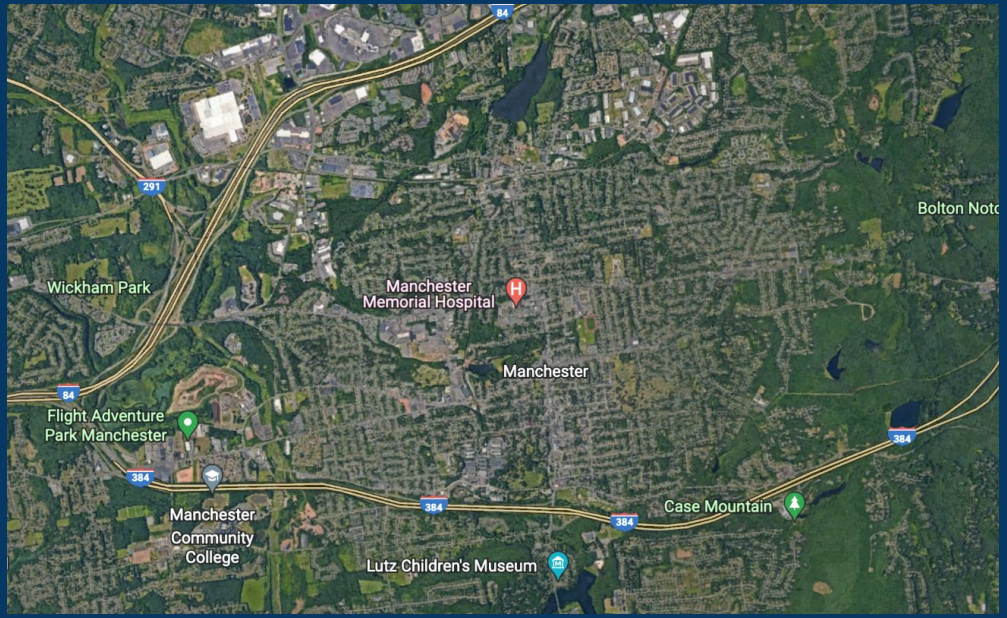
Stormwater Runoff Reduction Plan - Manchester, CT



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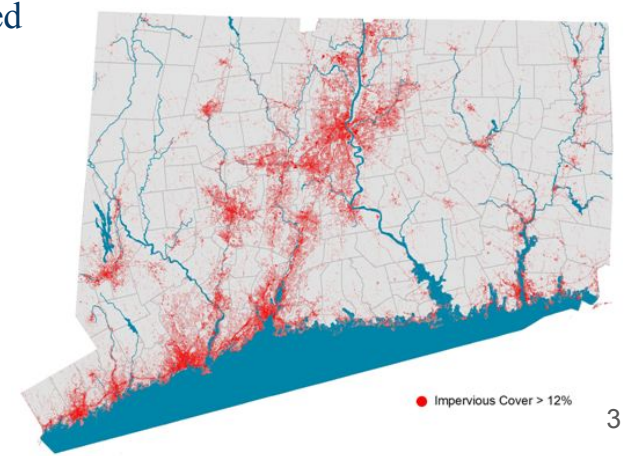
Impervious Surfaces & Runoff

- Increase in urban development leads to increase in ***impervious cover***
    - ***Impervious cover-*** any surface which prevents the natural infiltration of stormwater into soil
        - ***Ecological impact-*** Runoff collects pollutants as it flows across impervious cover where it gains volume and velocity leading to erosion, sedimentation, and increased flooding.
            - Increased runoff enters city sewer systems where it is discharged into water bodies having adverse ecological consequences
- ***Green Stormwater Infrastructure (GSI)*** disconnects stormwater runoff from city sewer systems allowing for infiltration into the ground



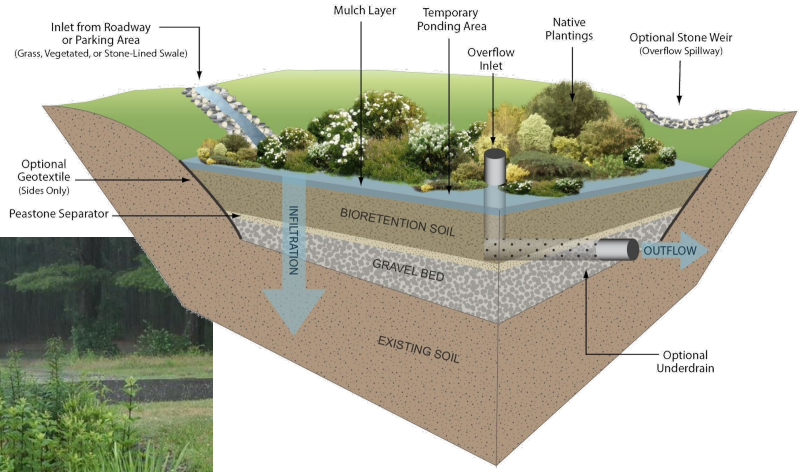
MS4 Requirements- Municipal Separate Storm Sewer Systems Permitting Program

- 2004- DEEP recognizes need for regulation of stormwater runoff
  - ***Nonpoint Source Pollution***: stormwater runs across impervious surfaces, collecting pollutants as it flows into storm drains.
  - Permitting program encourages use of ***Low Impact Development*** practices to mitigate pollution in waterways. These practices are designed to maintain or recreate ***pre-development hydrology***, with an emphasis on ***treatment of stormwater onsite***.

- 2017- DEEP issues additional MS4 requirements
  - As part of the development of stormwater management plans, along with subsequent monitoring and reporting, municipalities are required to ***disconnect 2% of directly connected impervious cover***.
  - ***Directly connected impervious cover*** is any impervious surface which discharges directly to waters of the state or to storm sewer systems which discharges to waters of the state sewer system, and which eventually flows into lakes, streams, and the ocean.

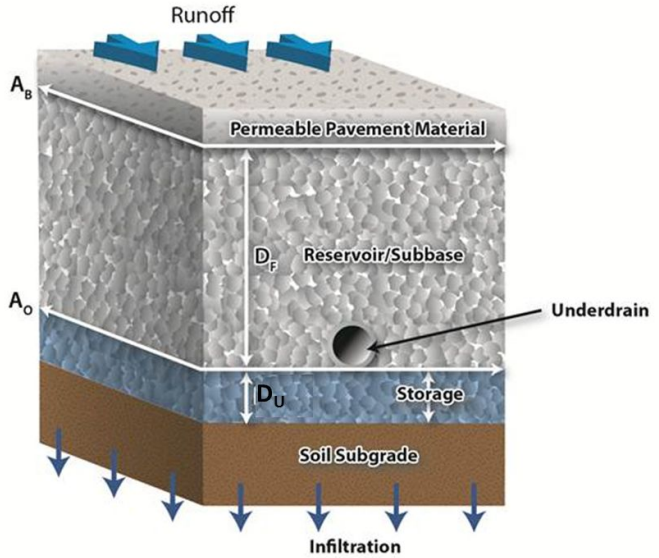
Rain Gardens and Bioretention

- Shallow depression which collects runoff from impervious cover
- Facilitates infiltration of runoff while filtering out pollutants and recharging groundwater
- Supports wildlife by providing food and shelter



Pervious Paving

- Allows for runoff to infiltrate into soil by passing directly through pavement surface
- Can be used to treat additional runoff from nearby impervious cover
- Can be implemented in a variety of light traffic areas
- Many cost effective options exist to suit site-specific needs



Gravel Grid Pavement

Permeable Interlocking Concrete Pavers

Tree Box Filters

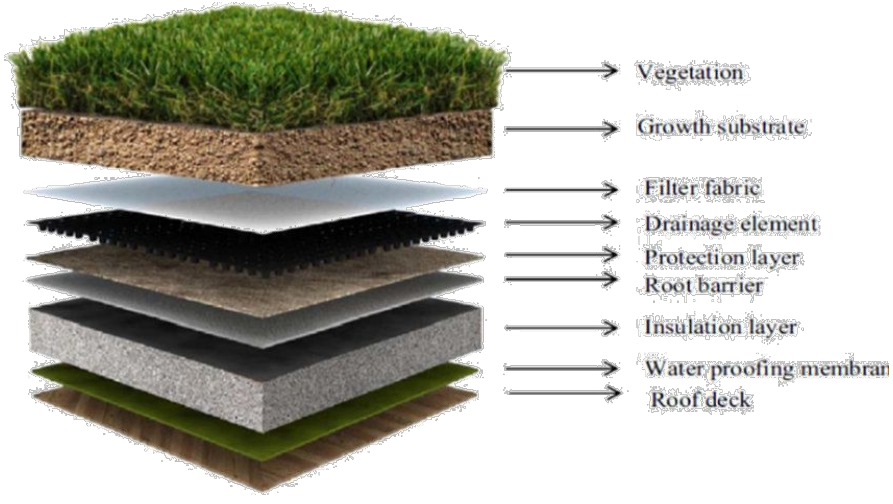
- Consist of a precast/cast in place concrete box filled with soil and filtration media
- Commonly used along sidewalks and roadways
- Runoff is contained within soil and consumed by tree, with overflow exiting the system via underdrain

