Impervious Cover Assessment
for
Hillsborough Township, Somerset County, New Jersey

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

February 24, 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

Hillsborough Township Impervious Cover Analysis

Located in Somerset County in central New Jersey, Hillsborough Township is approximately 55 square miles in size. Figures 3 and 4 illustrate that Hillsborough Township is dominated by urban land use. A total of 34.5% of the municipality's land use is classified as urban. Of the urban land use in Hillsborough 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 (NJDEP) 2007 land use/land cover geographical information system (GIS) data layer categorizes Hillsborough 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 Hillsborough Township. Based upon the NJDEP 2007 land use/land cover data, approximately 8.0% of Hillsborough Township has impervious cover. This level of impervious cover suggests that the streams in Hillsborough Township are likely sensitive streams.

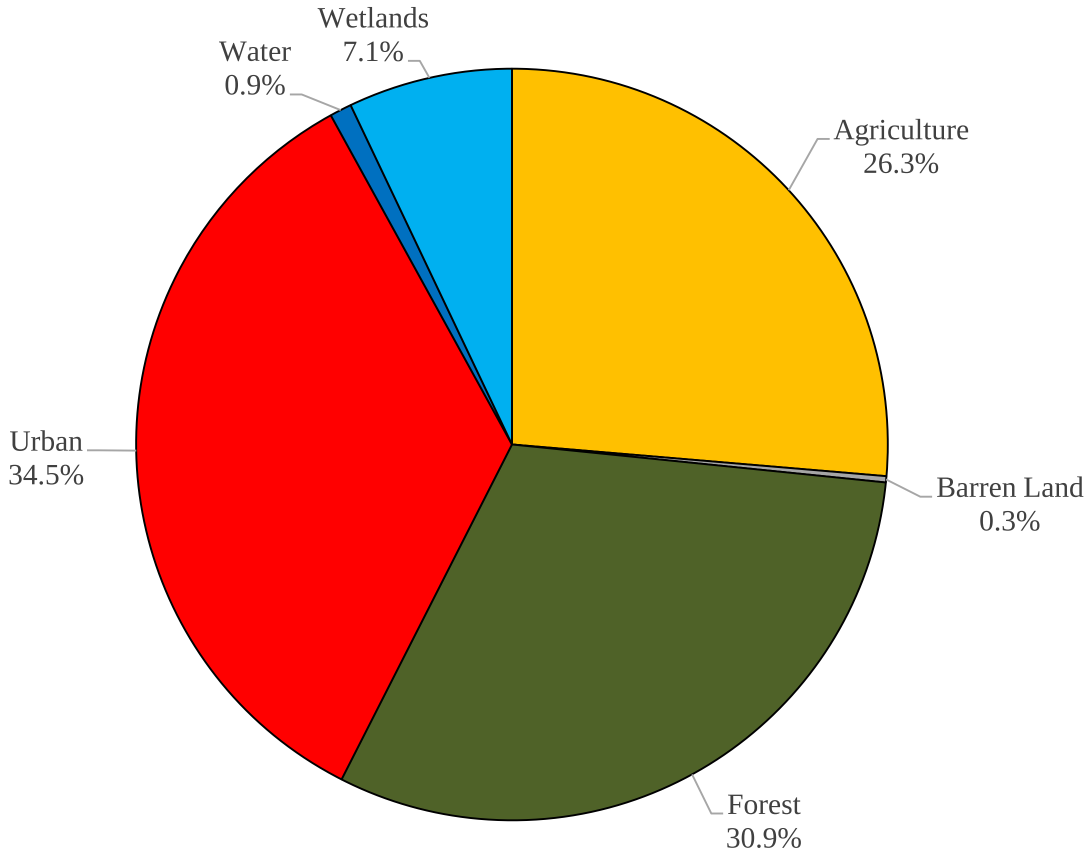


Figure 3: Pie chart illustrating the land use in Hillsborough Township

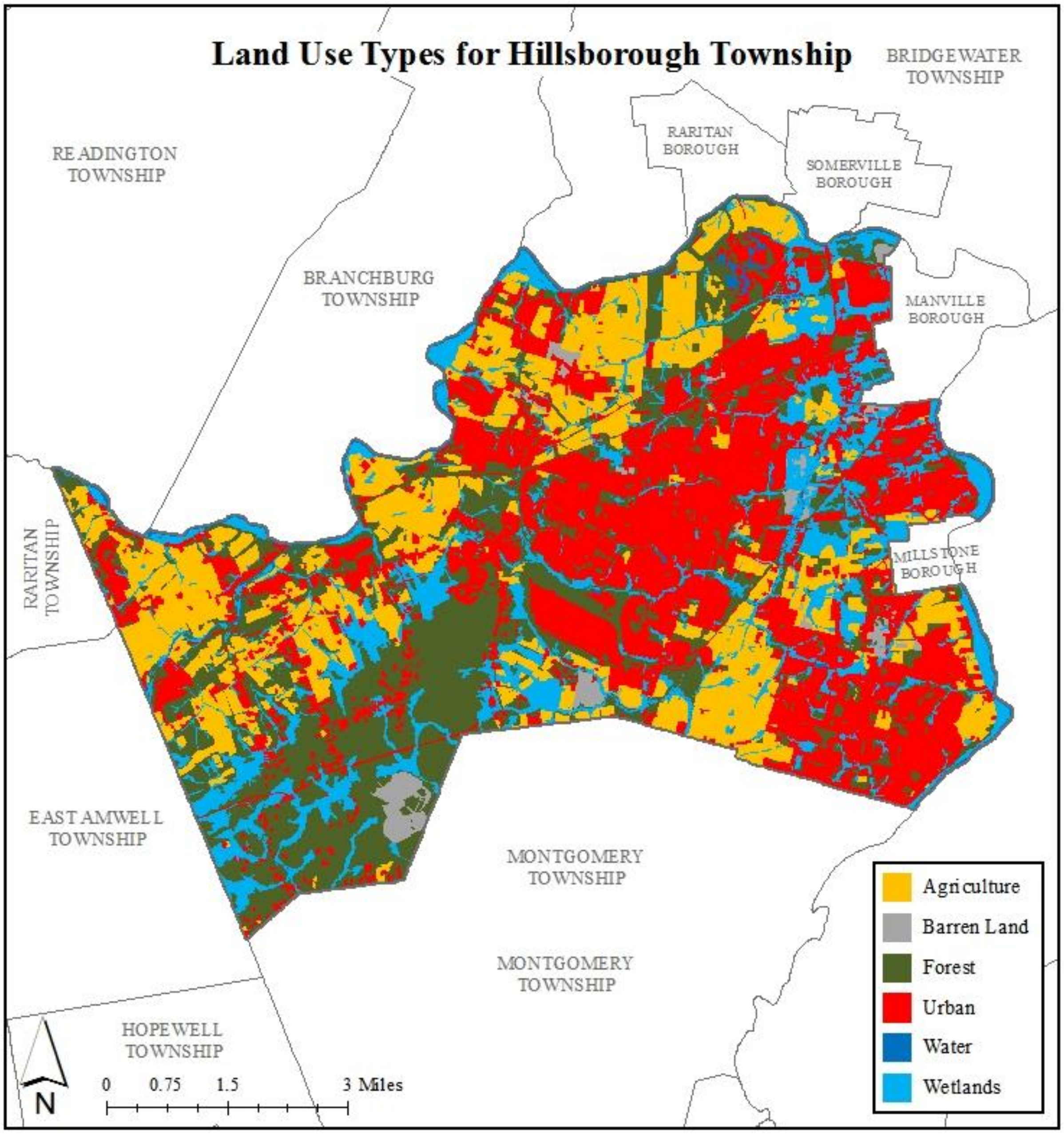


Figure 4: Map illustrating the land use in Hillsborough Township

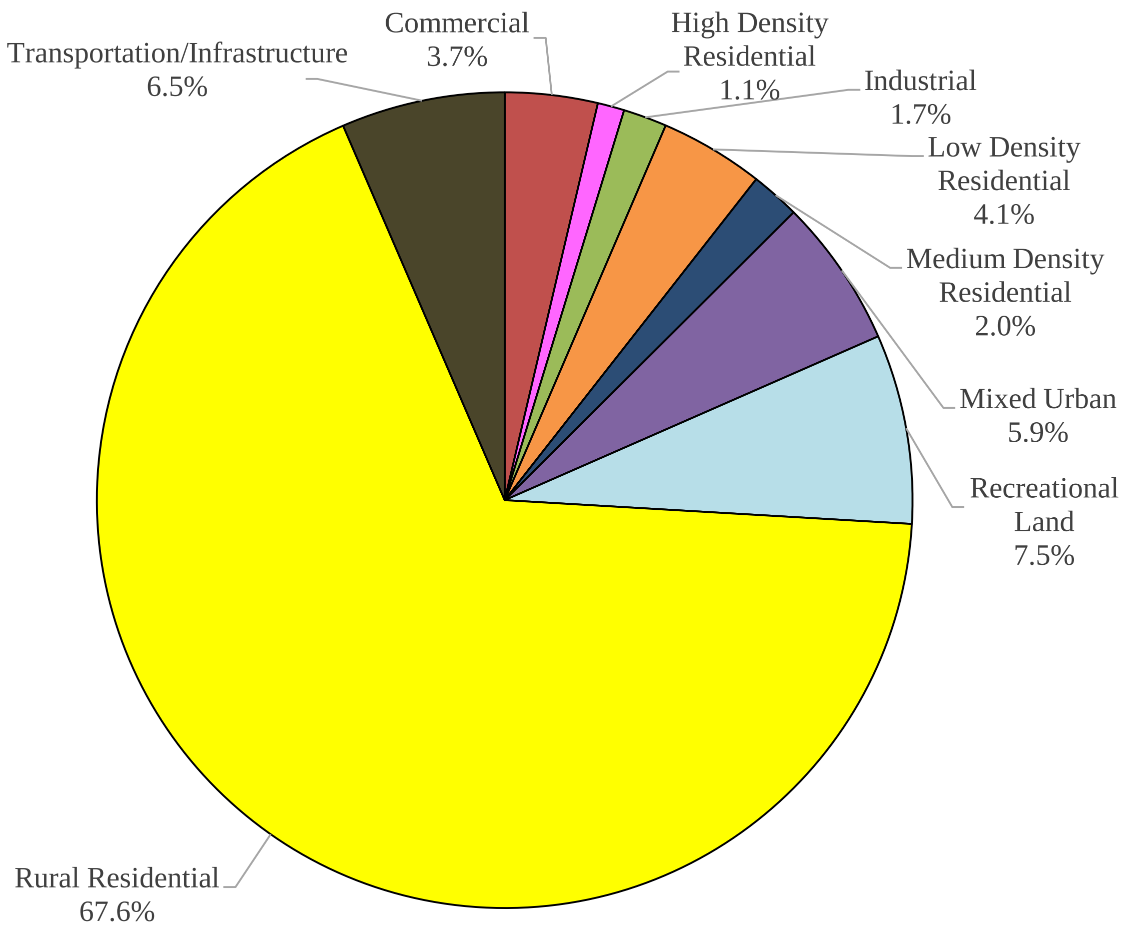


Figure 5: Pie chart illustrating the various types of urban land use in Hillsborough Township

Water resources are typically managed on a watershed/subwatershed basis; therefore an impervious cover analysis was performed for each Raritan River subwatershed within Hillsborough Township (Table 1 and Figure 6). On a subwatershed basis, impervious cover ranges from 0.5% in the Cruser Brook/Roaring Brook subwatershed to 16.5% in the Royce Brook subwatershed. The Royce Brook drains to the Millstone River through Manville. 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. The Royce Brook subwatershed would seem like a logical place to determine if there are options to reduce impervious surfaces and their environmental impacts.

