Draft

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

Prepared for Freehold 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

Freehold Township Impervious Cover Analysis

Located in Monmouth County in central New Jersey, Freehold Township covers approximately 38.9 square miles. Figures 3 and 4 illustrate that Freehold Township is dominated by urban land uses. A total of 40.8% of the municipality's land use is classified as urban. Of the urban land in Freehold Township, low density residential is the dominant land use (Figure 5).

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

The New Jersey Department of Environmental Protection's (NJDEP) 2007 land use/land cover geographical information system (GIS) data layer categorizes Freehold 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 Freehold Township. Based upon the 2007 NJDEP land use/land cover data, approximately 12.1% of Freehold Township has impervious cover. This level of impervious cover suggests that the streams in Freehold Township are likely impacted.

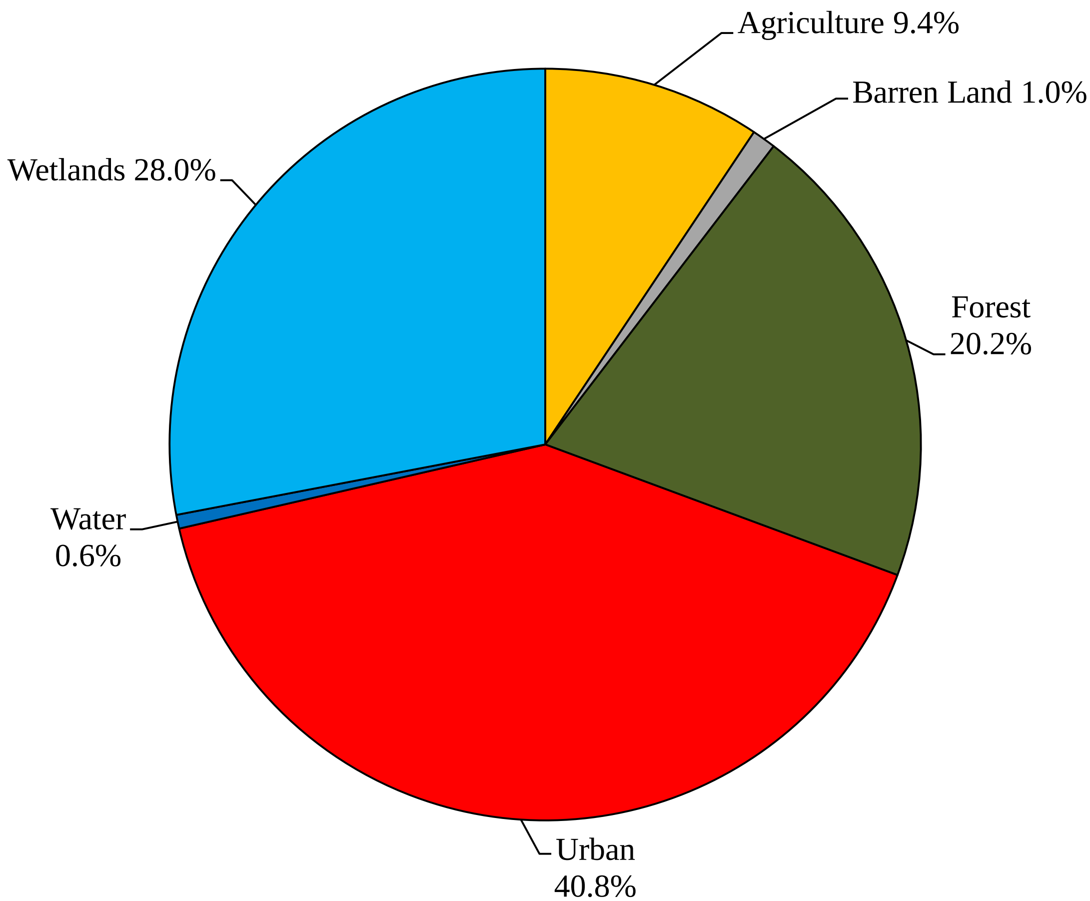


Figure 3: Pie chart illustrating the land use in Freehold Township

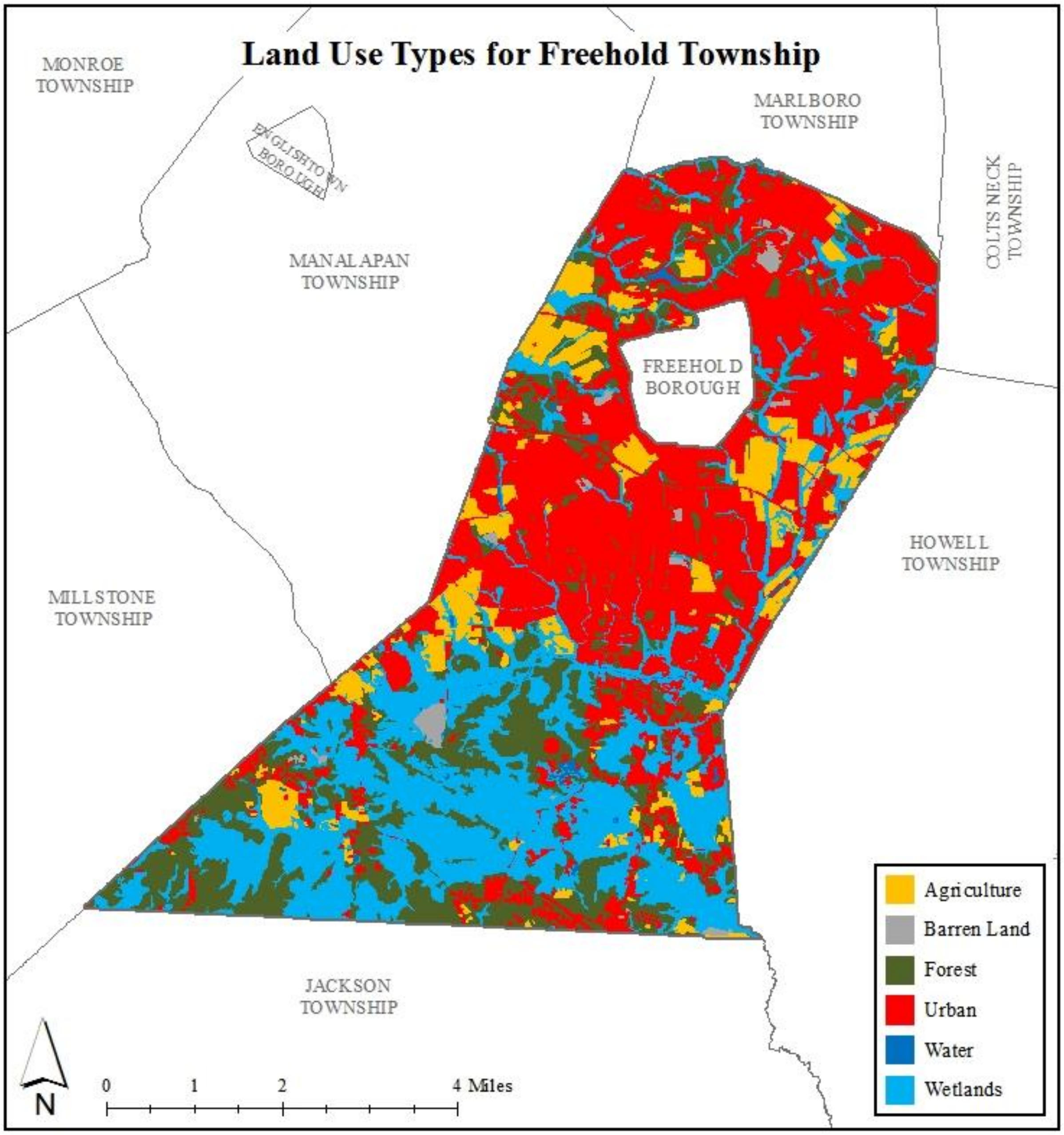


Figure 4: Map illustrating the land use in Freehold Township

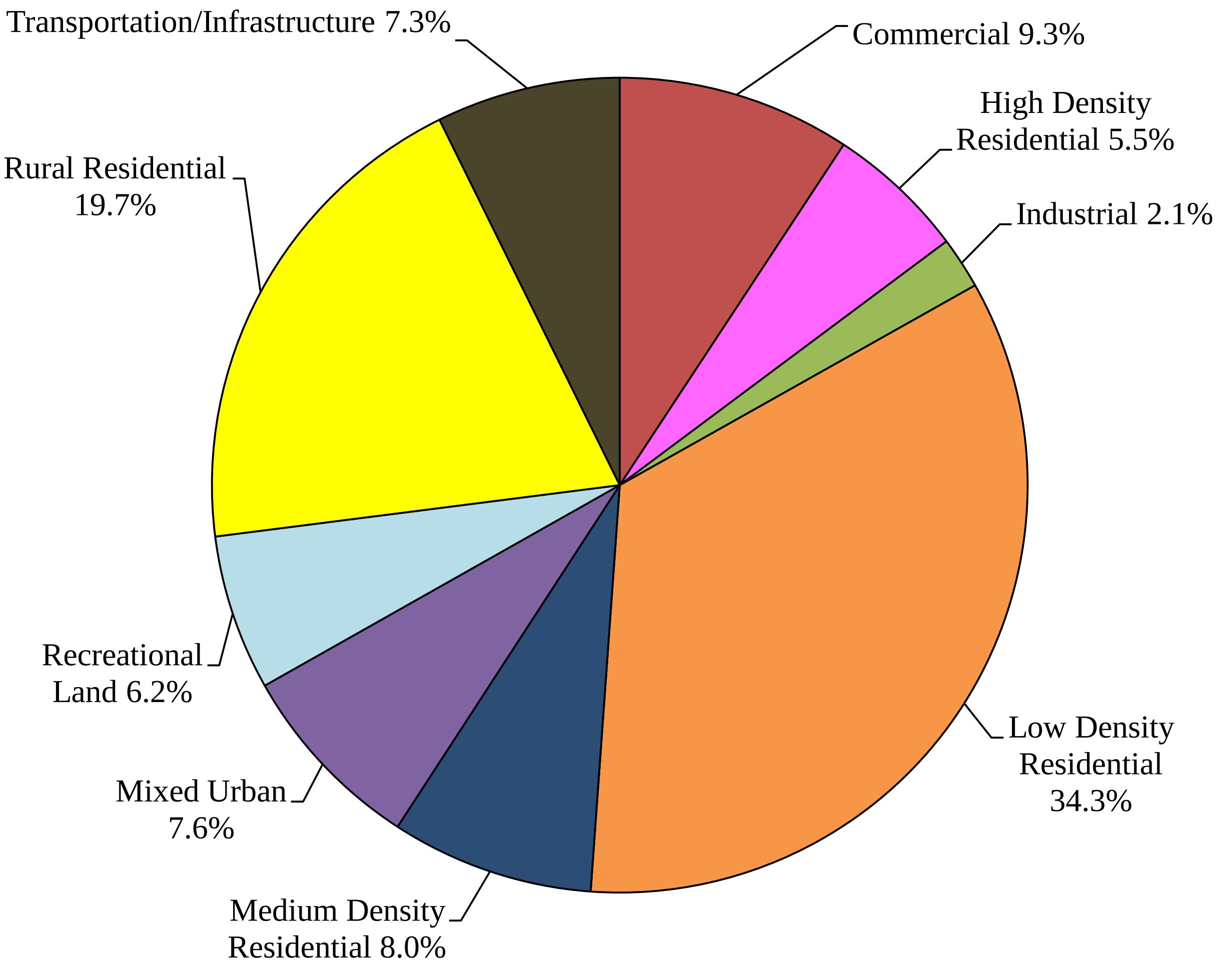


Figure 5: Pie chart illustrating the various types of urban land use in Freehold Township

