**Impervious Cover Assessment**
**for**
**Hackettstown, Warren County, New Jersey**

*Prepared for Hackettstown by the*
*Rutgers Cooperative Extension Water Resources Program*

August 10, 2016

## Introduction

Pervious and impervious are terms that are used to describe the ability or inability of water to flow through a surface. When rainfall hits a surface, it can soak into the surface or flow off the surface. Pervious surfaces are those which allow stormwater to readily soak into the soil and recharge groundwater. When rainfall drains from a surface, it is called "stormwater" runoff (Figure 1). An impervious surface can be any material that has been placed over soil that prevents water from soaking into the ground. Impervious surfaces include paved roadways, parking lots, sidewalks, and rooftops. As impervious areas increase, so does the volume of stormwater runoff.

Figure 1: Stormwater draining from a parking lot

New Jersey has many problems due to stormwater runoff, including:

- Pollution: According to the 2010 New Jersey Water Quality Assessment Report, 90% of the assessed waters in New Jersey are impaired, with urban-related stormwater runoff listed as the most probable source of impairment (USEPA, 2013). As stormwater flows over the ground, it picks up pollutants including animal waste, excess fertilizers, pesticides, and other toxic substances. These pollutants are then able to enter waterways.

- Flooding: Over the past decade, the state has seen an increase in flooding. Communities around the state have been affected by these floods. The amount of damage caused has also increased greatly with this trend, costing billions of dollars over this time span.

- Erosion: Increased stormwater runoff causes an increase in the velocity of flows in our waterways. The increased velocity after storm events erodes stream banks and shorelines, degrading water quality. This erosion can damage local roads and bridges and cause harm to wildlife.

The primary cause of the pollution, flooding, and erosion problems is the quantity of impervious surfaces draining directly to local waterways. New Jersey is one of the most developed states in the country. Currently, the state has the highest percent of impervious cover in the country at 12.1% of its total area (Nowak & Greenfield, 2012). Many of these impervious surfaces are directly connected to local waterways (i.e., every drop of rain that lands on these impervious surfaces ends up in a local river, lake, or bay without any chance of being treated or soaking into the ground). To repair our waterways, reduce flooding, and stop erosion, stormwater runoff from impervious surfaces has to be better managed. Surfaces need to be disconnected with green infrastructure to prevent stormwater runoff from flowing directly into New Jersey's waterways. Disconnection redirects runoff from paving and rooftops to pervious areas in the landscape.

Green infrastructure is an approach to stormwater management that is cost-effective, sustainable, and environmentally friendly. Green infrastructure projects capture, filter, absorb, and reuse stormwater to maintain or mimic natural systems and to treat runoff as a resource. As a general principal, green infrastructure practices use soil and vegetation to recycle stormwater runoff through infiltration and evapotranspiration. When used as components of a stormwater management system, green infrastructure practices such as bioretention, green roofs, porous pavement, rain gardens, and vegetated swales can produce a variety of environmental benefits. In addition to effectively retaining and infiltrating rainfall, these technologies can simultaneously help filter air pollutants, reduce energy demands, mitigate urban heat islands, and sequester carbon while also providing communities with aesthetic and natural resource benefits (USEPA, 2013).

The first step to reducing the impacts from impervious surfaces is to conduct an impervious cover assessment. This assessment can be completed on different scales: individual lot, municipality, or watershed. Impervious surfaces need to be identified for stormwater management. Once impervious surfaces have been identified, there are three steps to better manage these surfaces.

1. ***Eliminate surfaces that are not necessary.*** For example, a paved courtyard at a public school could be converted to a grassed area.

2. ***Reduce or convert impervious surfaces.*** There may be surfaces that are required to be hardened, such as roadways or parking lots, but could be made smaller and still be functional. A parking lot that has two-way car ways could be converted to one-way car ways. There also are permeable paving materials such as porous asphalt, pervious concrete, or permeable paving stones that could be substituted for impermeable paving materials (Figure 2).

3. ***Disconnect impervious surfaces from flowing directly to local waterways.*** There are many ways to capture, treat, and infiltrate stormwater runoff from impervious surfaces. Opportunities may exist to reuse this captured water.

Figure 2: Rapid infiltration of water through porous pavement is demonstrated at the USEPA Edison New Jersey test site

**Hackettstown Impervious Cover Analysis**

Located in Warren County in northern New Jersey, Hackettstown covers approximately 3.71 square miles. Figures 3 and 4 illustrate that Hackettstown is dominated by urban land uses. A total of 64.8% of the municipality's land use is classified as urban. Of the urban land in Hackettstown, medium density residential is the dominant land use (Figure 5).

The literature suggests a link between impervious cover and stream ecosystem impairment starting at approximately 10% impervious surface cover (Schueler, 1994; Arnold and Gibbons, 1996; May et al., 1997). Impervious cover may be linked to the quality of lakes, reservoirs, estuaries, and aquifers (Caraco et al., 1998), and the amount of impervious cover in a watershed can be used to project the current and future quality of streams. Based on the scientific literature, Caraco et al. (1998) classified urbanizing streams into the following three categories: sensitive streams, impacted streams, and non-supporting streams. Sensitive steams typically have a watershed impervious surface cover from 0 – 10%. Impacted streams have a watershed impervious cover ranging from 11-25% and typically show clear signs of degradation from urbanization. Non-supporting streams have a watershed impervious cover of greater than 25%; at this high level of impervious cover, streams are simply conduits for stormwater flow and no longer support a diverse stream community.

The New Jersey Department of Environmental Protection's (NJDEP) 2012 land use/land cover geographical information system (GIS) data layer categorizes Hackettstown into many unique land use areas, assigning a percent impervious cover for each delineated area. These impervious cover values were used to estimate the impervious coverage for Hackettstown. Based upon the 2012 NJDEP land use/land cover data, approximately 26.5% of Hackettstown has impervious cover. This level of impervious cover suggests that the streams in Hackettstown are likely non-supporting streams.