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 Hillsborough Township, Somerset County) associated with impervious surfaces were calculated for the following storms: the New Jersey water quality design storm of 1.25 inches of rain, an annual rainfall of 44 inches, the 2-year design storm (3.3 inches of rain), the 10-year design storm (5.0 inches of rain), and the 100-year design storm (8.2 inches of rain). These runoff volumes are summarized in Table 2. A substantial amount of rainwater is draining from impervious surfaces in Hillsborough Township. For example, if the stormwater runoff from one water quality storm (1.25 inches of rain) in the Royce Brook Watershed was harvested and purified, it could supply water to 510 homes for a year[1].

[1] Assuming 300 gallons per day per home

Table 1: Impervious cover analysis by subwatershed for Hillsborough Township

Subwatershed	**Total Area**		**Land Use Area**		**Water Area**		**Impervious Cover**		
	(ac)	**(mi^2)**	**(ac)**	**(mi^2)**	**(ac)**	**(mi^2)**	**(ac)**	**(mi^2)**	**(%)**
Cruser Brook/Roaring Brook	913	1.43	913	1.43	0.00	0.00	4.60	0.01	0.50%
Millstone River	3,889	6.08	3,841	6.00	48.2	0.08	372.9	0.58	9.71%
Neshanic River	4,810	7.52	4,769	7.45	40.9	0.06	97.5	0.15	2.04%
Pike Run	3,737	5.84	3,726	5.82	11.2	0.02	237.5	0.37	6.37%
Lower Raritan River	4,826	7.54	4670	7.30	156.5	0.24	241.5	0.38	5.17%
Raritan River South Branch	5,083	7.94	4,975	7.77	107.4	0.17	169.3	0.26	3.40%
Rock Brook	2,028	3.17	2,023	3.16	4.5	0.01	21.8	0.03	1.08%
Royce Brook	9,995	15.62	9,946	15.54	49.7	0.08	1,643	2.57	16.52%
Total	35,281	55.14	34,863	54.47	418.4	0.66	2,788	4.35	8.00%

