RUTGERS
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Experiment Station

Draft

Impervious Cover Assessment for Elsinboro Township, Salem County, New Jersey

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

April 2, 2018

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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 has also increased greatly with this trend, costing billions of dollars over this time span.

- <u>Erosion</u>: Increased stormwater runoff causes an increase in the velocity of flows in our waterways. The increased velocity after storm events erodes stream banks and shorelines, degrading water quality. This erosion can damage local roads and bridges and cause harm to wildlife.

The primary cause of the pollution, flooding, and erosion problems is the quantity of impervious surfaces draining directly to local waterways. New Jersey is one of the most developed states in the country. Currently, the state has the highest percent of impervious cover in the country at 12.1% of its total area (Nowak & Greenfield, 2012). Many of these impervious surfaces are directly connected to local waterways (i.e., every drop of rain that lands on these impervious surfaces ends up in a local river, lake, or bay without any chance of being treated or soaking into the ground). To repair our waterways, reduce flooding, and stop erosion, stormwater runoff from impervious surfaces has to be better managed. Surfaces need to be disconnected with green infrastructure to prevent stormwater runoff from flowing directly into New Jersey's waterways. Disconnection redirects runoff from paving and rooftops to pervious areas in the landscape.

Green infrastructure is an approach to stormwater management that is cost-effective, sustainable, and environmentally friendly. Green infrastructure projects capture, filter, absorb, and reuse stormwater to maintain or mimic natural systems and to treat runoff as a resource. As a general principal, green infrastructure practices use soil and vegetation to recycle stormwater runoff through infiltration and evapotranspiration. When used as components of a stormwater management system, green infrastructure practices such as bioretention, green roofs, porous pavement, rain gardens, and vegetated swales can produce a variety of environmental benefits. In addition to effectively retaining and infiltrating rainfall, these technologies can simultaneously help filter air pollutants, reduce energy demands, mitigate urban heat islands, and sequester carbon while also providing communities with aesthetic and natural resource benefits (USEPA, 2013).

The first step to reducing the impacts from impervious surfaces is to conduct an impervious cover assessment. This assessment can be completed on different scales: individual lot, municipality, or watershed. Impervious surfaces need to be identified for stormwater management. Once impervious surfaces have been identified, there are three steps to better manage these surfaces.

1. ***Eliminate surfaces that are not necessary.*** For example, a paved courtyard at a public school could be converted to a grassed area.

2. ***Reduce or convert impervious surfaces.*** There may be surfaces that are required to be hardened, such as roadways or parking lots, but could be made smaller and still be functional. A parking lot that has two-way car ways could be converted to one-way car ways. There also are permeable paving materials such as porous asphalt, pervious concrete, or permeable paving stones that could be substituted for impermeable paving materials (Figure 2).

3. ***Disconnect impervious surfaces from flowing directly to local waterways.*** There are many ways to capture, treat, and infiltrate stormwater runoff from impervious surfaces. Opportunities may exist to reuse this captured water.

Figure 2: Rapid infiltration of water through porous pavement is demonstrated at the USEPA Edison New Jersey test site

Elsinboro Township Impervious Cover Analysis

Elsinboro Township is located in Salem County, New Jersey and covers approximately 13.15 square miles south of Salem Figures 3 and 4 illustrate that Elsinboro Township is dominated by wetland land uses. A total of 6.7% of the municipality's land use is classified as urban. Of the urban land in Elsinboro Township, rural residential is the dominant land use (Figure 5).

The literature suggests a link between impervious cover and stream ecosystem impairment (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. Schueler (1994, 2004) developed an impervious cover model that classified "sensitive streams" as typically having 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. Schueler et al. (2009) reformulated the impervious cover model based upon new research that had been conducted. This new analysis determined that stream degradation was first detected at 2 to 15% impervious cover. The updated impervious cover model recognizes the wide variability of stream degradation at impervious cover below 10%. The updated model also moves away from having a fixed line between stream quality classifications. For example, 5 to 10% impervious cover is included for the transition from sensitive to impacted, 20 to 25% impervious cover for the transition between impacted and non-supporting, and 60 to 70% impervious cover for the transition from non-supporting to urban drainage.

