



FINAL

**Impervious Cover Assessment
for
Hamilton Township, Mercer County, New Jersey**

*Prepared for Hamilton Township by the
Rutgers Cooperative Extension Water Resources Program*

June 11, 2014

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 runs off 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 running off 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 (United States Environmental Protection Agency [USEPA], 2013). As stormwater flows over the ground, it picks up pollutants, including animal waste, excess fertilizers, and 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 cart ways could be converted to one-way cart 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: The rapid infiltration of porous asphalt is demonstrated at the USEPA Edison New Jersey test site.

Hamilton Township Impervious Cover Analysis

Located in Mercer County in central New Jersey, Hamilton Township covers over 40 square miles east of the City of Trenton. Hamilton Township is dominated by urban land uses (Figure 3). Over half of the municipality's land uses, approximately 59.0%, is comprised of residential properties. Of that residential land use, a large portion, 39.7%, is Residential, single unit, medium density development. The New Jersey Department of Environmental Protection (NJDEP) has defined single unit, medium density development as residential urban/suburban neighborhoods greater than 1/8-acre and up to and including 1/2-acre lots (Anderson et al., 1976). These areas generally contain about 30 to 35% impervious surface areas (Anderson et al., 1976). In addition to residential development, urban land use also includes land used for commercial, industrial, recreational, and transportation purposes (Figure 4). Natural lands (forests, wetlands, and water) make up approximately 31.7% of Hamilton Township. These areas generally have lower amounts of impervious cover than urban areas as they lack the associated infrastructure.

NJDEP's 2007 land use/land cover geographical information system (GIS) data layer categorizes Hamilton 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 Hamilton Township. Based upon the 2007 NJDEP land use/land cover data, Hamilton Township has impervious cover totaling 22.7%. Water resources are typically managed on a watershed basis; therefore an impervious cover analysis was performed for each watershed within Hamilton Township (Table 1 and Figure 5). On a watershed basis, impervious cover ranges from 7.6% in Doctors Creek Watershed to 30.5% in Pond Run Watershed. Evaluating impervious cover on a watershed basis allows the Township to focus impervious cover reduction or disconnection in watersheds where frequent flooding occurs.

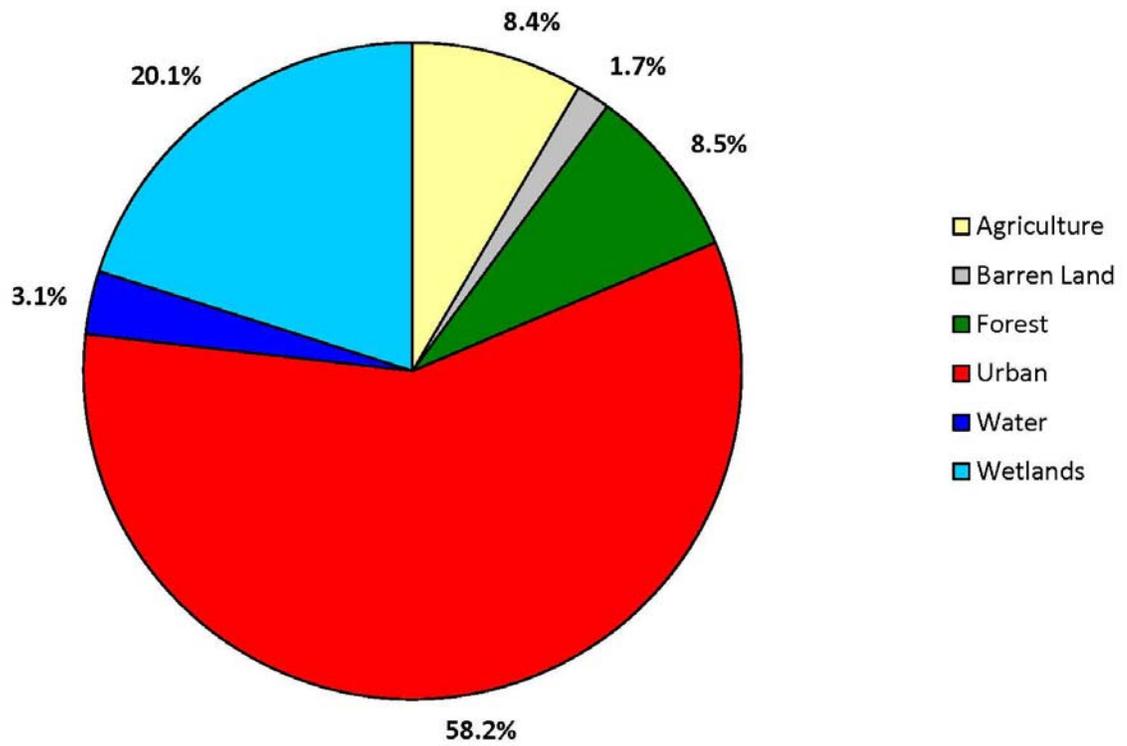
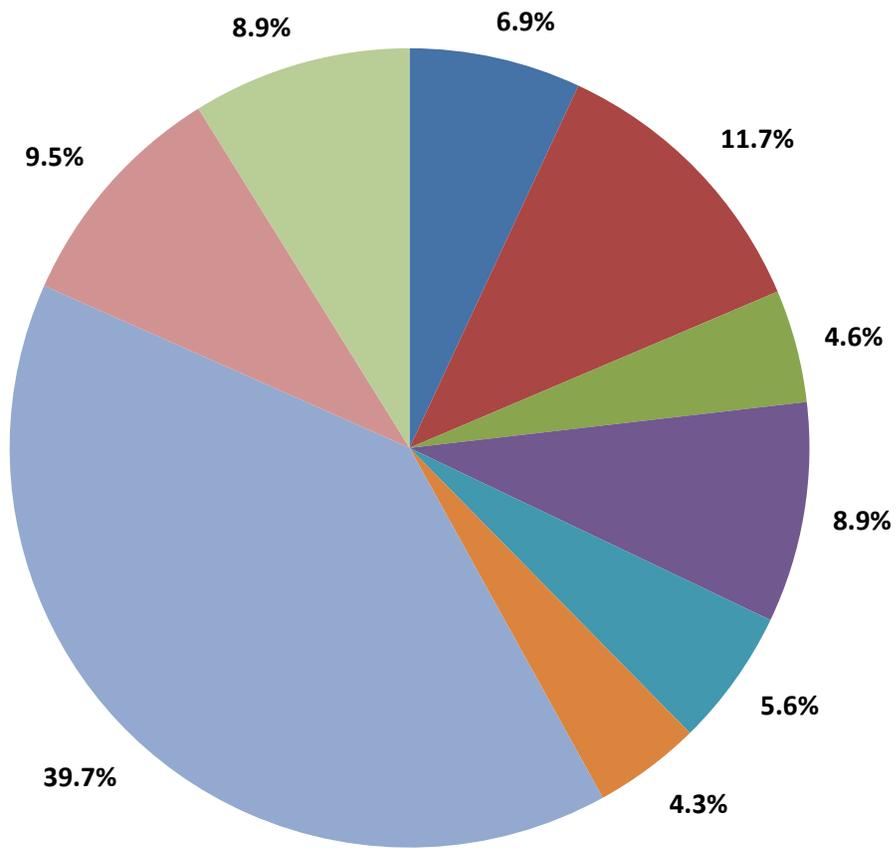


