Draft

Impervious Cover Assessment for Flemington Borough, Hunterdon County, New Jersey

Prepared for Flemington Borough by the Rutgers Cooperative Extension Water Resources Program

February 3, 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.

- <u>Erosion</u>: 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

Flemington Borough Impervious Cover Analysis

Located in Hunterdon County in central New Jersey, Flemington Borough covers approximately 1.08 square miles. Figures 3 and 4 illustrate that Flemington Borough is dominated by urban land uses. A total of 93.8% of the municipality's land use is classified as urban. Of the urban land in Flemington Borough, commercial 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 Flemington Borough 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 Flemington Borough. Based upon the 2007 NJDEP land use/land cover data, approximately 47.7% of Flemington Borough has impervious cover. This level of impervious cover suggests that the streams in Flemington Borough are likely non-supporting streams.

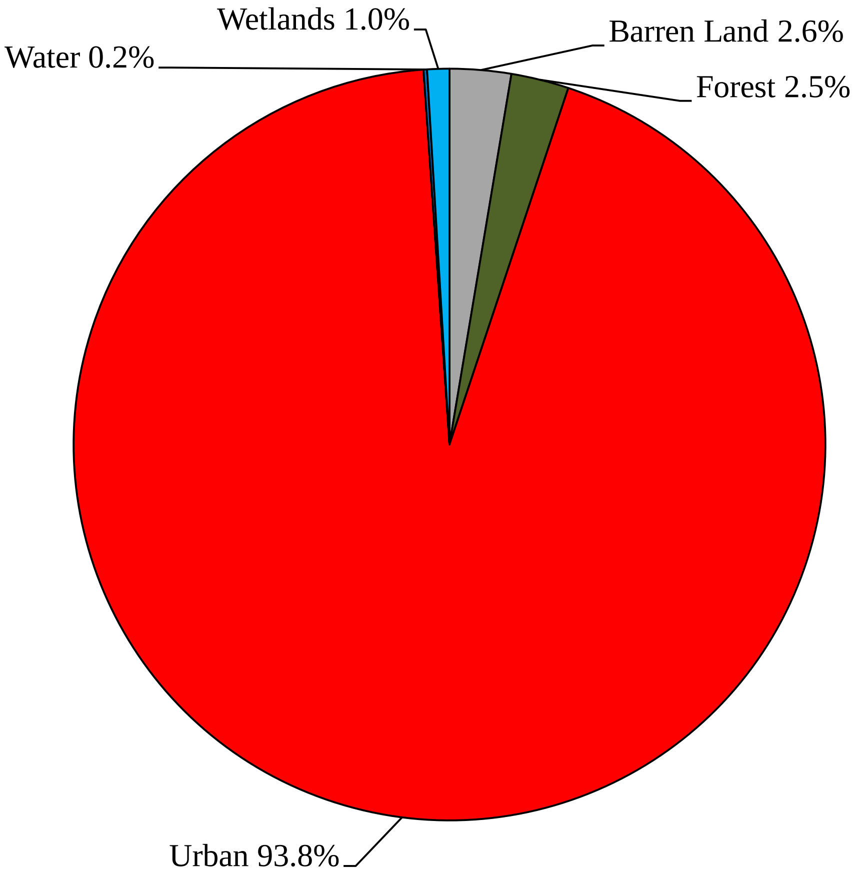


Figure 3: Pie chart illustrating the land use in Flemington Borough

