Impervious Cover Assessment
for
Monroe Township , Gloucester County, New Jersey

Prepared for Monroe Township by the
Rutgers Cooperative Extension Water Resources Program

January 31, 2019

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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

Monroe Township Impervious Cover Analysis

Located in Gloucester County in southern New Jersey, Monroe Township covers approximately 46.9 square miles west of Hammonton. Figures 3 and 4 illustrate that Monroe Township is dominated by forest land uses. A total of 30.8% of the municipality's land use is classified as urban. Of the urban land in Monroe Township , medium density residential is the dominant land use (Figure 5).

The literature suggests a link between impervious cover and stream ecosystem impairment (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. Schueler (1994, 2004) developed an impervious cover model that classified "sensitive streams" as typically having 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. Schueler et al. (2009) reformulated the impervious cover model based upon new research that had been conducted. This new analysis determined that stream degradation was first detected at 2 to 15% impervious cover. The updated impervious cover model recognizes the wide variability of stream degradation at impervious cover below 10%. The updated model also moves away from having a fixed line between stream quality classifications. For example, 5 to 10% impervious cover for the transition from sensitive to impacted, 20 to 25% impervious cover for the transition between impacted and non-supporting, and 60 to 70% impervious cover for the transition from non-supporting to urban drainage.

The New Jersey Department of Environmental Protection's (NJDEP) 2012 land use/land cover geographical information system (GIS) data layer categorizes Monroe Township 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 Monroe Township. Since water resources are typically managed on a watershed/subwatershed basis, an impervious cover analysis was performed for each subwatershed within Monroe Township (Table 1a and Figure 6). Based upon this analysis, approximately 7.7% of Monroe Township has impervious cover. On a subwatershed basis, impervious cover ranges from 0.3% in the Collings Lakes Tributaries subwatershed to 25.0% in the Big Timber Creek South Branch subwatershed. 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.

Since Monroe Township has historically required new development to have stormwater management, the New Jersey Hydrologic Modeling Database (http://hydro.rutgers.edu/) was reviewed to identify all stormwater management facilities in Monroe Township. The database contained 130 detention/infiltration basins in Monroe Township and provided the amount of impervious cover that each basin manages. These data were used to determine the unmanaged impervious cover for each subwatershed (See Table 1b). Based upon this analysis, Monroe Township has an unmanaged impervious cover of 5.5%. This level of impervious cover suggests that the streams in Monroe Township are likely sensitive.

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 Monroe Township, Gloucester County) associated with the unmanaged 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 (5.0 inches of rain), and the 100-year design storm (8.5 inches of rain). These runoff volumes are summarized in Table 2 for the unmanaged impervious cover. A substantial amount of rainwater drains from impervious surfaces in Monroe Township . For example, if the stormwater runoff from one water quality storm (1.25 inches of rain) in the Squankum Branch subwatershed was harvested and purified, it could supply water to 132 homes for one year[1].