Figure 3: Pie chart illustrating the land use in Hamilton Township (Urban, Agricultural, Forest, Wetlands, Barren Land, and Water).



- Recreational Land
- Commercial
- Industrial
- Mixed Urban
- Rural Residential
- Low Density Residential
- Medium Density Residential
- High Density Residential
- Tranportation/Infrastructure

Figure 4: Pie chart illustrating the various types of urban land use in Hamilton Township (low density residential, medium density residential, high density residential, mixed urban, commercial, industrial, etc.)

Table 1: Impervious cover analysis by watershed for Hamilton Township.

Subwatershed	Total Area		Land Use Area		Water Area		Impervious Cover		
	(ac)	(mi ²)	(ac)	(mi ²)	(ac)	(mi ²)	(ac)	(mi ²)	(%)
Pond Run	5,956	9.3	5,900	9.2	55.7	0.09	1,797	2.8	30.5%
Miry Run	3,716	5.8	3,653	5.7	63.0	0.10	1,026	1.6	28.0%
Shady Brook	2,838	4.4	2,787	4.4	50.0	0.08	822.5	1.3	29.5%
Assunpink Creek	1,809	2.8	1,783	2.8	25.8	0.04	429.3	0.7	24.0%
Doctors Creek	3,053	4.8	3,017	4.7	36.0	0.06	232.0	0.4	7.60%
Back Creek	2,980	4.7	2,969	4.6	11.3	0.02	563.0	0.9	19.0%
Delaware River and Crosswicks Creek	5,489	8.6	4,927	7.7	563.2	0.91	804.2	1.2	16.0%
TOTAL	25,841	40.4	25,036	39.1	805	1.3	5,674	8.9	22.7%

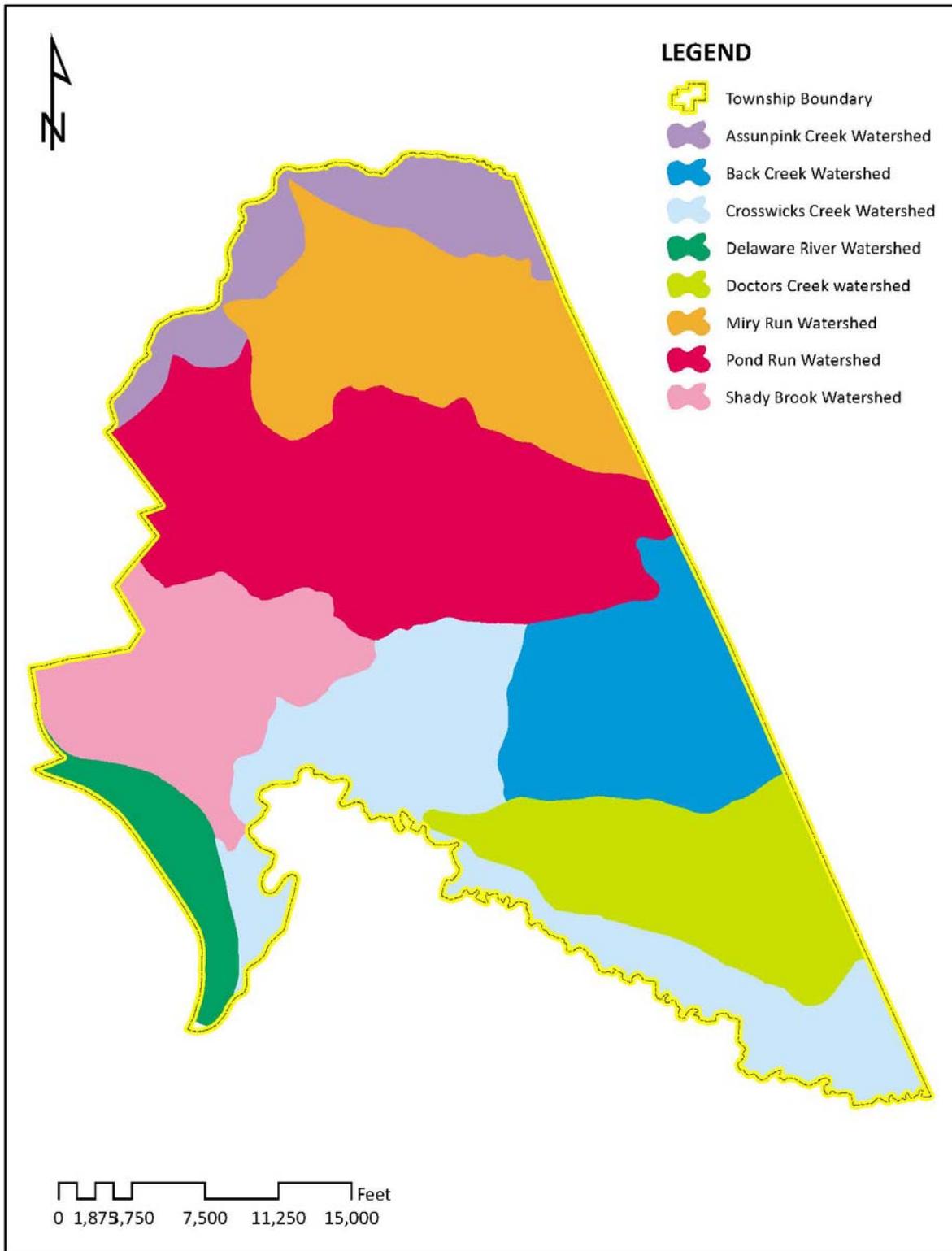


Figure 5: Map of the subwatersheds in Hamilton Township.

