GREEN INFRASTRUCTURE FEASIBILITY STUDY

LITTLE FALLS

PASSAIC VALLEY SEWERAGE COMMISSION
"Protecting Public Health and the Environment"

RUTGERS
New Jersey Agricultural Experiment Station

ACKNOWLEDGEMENTS

This document has been prepared by the Rutgers Cooperative Extension Water Resources Program, with funding and direction from the Passaic Valley Sewerage Commission and the New Jersey Agricultural Experiment Station, to highlight green infrastructure opportunities within Little Falls.

We would like to thank the Passaic Valley Sewerage Commission, the New Jersey Agricultural Experiment Station, and Little Falls for their input and support in creating this document.

"Protecting Public Health and the Environment"

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GLOSSARY OF GREEN INFRASTRUCTURE TERMINOLOGY

1 **BEST MANAGEMENT PRACTICE (BMP)**

Activities or structural improvements that help reduce the quantity and improve the quality of stormwater runoff

2 **COMBINED SEWER OVERFLOW (CSO)**

During wet weather events, stormwater flows can exceed the capacity of the combined sewer system and/or the sewage treatment plant causing an overflow of a slurry of untreated wastewater and stormwater to local waterways.

3 **COMBINED SEWER SYSTEM (CSS)**

A wastewater collection system designed to carry sanitary sewage (consisting of domestic, commercial, and industrial wastewater) and stormwater (surface drainage from rainfall or snowmelt) in a single pipe to a treatment facility

4 **CONNECTED IMPERVIOUS SURFACE**

When stormwater runoff flows directly from an impervious surface to a local waterway or a sewer system, the impervious surface is considered “connected” or “directly connected.”

5 **DISCONNECTED IMPERVIOUS SURFACE**

When stormwater runoff flows from an impervious surface onto a pervious surface or into a green infrastructure practice prior to entering a local waterway or a sewer system, the impervious surface is considered “disconnected.”

6 **GREEN INFRASTRUCTURE PRACTICE**

A stormwater management practice that captures, filters, absorbs, and/or reuses stormwater to help restore the natural water cycle by reducing stormwater runoff, promoting infiltration, and/or enhancing evapotranspiration

7 **IMPERVIOUS COVER ASSESSMENT (ICA)**

Readily available land use/land cover data from the New Jersey geographic information system (GIS) database are used to determine the percentage of impervious cover in municipalities by subwatershed. The ICA includes calculations of stormwater runoff volumes associated with impervious surfaces.

8 **IMPERVIOUS COVER REDUCTION ACTION PLAN (RAP)**

A plan that identifies opportunities to retrofit specific sites with green infrastructure practices to reduce the impacts of stormwater runoff from impervious surfaces

9 **IMPERVIOUS SURFACE**

Any surface that has been covered with a layer of material so that it is highly resistant to infiltration by water (e.g., paved roadways, paved parking areas, and building roofs)

10 **LONG-TERM CONTROL PLAN (LTCP)**

A systemwide evaluation of the sewage infrastructure and the hydraulic relationship between sewers, precipitation, treatment capacity, and overflows; it identifies measures needed to eliminate or reduce the occurrence of CSOs

11 **LOW IMPACT DEVELOPMENT (LID)**

A land planning and engineering design approach that emphasizes conservation and use of on-site natural features to manage stormwater runoff and protect water quality

12 **MUNICIPAL SEPARATE STORM SEWER SYSTEM (MS4)**

A conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains) that transports stormwater runoff to local waterways or stormwater facilities such as a detention basin

13 **NONPOINT SOURCE (NPS) POLLUTION**

"Nonpoint source pollution" is also called "people pollution." It is the pollution that comes from our everyday lives. It is the fertilizers that wash off farms and lawns. It is the pet waste that washes into streams. It is the sediment (or soil) that erodes from the land into local waterways. It is the oil and grease that comes from parking lots. Finally, it is the pollutants such as nitrogen, phosphorus, and heavy metals that settle out of the atmosphere onto roads and rooftops. When it rains, stormwater runoff carries nonpoint source pollution and may ultimately wash it into waterways.

14 **PERVIOUS SURFACE**

Any surface that allows water to pass through it (e.g., lawn area)

15 **STORMWATER RUNOFF**

The water from rain or melting snows that can become "runoff" flowing over the ground surface and returning to lakes and streams

INTRODUCTION

In 2013, the Passaic Valley Sewerage Commission (PVSC) began a new initiative to assist the 48 municipalities within its jurisdiction to manage flooding and eliminate combined sewer overflows. With municipalities spread across five counties, PVSC is dedicated to leading efforts throughout the PVSC Sewerage District by using green infrastructure to intercept stormwater runoff, reduce combined sewer overflows (CSOs), manage existing water infrastructure, and minimize frequent flooding events. To help with this effort, PVSC has entered into a partnership with the Rutgers Cooperative Extension (RCE) Water Resources Program.

By using cost-effective green infrastructure practices, Little Falls can begin to reduce the negative impacts of stormwater runoff and decrease the pressure on local infrastructure and waterways. This feasibility study is intended to be used as a guide for the community of Little Falls to begin implementing green infrastructure practices while demonstrating to residents and local leaders the benefits of and opportunities for better managing stormwater runoff.

For Little Falls, potential green infrastructure projects have been identified. Each project has been classified as a mitigation opportunity for recharge potential, total suspended solids removal, and stormwater peak reduction. For each proposed green infrastructure practice, detailed green infrastructure information sheets provide an estimate of gallons of stormwater captured and treated per year. Additionally, concept designs for three of the potential green infrastructure projects have been developed. These concept designs provide an aerial photograph of the site and details of the proposed green infrastructure practices. Lastly, Appendix A of this document offers information about community engagement opportunities related to green infrastructure, while Appendix B provides maintenance guidelines for green infrastructure practices.

Rutgers University professor, Tobiah Horton, reviews a rain garden design with a homeowner.

WHAT IS GREEN INFRASTRUCTURE?

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 principle, 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).


A community garden that harvests and recycles rainwater


Rain barrel workshop participants


A rain garden after planting

WHAT IS STORMWATER?

When rainfall hits the ground, it can soak into the ground or flow across the surface. When rainfall flows across a surface, it is called "stormwater" runoff. Pervious surfaces allow stormwater to readily soak into the soil and recharge groundwater. 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 amount of stormwater runoff. New Jersey has many problems due to stormwater runoff from impervious surfaces, including:

- POLLUTION: According to the 2010 New Jersey Water Quality Assessment Report, 90% of the assessed waters in New Jersey are impaired. Urban-related stormwater runoff is 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 carried to 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 increased greatly with this trend, costing billions of dollars over this time span.
- EROSION: Increased stormwater runoff causes an increase in stream velocity. 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.

Stormwater catch basin

Purple cone flower

Pervious pavers

To protect and repair our waterways, reduce flooding, and stop erosion, stormwater runoff has to be better managed. Impervious 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.

WHY ARE IMPERVIOUS SURFACES IMPORTANT?

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).

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.

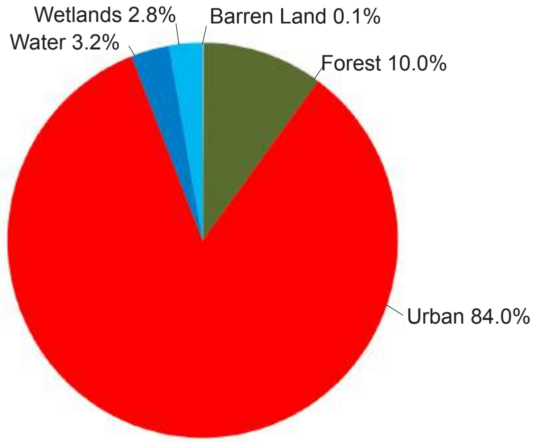
LITTLE FALLS

Little Falls is located in Passaic County and covers an area of approximately three square miles. The municipality has a population of 14,432 according to the 2010 US Census. The Passaic River runs along the northwest boundary of the municipality. The Peckman River, a tributary of the Passaic River, runs through the center of Little Falls. The Great Notch Brook starts from the southeastern side of Little Falls and runs along the north side of the municipality before flowing into the Peckman River. The municipality has a municipal separate storm sewer system (MS4).

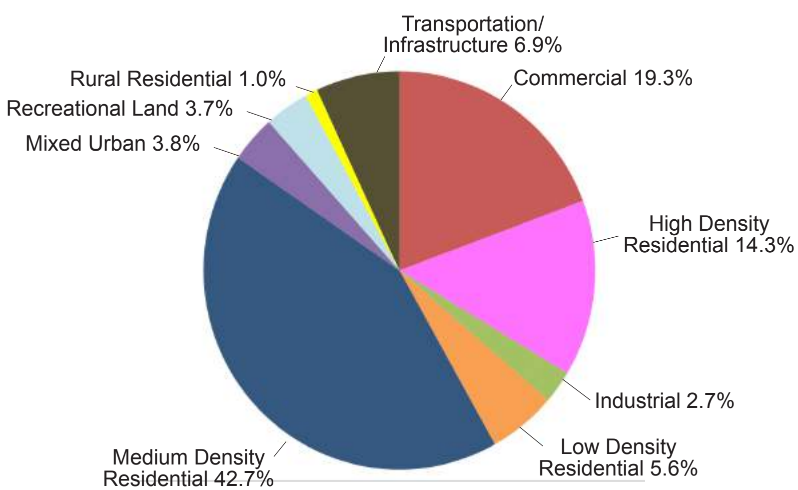
LAND USE IN LITTLE FALLS

Little Falls is dominated by urban land uses. A total of 80.4% of the municipality's land use is classified as urban. Of the urban land in Little Falls, medium density residential is the dominant land use. Urban land uses tend to have a high percentage of impervious surfaces.