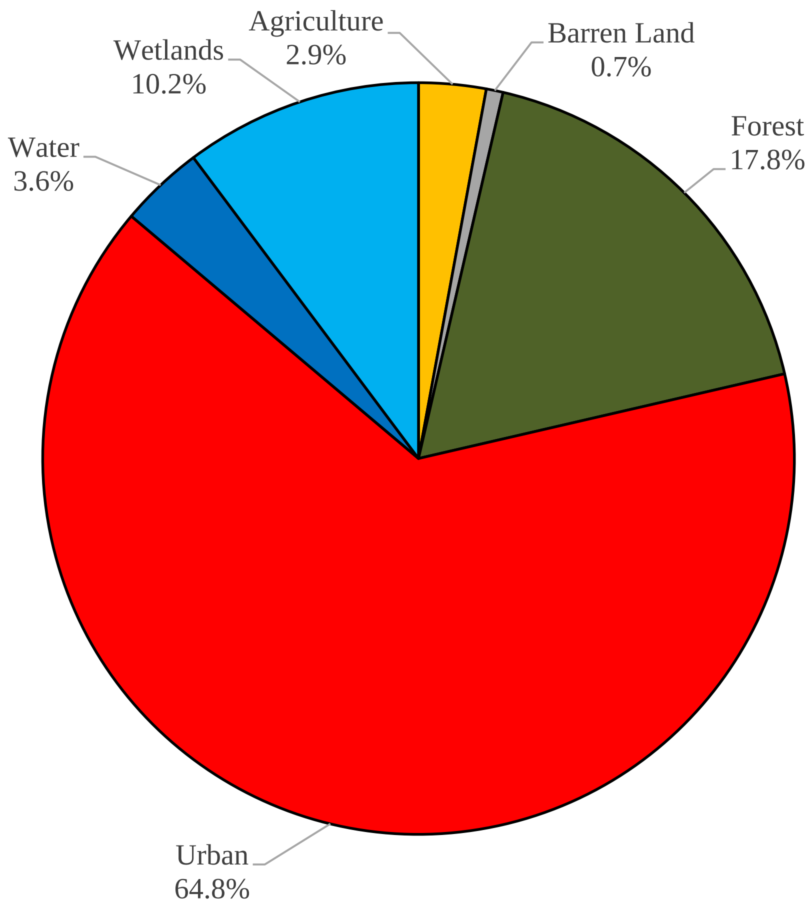



Figure 3:  Pie chart illustrating the land use in Hackettstown

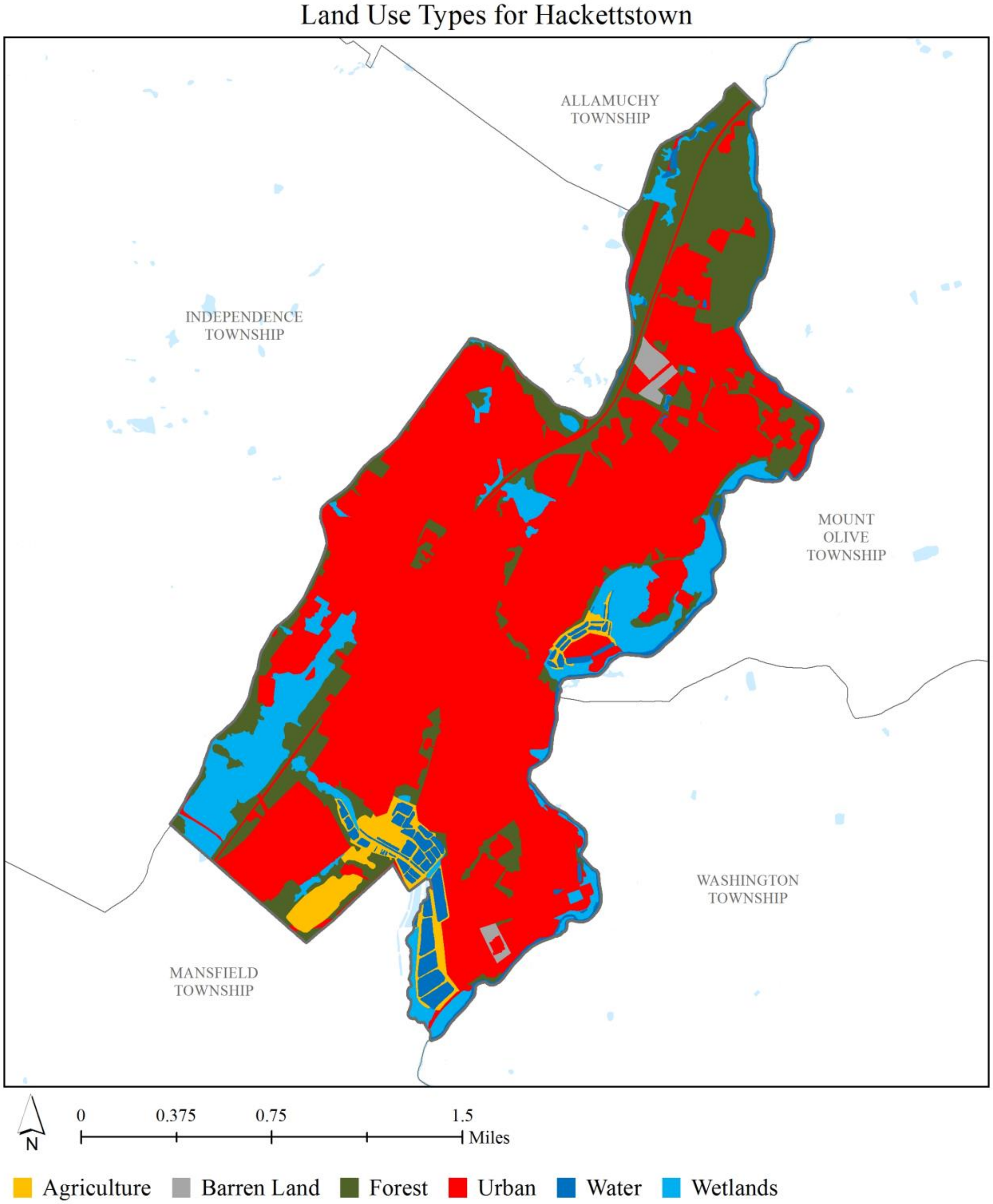



Figure 4: Map illustrating the land use in Hackettstown

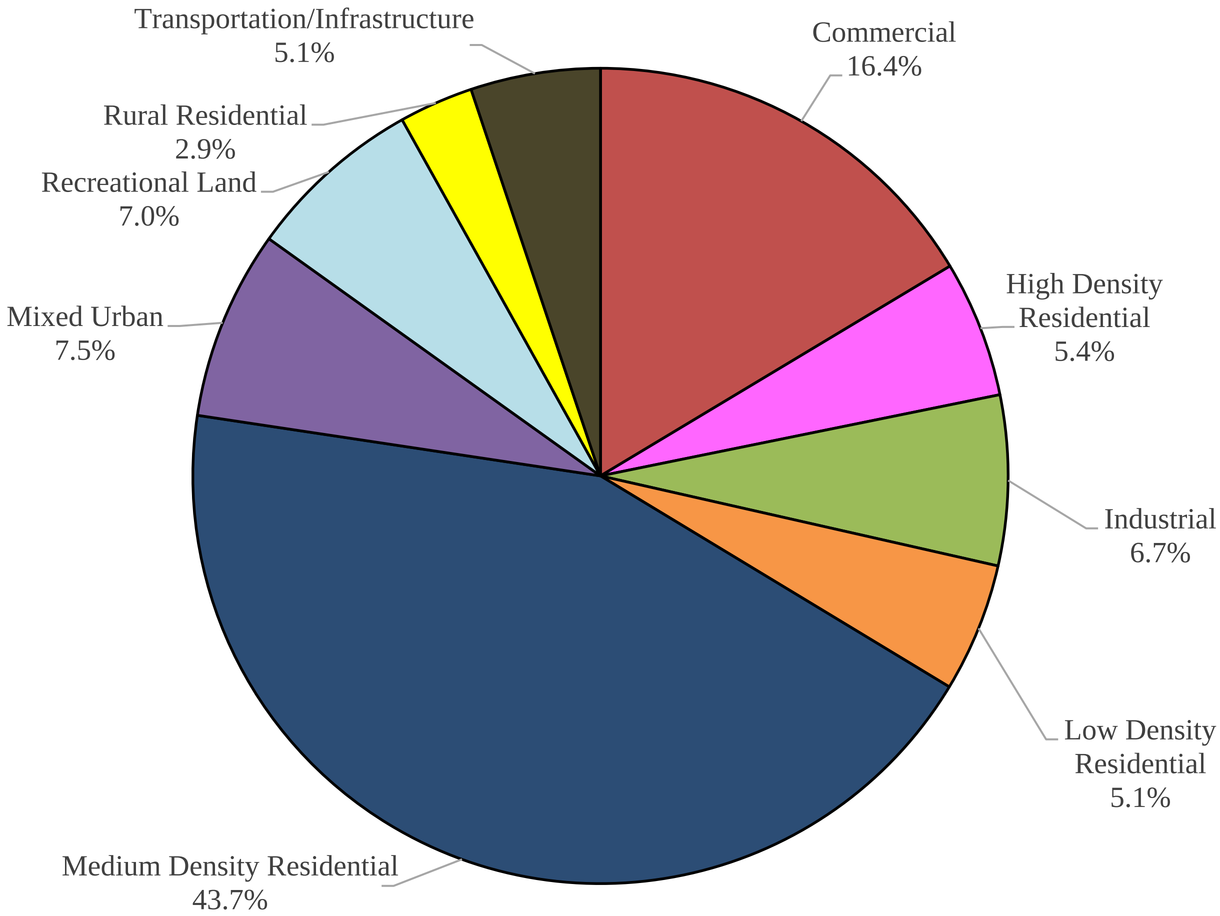



Figure 5: Pie chart illustrating the various types of urban land use in Hackettstown

Water resources are typically managed on a watershed/subwatershed basis; therefore an impervious cover analysis was performed for each subwatershed within Hackettstown (Table 1 and Figure 6). In Hackettstown, the Musconetcong River is the only subwatershed within the town with an impervious cover of 26.5%. Evaluating impervious cover on a subwatershed basis allows the municipality to focus impervious cover reduction or disconnection efforts in the subwatersheds where frequent flooding occurs.

In developed landscapes, stormwater runoff from parking lots, driveways, sidewalks, and rooftops flows to drainage pipes that feed the sewer system. The cumulative effect of these impervious surfaces and thousands of connected downspouts reduces the amount of water that can infiltrate into soils and greatly increases the volume and rate of runoff that flows to waterways. Stormwater runoff volumes (specific to Hackettstown, Warren County) associated with impervious surfaces were calculated for the following storms: the New Jersey water quality design storm of 1.25 inches of rain, an annual rainfall of 44 inches, the 2-year design storm (3.3 inches of rain), the 10-year design storm (4.9 inches of rain), and the 100-year design storm (7.8 inches of rain). These runoff volumes are summarized in Table 2. A substantial amount of rainwater drains from impervious surfaces in Hackettstown Township. For example, if the stormwater runoff from one water quality storm (1.25 inches of rain) in the Musconetcong River subwatershed was harvested and purified, it could supply water to 188 homes for one year[1].

[1] Assuming 300 gallons per day per home

Table 1: Impervious cover analysis by subwatershed for Hackettstown

| Subwatershed | Total Area | | Land Use Area | | Water Area | | Impervious Cover | | |
|---|---|---|---|---|---|---|---|---|---|
| | (ac) | ($mi^2$) | (ac) | ($mi^2$) | (ac) | ($mi^2$) | (ac) | ($mi^2$) | (%) |
| Musconetcong River | 2,374.3 | 3.71 | 2,288.3 | 3.58 | 86.0 | 0.13 | 607.1 | 0.95 | 26.5% |
| Total | 2,374.3 | 3.71 | 2,288.3 | 3.58 | 86.0 | 0.13 | 607.1 | 0.95 | 26.5% |

