Draft

Impervious Cover Assessment
for
Millstone Township, Monmouth County, New Jersey

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

February 4, 2015

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 also has 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

Millstone Township Impervious Cover Analysis

Located in Monmouth County in central New Jersey, Millstone Township covers approximately 37.2 square miles. Figures 3 and 4 illustrate that Millstone Township is dominated by urban land uses. A total of 28% of the municipality's land use is classified as urban. Of the urban land in Millstone Township, 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) 2007 land use/land cover geographical information system (GIS) data layer categorizes Millstone 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 Millstone Township. Based upon the 2007 NJDEP land use/land cover data, approximately 4.5% of Millstone Township has impervious cover. This level of impervious cover suggests that the streams in Millstone Township are likely sensitive streams.

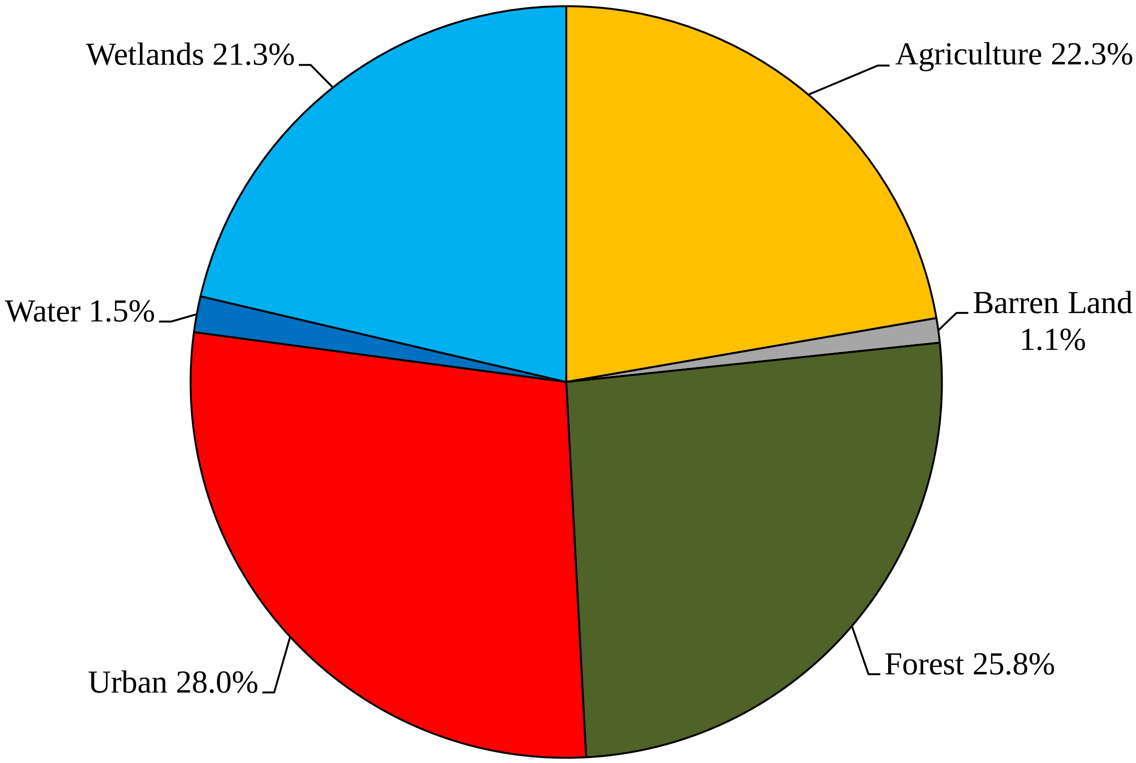


Figure 3: Pie chart illustrating the land use in Millstone Township