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 Hamilton Township, Mercer 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 (8.3 inches of rain). These runoff volumes are summarized in Table 2. A substantial amount of rainwater is running off of impervious surfaces in Hamilton Township. For example, if the stormwater runoff from one water quality storm (1.25 inches of rain) in the Pond Run Watershed was harvested and purified, it could supply water to 566 homes for a year¹.

The next step is to set a reduction goal for impervious area in each watershed. Based upon the Rutgers Cooperative Extension (RCE) Water Resources Program's experience, a 10% reduction would be a reasonably achievable reduction for these watersheds in Hamilton 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.

¹ Assuming 300 gallons per day per home.

Table 2: Stormwater runoff volumes from impervious surfaces by watershed in Hamilton 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)
Pond Run	61.0	2,147.0	161.0	244.0	405.0
Miry Run	34.8	1,225.8	91.9	139.3	231.2
Shady Brook	27.9	982.7	73.7	111.7	185.4
Assunpink Creek	14.6	512.9	38.5	58.3	96.8
Doctors Creek	7.9	277.2	20.8	31.5	52.3
Back Creek	19.1	672.7	50.4	76.4	126.9
Delaware River and Crosswicks Creek	27.3	960.8	72.1	109.2	181.3
TOTAL	192.6	6,779.2	508.4	770.4	1,278.8

Table 3: Impervious cover reductions by watershed in Hamilton Township

Subwatershed	Recommended Impervious Area Reduction (10%)	Annual Runoff Volume Reduction ²
	(ac)	(MGal)
Pond Run	180	215.1
Miry Run	103	123.1
Shady Brook	82	98.0
Assunpink Creek	43	51.4
Doctors Creek	23	27.5
Back Creek	56	66.9
Delaware River and Crosswicks Creek	80	95.6
TOTAL	567	677.4

As previously mentioned, once impervious surfaces have been identified, there 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.

Pervious Pavement

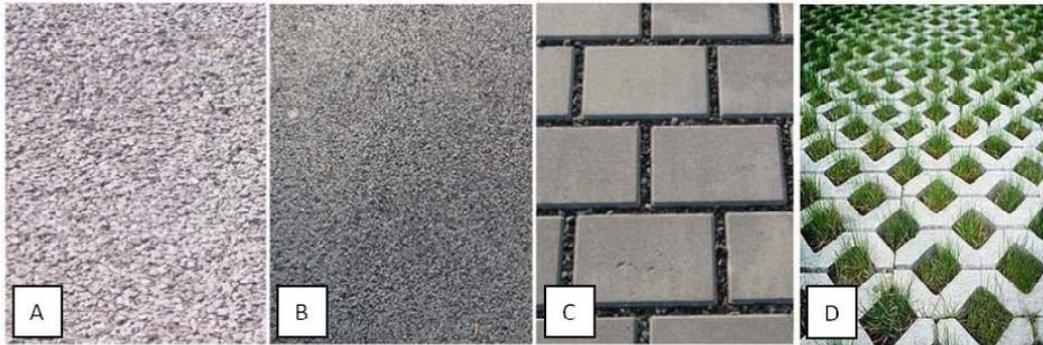
There are four different types of permeable pavement systems that are commonly being used throughout the country to reduce the environmental impacts from impervious surfaces. These surfaces include pervious concrete, porous asphalt, interlocking concrete pavers, and grid pavers.

² Annual Runoff Volume Reduction =

Acres of IC x 43,560 ft²/ac x 44 in x (1 ft/12 in) x 0.95 x (7.48 gal/ft³) x (1 MGal/1,000,000 gal)

All BMPs should be designed to capture the first 3.3 inches of rain from each storm. This would allow the BMP to capture 95% of the annual rainfall of 44 inches.

"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 an impervious surface from draining directly into a local waterway.

- **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 and treat a variety of impervious surfaces (Figure 6).



Figure 6: Rain garden outside the Gloucester County RCE Office designed to disconnect rooftop runoff from going directly to the local storm sewer system.

- **Rainwater Harvesting:** Rainwater harvesting includes the use of rain barrels and cisterns (Figures 7a and 7b). 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 7a: Rain barrel used to disconnect a downspout with overflow going to flower bed.



Figure 7b: A 5,000 gallon cistern used to disconnect the rooftop of the Department of Public Works in Clark Township, harvested water used for nonprofit car wash events.

Examples of Opportunities in Hamilton 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 and stormwater BMP information sheets are prepared for a selection of representative sites.

For Hamilton Township, three sites have been included in this Impervious Cover Assessment providing examples of concept plans and detailed BMP information sheets (Appendix A). The detailed BMP information sheets describe existing conditions and issues, proposed solutions, anticipated benefits, possible funding sources, potential partners and stakeholders, and estimated cost. Additionally, each project has been classified as a mitigation opportunity for recharge potential, total suspended solids removal, and stormwater peak reduction. Finally, these detailed BMP information sheets provide an estimate of gallons of stormwater captured and treated per year by each proposed BMP. The concept plans provide an aerial photograph of the site and a concept drawing of the BMP location. The concept plans also provide photographs of the site and details of the proposed BMP practices.