Green Roofs

- Consist of a layered system with plant material and filtration media separated from the existing roof by a layer of waterproofing and root repellent

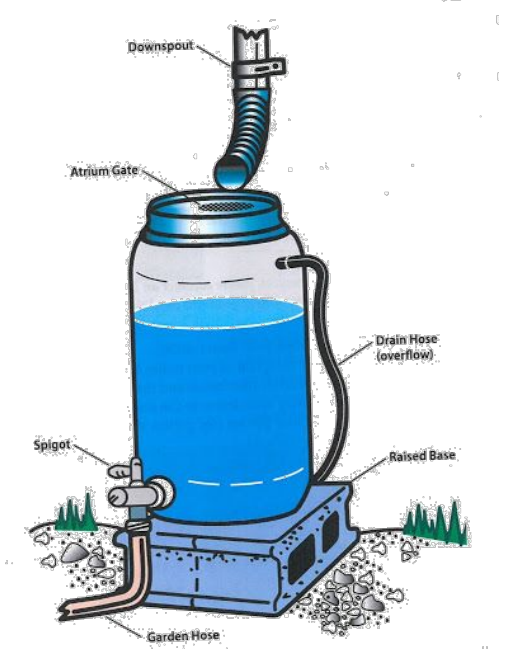
- Extensive-Intensive: varied degrees of complexity; from simple, inaccessible systems with low plant diversity, to accessible, highly diverse designs

- Feasibility dependent upon structural integrity of building



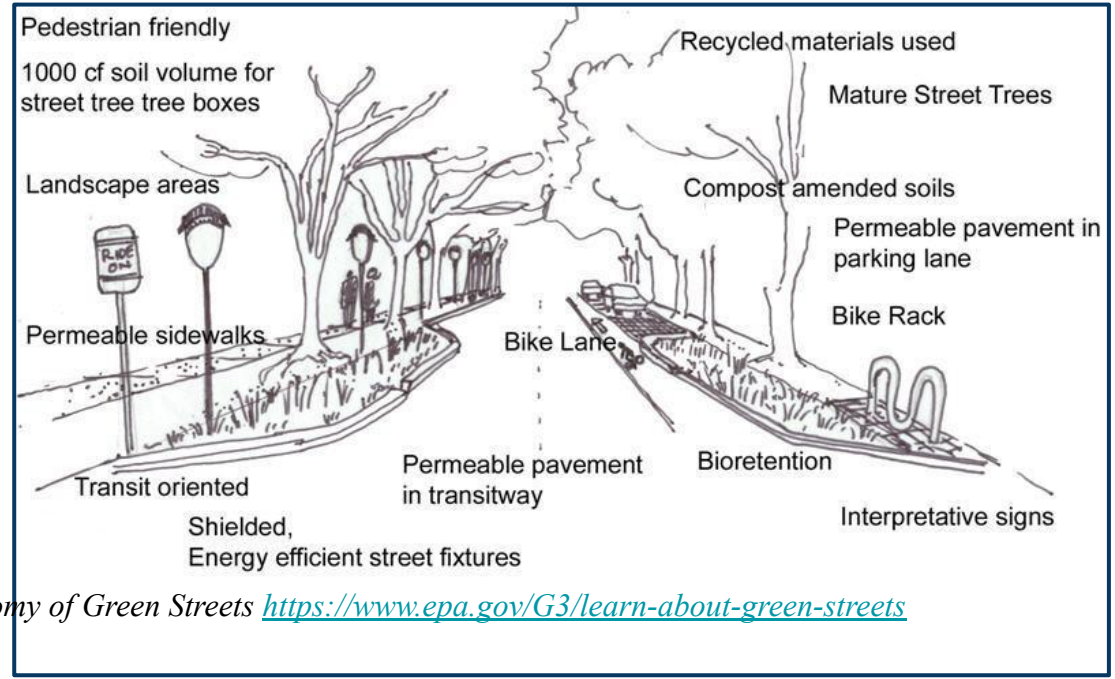
Rainwater Harvesting

- Runoff from rooftop conducted through downspouts to collection units, commonly rain barrels and cisterns
- Used for watering gardens, livestock, fire safety, domestic use, and long term storage
- Amount of runoff disconnected depends on use and use frequency



Green Streets

- Stormwater management that incorporates vegetation, soil, and engineered systems to slow, filter, and cleanse stormwater runoff from impervious surfaces.
- Green streets are designed to capture rainwater at its source.
- Replenish groundwater supplies, absorb carbon, improve air quality and neighborhood aesthetics
- Improve pedestrian and bicycle safety



EPA *Anatomy of Green Streets* https://www.epa.gov/G3/learn-about-green-streets

Our Recommendations

Bioretention units and rain gardens are visible to the public and can be aesthetically pleasing additions to public spaces.

We have selected locations that have the potential to benefit from LID that are also within the public eye. We aim to incorporate LID practices in a functional and educational way.

Explanation of Calculations

- **Drainage Area-**
  - The potential watershed area for each potential retrofit was estimated using geospatial measurement tools in Google Maps and confirmed during site visits
- **Practice Sizing-**
  - Sized for 1” rainfall event (around 90% of storms in CT)
    - Runoff volume based on watershed surface area, with dimensions of practice sized to accommodate total runoff volume
    - Minimum size requirements were calculated for a practice with a 6” depth
- **Nutrient Reductions-**
  - Determined using estimated drainage area and nutrient export coefficients developed by Dr. Charles Fink
    - Point source pollution not factored into calculations
- **Gallons Treated-**
  - Volume of stormwater treated determined by factoring CT’s 4 ft. annual rainfall into the drainage area for each potential retrofit

Site Selection & Approach

- **Preliminary Analysis-**
  - Web-based search to identify potential GSI project locations to conduct site visits
    - Research using town databases: identifying property ownership, prominent locations, and potential educational and community outreach opportunities
    - Geospatial analysis using aerial imagery from ArcGIS, Google Maps
      - Topography, impervious cover maps, parcel maps, satellite imagery
- **On Location-**
  - Site specific recommendations selected based on suitability for GSI practices
    - Identify location of existing storm drains or downspouts and their proximity to potential GSI practice area
    - Assess slope of surrounding land, determine drainage areas for storm drains and direction of runoff flow
    - Locate above and below ground obstructions
    - Determine best locations for visibility of practice, educational value, maximized impervious surface disconnection, and potential community involvement