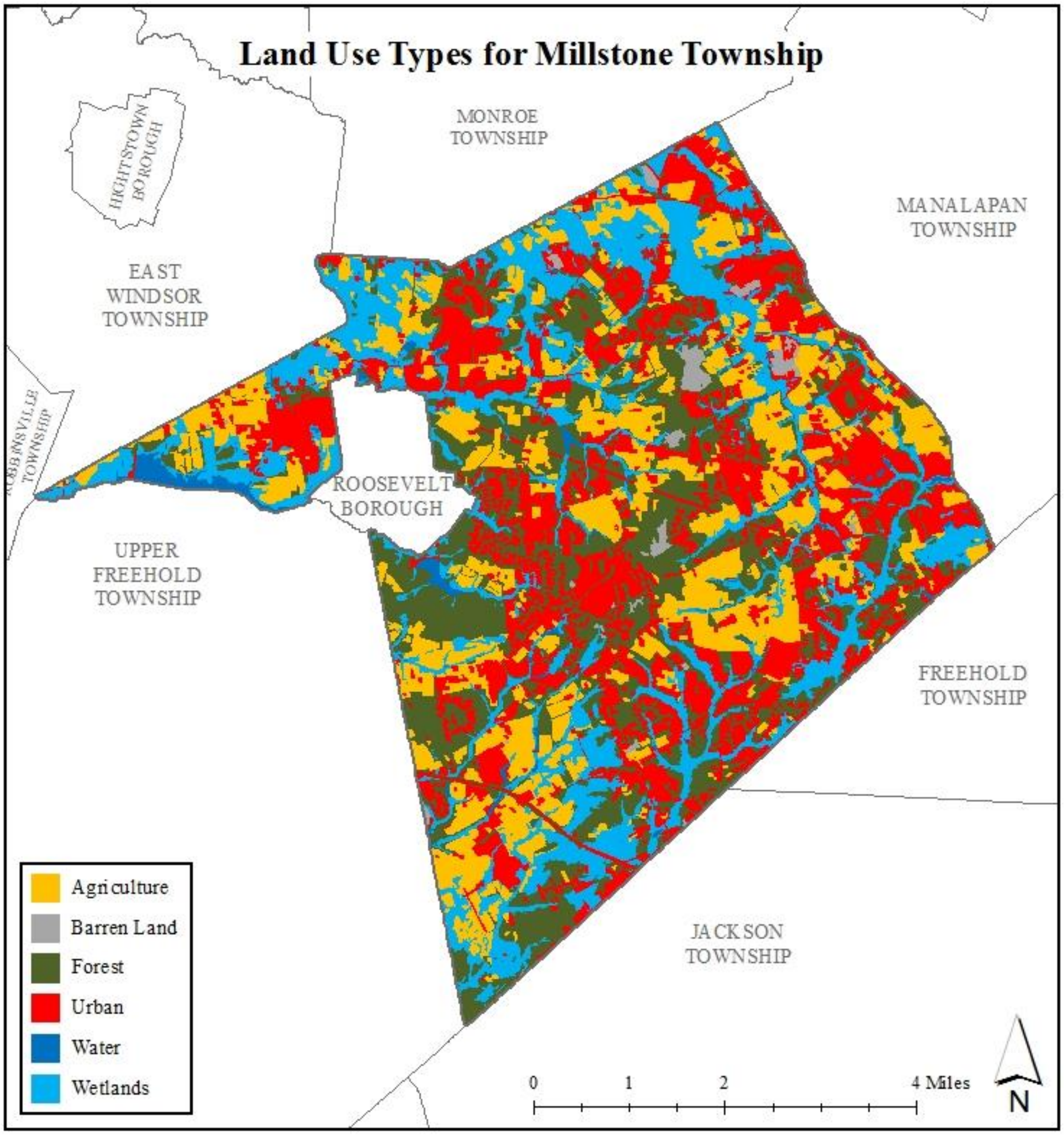


Figure 4: Map illustrating the land use in Millstone Township

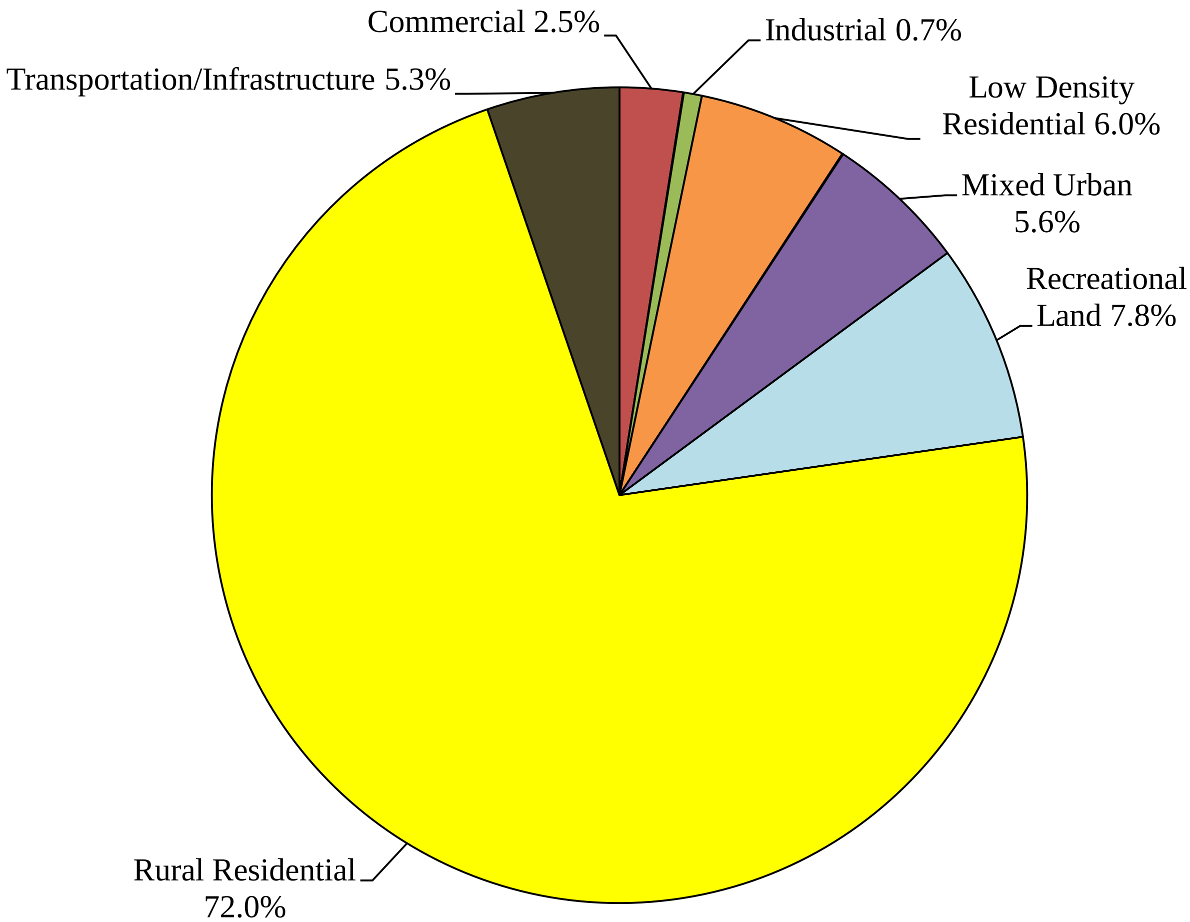


Figure 5: Pie chart illustrating the various types of urban land use in Millstone Township

Water resources are typically managed on a watershed/subwatershed basis; therefore an impervious cover analysis was performed for each Raritan River subwatershed within Millstone Township (Table 1 and Figure 6). On a subwatershed basis, impervious cover ranges from 2.9% in the Assunpink Creek subwatershed to 12.6% in the Cranbury Brook 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 Millstone Township, Monmouth 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 (3.4 inches of rain), the 10-year design storm (5.2 inches of rain), and the 100-year design storm (8.9 inches of rain). These runoff volumes are summarized in Table 2. A substantial amount of rainwater drains from impervious surfaces in Millstone Township. For example, if the stormwater runoff from one water quality storm (1.25 inches of rain) in the Millstone River subwatershed was harvested and purified, it could supply water to 99 homes for one year[1].