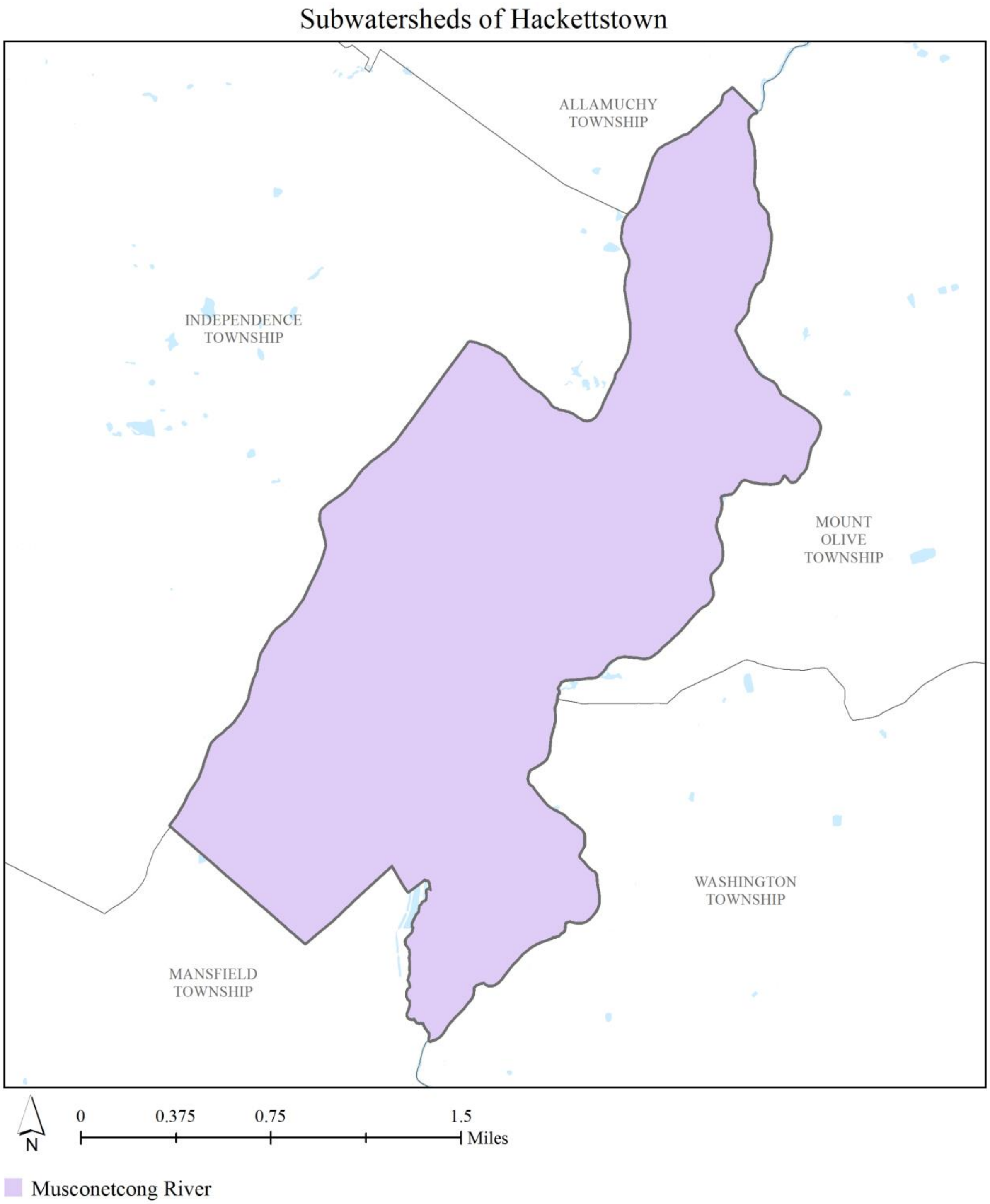



Figure 6: Map of the subwatersheds in Hackettstown

Table 2: Stormwater runoff volumes from impervious surfaces by subwatershed in Hackettstown

| **Subwatershed** | **Total Runoff Volume for the 1.25" NJ Water Quality Storm (MGal)** | **Total Runoff Volume for the NJ Annual Rainfall of 44" (MGal)** | **Total Runoff Volume for the 2-Year Design Storm (3.3") (MGal)** | **Total Runoff Volume for the 10-Year Design Storm (4.9") (MGal)** | **Total Runoff Volume for the 100-Year Design Storm (7.8") (MGal)** |
|---|---|---|---|---|---|
| Musconetcong River | 20.6 | 725.3 | 57.7 | 85.7 | 136.8 |
| Total | 20.6 | 725.3 | 57.7 | 85.7 | 136.8 |

The next step is to set a reduction goal for impervious area in each subwatershed. Based upon the Rutgers Cooperative Extension (RCE) Water Resources Program's experience, a 10% reduction would be a reasonably achievable reduction for these subwatersheds in Hackettstown. While it may be difficult to eliminate paved areas or replace paved areas with permeable pavement, it is relatively easy to identify impervious surfaces that can be disconnected using green infrastructure practices. For all practical purposes, disconnecting an impervious surface from a storm sewer system or a water body is an "impervious area reduction." The RCE Water Resources Program recommends that all green infrastructure practices that are installed to disconnect impervious surfaces should be designed for the 2-year design storm (3.3 inches of rain over 24-hours). Although this results in management practices that are slightly over-designed by NJDEP standards, which require systems to be designed for the New Jersey water quality storm (1.25 inches of rain over 2-hours), these systems will be able to handle the increase in storm intensities that are expected to occur due to climate change. By designing these management practices for the 2-year design storm, these practices will be able to manage 95% of the annual rainfall volume. The recommended annual reductions in runoff volumes are shown in Table 3.

As previously mentioned, once impervious surfaces have been identified, the next steps for managing impervious surfaces are to 1) eliminate surfaces that are not necessary, 2) reduce or convert impervious surfaces to pervious surfaces, and 3) disconnect impervious surfaces from flowing directly to local waterways.

**<u>Elimination of Impervious Surfaces</u>**

One method to reduce impervious cover is to "depave." Depaving is the act of removing paved impervious surfaces and replacing them with pervious soil and vegetation that will allow for the infiltration of rainwater. Depaving leads to the re-creation of natural space that will help reduce flooding, increase wildlife habitat, and positively enhance water quality as well as beautify neighborhoods. Depaving also can bring communities together around a shared vision to work together to reconnect their neighborhood to the natural environment.

Table 3: Impervious cover reductions by subwatershed in Hackettstown

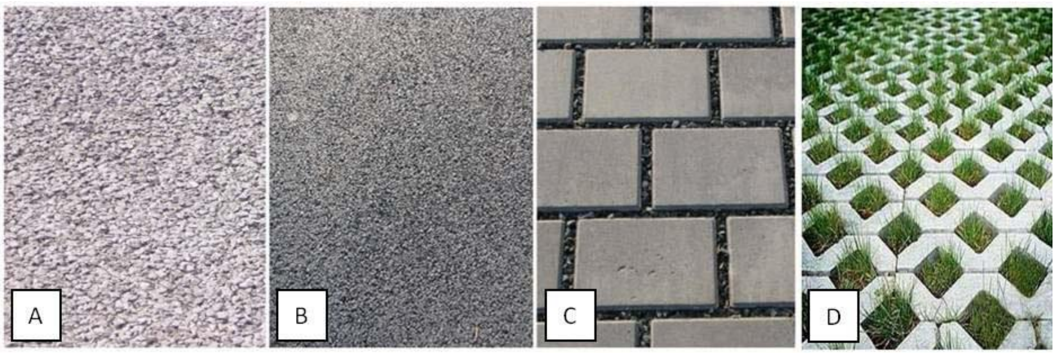
| **Subwatershed** | **Recommended Impervious Area Reduction (10%) (ac)** | **Annual Runoff Volume Reduction [2] (MGal)** |
|---|---|---|
| Musconetcong River | 60.7 | 68.9 |
| Total | 60.7 | 68.9 |

[2] Annual Runoff Volume Reduction =
Acres of IC x 43,560 $ft^2$/ac x 44 in x (1 ft/12 in) x 0.95 x (7.48 gal/$ft^3$) x (1 Mgal/1,000,000 gal)
All BMPs should be designed to capture the first 3.3 inches of rain from each storm. This would allow the BMP to capture 95% of the annual rainfall of 44 inches.

**Pervious Pavement**

There are four different types of permeable pavement systems that are commonly being used throughout the country to reduce the environmental impacts from impervious surfaces. These surfaces include pervious concrete, porous asphalt, interlocking concrete pavers, and grid pavers.

> "*Permeable pavement is a stormwater drainage system that allows rainwater and runoff to move through the pavement's surface to a storage layer below, with the water eventually seeping into the underlying soil. Permeable pavement is beneficial to the environment because it can reduce stormwater volume, treat stormwater water quality, replenish the groundwater supply, and lower air temperatures on hot days (Rowe, 2012).*"




*Permeable surfaces: (A) pervious concrete, (B) porous asphalt, (C) interlocking concrete pavers, (D) grid pavers (Rowe, 2012)*

Pervious concrete and porous asphalt are the most common of the permeable surfaces. They are similar to regular concrete and asphalt but without the fine materials. This allows water to quickly pass through the material into an underlying layered system of stone that holds the water, allowing it to infiltrate into the underlying uncompacted soil.

**Impervious Cover Disconnection Practices**

By redirecting runoff from paving and rooftops to pervious areas in the landscape, the amount of directly connected impervious area in a drainage area can be greatly reduced. There are many cost-effective ways to disconnect impervious surfaces from local waterways.

- Simple Disconnection: This is the easiest and least costly method to reduce stormwater runoff for smaller storm events. Instead of piping rooftop runoff to the street where it enters the catch basin and is piped to the river, the rooftop runoff is released onto a grassed area to allow the water to be filtered by the grass and soak into the ground. A healthy lawn typically can absorb the first one to two inches of stormwater runoff from a rooftop. Simple disconnection also can be used to manage stormwater runoff from paved areas. Designing a parking lot or driveway to drain onto a grassed area, instead of the street, can dramatically reduce pollution and runoff volumes.

- Rain Gardens: Stormwater can be diverted into shallow landscaped depressed areas (i.e., rain gardens) where the vegetation filters the water, and it is allowed to soak into the ground. Rain gardens, also known as bioretention systems, come in all shapes and sizes and can be designed to disconnect a variety of impervious surfaces (Figure 7).

Figure 7: Rain garden outside the RCE of Gloucester County office which was designed to disconnect rooftop runoff from the local storm sewer system

- Rainwater Harvesting: Rainwater harvesting includes the use of rain barrels and cisterns (Figures 8a and 8b). These can be placed below downspouts to collect rooftop runoff. The collected water has a variety of uses including watering plants and washing cars. This practice also helps cut down on the use of potable water for nondrinking purposes. It is important to divert the overflow from the rainwater harvesting system to a pervious area.

Figure 8a: Rain barrel used to disconnect a downspout with the overflow going to a flower bed

Figure 8b: A 5,000 gallon cistern used to disconnect the rooftop of the Department of Public Works in Clark Township to harvest rainwater for nonprofit car wash events

## Examples of Opportunities in Hackettstown

To address the impact of stormwater runoff from impervious surfaces, the next step is to identify opportunities in the municipality for eliminating, reducing, or disconnecting directly connected impervious surfaces. To accomplish this task, an impervious cover reduction action plan should be prepared. Aerial photographs are used to identify sites with impervious surfaces in the municipality that may be suitable for inclusion in the action plan. After sites are identified, site visits are conducted to photo-document all opportunities and evaluate the feasibility of eliminating, reducing, or disconnecting directly connected impervious surfaces. A brief description of each site discussing the existing conditions and recommendations for treatment of the impervious surfaces is developed. After a number of sites have been selected for inclusion in the action plan, concept plans and detailed green infrastructure information sheets are prepared for a selection of representative sites.

For Hackettstown, three sites have been included in this assessment. Examples of concept plans and detailed green infrastructure information sheets are provided in Appendix A. The detailed green infrastructure information sheets describe existing conditions and issues, proposed solutions, anticipated benefits, possible funding sources, potential partners and stakeholders, and estimated costs. Additionally, each project has been classified as a mitigation opportunity for recharge potential, total suspended solids removal, and stormwater peak reduction. Finally, these detailed green infrastructure information sheets provide an estimate of gallons of stormwater captured and treated per year by each proposed green infrastructure practice. The concept plans provide an aerial photograph of the site and details of the proposed green infrastructure practices.

