RUTGERS
New Jersey Agricultural
Experiment Station

Impervious Cover Assessment
for
Millville City, Cumberland County, New Jersey

Prepared for Millville City by the
Rutgers Cooperative Extension Water Resources Program

June 21, 2016

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FOUNDATION

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

Millville City Impervious Cover Analysis

Located in Cumberland County in southern New Jersey, Millville City covers approximately 44.5 square miles east of Fairfield. Figures 3 and 4 illustrate that Millville City is dominated by forest land uses. A total of 27.9% of the municipality's land use is classified as urban. Of the urban land in Millville City, rural 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 Millville City 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 Millville City. Based upon the 2012 NJDEP land use/land cover data, approximately 9.0% of Millville City has impervious cover. This level of impervious cover suggests that the streams in Millville City are likely sensitive streams.

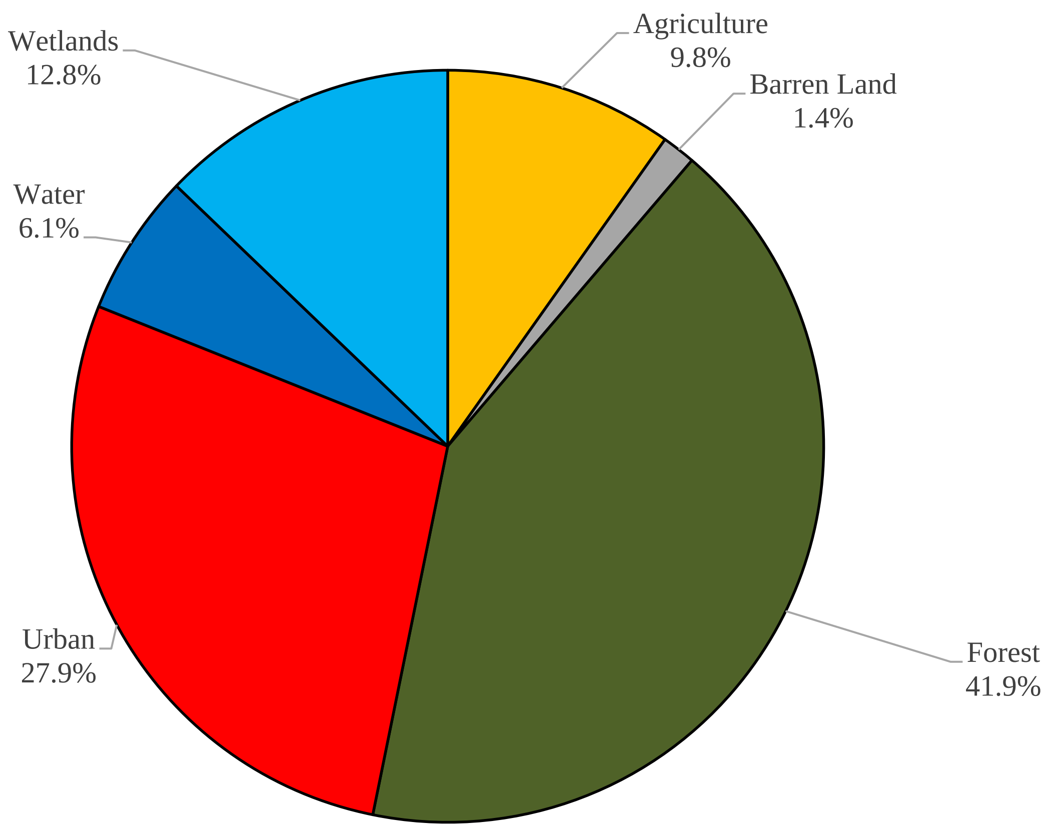


Figure 3: Pie chart illustrating the land use in Millville City

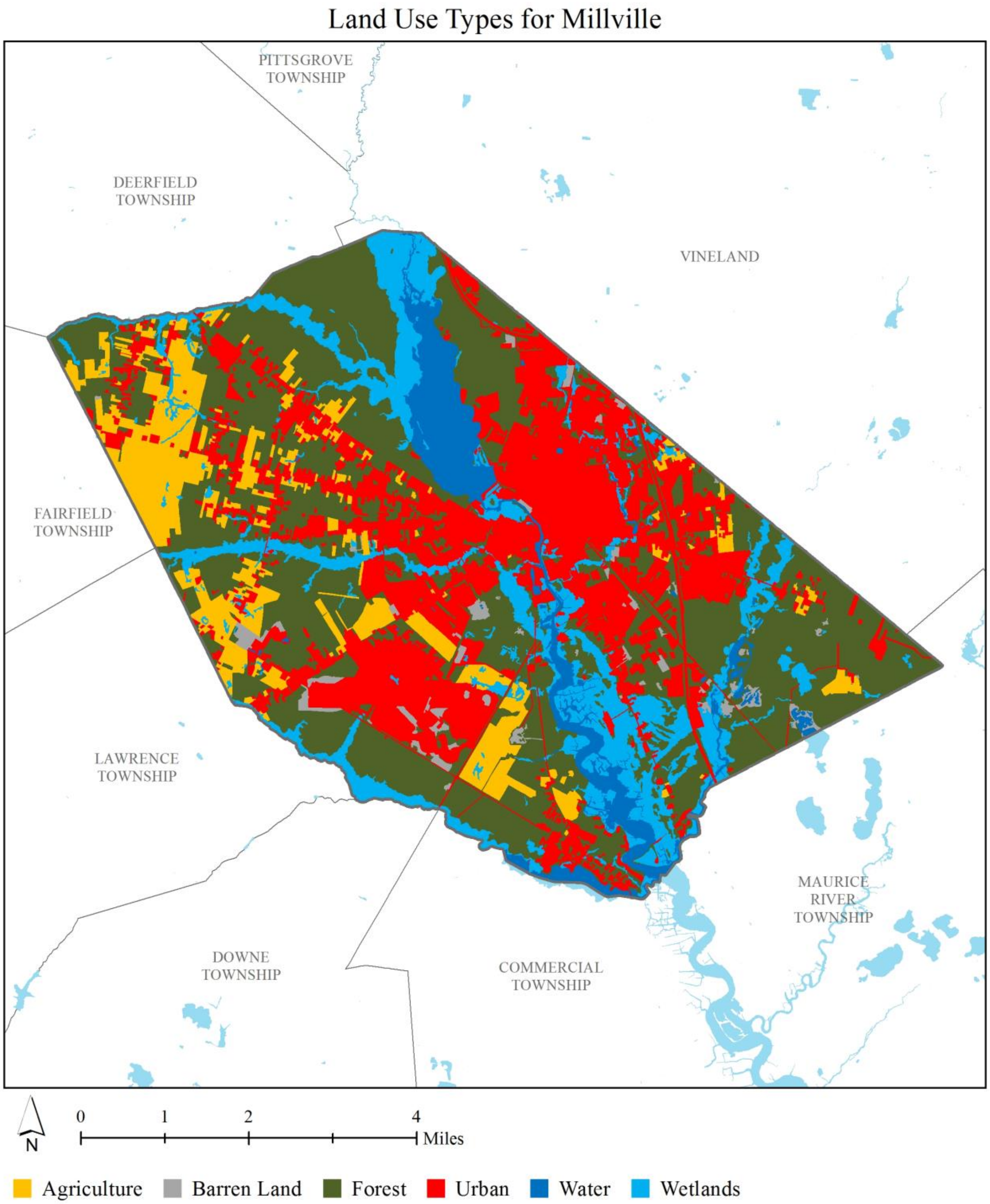


Figure 4: Map illustrating the land use in Millville City

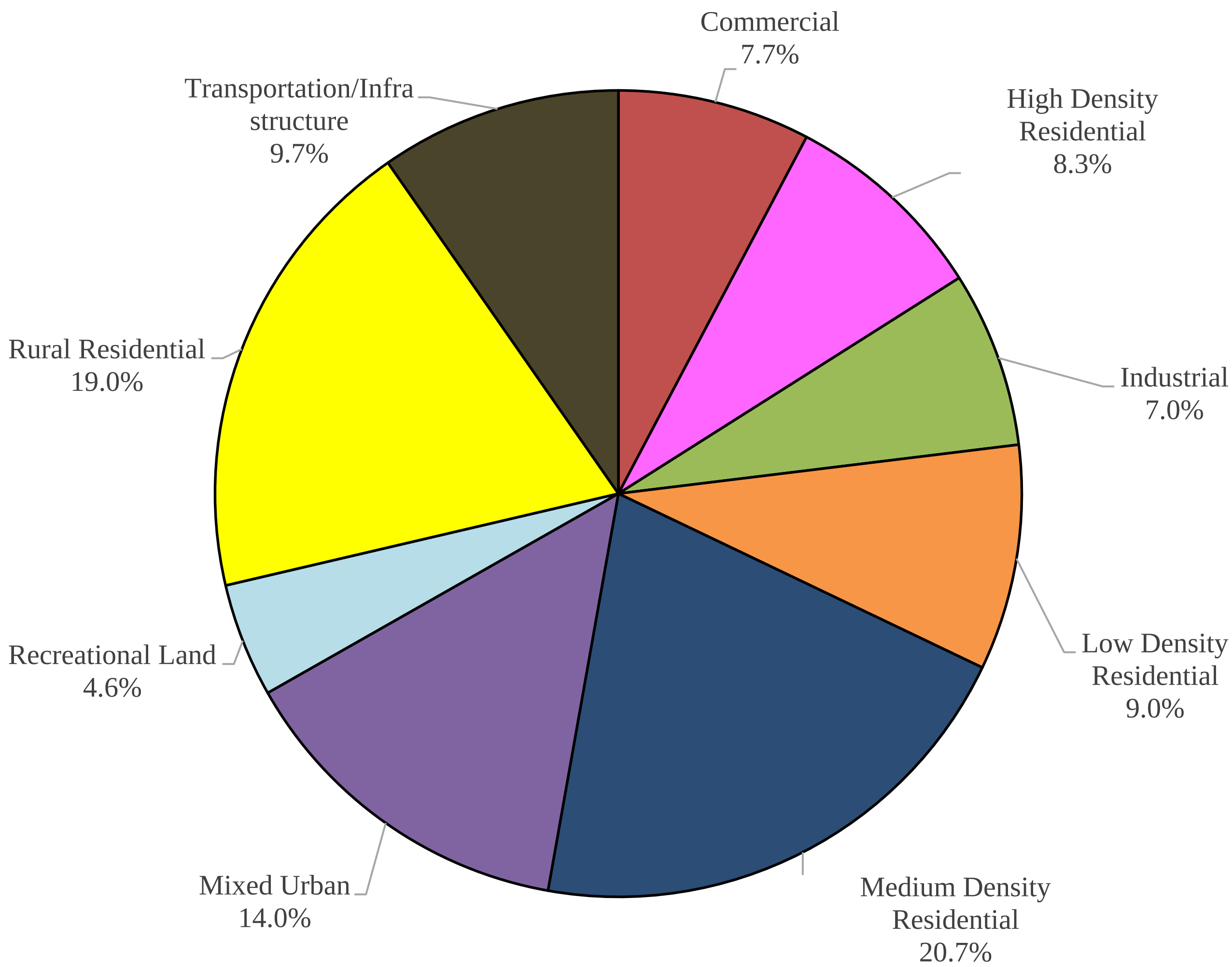


Figure 5: Pie chart illustrating the various types of urban land use in Millville City

Water resources are typically managed on a watershed/subwatershed basis; therefore an impervious cover analysis was performed for each subwatershed within Millville City (Table 1 and Figure 6). On a subwatershed basis, impervious cover ranges from 0.0% in the Lebanon Branch subwatershed to 30.1% in the Hankins Pond 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.