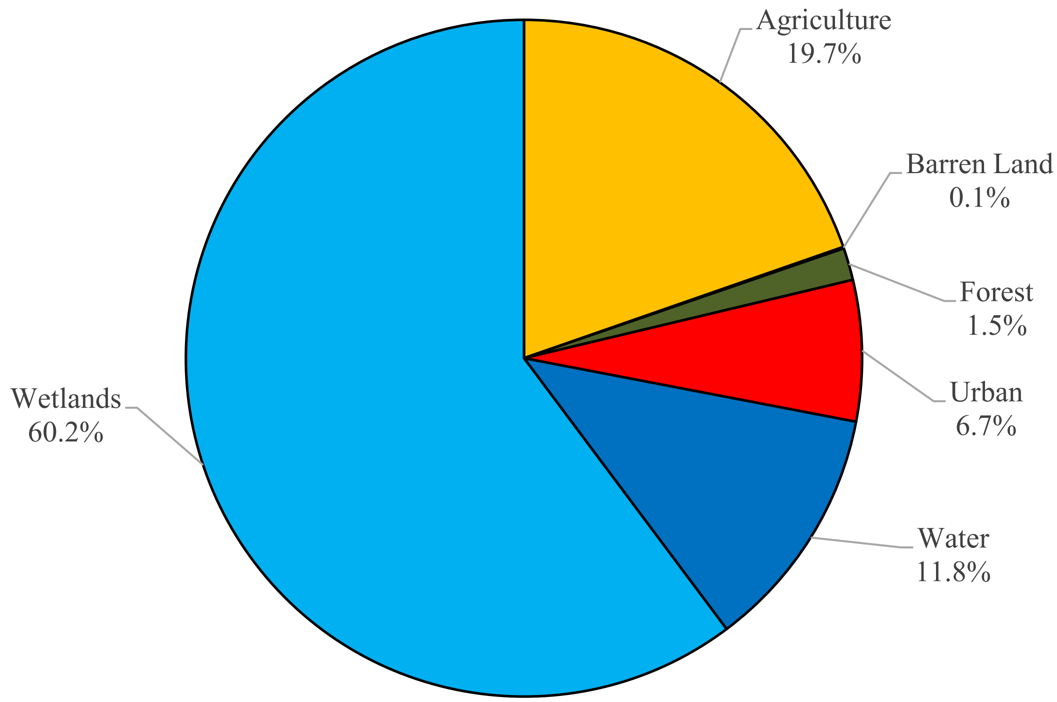


Figure 3: Pie chart illustrating the land use in Elsinboro Township

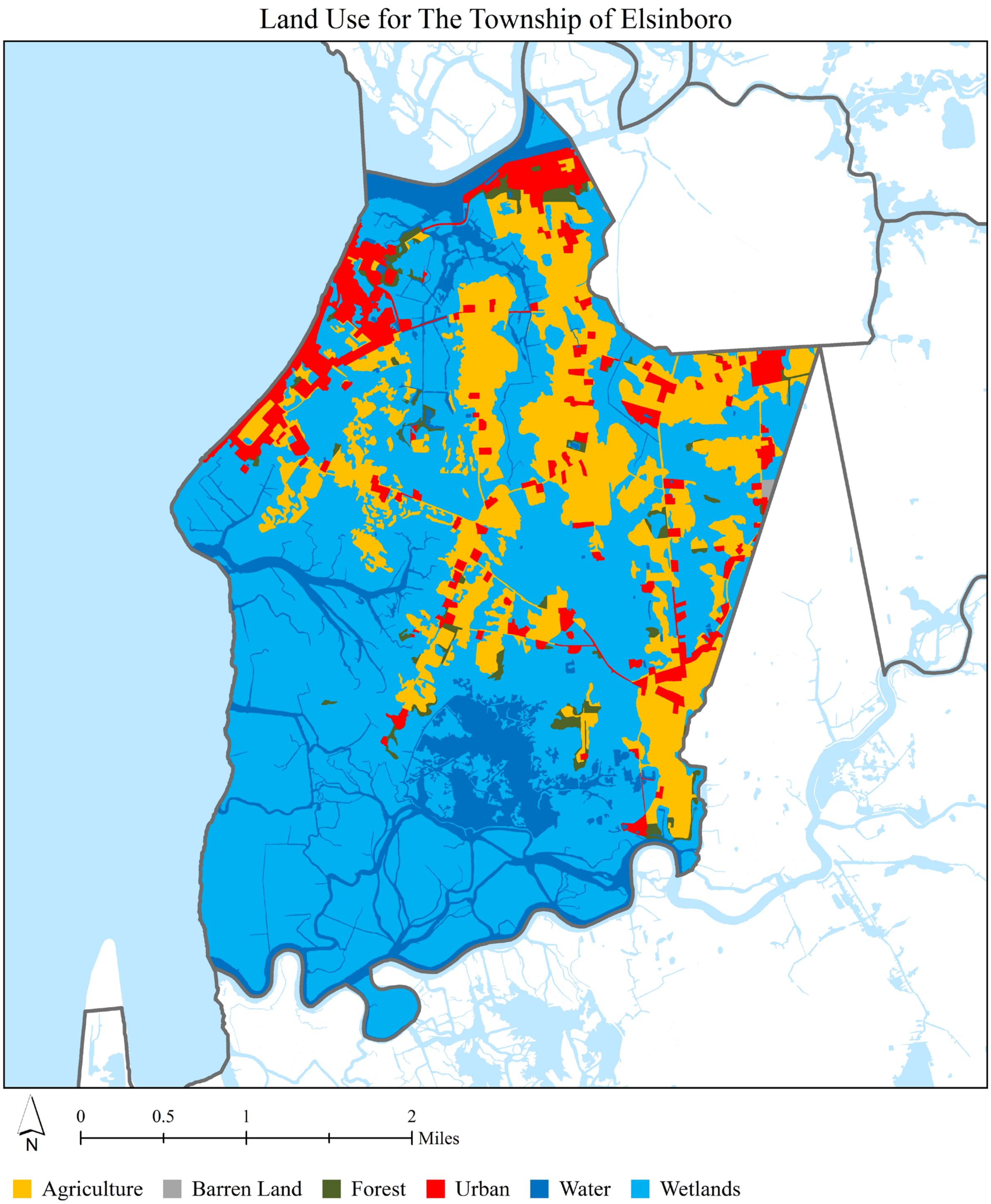


Figure 4: Map illustrating the land use in Elsinboro Township

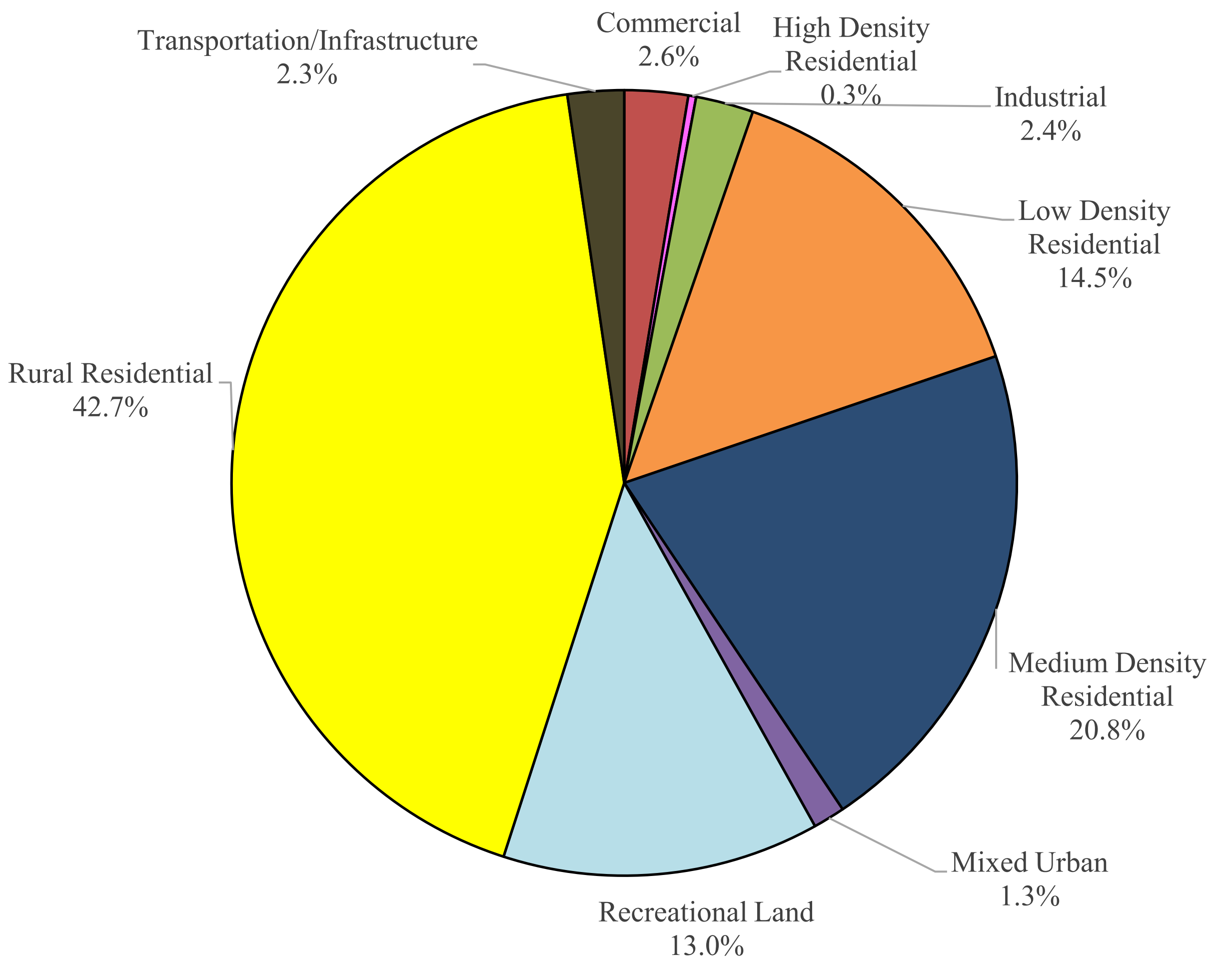


Figure 5: Pie chart illustrating the various types of urban land use in Elsinboro Township

The New Jersey Department of Environmental Protection's (NJDEP) 2012 land use/land cover geographical information system (GIS) data layer categorizes Elsinboro 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 Elsinboro Township. Based upon the 2012 NJDEP land use/land cover data, approximately 1.5% of Elsinboro Township has impervious cover. This level of impervious cover suggests that the streams in Elsinboro Township are likely sensitive streams.

Water resources are typically managed on a watershed/subwatershed basis; therefore, an impervious cover analysis was performed for each subwatershed within Elsinboro Township (Table 1 and Figure 6). On a subwatershed basis, impervious cover ranges from 1.0% in the Alloway Creek subwatershed to 6.0% in the Fenwick Creek/Keasbeys Creek 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 Elsinboro Township, Salem 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 (8.5 inches of rain). These runoff volumes are summarized in Table 2. A substantial amount of rainwater drains from impervious surfaces in Elsinboro Township. For example, if the stormwater runoff from one water quality storm (1.25 inches of rain) in the Salem River subwatershed was harvested and purified, it could supply water to 19 homes for one year[1].