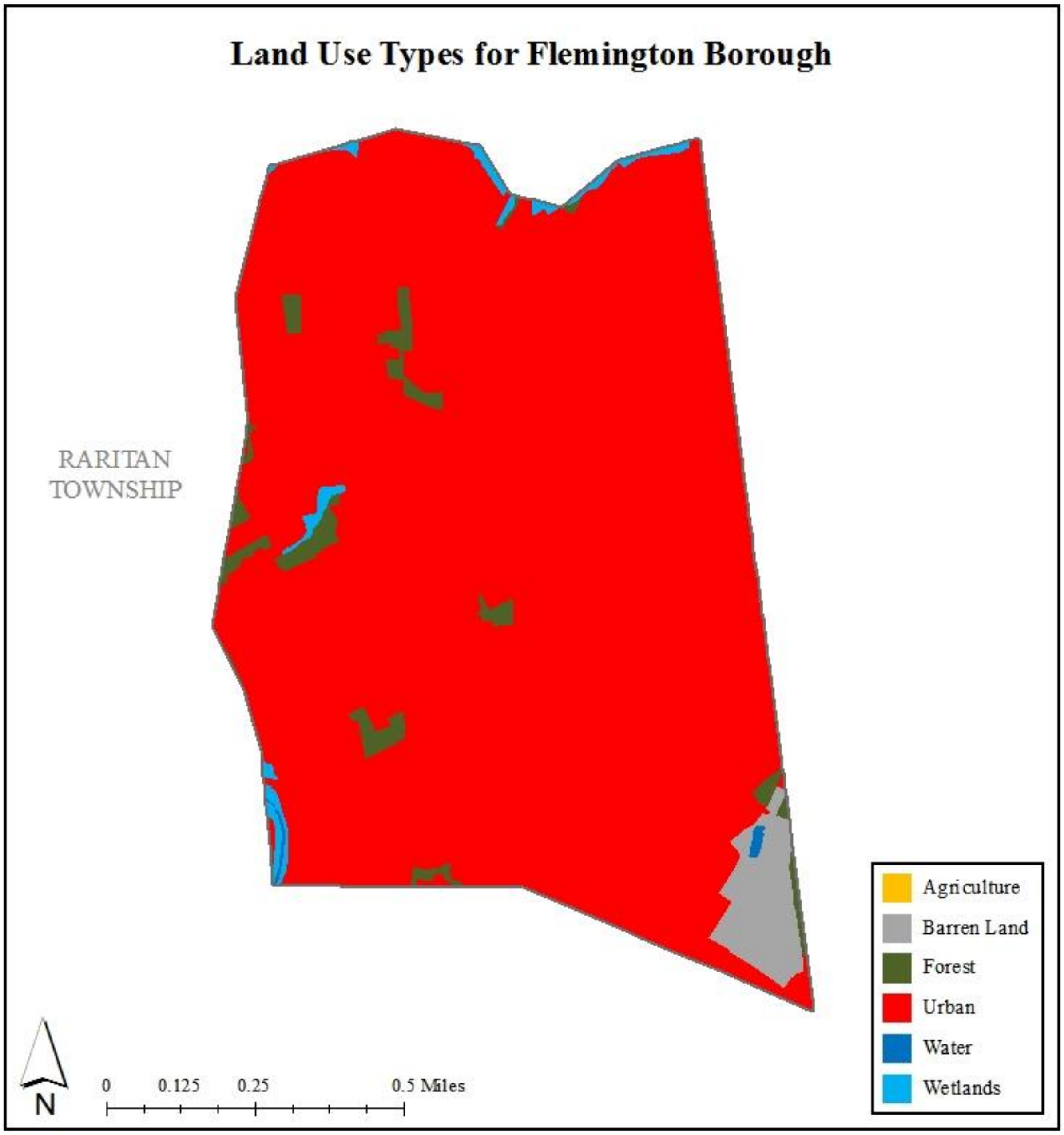


Figure 4: Map illustrating the land use in Flemington Borough

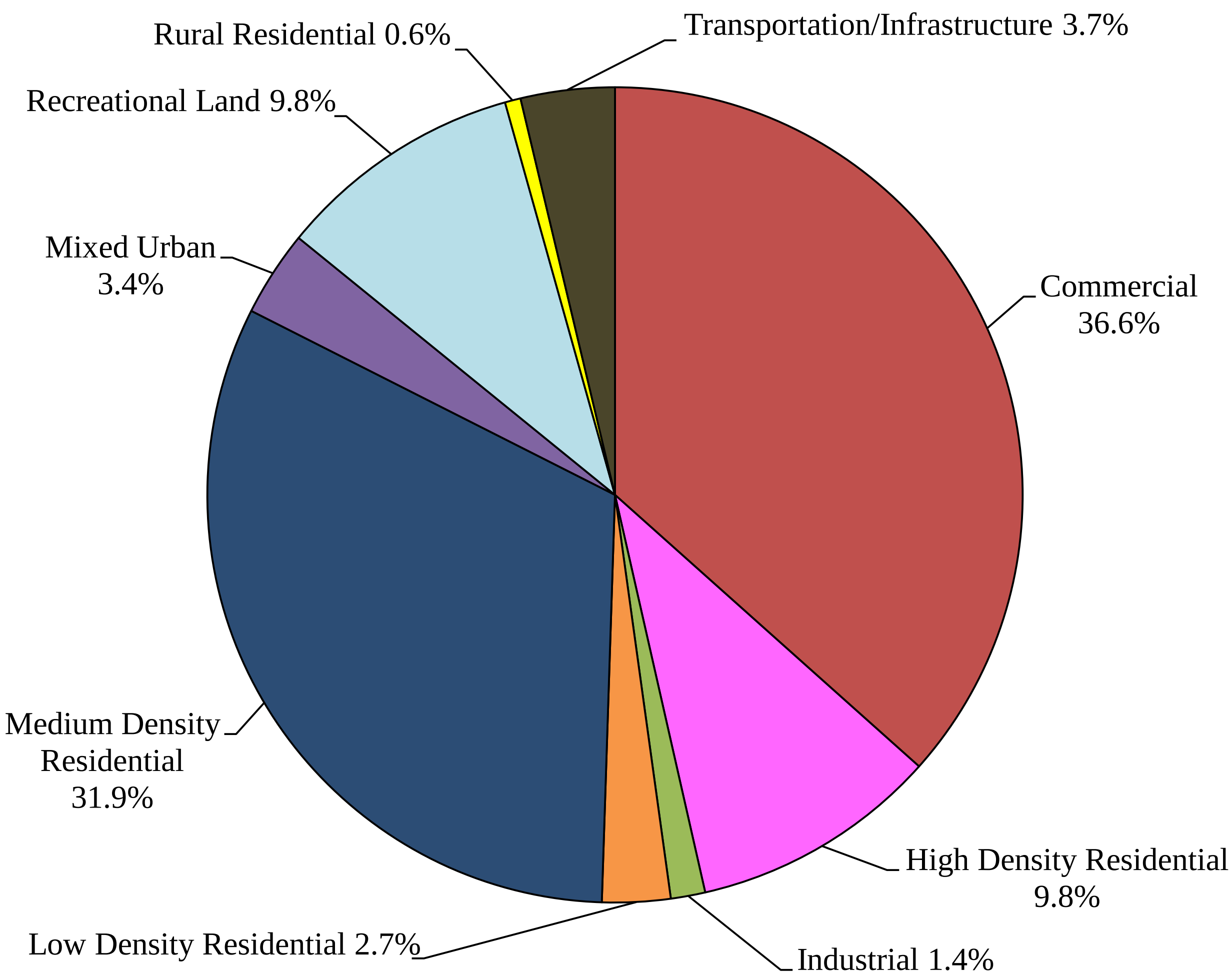


Figure 5: Pie chart illustrating the various types of urban land use in Flemington Borough

Water resources are typically managed on a watershed/subwatershed basis; therefore an impervious cover analysis was performed for each Raritan River subwatershed within Flemington Borough (Table 1 and Figure 6). On a subwatershed basis, impervious cover ranges from 46.9% in the Raritan River South Branch subwatershed to 52.5% in the First Neshanic River 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 Flemington Borough, Hunterdon 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 (5.0 inches of rain), and the 100-year design storm (8.0 inches of rain). These runoff volumes are summarized in Table 2. A substantial amount of rainwater drains from impervious surfaces in Flemington Borough. For example, if the stormwater runoff from one water quality storm (1.25 inches of rain) in the Raritan River South Branch subwatershed was harvested and purified, it could supply water to 86 homes for one year[1].