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 Millville City, Cumberland 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 (5.1 inches of rain), and the 100-year design storm (8.8 inches of rain). These runoff volumes are summarized in Table 2. A substantial amount of rainwater drains from impervious surfaces in Millville City. For example, if the stormwater runoff from one water quality storm (1.25 inches of rain) in the Maurice River subwatershed was harvested and purified, it could supply water to 313 homes for one year[1].

[1] Assuming 300 gallons per day per home

Table 1: Impervious cover analysis by subwatershed for Millville City

Subwatershed	Total Area		Land Use Area		Water Area		Impervious Cover		
	(ac)	(mi^2)	(ac)	(mi^2)	(ac)	(mi^2)	(ac)	(mi^2)	(%)
Berryman Branch/Menantico Creek	442.0	0.69	442.0	0.69	0.0	0.00	33.6	0.05	7.6%
Buckshutem Creek	3,222.4	5.04	3,109.1	4.86	113.4	0.18	211.6	0.33	6.8%
Chatfield Branch (Mill Creek)	2,190.8	3.42	2,190.4	3.42	0.4	0.00	46.3	0.07	2.1%
Hankins Pond	2,354.0	3.68	2,328.8	3.64	25.2	0.04	701.4	1.10	30.1%
Lebanon Branch (Mill Creek)	1.9	0.00	1.9	0.00	0.0	0.00	0.0	0.00	0.0%
Manumuskin River	471.8	0.74	471.7	0.74	0.1	0.00	5.3	0.01	1.1%
Maurice River	12,119.0	18.94	10,675.8	16.68	1,443.3	2.26	1,009.8	1.58	9.5%
Menantico Creek	2,966.9	4.64	2,815.7	4.40	151.2	0.24	112.7	0.18	4.0%
White Marsh Run	4,714.3	7.37	4,707.6	7.36	6.7	0.01	296.4	0.46	6.3%
Total	28,483.2	44.51	26,743.1	41.79	1,740.1	2.72	2,417.1	3.78	9.0%