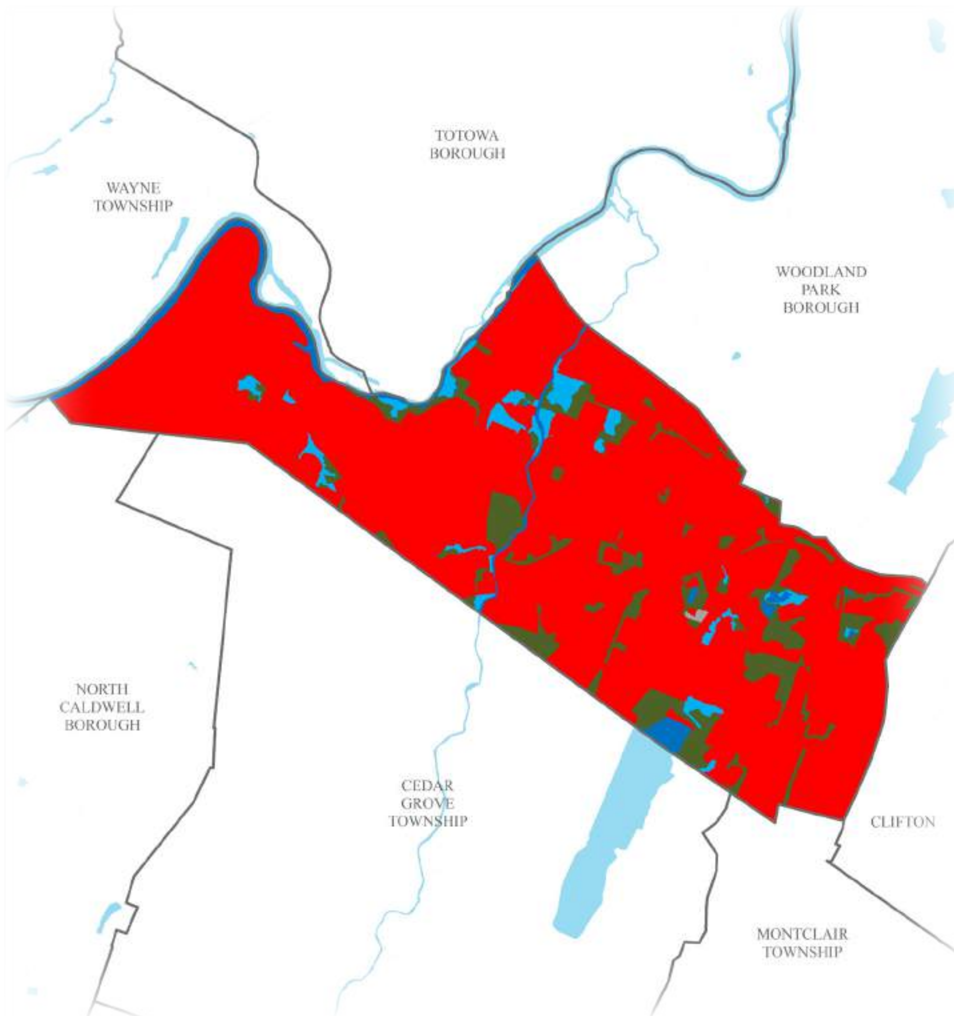
LITTLE FALLS LAND USE



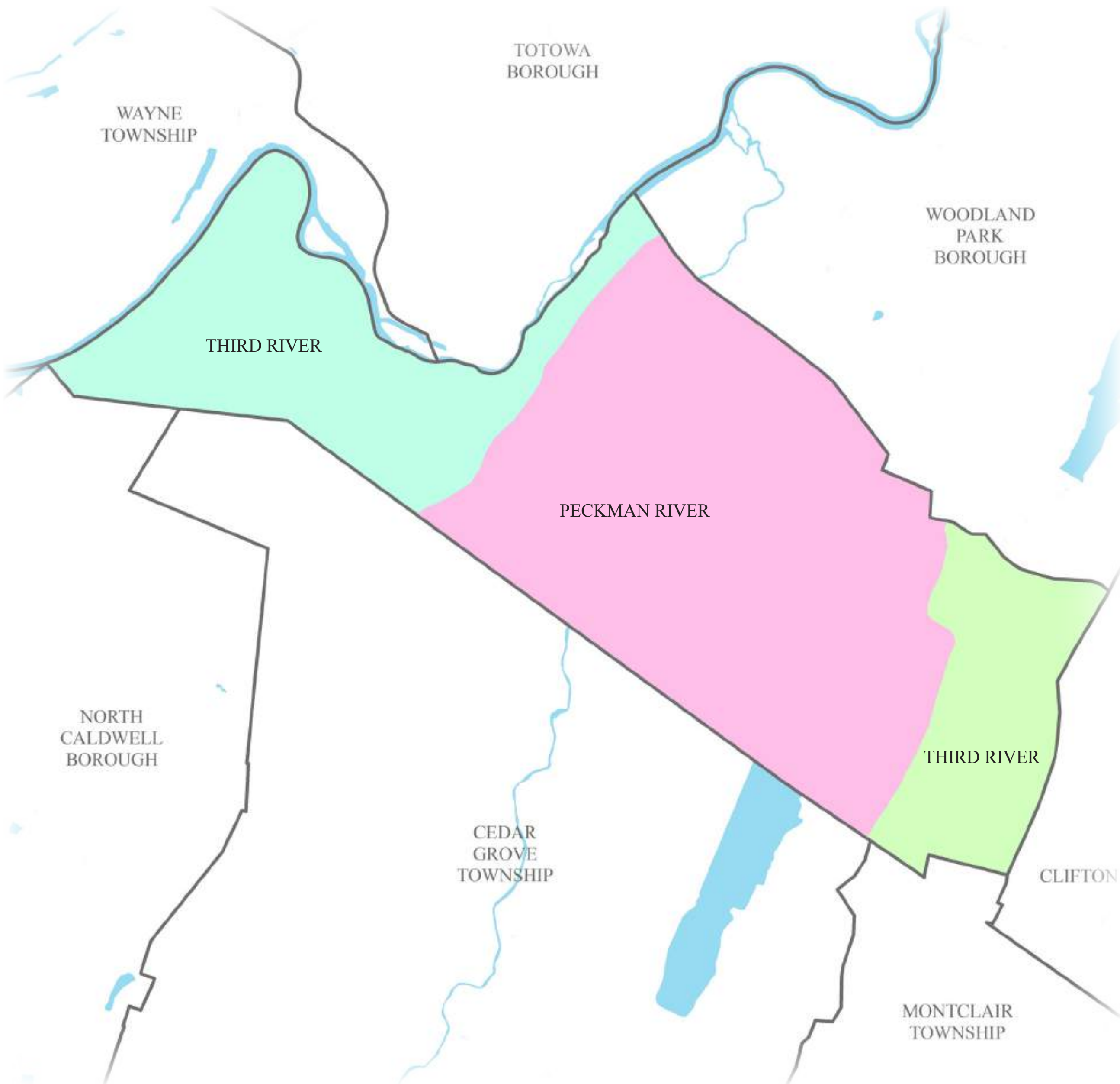
LITTLE FALLS URBAN LAND USE



LITTLE FALLS LAND USE



LITTLE FALLS SUBWATERSHEDS



IMPERVIOUS COVER ANALYSIS

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.

The New Jersey Department of Environmental Protection's (NJDEP) 2012 land use/land cover geographical information system (GIS) data layer categorizes Little Falls into many unique land use areas, assigning a percent impervious cover for each delineated area. These impervious cover values are used to estimate the impervious coverage for Little Falls. Based upon the 2012 NJDEP land use/land cover data, approximately 38.4% of Little Falls has impervious cover.

Water resources are typically managed on a watershed/subwatershed basis; therefore an impervious cover analysis has been performed for each subwatershed within Little Falls (Table 1). On a subwatershed basis, impervious cover ranges from 45.6% in the Lower Passaic River subwatershed to 33.8% in the Peckman River subwatershed. Evaluating impervious cover on a subwatershed basis allows the municipality to focus impervious cover reduction or disconnection efforts in the subwatersheds where frequent flooding occurs.


Connected downspout

Reservoir

TABLE 1. IMPERVIOUS COVER ANALYSIS BY SUBWATERSHED FOR LITTLE FALLS

Subwatershed	Total Area	Land Use Area	Water Area	Impervious Cover	
	(ac)	(ac)	(ac)	(ac)	(%)
Lower Passaic River	491.4	454.9	36.5	207.3	45.6%
Peckman River	1,072.7	1,052.0	20.7	355.1	33.8%
Third River	277.4	276.0	1.4	122.5	44.4%
Total	1,841.5	1,783.0	58.5	684.9	38.4%

TABLE 2. STORMWATER RUNOFF VOLUMES FROM IMPERVIOUS SURFACES BY SUBWATERSHED IN LITTLE FALLS

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 (3.5") (Mgal)	Total Runoff Volume for the 10-year Design Storm (5.3") (Mgal)	Total Runoff Volume for the 100 Year Design Storm(8.7") (Mgal)
Lower Passaic River	7.0	247.7	19.7	29.3	48.4
Peckman River	12.1	424.2	33.7	50.1	82.9
Third River	4.2	146.3	11.6	17.3	28.6
Total	23.2	818.2	65.1	96.7	161.8

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 Little Falls, Passaic County) associated with impervious surfaces have been 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 (3.5 inches of rain), the 10-year design storm (5.3 inches of rain), and the 100-year design storm (8.7 inches of rain). These runoff volumes are summarized in Table 2. A substantial amount of rainwater drains from impervious surfaces in Little Falls. For example, if the stormwater runoff from one water quality storm (1.25 inches of rain) in the Peckman River subwatershed was harvested and purified, it could supply water to 111 homes for a year (assuming 300 gallons per day per home).

WHAT CAN WE DO ABOUT IMPERVIOUS SURFACES?

Once impervious surfaces have been identified, there are three steps to better manage these surfaces through green infrastructure practices.

1

Eliminate surfaces that are not necessary. 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 recreation of natural areas that will help reduce flooding, increase wildlife habitat, and positively enhance water quality as well as beautify neighborhoods.

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.

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 also exist to harvest rainwater for non-potable uses such as water gardens.