Our Site Selections

1- Manchester High School Complex

2- Charter Oak Park

3- Mary Cheney Public Library

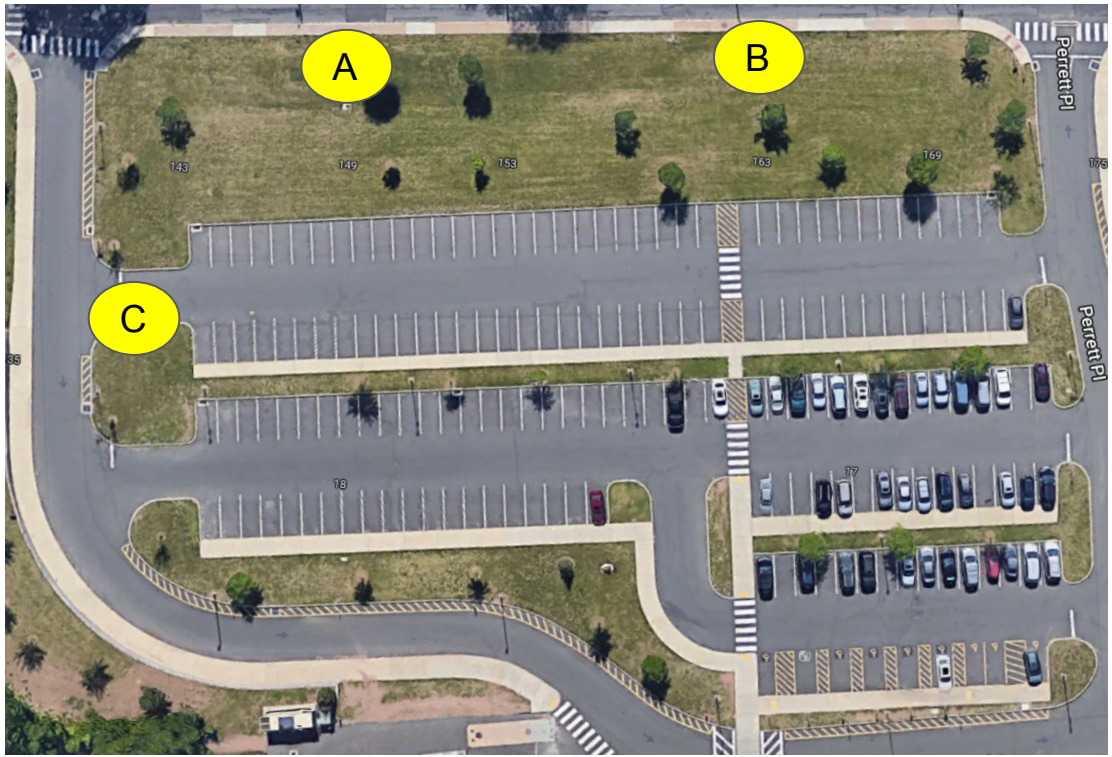
4- Manchester Town Hall

Site 1: Manchester High School

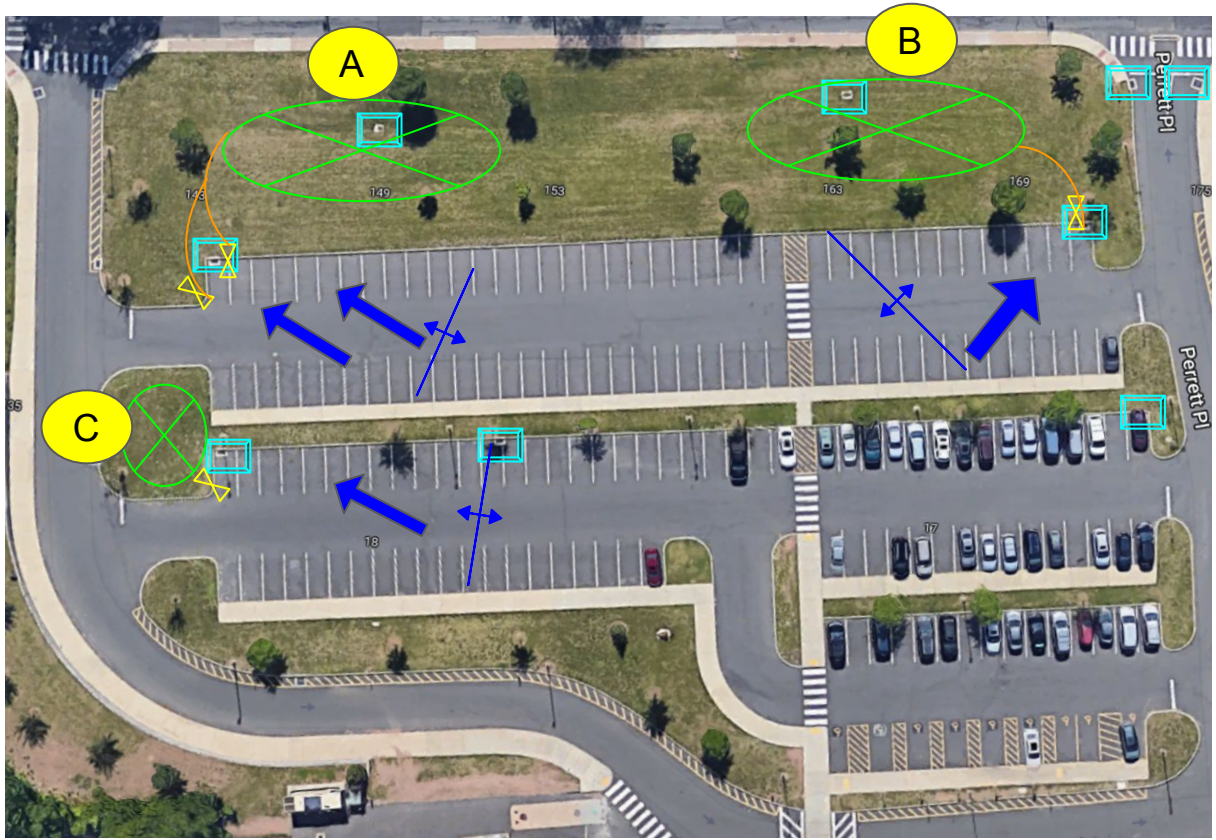
- 134 Middle Turnpike E, Manchester, CT 06040
- Summit Street entrance

Site 1: Manchester High School Parking Lot (Summit Street entrance)

Here is an overview of the Manchester High school parking lot from the Summit street entrance. At this site we will be focusing on the highlighted regions, A, B and C for green stormwater infrastructure.



Manchester High School: Proposed Plan Overview



- Existing Storm Drains
- Existing Lines of Water Flow
- Proposed Curb Cuts
- Proposed Stone Channel/Piping
- Proposed Practice

Existing storm drains can be used as overflow but they must raised above the level of bioretention basin.

Recommendation: *Bioretention basin*

Site A: Bioretention

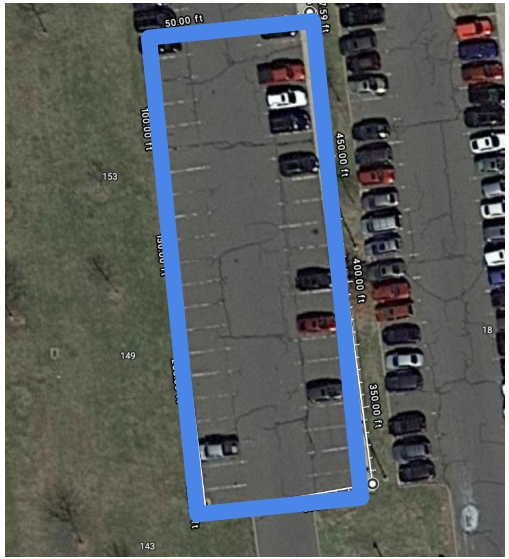
Bioretention at site A would disconnect the a large portion of the school parking lot. This location is highly visible and can be incorporated into public education.

Notes/ maintenance:

- Curb cuts need to made to allow water to reach the basin location.
- Existing storm drain can be used as an overflow if raised
- It is highly recommended to refrain from using fertilizer in the unit to protect water quality.
- Better to have the unit at the bottom of the slope to prevent erosion problems.

Manchester High School Site A: Bioretention

Site A Practice Size: 2,065 ft sq (6 in depth)



Site A Drainage Area Size: 12,388 ft sq

Annual Volume Reduction (Gal)	Total Phosphorus Reduction (lb/year)	Total Nitrogen Reduction (lb/year)
326,215	0.43	3.39

- The existing storm drain on site (red circle) can be used as an overflow for this bioretention area if raised a few inches.
- The preexisting slope of this area may lessen the need for excavation.

Site B- Bioretention

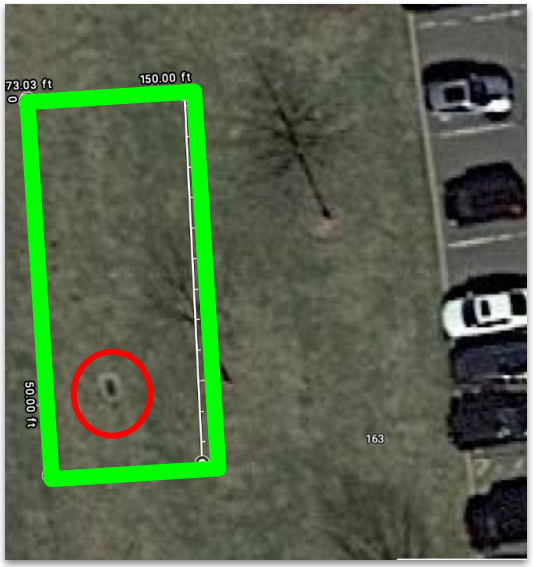
Recommendation: *Bioretention basin*

Bioretention would disconnect the a large portion of the school parking lot.
This location is highly visible and can be incorporated into public education.

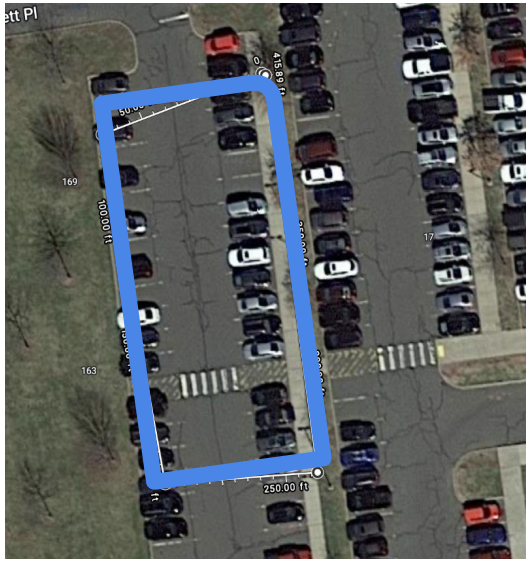
Notes/maintenance:

- Curb cuts required
- There is an existing slope which can be integrated in to the design
- If erosion were to occur design can be implemented to minimize this issue
- Do not fertilize!