## Conclusions

Hackettstown can reduce flooding and improve its waterways by better managing stormwater runoff from impervious surfaces. This impervious cover assessment is the first step toward better managing stormwater runoff. The next step is to develop an action plan to eliminate, reduce, or disconnect impervious surfaces where possible and practical. Many of the highly effective disconnection practices are inexpensive. The entire community can be engaged in implementing these disconnection practices.

## References

Arnold, C.L. Jr. and C.J. Gibbons. 1996. Impervious Surface Coverage The Emergence of a Key Environmental Indicator. *Journal of the American Planning Association* 62(2): 243-258.

Caraco, D., R. Claytor, P. Hinkle, H. Kwon, T. Schueler, C. Swann, S. Vysotsky, and J. Zielinski. 1998. Rapid Watershed Planning Handbook. A Comprehensive Guide for Managing Urbanizing Watersheds. Prepared by Center For Watershed Protection, Ellicott City, MD. Prepared for U.S. Environmental Protection Agency, Office of Wetlands, Oceans and Watersheds and Region V. October 1998.

May, C.W., R.R. Horner, J.R. Karr, B.W. Mar, E.G. Welch. 1997. Effects of Urbanization on Small Streams in the Puget Sound Lowland Ecoregion. *Watershed Protection Techniques* 2(4): 483-493.

Nowak, D. J., and E. J. Greenfield, 2012. Trees and Impervious Cover in the United States. *Landscape and Urban Planning* 107 (2012): 21-30.
http://www.nrs.fs.fed.us/pubs/jrnl/2012/nrs_2012_nowak_002.pdf

Rowe, A., 2012. Green Infrastructure Practices: An Introduction to Permeable Pavement. Rutgers NJAES Cooperative Extension, FS1177, pp. 4.
http://njaes.rutgers.edu/pubs/publication.asp?pid=FS1177

Schueler, T. 1994. The Importance of Imperviousness. *Watershed Protection Techniques*1(3): 100-111.

United States Environmental Protection Agency (USEPA), 2013. Watershed Assessment, Tracking, and Environmental Results, New Jersey Water Quality Assessment Report.
http://ofmpub.epa.gov/waters10/attains_state.control?p_state=NJ

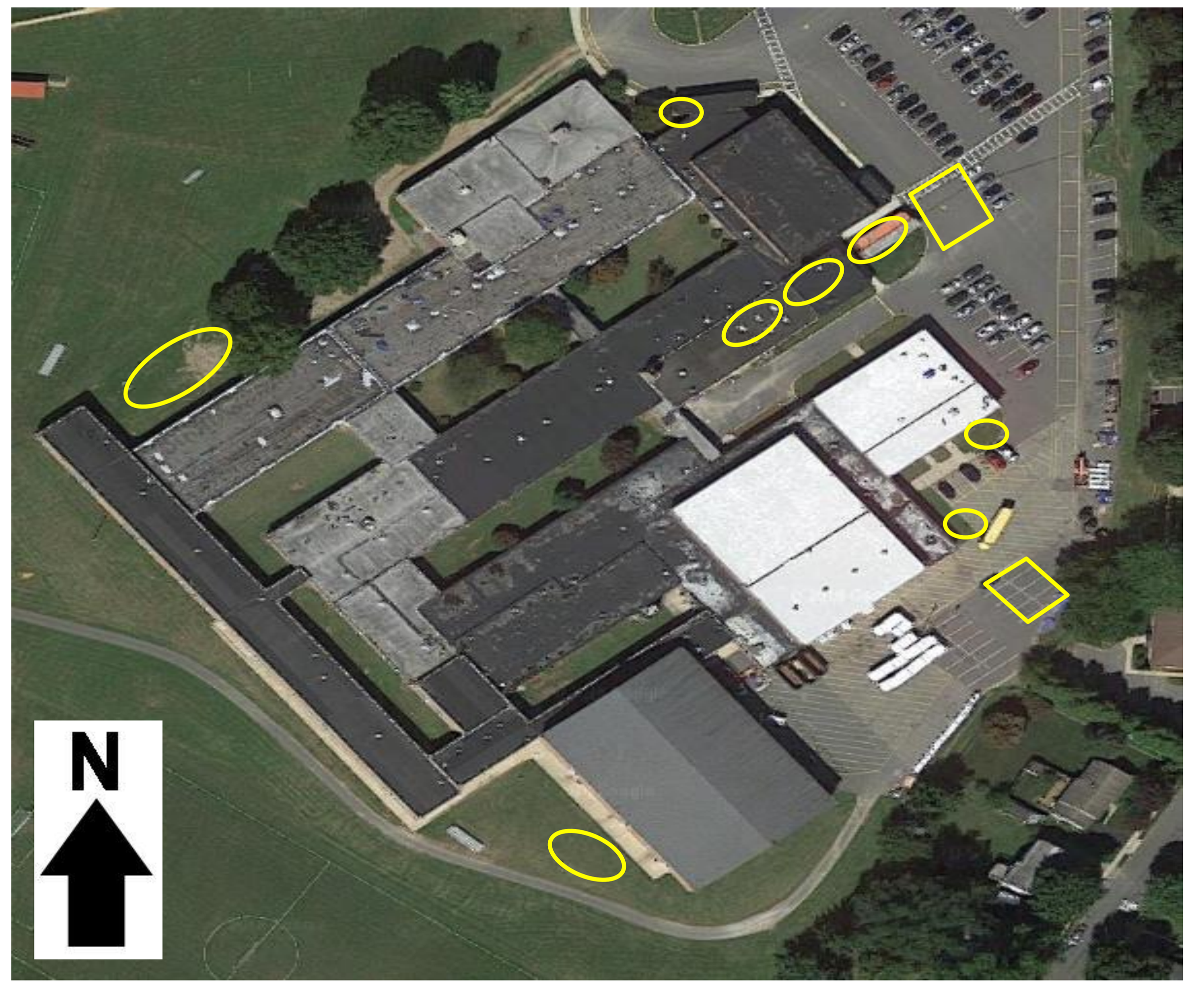
# Appendix A

## Examples of Impervious Cover Reduction Action Plan Projects

## Concept Plans and Detailed Green Infrastructure Information Sheets

Hackettstown
Impervious Cover Assessment
*Hackettstown High School, 701 Warren Street*

## PROJECT LOCATION:




## SITE PLAN:


1 **BIORETENTION SYSTEMS:** Rain gardens will be used to reduce sediment and nutrient loading to the local waterway and increase groundwater recharge. This site has seven locations for rain gardens including one at each corner of the building as well as three in an inner grass area. All of these rain gardens collect runoff from downspouts.

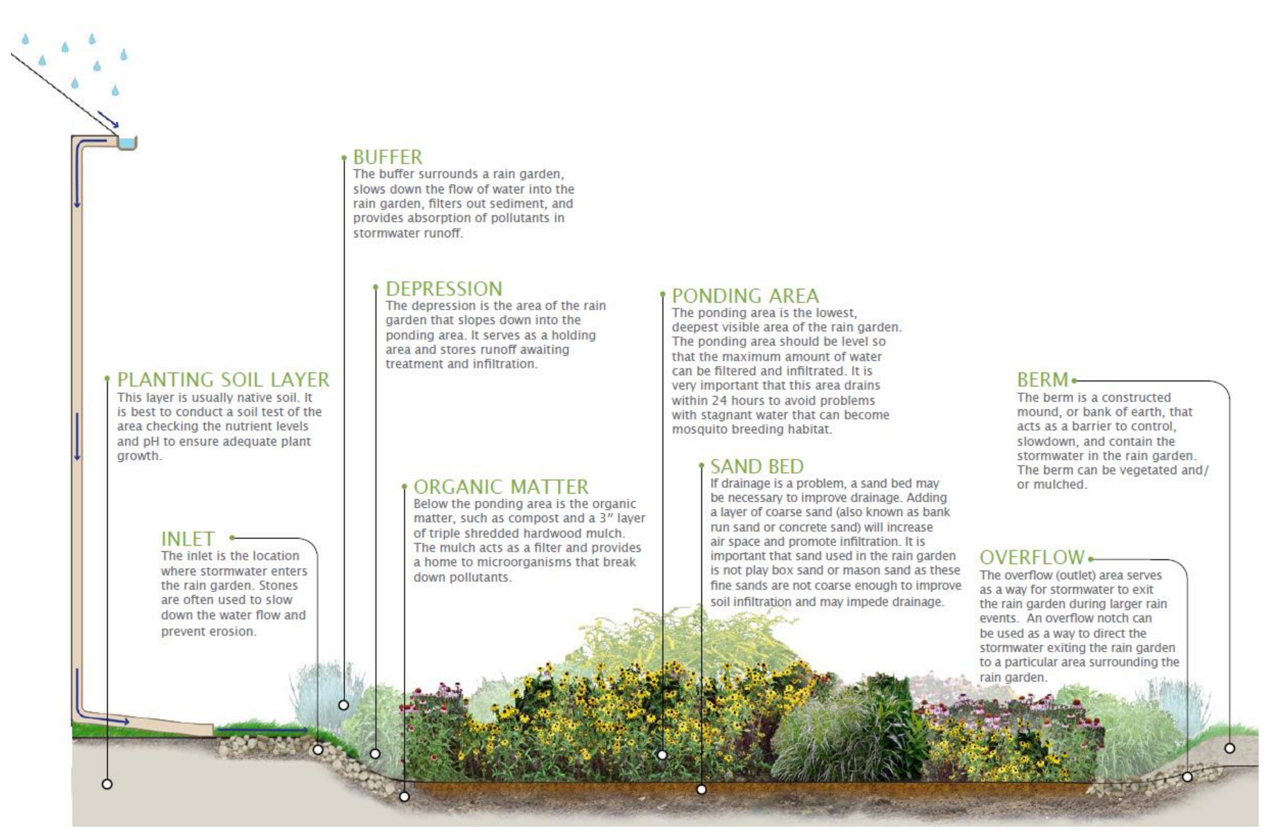
2 **POROUS PAVEMENT:** Parts of the northeast and southeast parking lots can be retrofitted with porous pavement. These are areas where runoff water tends to pool because of the uneven and sloped parking lot surface. They are also areas without heavy traffic, as excessive weight can impair the effectiveness of the pavement.