Conclusions

Hamilton Township can reduce flooding and clean up its waters by better managing stormwater runoff from impervious surfaces. This municipal 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

Anderson, J.R., E.E. Hardy, J.T. Roach and R.E. Witmer, 1976. A Land Use And Land Cover Classification System For Use With Remote Sensor Data. Geological Survey Professional Paper 964.

Nowak, D. J., and E. J. Greenfield, 2012. "Trees and Impervious Cover in the United States." *Landscape and Urban Planning* 107 (2012): 21-30. Web.
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Rowe, A., 2012. "Green Infrastructure Practices: An Introduction to Permeable Pavement," Rutgers NJAES Cooperative Extension, FS1177, pp. 4.
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Appendix A

Examples of Impervious Cover Reduction Action Plan Projects

Concept Plans and Detailed BMP Information Sheets

Project Site: Pearson Memorial United Methodist Church	
Location: Parent Avenue at Pearson Memorial United Methodist	Municipality: Hamilton
	Subwatershed: Crosswicks Creek
BMP Description: bioretention system/rain garden education program, porous asphalt, planter boxes	Targeted Pollutants: total nitrogen (TN), total phosphorous (TP), and total suspended solids (TSS) in surface runoff
Mitigation Opportunities: recharge potential: yes total suspended solids removal potential: yes stormwater peak reduction potential: yes	Stormwater Captured and Treated per year: rain garden: 966,705 gallons porous asphalt: 1,061,781 gallons planter Boxes: 105,733 gallons
Existing Conditions and Issues: Currently the northwest portion of the parking lot at the Pearson Memorial United Methodist Church slopes towards Parent Avenue, allowing runoff to flood the residential road. Concurrently the southeast portion of the parking lot is flooding a small section of grass and eventually flowing onto Rolf Avenue. The runoff from the parking lot is a significant contributor of nonpoint source pollution (i.e., sediment, nutrients, oil and grease, and other pollutants) to local waterways. The rooftop runoff from the Pearson Memorial United Methodist Church is also contributing stormwater runoff and pollutant loads.	
Proposed Solution: A bioretention system should be installed in the grassed area perpendicular to Rolf Avenue to capture, treat and infiltrate runoff from the parking lot and rooftop. Porous asphalt should be implemented to further capture and store some of the runoff from the parking lot before reaching Parent Avenue. Planter boxes should also be installed at the downspouts of the Pearson Memorial United Methodist Church to both capture and filter rooftop runoff.	
Anticipated Benefits: A bioretention system is estimated to achieve a 30% removal rate for TN and a 60% removal rate for TP (NJDEP BMP Manual). TSS loadings may be reduced by up to 80%. A bioretention system would also provide ancillary benefits, such as enhanced wildlife and aesthetic appeal to visiting church members. Porous Asphalt is estimated to remove 50% of TN and 60% of TP(NJDEP BMP Manual). TSS loadings may be reduced by up to 80%. Rutgers Cooperative Extension could present the <i>Stormwater Management in Your Schoolyard</i> program to church youth groups and include bioretention system planting efforts as an augmentation to the program. It can also be used as a demonstration project to launch educational programming for Hamilton Township Department of Public Works staff.	
Possible Funding Sources: mitigation funds from local developers NJDEP grant programs like 319(h) and 604(b) Hamilton Township Pearson Memorial United Methodist Church	
Partners/Stakeholders: Hamilton Township, Pearson Memorial United Methodist Church, and Rutgers Cooperative Extension	
Estimated Cost: The rain garden would need to be approximately 9,250 square feet in size. At \$5 per square foot, the estimated cost of the rain garden is \$46,250. Approximately 5,000 square feet of porous asphalt would be needed and would cost approximately \$125,000 at \$25 per square foot. The planter boxes would cost approximately \$3,000 per box, and 12 boxes would be needed for a total estimated cost of \$36,000.	

Hamilton Township Impervious Cover Assessment

Pearson Memorial United Methodist Church

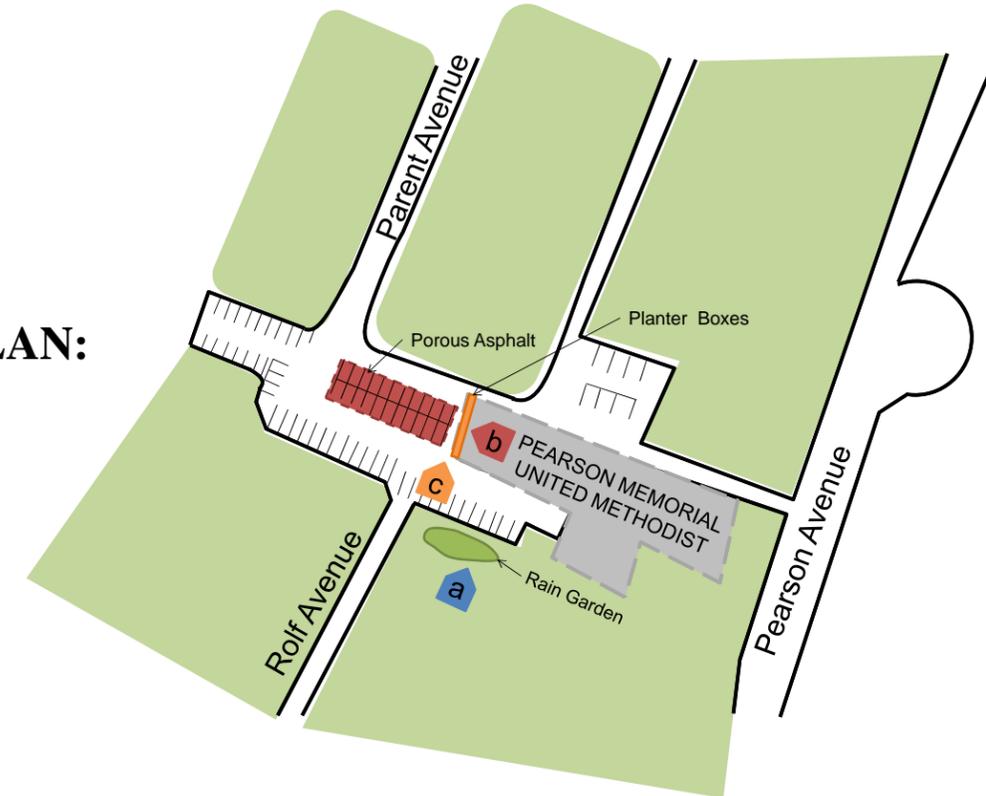
SITE PHOTOS:



PROJECT LOCATION:

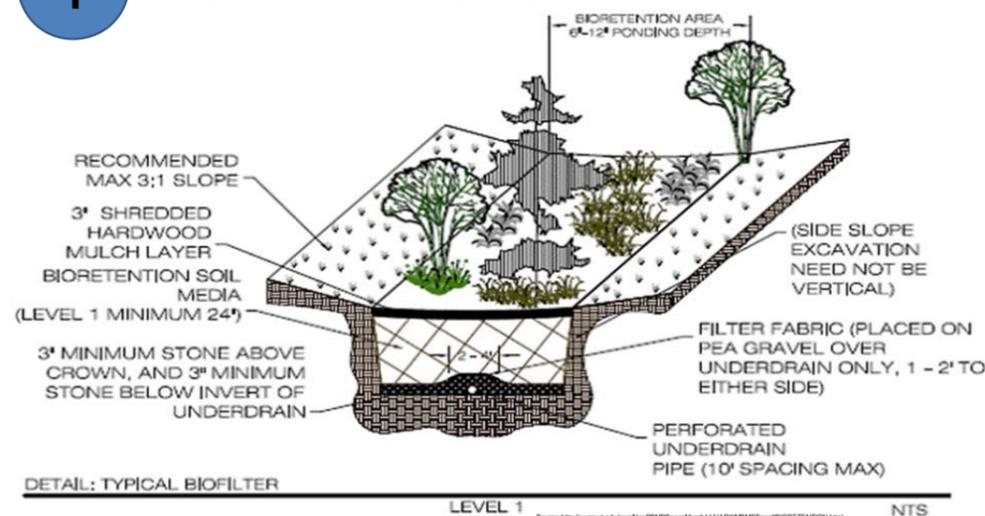


SITE PLAN:

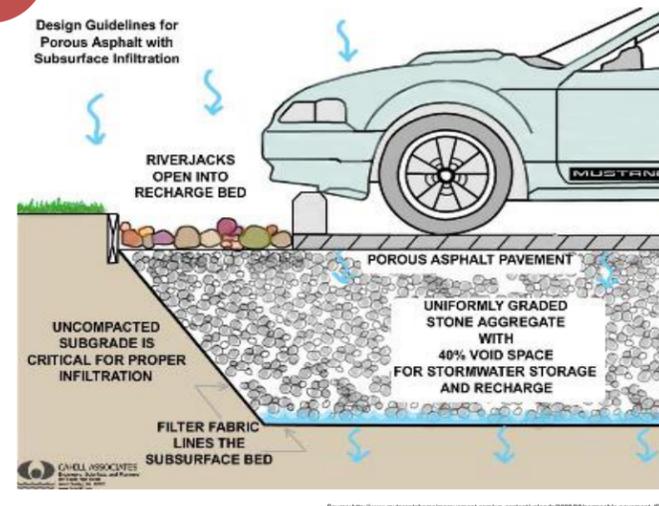


- BIORETENTION SYSTEM:** A bioretention system/rain garden should be installed on the grassed area perpendicular to Rolf Avenue. This will capture, treat, and infiltrate stormwater runoff from a portion of the parking lot and the roof top.
- POROUS ASPHALT:** The parking lot currently slopes towards Parent Avenue, resulting in localized flooding in the residential street. Porous asphalt should be implemented to capture, treat and infiltrate runoff from the parking lot and roof top.
- PLANTER BOXES:** Planter boxes should be installed at the downspouts of the Pearson Memorial United Methodist Church to intercept, treat, and filter a portion of the church's rooftop.

