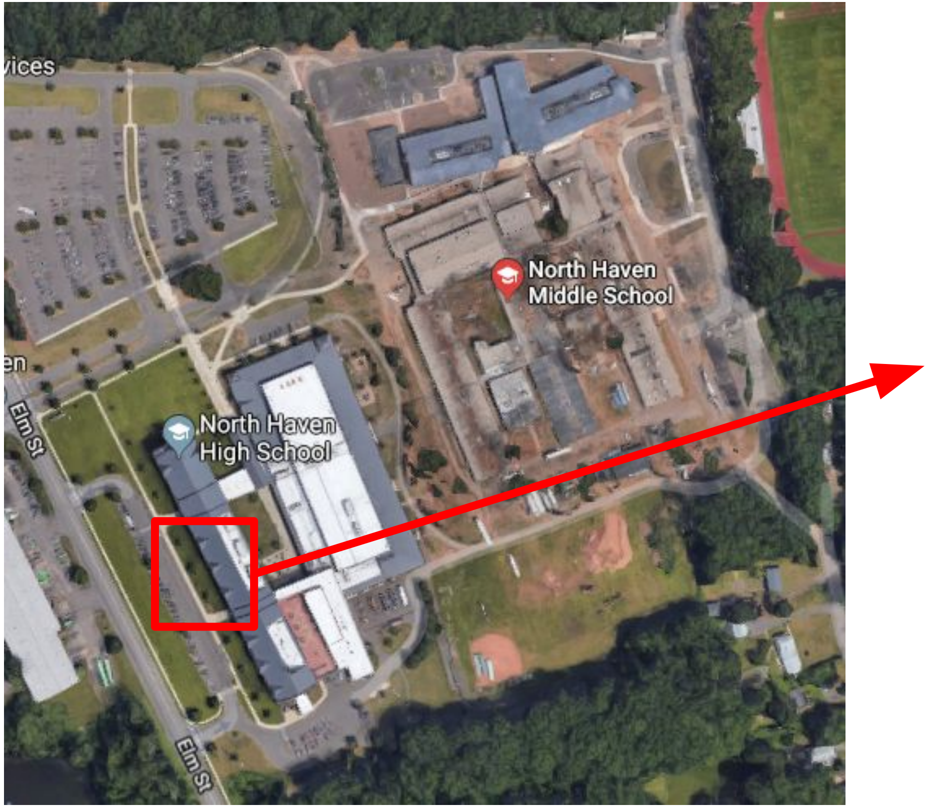
Other Impervious

Not Impervious

Parcel Boundaries

# NORTH HAVEN HIGH SCHOOL/MIDDLE SCHOOL

## Option 1: West side of High School

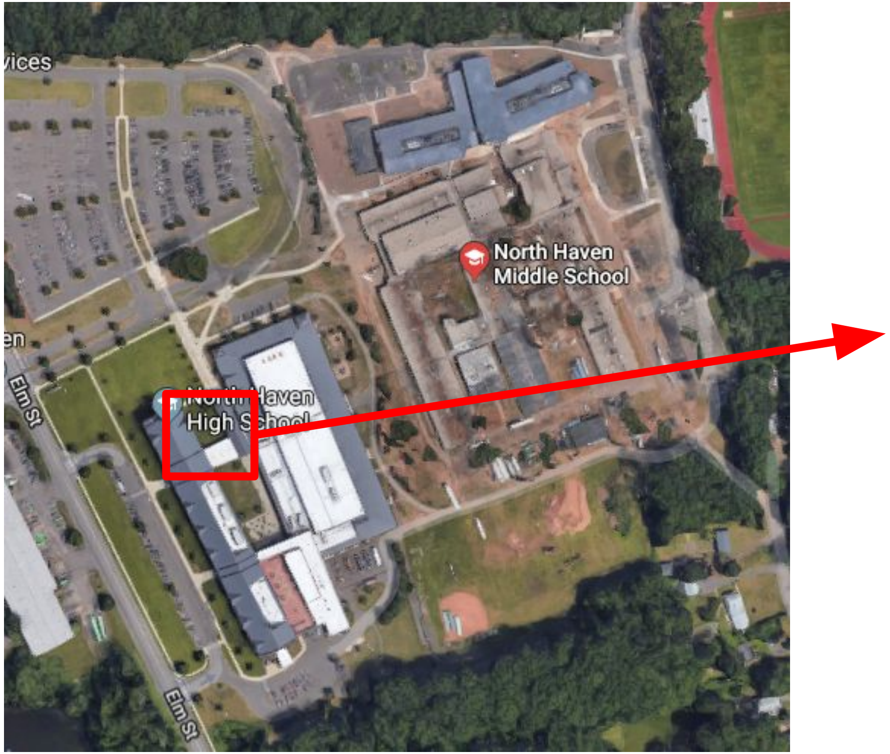



| Drainage area (sq ft) | Suggested green infrastructure | Annual gallons treated | Annual Nitrogen reduction (lb N/yr) | Annual phosphorus reduction (lb P/yr) | Suggested Practice Size (sq ft) |
|---|---|---|---|---|---|
| 3,964 | Rain Garden | 100,826 | 0.686 | 0.049 | 661 |

Our recommendation here is to disconnect the downspouts on this side of the high school from the storm drain