[1] Assuming 300 gallons per day per home

Table 1: Impervious cover analysis by subwatershed for Elsinboro Township

Subwatershed	Total Area		Land Use Area		Water Area		Impervious Cover		
	(ac)	(mi^2)	(ac)	(mi^2)	(ac)	(mi^2)	(ac)	(mi^2)	(%)
Alloway Creek	5,097.2	7.96	4,329.1	6.76	768.2	1.20	44.4	0.07	1.0%
Fenwick Creek / Keasbeys Creek	55.3	0.09	55.3	0.09	0.0	0.00	3.3	0.01	6.0%
Salem River	6,084.6	9.51	3,042.3	4.75	3042.3	4.75	61.5	0.10	2.0%
Total	11,237.1	17.56	7,426.7	11.60	3810.5	5.95	109.2	0.17	1.5%

Subwatersheds of The Township of Elsinboro

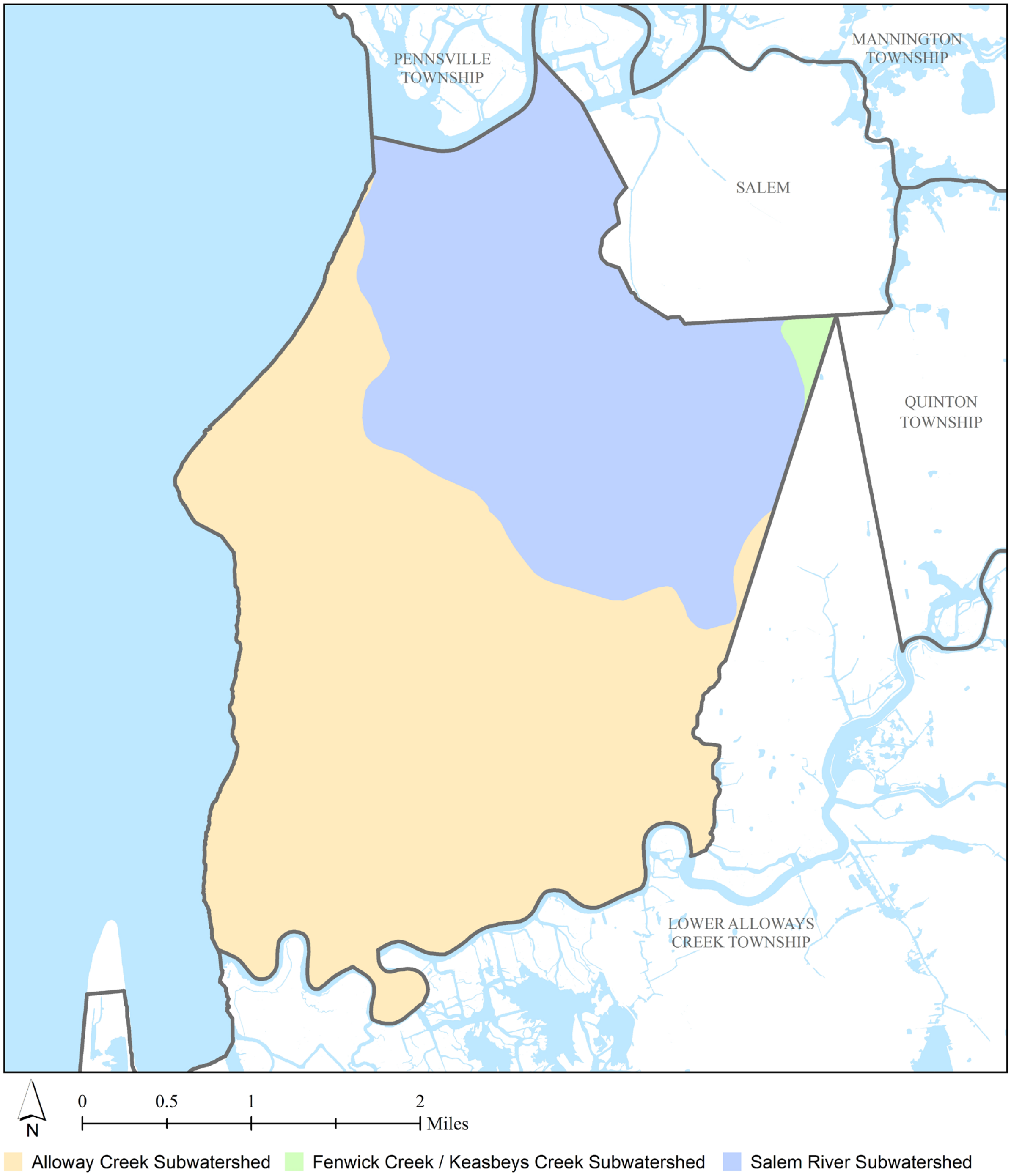


Figure 6: Map of the subwatersheds in Elsinboro Township

Table 2: Stormwater runoff volumes from impervious surfaces by subwatershed in Elsinboro 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 (8.5") (MGal)
Alloway Creek	1.5	53.1	3.9	6.0	10.2
Fenwick Creek / Keasbeys Creek	0.1	4.0	0.3	0.5	0.8
Salem River	2.1	73.4	5.4	8.3	14.1
Total	3.7	130.4	9.7	14.8	25.1

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 Elsinboro 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 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 Elsinboro Township

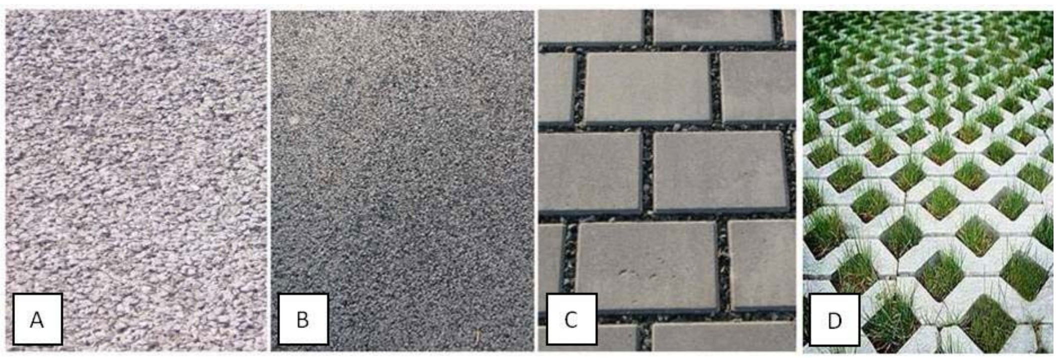
Subwatershed	Recommended Impervious Area Reduction (10%) (ac)	Annual Runoff Volume Reduction[2] (Mgal)
Alloway Creek	4.4	5.0
Fenwick Creek / Keasbeys Creek	0.3	0.4
Salem River	6.1	7.0
Total	10.9	12.4

[2] Annual Runoff Volume Reduction =
Acres of IC 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 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.

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 Elsinboro 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 Elsinboro 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