Water resources are typically managed on a watershed/subwatershed basis; therefore an impervious cover analysis was performed for each Raritan River subwatershed within Freehold Township (Table 1 and Figure 6). On a subwatershed basis, impervious cover ranges from 1.20% in the Toms River subwatershed to 28.3% in the Manalapan 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 Freehold 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 Freehold Township. For example, if the stormwater runoff from one water quality storm (1.25 inches of rain) in the Manasquan River subwatershed was harvested and purified, it could supply water to 569 homes for one year[1].

[1] Assuming 300 gallons per day per home

Table 1: Impervious cover analysis by subwatershed for Freehold Township

Subwatershed	Total Area		Land Use Area		Water Area		Impervious Cover		
	(ac)	(mi^2)	(ac)	(mi^2)	(ac)	(mi^2)	(ac)	(mi^2)	(%)
Manalapan Brook	641.0	1.00	633.5	0.99	7.49	0.01	179.3	0.28	28.3%
Manasquan River	11,553.9	18.1	11,480.1	17.9	73.8	0.12	1,835.1	2.87	16.0%
McGellairds Brook	2,082.5	3.25	2,055.3	3.21	27.2	0.04	342.2	0.53	16.7%
Metedeconk River North Branch	4,336.4	6.78	4,326.7	6.76	9.78	0.02	91.7	0.14	2.12%
Metedeconk River South Branch	2,484.2	3.88	2,473.8	3.87	10.4	0.02	31.0	0.05	1.25%
Toms River	445.9	0.70	444.5	0.69	1.44	0.00	5.33	0.01	1.20%
Weamaconk Creek	1,703.1	2.66	1,690.4	2.64	12.7	0.02	281.4	0.44	16.7%
Yellow Brook	1,634.3	2.55	1,629.6	2.55	4.68	0.01	224.1	0.35	13.8%
Total	24,881.3	38.9	24,733.8	38.7	147.4	0.23	2,990.3	4.67	12.1%