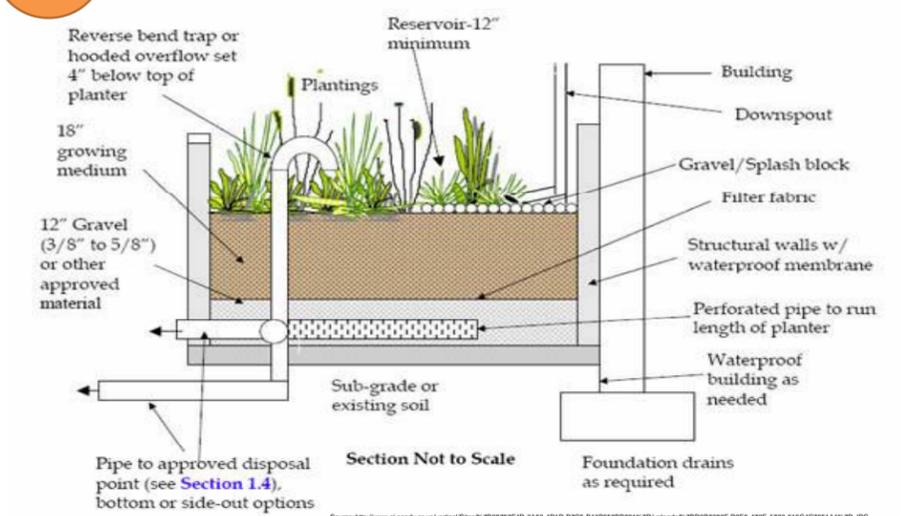
1 BIORETENTION SYSTEM



2 POROUS ASPHALT



3 PLANTER BOX



Project Site: Goeke Drive at Grice Middle School	
Location: Goeke Drive at Grice Middle School	Municipality: Hamilton
	Subwatershed: Shady Brook
BMP Description: bioretention system/rain garden education program, trench drain, curb cuts	Targeted Pollutants: total nitrogen (TN), total phosphorous (TP), and total suspended solids (TSS) in surface runoff
Mitigation Opportunities: recharge potential: yes TSS removal potential: yes stormwater peak reduction potential: yes	Stormwater Captured and Treated per year: rain garden: 275,000 gallons
Existing Conditions and Issues: Flooding has been reported at a low spot on the residential road, Goeke Drive. Flooding is a major concern for homeowners, and this road is frequented by cars because of its location relative to a residential neighborhood and school, Runoff is therefore carrying nonpoint source pollution, such as sediments, nutrients, oil and grease, and other pollutants, to local waterways .	
Proposed Solution(s): A bioretention system should be installed on a portion of the field adjacent to Goeke Drive. A bioretention system at this location will intercept some of the runoff from Goeke Drive before reaching the low spot. Additionally, a trench drain should be installed at this same location to convey water from the roadway to the bioretention system.	
Anticipated Benefits: A bioretention system is estimated to achieve a 30% removal rate for TN and a 60% removal rate for TP(NJDEP BMP Manual). TSS loadings may be reduced by up to 80%. A bioretention system would also provide ancillary benefits, such as enhanced wildlife and aesthetic appeal to both local residents and the students and faculty of Grice Middle School. The field at the proposed site is located at the Grice Middle School. Rutgers Cooperative Extension could present the <i>Stormwater Management in Your Schoolyard</i> program and could include bioretention system planting efforts as an augmentation to the program. It can also be used as a demonstration project to launch educational programming for Hamilton Township Department of Public Works staff.	
Possible Funding Sources: mitigation funds from local developers NJDEP grant programs like 319(h) and 604(b) Hamilton Township home and school associations	
Partners/Stakeholders: Hamilton Township, Grice Middle School, Rutgers Cooperative Extension, teachers, students and parents	
Estimated Cost: The rain garden would need to be approximately 2,650 square feet in size. At \$5 per square foot, the estimated cost of the rain garden is \$13,250.	

Hamilton Township

Impervious Cover Assessment

Goeke Drive near Grice Middle School

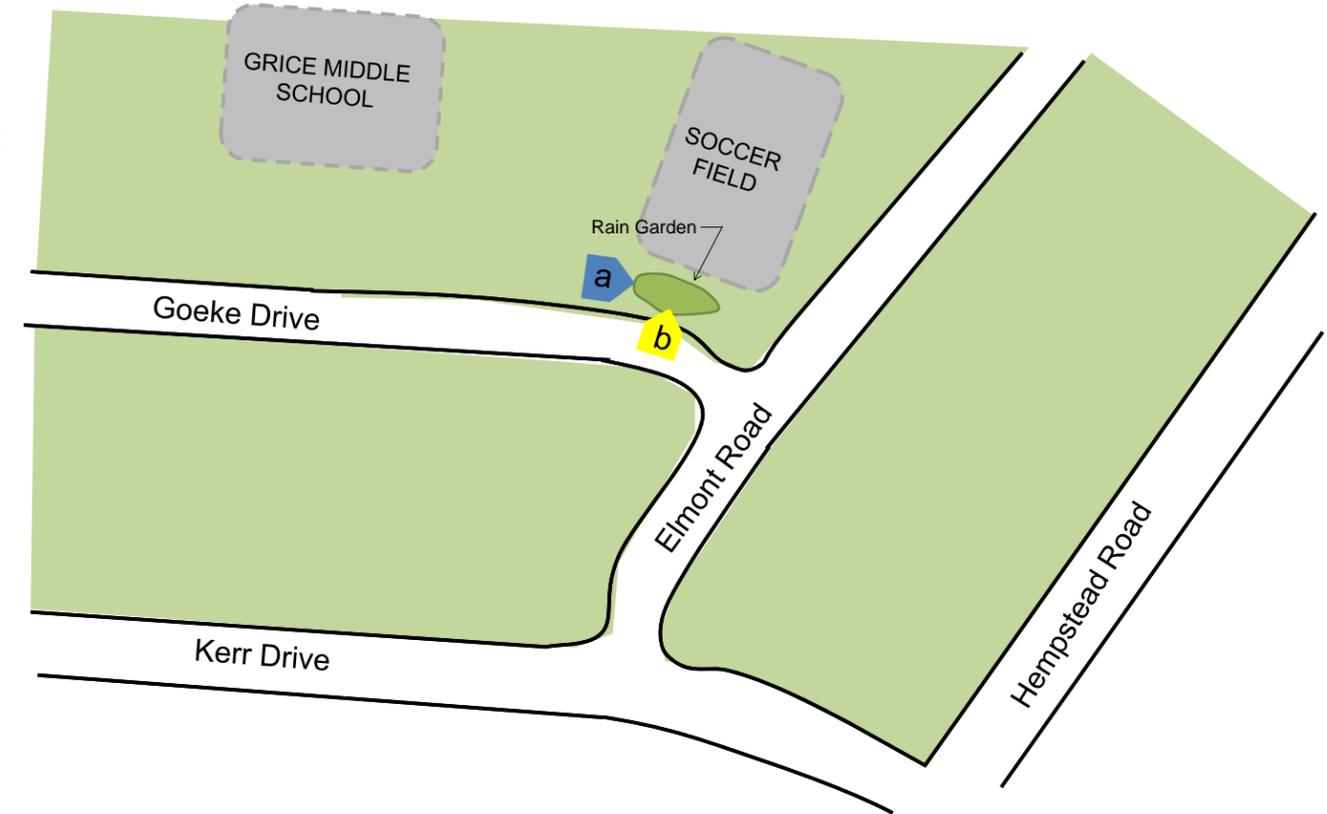
PROJECT LOCATION:



SITE PHOTOS:



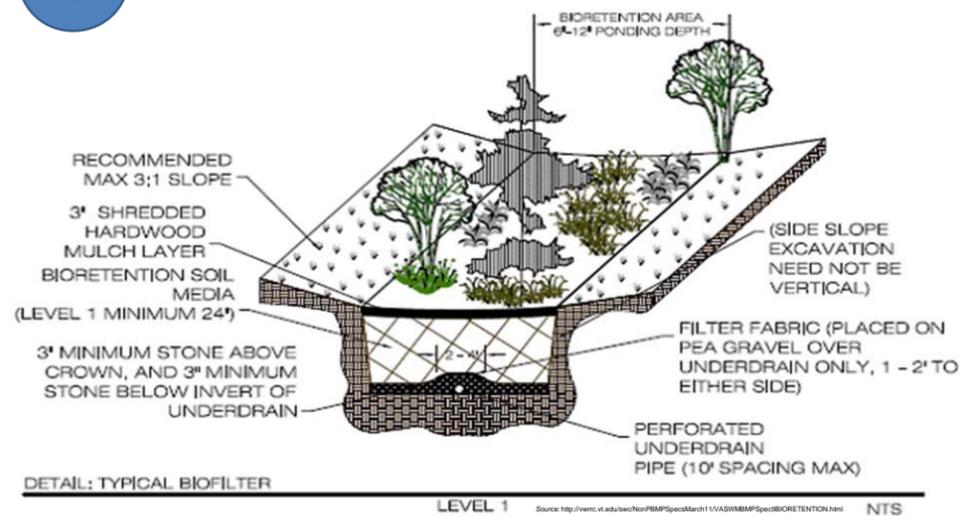
SITE PLAN:



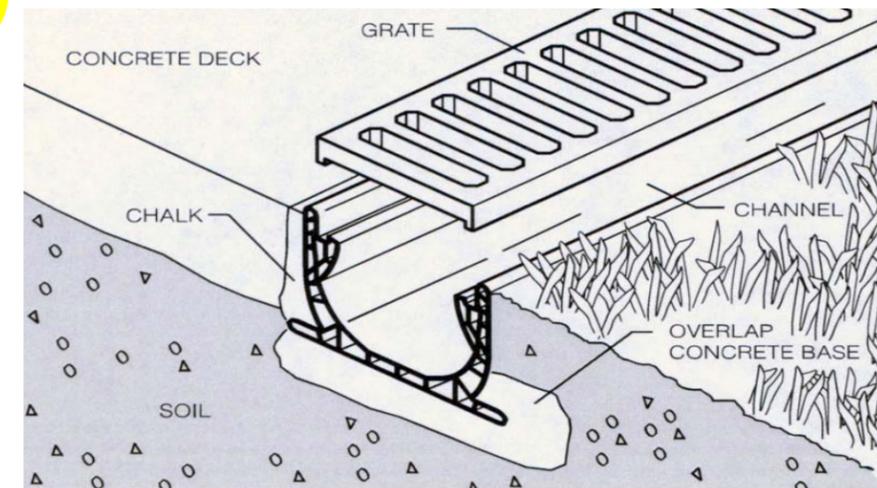
BIORETENTION SYSTEM: A bioretention system/rain garden should be installed on the grassed area adjacent to Goeke Drive. There has been flooding at a low spot further down Goeke Drive; a bioretention system at this location will intercept this runoff and decrease flooding on Goeke Drive.

TRENCH DRAIN: A trench drain should be installed to convey road runoff from Goeke Drive into the bioretention system.

1 BIORETENTION SYSTEM



2 TRENCH DRAIN



Source: http://schneiderconstruction.com/drainage/photos-drainage/NTS_Figure7-4_ChannelDrain_800.jpg

Project Site: Reynolds Middle School on Yardville Hamilton Square Road	
Location: Reynolds Middle School on Yardville Hamilton Square Road	Municipality: Hamilton
	Subwatershed: Pond Run
BMP Description: bioretention system/ rain garden education program, porous asphalt	Targeted Pollutants: total nitrogen (TN), total phosphorous (TP), and total suspended solids (TSS) in surface runoff
Mitigation Opportunities: recharge potential: yes total suspended solids removal potential: yes stormwater peak reduction potential: yes	Stormwater Captured and Treated per year: rain garden #1: 601,225 gallons rain garden #2: 1,954,150 gallons porous asphalt: 260,553 gallons
Existing Conditions and Issues: There are large amounts of impervious surfaces at this site that contribute to stormwater runoff volumes and nonpoint source pollution. There is a stormwater catchbasin near the northwest section of the Reynolds Middle School that is experiencing sediment accumulation; this can be attributed to water ponding around the catchbasin. There is a connected downspout on a triangular piece of lawn near the opening of the front building that is directing runoff onto the pavement without allowing water to infiltrate into the ground to promote groundwater recharge. There is a parking lot in the southeast portion of the site and one on the north side of the site. There is asphalt along the back of the building.	
Proposed Solution(s): Bioretention systems or rain gardens should be installed on a triangular piece of lawn near the front of the building. While this does not manage a large amount of stormwater runoff, it would make for a great educational opportunity for the students and visitors to the school. Stormwater runoff from the parking lot on the southwest side of the property can be treated with a rain garden (rain garden #1). The stormwater runoff from the parking lot on the north side of the building and the paved areas behind the building also can be treated with a rain garden (rain garden #2). These bioretention systems would capture, treat, and infiltrate stormwater runoff. The stormwater catch basin near the northwest entrance of Reynolds Middle School has sediment surrounding it, which demonstrates the poor drainage of the front driveway. This driveway could be replaced with porous asphalt to capture, treat, and infiltrate stormwater runoff.	
Anticipated Benefits: A bioretention system is estimated to achieve a 30% removal rate for TN and a 60% removal rate for TP (NJDEP BMP Manual). TSS loadings may be reduced by up to 80%. A bioretention system would also provide ancillary benefits, such as enhanced wildlife and aesthetic appeal to faculty and students. Porous asphalt is estimated to remove 50% of TN and 60% of TP (NJDEP BMP Manual). TSS loadings may be reduced by up to 80%. The proposed site is located at the Reynolds Middle School. Rutgers Cooperative Extension could present the <i>Stormwater Management in Your Schoolyard</i> program and include bioretention system planting efforts as an augmentation to the in-class lessons. It can also be used as a demonstration project to launch educational programming for Hamilton Township Department of Public Works staff.	
Possible Funding Sources: mitigation funds from local developers NJDEP grant programs like 319(h) and 604(b) Hamilton Township home and school associations	
Partners/Stakeholders: Hamilton Township, teachers, students and parents, and Rutgers Cooperative Extension	

Estimated Cost: Rain garden #1 would need to be approximately 5,750 square feet in size. At \$5 per square foot, the estimated cost of the rain garden is \$28,844. Rain garden #2 would need to be approximately 18,750 square feet in size. At \$5 per square foot, the estimated cost of the rain garden is \$93,750. The porous asphalt would be need to be approximately 10,000 square foot and would cost approximately \$250,000 at \$25 per square foot.