Elsinboro 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

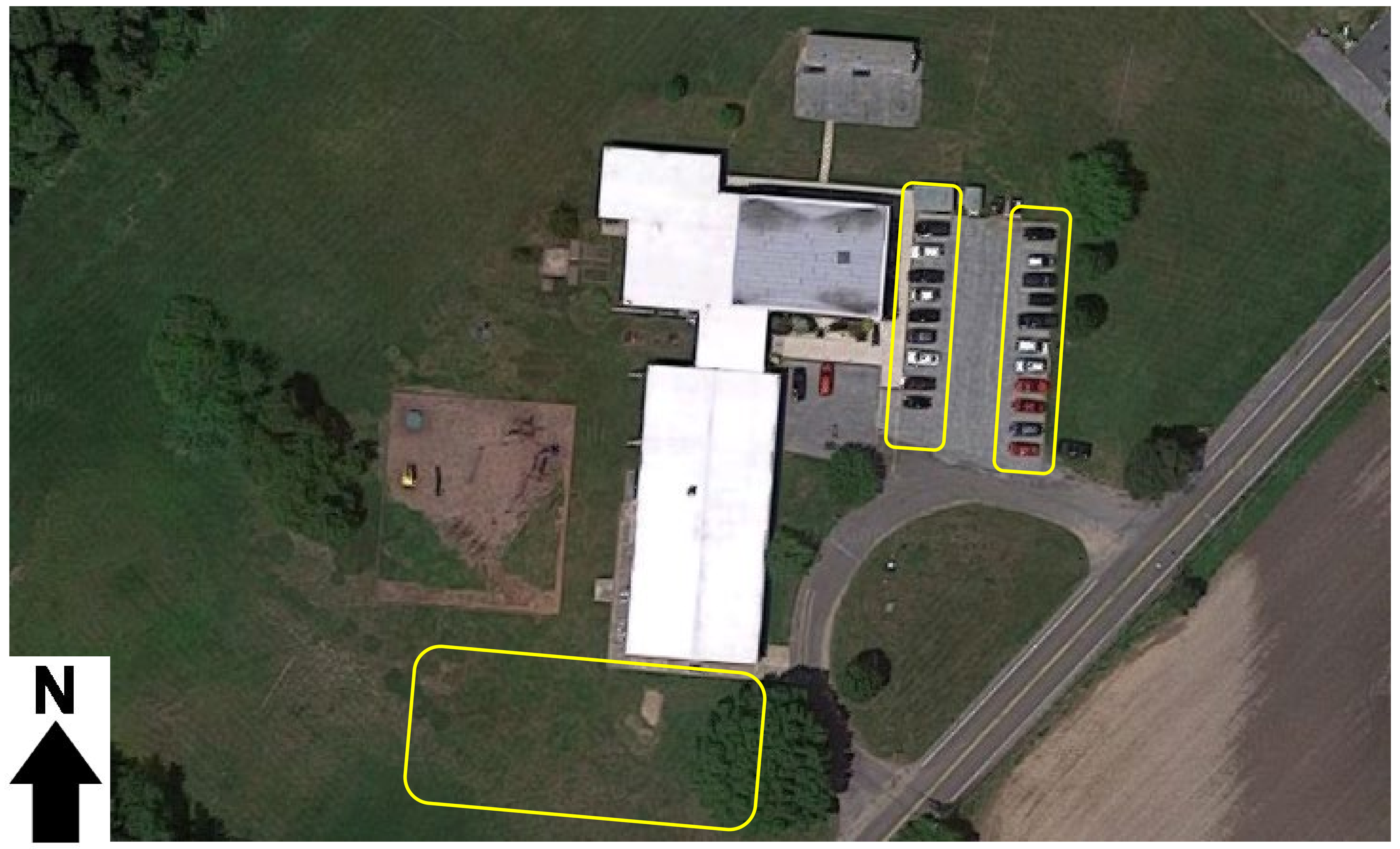
Concept Plans and Detailed Green Infrastructure Information Sheets

Elsinboro Township

Impervious Cover Assessment

Elsinboro Township School District, 631 Salem Fort Elfsborg Road

PROJECT LOCATION:

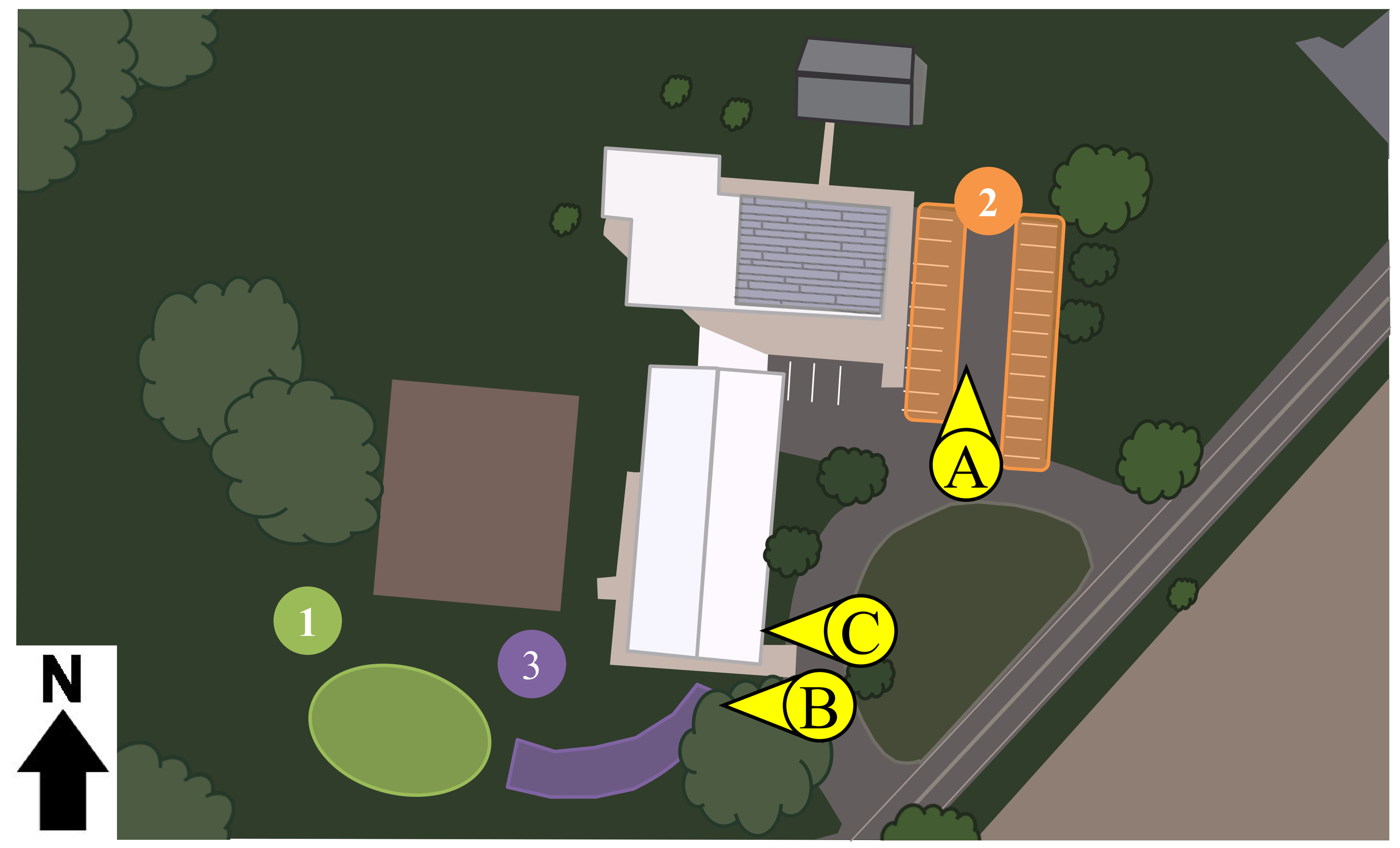


1 **BIORETENTION SYSTEM:** A rain garden could be installed in the turfgrass area southwest of the school district building. Rain gardens can be used to reduce sediment and nutrient loading to the local waterway and increase groundwater recharge.

2 **PERVIOUS PAVEMENT:** Parking spaces west of the building could be replaced with pervious pavement. Pervious pavement promotes groundwater recharge and filters stormwater. These surfaces are hard and support vehicle traffic but also allow water to infiltrate through the surface.