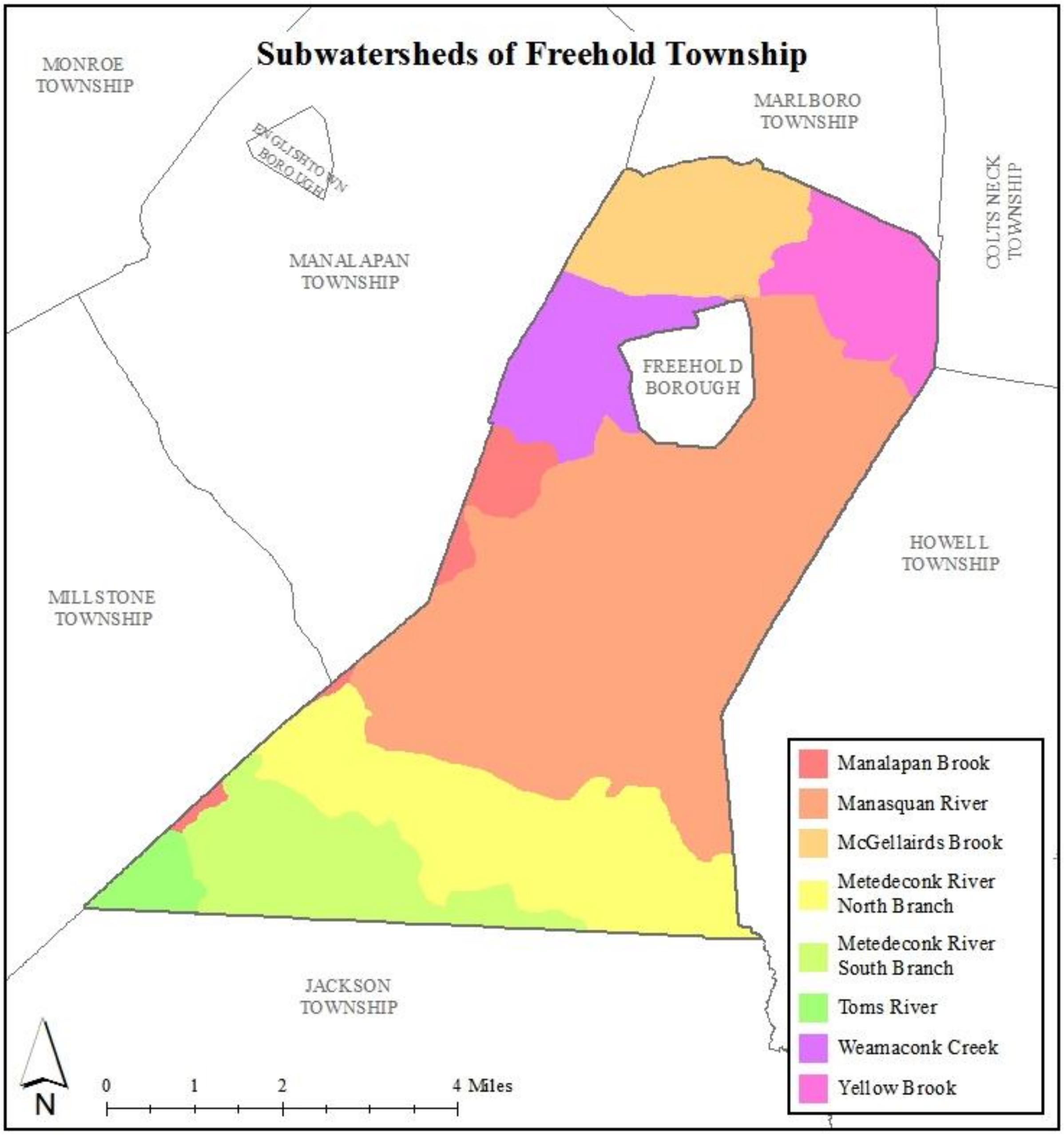


Figure 6: Map of the subwatersheds in Freehold Township

Table 2: Stormwater runoff volumes from impervious surfaces by subwatershed in Freehold 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)
Manalapan Brook	6.1	214.3	16.6	25.3	43.3
Manasquan River	62.3	2,192.4	169.4	259.1	443.5
McGellairds Brook	11.6	408.9	31.6	48.3	82.7
Metedeconk River North Branch	3.1	109.6	8.5	12.9	22.2
Metedeconk River South Branch	1.1	37.1	2.9	4.4	7.5
Toms River	0.2	6.4	0.5	0.8	1.3
Weamaconk Creek	9.6	336.2	26.0	39.7	68.0
Yellow Brook	7.6	267.7	20.7	31.6	54.2
Total	101.5	3,572.5	276.1	422.2	722.6

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 Freehold 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 Freehold Township

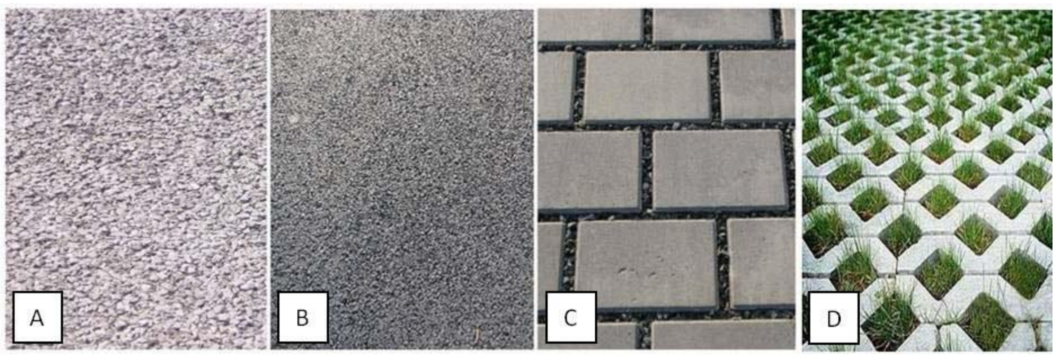
Subwatershed	Recommended Impervious Area Reduction (10%) (ac)	Annual Runoff Volume Reduction [2] (MGal)
Manalapan Brook	17.9	20.4
Manasquan River	183.5	208.3
McGellairds Brook	34.2	38.8
Metedeconk River North Branch	9.2	10.4
Metedeconk River South Branch	3.1	3.5
Toms River	0.5	0.6
Weamaconk Creek	28.1	31.9
Yellow Brook	22.4	25.4
Total	299.0	339.4

[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 Freehold 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 Freehold 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

Freehold 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

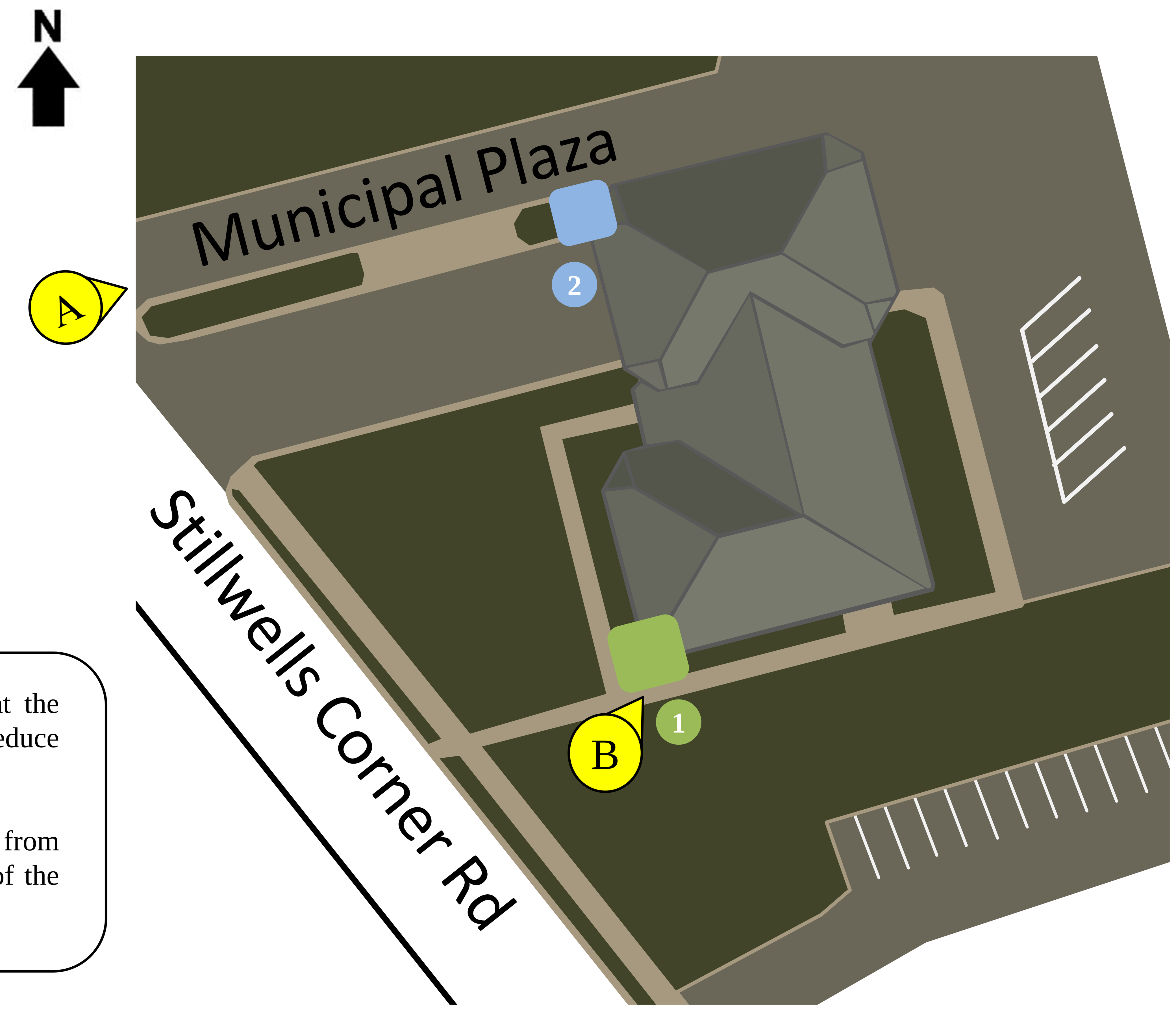
Concept Plans and Detailed Green Infrastructure Information Sheets