[1] Assuming 300 gallons per day per home

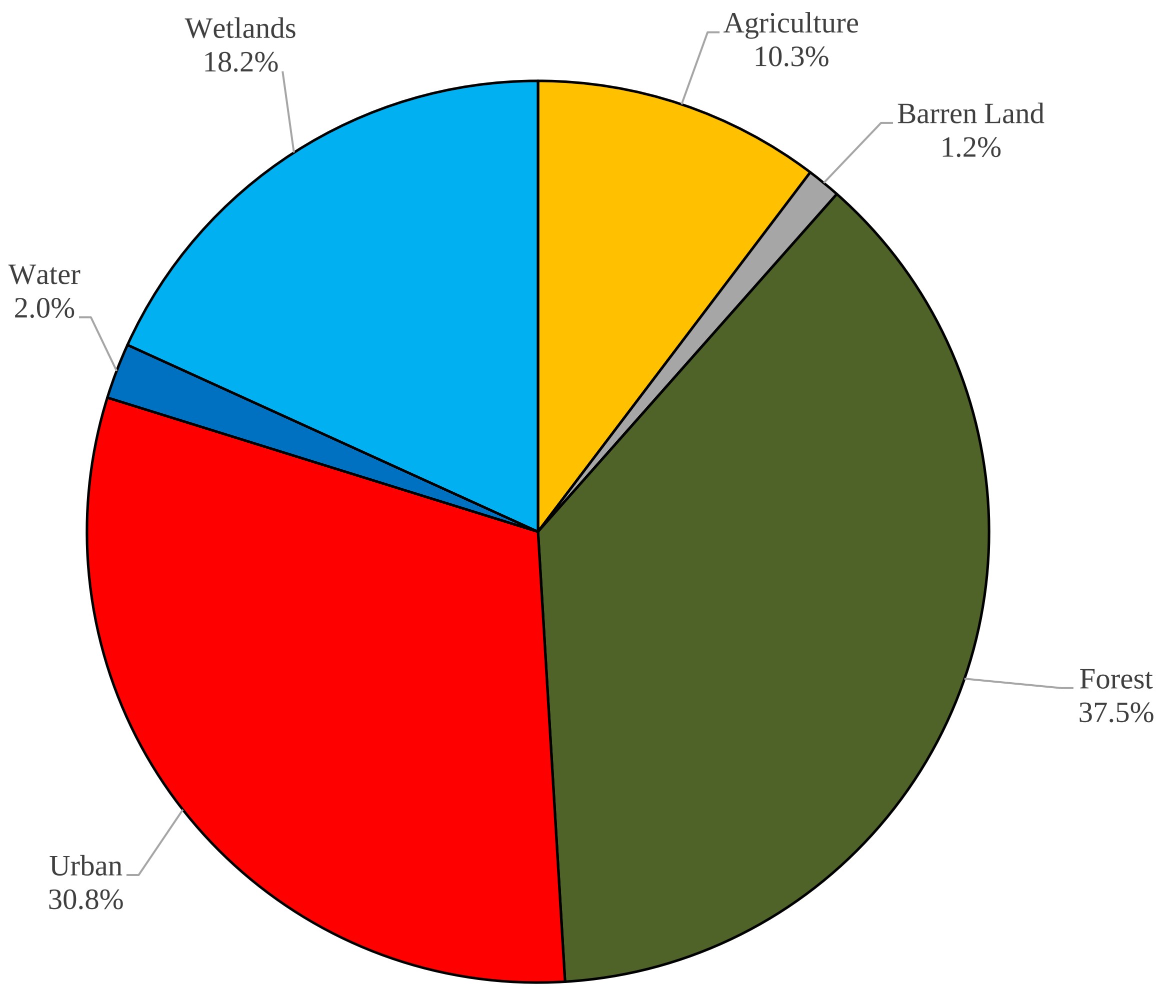


Figure 3: Pie chart illustrating the land use in Monroe Township

Land Use Types for Monroe

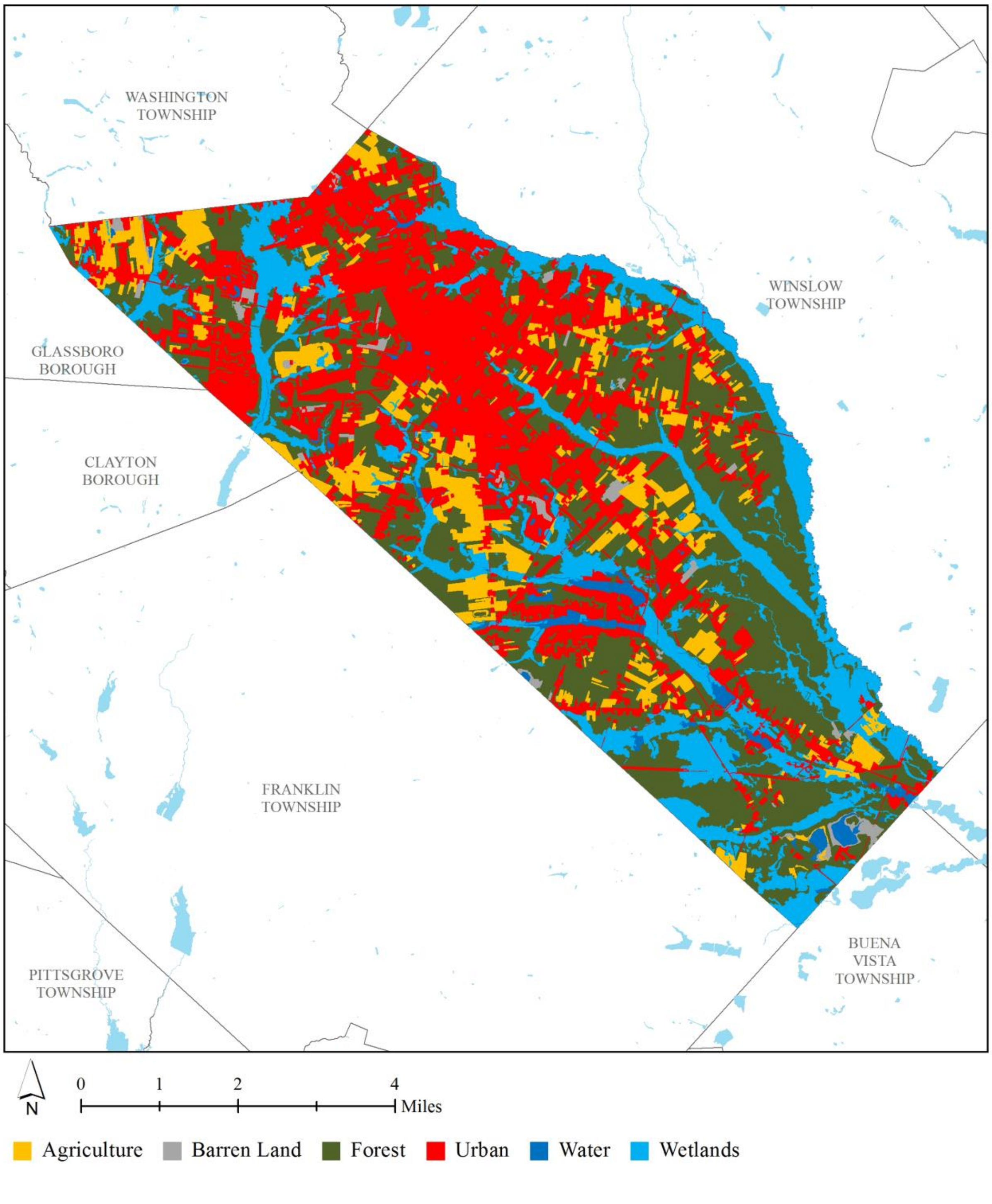


Figure 4: Map illustrating the land use in Monroe Township

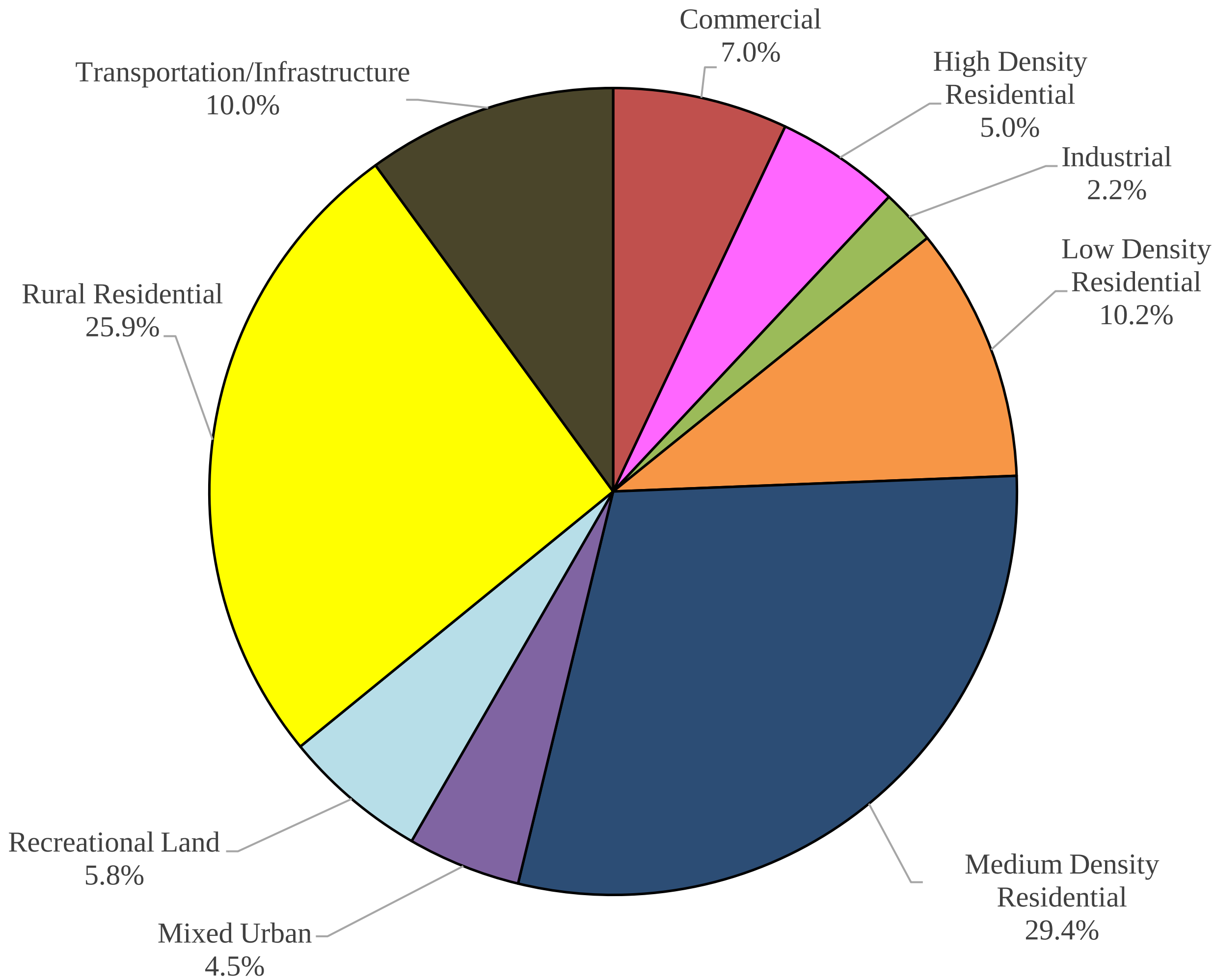


Figure 5: Pie chart illustrating the various types of urban land use in Monroe Township

Table 1a: Impervious cover analysis by subwatershed for Monroe Township

Subwatershed	Total Area	Land Use Area	Water Area	Impervious Cover	
	(ac)	**(ac)**	**(ac)**	**(ac)**	**(%)**
Big Timber Creek South Branch	2.20	0.14	2.00	0.04	25.0%
Collings Lakes Tributaries	598.80	576.90	21.88	2.00	0.3%
Four Mile Branch (GEHR)	3002.10	2984.50	17.50	453.60	15.2%
Greater Egg Harbor River	4601.00	4574.80	26.20	90.20	2.0%
Hospitality Branch	9818.60	9434.08	384.50	603.30	6.4%
Little Ease Run	1780.70	1762.90	17.80	99.01	5.6%
Mantua Creek	82.10	82.14	0.00	3.09	3.8%
Scotland Run	4214.80	4182.55	32.30	462.68	11.1%
Squankum Branch	4785.40	4765.31	20.10	553.54	11.6%
White Oak Branch	1145.10	1067.04	78.10	4.24	0.4%
Total	**30030.80**	**29430.46**	**600.40**	**2271.74**	**7.7%**