Manchester High School Site B- Bioretention



Site B Practice Size:1,522 ft sq (6in depth)



Site B Drainage Area Size: 9088 ft sq

Annual Volume Reduction (Gal)	Total Phosphorus Reduction (lb/year)	Total Nitrogen Reduction (lb/year)
239,315	0.32	2.48

- This proposed bioretention unit would mirror the previous design suggestion and allow for further disconnection of the school parking lot.
- The existing storm drain on site (red circle) can be used as an overflow for this bioretention area if raised.

Recommendation:

Rain Garden

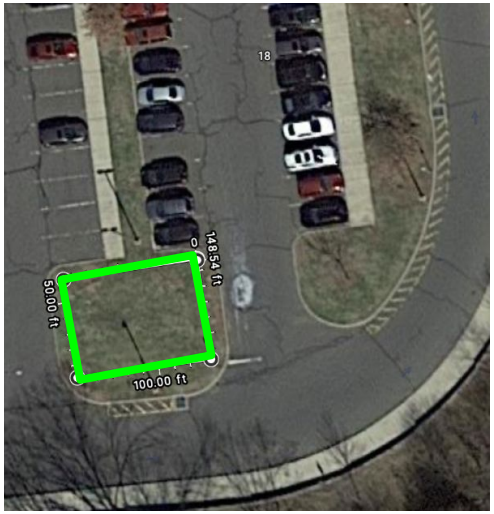
- A rain garden at site C would allow for a functional, visible way for the public to see bioretention in action at a local school.
- Rain gardens can be planted with a variety of appropriate plants.
- Visible from bus lane and front of the school.

Notes/maintenance:

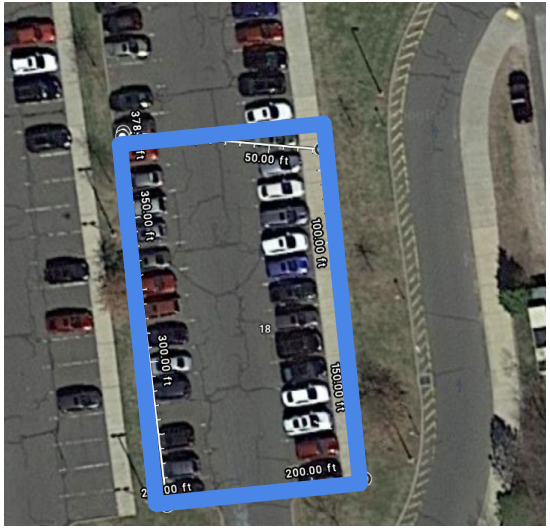
- Curb Cuts required
- Watch for electrical systems underground- *Potential Resize: can make the rain garden deeper than six inches and add fence for safety*
- General maintenance required for vegetation
- Important- Do not fertilize!

Site C- Rain Garden

Manchester High School Site C- Rain Garden



Site C Practice Size: 1,368 ft sq
(6 in depth)

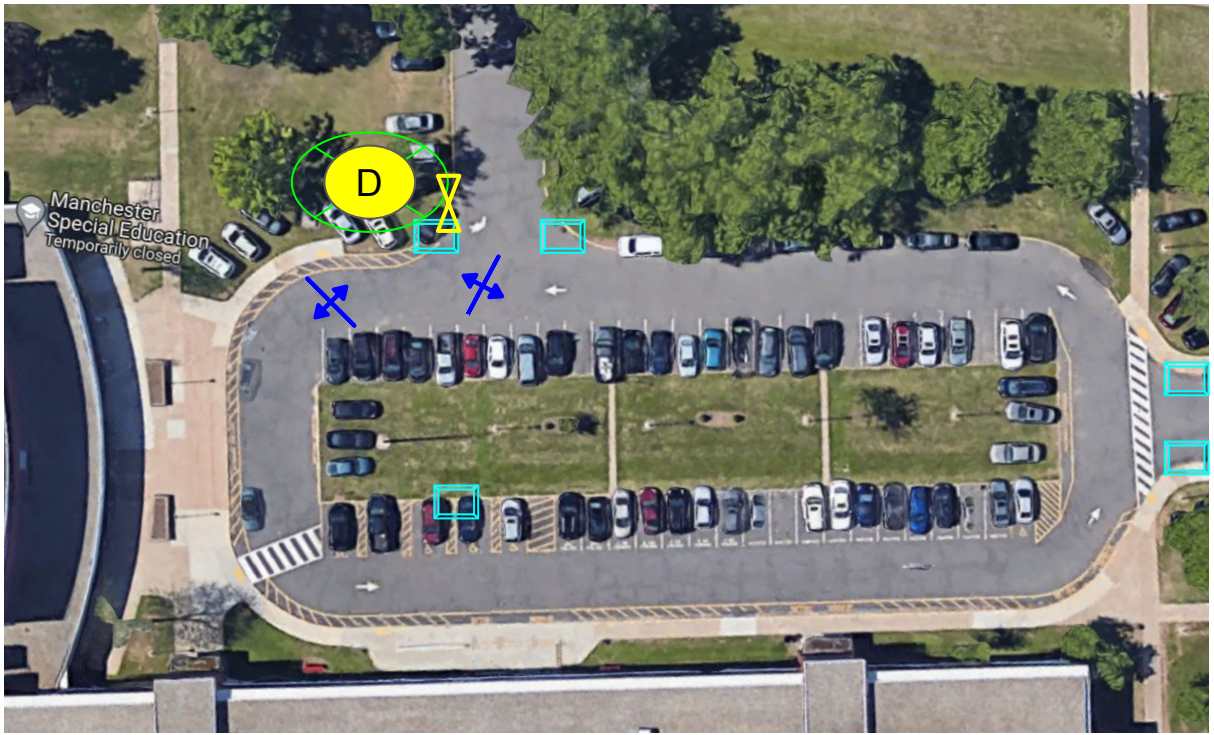


Site C Drainage Area Size: 8,206 ft sq

Annual Volume Reduction (Gal)	Total Phosphorus Reduction (lb/year)	Total Nitrogen Reduction (lb/year)
216,090	0.28	2.24

*A resize is possible for this rain garden design if there is concern for interference with electrical systems underground. This can be done by making the rain garden deeper than the proposed 6 inches. A fence can be added if there is a falling concern.

Site 1: Manchester High School Entrance (Middle Turnpike E Side)



- Existing Storm Drains
- Existing Lines of Water Flow
- Proposed Curb Cuts
- Proposed Practice

Recommendation:
Rain Garden

Site D- Rain Garden

A rain garden at site D would allow for a functional, visible way for the public to see LID in action at a local school.
Rain gardens can be planted with a variety of appropriate plants and are aesthetically enhancing to the area.

Notes/maintenance:

- Curb cuts required
- General maintenance for the plants
- If this is an area where snow is placed avoid woody shrubs as they may easily damage.
- More salt tolerant plants may also be chosen if the parking lot and walkway are salted.
- Important- do not fertilize!

Manchester High School Site D- Rain Garden

Site D Practice Size: 567 ft sq
(6 in depth)

Site D Drainage Area: 3,399 ft sq

Annual Volume Reduction (Gal)	Total Phosphorus Reduction (lb/year)	Total Nitrogen Reduction (lb/year)
89,506	0.12	0.93