system. These could be led into a bioretention area encompassing part of the western side of the high school. There is great visibility here from the road, and a lot of open area to work with.

# NORTH HAVEN HIGH SCHOOL/MIDDLE SCHOOL

## Option 2: North Side of High School (Quad)

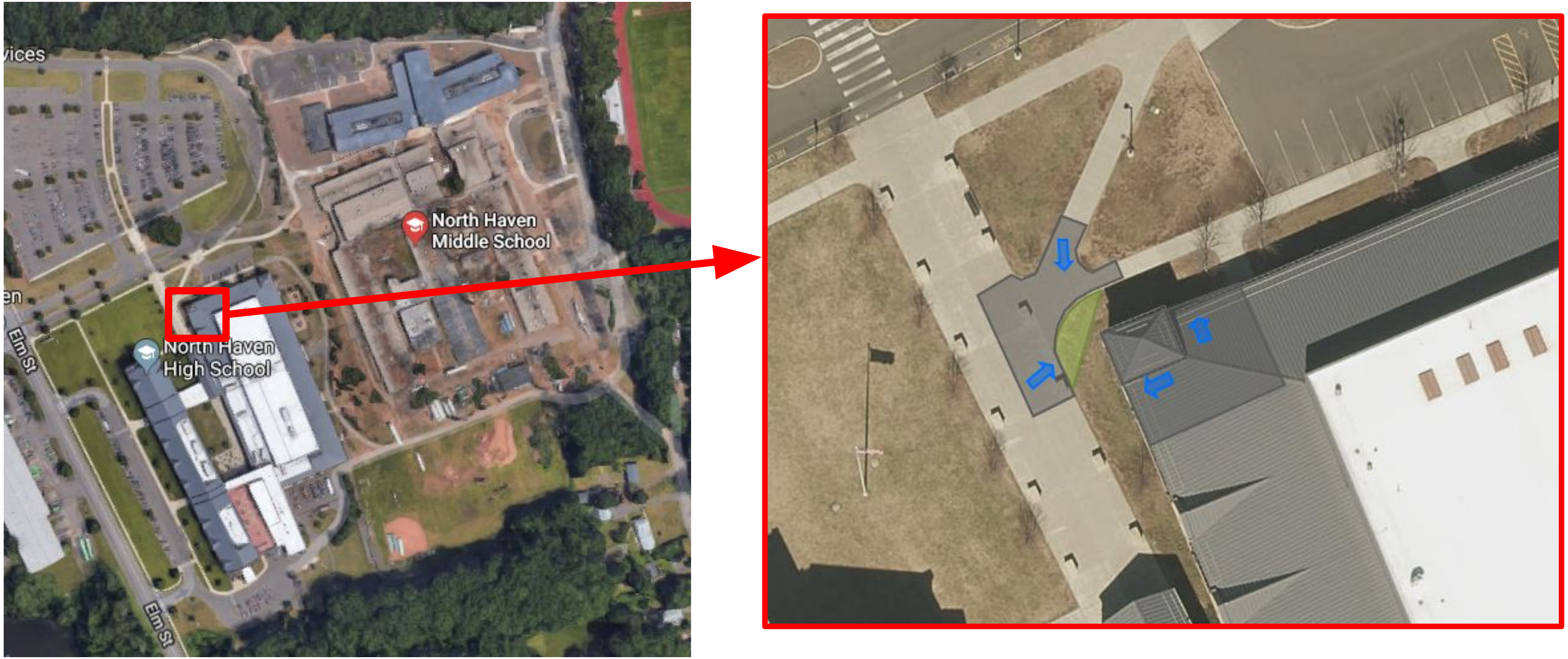



| Drainage area (sq ft) | Suggested green infrastructure | Annual gallons treated | Annual Nitrogen reduction (lb N/yr) | Annual phosphorus reduction (lb P/yr) | Suggested Practice Size (sq ft) |
|---|---|---|---|---|---|
| 9,975 | Rain Garden | 253,718 | 1.726 | 0.122 | 1,663 |