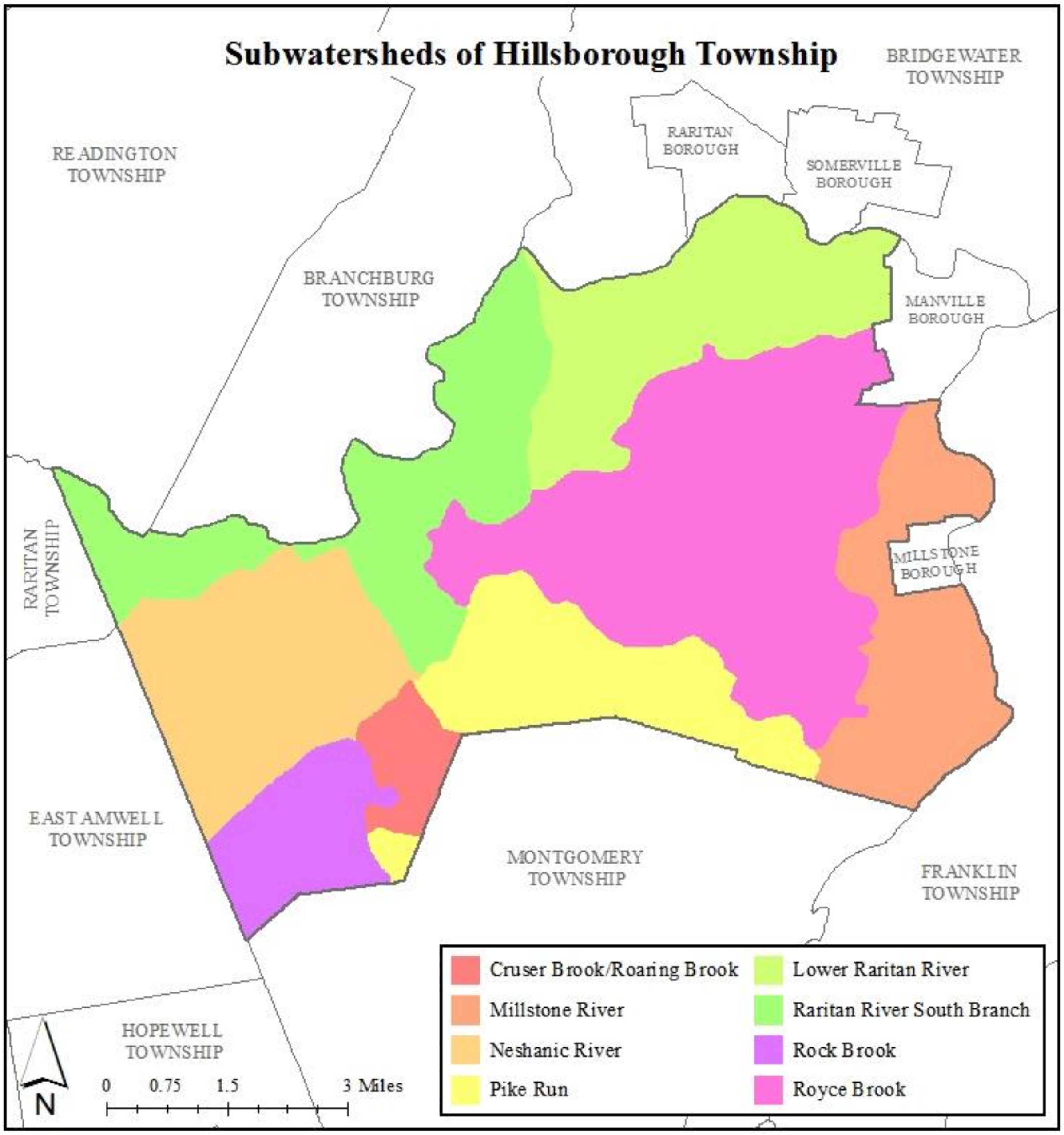


Figure 6: Map of the subwatersheds in Hillsborough Township

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

Subwatershed	**Total Runoff Volume for the 1.25" NJ Water Quality Storm (MGal)**	**Total Runoff Volume for the NJ Annual Rainfall of 44" (MGal)**	**Total Runoff Volume for the 2-Year Design Storm (3.3") (MGal)**	**Total Runoff Volume for the 10-Year Design Storm (5.0") (MGal)**	**Total Runoff Volume for the 100-Year Design Storm (8.2") (MGal)**
Cruser Brook/Roaring Brook	0.2	5.5	0.4	0.6	1.0
Millstone River	12.7	445.5	33.4	50.6	83.0
Neshanic River	3.3	116.5	8.7	13.2	21.7
Pike Run	8.1	283.7	21.3	32.2	52.9
Lower Raritan River	8.2	288.5	21.6	32.8	53.8
Raritan River South Branch	5.7	202.3	15.2	23.0	37.7
Rock Brook	0.7	26.0	2.0	3.0	4.9
Royce Brook	55.8	1,962.9	147.2	223.1	365.8
Total	94.6	3,330.8	249.8	378.5	620.7

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 Hillsborough Township. While it may be difficult to eliminate paved areas or replace paved areas with permeable pavement, it is relatively easy to identify impervious surfaces that can be disconnected using green infrastructure practices. For all practical purposes, disconnecting an impervious surface from a storm sewer system or a water body is an "impervious area reduction." The RCE Water Resources Program recommends that all green infrastructure practices that are installed to disconnect impervious surfaces should be designed for the 2-year design storm (3.3 inches of rain over 24-hours). Although this results in management practices that are slightly over-designed by NJDEP standards, which require systems to be designed for the New Jersey water quality storm (1.25 inches of rain over 2-hours), these systems will be able to handle the increase in storm intensities that are expected to occur due to climate change. By designing these management practices for the 2-year design storm, these practices will be able to manage 95% of the annual rainfall volume. The recommended annual reductions in runoff volumes are shown in Table 3.

As previously mentioned, once impervious surfaces have been identified, the next steps for managing impervious surfaces are to 1) eliminate surfaces that are not necessary, 2) reduce or convert impervious surfaces to pervious surfaces, and 3) disconnect impervious surfaces from draining directly to local waterways.

Table 3: Impervious cover reductions by subwatershed in Hillsborough Township

Subwatershed	**Recommended Impervious Area Reduction (10%) (ac)**	**Annual Reduction in Runoff Volume (MGal)** [2]
Cruser Brook/Roaring Brook	0.5	0.5
Millstone River	37.3	42.3
Neshanic River	9.8	11.1
Pike Run	23.8	27.0
Lower Raritan River	24.2	27.4
Raritan River South Branch	16.9	19.2
Rock Brook	2.2	2.5
Royce Brook	164.3	186.5
Total	278.8	316.4

[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 practices should be designed to capture the first 3.3 inches of rain from each storm. This would allow the green infrastructure practices to capture 95% of the annual rainfall of 44 inches.

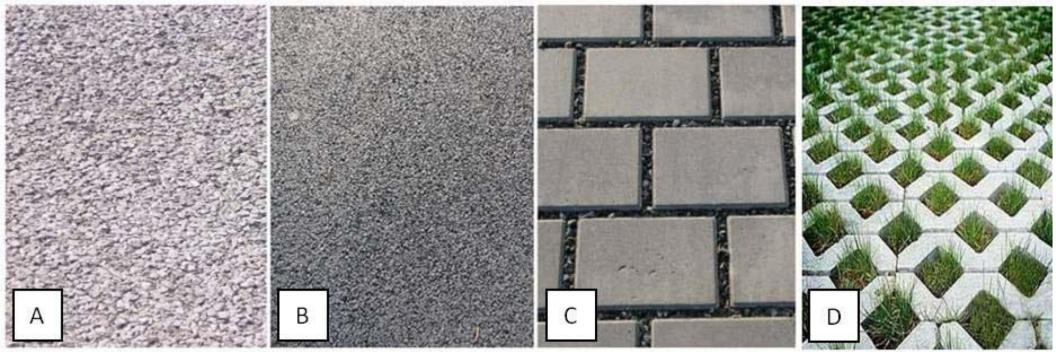
Elimination of Impervious Surfaces

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.