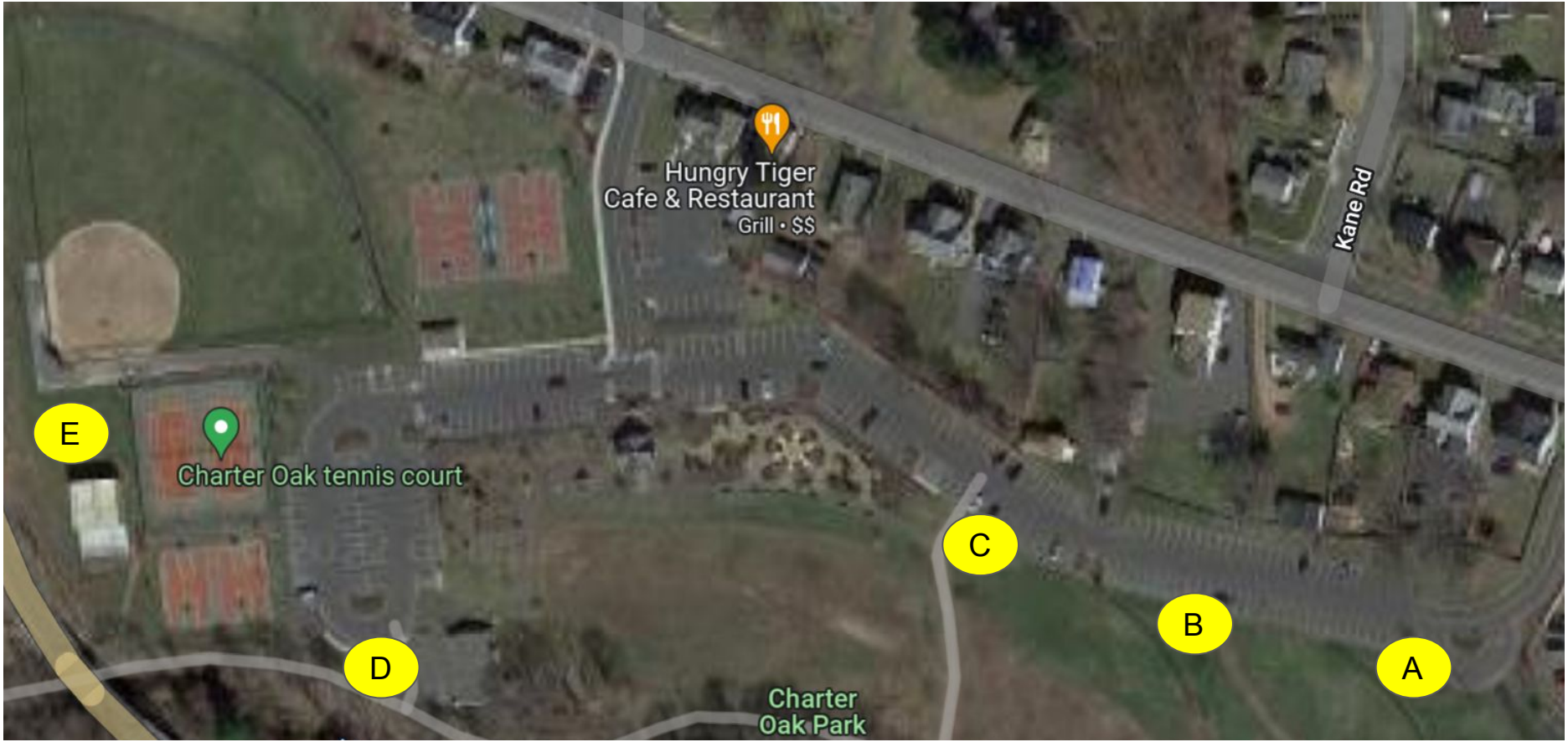
This location provides a highly visible rain garden which can be seen from the school and by those passing by on the road.

This shape was chosen for the design in order to preserve the existing tree here.

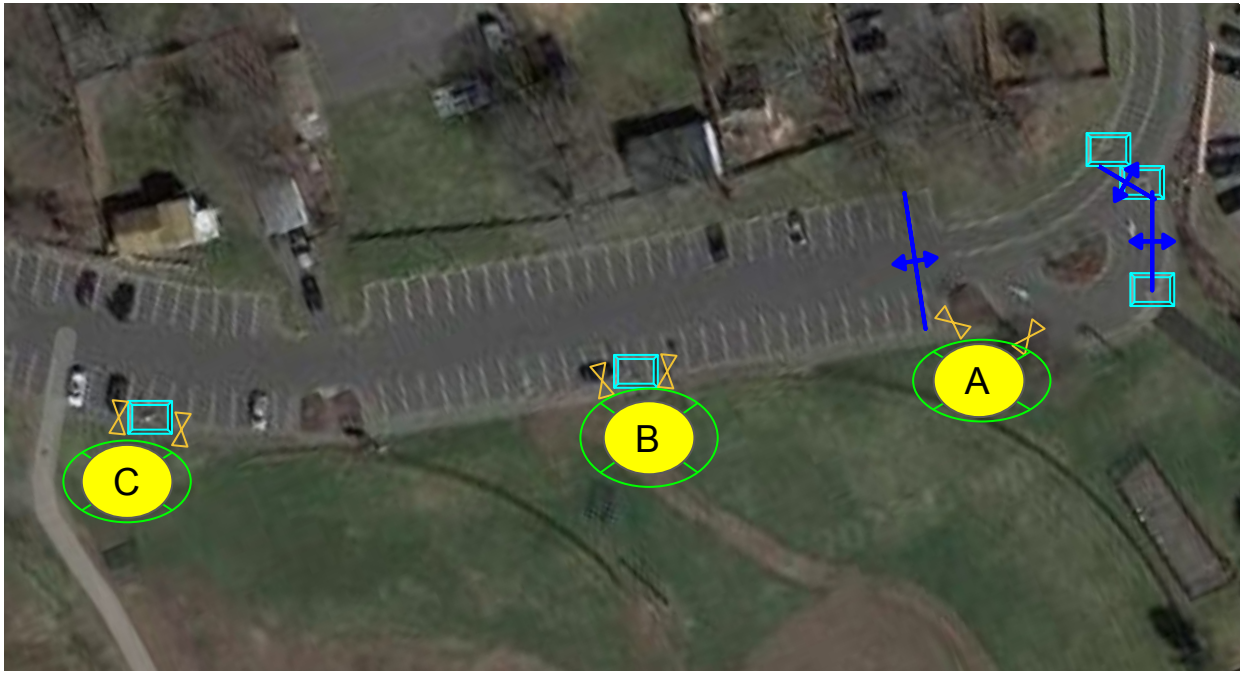
Site 2: Charter Oak Park

- 50 Charter Oak Street
  Manchester, CT 06040

Site 2: Charter Oak Park



Site 2: Charter Oak Park Proposed Plan Overview (Part 1)



- Existing Storm Drains
- Existing Lines of Water Flow
- Proposed Pipe
- Proposed Stone Channel
- Proposed Practice

Charter Oak Park Site A - Rain Garden

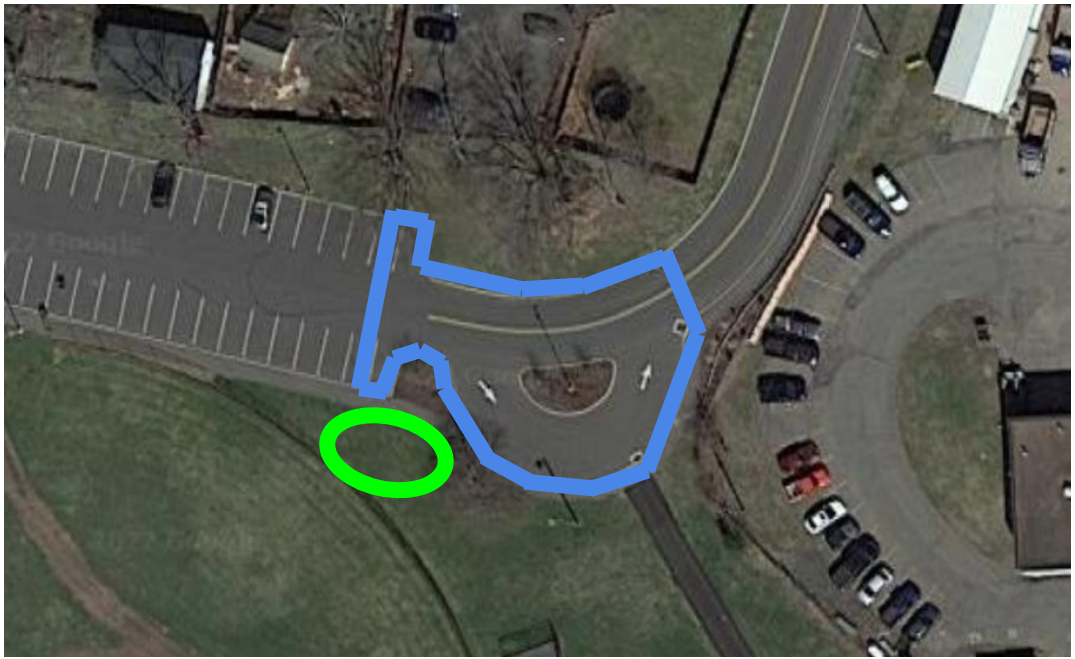
Recommendation:
Rain Garden

- A stone channel or pipe would need to be added to allow the parking lot runoff to get across the sidewalk and into the rain garden
    - A pipe under the sidewalk is recommended
- Placing a rain garden here would complete the aesthetic at this entrance to the park

Notes/maintenance:

- Create a shape that is easy to mow around
- Do not fertilize!

Charter Oak Park Site A - Rain Garden



Annual Volume Reduction (Gal)	Total Phosphorus Reduction (lb/year)	Total Nitrogen Reduction (lb/year)
135,935	0.18	1.41

This location would enhance the aesthetic of this entrance to the park while providing a disconnection for a portion of the extremely long parking lot.

Site A Practice Size: 900 ft sq

Site A Drainage Area: 5,162 ft sq

Charter Oak Park Site B - Rain Garden

Recommendation:
Rain Garden

- A stone channel or pipe would need to be added to allow the parking lot runoff to get across the sidewalk and into the rain garden
    - A pipe under the sidewalk is recommended
- This rain garden disconnects the largest portion of the parking lot, and therefore would need to be the largest

Notes/maintenance:

- Create a shape that is easy to mow around
- Do not fertilize!