Our recommendation here is to implement a bioretention area in the quadrangle. This would be able to intercept all the water from the adjacent roof. It may also be possible to work with the downspout coming out of the side of the southern wall. This location has excellent visibility as it is the main entrance to the high school. There is already a storm drain on this grass so this could act as an overflow.

# NORTH HAVEN HIGH SCHOOL/MIDDLE SCHOOL

## Option 3: North Side of High School

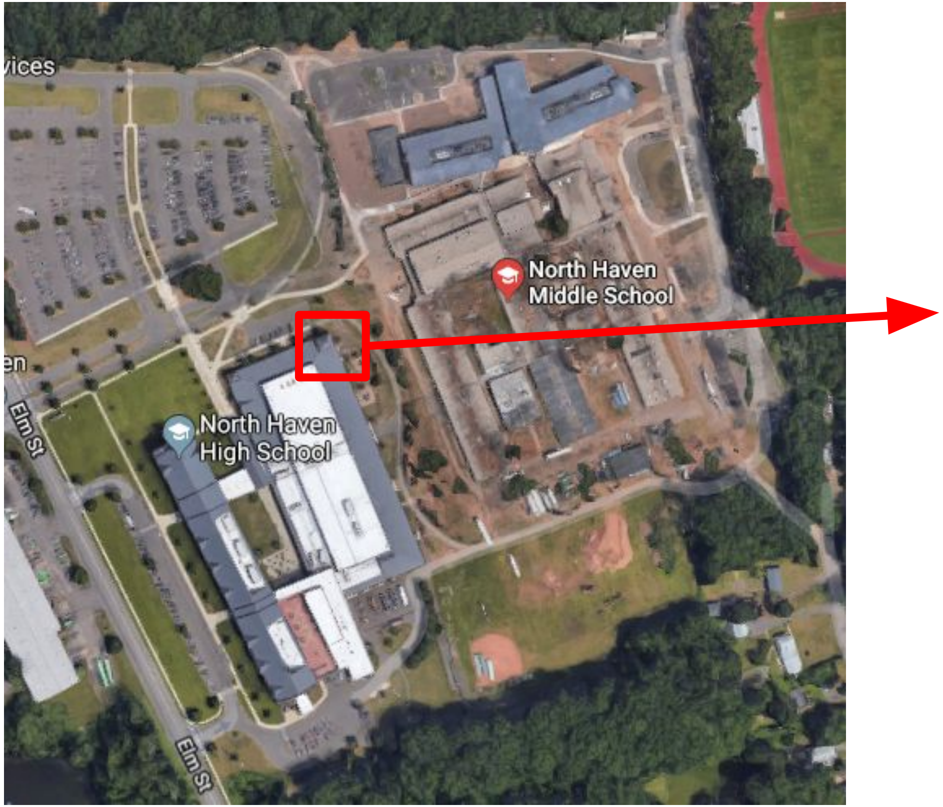


| Drainage area (sq ft) | Suggested green infrastructure | Annual gallons treated | Annual Nitrogen reduction (lb N/yr) | Annual phosphorus reduction (lb P/yr) | Suggested Practice Size (sq ft) |
|---|---|---|---|---|---|
| 915 | Rain Garden | 23,273 | 0.158 | 0.011 | 153 |

For this location, a relatively small amount of water would be redirected. We would recommend establishing a small rain garden at the corner of the building to take the water that would otherwise run into the already present storm drain. This is located in an area with high visibility as it is proximal to the main entrance of the high school.