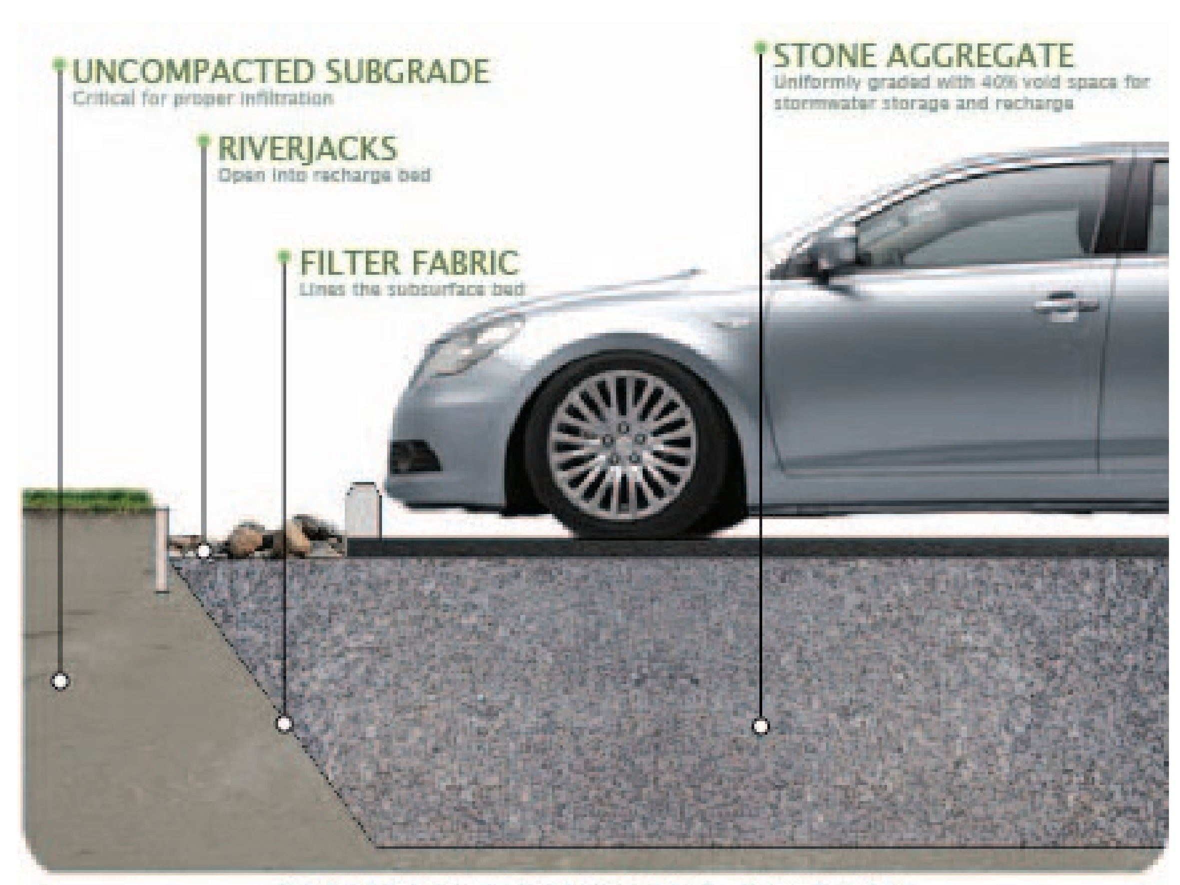
3 **BIOSWALE:** Bioswales are landscape features that convey stormwater from one location to another while removing pollutants and providing water an opportunity to infiltrate.

SITE PLAN:

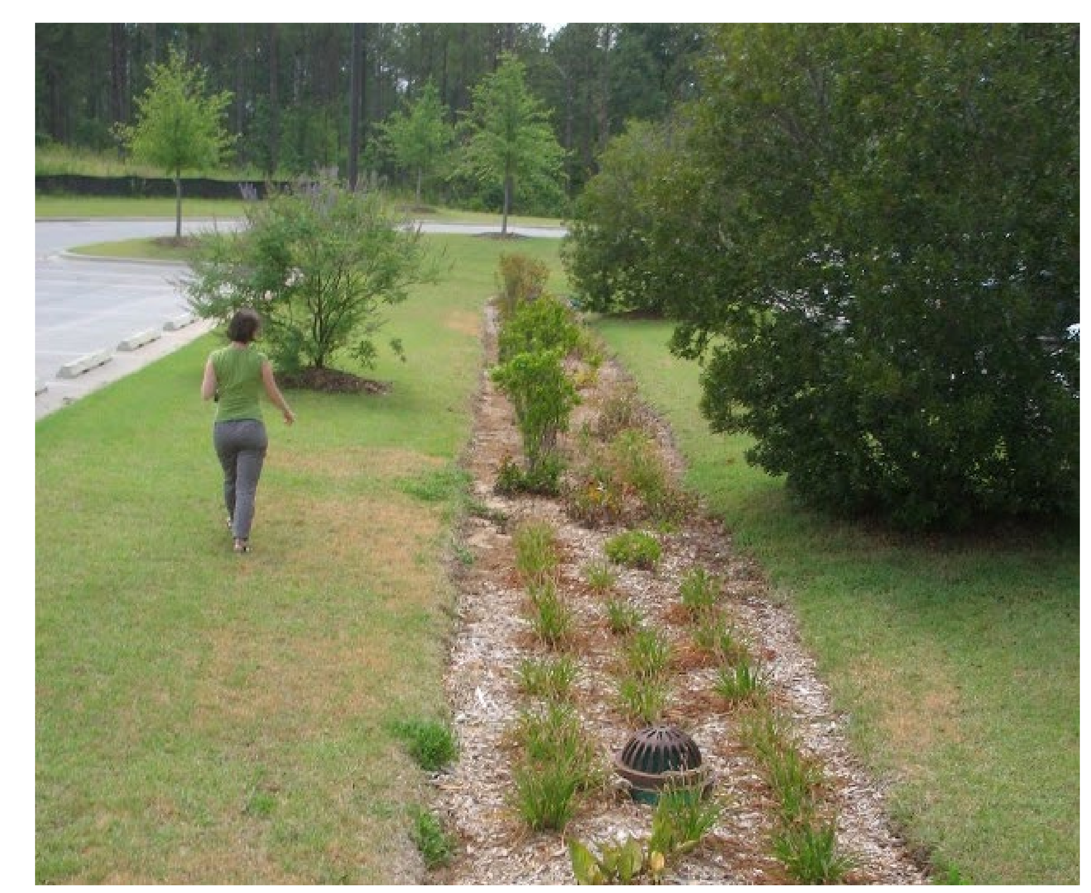


1 BIORETENTION SYSTEM

2 PERVIOUS PAVEMENT



3 BIOSWALE



Elsinboro Township School District
Green Infrastructure Information Sheet

Location: 631 Salem Fort Elfsborg Road Salem, NJ 08079	**Municipality:** Elsinboro Township **Subwatershed:** Alloway Creek
Green Infrastructure Description: bioretention system (rain garden) bioswale pervious pavement	**Targeted Pollutants:** total nitrogen (TN), total phosphorus (TP), and total suspended solids (TSS) in surface runoff
Mitigation Opportunities: recharge potential: yes stormwater peak reduction potential: yes total suspended solids removal potential: yes	**Stormwater Captured and Treated Per Year:** bioretention system: 288,560 gal. porous pavement #1: 295,990 gal. porous pavement #2: 225,120 gal. bioswale: 228,640 gal.

Existing Conditions and Issues:
Several downspouts direct rooftop runoff from the building to the eastern parking lot. The lot is pitched away from the building. Southwest of the school district building there is a steeply sloped turfgrass area with considerable pooling of water at its bottom.

Proposed Solutions:
Pervious pavement can be installed in the eastern parking lot to capture and infiltrate rooftop runoff and stormwater runoff from the remainder of the parking lot. A bioswale can be used to convey water from downspouts at the southern part of the building to a rain garden installed in the southwest turfgrass area.

Anticipated Benefits:
Since the bioretention system would be designed to capture, treat, and infiltrate the entire 2-year design storm (3.3 inches of rain over 24 hours), the system is estimated to reduce TN by 30%, TP by 60%, and TSS by 90%. A bioretention system would also provide ancillary benefits, such as enhanced wildlife and aesthetic appeal, to the students, parents, and educators of Elsinboro Township School District.

The bioswale will capture, treat, and infiltrate stormwater reducing TN by 30%, TP by 60%, and TSS by 90%.

Pervious pavement allows stormwater to infiltrate through to soil layers which will promote groundwater recharge as well as intercept and filter stormwater runoff. The pervious pavement system will achieve the same level of pollutant load reduction for TN, TP, and TSS as the bioretention system.