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 expensive 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 and treat a variety of impervious surfaces (Figure 8).

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 9a and 9b). 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 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 Hillsborough 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 Hillsborough 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

Hillsborough 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.

References

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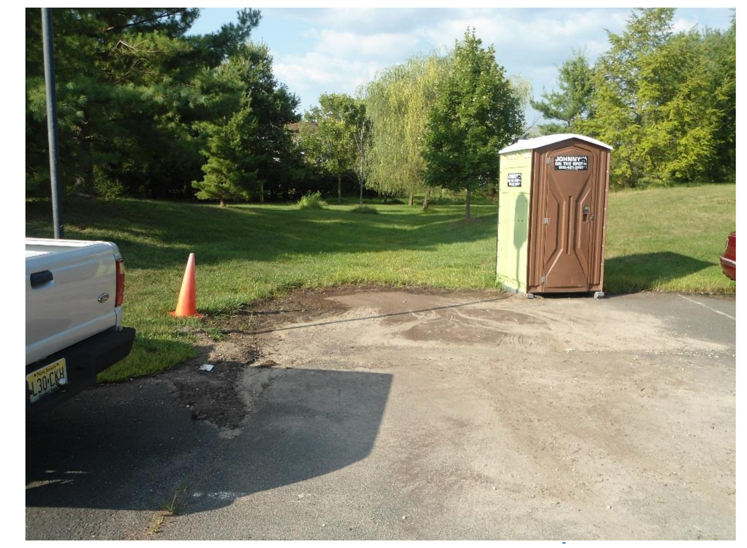
Appendix A

Examples of Impervious Cover Reduction Action Plan Projects

Concept Plans and Detailed Green Infrastructure Information Sheets

Hillsborough Township
Impervious Cover Assessment
Hillsborough Municipal Building, 379 South Branch Road

PROJECT LOCATION: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SITE PLAN:

1 **BIOSWALE:** A bioswale could be installed to treat runoff from the parking lot. A bioswale is a vegetated system that will convey stormwater to the tributary on the north edge of the municipally owned property while removing sediment and nutrients.

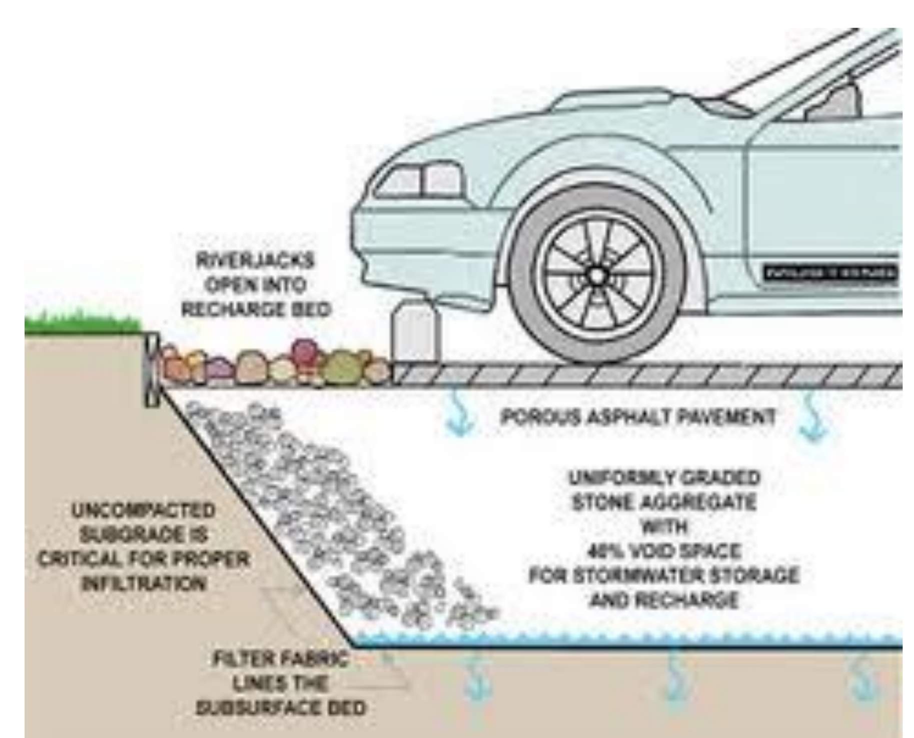
2 **BIORETENTION SYSTEMS:** Curb cuts will be used to allow stormwater runoff from the parking areas to enter into the bioretention systems. The bioretention systems will reduce sediment and nutrient loading to the local tributary.

3 **POROUS ASPHALT:** Porous asphalt promotes groundwater recharge and filters stormwater.

1 BIOSWALE

2 BIORETENTION SYSTEM

3 POROUS ASPHALT



Location: 379 South Branch Road, Hillsborough, NJ	**Municipality:** Hillsborough, NJ **Subwatershed:** Royce Brook
BMP Description: bioswale bioretention systems/rain gardens porous asphalt	**Targeted Pollutants:** nutrients, pathogens, petroleum hydrocarbons

Existing Conditions and Issues:

This site is the Hillsborough Municipal Complex which includes the library, police station and the municipal offices. Due it is proximity to the Royce Brook and the large amount of directly connected impervious surfaces, the Hillsborough Municipal Complex contributes to localized flooding and degrades the water quality of the Royce Brook. The parking lot adjacent to the soccer field drains to a grassed area and then to a small tributary to the Royce Brook. The parking lot on the north end of the complex drains to a series of catch basins, which carries the runoff to the Royce Brook. The parking lot on the east end of the complex drains directly to the Royce Brook via a series of catch basins. The parking lot at the south side of the Municipal Complex drains directly to the Royce Brook.

Proposed Solution(s):

A portion of the parking lot adjacent to the soccer field (approximately 20,450 square feet) can be treated with a bioswale. The parking lot on the north end of the complex is approximately 20,440 square feet and can be treated by a bioretention system or rain garden. Curb cuts would be installed to divert stormwater runoff to the bioretention system prior to it entering the existing catch basins. The bioretention basin would be approximately 5,000 square feet in size and 0.5 feet deep. Stormwater runoff from a portion of the parking lot on the east side of the complex (7,110 square feet) can be diverted to a bioretention system or rain garden. A curb cut would be installed to allow the water to bypass the existing catch basin and enter the rain garden. The rain garden will be constructed around an existing lawn inlet, which would be used as an overflow for the garden. This rain garden would be approximately 1,775 square feet with a depth of 0.5 feet. The parking lot on the south side of the complex is approximately 29,150 square feet in size. A portion of the parking lot could be converted to porous asphalt to capture, treat, and infiltrate stormwater runoff from the entire parking lot. The porous asphalt would have a one and one-half foot stone reservoir beneath it to store the stormwater and slowly let it infiltrate into the ground. The system would contain an underdrain so larger rainfall events could bypass the system.