A

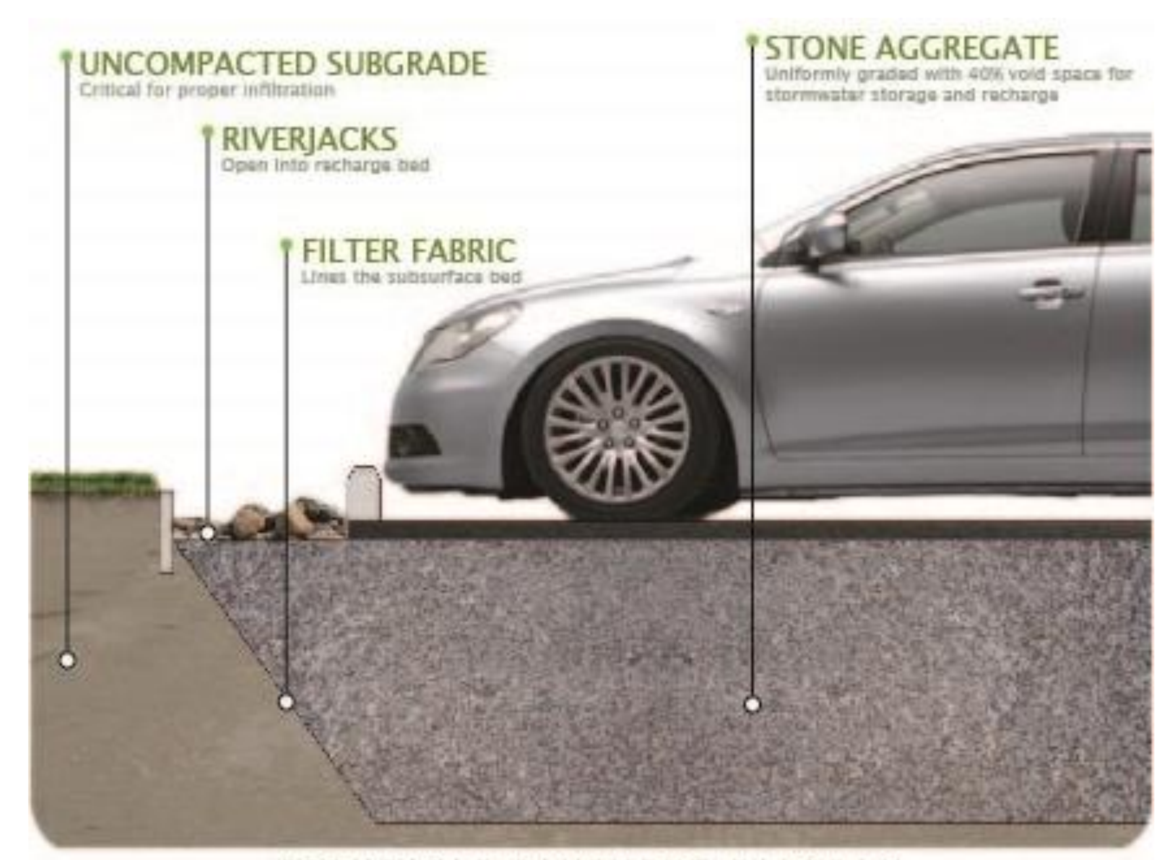
B

C

## 1 BIORETENTION SYSTEM




## 2 POROUS PAVEMENT



Hackettstown High School
Green Infrastructure Information Sheet

| | |
|---|---|
| **Location:**<br>701 Warren Street<br>Hackettstown, NJ 07840 | **Municipality:**<br>Hackettstown<br>**Subwatershed:**<br>Musconetcong River |
| **Green Infrastructure Description:**<br>bioretention system (bioretention system )<br>porous pavement | **Targeted Pollutants:**<br>total nitrogen (TN),<br>total phosphorus (TP),<br>total suspended solids (TSS) in surface runoff |
| **Mitigation Opportunities:**<br>recharge potential: yes<br>stormwater peak reduction potential: yes<br>total suspended solids removal potential: yes | **Stormwater Captured and Treated Per Year:**<br>bioretention system #1: 101,095 gal.<br>bioretention system #2: 22,408 gal.<br>bioretention system #3: 23,971 gal.<br>bioretention system #4: 26,576 gal.<br>bioretention system #5: 55,237 gal.<br>bioretention system #6: 69,828 gal.<br>bioretention system #7: 83,898 gal.<br>porous pavement system #1: 59,823 gal.<br>porous pavement system #2: 257,531 gal. |

**Existing Conditions and Issues:**

The school has a large parking area with impervious pavement. The parking lot is sloped away from the school and towards the grassy area to the east. The school has a mix of connected and disconnected downspouts. Runoff is carrying nonpoint source pollution, such as sediments, nutrients, oil, and grease to local waterways. The downspouts at this school either drain directly to the pavement or are connected to the storm sewer system. Both types of connections are carrying the rooftop runoff to local waterways. The pavement appears to be in good condition.

**Proposed Solution(s):**

Bioretention systems could be installed to capture a portion of the rooftop runoff and parking lot runoff. They can be placed at each corner of the school as well as in an inner grass area. Some of the other downspouts are already disconnected, and others can be disconnected so that they direct runoff from the roof into the bioretention systems. Porous pavement can also be installed in small parts of the northeast and southeast parking lots. This pavement can catch and absorb runoff that flows across the parking lot.

**Anticipated Benefits:**

Since the bioretention systems would be designed to capture, treat, and infiltrate the entire 2-year design storm (3.3 inches of rain over 24 hours), these systems are estimated to achieve a 95% pollutant load reduction for TN, TP, and TSS. A bioretention system would also provide ancillary benefits, such as enhanced wildlife and aesthetic appeal to the local residents of Hackettstown, especially the high school students.

Porous pavement allows stormwater to penetrate through to soil layers which will promote groundwater recharge as well as intercept and filter stormwater runoff. The porous pavement system will achieve the same level of pollutant load reduction for TN, TP and TSS as the bioretention system.

**Possible Funding Sources:**
Hackettstown School Board
mitigation funds from local developers
NJDEP grant programs

**Partners/Stakeholders:**
Hackettstown residents
local community groups (Boy Scouts, Girl Scouts, etc.)
students and parents
Rutgers Cooperative Extension

**Estimated Cost:**
Bioretention system #1 would need to be approximately 978 square feet. At $5 per square foot, the estimated cost is $4,890.
Bioretention system #2 would need to be approximately 215 square feet. At $5 per square foot, the estimated cost is $1,075.
Bioretention system #3 would need to be approximately 230 square feet. At $5 per square foot, the estimated cost is $1,150.
Bioretention system #4 would need to be approximately 255 square feet. At $5 per square foot, the estimated cost is $1,275.
Bioretention system #5 would need to be approximately 530 square feet. At $5 per square foot, the estimated cost is $2,650.
Bioretention system #6 would need to be approximately 670 square feet. At $5 per square foot, the estimated cost is $3,350.
Bioretention system #7 would need to be approximately 805 square feet. At $5 per square foot, the estimated cost is $4,025.

The first porous asphalt area would cover 820 square feet and have a one-foot stone reservoir under the surface. At $20 per square foot, the cost of the porous asphalt system would be $16,400.

The second porous asphalt area would cover 3,530 square feet and have a one-foot stone reservoir under the surface. At $20 per square foot, the cost of the porous asphalt system would be $70,600.

Disconnecting the five downspouts will cost about $250 each for a total cost of $1,250.

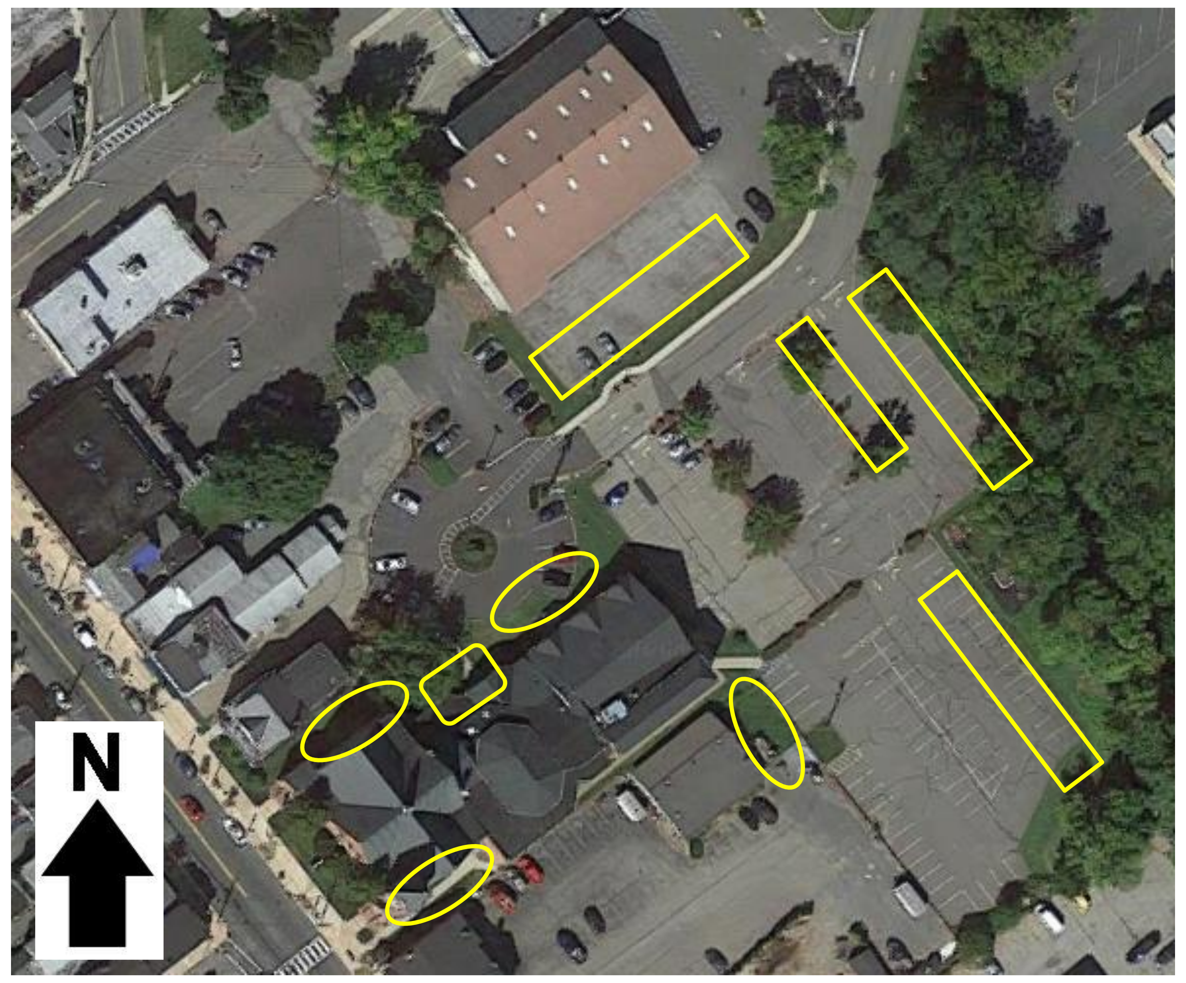
The total cost of the project will thus be approximately $106,665.