# NORTH HAVEN HIGH SCHOOL/MIDDLE SCHOOL

## Option 4: Eastern side of High School

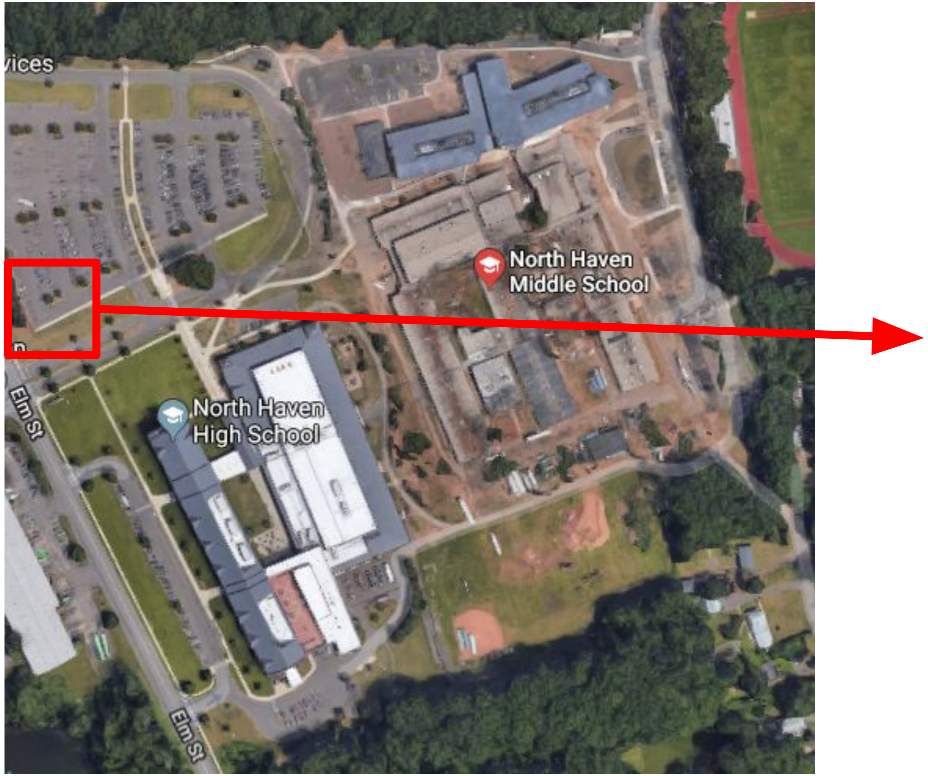



| Drainage area (sq ft) | Suggested green infrastructure | Annual gallons treated | Annual Nitrogen reduction (lb N/yr) | Annual phosphorus reduction (lb P/yr) | Suggested Practice Size (sq ft) |
|---|---|---|---|---|---|
| 7,144 | Rain garden | 181,710 | 1.236 | 0.088 | 1191 |

Here, we recommend to build a rain garden in the proximity of the storm drain. This would take much of the water from the adjacent roof, sidewalks, and downsloping grass. The already present storm drain is at a low lying area and could be used as an overflow for the potential rain garden.