[1] Assuming 300 gallons per day per home

Table 1: Impervious cover analysis by subwatershed for Flemington Borough

Subwatershed	Total Area		Land Use Area		Water Area		Impervious Cover		
	(ac)	(mi^2)	(ac)	(mi^2)	(ac)	(mi^2)	(ac)	(mi^2)	(%)
First Neshanic River	97.9	0.15	97.5	0.15	0.45	0.00	51.2	0.08	52.5%
Raritan River South Branch	592.4	0.93	591.8	0.92	0.60	0.00	277.4	0.43	46.9%
Total	690.3	1.08	689.3	1.08	1.05	0.00	328.6	0.51	47.7%

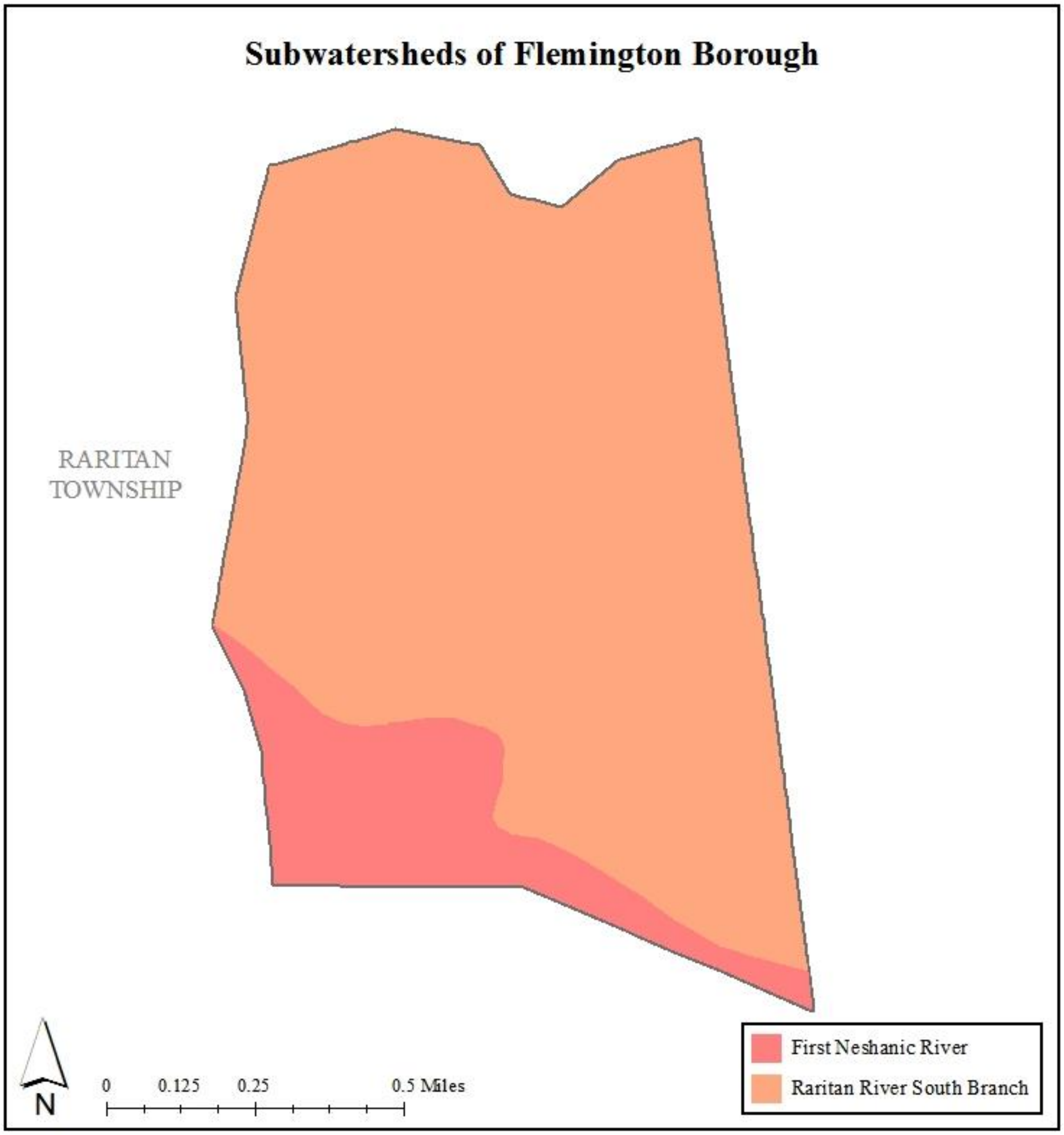


Figure 6: Map of the subwatersheds in Flemington Borough

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

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 (5.0") (MGal)**	**Total Runoff Volume for the 100-Year Design Storm (8.0") (MGal)**
First Neshanic River	1.7	61.2	4.7	7.0	11.1
Raritan River South Branch	9.4	331.4	25.6	37.7	60.3
Total	11.2	392.6	30.3	44.6	71.4

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 Flemington Borough. 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 Flemington Borough

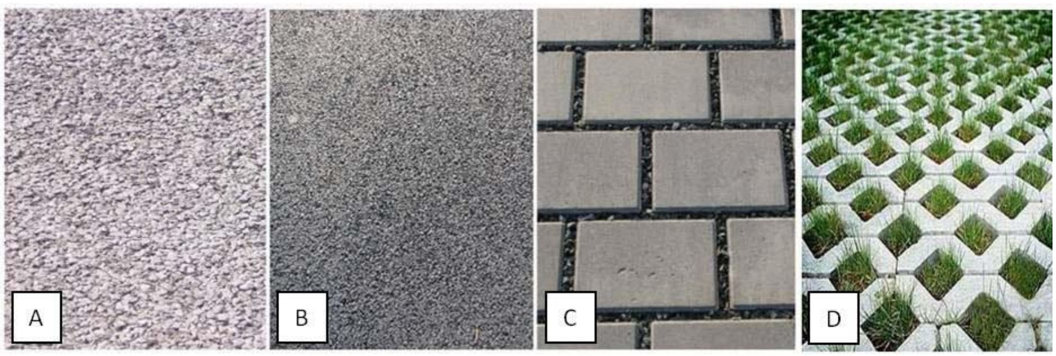
Subwatershed	**Recommended Impervious Area Reduction (10%) (ac)**	**Annual Runoff Volume Reduction [2] (MGal)**
First Neshanic River	5.1	5.8
Raritan River South Branch	27.7	31.5
Total	32.9	37.3