Anticipated Benefits:

Basically, bioretention systems or rain gardens are an inexpensive, simple to implement, and environmentally sound solution to urban stormwater runoff. A rain garden is a site specific landscaping system that utilizes native plants to absorb excessive stormwater runoff and allows it to infiltrate into the ground. The rain garden removes nutrients, pathogens, and petroleum hydrocarbons. Additionally, a rain garden enhances the beauty of the site and provides valuable habitat for birds, butterflies, and many beneficial insects. The porous pavement also has water quality benefits by filtering pollutants and providing storage for stormwater by allowing it to infiltrate into the ground. Porous asphalt is a safe and well-studied system that works very well in parking lots to manage stormwater runoff. Finally, the bioswale will treat stormwater runoff and promote infiltration.

Possible Funding Sources:
New Jersey Department of Environmental Protection
Hillsborough Township
local social and community groups

Partners/Stakeholders:
Hillsborough residents
Rutgers Cooperative Extension of Somerset County
Rutgers Cooperative Extension Water Resources Program

Estimated Cost:
The bioswale to treat runoff from the parking lot adjacent to the soccer field will be approximately 2,000 square feet in size. At $10 per square foot, the estimated cost of the bioswale is $20,000. The bioretention basin/rain garden to treat runoff from the north parking lot would need to be approximately 5,000 square feet in size. At $5 per square foot, the estimated cost of the rain garden is $25,000. The rain garden to treat runoff from the parking lot on the east side would need to be approximately 1,775 square feet in size. At $5 per square foot, the estimated cost of the rain garden is $8,875. The porous asphalt would be need to be approximately 7,200 square feet and would cost approximately $180,000 at $25 per square foot.

Rutgers
New Jersey Agricultural Experiment Station

Hillsborough Township
Impervious Cover Assessment
Hillsborough Township Volunteer Firehouse
Hillsborough Radiology Associates, 375 US Highway 206

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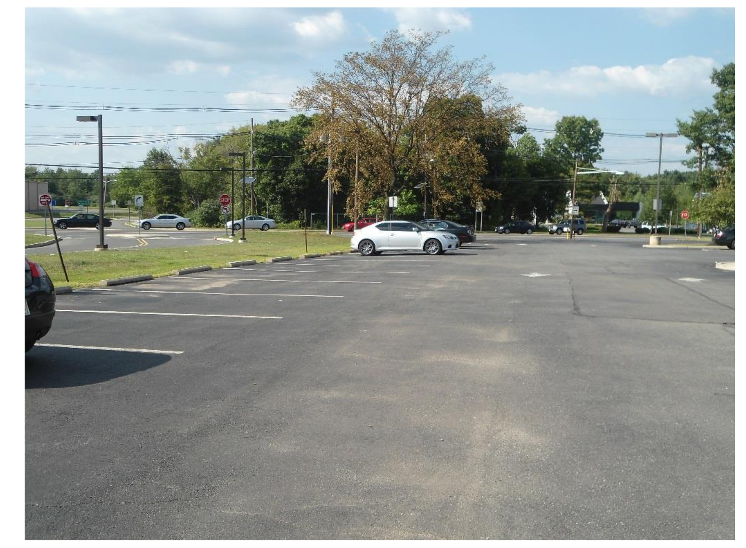

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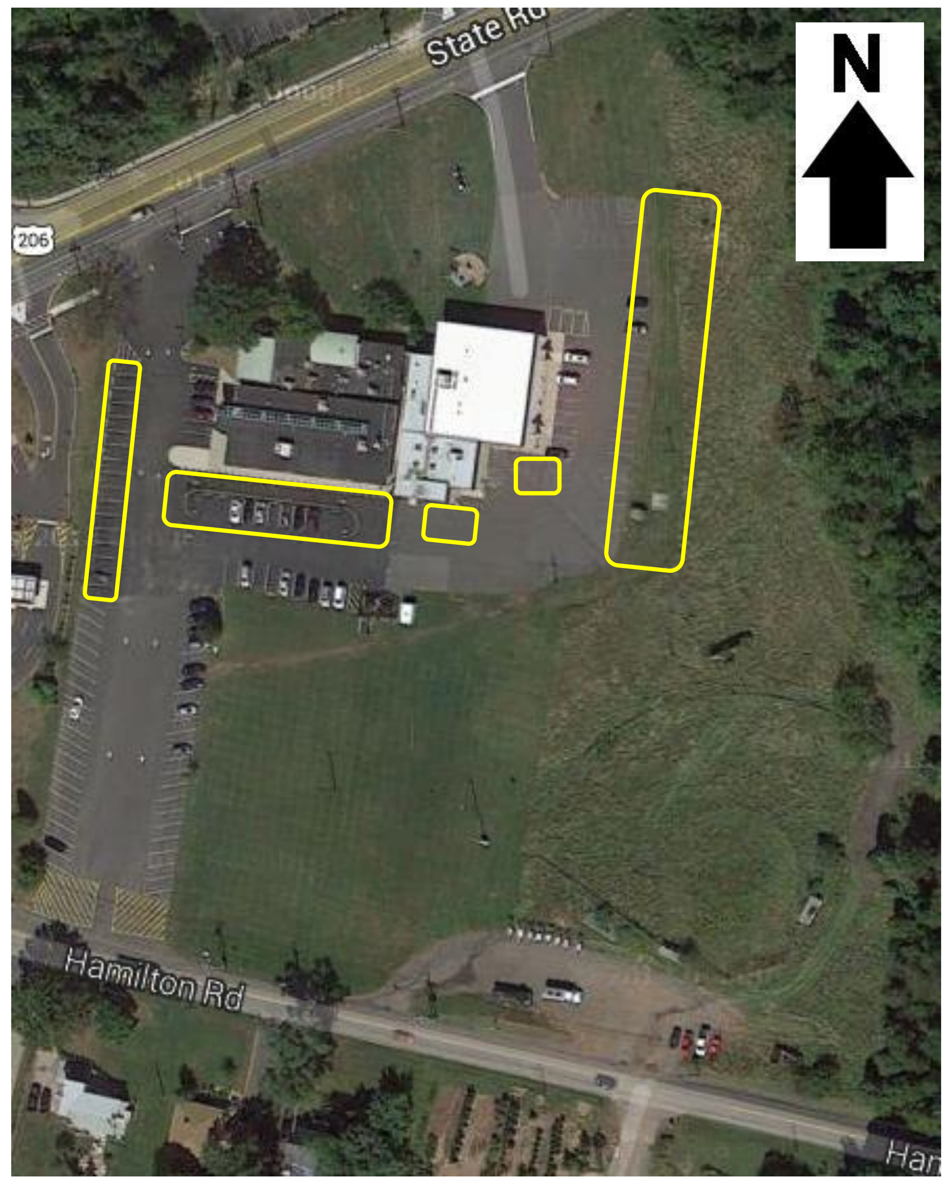
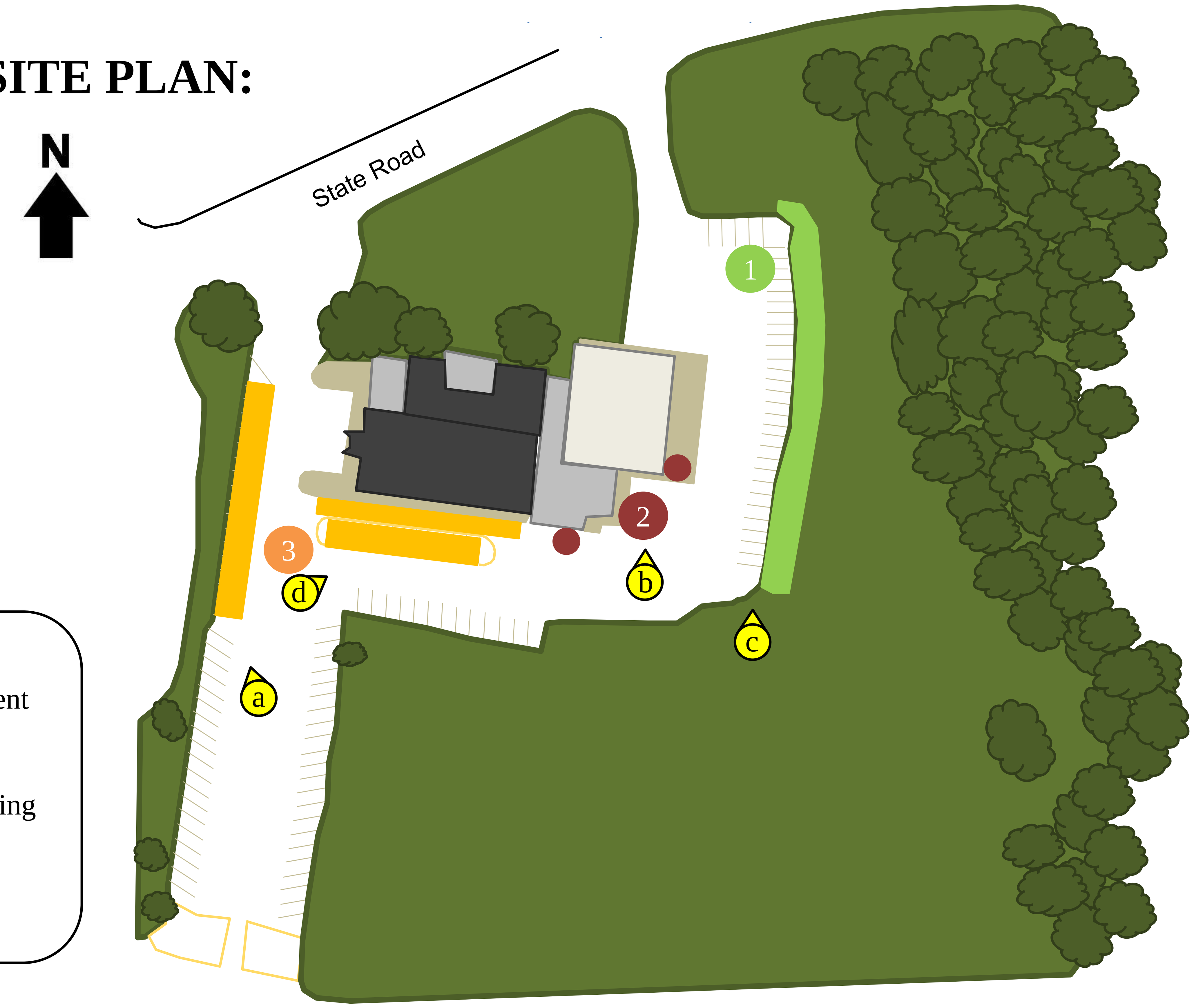
PROJECT LOCATION:



SITE PLAN:



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1 **BIORETENTION SYSTEM:** Curb cuts will be used to allow stormwater runoff from the parking areas to enter into the bioretention system. The bioretention system will reduce sediment and nutrient loading to the local tributary.

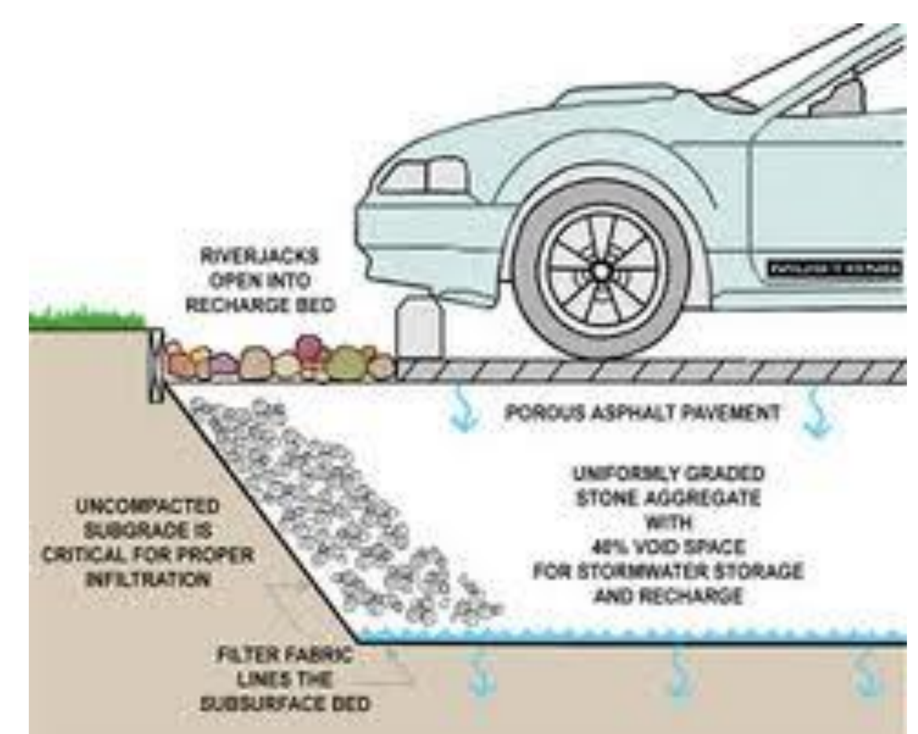
2 **RAINWATER HARVESTING SYSTEM:** Rainwater will be harvested from the roof of the building and stored in cisterns. The water will be used to wash the fire trucks.

3 **POROUS ASPHALT:** Porous asphalt promotes groundwater recharge and filters stormwater.

1 BIORETENTION SYSTEM

2 RAINWATER HARVESTING SYSTEM

3 POROUS ASPHALT



Hillsborough Township Volunteer Firehouse
and Hillsborough Radiology Associates
Green Infrastructure Information Sheet

Location: 375 US Highway 206, Hillsborough, NJ	**Municipality:** Hillsborough, NJ **Subwatershed:** Royce Brook
BMP Description: bioretention systems/rain gardens porous asphalt rainwater harvesting systems	**Targeted Pollutants:** nutrients, pathogens, petroleum hydrocarbons

Existing Conditions and Issues:

This site is the Hillsborough Township Volunteer Firehouse and Hillsborough Radiology Associates. Due it is proximity to the Royce Brook and the large amount of directly connected impervious surfaces, this site contributes to localized flooding and degrades the water quality of the Royce Brook. The parking lot on the east side of the site drains directly to the Royce Brook via overland flow. The rooftops of the buildings drain directly to the storm sewer system or to the parking lot and ultimately to the Royce Brook. The parking lot on the west and south side of the building drain directly to the existing storm sewer system which carries the stormwater runoff to the Royce Brook.