GEHR = Great Egg Harbor River

Table 1b: Managed impervious cover and unmanaged impervious cover

Subwatershed	Managed Impervious Cover*		Unmanaged Impervious Cover		Unmanaged Impervious Cover
	(ac)	**(%)**	**(ac)**	**(%)**	**(%)**
Big Timber Creek South Branch	0.00	0.0%	0.04	100.0%	25.0%
Collings Lakes Tributaries	0.00	0.0%	2.00	100.0%	0.3%
Four Mile Branch (GEHR)	94.64	20.9%	358.96	79.1%	12.0%
Greater Egg Harbor River	0.00	0.0%	90.20	100.0%	2.0%
Hospitality Branch	197.32	32.7%	405.98	67.3%	4.3%
Little Ease Run	60.85	61.5%	38.16	38.5%	2.2%
Mantua Creek	0.00	0.0%	3.09	100.0%	3.8%
Scotland Run	159.56	34.5%	303.12	65.5%	7.2%
Squankum Branch	129.81	23.5%	423.73	76.5%	8.9%
White Oak Branch	0.57	13.4%	3.67	86.6%	0.3%
Total	**642.75**	**28.3%**	**1628.99**	**71.7%**	**5.5%**

*Managed by 130 detention/infiltration basins

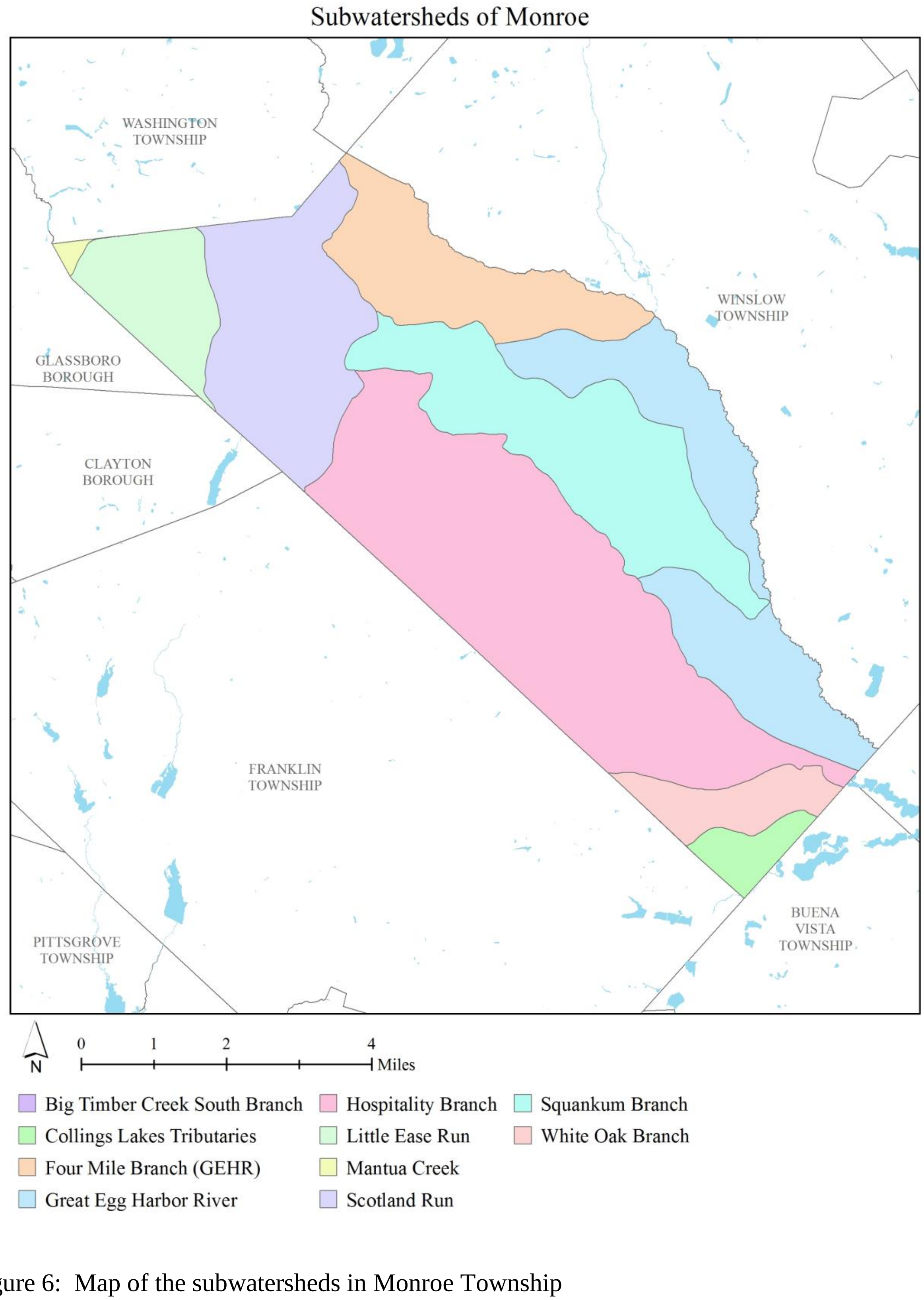


Figure 6: Map of the subwatersheds in Monroe Township

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

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 (5.0") (Mgal)	Total Runoff Volume for the 100-Year Design Storm (8.5") (Mgal)
Big Timber Creek South Branch	0.0	0.0	0.0	0.0	0.0
Collings Lakes Tributaries	0.1	2.4	0.2	0.3	0.5
Four Mile Branch (GEHR)	12.2	428.9	32.2	48.7	82.8
Greater Egg Harbor River	3.1	107.8	8.1	12.2	20.8
Hospitality Branch	13.8	485.0	36.4	55.1	93.7
Little Ease Run	1.3	45.6	3.4	5.2	8.8
Mantua Creek	0.1	3.7	0.3	0.4	0.7
Scotland Run	10.3	362.1	27.2	41.2	70.0
Squankum Branch	14.4	506.2	38.0	57.5	97.8
White Oak Branch	0.1	4.4	0.3	0.5	0.8
Total	55.3	1,946.2	146.0	221.2	376.0

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 Monroe Township. 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.

Elimination of Impervious Surfaces

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 Monroe Township

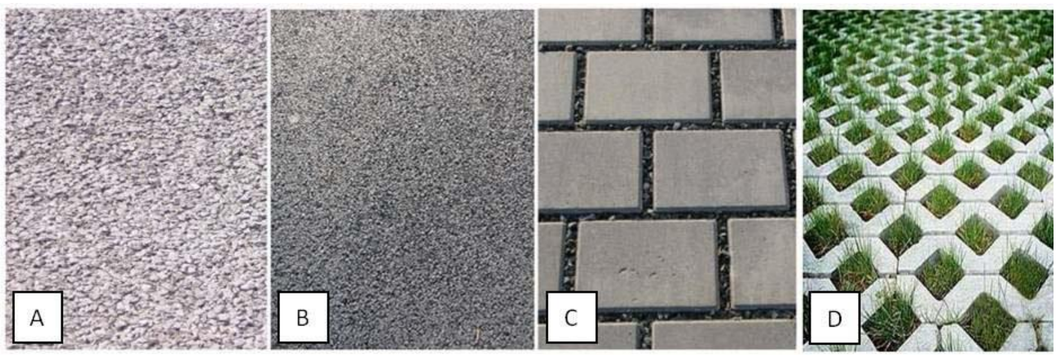
Subwatershed	**Recommended Impervious Area Reduction (10%) (ac)**	**Annual Runoff Volume Reduction [2] (MGal)**
Big Timber Creek South Branch	0.0	0.0
Collings Lakes Tributaries	0.2	0.2
Four Mile Branch (GEHR)	35.9	40.7
Greater Egg Harbor River	9.0	10.2
Hospitality Branch	40.6	46.1
Little Ease Run	3.8	4.3
Mantua Creek	0.3	0.4
Scotland Run	30.3	34.4
Squankum Branch	42.4	48.1
White Oak Branch	0.4	0.4
Total	162.9	184.9

[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 Monroe Township

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 Monroe Township, 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

Monroe Township 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.