Freehold Township
Impervious Cover Assessment

Freehold Township Independent Fire Company, 1 Municipal Plaza

PROJECT LOCATION:

SITE PLAN:



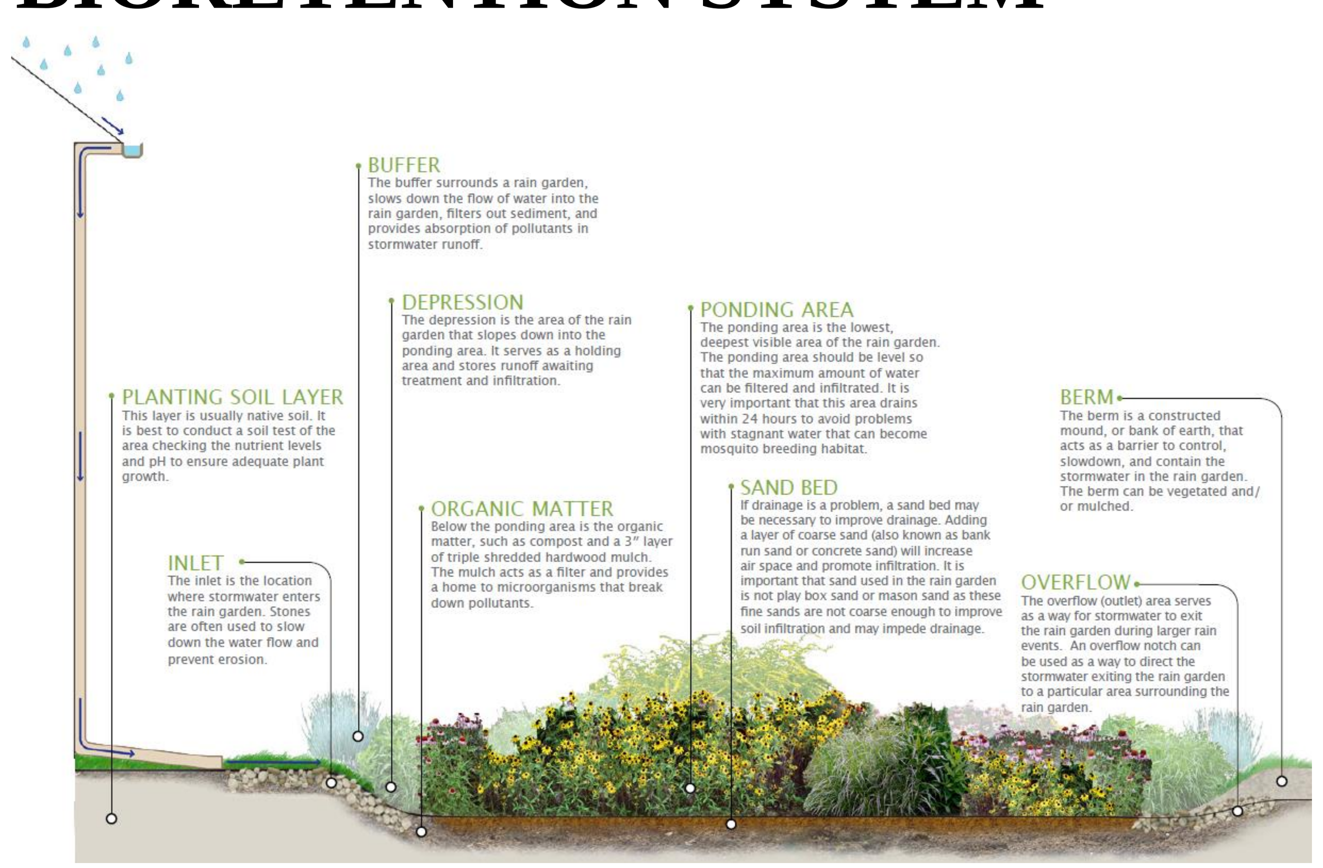
A

B

1 **BIORETENTION SYSTEM:** A bioretention system could be installed at the southwestern corner of the firehouse. The bioretention system will reduce sediment and nutrient loading to the local waterways.

2 **RAINWATER HARVESTING SYSTEM:** Rainwater could be harvested from the roof of the building and stored in a cistern at the northwestern corner of the building. The water could be used to wash the fire trucks.

1 BIORETENTION SYSTEM



2 RAINWATER HARVESTING SYSTEM

Location: 1 Municipal Plaza Freehold, NJ 07728	**Municipality:** Freehold Township **Subwatershed:** Manasquan River
Green Infrastructure Description: bioretention system (rain garden) disconnected downspouts rainwater harvesting system (cistern)	**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: 26,055 gal. cistern: 23,450 gal.

Existing Conditions and Issues:
This site contains several impervious surfaces including driveways, walkways, parking areas, and a firehouse. These impervious surfaces are directly connected to a storm sewer system. The main parking area directly behind the firehouse was in good condition, but the southern parking lot exhibited eroded grass, ponding, cracked pavement, and gullies. The firehouse covers roughly 11,000 square feet of land and has several connected downspouts on each face of the building. There are areas of turf grass at the firehouse's northwestern and southwestern corners and eastern edge.

Proposed Solution(s):
Three downspouts could be disconnected and routed to a rain garden on the turf grass at the southwestern corner of the firehouse. Four downspouts could be disconnected and routed to a 1,500 gallon cistern that would sit in the grass area at the northwestern corner of the firehouse.

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 rainwater harvesting system could harvest rainwater from the roof of the building and store it in a cistern, which can be used for washing the fire trucks and watering plants.

Possible Funding Sources:
mitigation funds from local developers
NJDEP grant programs
Freehold Township
Freehold Township Independent Fire Company
local social and community groups

Partners/Stakeholders:
Freehold Township
Freehold Township Independent Fire Company
local social and community groups
local residents
Rutgers Cooperative Extension