Hackettstown

Impervious Cover Assessment

*Trinity United Methodist Church, 213 Main Street*

**PROJECT LOCATION:**



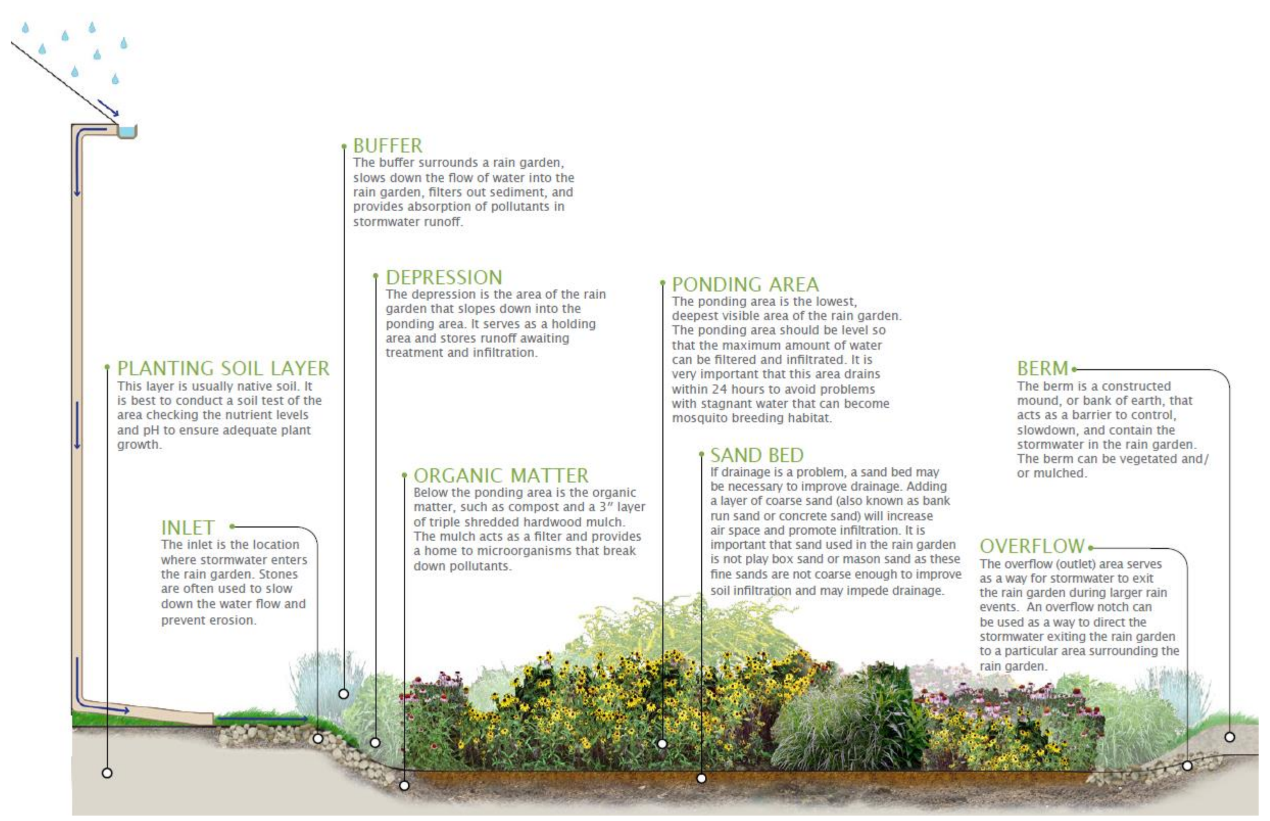

**SITE PLAN:**


1 **BIORETENTION SYSTEMS:** Rain gardens will be used to reduce sediment and nutrient loading to the local waterway and increase groundwater recharge. This site has four locations for rain gardens: along the northwest side, at the east corner, and at the south corner. All of these rain gardens collect runoff from downspouts.

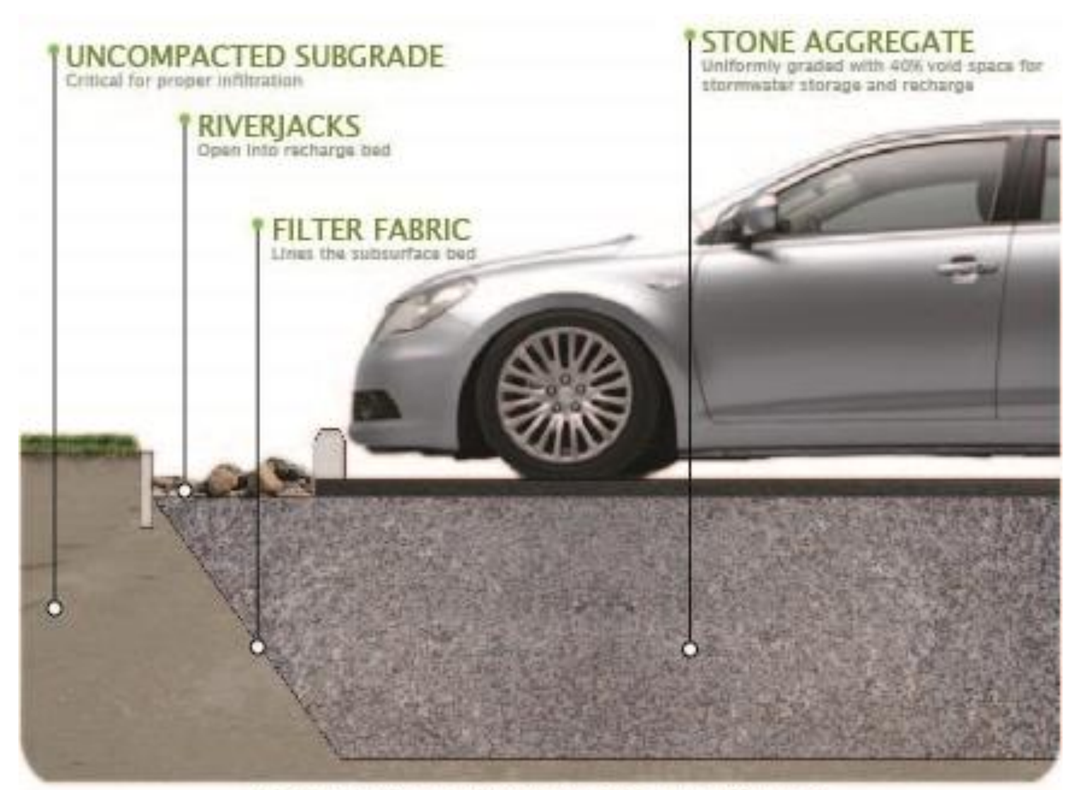
2 **POROUS PAVEMENT:** Parts of the parking lots east and north of the main building can be retrofitted with porous pavement. The first location would catch runoff from the downspouts of the side building, while the other three would catch runoff from the main building. These are areas where runoff water tends to collect because of the uneven and sloped parking lot surface. There are also areas without heavy traffic, as excessive weight can impair the effectiveness of the pavement.

3 **PLANTER BOX:** A planter box could be installed along the northwest side of the building underneath a downspout. Planter boxes reduce runoff and allow water to slowly infiltrate while being treated for pollutants.