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Appendix A

Concept Plans and Detailed Green Infrastructure Information Sheets

Monroe Township
Impervious Cover Assessment
Holly Glen Elementary School, 900 North Main Street

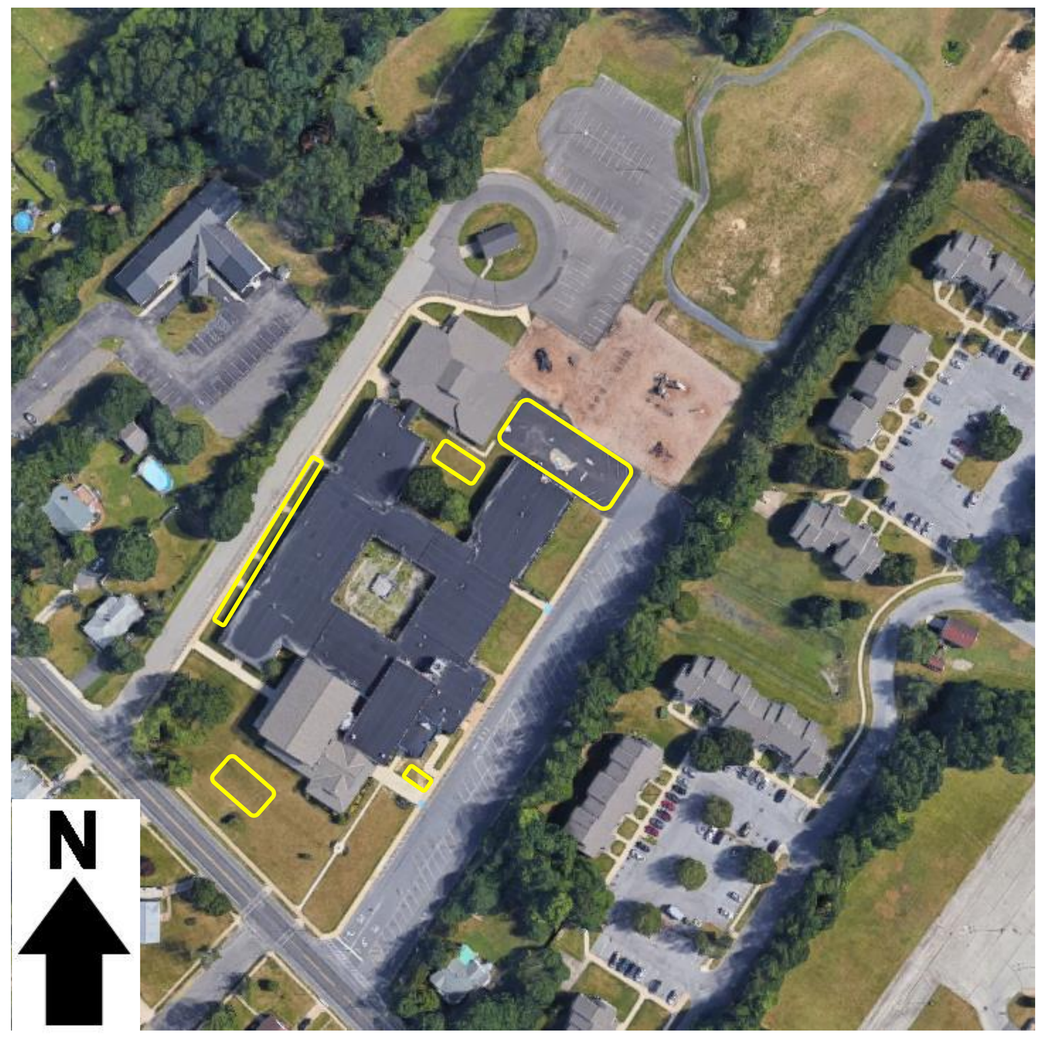
RUTGERS
New Jersey Agricultural Experiment Station

A

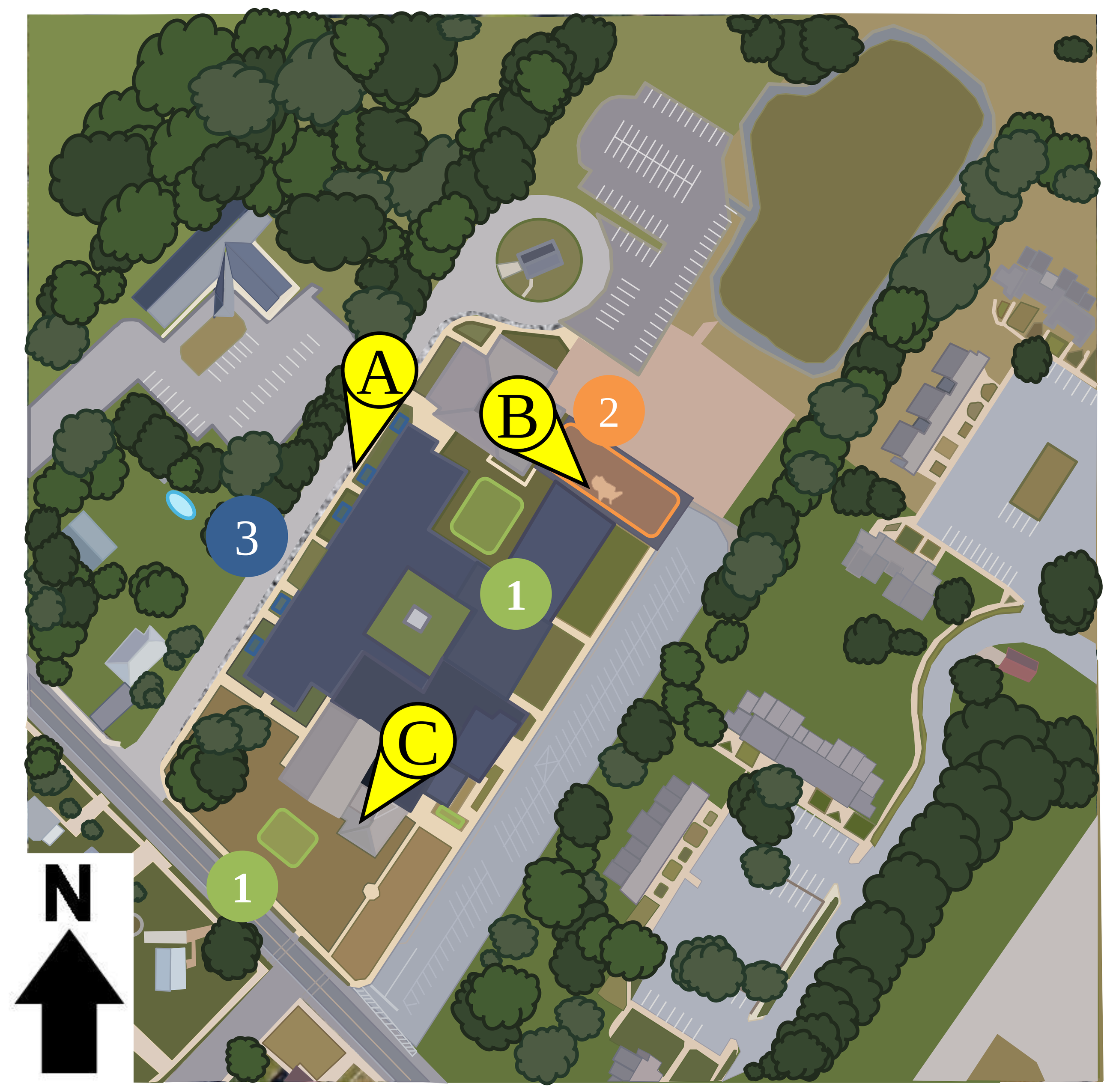
B

C

PROJECT LOCATION:



SITE PLAN:

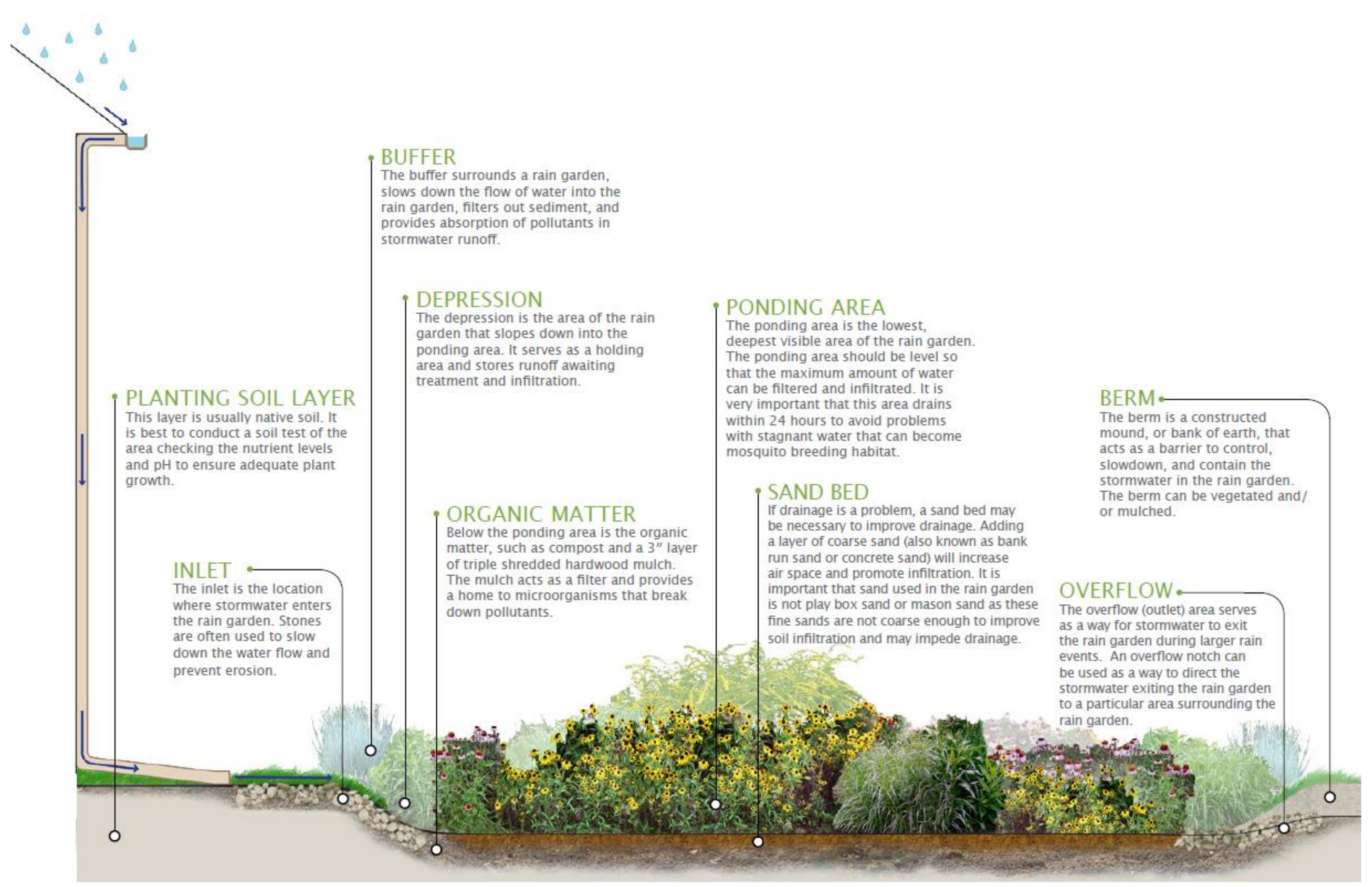


1 **BIORETENTION SYSTEM:** A rain garden could be installed south of the site between the main road and school building. Another rain garden could be installed on the eastern side of the school to capture runoff from the roof via downspouts.

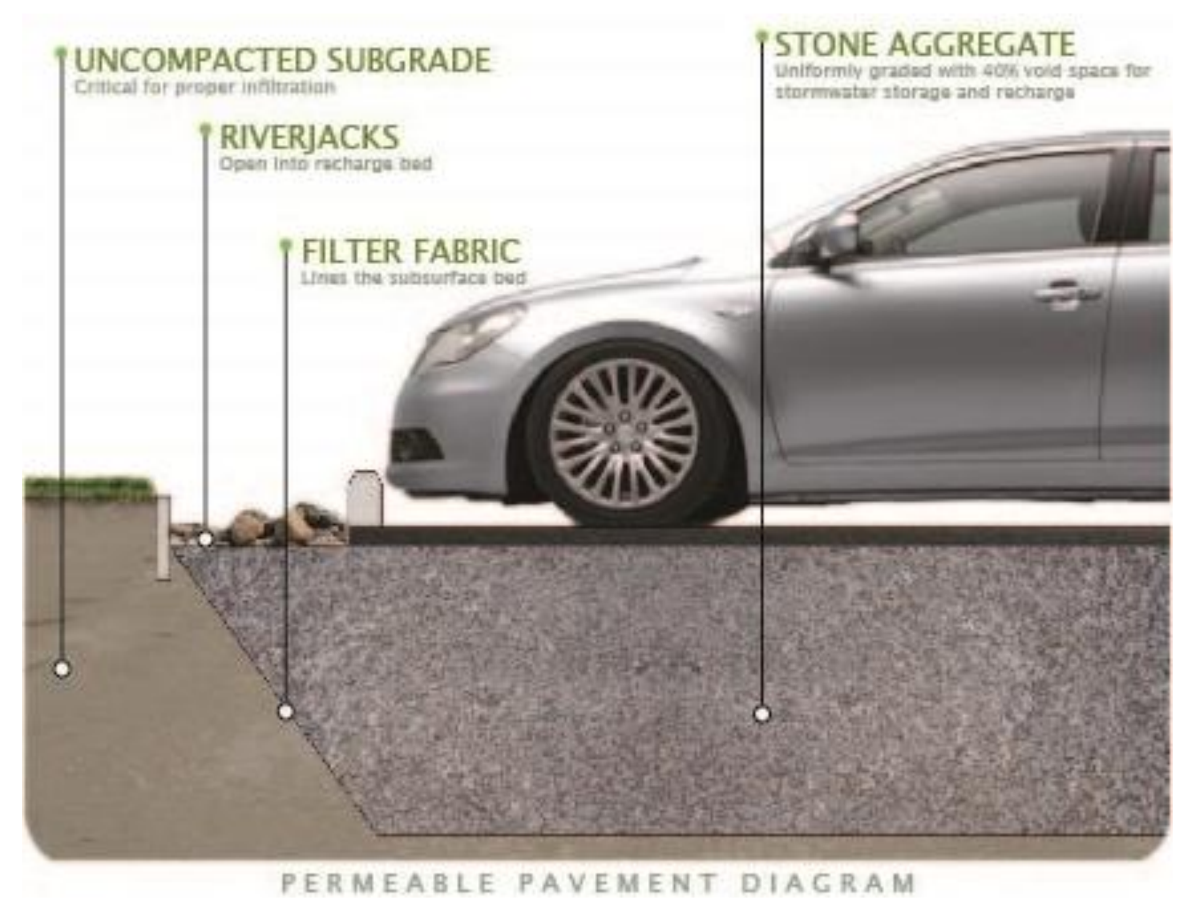
2 **PERVIOUS PAVEMENT:** Pervious pavement promotes groundwater recharge and filters stormwater.

3 **DOWNSPOUT PLANTER BOX:** Downspout planter boxes could be installed along the western face of the building at the downspouts to capture runoff from the roof.