[1] Assuming 300 gallons per day per home

Table 1: Impervious cover analysis by subwatershed for Millstone Township

Subwatershed	Total Area		Land Use Area		Water Area		Impervious Cover		
	(ac)	(mi^2)	(ac)	(mi^2)	(ac)	(mi^2)	(ac)	(mi^2)	(%)
Assunpink Creek	3,050.1	4.77	2,874.3	4.49	175.8	0.27	84.0	0.13	2.9%
Cranbury Brook	380.5	0.59	378.7	0.59	1.81	0.00	47.7	0.07	12.6%
Doctors Creek	2,413.2	3.77	2,371.9	3.71	41.3	0.06	109.3	0.17	4.6%
Lahaway Creek	2,149.9	3.36	2,146.3	3.35	3.60	0.01	82.7	0.13	3.9%
Manalapan Brook	2,287.0	3.57	2,258.5	3.53	28.5	0.04	86.1	0.13	3.8%
Metedeconk River North Branch	91.6	0.14	89.8	0.14	1.76	0.00	9.17	0.01	10.2%
Metedeconk River South Branch	19.3	0.03	19.3	0.03	0.00	0.00	2.16	0.00	11.2%
Millstone River	6,949.8	10.9	6,897.0	10.8	52.8	0.08	318.4	0.50	4.6%
Rocky Brook	4,387.4	6.86	4,336.4	6.78	51.0	0.08	188.9	0.30	4.4%
Toms River	2,071.4	3.24	2,060.6	3.22	10.8	0.02	124.7	0.19	6.1%
Total	23,800.2	37.2	23,432.8	36.6	367.4	0.57	1,053.1	1.65	4.5%

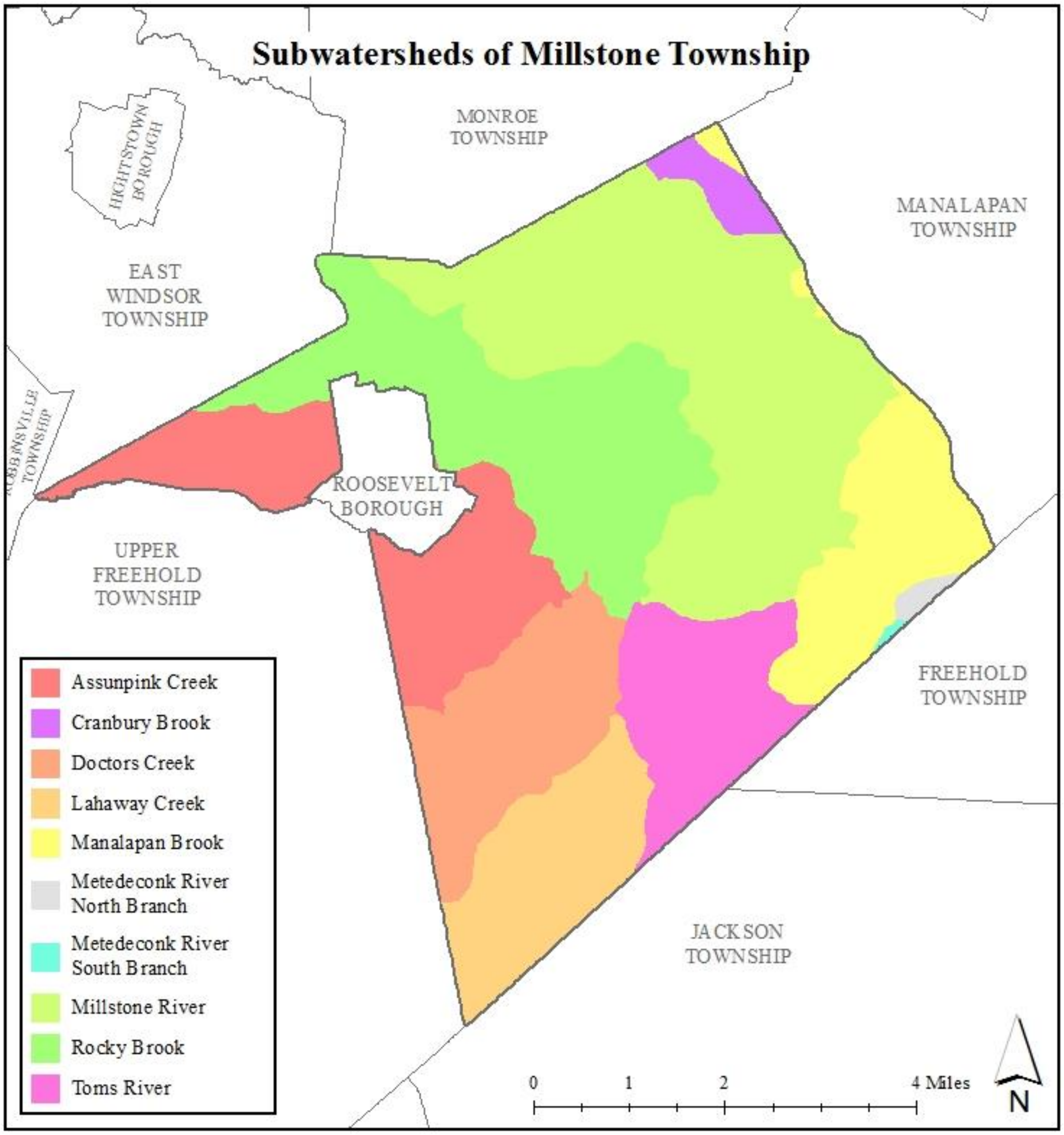


Figure 6: Map of the subwatersheds in Millstone Township

Table 2: Stormwater runoff volumes from impervious surfaces by subwatershed in Millstone 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 (3.4") (MGal)	Total Runoff Volume for the 10-Year Design Storm (5.2") (MGal)	Total Runoff Volume for the 100-Year Design Storm (8.9") (MGal)
Assunpink Creek	2.8	100.3	7.8	11.9	20.3
Cranbury Brook	1.6	57.0	4.4	6.7	11.5
Doctors Creek	3.7	130.6	10.1	15.4	26.4
Lahaway Creek	2.8	98.8	7.6	11.7	20.0
Manalapan Brook	2.9	102.8	7.9	12.1	20.8
Metedeconk River North Branch	0.3	11.0	0.8	1.3	2.2
Metedeconk River South Branch	0.1	2.6	0.2	0.3	0.5
Millstone River	10.8	380.4	29.4	45.0	76.9
Rocky Brook	6.4	225.7	17.4	26.7	45.7
Toms River	4.2	149.0	11.5	17.6	30.1
Total	35.7	1,258.1	97.2	148.7	254.4

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 Millstone 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 (3.4 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 Millstone Township