# NORTH HAVEN HIGH SCHOOL/MIDDLE SCHOOL

## Option 5: Southwestern Side of Student Parking Lot

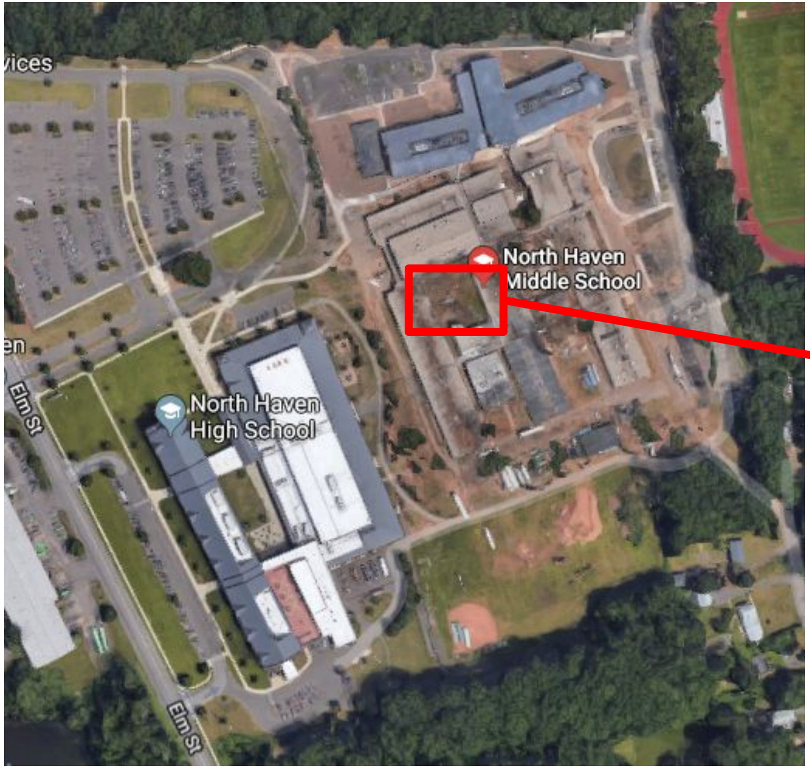



| Drainage area (sq ft) | Suggested green infrastructure | Annual gallons treated | Annual Nitrogen reduction (lb N/yr) | Annual phosphorus reduction (lb P/yr) | Suggested Practice Size (sq ft) |
|---|---|---|---|---|---|
| 26,354 | Rain Garden | 670,325 | 4.559 | 0.323 | 4,392 |

Our recommendation here is to build a bioretention area to capture the water that would otherwise enter the storm drain. As seen in the upper picture, there is a tremendous amount of water and debris that floods into this low lying area. We recommend bypassing the present storm drain and leading all this water into a large deep basin so it could slowly percolate.

# NORTH HAVEN HIGH SCHOOL/MIDDLE SCHOOL

## Option 6: Western Side of Middle School




| 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) |
|---|---|---|---|---|---|
| 2,265 | Rain garden | 57,611 | 0.392 | 0.028 | 378 |

For this site we recommend detaching the downspouts from the storm drain system and leading them into a rain garden. This would capture water from a relatively small section of the roof and therefore wouldn't need to be very large. It is adjacent to the entrance of the school so it would have great visibility.