Proposed Solution(s):

A bioretention system or rain garden can be built to capture, treat, and infiltrate runoff from the parking lot on the east side of the site. This parking lot is approximately 27,750 square feet in size. The rain garden would be 0.5 ft deep and approximately 6,435 square feet in size. For the parking lots on the south side and the west side of the building, porous asphalt could be used in the parking spots, and regular asphalt would be used in the cart ways to handle the heavy loads of the buses. Approximately 6,225 square feet of parking space would be converted to porous asphalt to treat 48,090 square feet of parking lot. The porous asphalt would have a three foot stone reservoir beneath it to store the stormwater and slowly let it infiltrate into the ground. The system would contain an underdrain so larger rainfall events could bypass the system. Two 2,500 gallon cisterns could be used to harvest rainwater from the roof tops. This water could be used to wash the fire trucks.

Anticipated Benefits:

Bioretention systems or rain gardens are an inexpensive, simple to implement, and environmentally sound solution to urban stormwater runoff. A rain garden is a site specific landscaping system that utilizes native plants to absorb excessive stormwater runoff and allows it to infiltrate into the ground. The rain garden removes nutrients, pathogens, and petroleum hydrocarbons. Additionally, a rain garden enhances the beauty of the site and provides valuable habitat for birds, butterflies, and many beneficial insects. The porous pavement also has water quality benefits by filtering pollutants and providing storage for stormwater by allowing it to infiltrate into the ground. Porous asphalt is a safe and well-studied system that works very well in parking lots to manage stormwater runoff. Rainwater harvesting not only helps reduce stormwater from entering local waterways, it helps with water conservation.

Possible Funding Sources:

New Jersey Department of Environmental Protection

Hillsborough Township
local social and community groups

Partners/Stakeholders:
volunteer fire department
Hillsborough residents
Rutgers Cooperative Extension of Somerset County
Rutgers Cooperative Extension Water Resources Program

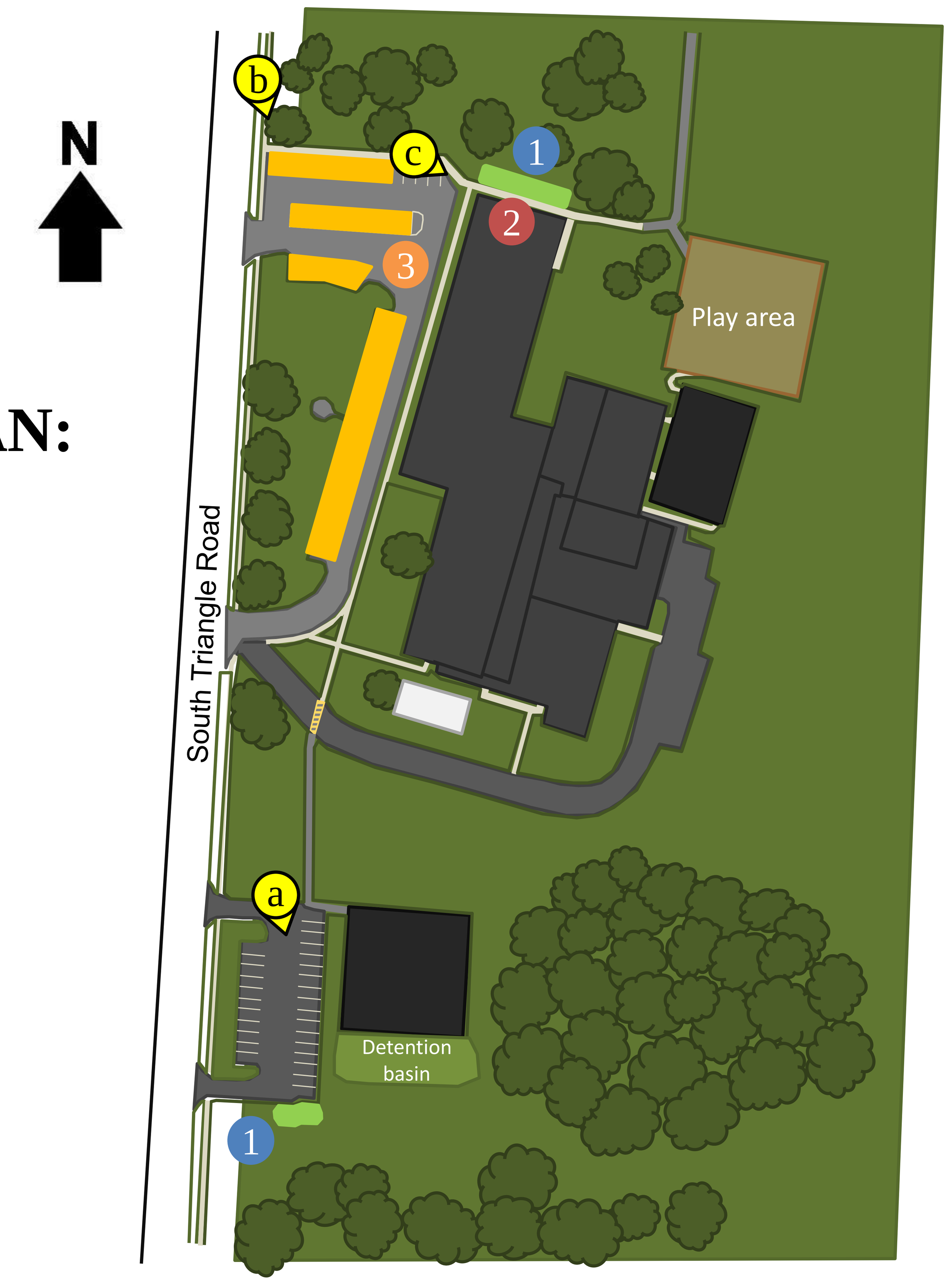
Estimated Cost:
The rain garden to treat runoff from the parking lot on the east side of the complex would need to be approximately 6,435 square feet in size. At $5 per square foot, the estimated cost of the rain garden is $32,175. The porous asphalt would be need to be approximately 6,225 square feet and would cost approximately $217,875 at $35 per square foot. The two 2,500 gallon cisterns would cost approximately $20,000.

Hillsborough Township
Impervious Cover Assessment
Triangle Elementary School,156 South Triangle Road

Rutgers New Jersey Agricultural Experiment Station

PROJECT LOCATION:

SITE PLAN:



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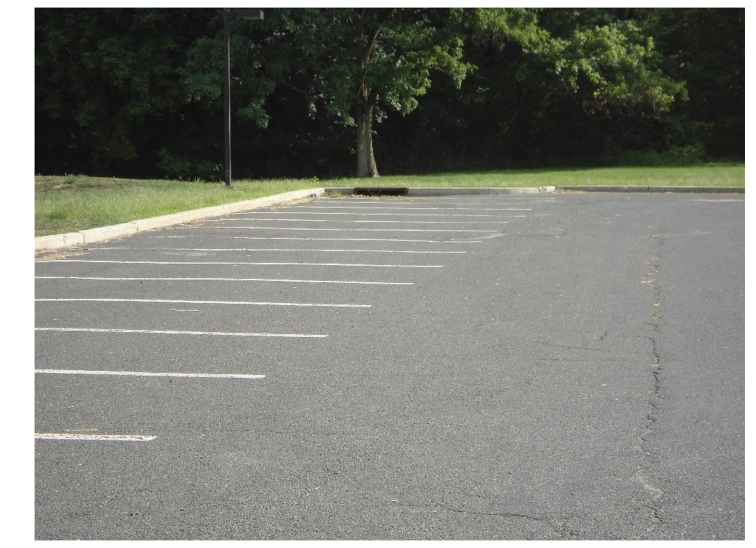

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1 **BIORETENTION SYSTEM:** Bioretention systems should be installed near the smaller parking lot as well as along the side of the school. A bioretention system will reduce runoff and allow stormwater infiltration, decreasing the amount of contaminants that reach the catch basin.