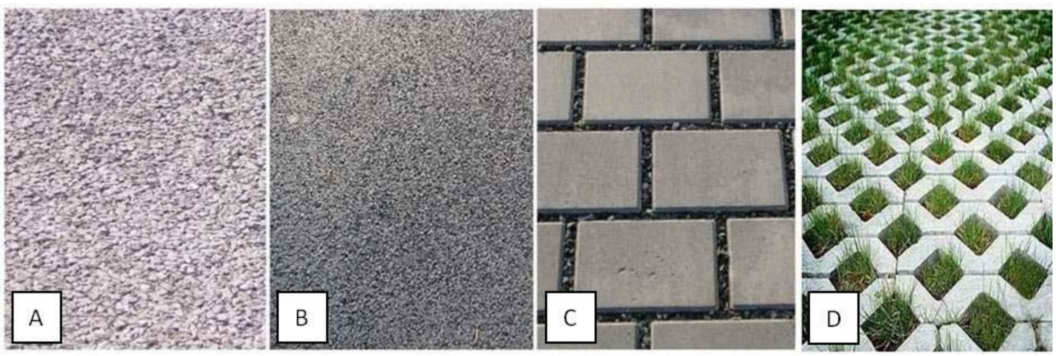
Subwatershed	**Recommended Impervious Area Reduction (10%) (ac)**	**Annual Runoff Volume Reduction [2] (MGal)**
Assunpink Creek	8.4	9.5
Cranbury Brook	4.8	5.4
Doctors Creek	10.9	12.4
Lahaway Creek	8.3	9.4
Manalapan Brook	8.6	9.8
Metedeconk River North Branch	0.9	1.0
Metedeconk River South Branch	0.2	0.2
Millstone River	31.8	36.1
Rocky Brook	18.9	21.4
Toms River	12.5	14.2

[2] Annual Runoff Volume Reduction =
Acres of impervious cover 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 green infrastructure should be designed to capture the first 3.4 inches of rain from each storm. This would allow the green infrastructure 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 Millstone 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 Millstone 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

Millstone 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

Examples of Impervious Cover Reduction Action Plan Projects

Concept Plans and Detailed Green Infrastructure Information Sheets

RUTGERS
New Jersey Agricultural Experiment Station

Millstone Township
Impervious Cover Assessment
Millstone Primary School, 18 Schoolhouse Road

PROJECT LOCATION:

1 **POROUS PAVEMENT:** Porous pavement promotes groundwater recharge and filters stormwater. The parking spots along Schoolhouse Road could be retrofitted with porous pavement.

2 **BIORETENTION SYSTEM:** On this property a rain garden can be used to reduce sediment and nutrient loading to the local waterway and increase groundwater recharge. There are opportunities to install rain gardens at the main entrance and in the rear courtyard of the school.

3 **DISCONNECTED DOWNSPOUTS:** Downspouts can be disconnected to allow rainwater to flow into the rain gardens that may be installed on this site. This will help to remove pollutants and allow stormwater to infiltrate into the ground.

SITE PLAN:

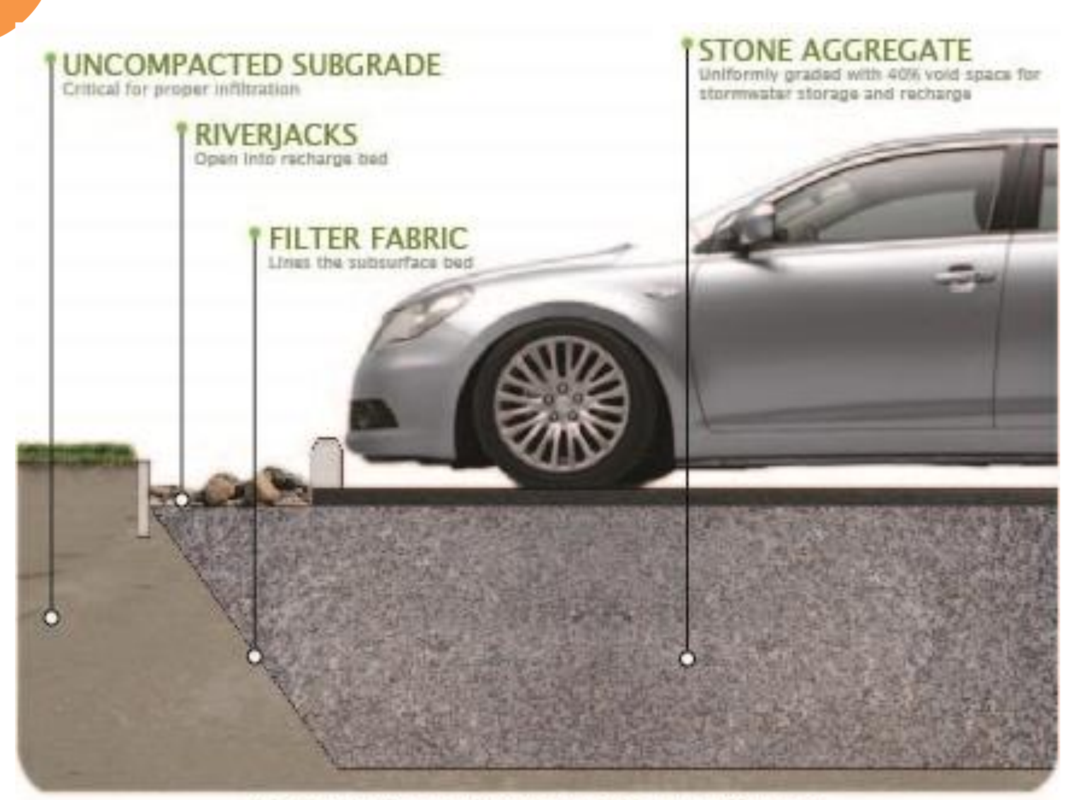
A

B

C

D

1 POROUS PAVEMENT



PERMEABLE PAVEMENT DIAGRAM

2 BIORETENTION SYSTEM

3 DISCONNECTED DOWNSPOUTS

Location: 18 Schoolhouse Road Millstone Twp., NJ 08510	**Municipality:** Millstone Township **Subwatershed:** Rocky Brook
Green Infrastructure Description: bioretention systems (rain gardens) disconnected downspouts porous pavement educational program	**Targeted Pollutants:** total nitrogen (TN), total phosphorous (TP), and total suspended solids (TSS) in surface runoff
Mitigation Opportunities: recharge potential: yes stormwater peak reduction potential: yes TSS removal potential: yes	**Stormwater Captured and Treated Per Year:** bioretention system #1: 69,000 gal. bioretention system #2: 52,100 gal. porous pavement system #1: 612,800 gal. porous pavement system #2: 218,900 gal.