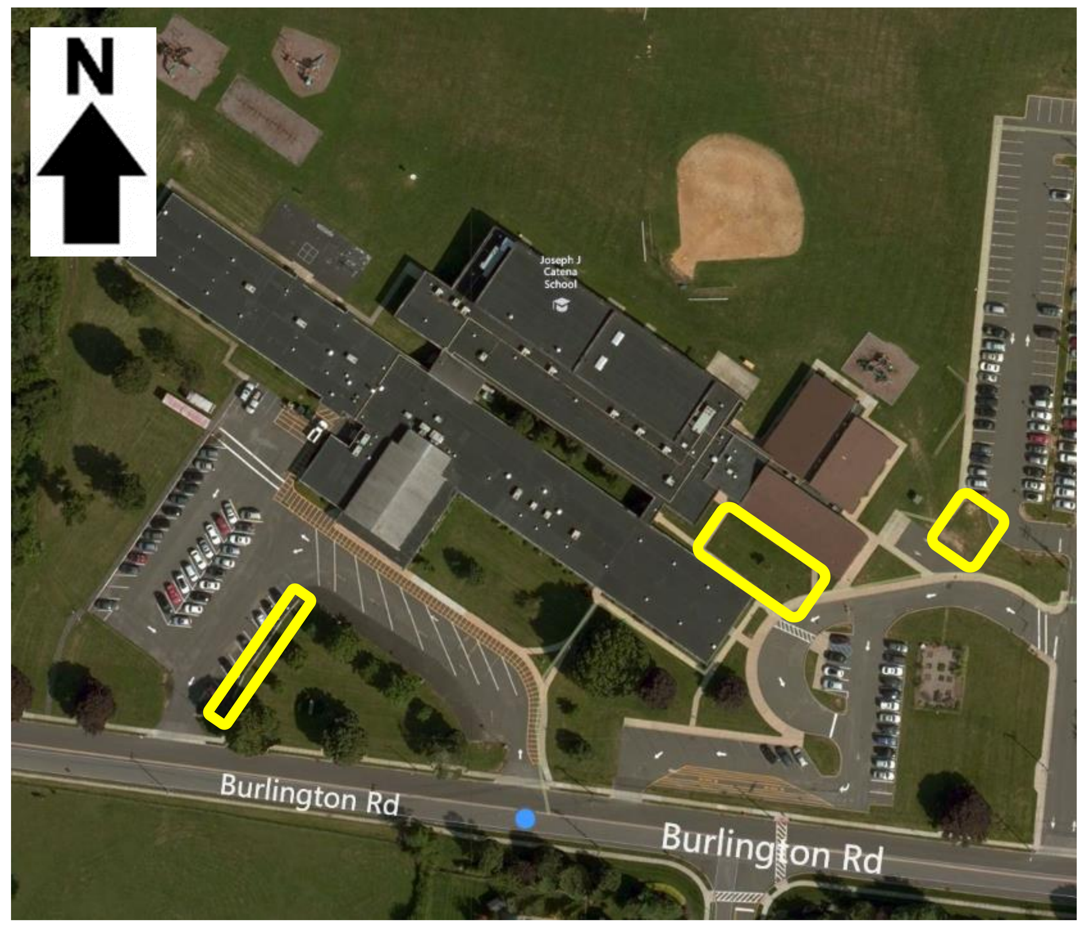
Estimated Cost:
The bioretention system would need to be approximately 250 square feet. At $5 per square foot, the estimated cost of this bioretention system is $1,250. Three downspouts would need to be routed to this system, adding $750 to its estimated cost. The cistern would be 1,500 gallons and cost approximately $3,000 to purchase and install. Four downspouts on the gutter system would be modified to bring water to this system, adding $1,000 to its estimated cost. The total cost of the project will thus be approximately $6,000.

Freehold Township

Impervious Cover Assessment

Joseph J. Catena School, 275 Burlington Road

PROJECT LOCATION:



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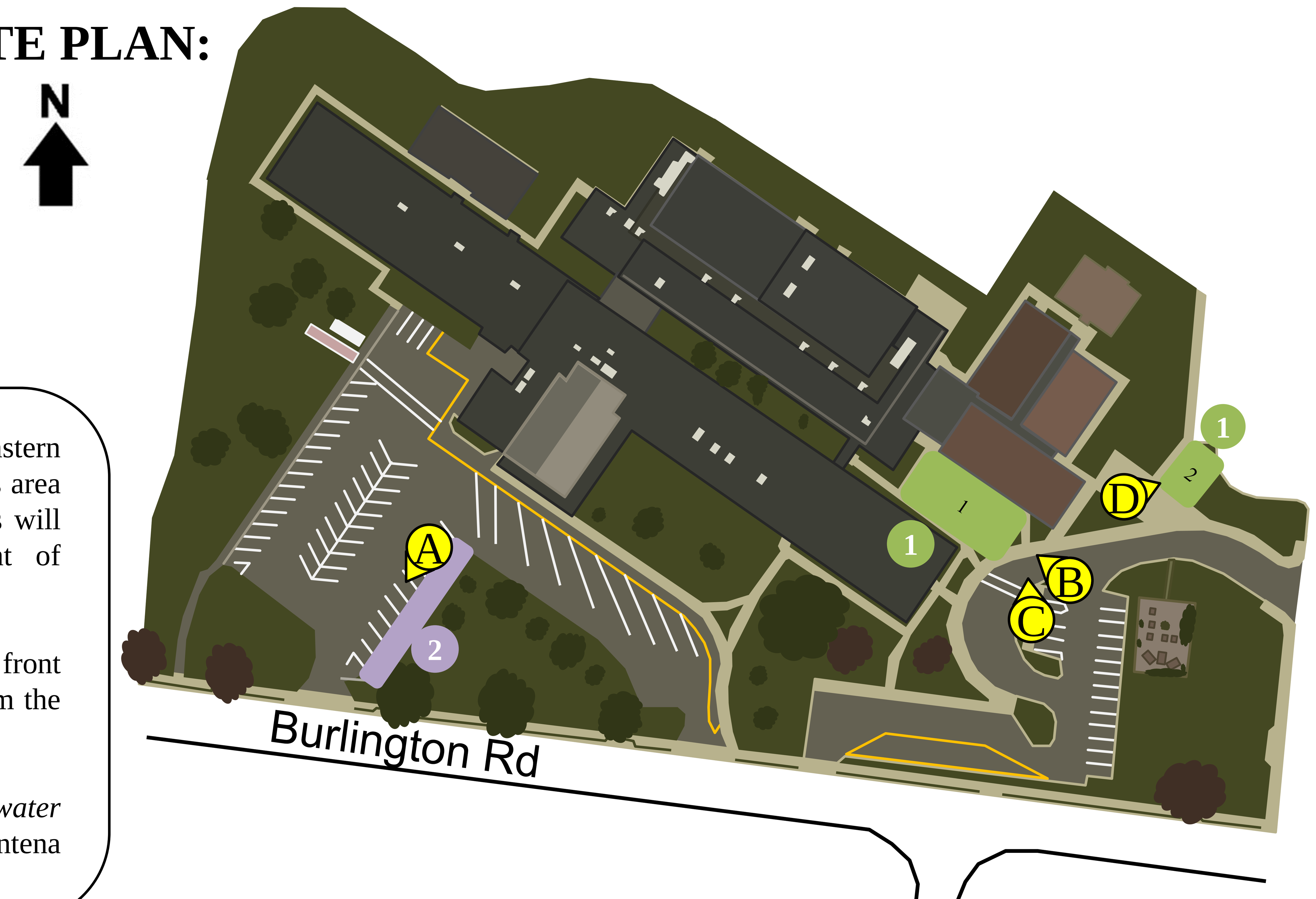
SITE PLAN:

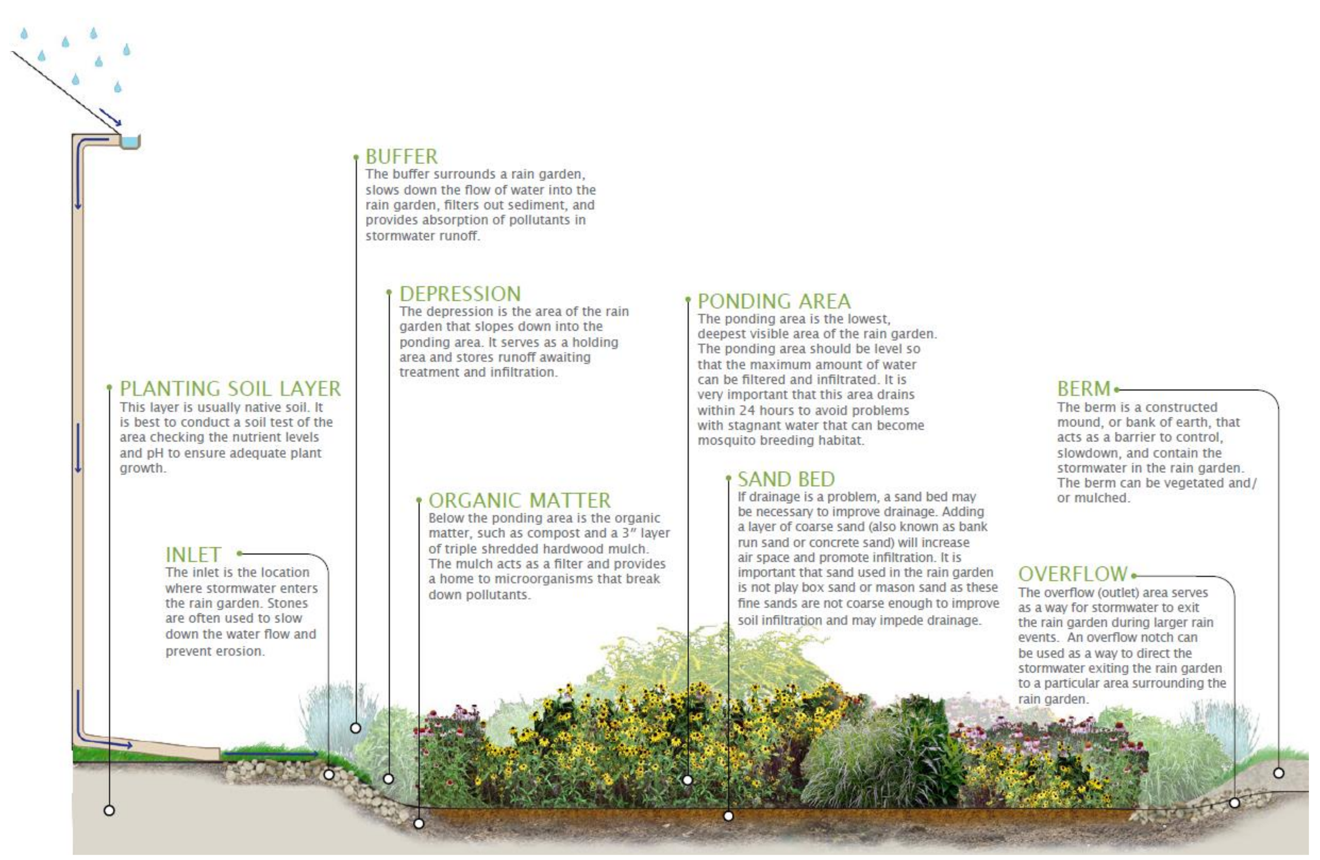


1 **BIORETENTION SYSTEM:** Bioretention systems could be installed in the eastern courtyard and in a turf grass area between the Catena School and the turf grass area adjacent to the neighboring middle school's parking lot. Bioretention systems will reduce runoff and allow stormwater infiltration, decreasing the amount of contaminants that reaches catch basins.

2 **BIOSWALE:** A bioswale could be installed along the eastern edge of the front parking lot. A bioswale is a vegetated system that will convey stormwater from the parking lot to the grass while removing sediment and nutrients.

EDUCATIONAL PROGRAM: The RCE Water Resources Program's *Stormwater Management in Your Schoolyard* program can be delivered at the Joseph J. Cantena School to educate the school children about stormwater management.

1 BIORETENTION SYSTEM



2 BIOSWALE

EDUCATIONAL PROGRAM

Joseph J. Catena School
Green Infrastructure Information Sheet

Location: 275 Burlington Road Freehold, NJ 07728	**Municipality:** Freehold Township **Subwatershed:** Yellow Brook
Green Infrastructure Description: bioretention systems (rain gardens) bioswale 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: 218,865 gal. bioretention system #2: 36,477 gal. bioswale: 104,220 gal.

Existing Conditions and Issues:
This site contains several impervious surfaces including driveways, walkways, parking areas, and a school complex. These impervious surfaces are directly connected to a storm sewer system. The pavement in the school's parking lots and driveways was in good condition at the time of the site visit. Eroded grass and soil were observed along the southern and eastern edges of the front parking lot at the time of the site visit. Six connected downspouts were observed in the courtyard.

Proposed Solution(s):
Two bioretention systems could be installed at this site to treat runoff from the parking areas and enhance the site's aesthetic quality. The first bioretention system (#1) could be installed within the school's eastern courtyard and receive water by disconnecting six nearby downspouts. The second bioretention system (#2) could be installed in the turf grass area adjacent to the middle school parking lot. A bioswale could also be installed along the eastern edge of the front parking lot to mitigate erosion and reduce localized flooding.

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 bioswale would reduce TN by 30%, TP by 60%, and TSS by 90%. 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 Freehold Township Department of Public Works staff to launch educational programming.

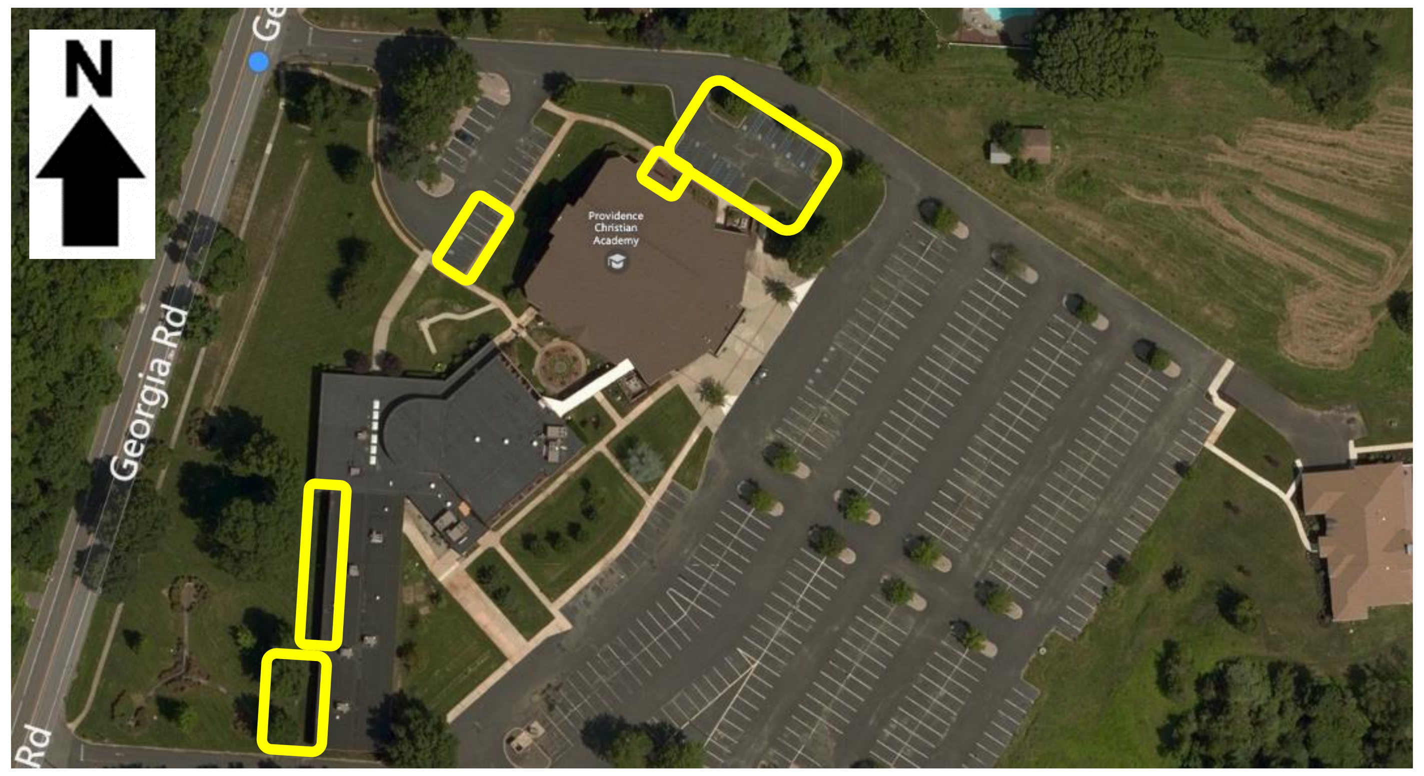
Possible Funding Sources:
mitigation funds from local developers
NJDEP grant programs
Freehold Township
Joseph J. Catena School
local social and community groups

Partners/Stakeholders:
Freehold Township
Joseph J. Catena School
local social and community groups
students, parents, faculty, and staff
Rutgers Cooperative Extension

Estimated Cost:
Bioretention system #1 would need to be approximately 2,100 square feet. At $5 per square foot, the estimated cost of this bioretention system is $10,500. Six downspouts would be disconnected and routed to this system, which would add $1,500 to its total cost. 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. The bioswale would be approximately 1,000 square feet. At $5 per square foot, the estimated cost of this bioretention system is $5,000. The total cost of the project will be approximately $18,750.