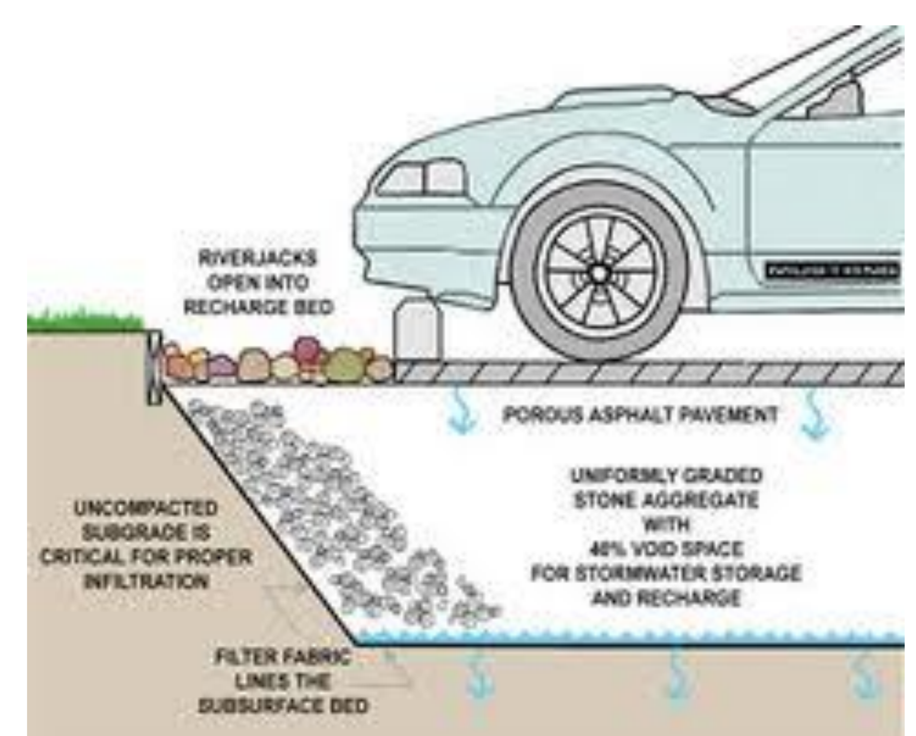
2 **TRENCH DRAIN:** Trench drains should be installed to allow the roof runoff to drain under the sidewalks into the bioretention systems.

3 **POROUS ASPHALT:** Porous asphalt promotes groundwater recharge and filters stormwater.

1 BIORETENTION SYSTEM

2 TRENCH DRAIN

3 POROUS ASPHALT



Triangle Elementary School
Green Infrastructure Information Sheet

Location: South Triangle Road, Hillsborough, NJ	**Municipality:** Hillsborough, NJ **Subwatershed:** Royce Brook
BMP Description: bioretention systems/rain gardens porous asphalt	**Targeted Pollutants:** nutrients, pathogens, petroleum hydrocarbons

Existing Conditions and Issues:

This site is the Triangle Road Elementary School. Due it is proximity to the Royce Brook and the large amount of directly connected impervious surfaces, the Triangle Elementary School contributes to localized flooding and degrades the water quality of the Royce Brook. The parking lot adjacent to the school is deteriorated and will need to be replaced shortly. This parking is approximately 26,900 square feet and drains to a series of catch basins located in front of the school at the edge of the fire lane where the buses drop off the children. An overflow parking lot of approximately 11,000 square feet was built on the side of the school. This entire overflow parking lot drains to a single catch basin that discharges directly to the Royce Brook which is approximately 100 feet away. Additionally, the building rooftops drain via downspouts onto a compacted lawn with the runoff ultimately finding its way to the storm sewer system which carries it directly to the stream. There is one small detention basin on the site which was designed to capture runoff from an asphalt playground adjacent to the overflow parking area.

Proposed Solution(s):

A bioretention system or rain garden can be built on the green adjacent to the overflow parking lot. The rain garden would be 0.5 feet deep and approximately 2,200 square feet in size. A curb cut would be installed to allow the water to bypass the existing catch basin and enter the rain garden. When the stormwater runoff flows are high, the existing catch basin can handle the overflow from the rain garden. A rain garden also could be installed to capture roof runoff at the north end of the school. Trench drains under the sidewalk would convey stormwater to the rain garden. A rain garden of 1,300 square feet in size with a depth of four inches would capture stormwater runoff from 2,650 square feet of the rooftop. Finally, the parking lot could be repaved with porous asphalt. Porous asphalt would be used in the parking spots, and regular asphalt would be used in the cart ways to handle the heavy loads of the buses. Approximately 32% of the parking lot would be porous asphalt (8,800 square feet), and the remainder would be regular asphalt. The porous asphalt would have a one foot stone reservoir beneath it to store the stormwater and slowly let it infiltrate into the ground. The system would contain an underdrain so larger rainfall events could bypass the system.

Anticipated Benefits:

Basically, bioretention systems or rain gardens are an inexpensive, simple to implement, and environmentally sound solution to urban stormwater runoff. A rain garden is a site specific landscaping system that utilizes native plants to absorb excessive stormwater runoff and allows it to infiltrate into the ground. The rain garden removes nutrients, pathogens, and petroleum hydrocarbons. Additionally, a rain garden enhances the beauty of the site and provides valuable habitat for birds, butterflies, and many beneficial insects. The porous pavement also has water quality benefits by filtering pollutants and providing storage for stormwater by allowing it to infiltrate into the ground. Porous asphalt is a safe and well-studied system that works very well in parking lots to manage stormwater runoff. Finally, since these systems are being installed at a school, it provides an educational opportunity for school children, parents, and teachers. Rutgers Cooperative Extension has a *Stormwater Management in your Schoolyard* program that engages youth in experiential learning, working to make the school grounds more sustainable.

Possible Funding Sources:
New Jersey Department of Environmental Protection
Hillsborough Township
Hillsborough Board of Education
home and school association

Partners/Stakeholders:
Triangle Road Elementary School students, teachers and parents
Rutgers Cooperative Extension of Somerset County
Rutgers Cooperative Extension Water Resources Program

Estimated Cost:
The rain garden to treat runoff from the overflow parking lot would need to be approximately 2,200 square feet in size. At $5 per square foot, the estimated cost of the rain garden is $11,000. The rain garden to treat the rooftop at the north end of the school would need to be approximately 13,000 square feet in size. At $5 per square foot, the estimated cost of the rain garden is $65,000. The porous asphalt would need to be approximately 8,800 square feet and would cost approximately $220,000 at $25 per square foot.