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

Partners/Stakeholders: Elsinboro Township Elsinboro Township School District local community groups students and parents Rutgers Cooperative Extension
Estimated Cost: A rain garden to capture the rooftop runoff would need to be approximately 2,770 square feet. At $5 per square foot, the estimated cost of the rain garden is $13,850. The bioswale would need to be 115 feet long and 20 feet wide (2,300 square feet). At $5 per square foot, the estimate cost of the bioswale is $11,500. The porous asphalt would cover 3,910 square feet and have a two-foot stone reservoir under the surface. At $25 per square foot, the cost of the porous asphalt system would be $97,750. The total cost of the project will be approximately $123,100.

Elsinboro Township
Impervious Cover Assessment
Elsinboro Town Hall, 619 Fort Elfsborg Road

Rutgers New Jersey Agricultural Experiment Station

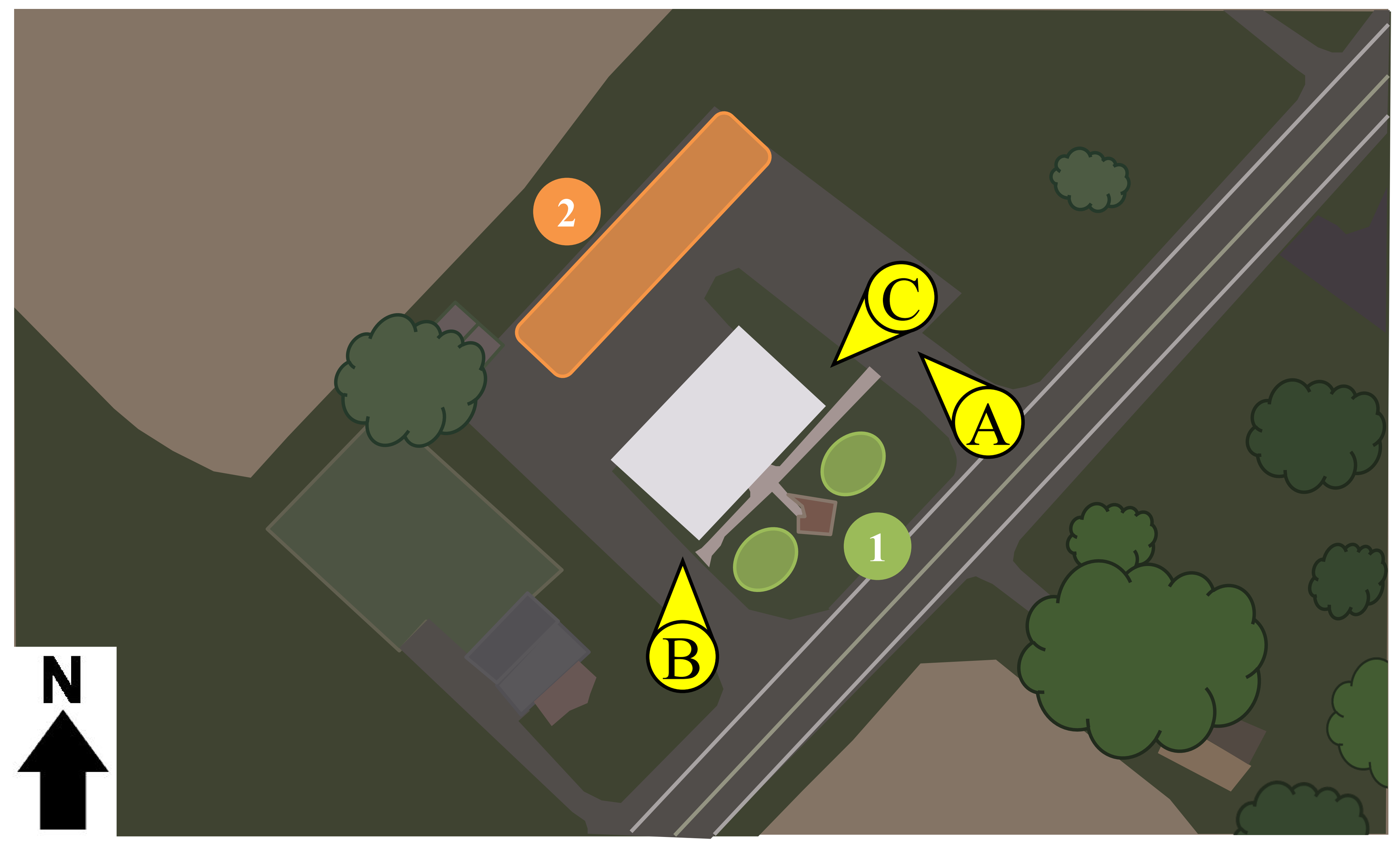
A

B

C

PROJECT LOCATION:

SITE PLAN:

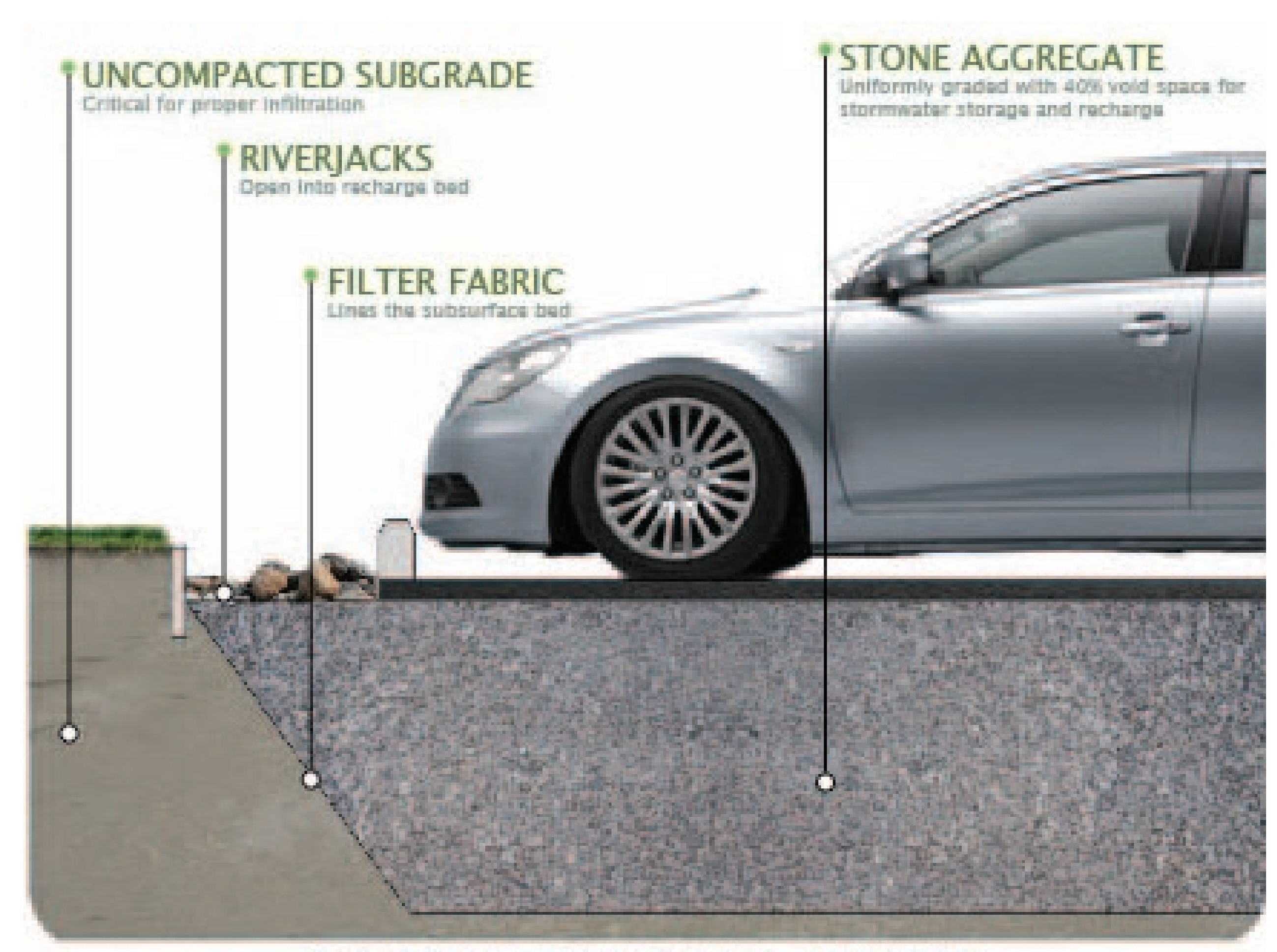


1 **BIORETENTION SYSTEM:** Rain gardens could be installed in the turfgrass at the entrance to town hall. Rain gardens could be used to reduce sediment and nutrient loading to the local waterway and increase groundwater recharge.