Freehold Township
Impervious Cover Assessment
St. Robert Bellarmine Church, 61 Georgia Road

PROJECT LOCATION:



A

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SITE PLAN:

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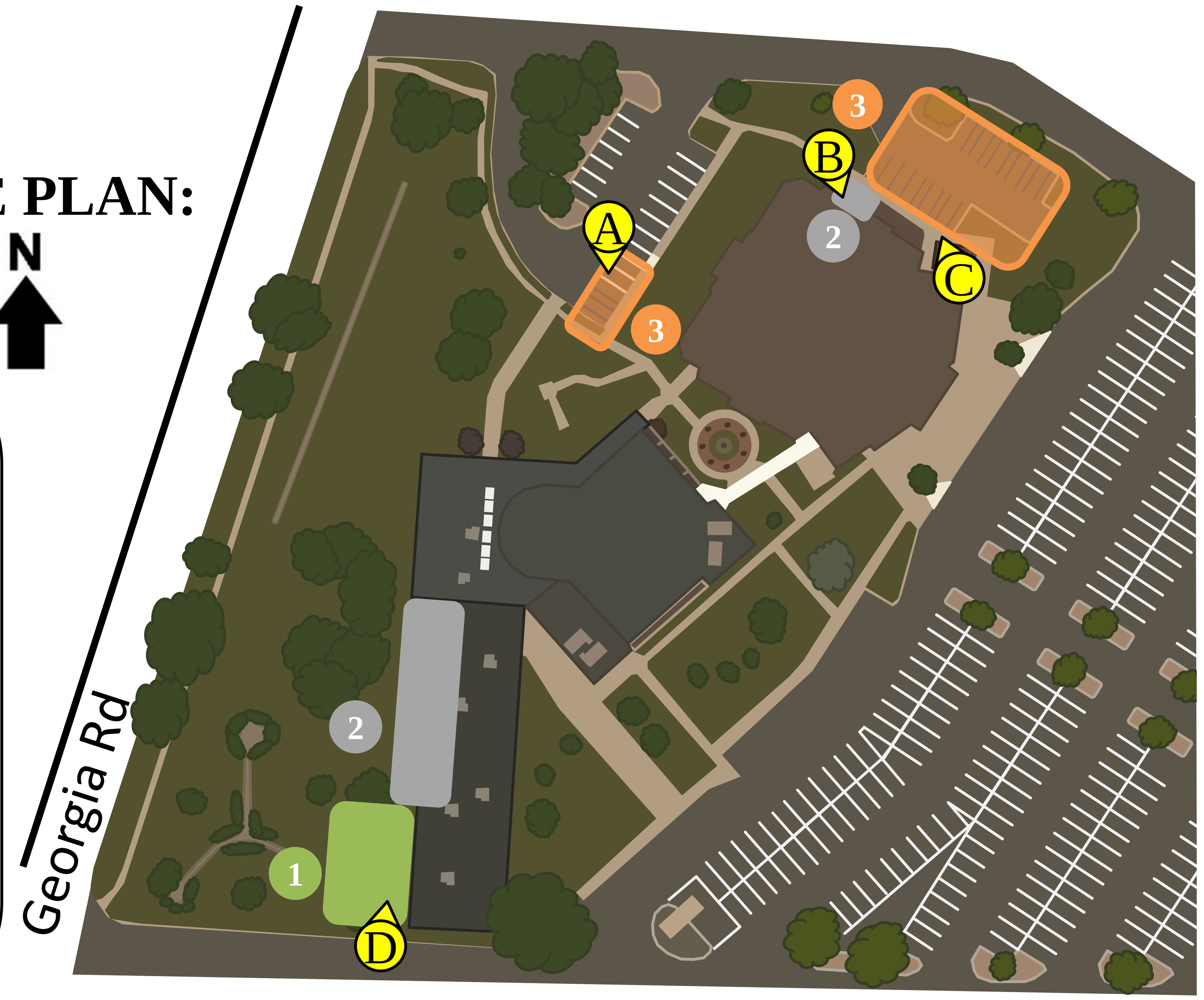


C

D

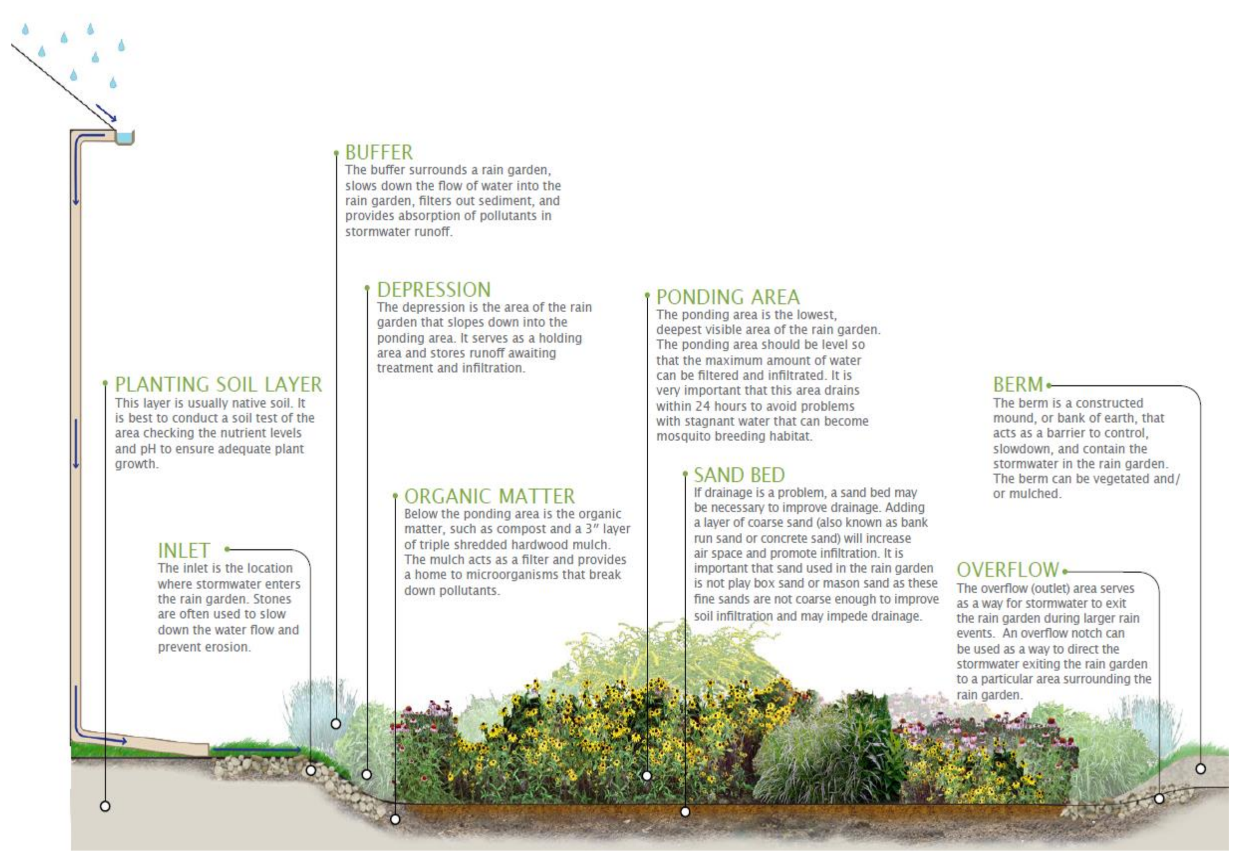
1 **BIORETENTION SYSTEM:** A bioretention system could be installed at the southwestern corner of the classroom building. The bioretention system will reduce runoff and allow stormwater infiltration, decreasing the amount of contaminants that reaches catch basins.