[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 Flemington Borough

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 Flemington Borough, 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

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

References

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

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

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

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

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

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

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

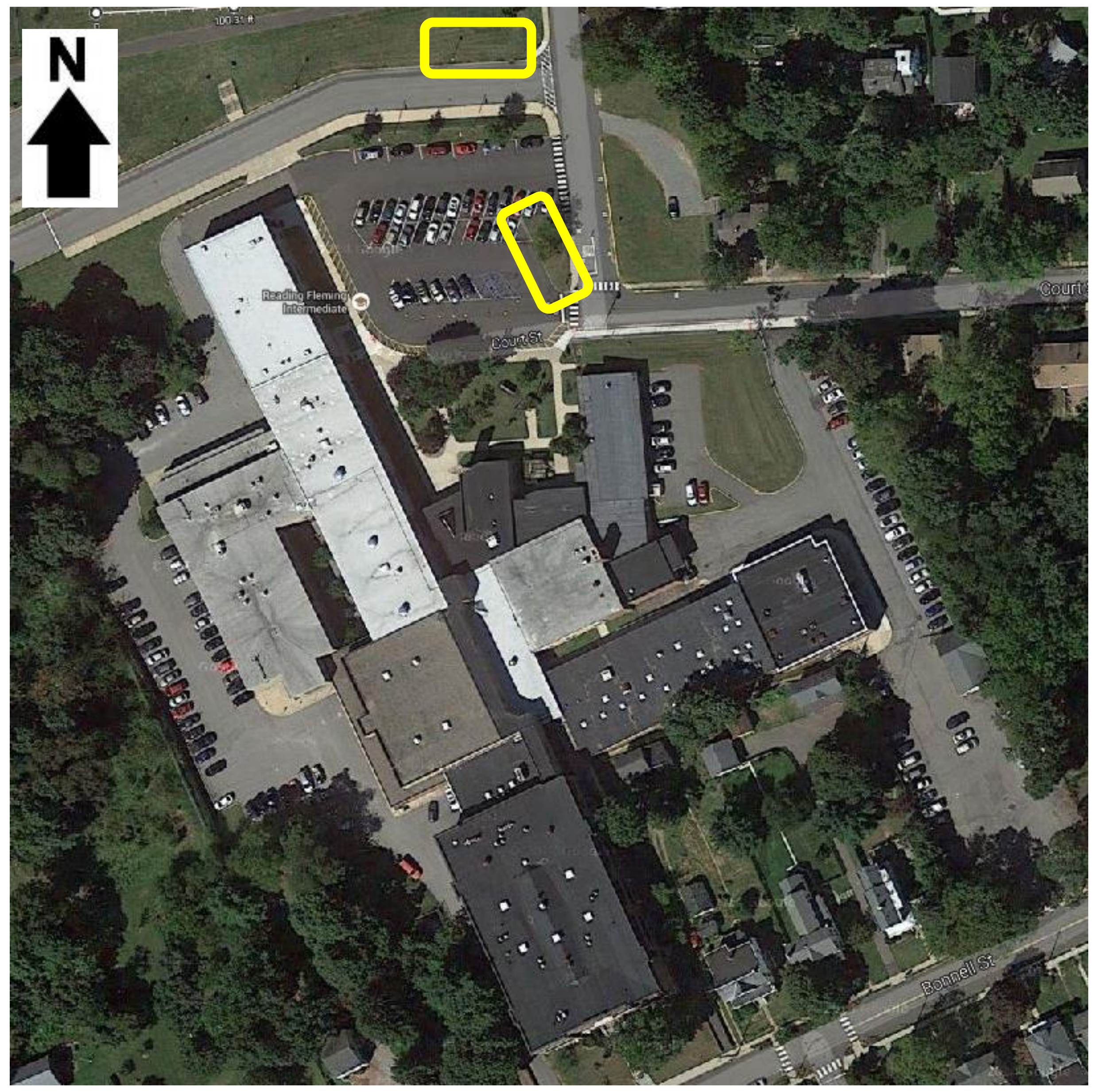
Appendix A

Examples of Impervious Cover Reduction Action Plan Projects

Concept Plans and Detailed Green Infrastructure Information Sheets

Flemington Borough
Impervious Cover Assessment
Reading-Fleming Intermediate School, 50 Court Street

PROJECT LOCATION:



SITE PLAN:

N

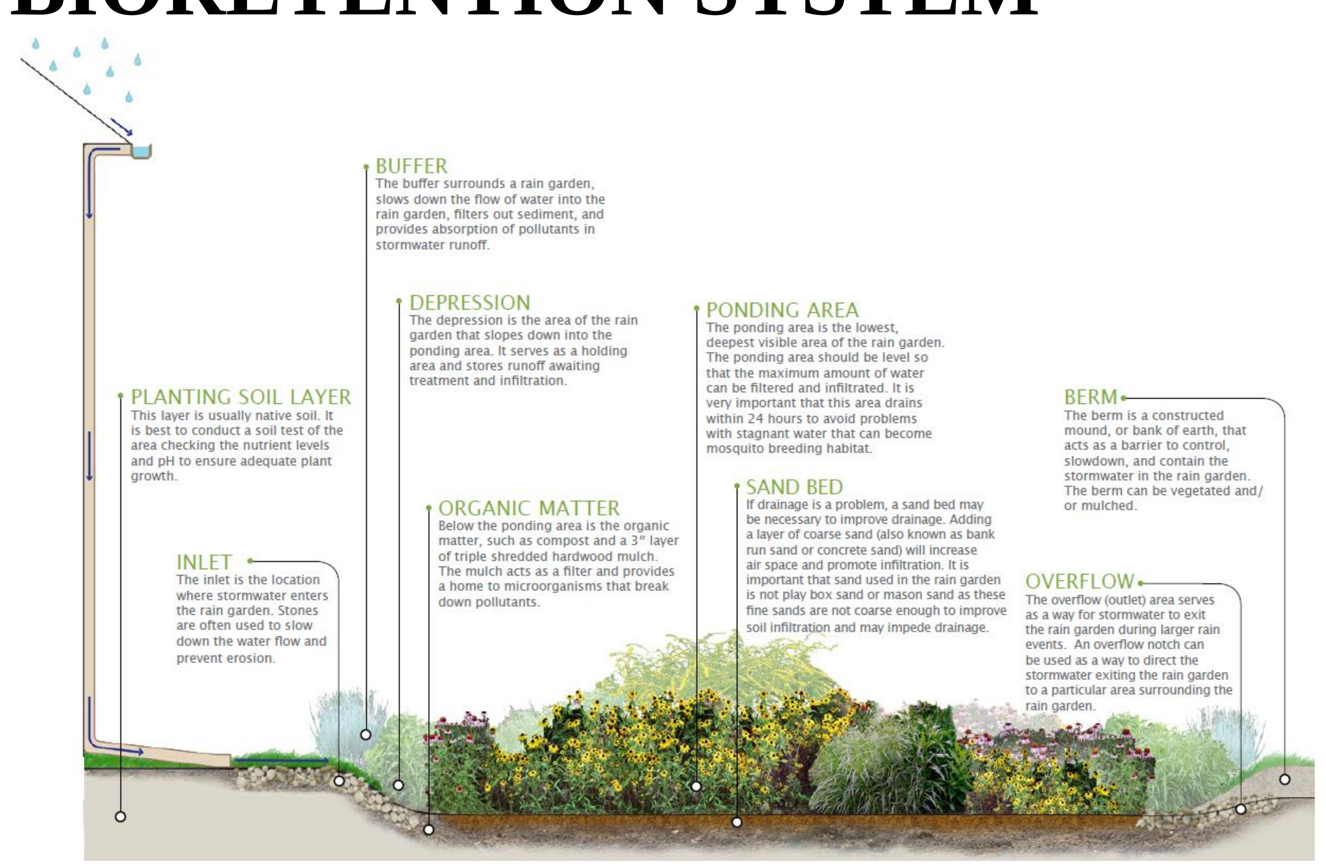
A

B

C

1 **BIORETENTION SYSTEM:** Two bioretention systems can be installed; one along the eastern edge of the parking lot and another along the northern edge of the site. Curb cuts should be made to allow the flow of runoff into the bioretention systems. Bioretention systems will reduce runoff and allow stormwater infiltration, decreasing the amount of contaminants that reaches the storm sewer system

1 BIORETENTION SYSTEM



CURB CUTS

Location: 50 Court Street Flemington, NJ 08822	**Municipality:** Flemington Borough **Subwatershed:** Raritan River South Branch
Green Infrastructure Description: bioretention systems (rain gardens) curb cuts 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: 20,844 gal. bioretention system # 2: 31,266 gal.

Existing Conditions and Issues:
This site contains several impervious surfaces including paved walkways, driveways, roadways, and parking areas. These impervious surfaces are directly connected to a storm sewer system. Sediment and debris accumulation occurs near the island in the front parking lot. The existing pavement is in good condition.

Proposed Solution(s):
Bioretention system #1 could be installed west of the storm drain near the intersection of Allen Street and the school's drive, which is north of Court Street. Bioretention system #2 could be installed along the western edge of the island at the intersection of Allen Street and Court Street. Curb cuts could be installed at both proposed locations allowing stormwater to flow into bioretention systems.

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. Rutgers Cooperative Extension could additionally present the *Stormwater Management in Your Schoolyard* program to students and include them in bioretention system planting efforts. This may also be used as a demonstration project for Flemington Borough Public Works staff to launch educational programming.