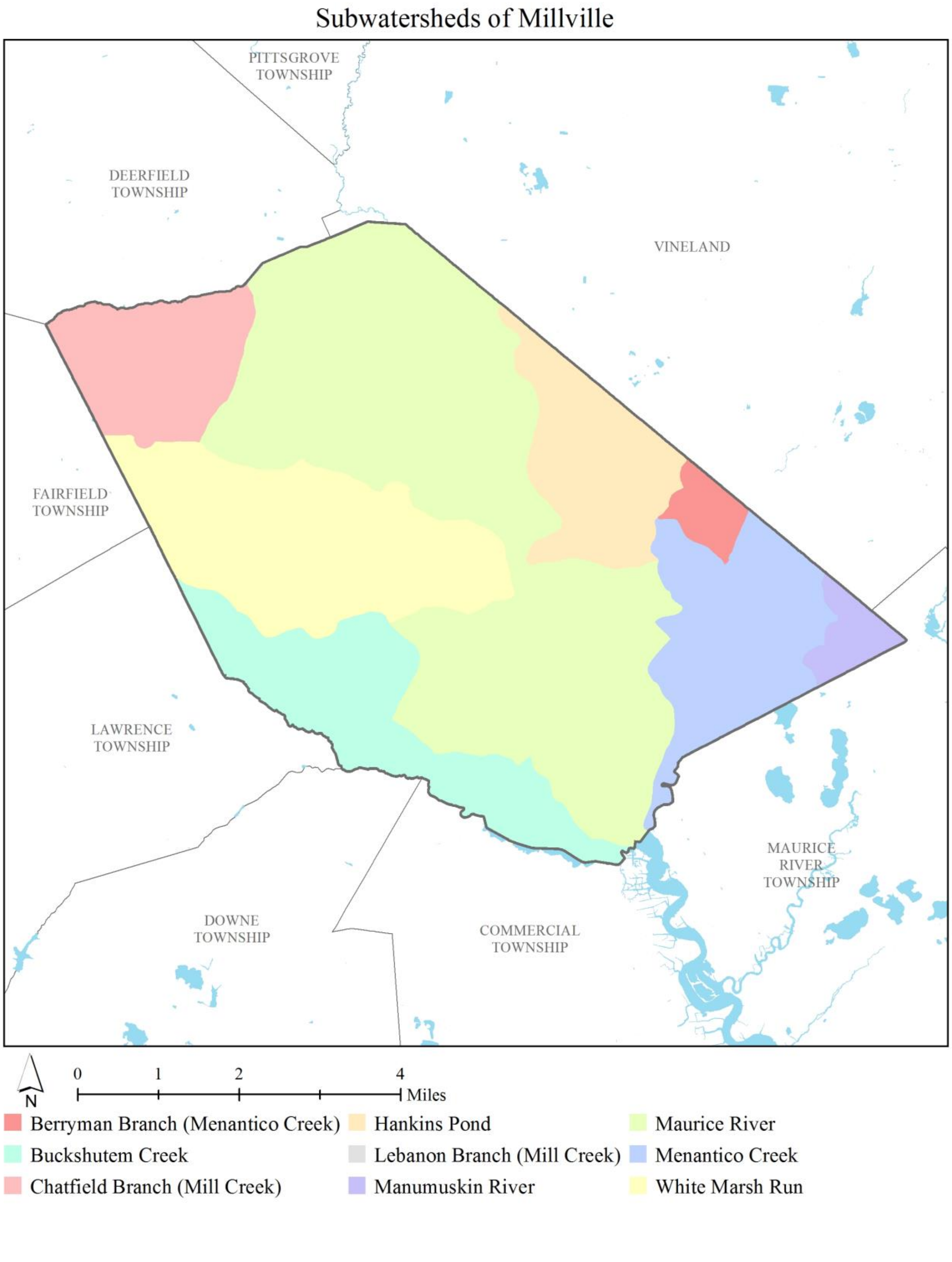


Figure 6: Map of the subwatersheds in Millville City

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

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 (5.1") (MGal)	Total Runoff Volume for the 100-Year Design Storm (8.8") (MGal)
Berryman Branch/Menantico Creek	1.1	40.2	3.0	4.7	8.0
Buckshutem Creek	7.2	252.8	19.0	29.3	50.6
Chatfield Branch (Mill Creek)	1.6	55.3	4.1	6.4	11.1
Hankins Pond	23.8	838.0	62.9	97.1	167.6
Lebanon Branch (Mill Creek)	0.0	0.0	0.0	0.0	0.0
Manumuskin River	0.2	6.3	0.5	0.7	1.3
Maurice River	34.3	1,206.5	90.5	139.8	241.3
Menantico Creek	3.8	134.7	10.1	15.6	26.9
White Marsh Run	10.1	354.1	26.6	41.0	70.8
Totals	82.0	2,887.8	216.6	334.7	577.6

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 Millville City. 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 Millville City

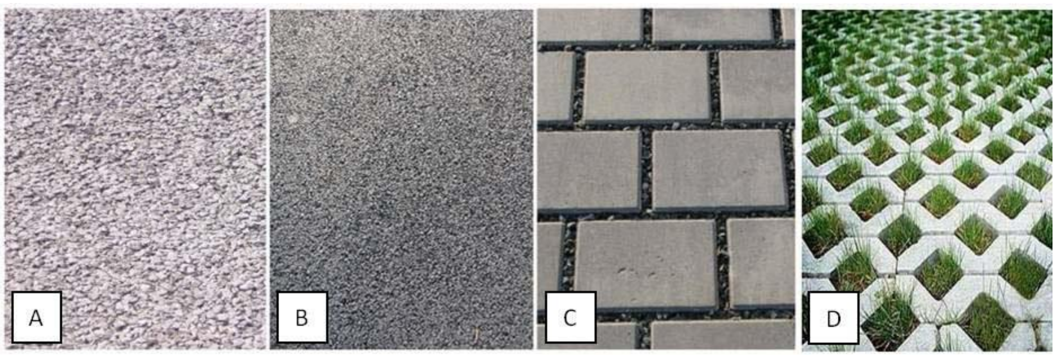
Subwatersheds	Recommended Impervious Area Reduction (10%) (ac)	Annual Runoff Volume Reduction[2] (Mgal)
Berryman Branch/Menantico Creek	3.4	3.8
Buckshutem Creek	21.2	24.0
Chatfield Branch (Mill Creek)	4.6	5.3
Hankins Pond	70.1	79.6
Lebanon Branch (Mill Creek)	0.0	0.0
Manumuskin River	0.5	0.6
Maurice River	101.0	114.6
Menantico Creek	11.3	12.8
White Marsh Run	29.6	33.6
Total	241.7	274.3

[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 Millville City

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 Millville City, 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

Millville City 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

Examples of Impervious Cover Reduction Action Plan Projects

Concept Plans and Detailed Green Infrastructure Information Sheets

Millville City
Impervious Cover Assessment
First Assembly of God, 1700 Wheaton Street

A

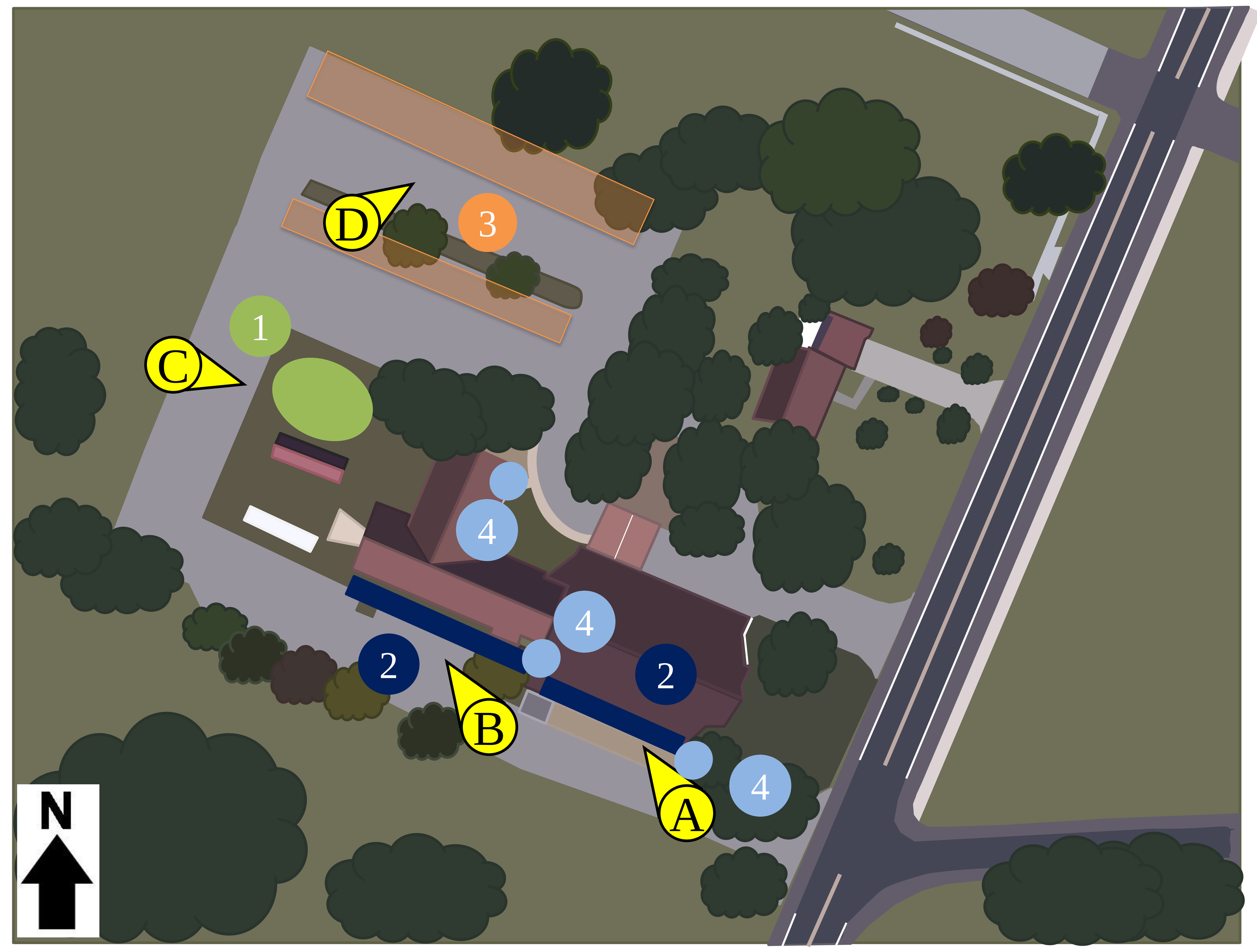
B

C

D

PROJECT LOCATION:

SITE PLAN:



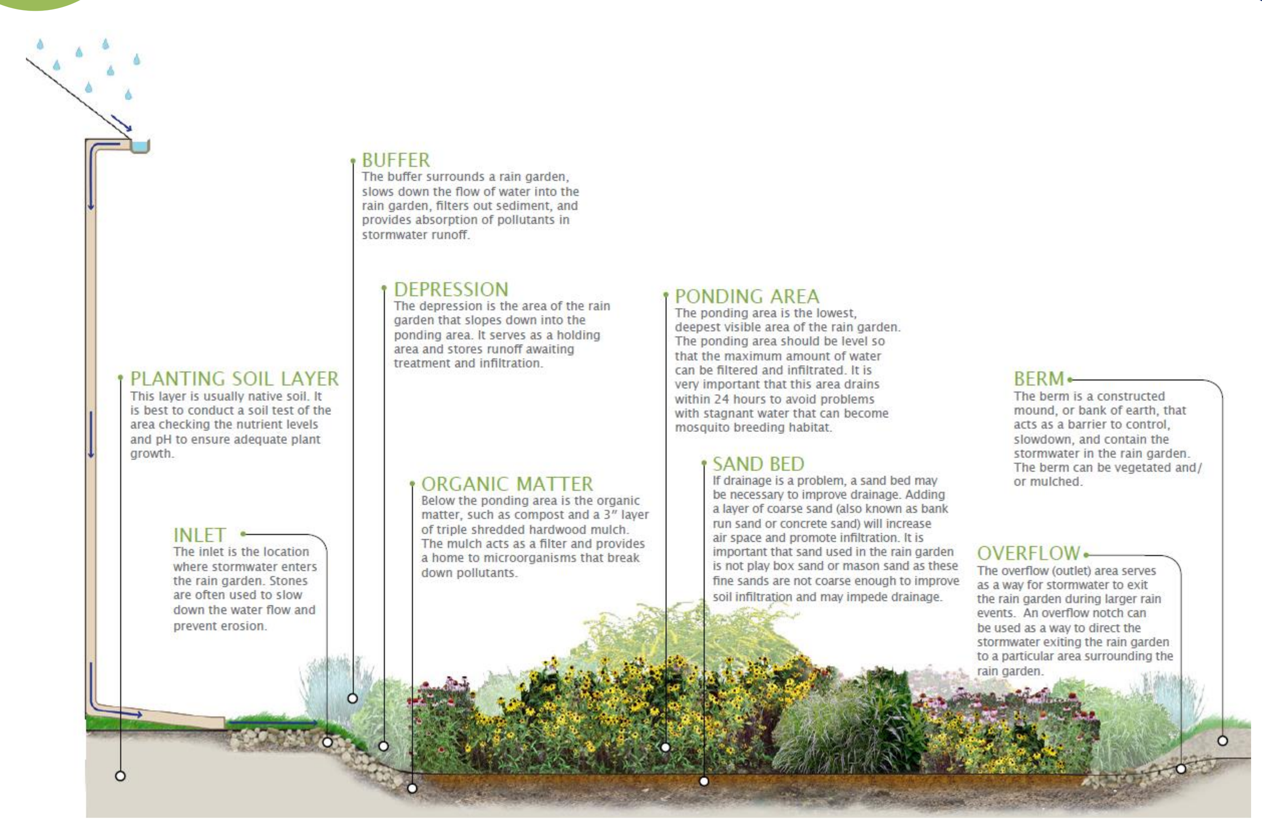
1 **BIORETENTION SYSTEMS:** Rain gardens can be used to reduce sediment and nutrient loading to the local waterway and increase groundwater recharge. A rain garden can be installed west of the church to capture, treat, and infiltrate the runoff from the downspouts coming off the building.

2 **DOWNSPOUT PLANTER BOX:** A planter box could be installed at the southern end of the building to collect water from the nearby downspouts. Planter boxes reduce runoff and allow water to slowly flow through and be treated for pollutants.

3 **POROUS PAVEMENT:** A portion of the northern section of the parking lot can be retrofitted with porous pavement to allow some of the runoff to infiltrate.

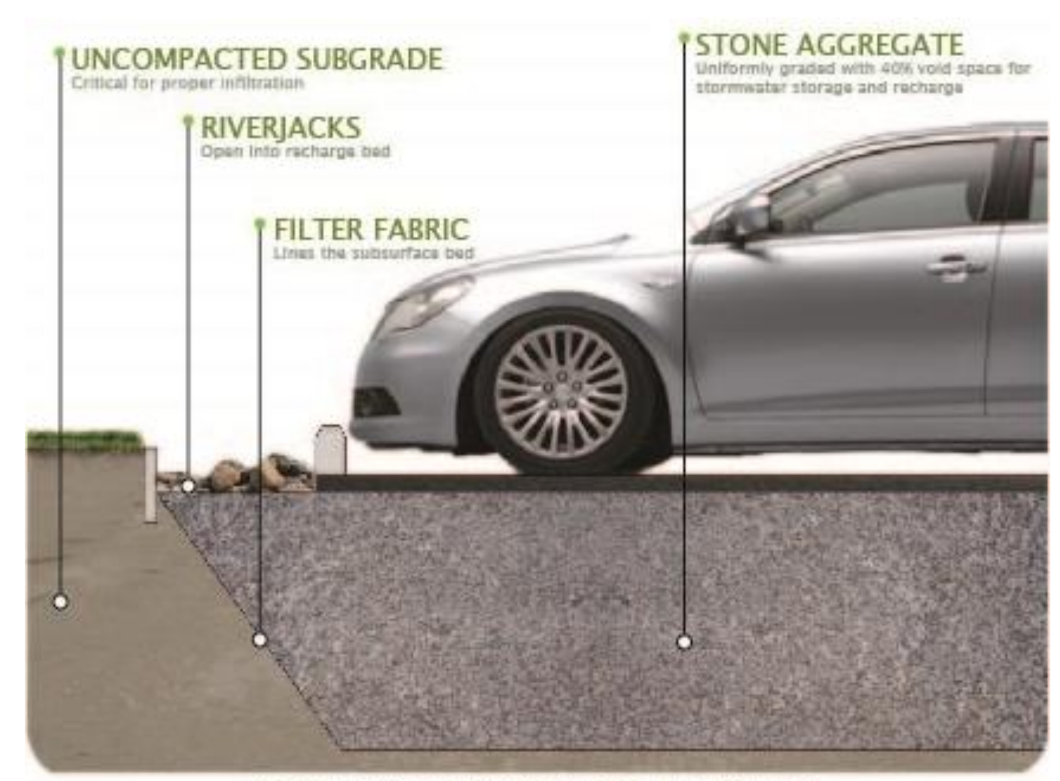
4 **RAINWATER HARVESTING:** Cisterns can be installed under three downspouts to collect runoff from the roof of the church. The harvested water can be used to water the plants of the surrounding area.

1 BIORETENTION SYSTEM



2 DOWNSPOUT PLANTER BOX

3 POROUS PAVEMENT



4 RAINWATER HARVESTING

Location: 1700 Wheaton Street Millville, NJ 08332	**Municipality:** Millville City **Subwatershed:** Hankins Pond
Green Infrastructure Description: bioretention systems (rain gardens) downspout planter boxes porous 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:** cistern #1: 10,515 gal. cistern #2: 27,955 gal. cistern #3: 45,172 gal. rain garden: 45,519 gal. porous pavement #1: 202,085 gal. porous pavement #2: 98,072 gal. 3 downspout planters #1: 4,200 gal. 3 downspout planters #2: 4,200 gal.