2 **DISCONNECTED DOWNSPOUTS:** Disconnection of downspouts allows stormwater to flow into the ground, which reduces pollutant loading by 90% and enhances groundwater recharge.

3 **POROUS PAVEMENT:** Porous pavement could be installed in two locations – at the southern corner of the front parking lot and also in the handicapped parking lot. Porous pavement promotes groundwater recharge and filters stormwater.

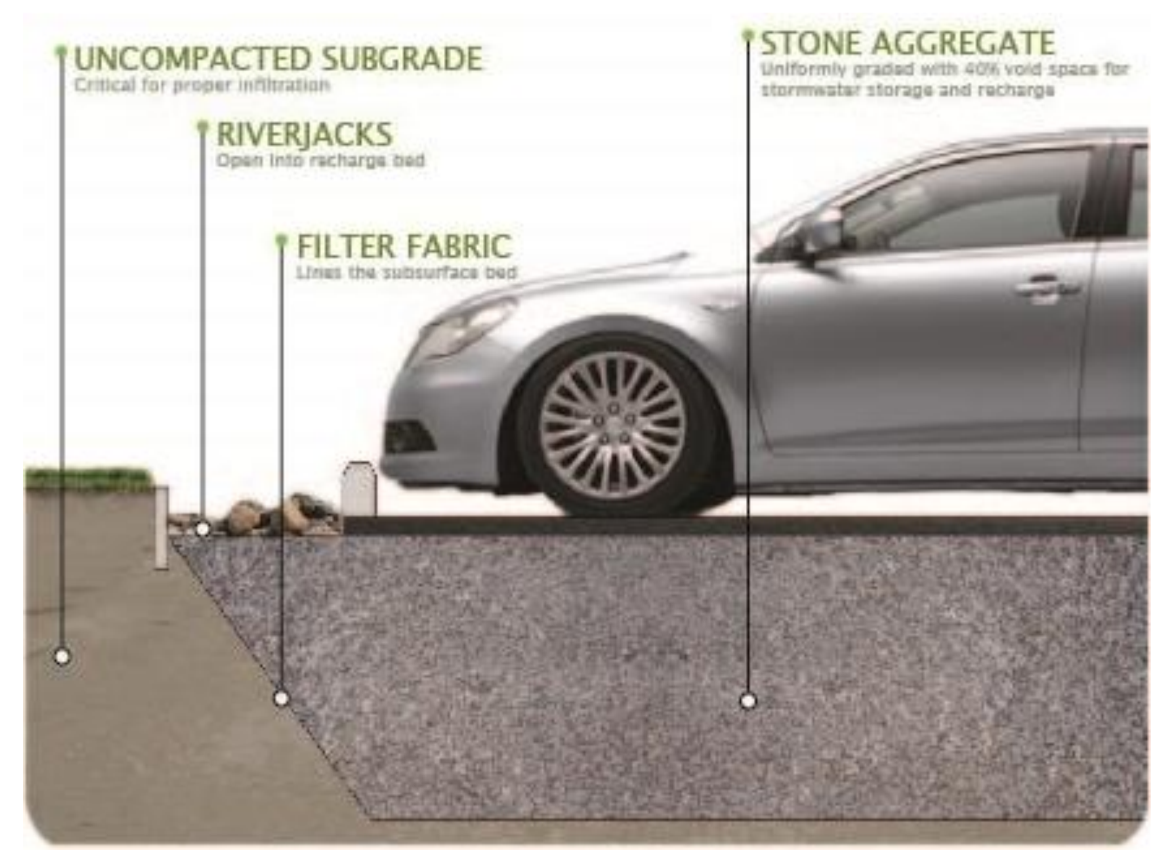
EDUCATIONAL PROGRAM: The RCE Water Resources Program's *Stormwater Management in Your Backyard* program can be delivered to educate the community about stormwater management.

1 BIORETENTION SYSTEM



2 DISCONNECTED DOWNSPOUTS

3 POROUS PAVEMENT



EDUCATIONAL PROGRAM

Location: 61 Georgia Road Freehold, NJ 07728	**Municipality:** Freehold Township **Subwatershed:** Manasquan River
Green Infrastructure Description: bioretention system (rain garden) disconnected 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: 57,322 gal. disconnected downspouts #1: 17,772 gal. disconnected downspouts #2: 81,457 gal. porous pavement #1: 153,726 gal. porous pavement #2: 78,791 gal.

Existing Conditions and Issues:
This site contains several impervious surfaces including driveways, walkways, parking areas, a church, and a school. Although ponding was observed at the time of the site visit, the pavement was in good condition and there were light poles, catch basins, and parking islands observed within the lot. The front and handicapped parking lots are graded to the south and east, respectively, where stormwater flows into catch basins. Connected downspouts were identified at the northern face of the church and along the western edge of the school. Detention basins to the west manage most of the runoff from this site.

Proposed Solution(s):
Two downspouts could be disconnected along the western face of the school building and routed to a bioretention system in the turf grass. Three downspouts on the western face of this same building could also be disconnected and allowed to discharge stormwater to the ground below. A downspout at the northwestern entrance to the church near the handicapped parking lot could be disconnected as well. The handicapped parking lot in the northeast could be repaved with porous pavement. Six parking spaces at the southern corner of the front parking lot could be repaved with porous pavement. The porous pavement areas would intercept runoff prior to catch basins and reduce localized flooding conditions.

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. Porous pavement allows stormwater to infiltrate through to soil layers which will promote groundwater recharge as well as

intercept and filter stormwater runoff. These systems are expected to achieve a 95% pollutant load reduction for TN, TP, and TSS. Simple disconnection reduces the pollutant loading by 90% since this technique manages the water quality design storm of 1.25 inches of rain. 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.

Possible Funding Sources:
mitigation funds from local developers
NJDEP grant programs
Freehold Township
St Robert Bellarmine Church
local social and community groups

Partners/Stakeholders:
Freehold Township
St Robert Bellarmine Church
local social and community groups
local residents
clergy, parishioners, students, parents, faculty, and staff
Rutgers Cooperative Extension

Estimated Cost:
The bioretention system would need to be approximately 550 square feet. At $5 per square foot, the estimated cost of this bioretention system is $2,750. Two downspouts would need to be routed to this system, which would add $500 to its total estimated cost. Porous pavement #1 in the handicapped parking lot in the northeast would cover 5,000 square feet and have a 0.5 feet deep stone reservoir under the surface. At $15 per square foot, the cost of this system would be $75,000. Porous pavement #2 at the southern corner of the front parking lot would cover 1,080 square feet and have a 1 foot deep stone reservoir under the surface. At $20 per square foot, the cost of this system would be $21,600. Disconnected downspouts #1 at the north would disconnect one downspout and will cost $250. Disconnected downspouts #2 at the west would disconnect three downspouts and will cost $750. The total cost of the project will thus be approximately $100,850.