1 BIORETENTION SYSTEM



2 PERVIOUS PAVEMENT



3 DOWNSPOUT PLANTER BOX

Holly Glen Elementary School
Green Infrastructure Information Sheet

Location: 900 North Main Street Williamstown, NJ 08094	**Municipality:** Monroe Township **Subwatershed:** Four Mile Branch
Green Infrastructure Description: bioretention system (rain garden) downspout planter box pervious pavement	**Targeted Pollutants:** total nitrogen (TN), total phosphorus (TP), and total suspended solids (TSS) in surface runoff
Mitigation Opportunities: recharge potential: yes TSS removal potential: yes stormwater peak reduction potential: yes	**Stormwater Captured and Treated Per Year:** rain garden #1: 109,432 gal. rain garden #2: 101,616 gal. downspout planter boxes: 6,660 gal. pervious pavement: 354,090 gal.

Existing Conditions and Issues:
Towards the west, south, and east sides of the building there are disconnected downspouts discharging onto a turfgrass area causing flooding. On the western side of the school there are patches of turfgrass alongside the school with disconnected downspouts discharging onto the turfgrass. Towards the north there is a turfgrass area that the building surrounds, and there are two trees that several disconnected downspouts drain to. Furthermore, there is a paved area to the north where runoff from the surrounding school buildings drain to.

Proposed Solution(s):
Alongside the western facing side of the school, five downspout planter boxers can be installed at the downspouts to capture and infiltrate runoff from the roof. Two rain gardens, one in the large turfgrass area in front of the building and another towards the northern area of the site in the turfgrass area surrounded by the building can be installed to capture the runoff from the roof via the disconnected downspouts. Lastly, pervious pavement can be installed to promote groundwater recharge and filter stormwater.

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. This bioretention system would provide additional benefits such as aesthetic appeal and wildlife habitat. Rutgers Cooperative Extension could additionally present the *Stormwater Management in Your Schoolyard* program to students and include them in bioretention system planting efforts to enhance the program.

The downspout planter boxes could manage the runoff from the roof by storing, infiltrating, and releasing runoff into groundwater supplies.

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:
mitigation funds from local developers
NJDEP grant programs
grants from foundations
home and school associations

Partners/Stakeholders:
Township of Monroe
students and parents
local social and community groups
Rutgers Cooperative Extension

Estimated Cost:
Rain garden #1 would need to be approximately 2,830 square feet. At $5 per square foot, the estimated cost is $14,150.

Rain garden #2 would need to be approximately 2,280 square feet. At $5 per square foot, the estimated cost is $11,400.

The pervious pavement would cover approximately 5,705 square feet and have a two-foot stone reservoir under the surface. At $25 per square foot, the estimated cost of the pervious pavement would be $142,625.

The total cost of the project will be approximately $168,175.

Monroe Township
Impervious Cover Assessment
Monroe Township Public Library,713 Marsha Avenue

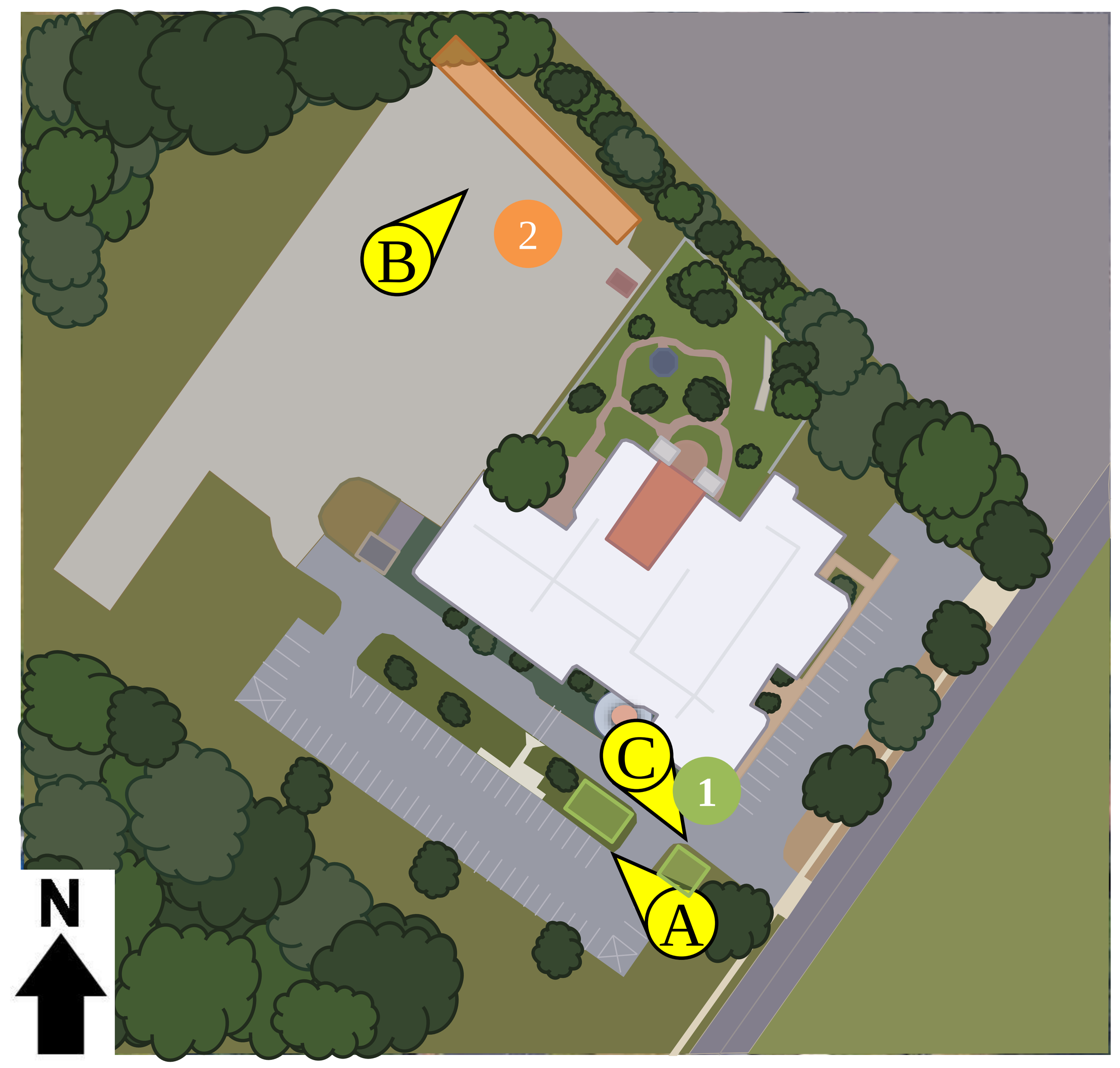
RUTGERS
New Jersey Agricultural Experiment Station

PROJECT LOCATION:

1 **BIORETENTION SYSTEM:** A rain garden could be installed in the turfgrass area alongside the parking lot south of the building. Another rain garden could be installed in the turfgrass area adjacent to the parking lot's entrance. Rain gardens can be used to reduce sediment and nutrient loading to the local waterway and increase groundwater recharge.

2 **PERVIOUS PAVEMENT:** Pervious pavement could be installed in the parking lot along the northwest side of the building to promote groundwater recharge and filter stormwater.