Existing Conditions and Issues:

In the parking lot in front of the church there are multiple cracks which indicate water damage within the pavement. There are two to three disconnected downspouts flowing onto the existing pavement that causes flooding. To the west of the entrance to the church there is a grass area that has three disconnected downspouts draining into the area. On the southern end of the church there are at least four disconnected downspouts draining onto the pavement and a small strip of grass. The area exists on a slope that drains toward the northwestern area of the site. This means that water is collected on the western and northern sections of the area which is primarily the parking lot area.

Proposed Solution(s):

Near the western end of the entrance the three disconnected downspouts can be redirected into the bioretention system in the middle of the grass area. In the area with four disconnected downspouts, three of the existing downspouts can be retrofitted to have downspout planter boxes that can capture enough runoff, with the overflow going from the fourth downspout into a cistern. This can be done for both south faces of the church. Because most of the disconnected downspouts are directed to the pavement, a proposed solution to prevent flooding is to place porous pavement in the northwestern end of the parking lot and on the south of the island in the middle of the parking lot. This water can be redirected elsewhere. Near the north entrance of the building, there is a disconnected downspout that can be connected to a cistern that can store water for plants and gardening.

Anticipated Benefits:

Since the bioretention systems and porous pavement 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. Porous pavement allows stormwater to infiltrate 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 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).

The downspout planter boxes would provide an opportunity to beneficially reuse rooftop runoff.

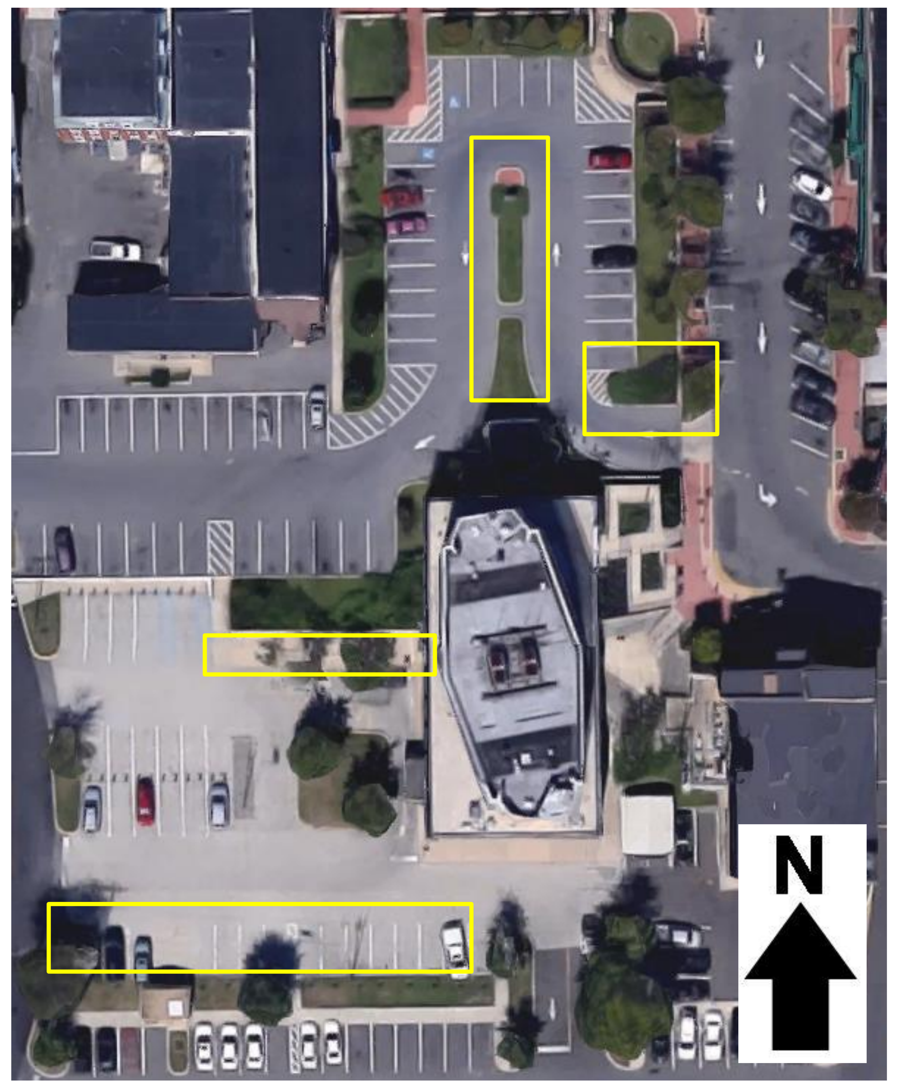
Possible Funding Sources:
mitigation funds from local developers
NJDEP grant programs
grants from foundations

Partners/Stakeholders:
Millville City
parishioners
local community groups (Boy Scouts, Girl Scouts, etc.)
Rutgers Cooperative Extension

Estimated Cost:
The rain garden would need to be approximately 440 square feet. At $5 per foot, the estimated cost of the rain garden is $2,200. The downspout planter boxes would be 36 square feet in size and will cost $300 each for a combined cost of $1,800. The porous pavement is 4,000 and 2,700 square feet in size with a 1-foot stone layer. They will cost $80,000 and $54,000, respectively. For cisterns #1, #2, #3 of sizes 660 gal., 1,765 gal., and 2,850 gal.; it will cost $1,320, $3,530, and $5,700 respectively. The total cost of the project is approximately $148,550.

Millville City
Impervious Cover Assessment
City Hall, 12 South High Street

PROJECT LOCATION:



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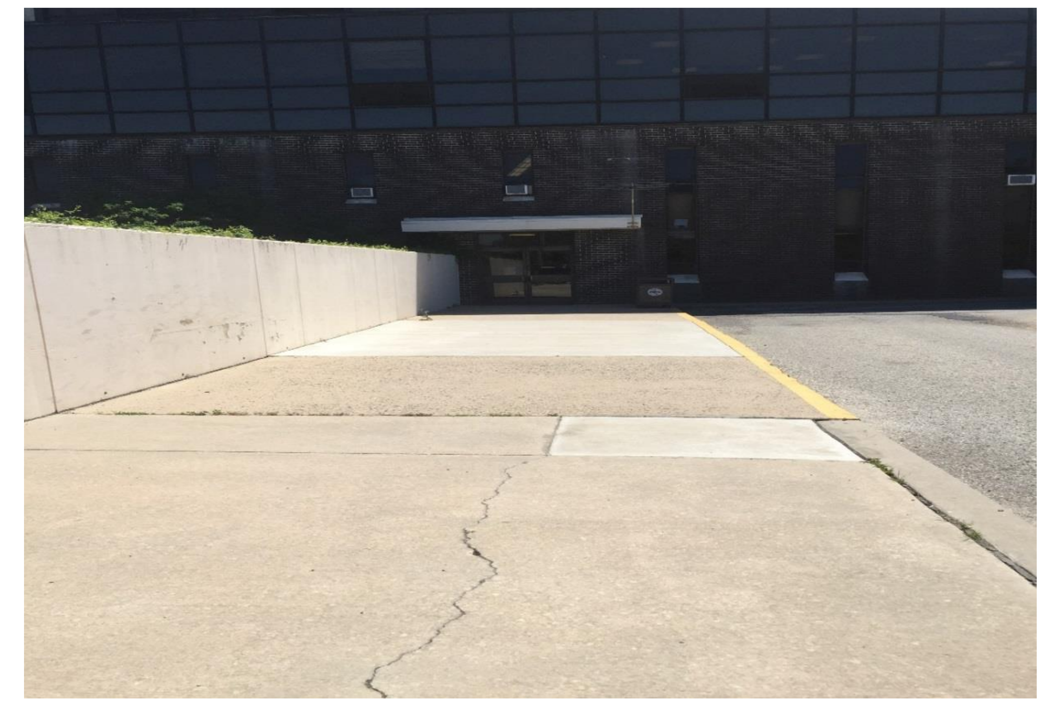
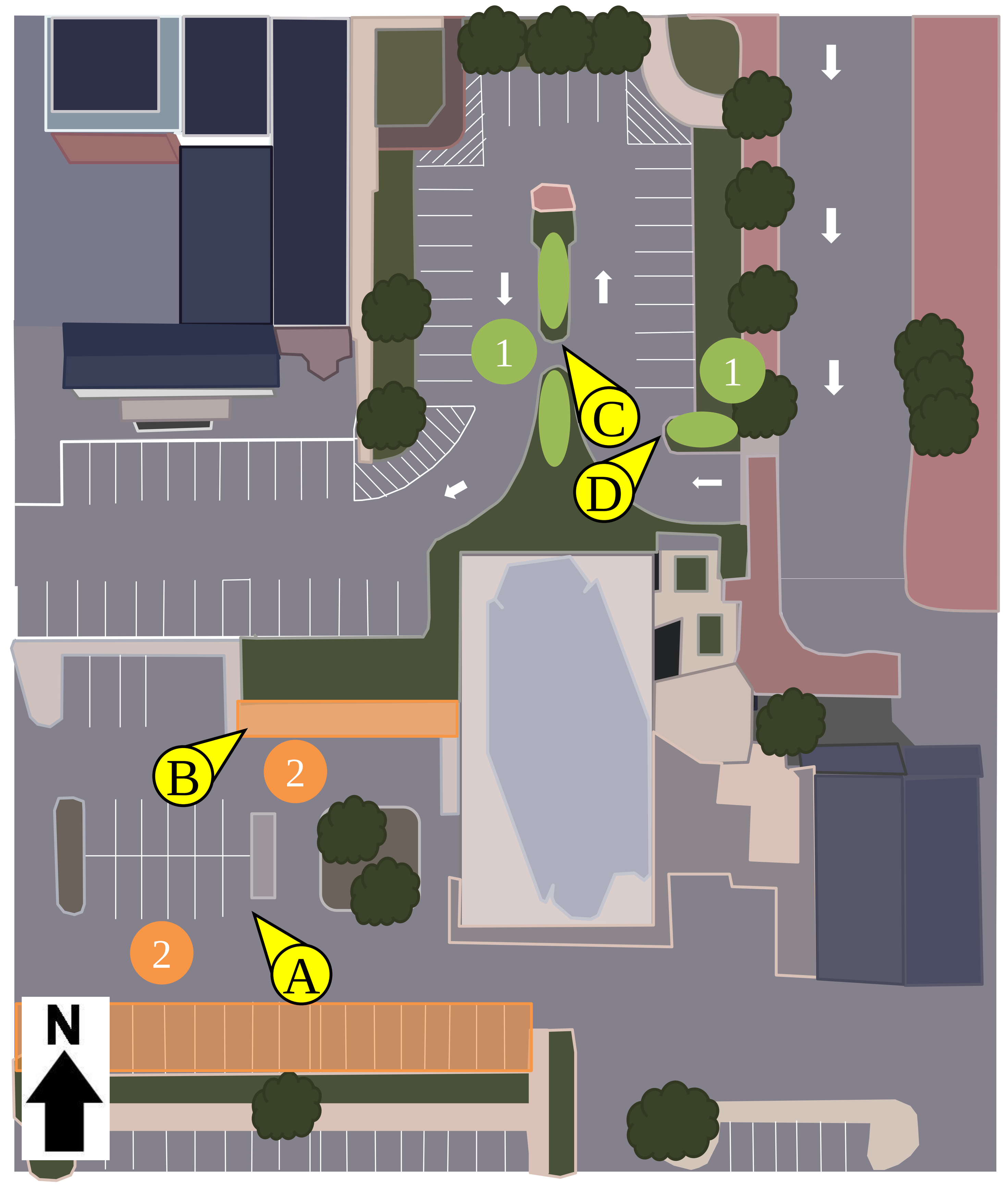


SITE PLAN:



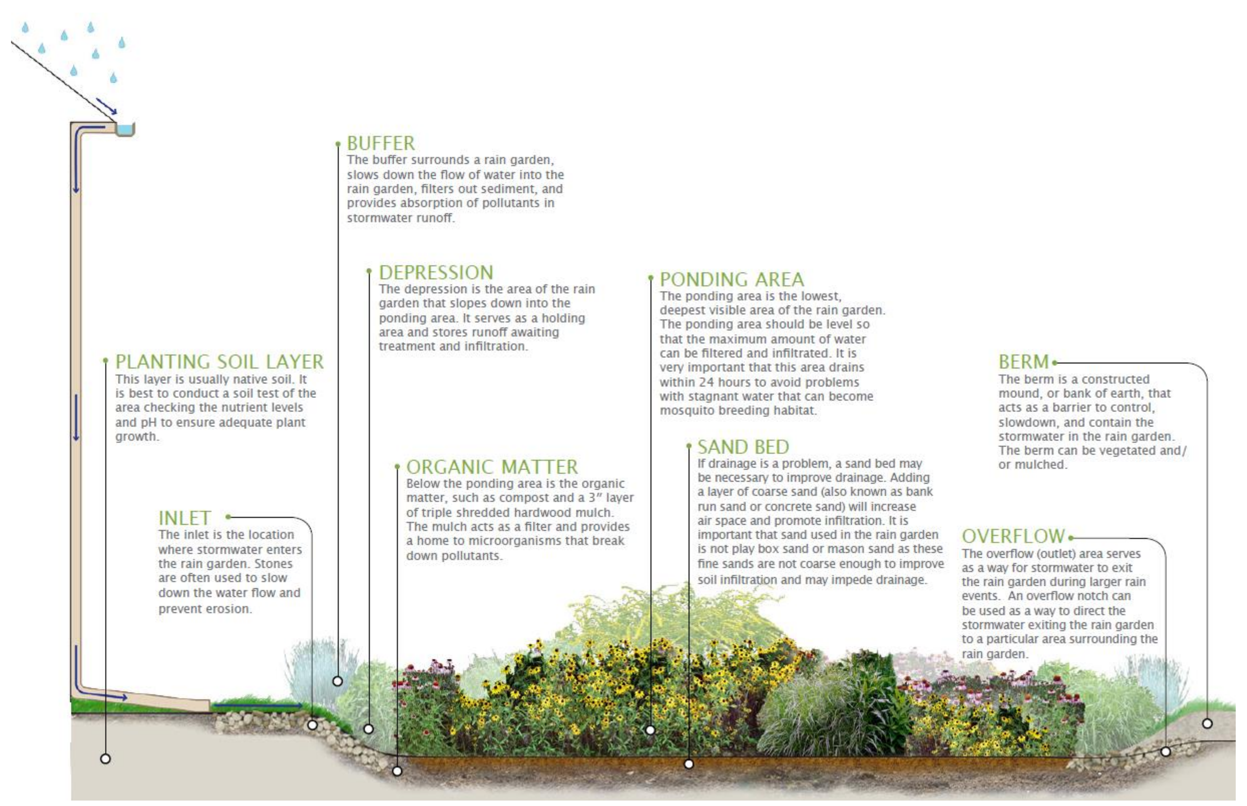
C


D


1 **BIORETENTION SYSTEMS:** Rain gardens can be used to reduce sediment and nutrient loading to the local waterway and increase groundwater recharge. This site has multiple areas where downspouts can be disconnected and rain gardens installed in the north parking lot area. Curb cuts can be made to allow stormwater to enter the bioretention systems from the street and parking lot.

2 **POROUS PAVEMENT:** The southwestern area of the parking lot can be retrofitted with porous pavement. Porous pavement promotes groundwater recharge and filters stormwater.

1 BIORETENTION SYSTEM



CURB CUTS

2 POROUS PAVEMENT

City Hall and Police Department
Green Infrastructure Information Sheet

Location: 12 & 18 South High Street Millville, NJ 08332	**Municipality:** Millville City **Subwatershed:** Maurice River
Green Infrastructure Description: bioretention system porous 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: 11,230 gal. rain garden #2: 35,461 gal. rain garden #3: 35,748 gal. porous pavement #1: 190,647 gal. porous pavement #2: 27,384 gal.

Existing Conditions and Issues:
This area generally slopes downward in the southern direction. The northern parking lot slopes downward in the western direction. There is a pavement area on the western side of the city hall building that has several cracks. There is a catch basin located in the southern parking lot at the southwestern most part of the area. There is a catch basin at the bottom of the slope on the eastern hill as well as one broken downspout and one disconnected downspout on the eastern side of the police department building.