Hamilton Township Impervious Cover Assessment

Reynolds Middle School

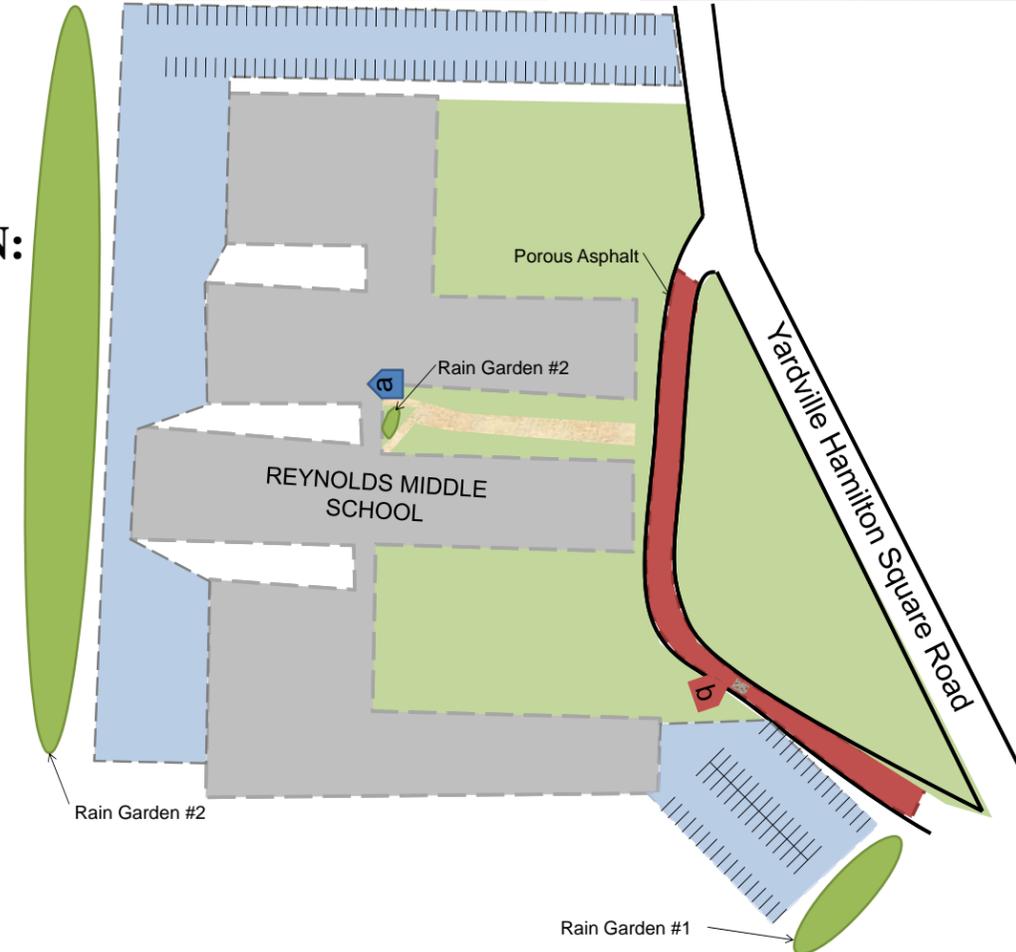
PROJECT LOCATION:



SITE PHOTOS:



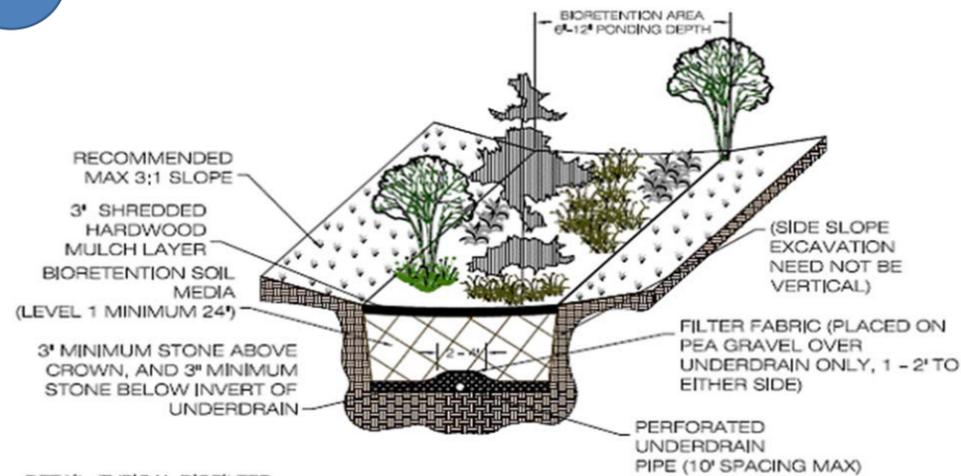
SITE PLAN:



BIORETENTION SYSTEM: A bioretention system/rain garden should be installed on a triangular piece of lawn near the front of the building. Currently there is a connected downspout that is directing runoff to the pavement. Rain gardens also can be used to capture runoff from the parking lots in the southeast corner of the site and north side of the property. The bioretention system would also capture runoff from the asphalt in the back of the school. A bioretention system would intercept, infiltrate, and treat runoff from a portion of the school's rooftop.

POROUS ASPHALT: The front drive would be replaced with porous asphalt. The area around an existing catch basin shows water pooling in the front drive.

1 BIORETENTION SYSTEM



DETAIL: TYPICAL BIOFILTER

2 POROUS ASPHALT