SMART
RAIN GARDEN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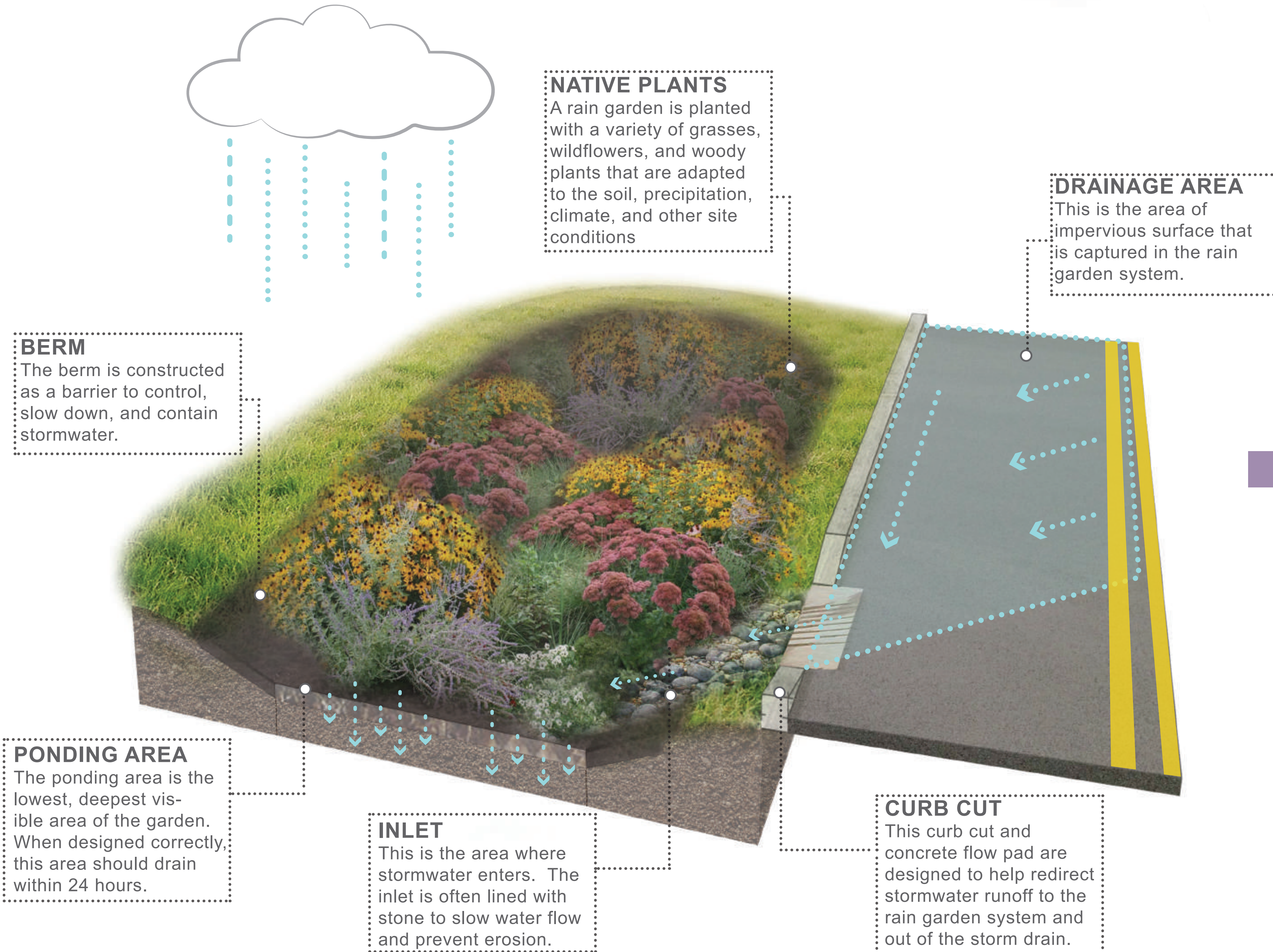
GREEN INFRASTRUCTURE PRACTICES

BIORETENTION SYSTEMS

A rain garden, or bioretention system, is a landscaped, shallow depression that captures, filters, and infiltrates stormwater runoff. The rain garden removes nonpoint source pollutants from stormwater runoff while recharging groundwater. A rain garden serves as a functional system to capture, filter, and infiltrate stormwater runoff at the source while being aesthetically pleasing. Rain gardens are an important tool for communities and neighborhoods to create diverse, attractive landscapes while protecting the health of the natural environment. Rain gardens can also be installed in areas that do not infiltrate by incorporating an underdrain system.

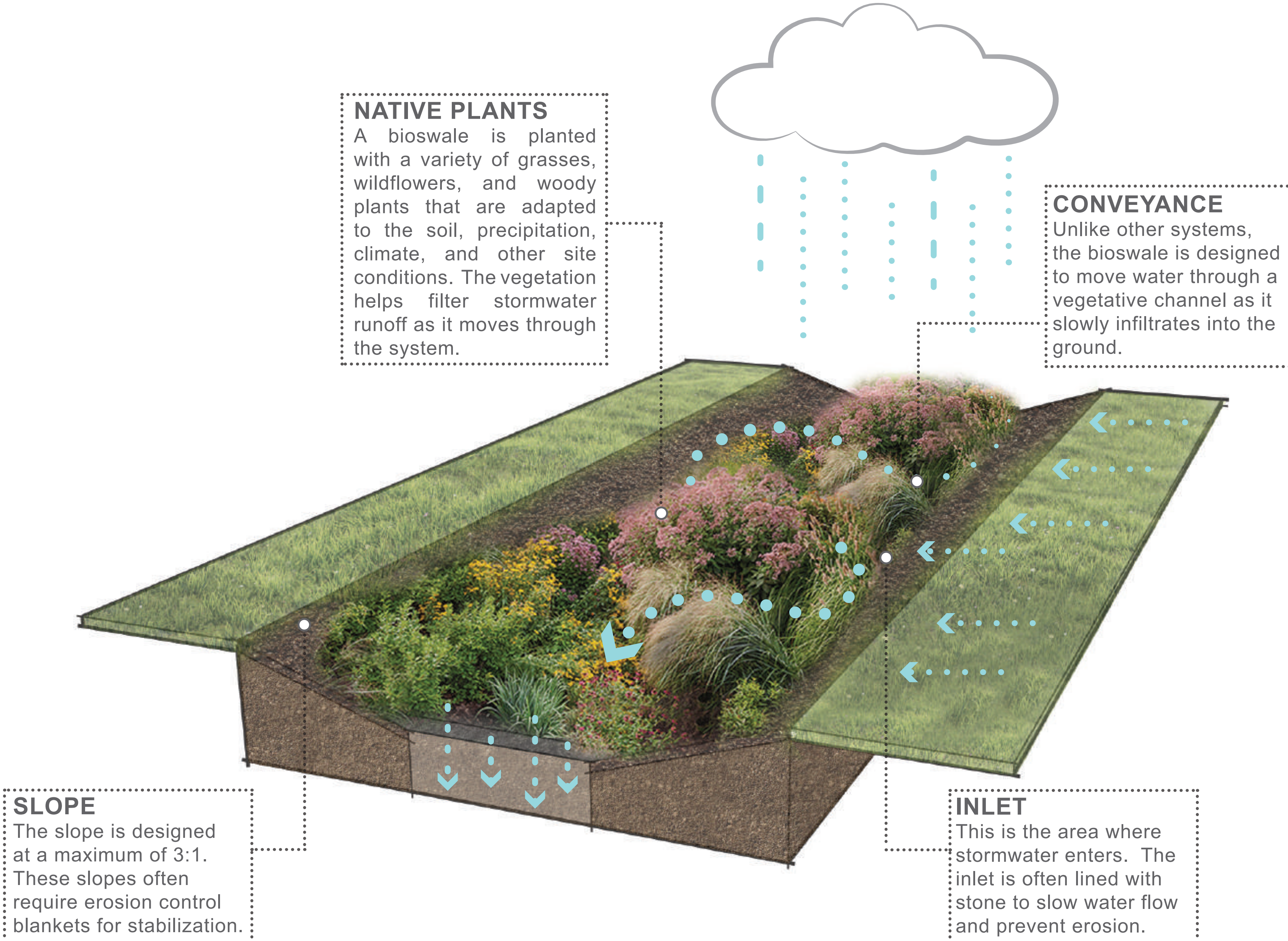
Rain gardens can be implemented throughout communities to begin the process of re-establishing the natural function of the land. Rain gardens offer one of the quickest and easiest methods to reduce runoff and help protect our water resources. Beyond the aesthetic and ecological benefits, rain gardens encourage environmental stewardship and community pride.


NATIVE PLANTS
A rain garden is planted with a variety of grasses, wildflowers, and woody plants that are adapted to the soil, precipitation, climate, and other site conditions
DRAINAGE AREA
This is the area of impervious surface that is captured in the rain garden system.
BERM
The berm is constructed as a barrier to control, slow down, and contain stormwater.
PONDING AREA
The ponding area is the lowest, deepest visible area of the garden. When designed correctly, this area should drain within 24 hours.
INLET
This is the area where stormwater enters. The inlet is often lined with stone to slow water flow and prevent erosion.
CURB CUT
This curb cut and concrete flow pad are designed to help redirect stormwater runoff to the rain garden system and out of the storm drain.

BIOSWALES

Bioswales are landscape features that convey stormwater from one location to another while removing pollutants and allowing water to infiltrate. Bioswales are often designed for larger scale sites where water needs time to move and slowly infiltrate into the groundwater.

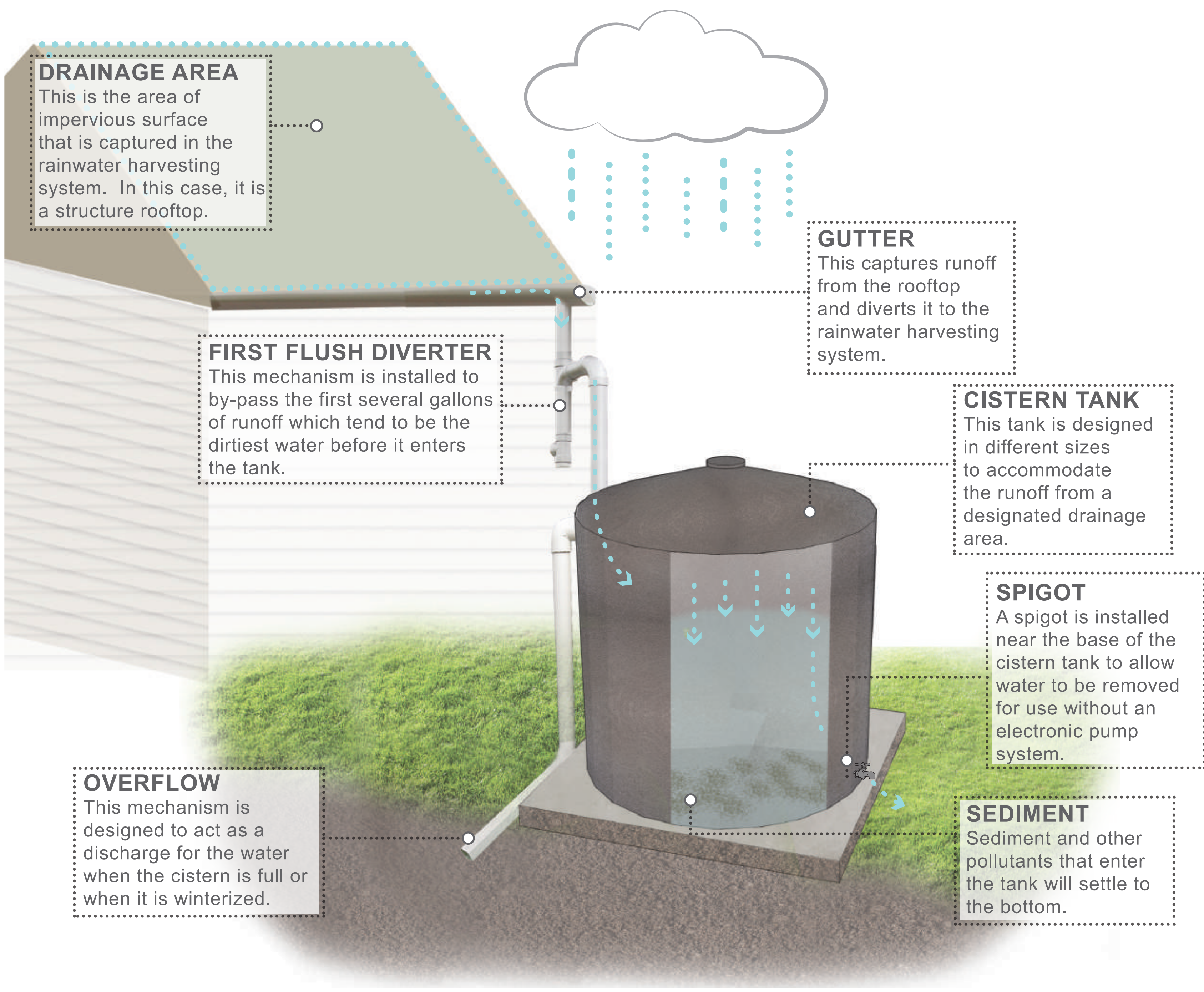
Much like the rain garden systems, bioswales can also be designed with an underdrain pipe that allows excess water to discharge to the nearest catch basin or existing stormwater system.