# Site 9: RECREATIONAL CENTER AND WALTER GAWRYCH COMMUNITY POOL

**Location:**

45 Elm Street, North Haven CT 06473

**Impermeable cover area:**

16,378 sq feet

**Subregional Watershed:**

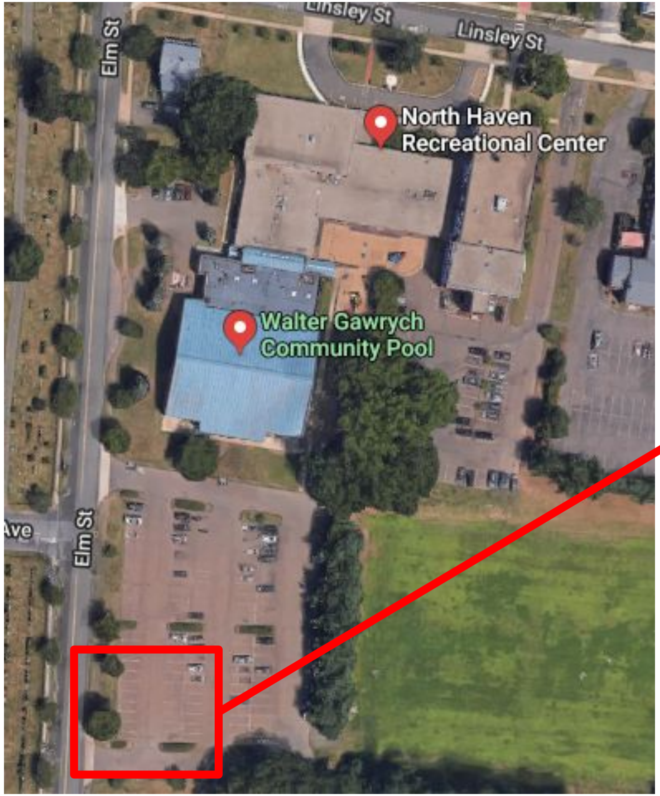
5200; Quinnipiac River


2
1
Rain Garden/
Bioretention Area
Drainage Area
Direction of
Water Flow


Roads
Buildings
Other Impervious
Not Impervious
Parcel Boundaries

# RECREATIONAL CENTER AND WALTER GAWRYCH COMMUNITY POOL

## Option 1: Southern Road Side of Parking Lot

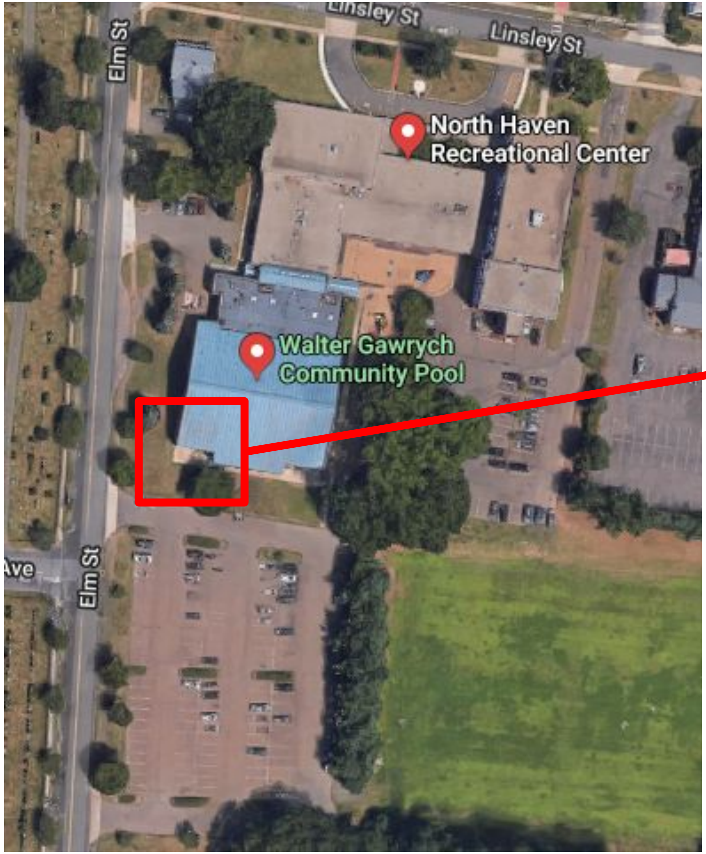


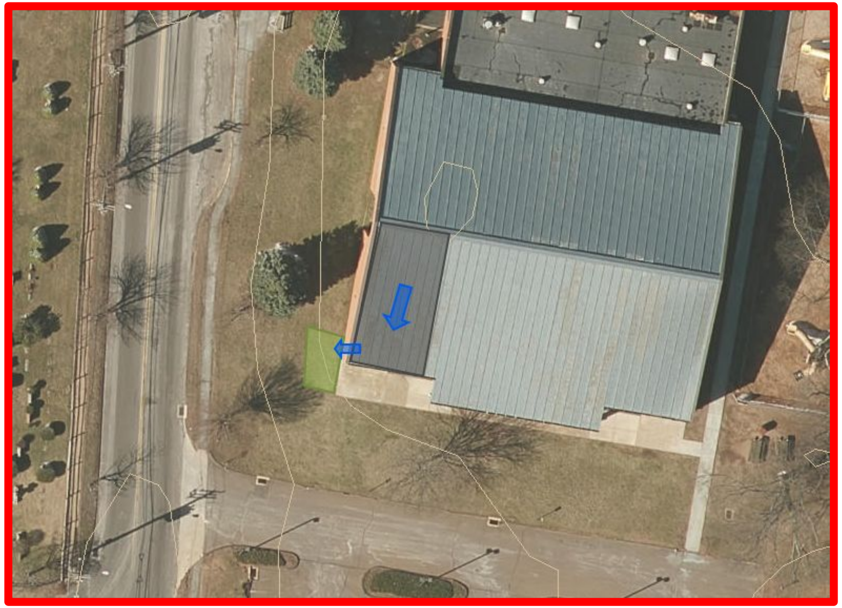

| Drainage area (sq ft) | Suggested green infrastructure | Annual gallons treated | Annual Nitrogen reduction (lb N/yr) | Annual phosphorus reduction (lb P/yr) | Suggested Practice Size (sq ft) |
|---|---|---|---|---|---|
| 16,378 | Rain garden | 416,581 | 2.834 | 0.201 | 2,730 |

Our recommendation here would be to cut the curb and lead the water into a rain garden. This rain garden could be placed between the two trees that are planted in this stretch of grass. This would receive much of the water from the lower half of the parking lot.

# RECREATIONAL CENTER AND WALTER GAWRYCH COMMUNITY POOL

## Option 2: West of Building Road Side



| 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) |
|---|---|---|---|---|---|
| 1,611 | Rain garden | 40,976 | 0.278 | 0.020 | 277 |

Our recommendation for this site would be to disconnect this downspout from the storm drain system and build a rain garden here. This would receive water from a smaller portion of the western side of the community pool roof. It would also be located in a very visible spot.

# CONTACT & PARTNERS PAGE

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