Charter Oak Park Site B - Rain Garden

Annual Volume Reduction (Gal)	Total Phosphorus Reduction (lb/year)	Total Nitrogen Reduction (lb/year)
409,964	0.54	4.26

This location disconnects a majority of this long parking lot, and provides a visually appealing aspect to the very long stretch of unused grass.

Site B Practice Size: 2,600 ft sq

Site B Drainage Area: 15,568 ft sq

Recommendation:
Rain Garden

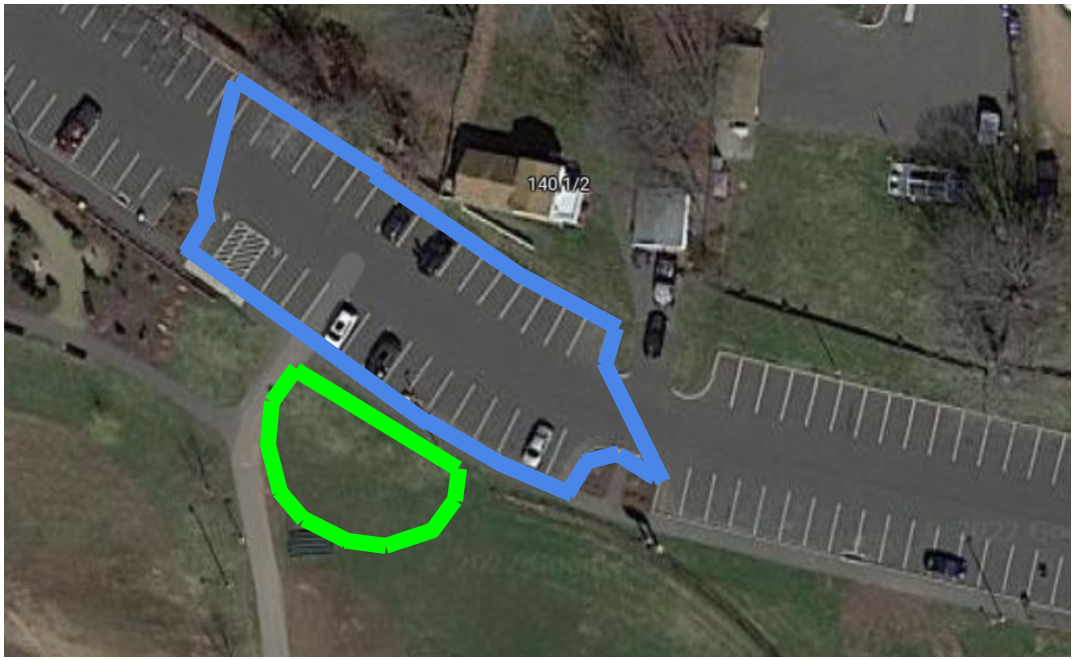
Charter Oak Park Site C - Rain Garden

- A stone channel or pipe would need to be added to allow the parking lot runoff to get across the sidewalk and into the rain garden
    - A pipe under the sidewalk is recommended
- Placing the rain garden between the sidewalk and path provides an opportunity for many park visitors to learn about rain gardens

Notes/maintenance:

- Create a shape that is easy to mow around
- Do not fertilize!

Charter Oak Park Site C - Rain Garden



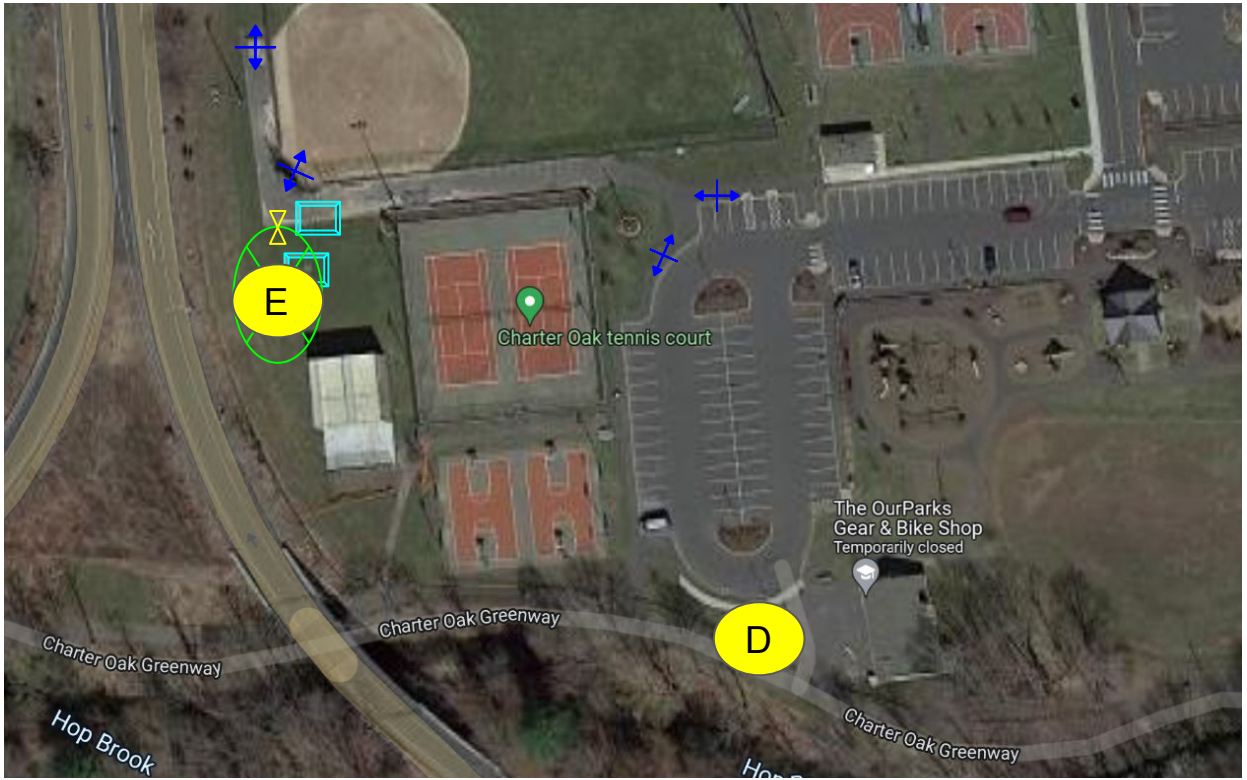
Annual Volume Reduction (Gal)	Total Phosphorus Reduction (lb/year)	Total Nitrogen Reduction (lb/year)
263,028	0.35	2.73

This location further disconnects this parking lot, greatly reducing the amount of directly connected impervious cover at the park. There is the potential to frame the path by mirroring the existing landscaped area, enhancing the aesthetic.

Site C Practice Size: 1,700 ft sq

Site C Drainage Area: 9,988 ft sq

Site 2: Charter Oak Park Proposed Plan Overview (Part 2)



- Existing Storm Drains
- Existing Lines of Water Flow
- Proposed Curb Cuts
- Proposed Stone Channel
- Proposed Practice

Charter Oak Park Site D - Rain Garden

Recommendation:
Rain Garden

- This rain garden would be placed near the playground and along a popular entrance to the Greenway, making it a perfect educational opportunity
- Account for underground electrics when creating the rain garden shape

Notes/maintenance:

- Place mulch in the area between the rain garden and parking lot in order to avoid small patches of grass that would need to be mowed
- Do not fertilize!

Charter Oak Park Site D - Rain Garden

Annual Volume Reduction (Gal)	Total Phosphorus Reduction (lb/year)	Total Nitrogen Reduction (lb/year)
51,584	0.07	0.54

Site D Practice Size: 400 ft sq

Site D Drainage Area: 1,959 ft sq

This location has great visibility from the playground as well as parking lot. Due to the existing bike racks, sidewalk, and railing this area is already fairly outlined. The placement along a popular entrance to the Greenway provides an opportunity for many community members to view this rain garden.