2 **PERVIOUS PAVEMENT:** Pervious pavement promotes groundwater recharge and filters stormwater. These surfaces are hard and support vehicle traffic but also allow water to infiltrate through the surface. Parking spaces north of the building could be replaced with pervious pavement.

1 BIORETENTION SYSTEM

2 PERVIOUS PAVEMENT



Elsinboro Township Town Hall
Green Infrastructure Information Sheet

Location: 619 Fort Elfsborg Road Salem, NJ 08079	**Municipality:** Elsinboro Township **Subwatershed:** Alloway Creek
Green Infrastructure Description: bioretention system (rain garden) pervious pavement	**Targeted Pollutants:** total nitrogen (TN), total phosphorus (TP), and total suspended solids (TSS) in surface runoff
Mitigation Opportunities: recharge potential: yes stormwater peak reduction potential: yes total suspended solids removal potential: yes	**Stormwater Captured and Treated Per Year:** bioretention system # 1: 33,870 gal. bioretention system # 2: 33,870 gal. porous pavement: 279,700 gal.

Existing Conditions and Issues:
The parking lot, which surrounds the building, is pitched towards a nearby northwestern field in which water seems to pool. Several downspouts on all sides of the building direct rooftop runoff to the pavement, which shows signs of water damage. Two adjacent turfgrass areas frame the entranceway of the building.

Proposed Solution(s):
Pervious pavement can be installed along the northwest edge of the parking lot to capture and infiltrate stormwater runoff. Downspouts can be redirected to the turfgrass areas on either side of the entrance where rain gardens can be installed to capture, treat, and infiltrate rooftop runoff.

Anticipated Benefits:
Since the bioretention systems would be designed to capture, treat, and infiltrate the entire 2-year design storm (3.3 inches of rain over 24 hours), these systems are estimated to reduce TN by 30%, TP by 60%, and TSS by 90%. A bioretention system would also provide ancillary benefits, such as enhanced wildlife and aesthetic appeal, to the local residents of Elsinboro Township.

Pervious pavement allows stormwater to infiltrate through to soil layers which will promote groundwater recharge as well as intercept and filter stormwater runoff. The pervious pavement system will achieve the same level of pollutant load reduction for TN, TP, and TSS as the bioretention system.

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

Partners/Stakeholders:
Elsinboro Township
Elsinboro Township Town Hall
local community groups
residents
Rutgers Cooperative Extension

Estimated Cost:
Rain garden #1 would need to be approximately 325 square feet. At $5 per square foot, the estimated cost is $1,625. Rain garden #2 would need to be approximately 325 square feet. At $5 per square foot, the estimated cost is $1,625.

The porous asphalt would cover 2,384 square feet and have a two-foot stone reservoir under the surface. At $25 per square foot, the cost of the porous asphalt system would be $59,600.

The total cost of the project will be approximately $62,850.

Elsinboro Township
Impervious Cover Assessment
The Inn at Salem Country Club, 91 Salem Country Club Road

Rutgers New Jersey Agricultural Experiment Station

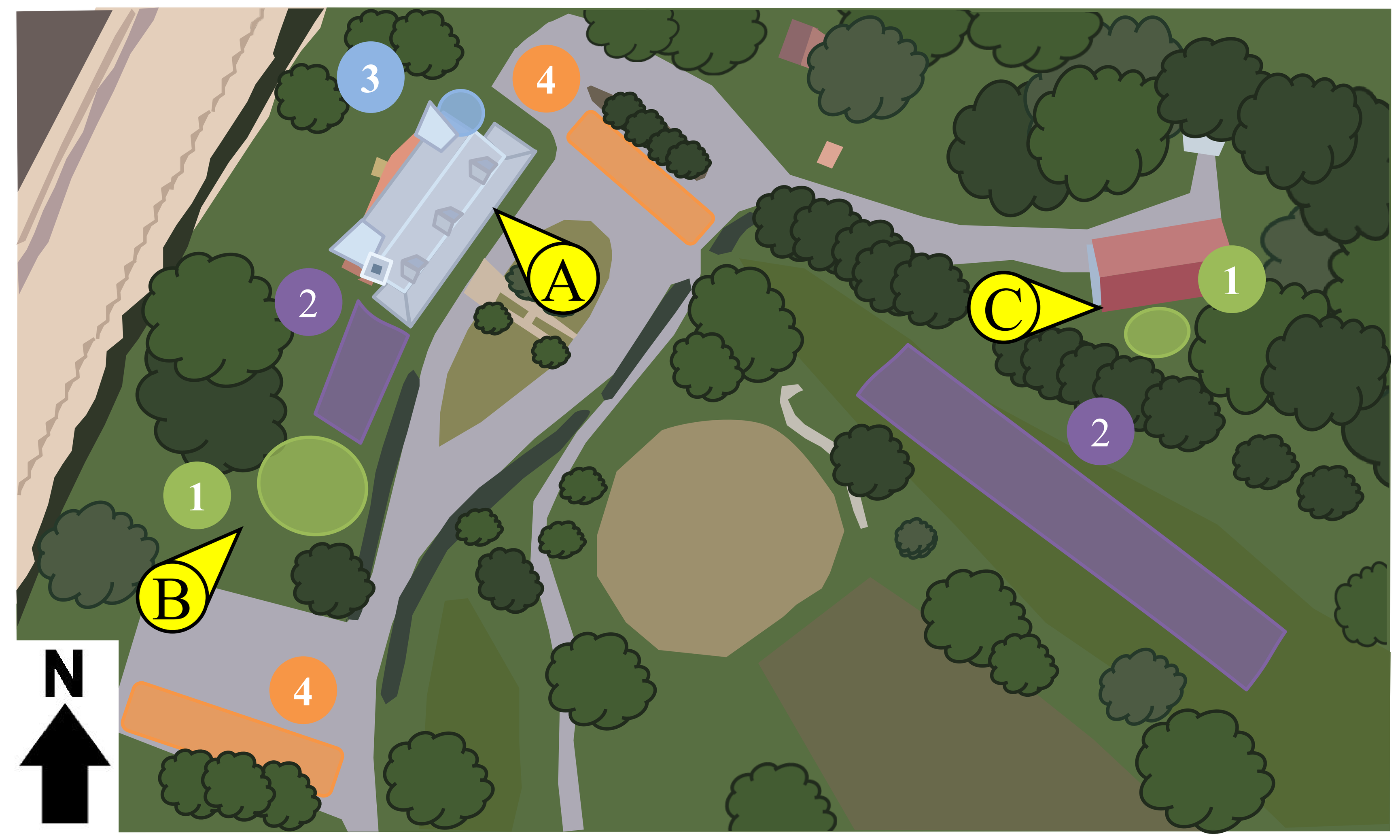
A

B

C

PROJECT LOCATION:

SITE PLAN:



1 **BIORETENTION SYSTEM:** Two rain gardens can be installed to reduce sediment and nutrient loading to the local waterway and increase groundwater recharge.