NATIVE PLANTS
A bioswale is planted with a variety of grasses, wildflowers, and woody plants that are adapted to the soil, precipitation, climate, and other site conditions. The vegetation helps filter stormwater runoff as it moves through the system.
CONVEYANCE
Unlike other systems, the bioswale is designed to move water through a vegetative channel as it slowly infiltrates into the ground.
SLOPE
The slope is designed at a maximum of 3:1. These slopes often require erosion control blankets for stabilization.
INLET
This is the area where stormwater enters. The inlet is often lined with stone to slow water flow and prevent erosion.

RAINWATER HARVESTING SYSTEMS

These systems capture rainwater, mainly from rooftops, in cisterns or rain barrels. The water can then be used for watering gardens, washing vehicles, or for other non-potable uses.

Rainwater harvesting systems come in all shapes and sizes. These systems are good for harvesting rainwater in the spring, summer, and fall but must be winterized during the colder months. Cisterns are winterized, and then their water source is redirected from the cistern back to the original discharge area.

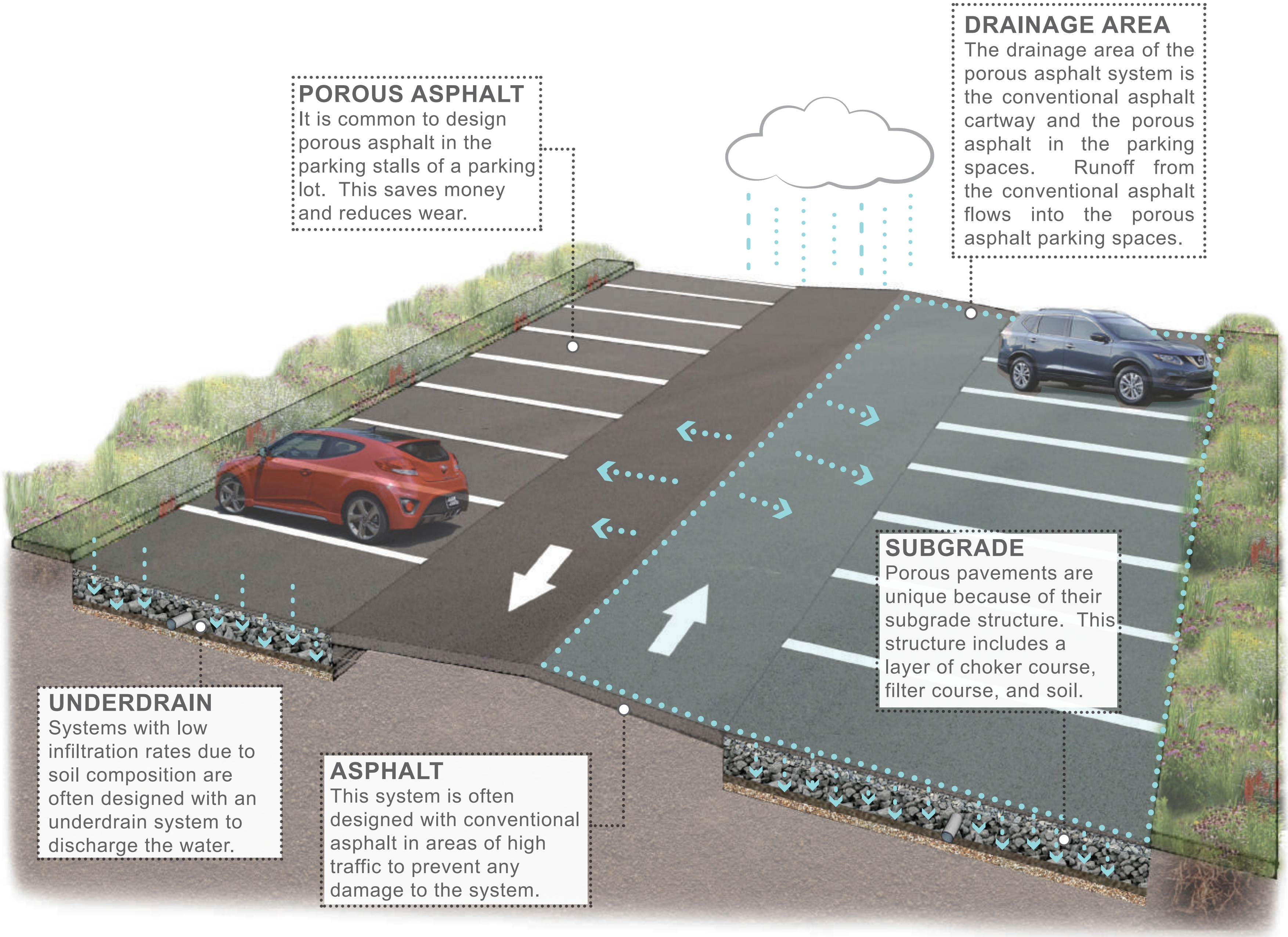


DRAINAGE AREA
This is the area of impervious surface that is captured in the rainwater harvesting system. In this case, it is a structure rooftop.
GUTTER
This captures runoff from the rooftop and diverts it to the rainwater harvesting system.
FIRST FLUSH DIVERTER
This mechanism is installed to by-pass the first several gallons of runoff which tend to be the dirtiest water before it enters the tank.
CISTERN TANK
This tank is designed in different sizes to accommodate the runoff from a designated drainage area.
SPIGOT
A spigot is installed near the base of the cistern tank to allow water to be removed for use without an electronic pump system.
OVERFLOW
This mechanism is designed to act as a discharge for the water when the cistern is full or when it is winterized.
SEDIMENT
Sediment and other pollutants that enter the tank will settle to the bottom.

PERMEABLE PAVEMENTS

These surfaces include pervious concrete, porous asphalt, interlocking concrete pavers, and grid pavers. 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. They have an underlying stone layer to store stormwater runoff and allow it to slowly seep into the ground.

By installing an underdrain system, these systems can be used in areas where infiltration is limited. The permeable pavement system will still filter pollutants and provide storage but will not infiltrate the runoff.


POROUS ASPHALT
It is common to design porous asphalt in the parking stalls of a parking lot. This saves money and reduces wear.
DRAINAGE AREA
The drainage area of the porous asphalt system is the conventional asphalt cartway and the porous asphalt in the parking spaces. Runoff from the conventional asphalt flows into the porous asphalt parking spaces.
SUBGRADE
Porous pavements are unique because of their subgrade structure. This structure includes a layer of choker course, filter course, and soil.
UNDERDRAIN
Systems with low infiltration rates due to soil composition are often designed with an underdrain system to discharge the water.
ASPHALT
This system is often designed with conventional asphalt in areas of high traffic to prevent any damage to the system.

DOWNSPOUT PLANTER BOXES

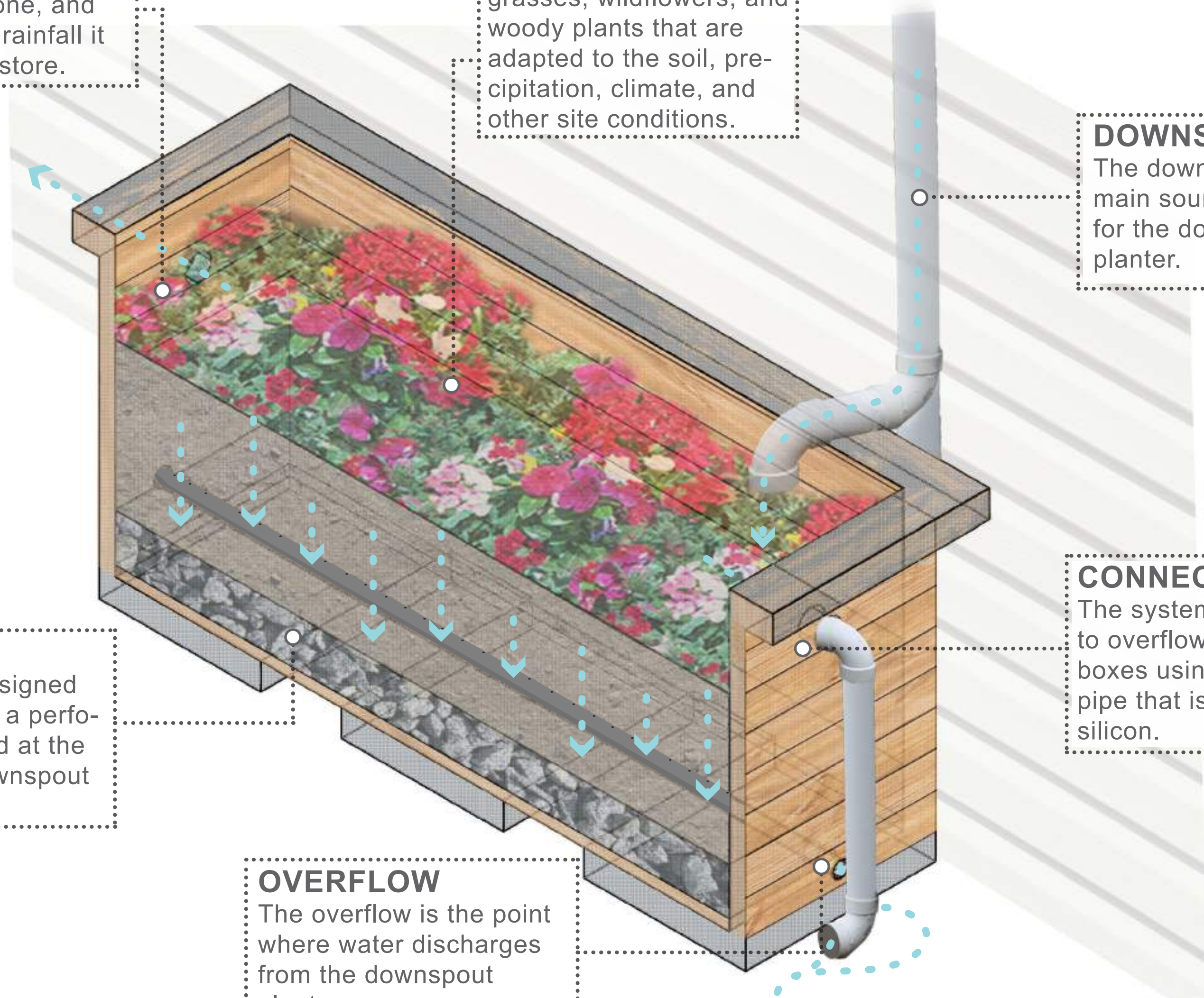
Downspout planter boxes are wooden or concrete boxes with plants installed at the base of the downspout that provide an opportunity to beneficially reuse rooftop runoff. Although small, these systems have some capacity to store rooftop runoff during rainfall events and release it slowly back into the storm sewer system through an overflow.