Recommendation:
Bioretention

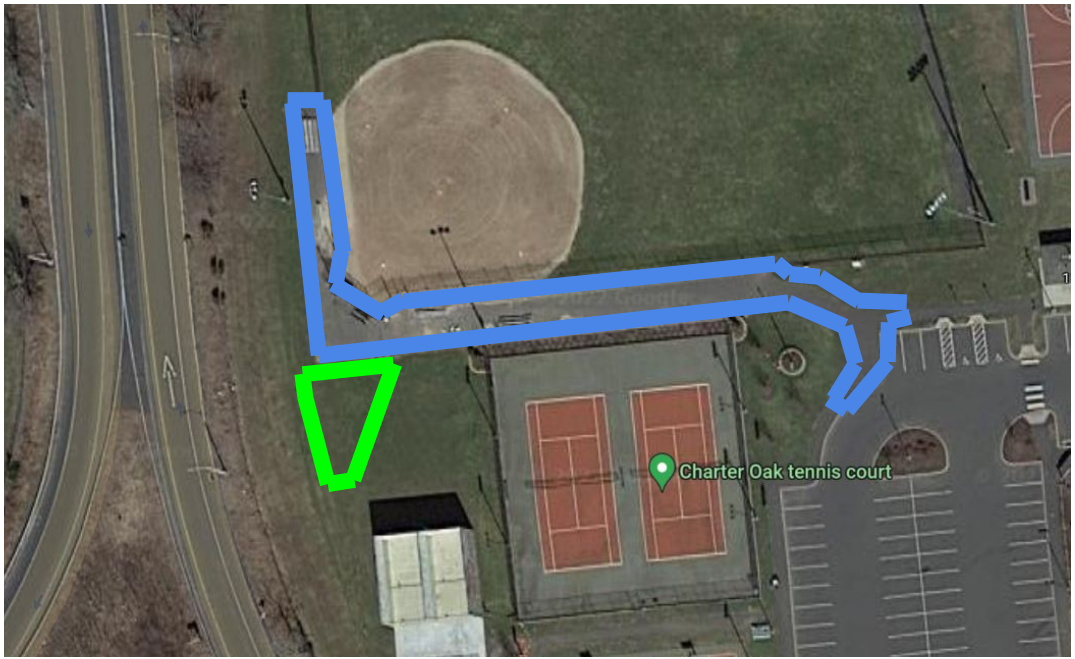
Charter Oak Park Site E - Bioretention

- Due to the existing drain, a bioretention would be easy to install in this location
- There is a grassy area for recreation next to the bioretention, consult local teams about area usage
- Highly visible area with a great educational opportunity and potential for themed shape, such as a baseball

Notes/maintenance:

- A sediment trap would need to be installed at the curb cut to prevent the bioretention from filling with sediment
- Do not fertilize!

Charter Oak Park Site E - Bioretention



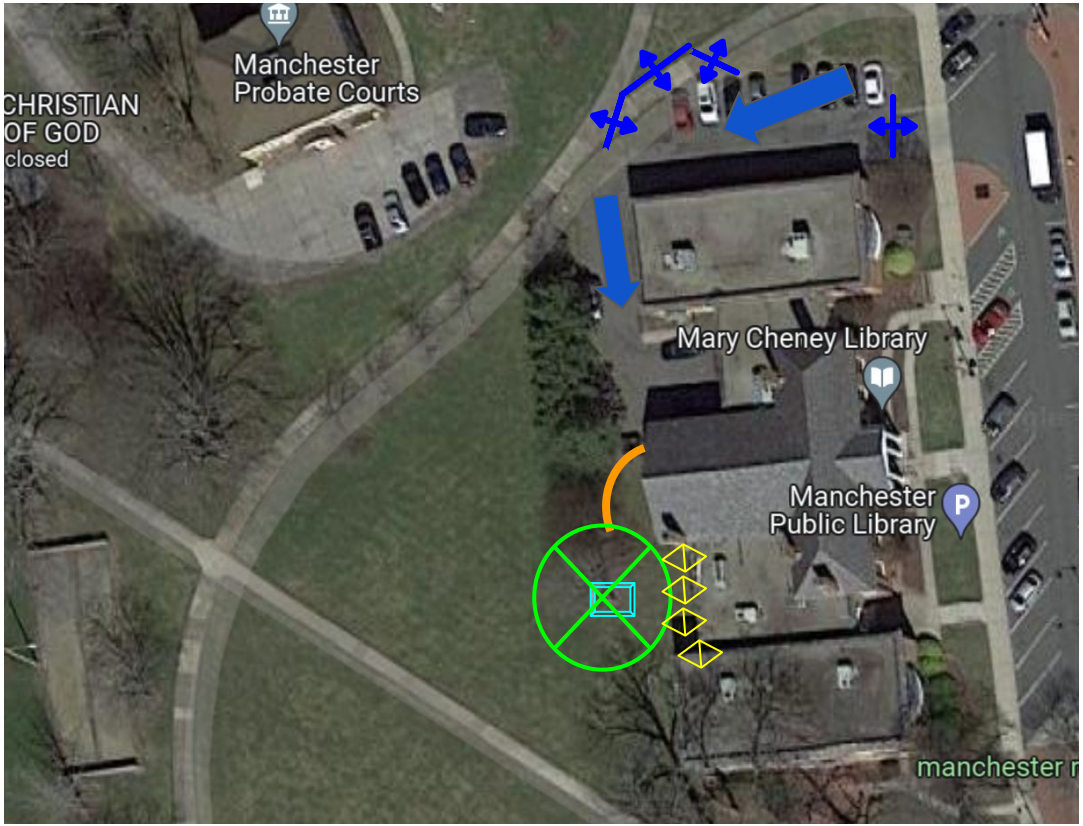
Annual Volume Reduction (Gal)	Total Phosphorus Reduction (lb/year)	Total Nitrogen Reduction (lb/year)
178,507	0.24	1.85

Site E Practice Size: 1,200 ft sq

Site E Drainage Area: 6,779 ft sq

This bioretention would be in a prime spot for community members to view and learn about. Be sure to consult local baseball teams about the area usage to create a shape that does not take away warm up/practice space. There is the potential to work with the community to have a theme design contest in order to build interest in the implementation.

Site 3: Manchester Public Library



- Existing Storm Drains
- Existing Lines of Water Flow
- Existing Downspout
- Proposed Stone Channel
- Proposed Practice

At this location impervious cover from the back parking lot as well as the building's roof are being disconnected.

Recommendation:
Rain Garden

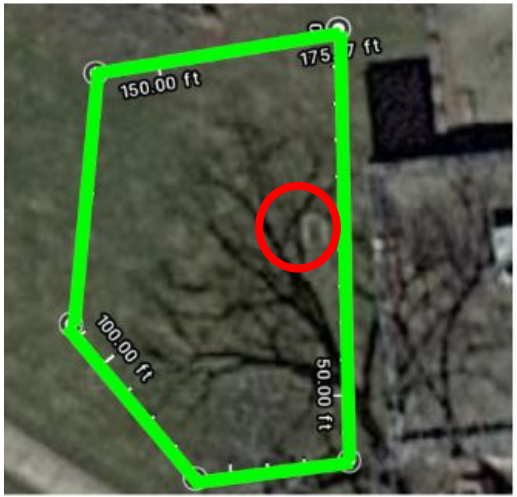
Manchester Public Library- Rain Garden

- A rain garden would disconnect a large portion of the roof and side parking lot.
- This location is highly visible and can be incorporated into public education.
- This could reduce basement flooding issues on the property

Notes/maintenance:

- Keep the garden where it can be easily mowed around and mulched. Apply mulch in any gap spacing the minimize issues with mowing.
- Stone channel and rain garden must be clear of the trees
- Do not fertilize!
- The existing storm drain can be kept as an overflow if raised a few inches.

Manchester Public Library- Rain Garden



Practice Size: 1,900 sq ft
(6 in depth)

Drainage Area: 4,941.13 + 6,105.72 = 11,046.85 sq ft

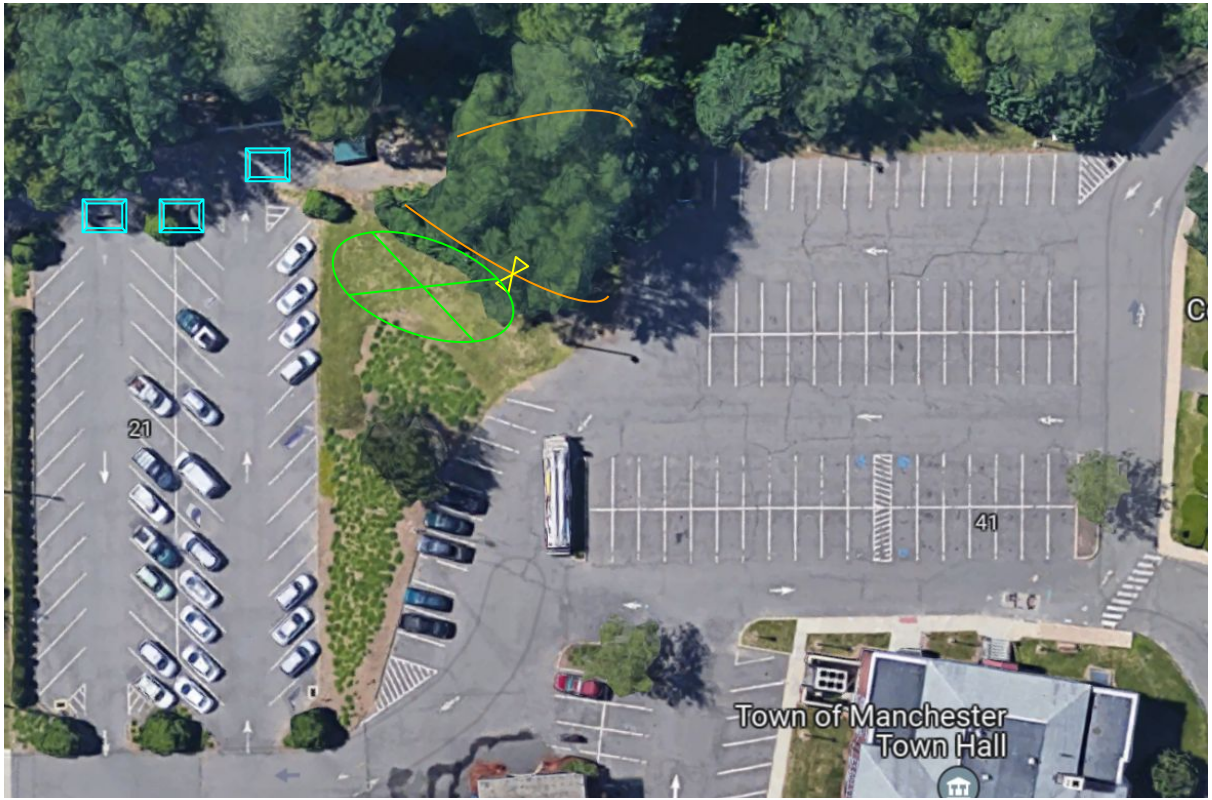
Annual Volume Reduction (Gal)	Total Phosphorus Reduction (lb/year)	Total Nitrogen Reduction (lb/year)
290,898	0.38	3.02