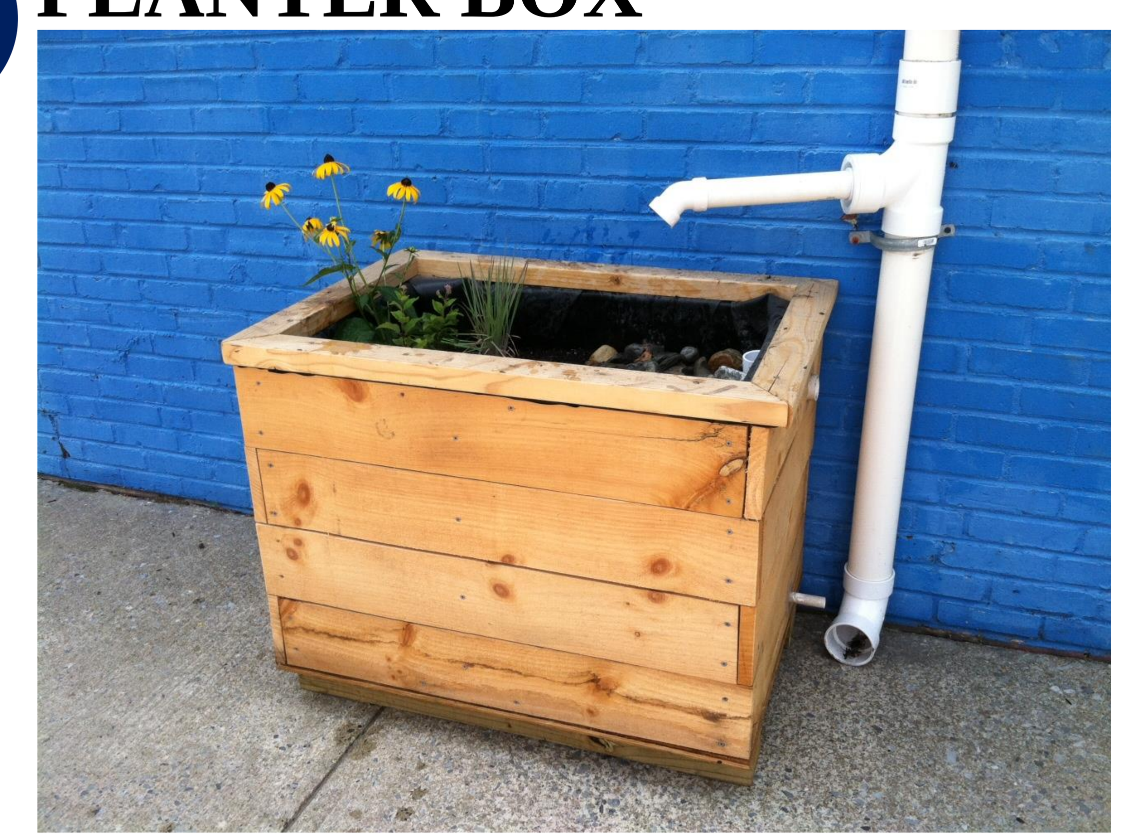
## 1 BIORETENTION SYSTEM




## 2 POROUS PAVEMENT




## 3 PLANTER BOX



Trinity United Methodist Church
Green Infrastructure Information Sheet

| | |
|---|---|
| **Location:**<br>213 Main Street<br>Hackettstown, NJ 07840 | **Municipality:**<br>Hackettstown<br><br>**Subwatershed:**<br>Musconetcong River |
| **Green Infrastructure Description:**<br>bioretention system (bioretention system )<br>porous pavement<br>planter box | **Targeted Pollutants:**<br>total nitrogen (TN),<br>total phosphorus (TP),<br>total suspended solids (TSS) in surface runoff |
| **Mitigation Opportunities:**<br>recharge potential: yes<br>stormwater peak reduction potential: yes<br>total suspended solids removal potential: yes | **Stormwater Captured and Treated Per Year:**<br>porous pavement system #1: 130,225 gal.<br>porous pavement system #2: 68,578 gal.<br>porous pavement system #3: 66,754 gal.<br>porous pavement system #4: 134,237 gal.<br><br>bioretention system #1: 28,140 gal.<br>bioretention system #2: 21,365 gal.<br>bioretention system #3: 34,393 gal.<br>bioretention system #4: 38,562 gal.<br><br>planter box: 2,654 gal. |

**Existing Conditions and Issues:**
This site consists of the main church building as well as a smaller side building to the north. It also includes a large parking area adjacent to both buildings. Almost all of the main building's downspouts are connected, but the side building has a few disconnected downspouts as well. Runoff is carrying nonpoint source pollution, such as sediments, nutrients, oil, and grease to local waterways. The pavement appears to be in good condition.

**Proposed Solution(s):**
Bioretention systems could be installed to capture a portion of the rooftop runoff and parking lot runoff. They can be placed along the northwest side and at the east and south corners of the main building. Several downspouts must be disconnected so that they direct runoff from the roof into the bioretention system s. Porous pavement can also be installed at various locations throughout the parking lot. This pavement can catch and absorb runoff that flows across the parking lot. At one point along the northwest side of the main building, a planter box can be installed to collect water from a downspout. This downspout would also have to be disconnected.

**Anticipated Benefits:**
Since the bioretention systems would be designed to capture, treat, and infiltrate the entire 2-year design storm (3.3 inches of rain over 24 hours), these systems are estimated to achieve a 95% pollutant load reduction for TN, TP, and TSS. A bioretention system would also provide ancillary benefits, such as enhanced wildlife and aesthetic appeal to the local residents of Hackettstown, especially the churchgoers.

Porous pavement allows stormwater to penetrate through to soil layers which will promote groundwater recharge as well as intercept and filter stormwater runoff. The porous pavement system will achieve the same level of pollutant load reduction for TN, TP and TSS as the bioretention system.

The planter box will take in runoff from downspouts and achieve similar reductions in TN, TP, and TSS as the bioretention systems.

**Possible Funding Sources:**
Town of Hackettstown
Trinity UMC administration
mitigation funds from local developers
local social and community groups

**Partners/Stakeholders:**
Hackettstown residents and parishioners
local community groups (Boy Scouts, Girl Scouts, etc.)
Rutgers Cooperative Extension

**Estimated Cost:**
Bioretention system #1 would need to be approximately 270 square feet. At $5 per square foot, the estimated cost is $1,350.
Bioretention system #2 would need to be approximately 205 square feet. At $5 per square foot, the estimated cost is $1,025.
Bioretention system #3 would need to be approximately 330 square feet. At $5 per square foot, the estimated cost is $1,650.
Bioretention system #4 would need to be approximately 370 square feet. At $5 per square foot, the estimated cost is $1,850.

The first porous asphalt area would cover 1,785 square feet and have a one-foot stone reservoir under the surface. At $20 per square foot, the cost of the porous asphalt system would be $35,700.

The second porous asphalt area would cover 940 square feet and have a one-foot stone reservoir under the surface. At $20 per square foot, the cost of the porous asphalt system would be $18,800.

The third porous asphalt area would cover 915 square feet and have a one-foot stone reservoir under the surface. At $20 per square foot, the cost of the porous asphalt system would be $18,300.

The fourth porous asphalt area would cover 1,840 square feet and have a one-foot stone reservoir under the surface. At $20 per square foot, the cost of the porous asphalt system would be $36,800.

The planter box will cost $1,000.

Disconnecting the nine downspouts will cost about $250 each for a total cost of $2,250.

The total cost of the project will thus be approximately $118,725.