Most often, downspout planter boxes are a reliable green infrastructure practice used to provide some rainfall storage and aesthetic value for property.

PLANTER BOXES
The downspout planter box can be wooden or concrete. However, all boxes must be reinforced to hold soil, stone, and the quantity of rainfall it is designed to store.

NATIVE PLANTS
A downspout planter is planted with a variety of grasses, wildflowers, and woody plants that are adapted to the soil, precipitation, climate, and other site conditions.

DOWNSPOUT
The downspout is the main source of water for the downspout planter.



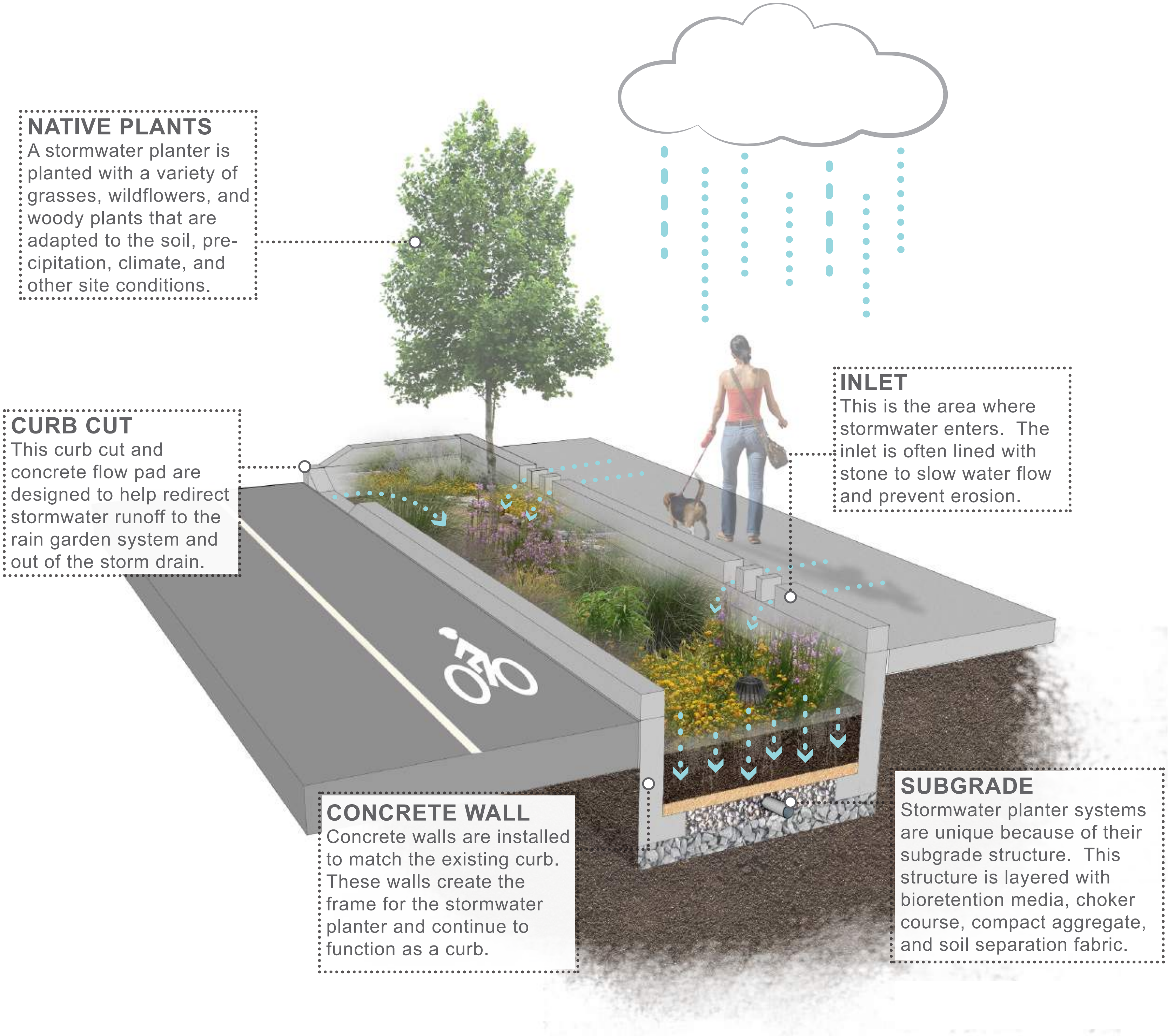
CONNECTION
The system is designed to overflow into adjacent boxes using a connecting pipe that is sealed with silicon.

SUBGRADE
The system is designed to overflow using a perforated pipe located at the bottom of the downspout planter box.

OVERFLOW
The overflow is the point where water discharges from the downspout planter.

STORMWATER PLANTERS

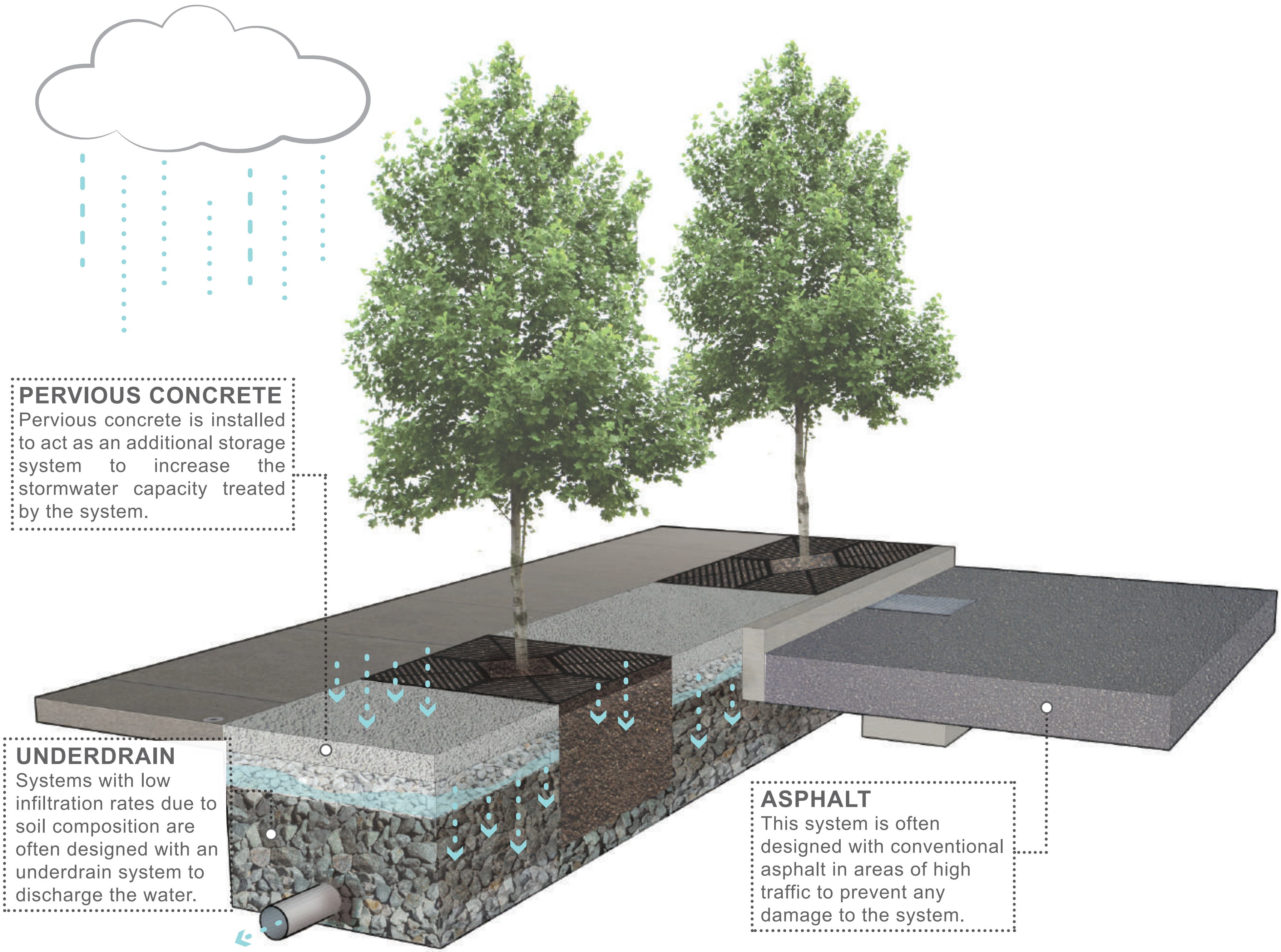
Stormwater planters are vegetated structures that are built into the sidewalk to intercept stormwater runoff from the roadway or sidewalk. Stormwater planters, like rain gardens, are a type of bioretention system. This means many of these planters are designed to allow the water to infiltrate into the ground. However, some are designed simply to filter the water and convey it back into the storm sewer system via an underdrain system.


NATIVE PLANTS
A stormwater planter is planted with a variety of grasses, wildflowers, and woody plants that are adapted to the soil, precipitation, climate, and other site conditions.
CURB CUT
This curb cut and concrete flow pad are designed to help redirect stormwater runoff to the rain garden system and out of the storm drain.
INLET
This is the area where stormwater enters. The inlet is often lined with stone to slow water flow and prevent erosion.
CONCRETE WALL
Concrete walls are installed to match the existing curb. These walls create the frame for the stormwater planter and continue to function as a curb.
SUBGRADE
Stormwater planter systems are unique because of their subgrade structure. This structure is layered with bioretention media, choker course, compact aggregate, and soil separation fabric.

TREE FILTER BOXES

Tree filter boxes can be pre-manufactured concrete boxes or enhanced tree pits that contain a special soil mix and are planted with a tree or shrub. They filter stormwater runoff but provide little storage capacity. They are typically designed to quickly filter stormwater and then discharge it to the local storm sewer system.

Often tree filter boxes are incorporated into streetscape systems that include an underlying stormwater system which connects several boxes (as shown on the next page). This is also coupled with pervious concrete to increase the storage capacity for rainwater into the system.