The middle image shows **rooftop** disconnection while the image on the left shows potential **parking lot** disconnection.

Roof disconnection can be done by **disconnecting gutter downspouts** and directing that water to the garden by use of stone channels or pipes.

Existing storm drain can be lifted up to act as an overflow.

Site 4: Town of Manchester Town Hall



- Existing Storm Drains
- Existing Lines of Water Flow
- Existing Paved Channel
- Proposed Curb Cuts
- Proposed Practice

Recommendation:
Bioretention

Manchester Town Hall - Bioretention

- A disconnection or diversion would be needed to redirect the water in the paved channels towards the bioretention
- Calculations were made for a 6” deep bioretention, however a deeper bioretention would require less square footage
- A tiered shape should be utilized so water can overflow from one section to another

Notes/maintenance:

- Create a shape that is easy to mow around
- Do not fertilize!

Manchester Town Hall - Bioretention

Annual Volume Reduction (Gal)	Total Phosphorus Reduction (lb/year)	Total Nitrogen Reduction (lb/year)
416,129	0.55	4.32

This location seems to have an issue with the parking lot runoff. There are several paved channels that lead down to what looks like several newly installed storm drains. A bioretention along the hill could solve the runoff problem.

Practice Size: 2,000 ft sq

Drainage Area: 15,802 ft sq

Recommendation:
Pervious Asphalt

Manchester Town Hall - Alternative

- By making the parking lot pervious, the need for a bioretention would be eliminated
- Making portions of the lot pervious could lower costs if making the entire parking lot pervious is not feasible
    - It is recommended to make the parking stalls pervious

Notes/maintenance:

- Apply very minimal salt
- Do not sand!
- Remove built-up sediments 1-2 times per year

Water flowing off of impervious asphalt into pervious asphalt

Total Project Statistics:

	Drainage Area (sq ft) (disconnected impervious cover)	Suggested Green Infrastructure	Annual Gallon Intake	Annual Nitrogen reduction (lb N/yr)	Annual Phosphorus reduction (lb P/yr)	Suggested Practice Size (sq ft)
Manchester High School	33,081	Rain Garden Bioretention	871,126	9.04	1.15	5,879
Charter Oak Park	39,456	Rain Garden Bioretention	1,039,018	10.79	1.38	6,576
Manchester Public Library	11,046	Rain Garden	290,898	3.02	0.38	1,900
Manchester Town Hall	15,802	Bioretention	416, 129	4.32	0.55	2,048
Totals:	99,385		2,617,171	27.17	3.46	16,403

Summary

The integration of ***green stormwater infrastructure practices*** (LID) in the town of Manchester will provide many community benefits. Implementation of these practices can help keep Manchester on track on to ***disconnect directly connected impervious cover*** throughout the town. A variation of stormwater practices will provide the town with numerous demonstrative, educational, and beautiful additions to the landscape while serving an important purpose.

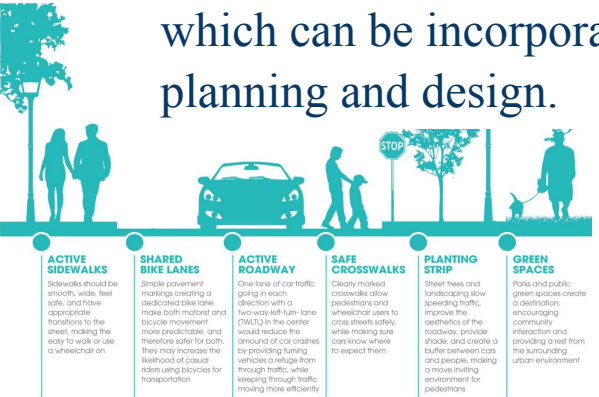
We focused on public spaces such as the local schools, parks and library to ensure the ***public connection*** and awareness of these practices.

Sites Not Chosen

- Bentley Alternative Education
  - Newly renovated parking lot
  - No room to add a rain garden or tree box filter
- Center Springs Park
  - Little impervious cover on the site
  - Wanted to focus on Charter Oak Park
- Main Street
  - Current plan for future renovation inhibited the ability to address the site

Main Street Explanation

- Future design for renovation could include green street design, treebox filters, pervious pavement, and other forms of LID.
- There is a lot of potential for green stormwater infrastructure which can be incorporated into planning and design.



Codes & Ordinances Review

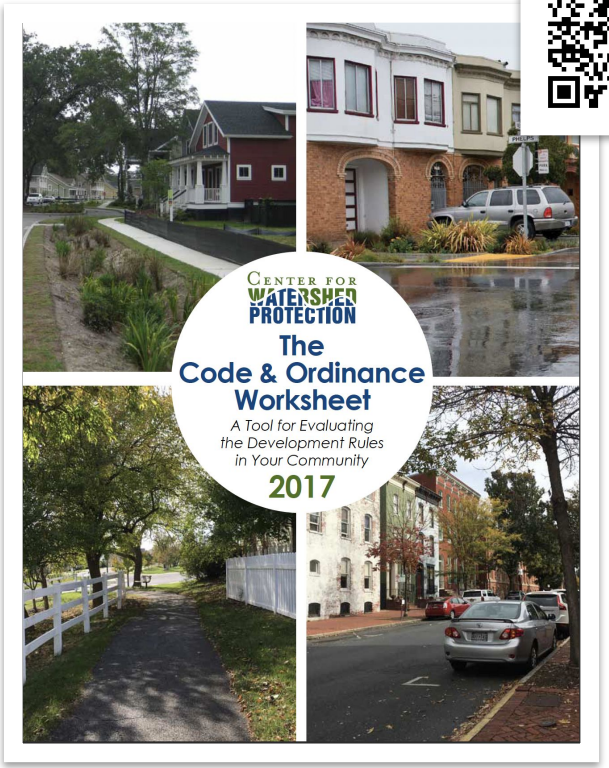
Used Code and Ordinances Worksheet (COW)

- Developed by Center for Watershed Protection (CWP) w/ input from panel of national experts
- **94** recommended policies designed to: Reduce IC, Conserve open space, Prevent stormwater pollution
- 4 versions: ultra-urban, urban, suburban, rural
- Typical scores in the 30-40% range (always room for improvement)
- Helps to meet MS4 requirement to remove barriers to LID/GSI

Documents reviewed:

- *Town of Manchester, Connecticut Zoning Regulations*
- *Town of Manchester Subdivision Regulations*
- *Town of Manchester, Connecticut Public Improvement Standards*
- *Town of Manchester Stormwater Management Plan*

CENTER FOR WATERSHED PROTECTION



https://cwp.org/updated-code-ordinance-worksheet-improving-local-development-regulations/

Codes and Ordinances Worksheet Summary

- Grade: 41%
  - Higher than most towns currently
  - Room for improvement
- General Overview:
  - Mentioned support for green stormwater infrastructure / low impact development is not consistently demonstrated throughout all sections of the codes and ordinances
- Strengths:
  - Parking lot runoff management
  - Tree conservation
- Opportunities For Improvement:
  - Open space management
    - Include entities responsible for maintenance and management
    - Create incentives for utilizing open space beyond the minimum
  - Street width requirements
    - Decrease requirements for low volume roads

- The full codes and ordinances review can be found here: https://docs.google.com/document/d/1mSw4umZbDpI3hh8mjWboGPi1wjr08Bb9/edit?usp=sharing&ouid=118417588304091827192&rtpof=true&sd=true

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