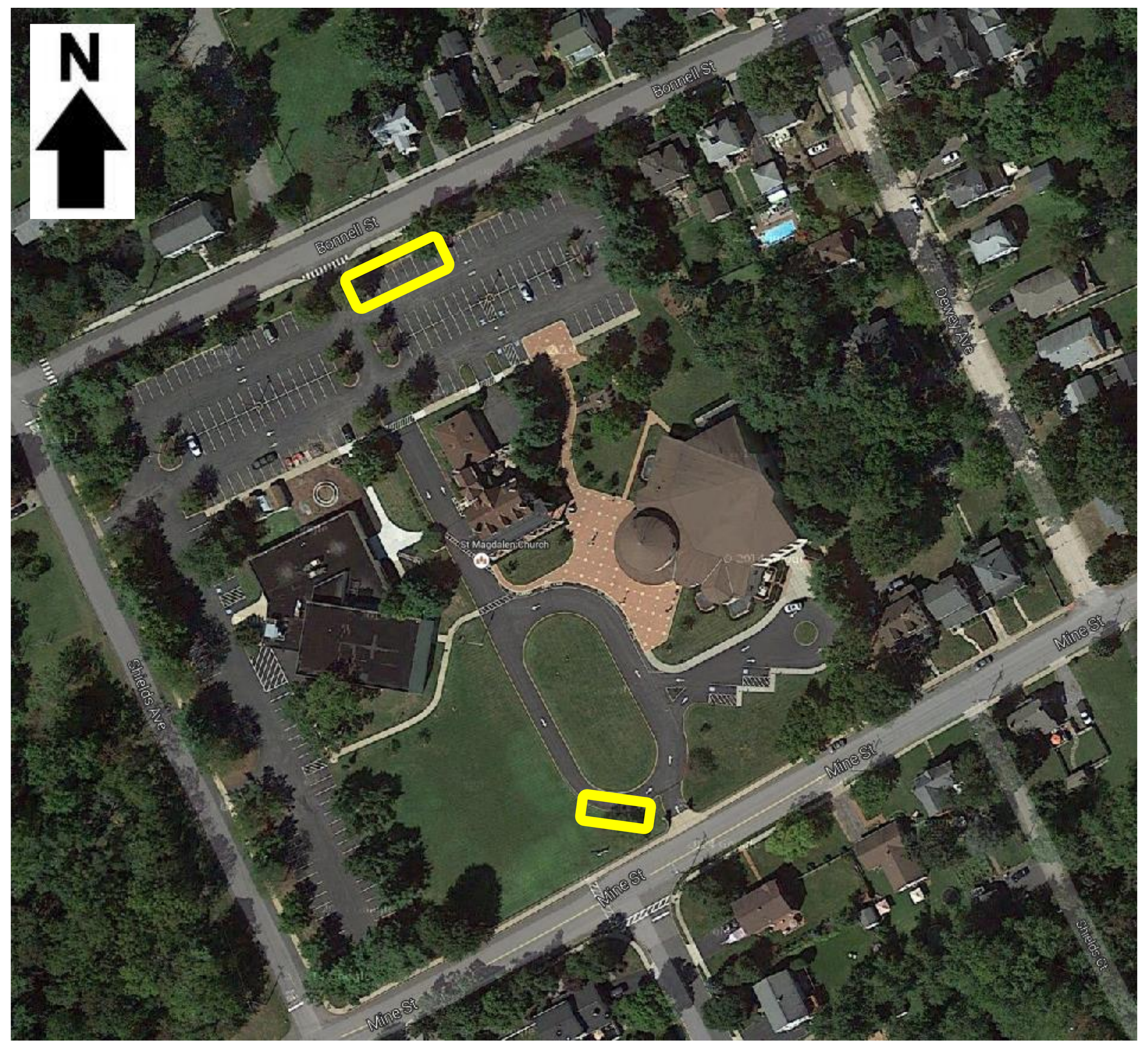
Possible Funding Sources:
mitigation funds from local developers
NJDEP grant programs
Flemington Borough
local social and community groups

Partners/Stakeholders:
Flemington Borough
Reading-Fleming Intermediate School
local social and community groups
students and parents
Rutgers Cooperative Extension

Estimated Cost:
Bioretention system #1 would need to be approximately 200 square feet. At $5 per square foot, the estimated cost of this bioretention system is $1,000. Bioretention system #2 would need to be approximately 300 square feet. At $5 per square foot, the estimated cost of this bioretention system is $1,500. The total cost of the project will be approximately $2,500.

Flemington Borough
Impervious Cover Assessment
St. Magdalen Church, 105 Mine Street

PROJECT LOCATION:



SITE PLAN:

N

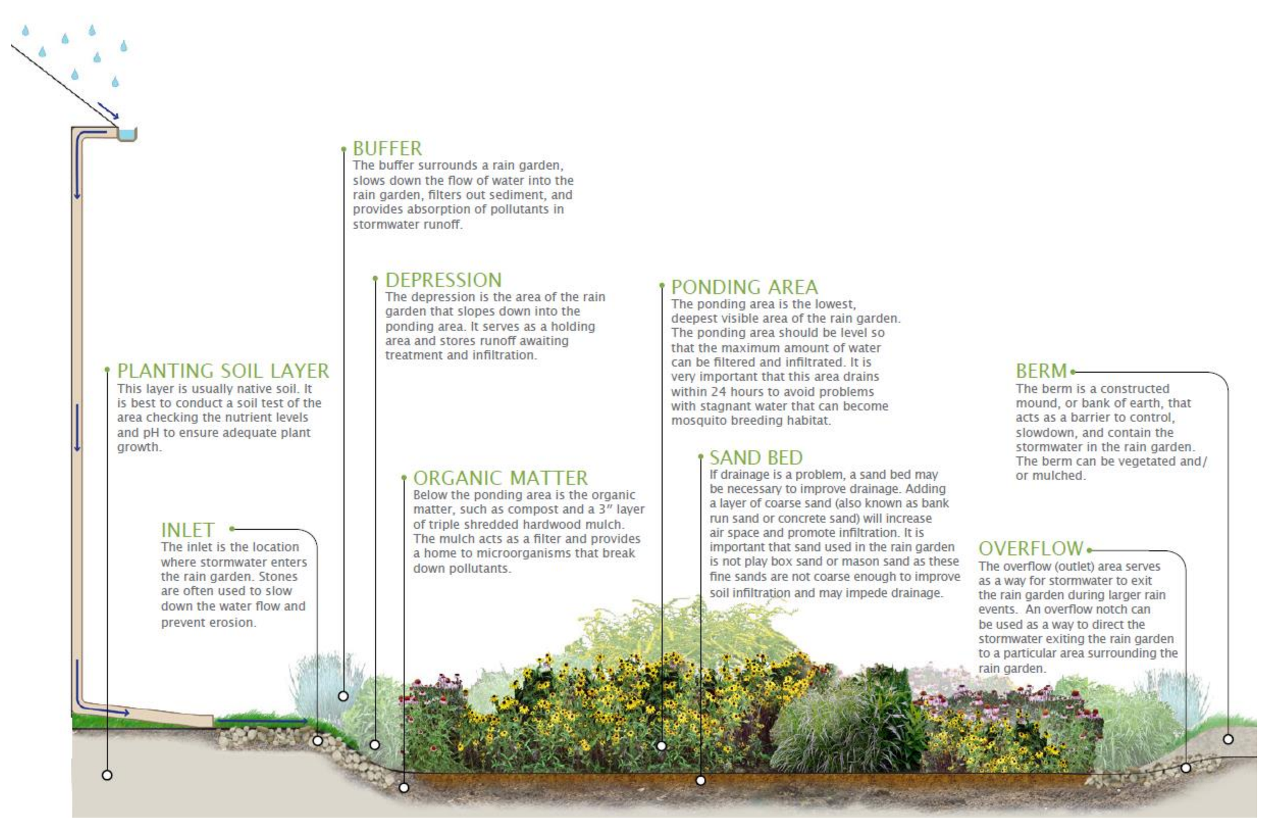
A

B

1 **BIORETENTION SYSTEM:** A bioretention system could be installed along the curve of the main driveway entrance from Mine Street. A bioretention system will reduce runoff and allow stormwater infiltration, decreasing the amount of contaminants that reaches the storm sewer system. Curb cuts should be installed to allow the flow of runoff into the bioretention system.