PERVIOUS CONCRETE
Pervious concrete is installed to act as an additional storage system to increase the stormwater capacity treated by the system.
UNDERDRAIN
Systems with low infiltration rates due to soil composition are often designed with an underdrain system to discharge the water.
ASPHALT
This system is often designed with conventional asphalt in areas of high traffic to prevent any damage to the system.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GREEN INFRASTRUCTURE IN LITTLE FALLS

SITE SELECTION & METHODOLOGY

TABLE 1. AERIAL LOADING COEFFICIENTS

Land Cover	Total Phosphorus (lbs/acre/yr)	Total Nitrogen (lbs/acre/yr)	Total Suspended Solids (lbs/acre/yr)
High, Medium Density Residential	1.4	15	140
Low Density, Rural Residential	0.6	5	100
Commercial	2.1	22	200
Industrial	1.5	16	200
Urban, Mixed Urban, Other Urban	1.0	10	120
Agriculture	1.3	10	300
Forest, Water, Wetlands	0.1	3	40
Barrenland/ Transitional Area	0.5	5	60

A collection of sites have been identified in Little Falls based on site visibility, feasibility, cost-effectiveness, and potential partnerships. The RCE Water Resources Program uses a "look here first" method to identify the most accessible and visible sites. These sites include: schools, churches, libraries, municipal buildings, public works, firehouses, post offices, social clubs such as the Elks or Moose lodge, and parks/recreational fields. These sites often have large amounts of impervious cover and typically are relatively easy to engage in implementing green infrastructure practices. Sites are selected based on their feasibility or the ability to get the project in the ground. This criteria is based on property ownership and ability to do maintenance. In addition, potential partnerships related to the site help make a project feasible.

Initially, aerial imagery was used to identify potential project sites that contain extensive impervious cover. Field visits were then conducted at each of these potential project sites to determine if a viable option exists to reduce impervious cover or to disconnect impervious surfaces from draining directly to the local waterway or storm sewer system. During the site visit, appropriate green infrastructure practices for the site were determined.

For each potential project site, specific aerial loading coefficients for commercial land use were used to determine the annual runoff loads for total phosphorus (TP), total nitrogen (TN), and total suspended solids (TSS) from impervious surfaces (Table 1). These are the same aerial loading coefficients that NJDEP uses to develop total maximum daily loads (TMDLs) for impaired waterways of the state. The percentage of impervious cover for each site was extracted from the 2012 NJDEP land use/land cover database.

For impervious areas, runoff volumes were determined for the water quality design storm (1.25 inches of rain over two-hours) and for the annual rainfall total of 44 inches.

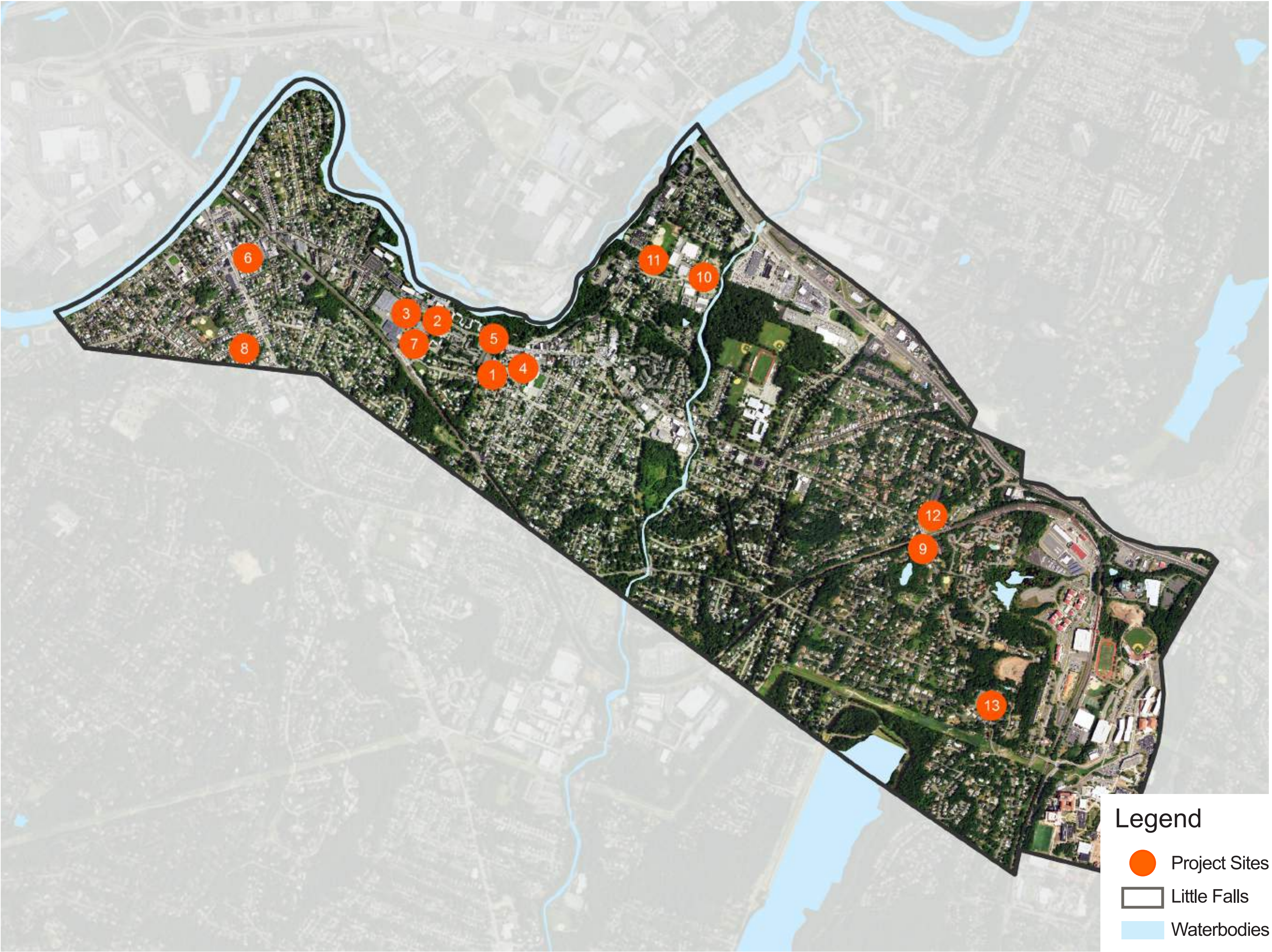
Preliminary soil assessments were conducted for each potential project site identified in Little Falls using the United States Department of Agriculture Natural Resources Conservation Service Web Soil Survey, which utilizes regional and statewide soil data to predict soil types in an area.

For each potential project site, drainage areas were determined for each of the green infrastructure practices proposed at the site. These green infrastructure practices were designed to manage the 2-year design storm, enabling these practices to capture 95% of the annual rainfall. Runoff volumes were calculated for each proposed green infrastructure practice. The reduction in TSS loading was calculated for each drainage area for each proposed green infrastructure practice using the aerial loading coefficients in Table 1. The maximum volume reduction in stormwater runoff for each green infrastructure practice for a storm was determined by calculating the volume of runoff captured from the 2-year design storm. For each green infrastructure practice, peak discharge reduction potential was determined through hydrologic modeling in HydroCAD. For each green infrastructure practice, a cost estimate is provided. These costs are based upon the square footage of the green infrastructure practice and the real cost of green infrastructure practice implementation in New Jersey.

POTENTIAL PROJECT SITES
WITHIN STUDY AREA

Site	Name	Address	Page #
1	Little Falls Historical Society	19 Warren Street, Little Falls, NJ 07424	40
2	Little Falls Municipal Court	225 Main Street, Little Falls, NJ 07424	42
3	Little Falls Post Office*	229 Main Street, Little Falls, NJ 07424	44
4	Little Falls Public Library	8 Warren Street, Little Falls, NJ 07424	48
5	Little Falls United Methodist Church	139 Main Street, Little Falls, NJ 07424	50
6	Our Lady of the Holy Angels Roman Catholic Church	465 Main Street, Little Falls, NJ 07424	52
7	St. Agnes' Episcopal Church	65 Union Avenue, Little Falls, NJ 07424	54
8	St. John the Baptist Russian Orthodox Church	29 Weaver Street, Little Falls, NJ 07424	56
9	Great Notch Fire Company*	170 Long Hill Road, Little Falls, NJ 07424	58
10	Little Falls Department of Public Works	70 Sindle Avenue, Little Falls, NJ 07424	62
11	Little Falls Recreation Center*	160 Paterson Avenue, Little Falls, NJ 07424	64
12	Sacred Heart Armenian Catholic Church	155 Long Hill Road, Little Falls, NJ 07424	68
13	St. George Antiochian Orthodox Church	237 Long Hill Road, Little Falls, NJ 07424	70

* Contains a concept design


1
2
3
4
5
6
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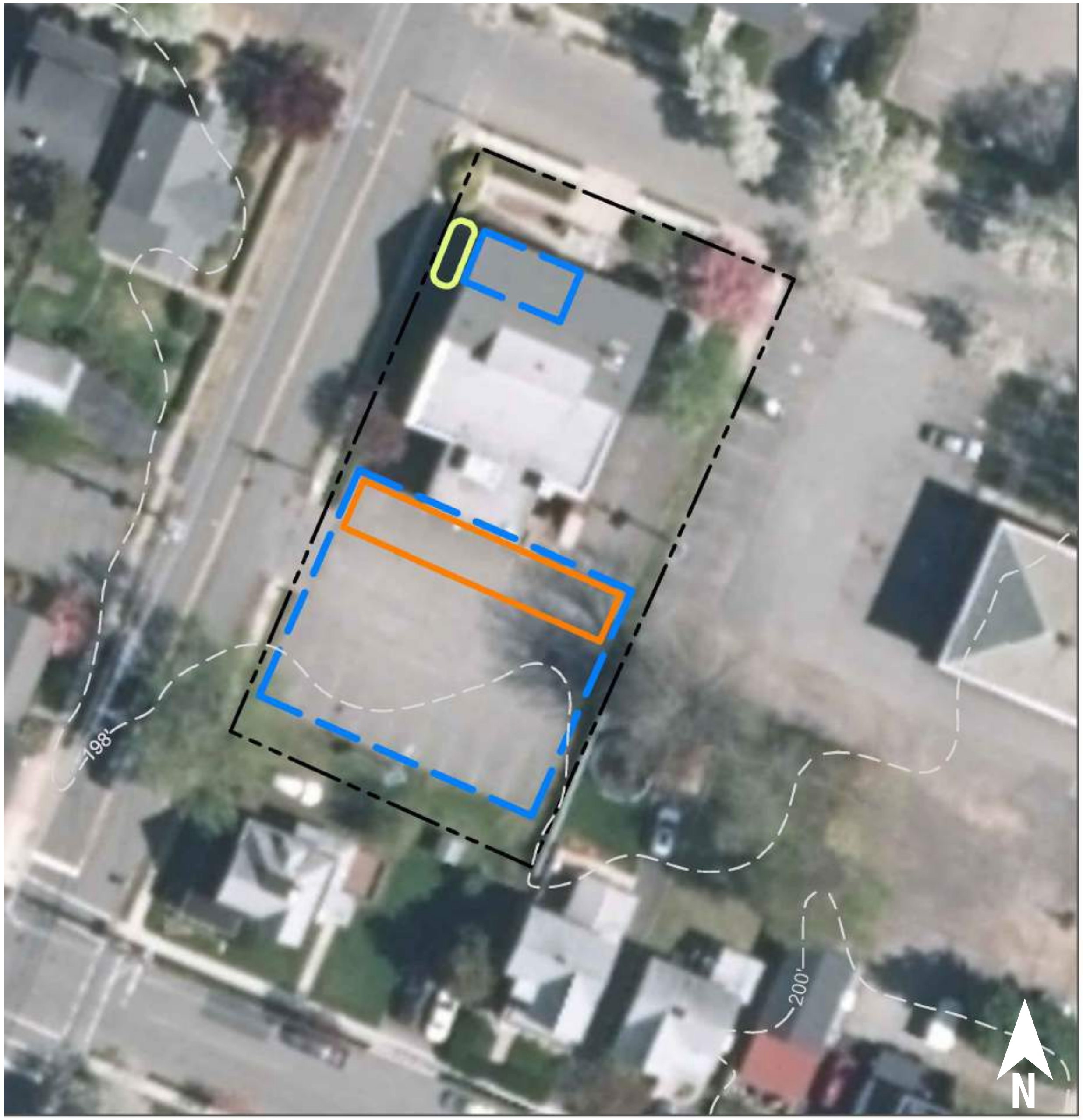
9
10
11
12
13
Legend
Project Sites
Little Falls
Waterbodies