Existing Conditions and Issues:
This site contains several impervious surfaces including driveways, walkways, parking areas, a garage, and a school complex. The site's impervious surfaces produce stormwater runoff during rain events. The largest impervious surface at this site is the school complex followed by the front parking lot. There are several connected downspouts on the perimeter of the building. One downspout is located near the main entrance to the school where there is ample space for a rain garden. Six downspouts surround the rear lawn of the school building (to the west near a large mechanical system). There is a small existing garden near the playground to the southwest that may be used for educational purposes. Most of the site's stormwater (and some of Schoolhouse Road's runoff) seems to be managed by a large detention basin to the north of the property. The main parking lot's runoff flows to the north where it is collected by catch basins and routed to this basin.

Proposed Solution(s):
Two bioretention systems could be installed on the lawn directly behind (or west of) the school. Each system would have three downspouts routed to it. The first system would be installed near the utility building behind the school; the second system would be installed in the interior area of the lawn. Two sections of the front parking lot could be repaved with porous pavement systems to better manage its stormwater.

Anticipated Benefits:
Since the bioretention systems would be designed to capture, treat, and infiltrate the entire 2-year design storm (3.4 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 habitat and aesthetic appeal. The porous pavement system will

achieve the same level of pollutant load reduction for TN, TP and TSS. 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. This may also be used as a demonstration project for the Millstone Township Department of Public Works staff to launch educational programming.

Possible Funding Sources:
mitigation funds from local developers
NJDEP grant programs
Millstone Township
Millstone Primary School
local social and community groups

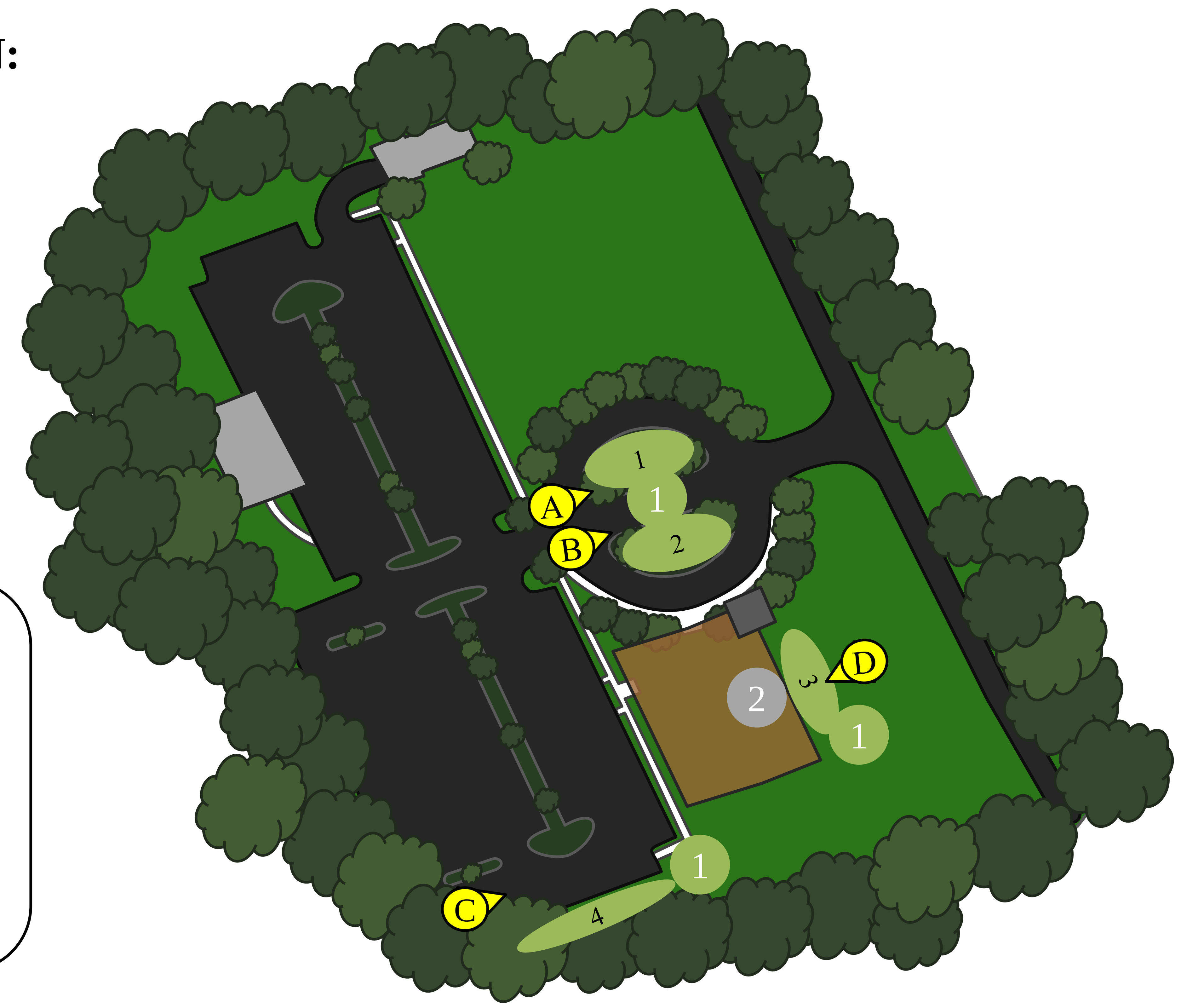
Partners/Stakeholders:
Millstone Township
Millstone Primary School
local social and community groups
students, parents, faculty, and staff
Rutgers Cooperative Extension

Estimated Cost:
Bioretention system #1 would need to be approximately 700 square feet. At $5 per square foot, the estimated cost of this bioretention system is $3,500. Three downspouts would also need to be disconnected and routed to this system, adding an additional $750 to its cost. Bioretention system #2 would need to be approximately 500 square feet. At $5 per square foot, the estimated cost of this bioretention system is $2,500. Three downspouts would also need to be disconnected and routed to this system, adding an additional $750 to its cost. Porous pavement system #1 would cover approximately 4,200 square feet and utilize a 2 feet deep stone reservoir. At $20 per square foot, the cost of the porous asphalt system would be $84,000. Porous pavement system #2 would cover approximately 1,000 square feet and utilize a 3 feet deep stone reservoir. At $30 per square foot, the cost of the porous asphalt system would be $30,000. The total cost of the project will thus be approximately $121,500.