SITE PLAN:



A

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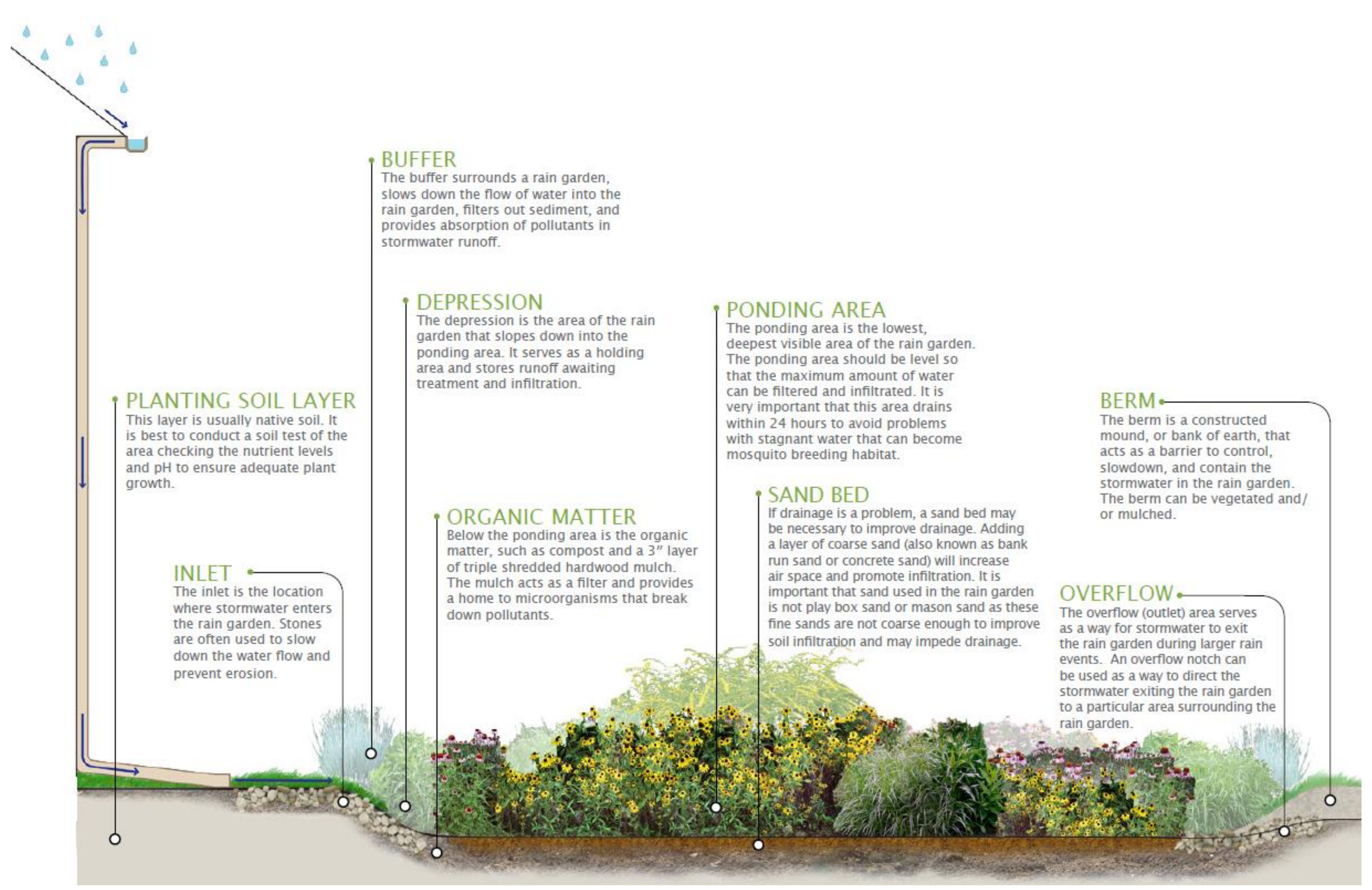
C

1 BIORETENTION SYSTEM



2 PERVIOUS PAVEMENT

Location: 713 Marsha Avenue Williamstown, NJ 08094	**Municipality:** Monroe Township **Subwatershed:** Four Mile Branch
Green Infrastructure Description: bioretention system (rain garden) pervious pavement	**Targeted Pollutants:** total nitrogen (TN), total phosphorus (TP), and total suspended solids (TSS) in surface runoff
Mitigation Opportunities: recharge potential: yes TSS removal potential: yes stormwater peak reduction potential: yes	**Stormwater Captured and Treated Per Year:** rain garden #1: 65,660 gal. rain garden #2: 54,200 gal. pervious pavement : 262,640 gal.

Existing Conditions and Issues:
In the parking lot in the back of the site, heavy erosion and pooling are present. A catch basin is located on the asphalt connecting the two parking lots, where improper drainage and pooling occurs around the catch basin. In the northwest corner of the back parking lot a shed is located, and next to that is a large depression in the asphalt where heavy pooling occurs.

Proposed Solution(s):
In the main parking lot in front of the main entrance, two rain gardens can be installed in the turfgrass area between the main entrance and parking lot to capture runoff from the parking lot. For the larger parking lot in the back, a strip of pervious pavement can be placed in the northwest corner, stretching from west to east, capturing and infiltrating runoff from the pavement to remove pooling in the affected area.

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. This bioretention system would provide additional benefits such as aesthetic appeal and wildlife habitat.

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

Possible Funding Sources:
mitigation funds from local developers
NJDEP grant programs
grants from foundations

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

Estimated Cost:
Rain garden #1 would need to be approximately 630 square feet. At $5 per square foot, the estimated cost is $3,150.

Rain garden #2 would need to be approximately 520 square feet. At $5 per square foot, the estimated cost is $2,600.

The pervious pavement would cover approximately 2,935 square feet and have a two-foot stone reservoir under the surface. At $25 per square foot, the estimated cost of the pervious pavement would be $73,375.

The total cost of the project will be approximately $79,125.

Monroe Township
Impervious Cover Assessment
Monroe Township Ambulance Association, 700 Corkery Lane

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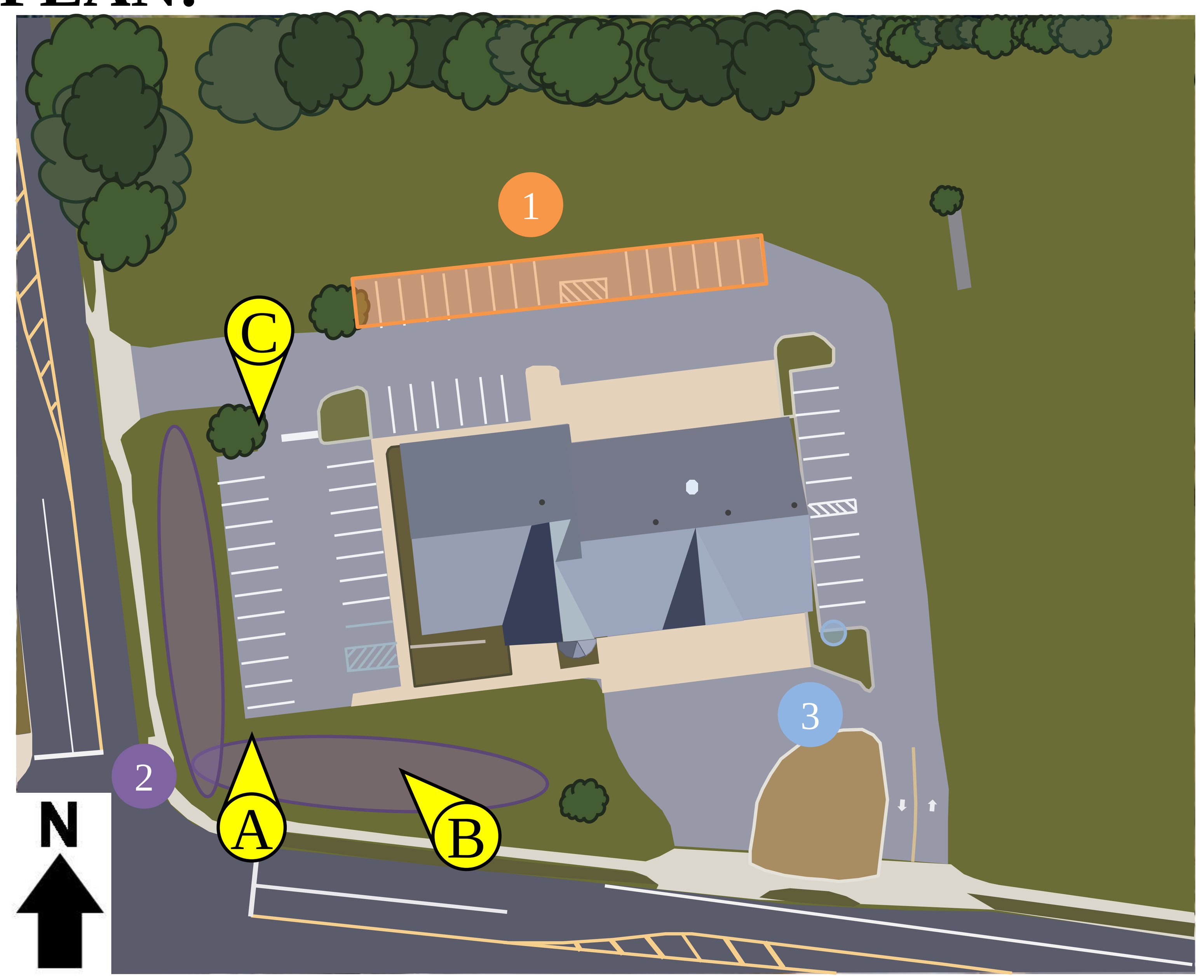
PROJECT LOCATION:

SITE PLAN:

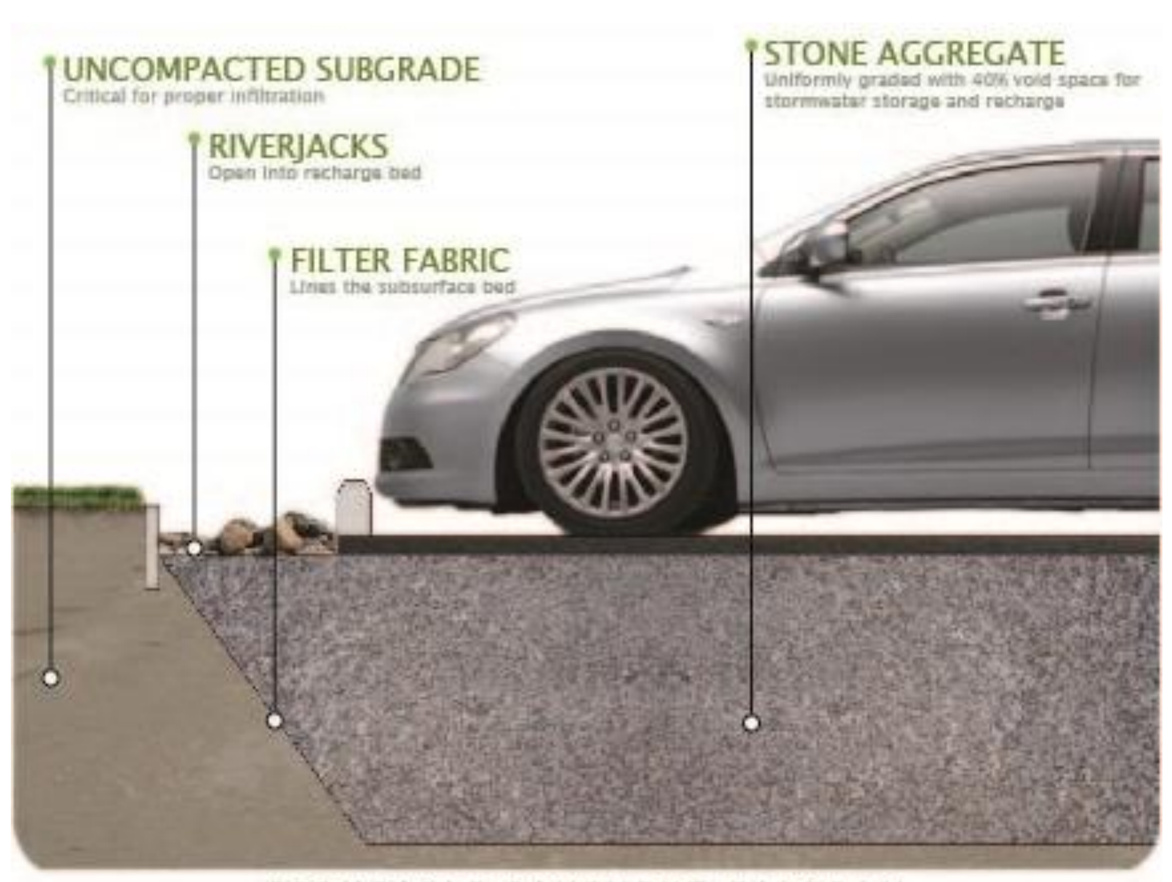


1 **PERVIOUS PAVEMENT:** Pervious pavement could be installed in the northernmost parking spaces to capture stormwater from the roof and surrounding pavement. Pervious pavement promotes groundwater recharge and filters stormwater.

2 **BIOSWALE:** A bioswale is a vegetated system that could convey stormwater to the detention basin to the north while removing sediment and nutrients. The existing trench already conveys water towards the basin, but the bioswale could reduce sediment and nutrient loading to the local waterway and increase groundwater recharge.

3 **RAINWATER HARVESTING SYSTEM:** Rainwater could be harvested from the roof of the building and stored in a cistern. The water could be used to wash EMS vehicles or for other non-potable uses.

1 PERVIOUS PAVEMENT



2 BIOSWALE

3 RAINWATER HARVESTING SYSTEM

Location: 700 Corkery Lane Williamstown, NJ 08028	**Municipality:** Monroe Township **Subwatershed:** Hospitality Branch
Green Infrastructure Description: bioswale pervious pavement rainwater harvesting (cistern)	**Targeted Pollutants:** total nitrogen (TN), total phosphorus (TP), and total suspended solids (TSS) in surface runoff
Mitigation Opportunities: recharge potential: yes TSS removal potential: yes stormwater peak reduction potential: yes	**Stormwater Captured and Treated Per Year:** bioswale: 287,130 gal. pervious pavement: 552,370 gal. rainwater harvesting (cistern): 20,305 gal.

Existing Conditions and Issues:
In the southwest corner of the site property, a trench exists where it channels water towards a detention basin. Curbs are not present around the perimeter of the parking lot near trench. Erosion is present on the pavement and sidewalk. Downspouts are connected.

Proposed Solution(s):
In the trench a bioswale could be installed to infiltrate the stormwater even further. Pervious pavement can be installed in the parking spaces towards the north of the building to capture runoff from the pavement and roof. A cistern can be installed in the southeast corner of the building to capture a portion of the runoff from the roof for non-potable uses.

Anticipated Benefits:
The bioswale will capture, treat, and infiltrate stormwater reducing TN by 30%, TP by 60%, and TSS by 90%.

The disconnected downspouts will allow stormwater to penetrate into the ground naturally, promoting groundwater recharge and reducing loads of TN, TP, and TSS, rather than being sent straight into the stormwater management systems. The simple disconnection also would reduce the pollutant loading by 90% since it will manage the water quality design storm of 1.25 inches of rain.

Pervious pavement allows stormwater to penetrate through to soil layers which will promote groundwater recharge as well as intercept and filter stormwater runoff.

Cisterns can harvest stormwater, which can be used for watering plants or other purposes which cuts back on the use of potable water for nondrinking purposes. 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).

Possible Funding Sources: mitigation funds from local developers NJDEP grant programs grants from foundations home and school associations
Partners/Stakeholders: Township of Monroe local social and community groups Rutgers Cooperative Extension
Estimated Cost: The bioswale would need to be approximately 3,600 square feet. At $5 per square foot, the estimated cost for the bioswale is approximately $18,000. The pervious pavement would cover approximately 2,935 square feet and have a two-foot stone reservoir under the surface. At $25 per square foot, the estimated cost of the pervious pavement would be $73,375. Lastly, the cost for the rainwater harvesting system would be approximately $3,000. The total cost of the project will be approximately $94,375.