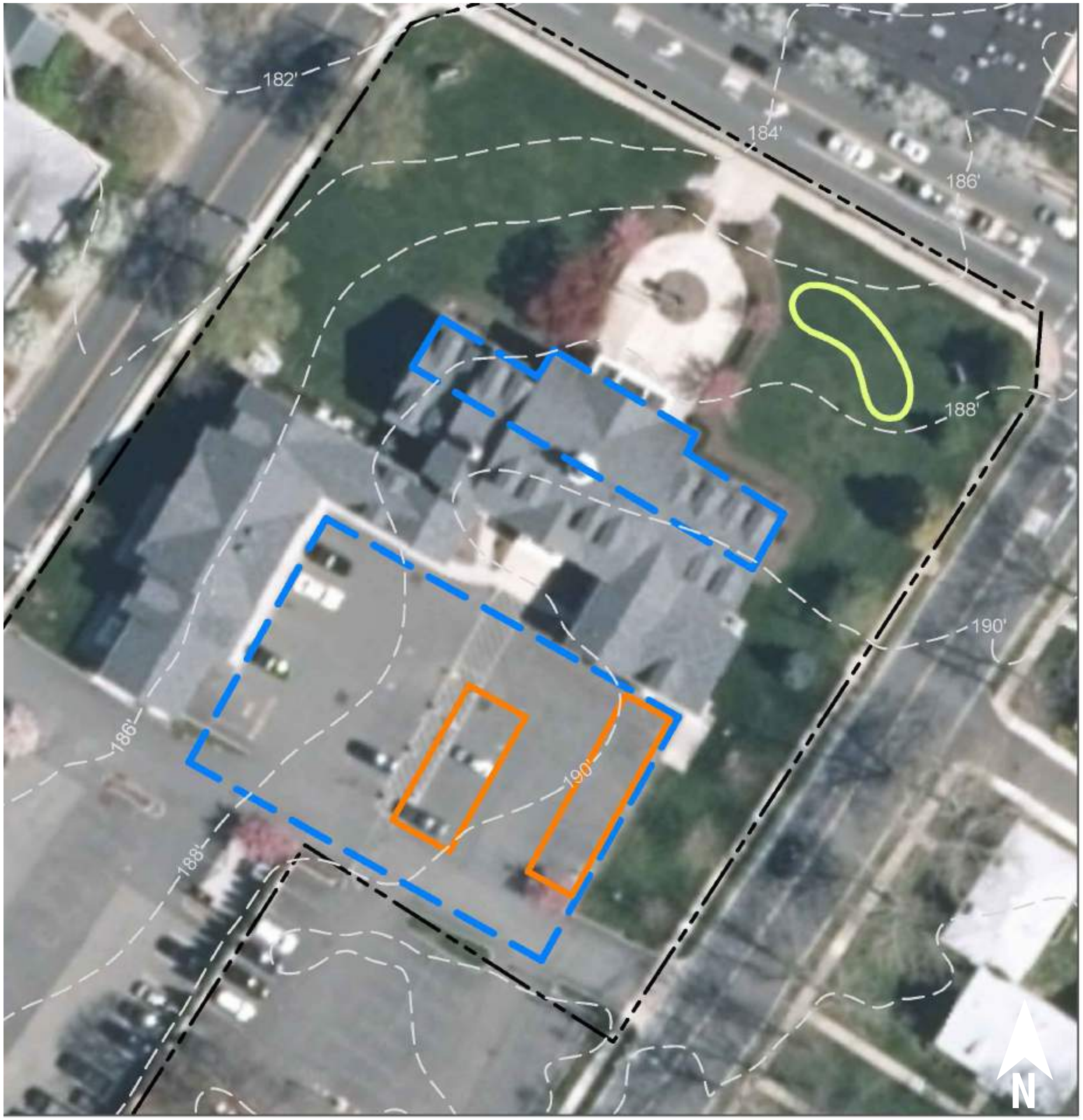
bioretention system
pervious pavement
drainage area
property line
2015 Aerial: NJOIT, OGIS

0' 25' 50'

Stormwater currently flows directly into a catch basin from the internal drainage system. A rain garden can be placed in that area of the property to capture, treat, and infiltrate rooftop runoff. This property can also benefit from pervious asphalt in the parking lot to capture and infiltrate stormwater runoff from the parking lot. A preliminary soil assessment suggests that the soils have suitable drainage characteristics for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs/yr)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	From the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
70	67,798	3.3	34.2	311.3	0.053	1.86

Recommended Infrastructure Practices	Recharge Potential (Mgal/yr)	TSS Removal Potential (lbs/yr)	Maximum Volume Reduction Potential (gal/storm)	Peak Discharge Reduction Potential (cu. ft./second)	Estimated Size (sq. ft.)	Estimated Cost
Bioretention system	0.093	16	7,279	0.27	895	$4,475
Pervious pavement	0.375	63	29,324	1.10	2,570	$64,250



bioretention system

drainage area

property line

2015 Aerial: NJOIT, OGIS

0' 50' 100'

Stormwater is currently directed into the ground through connected downspouts. A rain garden can be installed in the northeast front lawn of the building to capture, treat, and infiltrate rooftop runoff. Parking spaces in the center and west side of the parking lot can be retrofitted with porous asphalt to capture and infiltrate stormwater runoff as well. A preliminary soil assessment suggests that the soils have suitable drainage characteristics for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs/yr)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	From the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
70	67,798	3.3	34.2	311.3	0.053	1.86

Recommended Infrastructure Practices	Recharge Potential (Mgal/yr)	TSS Removal Potential (lbs/yr)	Maximum Volume Reduction Potential (gal/storm)	Peak Discharge Reduction Potential (cu. ft./second)	Estimated Size (sq. ft.)	Estimated Cost
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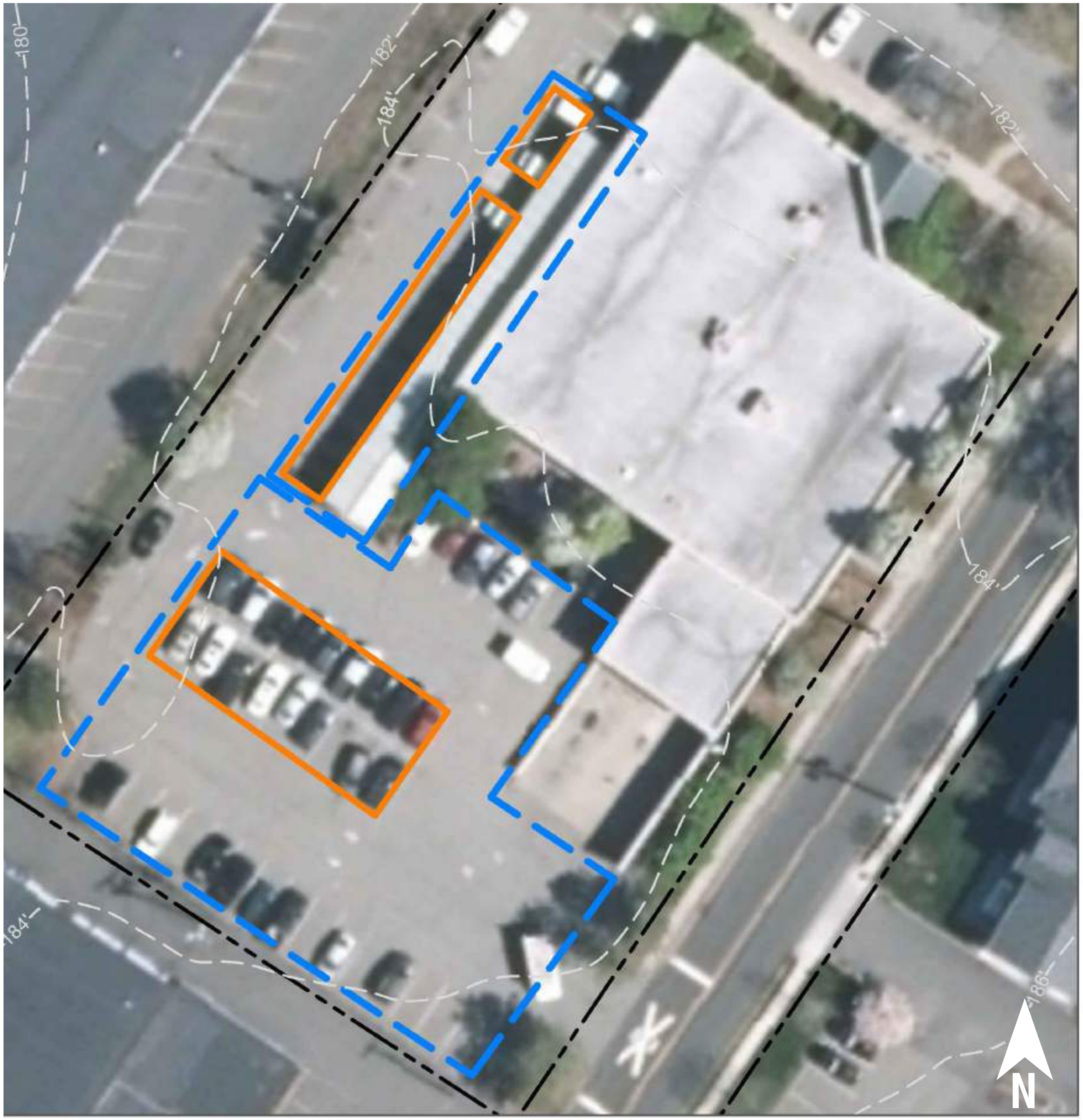


pervious pavement

drainage area

property line

2015 Aerial: NJOIT, OGIS

0' 25' 50'