2 **BIOSWALE:** Bioswales are landscape features that convey stormwater from one location to another while removing pollutants and providing water an opportunity to infiltrate. Bioswales can be built south and southwest of the Inn to help manage the stormwater generated from the site.

3 **RAINWATER HARVESTING SYSTEM:** Rainwater can be harvested from the roof of the building and stored in a cistern for non-potable uses such as watering a garden or washing vehicles.

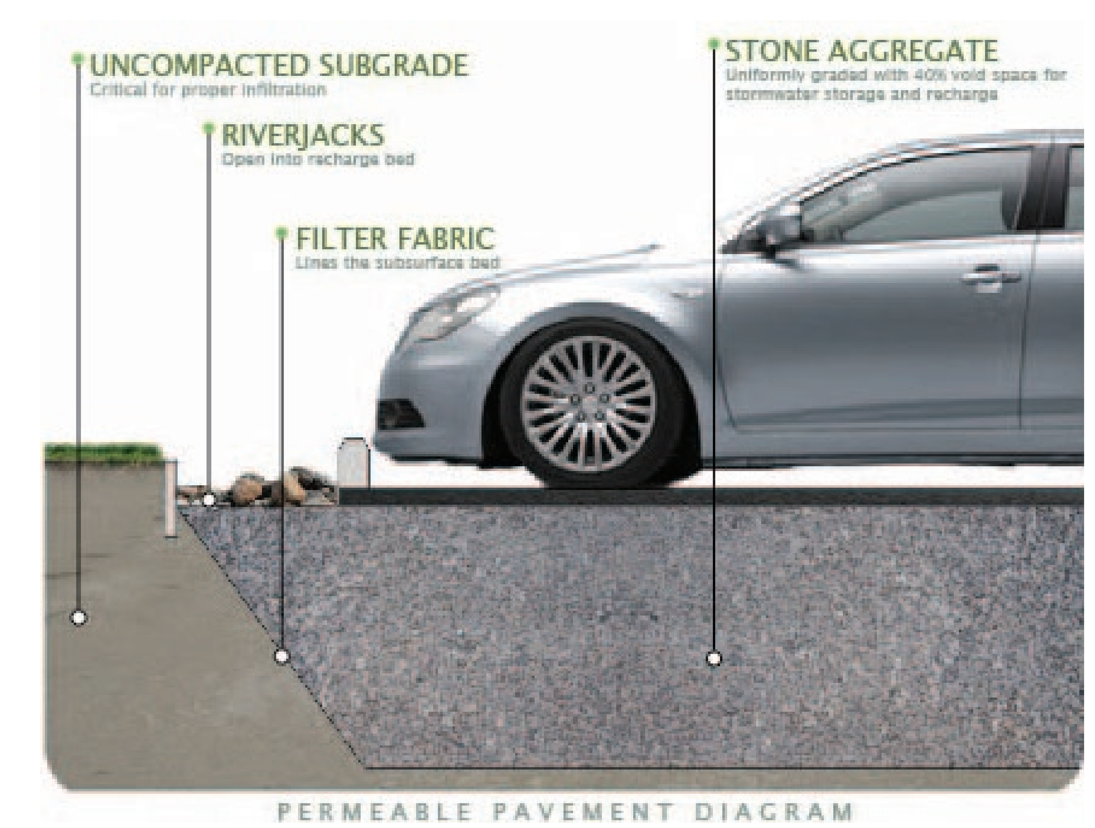
4 **PERVIOUS PAVEMENT:** Pervious pavement promotes groundwater recharge and filters stormwater. These surfaces are hard and support vehicle traffic but also allow water to infiltrate through the surface. Parking spaces could be replaced with pervious pavement.

1 BIORETENTION SYSTEM

2 BIOSWALE

3 RAINWATER HARVESTING SYSTEM

4 PERVIOUS PAVEMENT



The Inn at Salem Country Club
Green Infrastructure Information Sheet

Location: 91 Salem Country Club Road Salem, NJ 08079	**Municipality:** Elsinboro Township **Subwatershed:** Salem River
Green Infrastructure Description: bioretention system (rain garden) bioswale porous pavement rain harvesting system (rain barrel/cistern)	**Targeted Pollutants:** total nitrogen (TN), total phosphorus (TP), and total suspended solids (TSS) in surface runoff
Mitigation Opportunities: recharge potential: yes stormwater peak reduction potential: yes total suspended solids removal potential: yes	**Stormwater Captured and Treated Per Year:** bioretention system # 1: 154,770 gal. bioretention system # 2: 95,100 gal. bioswale # 1: 625,330 gal. bioswale # 2: 123,370 gal. porous pavement # 1: 350,700 gal. porous pavement # 2: 133,270 gal. rain harvesting system: 31,655 gal.

Existing Conditions and Issues:
Downspouts from all sides of the Inn convey water into nearby turfgrass areas surrounding the building. East of the Inn is a cart barn that is near a sloped turfgrass area. This area shows signs of flooding and erosion. Southeast of the Inn is an area that drains poorly. There are two parking lots: one south of the Inn and another other east of the Inn. The southern parking lot is somewhat irregular and seemingly pitched, while the eastern lot seems newer. Monarch butterflies frequently migrate through this property.

Proposed Solution(s):
Downspouts can be redirected towards a cistern north of the building and towards a bioswale and rain garden in the turfgrass area south of the Inn. The water collected by the cistern can be used to water the garden located southeast of the Inn. A rain garden can also be installed in the turfgrass area adjacent to the cart barn to capture and infiltrate rooftop runoff. The rain gardens can be comprised of plants that would attract migrating Monarch butterflies. Strips of both parking lots can be converted to pervious pavement to manage stormwater runoff from the street and from the rest of the lot. A bioswale can be installed southeast of the Inn to divert water away from the area that drains poorly and towards an area where it will be more likely to infiltrate.

Anticipated Benefits:

Since the bioretention systems would be designed to capture, treat, and infiltrate the entire 2-year design storm (3.3 inches of rain over 24 hours), these systems are estimated to reduce TN by 30%, TP by 60%, and TSS by 90%. A bioretention system would also provide ancillary benefits, such as enhanced wildlife and aesthetic appeal, to local residents and to patrons of the Inn.

The bioswales will capture, treat, and infiltrate stormwater reducing TN by 30%, TP by 60%, and TSS by 90%.

Pervious pavement allows stormwater to infiltrate through to soil layers which will promote groundwater recharge as well as intercept and filter stormwater runoff. The pervious pavement system will achieve the same level of pollutant load reduction for TN, TP, and TSS as the bioretention system.

Rain barrels or cisterns can harvest stormwater which can be used for watering plants or other purposes which cuts back on use of potable water for nondrinking purposes. Since the rainwater harvesting system would be designed to capture the first 1.25 inches of rain, it would reduce the pollutant loading by 90% during the periods it is operational (i.e., it would not be used in the winter when there is a chance of freezing).

Possible Funding Sources:

mitigation funds from local developers
NJDEP grant programs
Elsinboro Township
local social and community groups

Partners/Stakeholders:

Elsinboro Township
The Inn at Salem Country Club
local community groups
local residents
Rutgers Cooperative Extension

Estimated Cost:

Rain garden #1 would need to be approximately 1,485 square feet. At $5 per square foot, the estimated cost is $7,425. Rain garden #2 would need to be approximately 950 square feet. At $5 per square foot, the estimated cost is $4,750.

The bioswale would need to be 150 feet long and 40 feet wide (6,000 square feet). At $5 per square foot, the estimate cost of the bioswale is $30,000. The second bioswale would need to be 70 feet long and 17 feet wide (1,190 square feet). At $5 per square foot, the estimate cost of the bioswale is $5,950.

The porous asphalt would cover a total of 3,582 square feet and have a two-foot stone reservoir under the surface. At $25 per square foot, the cost of the porous asphalt system would be $89,550.

The cistern would be 2,000 gallons and cost approximately $4,000 to purchase and install.

The total cost of the project will be approximately $141,675.