Millstone Township
Impervious Cover Assessment
St. Joseph's of Millstone, 91 Stillhouse Road

PROJECT LOCATION:

SITE PLAN:



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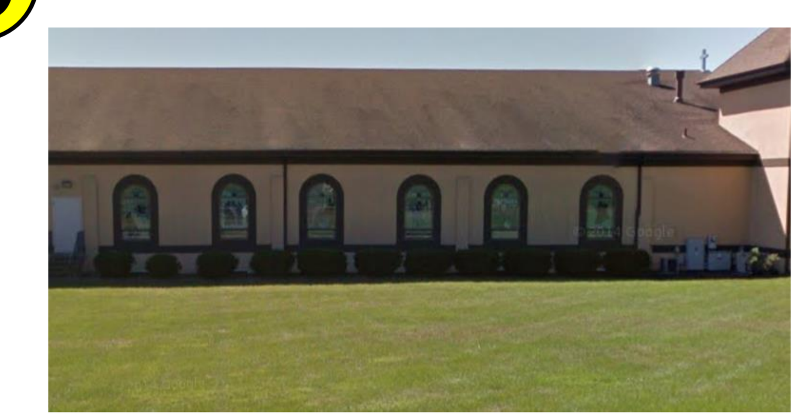


1 **BIORETENTION SYSTEM:** On this property bioretention systems or rain gardens can be used to reduce sediment and nutrient loading to the local waterway and increase groundwater recharge. The two tree islands at the entrance could be retrofitted with rain gardens, and curb cuts to allow stormwater runoff to enter. Additionally, a rain garden can be installed in the field adjacent to the building and at the edge of the parking lot. Curb cuts would also be needed at the proposed rain garden at the edge of the parking lot.

2 **DISCONNECTED DOWNSPOUTS:** Downspouts can be disconnected to allow rainwater to flow into the rain garden alongside the building which will help remove pollutants and allow for the stormwater to infiltrate into the ground.

1 BIORETENTION SYSTEM

CURB CUTS

2 DISCONNECTED DOWNSPOUTS

RUTGERS
New Jersey Agricultural Experiment Station

Location: 91 Stillhouse Road Millstone Township, NJ 08510	**Municipality:** Millstone Township **Subwatershed:** Millstone River
Green Infrastructure Description: bioretention systems (rain gardens) disconnected downspouts	**Targeted Pollutants:** total nitrogen (TN), total phosphorous (TP), and total suspended solids (TSS) in surface runoff
Mitigation Opportunities: recharge potential: yes stormwater peak reduction potential: yes TSS removal potential: yes	**Stormwater Captured and Treated Per Year:** bioretention system #1: 36,500 gal. bioretention system #2: 36,500 gal. bioretention system #3: 62,500 gal. bioretention system #4: 36,500 gal.

Existing Conditions and Issues:

This site contains several impervious surfaces including driveways, walkways, parking areas, and three buildings. The site's impervious surfaces produce stormwater runoff during rain events. A tributary to the Millstone River borders this property on the southwest. The most extensive impervious surface on this site is its parking lot, which is graded so that runoff flows to the south into a pond. The parking lot is in good condition and has several parking islands with light poles. An existing rock swale runs on the western edge of the parking lot. There is a hill blocked by a curb that runs along the southern edge of the parking lot. The front driveway is divided by two islands into three parts, which are all graded in a general westerly direction. These two islands each have four trees along their inside edge and a lightpole in their interior. The church has several downspouts on each face and has a terraced garden on its western face. The front lawn near the church is spacious and offers plenty of room for a potential rain garden.

Proposed Solution(s):

One bioretention system could be installed along the outside edge of each island within the front driveway. These systems would receive water through curb cuts in the islands. A third bioretention system could be installed alongside the church in the front lawn. This system would receive its water from two downspouts, which would need to be disconnected and routed to the bioretention system. A rain garden can also be used to treat runoff from the parking lot. This rain garden would be located along the southern edge of the parking lot, currently occupied by a grass hill that leads into a swale. Curb cuts would need to be made to allow water to flow into this rain garden as well.

Anticipated Benefits:

Since the bioretention systems would be designed to capture, treat, and infiltrate the entire 2-year design storm (3.4 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 habitat and aesthetic appeal. Curb cuts allow stormwater runoff to flow into vegetated areas and bioretention systems rather than flow into catch basins.

Possible Funding Sources:
mitigation funds from local developers
NJDEP grant programs
Millstone Township
St. Joseph's Church
local social and community groups

Partners/Stakeholders:
Millstone Township
St. Joseph's Church
local social and community groups
clergy, parishioners, and local residents
Rutgers Cooperative Extension

Estimated Cost:
Bioretention system #1 would need to be approximately 350 square feet. At $5 per square foot, the estimated cost of this bioretention system is $1,750. Bioretention system #2 would need to be approximately 350 square feet. At $5 per square foot, the estimated cost of this bioretention system is $1,750. Bioretention system #3 would need to be approximately 600 square feet. At $5 per square foot, the estimated cost of this bioretention system is $3,000. Two downspouts would be disconnected and routed to this system, which adds $500 to the total cost of this system. Bioretention system #4 would need to be approximately 4,200 square feet. At $5 per square foot, the estimated cost of this bioretention system is $21,000. The total cost of the project will be approximately $28,000.