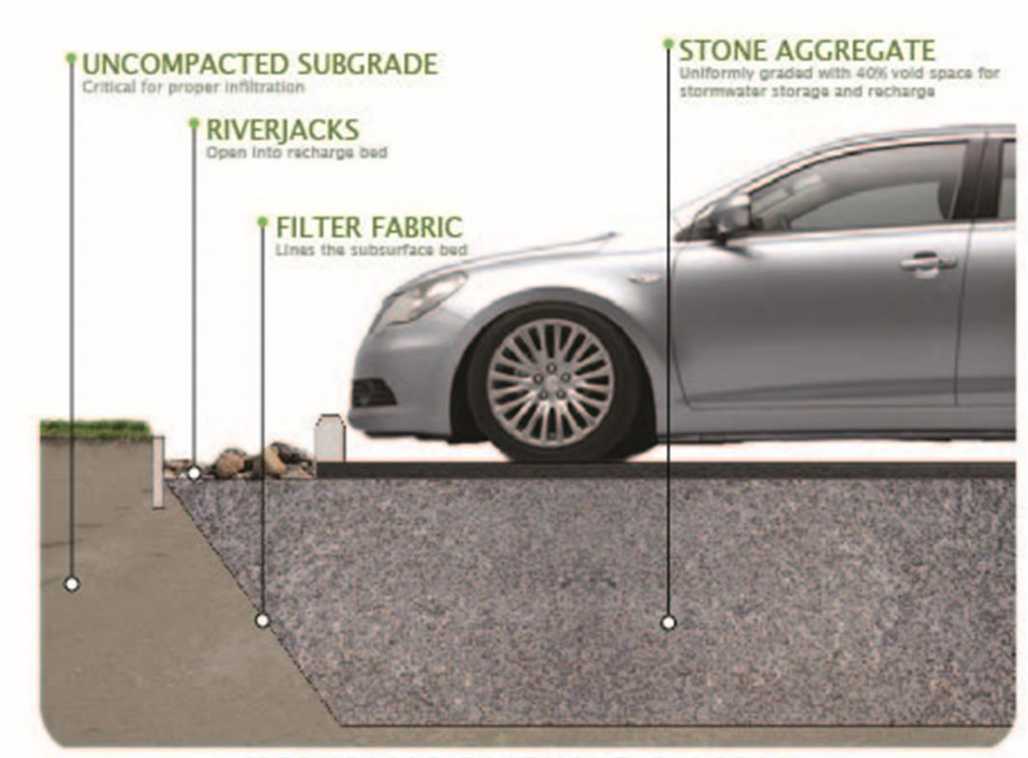
2 **POROUS PAVEMENT:** Porous pavement should be installed along the northern side of the parking lot near the entrance to Bonnell Street. Porous pavement promotes groundwater recharge and filters stormwater.

1 BIORETENTION SYSTEM



CURB CUTS

2 POROUS PAVEMENT



St. Magdalen Church
Green Infrastructure Information Sheet

Location: 105 Mine Street Flemington, NJ 08822	**Municipality:** Flemington Borough **Subwatershed:** Raritan River South Branch
Green Infrastructure Description: bioretention system (rain garden) curb cuts 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: 104,221 gal. porous pavement: 325,014 gal.

Existing Conditions and Issues:
This site contains several extensive impervious surfaces including paved walkways, driveways, three large buildings (complete with roofing and downspout systems), and parking areas. These impervious surfaces are directly connected to a storm sewer system. The site's impervious surfaces produce stormwater runoff during rain events. The northeastern parking area is graded toward the west and the entrance to Bonnell Street. The grading of this portion of the parking lot encourages deposition of debris and sediment in these parking spaces. The runoff is directed to a catch basin, located at this corner of the lot. The driveway entrance at the southern side of the site is graded towards Mine Street.

Proposed Solution(s):
Porous pavement could be installed in several parking spaces on the eastern side of the exit of the parking lot to Bonnell Street. The porous pavement would intercept stormwater flowing westward through the parking lot prior to entering the storm sewer system. A 1,000 square foot area of lawn along the southern curve of the driveway entrance along Mine Street could be replaced with a bioretention system (also known as a rain garden) to better manage stormwater flowing towards the storm sewer system and Mine Street.

Anticipated Benefits:
Since the bioretention system would be designed to capture, treat, and infiltrate the entire 2-year design storm (3.4 inches of rain over 24 hours), this system is 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. Porous pavement allows stormwater to infiltrate through to soil layers which will promote groundwater recharge as well as intercept and filter stormwater runoff. The system is expected to achieve a 95% pollutant load reduction for TN, TP, and TSS.

Possible Funding Sources:
mitigation funds from local developers
NJDEP grant programs
Flemington Borough
St. Magdalen Church and its parishioners
local social and community groups

Partners/Stakeholders:
Flemington Borough
St. Magdalen Church and its parishioners
local social and community groups
Rutgers Cooperative Extension

Estimated Cost:
The bioretention system would need to be approximately 1,000 square feet. At $5 per square foot, the estimated cost of this bioretention system is $5,000. The porous pavement would cover approximately 2,000 square feet and have a 2.5 foot deep stone reservoir under the surface. At $27.50 per square foot, the cost of the porous asphalt system would be approximately $55,000. The total cost of the project will be approximately $60,000.