Proposed Solution(s):
A rain garden can be installed at the entrance of the northern parking lot to capture and infiltrate water that comes from the roads and/or pavements. Since the parking lot slopes in the western direction, water can be captured as it enters the slope. Two additional rain gardens can be built in the grassed area in the middle of the parking lot. In the paved area west of the building for city hall, a solution would be to depave the area and put in a pervious concrete walkway which would capture runoff from its surface. Porous pavement can be installed at the south end of the southern parking lot. This would capture water before it goes into the catch basin located in the parking lot.

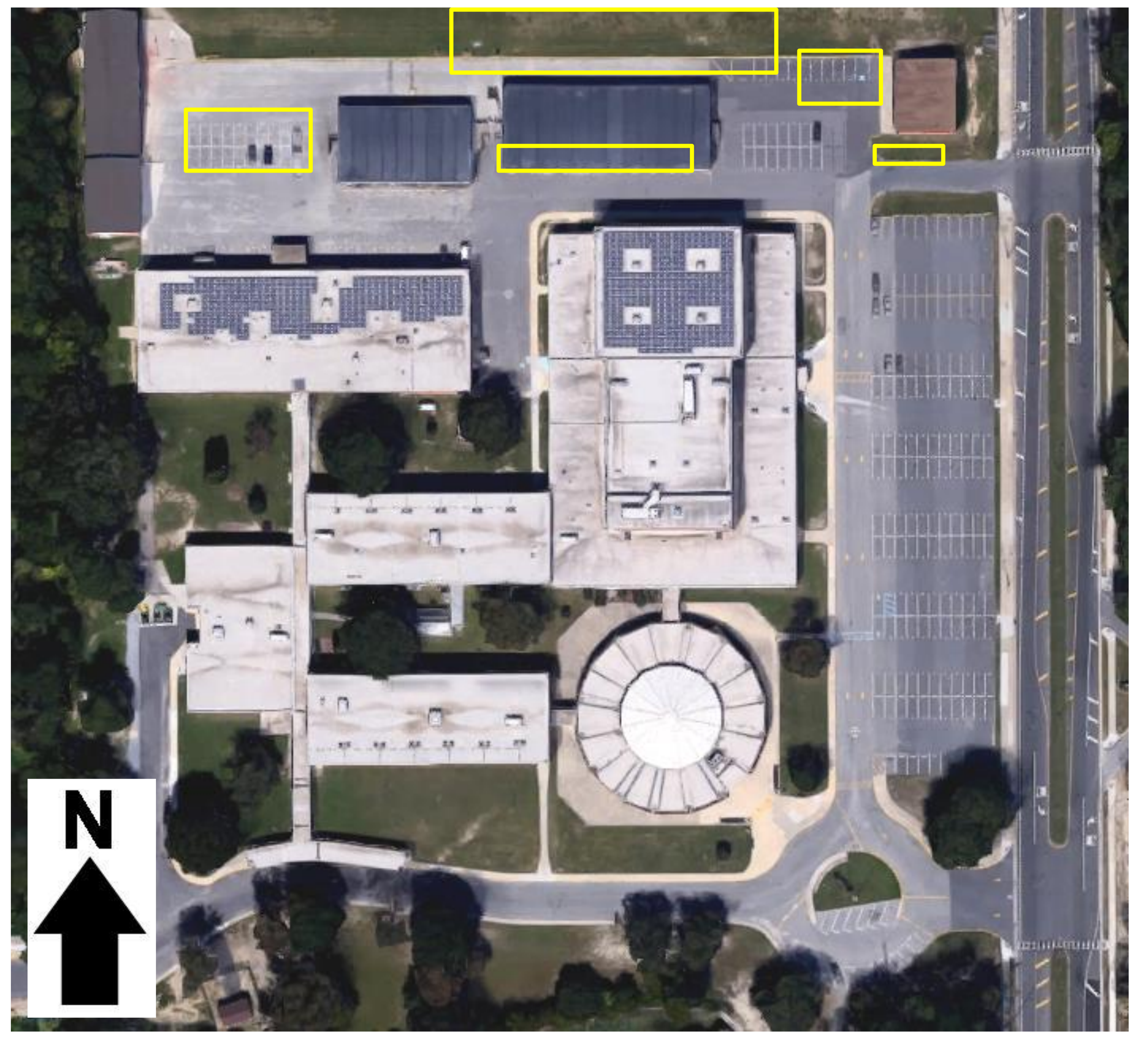
Anticipated Benefits:
Since the bioretention systems and porous pavement would be designed to capture, treat, and infiltrate the entire 2-year design storm (3.3 inches of rain over 24 hours), these systems are estimated to achieve a 95% pollutant load reduction for TN, TP, and TSS. This bioretention system would provide additional benefits such as aesthetic appeal and wildlife habitat.

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

Partners/Stakeholders: City of Millville residents local community groups (Boy Scouts, Girl Scouts, etc.) Rutgers Cooperative Extension
Estimated Cost: For rain gardens 1, 2, 3 the rain gardens are 110, 340, and 340 square feet in size. At $5 per foot, the estimated cost of the rain gardens are $550, $1,700 and $1,700 respectively. For the porous pavement #1 which is 2,550 square feet with a one-foot stone layer, the estimated cost is $51,000. For porous pavement #2 which is 1,050 square feet with a one-foot stone layer the estimated cost is $21,000. The total cost of the project is $95,650.

Millville City
Impervious Cover Assessment
Millville Senior High School, 200 North Wade Boulevard

PROJECT LOCATION:

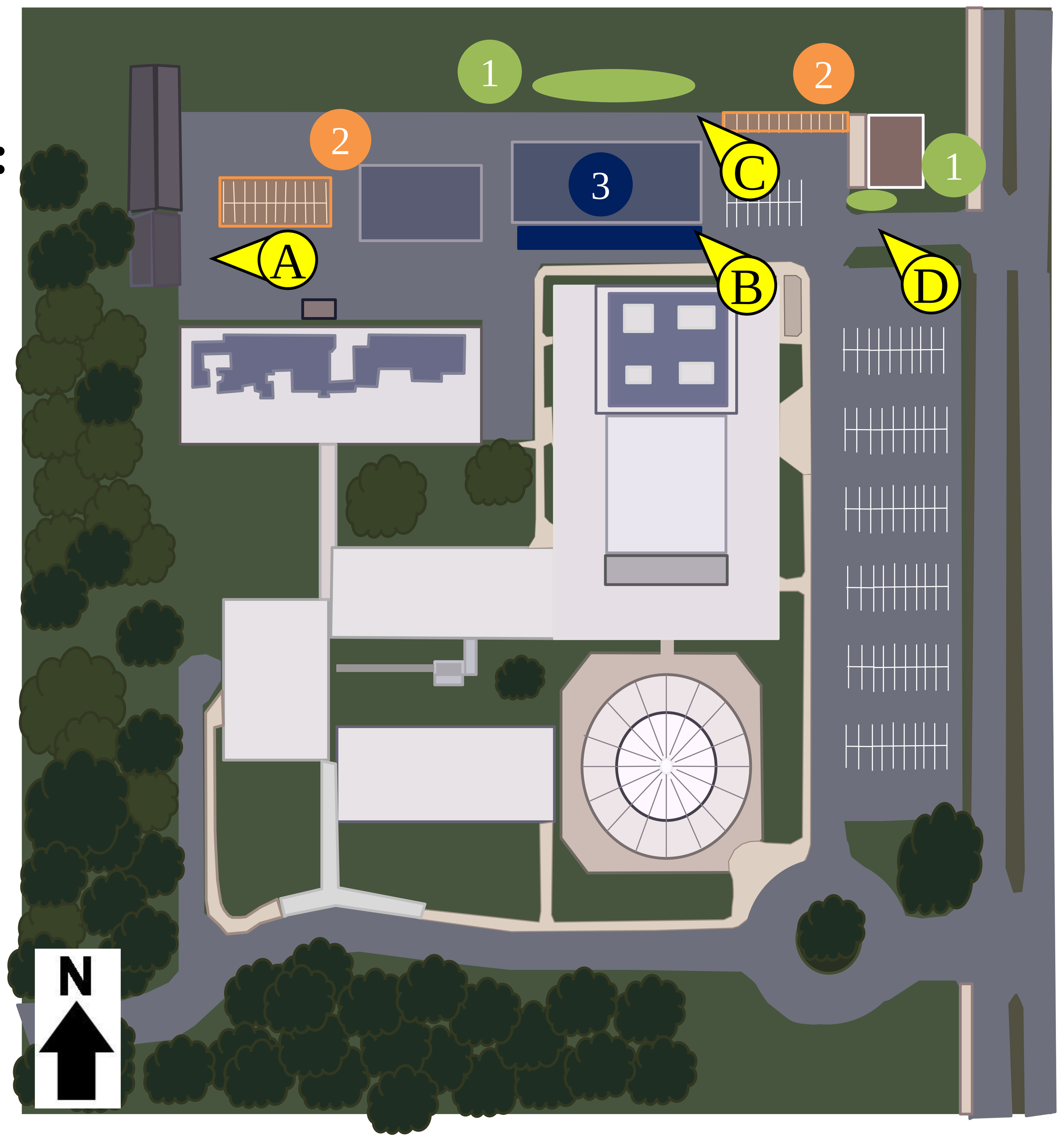


A

B

RUTGERS
New Jersey Agricultural Experiment Station

SITE PLAN:



C

D

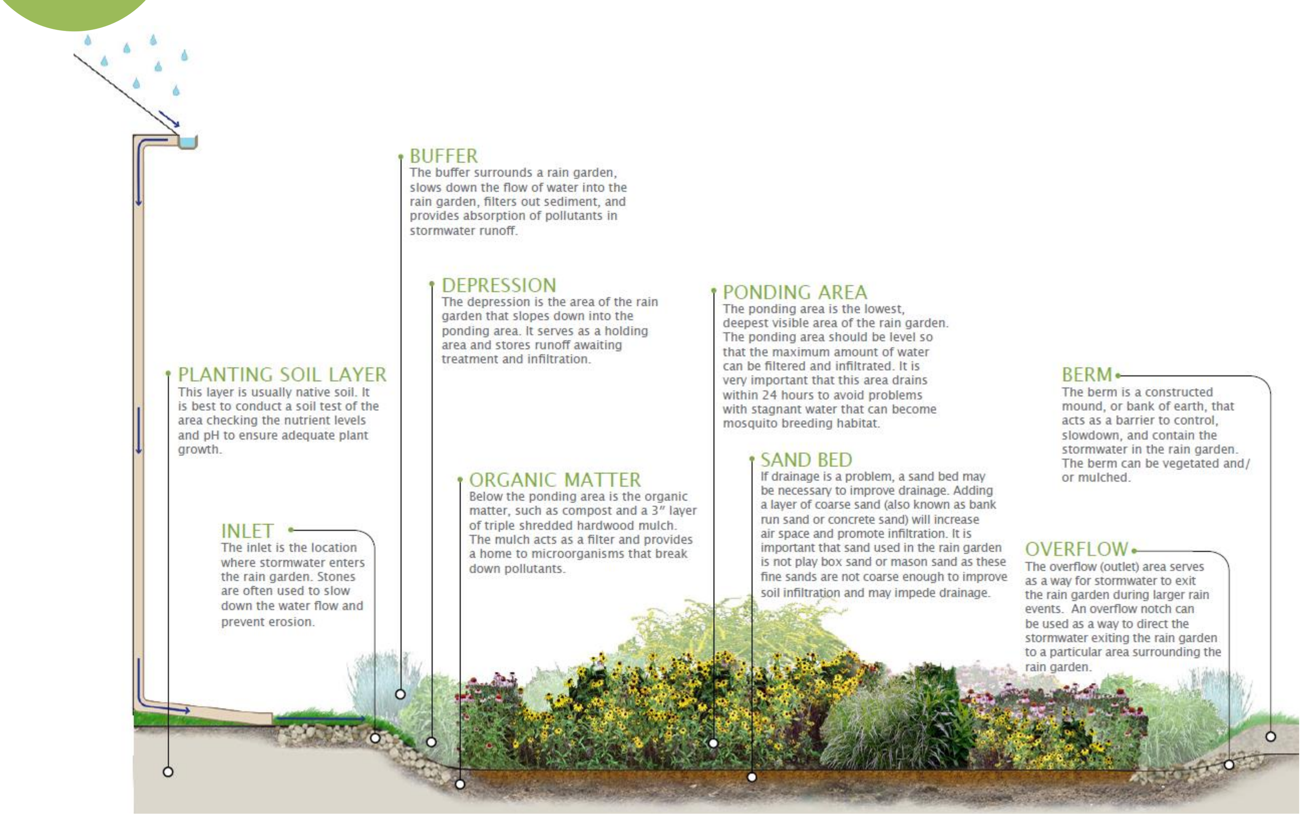
1 **BIORETENTION SYSTEMS:** Rain gardens be used to reduce sediment and nutrient loading to the local waterway and increase groundwater recharge. Rain gardens can be installed at the northern end near the field and at the northeast entrance.

2 **POROUS PAVEMENT:** Porous pavement can be placed at the west end of the north parking lot to capture runoff before reaching a nearby a catch basin. The northeast strip of parking spaces could also be porous to capture additional runoff.

3 **DOWNSPOUT PLANTER BOX:** A downspout planter box could be installed at the southern end of the north building to collect water from the nearby downspout. Planter boxes reduce runoff and allow water to slowly flow through while being treated for pollutants.

EDUCATIONAL PROGRAM: The RCE Water Resources Program's *Stormwater Management in Your Schoolyard* can be delivered to the Senior High School to educate the students about stormwater management and engage them in designing and building the bioretention systems.

1 BIORETENTION SYSTEM



2 POROUS PAVEMENT

3 DOWNSPOUT PLANTER BOX

EDUCATIONAL PROGRAM

Millville Senior High School
Green Infrastructure Information Sheet

Location: 200 North Wade Boulevard Millville, NJ 08332	**Municipality:** Millville City **Subwatershed:** Hankins Pond
Green Infrastructure Description: bioretention system porous pavement educational program downspout planter box	**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: 257,036 gal. rain garden #2: 78,166 gal. four downspout planter boxes: 5,600 gal. porous pavement #1: 326,499 gal. porous pavement #2: 279,313 gal.

Existing Conditions and Issues:
The long detached building in the north area of the site has four disconnected downspouts on either side of the building. All these downspouts carry water that eventually drains into the nearby catch basins. There is one disconnected downspout on the isolated northeast building.

Proposed Solution(s):
A rain garden can be installed near the playing field north of the school to capture runoff from the four disconnected downspouts on the nearby building. On the south face of the same building, downspout planter boxes can be set up to collect and filter water before reaching the pavement. Porous pavement can be used in the north parking area in parking spaces close to the field to catch runoff from the parking area. Another rain garden can be built at the north entrance to the northern parking lot by routing the disconnected downspout coming off the north adjacent building to the bioretention system.

Anticipated Benefits:
Since the bioretention systems and porous pavement 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. These bioretention systems 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. Porous pavement allows stormwater to infiltrate through to soil layers which will promote groundwater recharge as well as intercept and filter stormwater runoff.

The downspout planter boxes would provide an opportunity to beneficially reuse rooftop runoff.

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

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

Estimated Cost:
Rain gardens 1 and 2 would be 2,470 and 750 square feet in size, respectively. At $5 per foot, the estimated cost of the rain gardens are $12,350 and $3,750, respectively. The downspout planter boxes would be 36 square feet in size and will cost $300 each for a combined cost of $1,200. For the porous pavement #1 to the west, it will be 3,665 square feet and with a two-foot stone layer would cost $91,625. For the porous pavement #2 to the east, it will be 2,260 square feet and with a two-foot stone layer would cost $56,500. The total cost of the project is approximately $165,425.