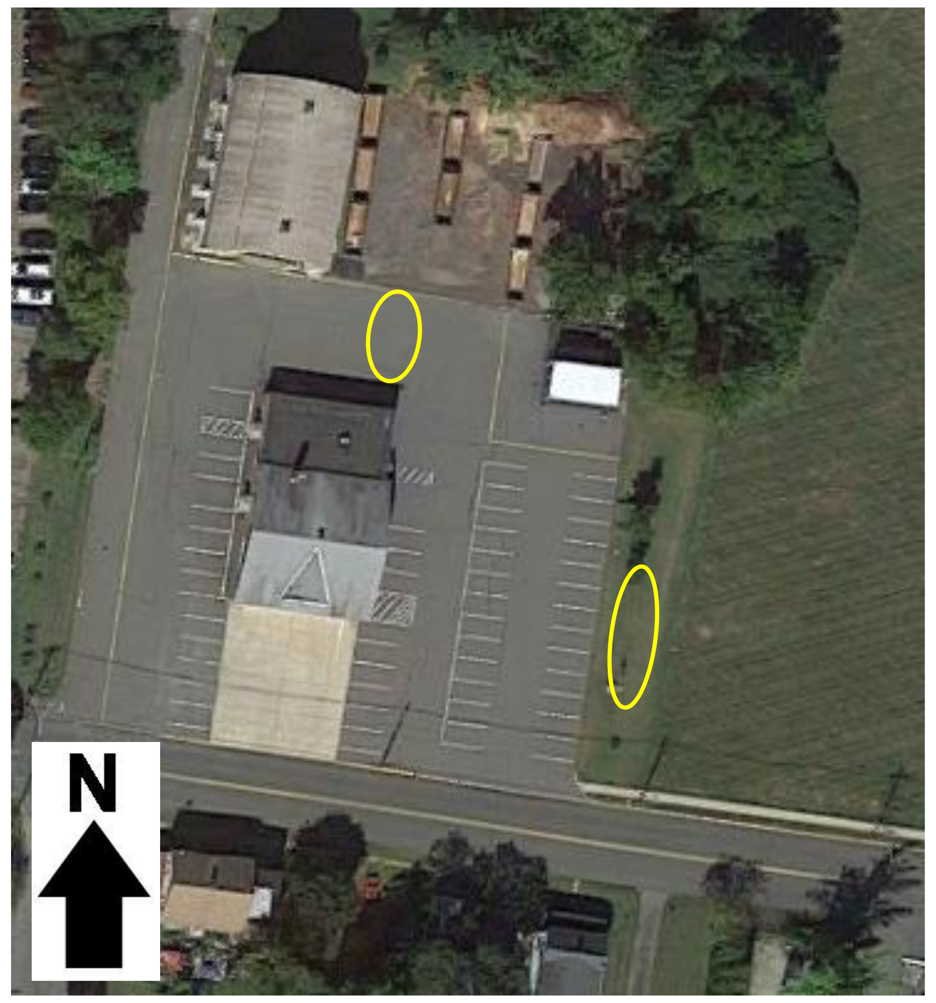
Hackettstown

Impervious Cover Assessment

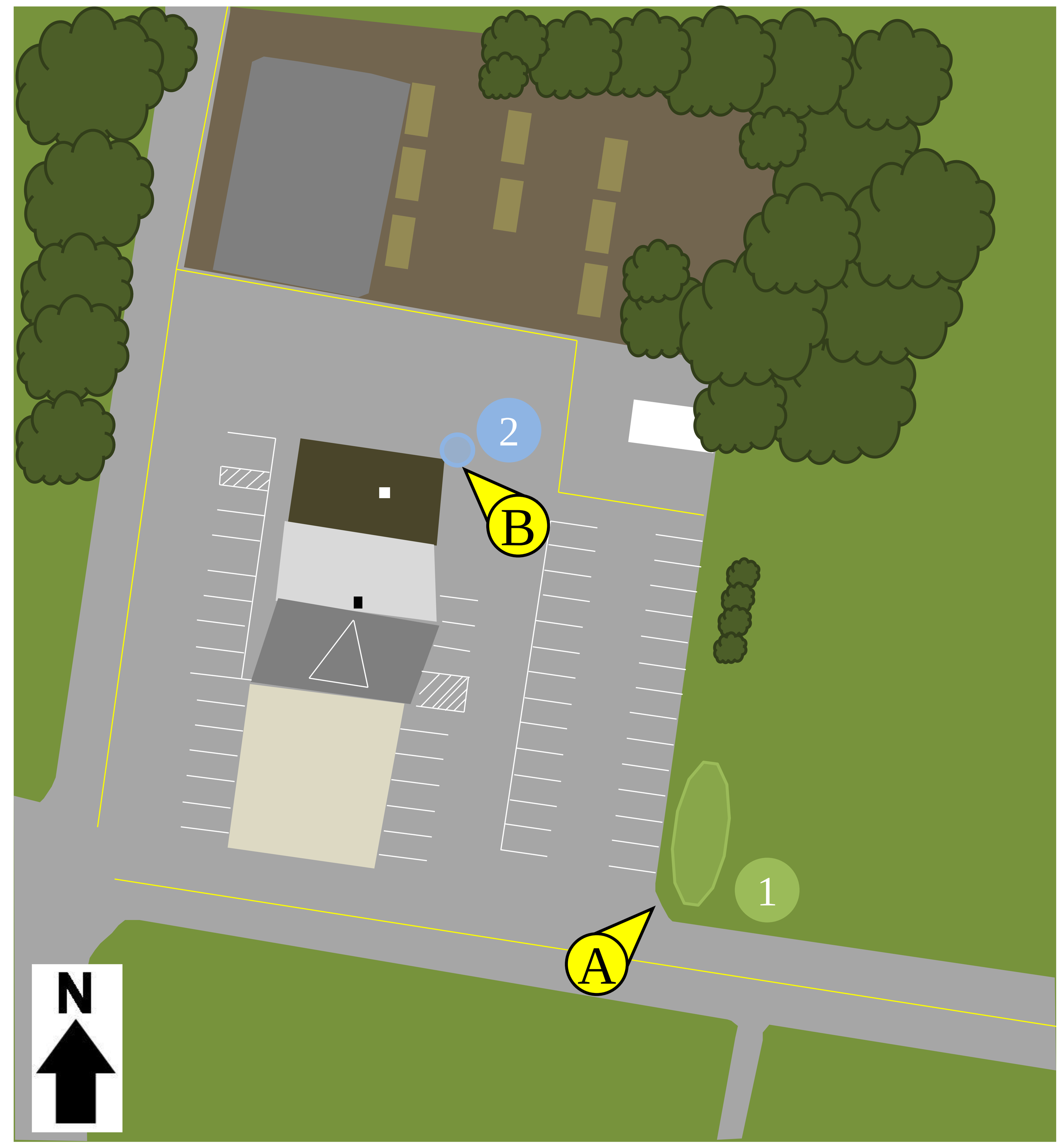
*Hackettstown Fire Department, 101 Miller Street*

RUTGERS
New Jersey Agricultural Experiment Station

**PROJECT LOCATION:**




**SITE PLAN:**



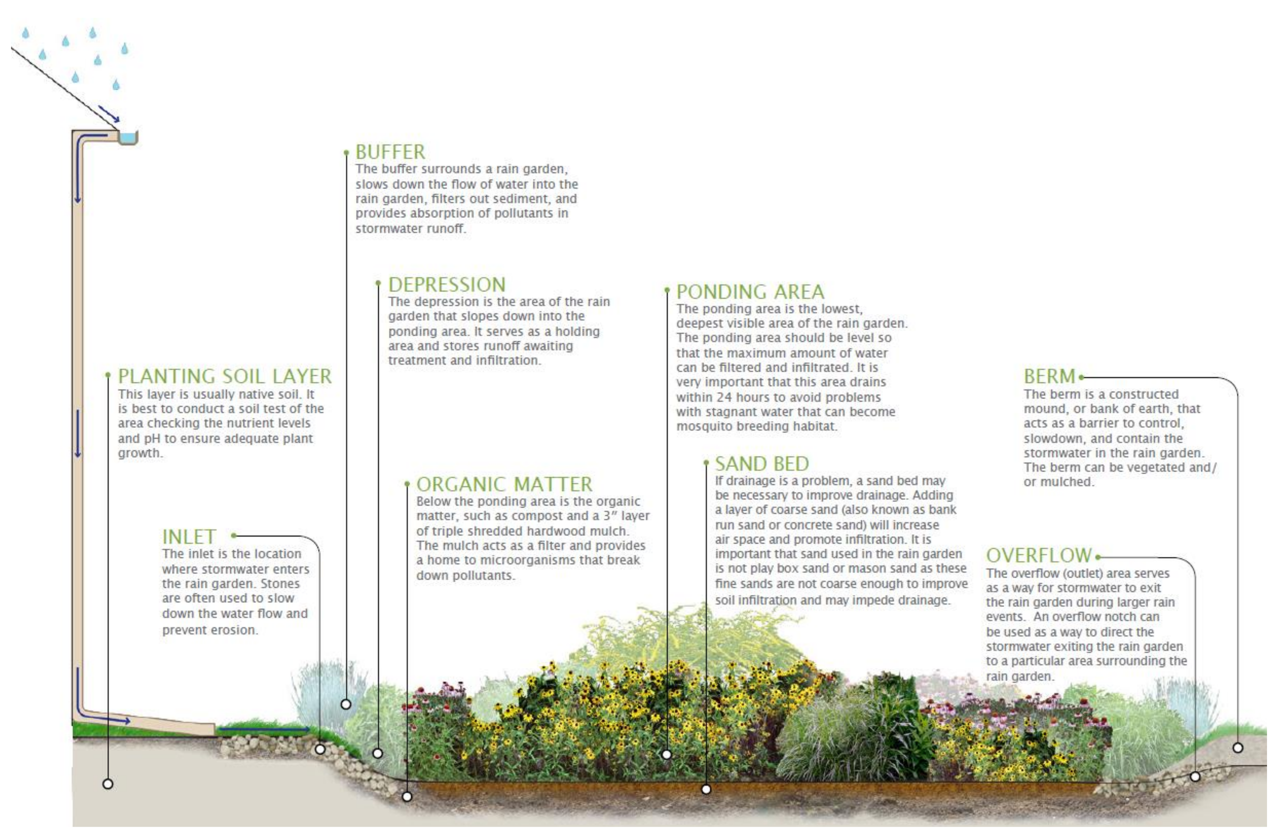

A

B

1 **BIORETENTION SYSTEM:** A rain garden will be used to reduce sediment and nutrient loading to the local waterway and increase groundwater recharge. The rain garden would catch runoff flowing off the parking lot which would otherwise flow into the grass.

2 **RAINWATER HARVESTING SYSTEM:** Rainwater will be harvested from the roof of the building and stored in a cistern located under a downspout at the northeast corner of the building. The water can be used to wash the station's firetrucks.

## 1 BIORETENTION SYSTEM




## 2 RAINWATER HARVESTING SYSTEM

# Hackettstown Fire Department
## Green Infrastructure Information Sheet

| | |
|---|---|
| **Location:**<br>101 Miller Street<br>Hackettstown, NJ 08740 | **Municipality:**<br>Hackettstown<br><br>**Subwatershed:**<br>Musconetcong River |
| **Green Infrastructure Description:**<br>bioretention system (rain garden)<br>rainwater harvesting system (cistern) | **Targeted Pollutants:**<br>total nitrogen (TN), total phosphorus (TP),<br>total suspended solids (TSS) in surface runoff |
| **Mitigation Opportunities:**<br>recharge potential: yes<br>stormwater peak reduction potential: yes<br>total suspended solids removal potential: yes | **Stormwater Captured and Treated Per Year:**<br>bioretention system: 316,312 gal.<br>rainwater harvesting system: 15,859 gal. |

**Existing Conditions and Issues:**

This site consists of the main building, which stores the firetrucks, and an additional building to the north. The main building is surrounded by a parking lot, and there is an expansive grass area to the east of the parking lot. There are four downspouts, one on each corner of the main building, and they are all disconnected. Runoff is carrying nonpoint source pollution, such as sediments, nutrients, oil, and grease to local waterways. The pavement appears to be in good condition.

**Proposed Solution(s):**

A bioretention system could be installed to capture a portion of the rooftop runoff and driveway runoff. It would be placed in the grass area east of the parking lot. A cistern can also be placed underneath the downspout at the northeast corner of the main building. The water in this cistern can then be used to wash the firetrucks when needed. Since the rainwater harvesting system would be designed to capture the first 1.25 inches of rain, it would reduce the pollutant loading by 90% during the periods it is operational (i.e., it would not be used in the winter when there is a chance of freezing).

**Anticipated Benefits:**

Since the bioretention systems would be designed to capture, treat, and infiltrate the entire 2-year design storm (3.3 inches of rain over 24 hours), these systems are estimated to achieve a 95% pollutant load reduction for TN, TP, and TSS. A bioretention system would also provide ancillary benefits, such as enhanced wildlife and aesthetic appeal to the local residents of Hackettstown.

Since the rainwater harvesting system would be designed to capture the first 1.25 inches of rain, it would reduce the pollutant loading by 90% during the periods it is operational (i.e., it would not be used in the winter when there is a chance of freezing).

The planter box will take in runoff from downspouts and achieve similar reductions in TN, TP, and TSS as the bioretention systems.

**Possible Funding Sources:**
Town of Hackettstown
mitigation funds from local developers
local social and community groups

**Partners/Stakeholders:**
Town of Hackettstown
local community groups (Boy Scouts, Girl Scouts, etc.)
Rutgers Cooperative Extension

**Estimated Cost:**
The rain garden would need to be approximately 3,035 square feet. At $5 per square foot, the estimated cost is $15,175.

The cistern would be 1,000 gallons and cost approximately $2,000 to purchase and install.

The total cost of the project will thus be approximately $17,175.