Flemington Borough
Impervious Cover Assessment
Flemington Presbyterian Church, 10 East Main Street

PROJECT LOCATION:

SITE PLAN:

N

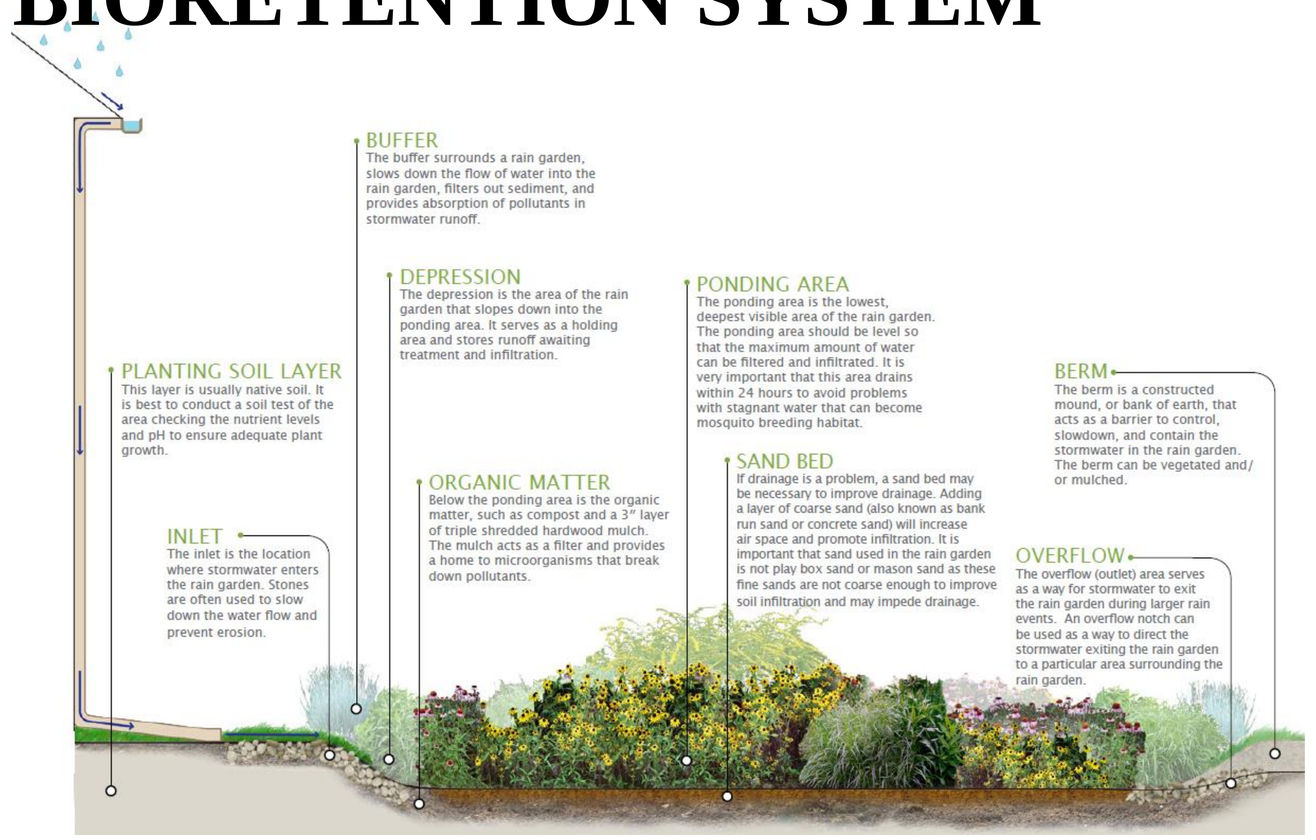
A

B

1 **BIORETENTION SYSTEM:** A bioretention system could be installed in the front courtyard of the church, adjacent to North Main Street. This system may have one or more downspouts redirected to it. A bioretention system will reduce runoff and allow stormwater infiltration, decreasing the amount of contaminants that reach catch basins.

2 **POROUS PAVEMENT:** The seven parking spaces near the nursery building and East Main Street could be repaved with porous pavement. Porous pavement promotes groundwater recharge and filters stormwater.

1 BIORETENTION SYSTEM



2 POROUS PAVEMENT

Location: 10 East Main Street Flemington, NJ 08822	**Municipality:** Flemington Borough **Subwatershed:** Raritan River South Branch
Green Infrastructure Description: bioretention system (rain garden) disconnecting downspouts 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 # 1: 45,597 gal. porous pavement: 91,923 gal.

Existing Conditions and Issues:
This site contains several impervious surfaces including paved walkways, driveways, a building complex, and parking areas. These impervious surfaces are directly connected to a storm sewer system. The parking area adjacent to East Main Street is graded to the north, flowing directly into the storm sewer system. The parking area is in in fair condition. There are two directly connected downspouts on the northernmost building in the church complex. The downspouts are directly connected to the storm sewer system and discharge to a lawn inlet located in the courtyard on the western side of the site.

Proposed Solution(s):
Two green infrastructure practices have been selected to improve this site's stormwater management. Seven parking spaces in the northeastern corner of the parking lot could be repaved with a porous pavement system with a one foot deep stone reservoir. The two downspouts in the central courtyard could be disconnected and allowed to flow into a bioretention system (rain garden) that would intercept stormwater prior to entering the storm sewer system.

Anticipated Benefits:
Since the bioretention system would be designed to capture, treat, and infiltrate the entire 2-year design storm (3.4 inches of rain over 24 hours), this system is 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. Porous pavement allows stormwater to infiltrate through to soil layers which will promote groundwater recharge as well as intercept and filter stormwater runoff. The system is estimated to achieve a 95% pollutant load reduction for TN, TP, and TSS.

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

Flemington Borough
local social and community groups

Partners/Stakeholders:
Flemington Borough
Flemington Presbyterian Church
local social and community groups
parents, parishioners, and residents
Rutgers Cooperative Extension

Estimated Cost:
The bioretention system would need to be approximately 440 square feet. At $5 per square foot, the bioretention system would cost approximately $2,200. Two downspouts would be disconnected and routed to this system adding an additional $500 to its cost. The porous pavement would cover approximately 1,260 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 $25,200. The total cost of the project will be approximately $27,900.