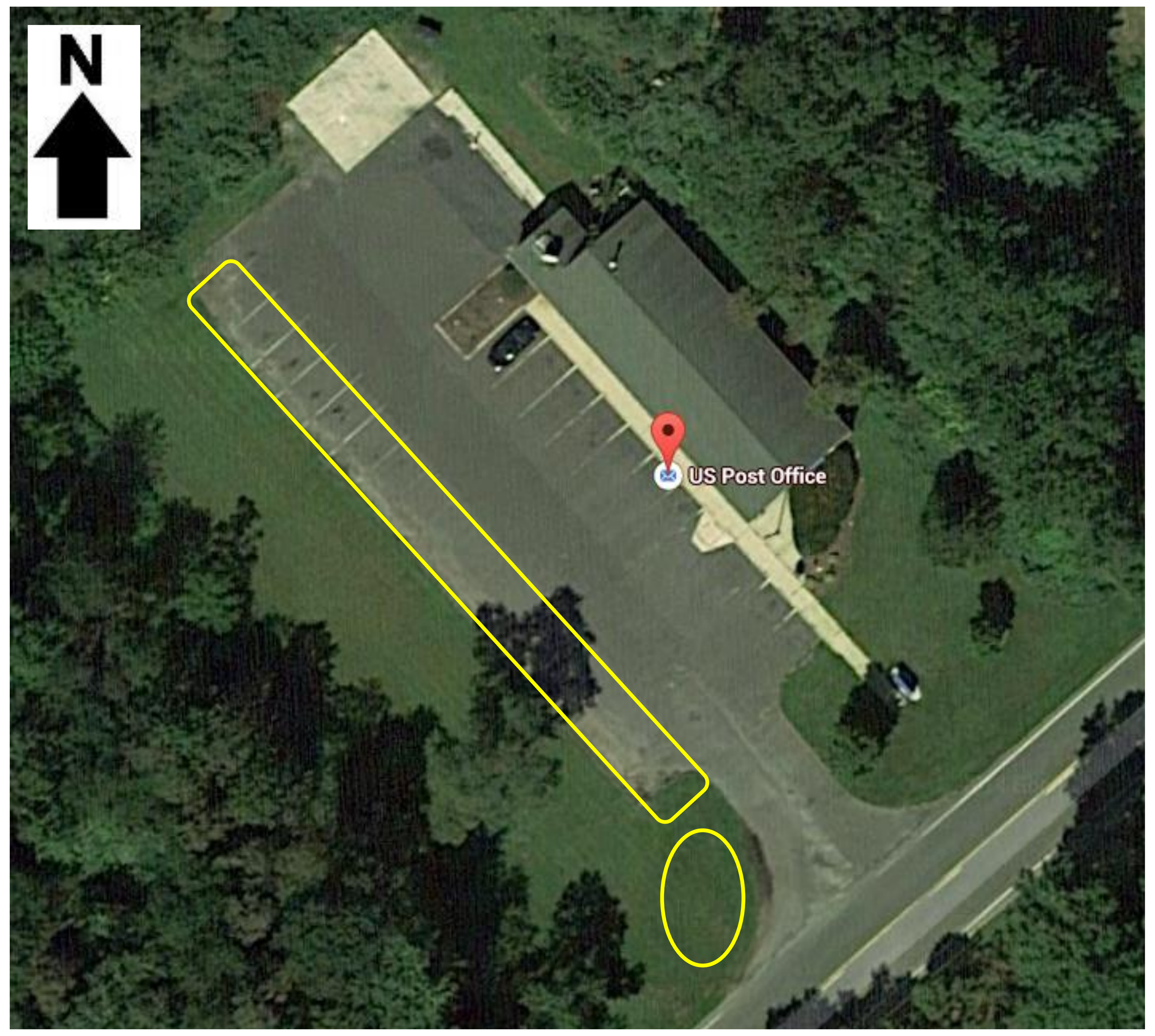
Millstone Township
Impervious Cover Assessment
Clarksburg Post Office, 424 Stagecoach Road

A

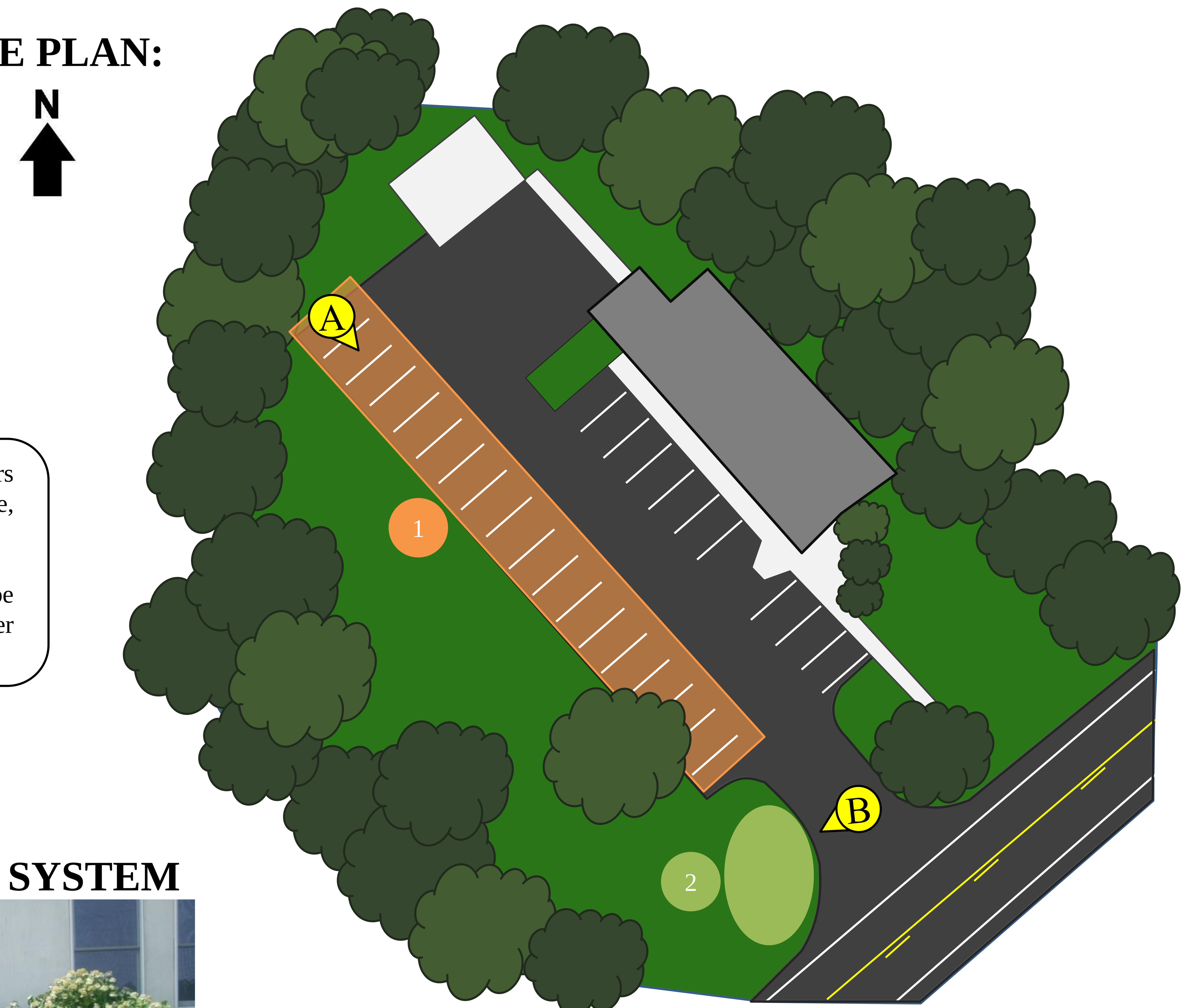
B

Rutgers
New Jersey Agricultural Experiment Station

PROJECT LOCATION:



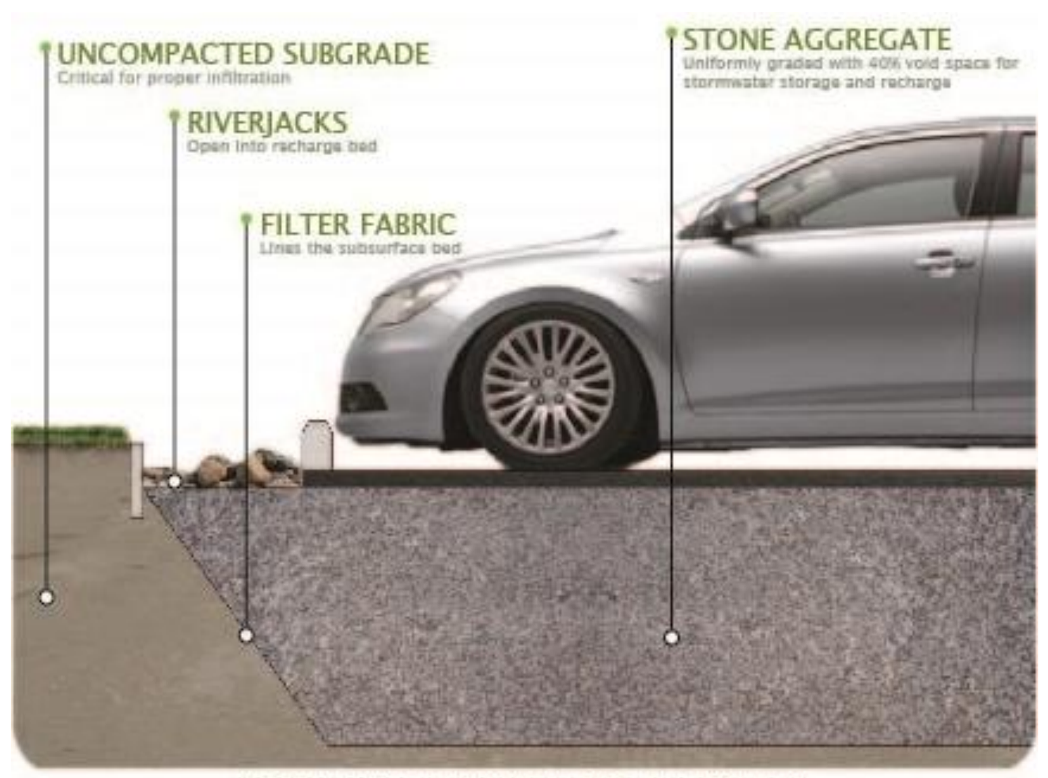
SITE PLAN:



1 **POROUS PAVEMENT:** Porous pavement promotes groundwater recharge and filters stormwater. A portion of the parking lot can be replaced with a porous asphalt system to capture, treat, and infiltrate stormwater runoff.

2 **BIORETENTION SYSTEM:** On this property a bioretention system or rain garden can be used to reduce sediment and nutrient loading to the local waterway and increase groundwater recharge. This garden could be installed along the main entrance.

1 POROUS PAVEMENT



2 BIORETENTION SYSTEM

Location: 424 Stagecoach Road Clarksburg, NJ 08510	**Municipality:** Millstone Township **Subwatershed:** Doctors Creek
Green Infrastructure Description: bioretention system (rain garden) porous pavement	**Targeted Pollutants:** total nitrogen (TN), total phosphorous (TP), and total suspended solids (TSS) in surface runoff
Mitigation Opportunities: recharge potential: yes stormwater peak reduction potential: yes TSS removal potential: yes	**Stormwater Captured and Treated Per Year:** bioretention system: 52,100 gal. porous pavement: 236,400 gal.

Existing Conditions and Issues:
This site contains several impervious surfaces including a driveway, walkway, parking lot, and post office building. These impervious surfaces are directly connected to a storm sewer system. The site's impervious surfaces produce stormwater runoff during rain events. The largest impervious surface at this site is the parking lot. The parking lot is in poor condition. There is a depression that runs through the southern parking area along with two storm drains. The southernmost edge of this lot has a damaged berm. Debris and sediment has built up at the southern and western corner of this lot, and stormwater appears to flow in a westerly direction at this site. A lawn extends from the entrance to the post office to the northern end of the parking lot. The entrance to the post office is in poor condition with potholes where water ponds, and the western grass area along the entrance has been eroded away. Large puddles of water were observed along the western side of the entrance at the time of the site visit.

Proposed Solution(s):
A bioretention systems could be installed along the western side of the entrance to the post office to capture stormwater from the roadway and parking lot and enhance the visual appeal of this space. The southwest parking area could be repaved with porous asphalt with a stone reservoir underneath to store stormwater while it is slowly infiltrated.

Anticipated Benefits:
Since the bioretention systems would be designed to capture, treat, and infiltrate the entire 2-year design storm (3.4 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 habitat and aesthetic appeal. The porous pavement system will achieve the same level of pollutant load reduction for TN, TP and TSS.

Possible Funding Sources:
mitigation funds from local developers

NJDEP grant programs Millstone Township Clarksburg Post Office local social and community groups
Partners/Stakeholders: Millstone Township Clarksburg Post Office local social and community groups local residents Rutgers Cooperative Extension
Estimated Cost: The bioretention system would need to be approximately 500 square feet. At $5 per square foot, the estimated cost of this bioretention system is $2,500. The porous asphalt would cover approximately 3,240 square feet and have a 1 foot deep stone reservoir under the surface. At $20 per square foot, the cost of the porous asphalt system would be $64,800. The total cost of the project will thus be approximately $67,300.