229 Main Street
Little Falls, NJ 07424

Stormwater is directed to the ground via connected downspouts on the northwest side of the building. Porous asphalt can be installed on that same side of the building as well as in the center spots of the southwest section of the parking lot to capture and treat stormwater runoff. A preliminary soil assessment suggests that the soils have suitable drainage characteristics for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs/yr)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	From the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
85	63,639	3.1	32.1	292.2	0.050	1.75

Recommended Infrastructure Practices	Recharge Potential (Mgal/yr)	TSS Removal Potential (lbs/yr)	Maximum Volume Reduction Potential (gal/storm)	Peak Discharge Reduction Potential (cu. ft./second)	Estimated Size (sq. ft.)	Estimated Cost
Pervious pavement	0.576	96	45,003	1.69	4,800	$120,000

CURRENT CONDITION

CONCEPT DESIGN


196'
198'
198'
198'

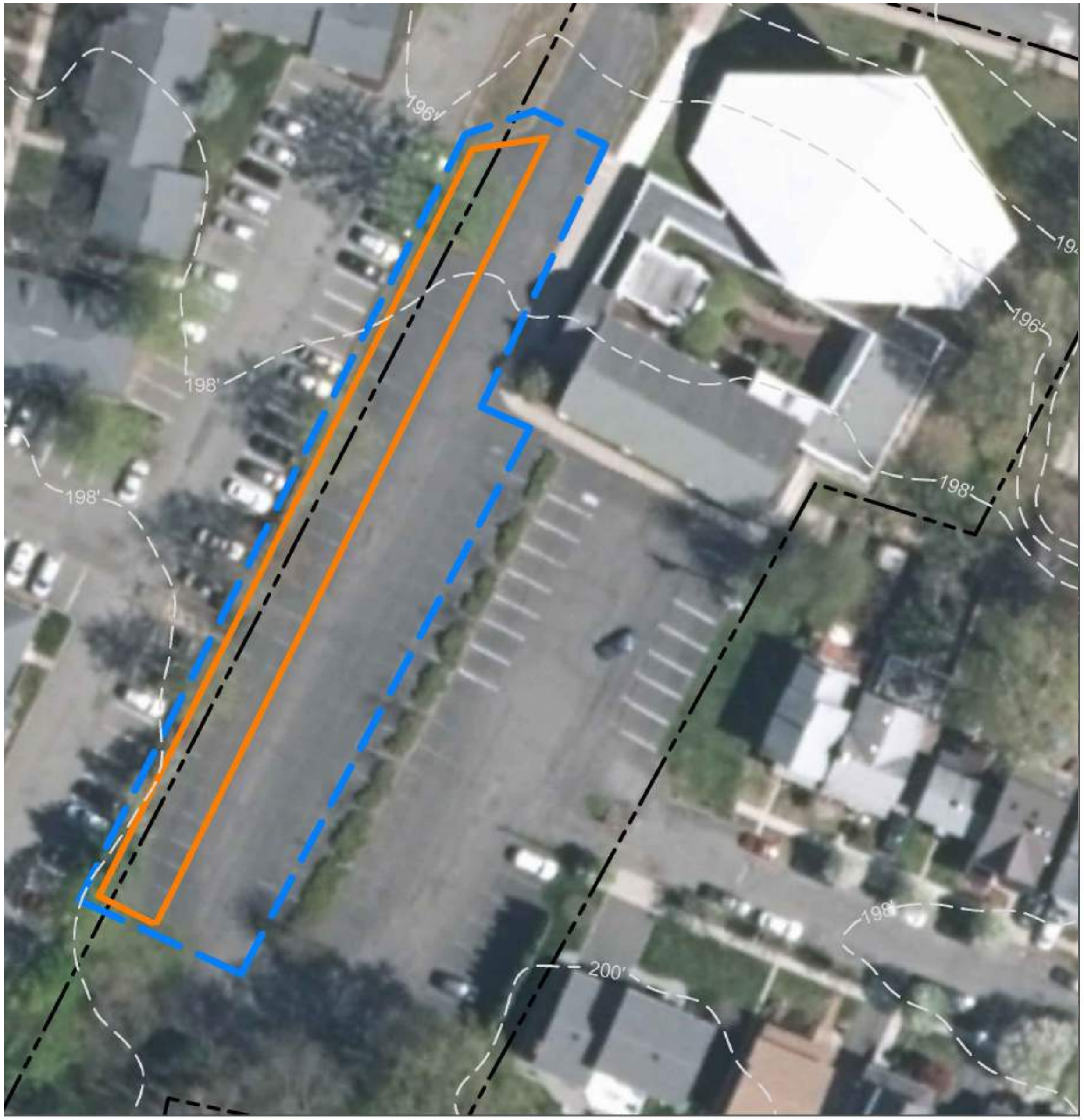
pervious pavement
drainage area
property line
2015 Aerial: NJOIT, OGIS
0'
50'
100'



There are disconnected downspouts on the southeast side of the library that direct stormwater over the sidewalk. The sidewalk can be retrofitted with pervious concrete to capture and infiltrate rooftop runoff. A preliminary soil assessment suggests that the soils have suitable drainage characteristics for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs/yr)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	From the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
90	12,172	0.6	6.1	55.9	0.009	0.33

Recommended Infrastructure Practices	Recharge Potential (Mgal/yr)	TSS Removal Potential (lbs/yr)	Maximum Volume Reduction Potential (gal/storm)	Peak Discharge Reduction Potential (cu. ft./second)	Estimated Size (sq. ft.)	Estimated Cost
Pervious pavement	0.112	19	8,752	0.33	750	$18,750



pervious pavement

drainage area

property line

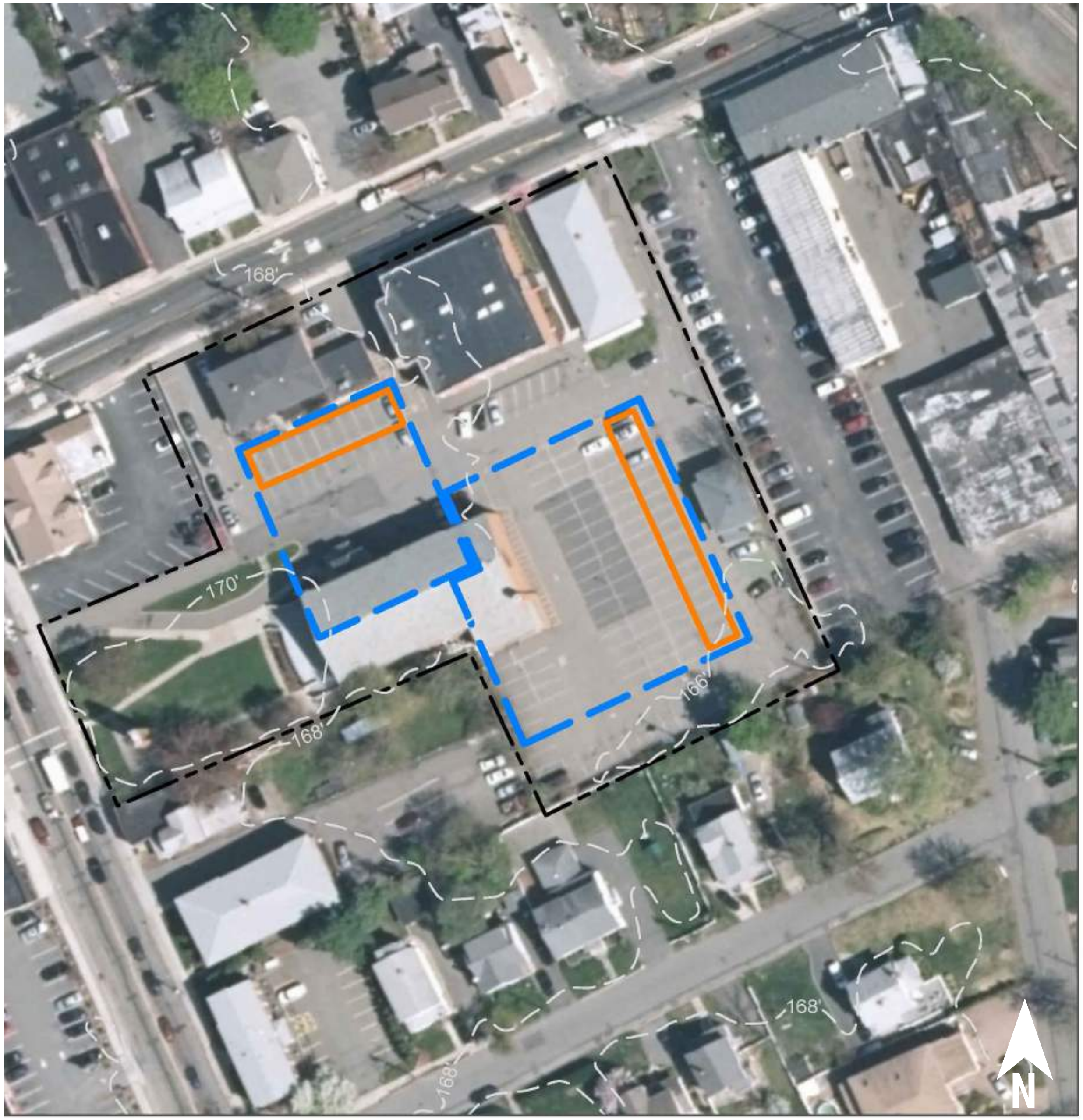
2015 Aerial: NJOIT, OGIS

0' 30' 60'


Stormwater flows toward the left side of the parking lot and to the ground through some connected downspouts. Porous asphalt can be installed in the parking spots on the left side of the parking lot to capture and infiltrate stormwater. A preliminary soil assessment suggests that the soils have suitable drainage characteristics for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs/yr)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	From the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
68	59,638	2.9	30.1	273.8	0.046	1.64

Recommended Infrastructure Practices	Recharge Potential (Mgal/yr)	TSS Removal Potential (lbs/yr)	Maximum Volume Reduction Potential (gal/storm)	Peak Discharge Reduction Potential (cu. ft./second)	Estimated Size (sq. ft.)	Estimated Cost
Pervious pavement	0.498	83	38,891	1.46	6,800	$170,00



pervious pavement

drainage area

property line

2015 Aerial: NJOIT, OGIS

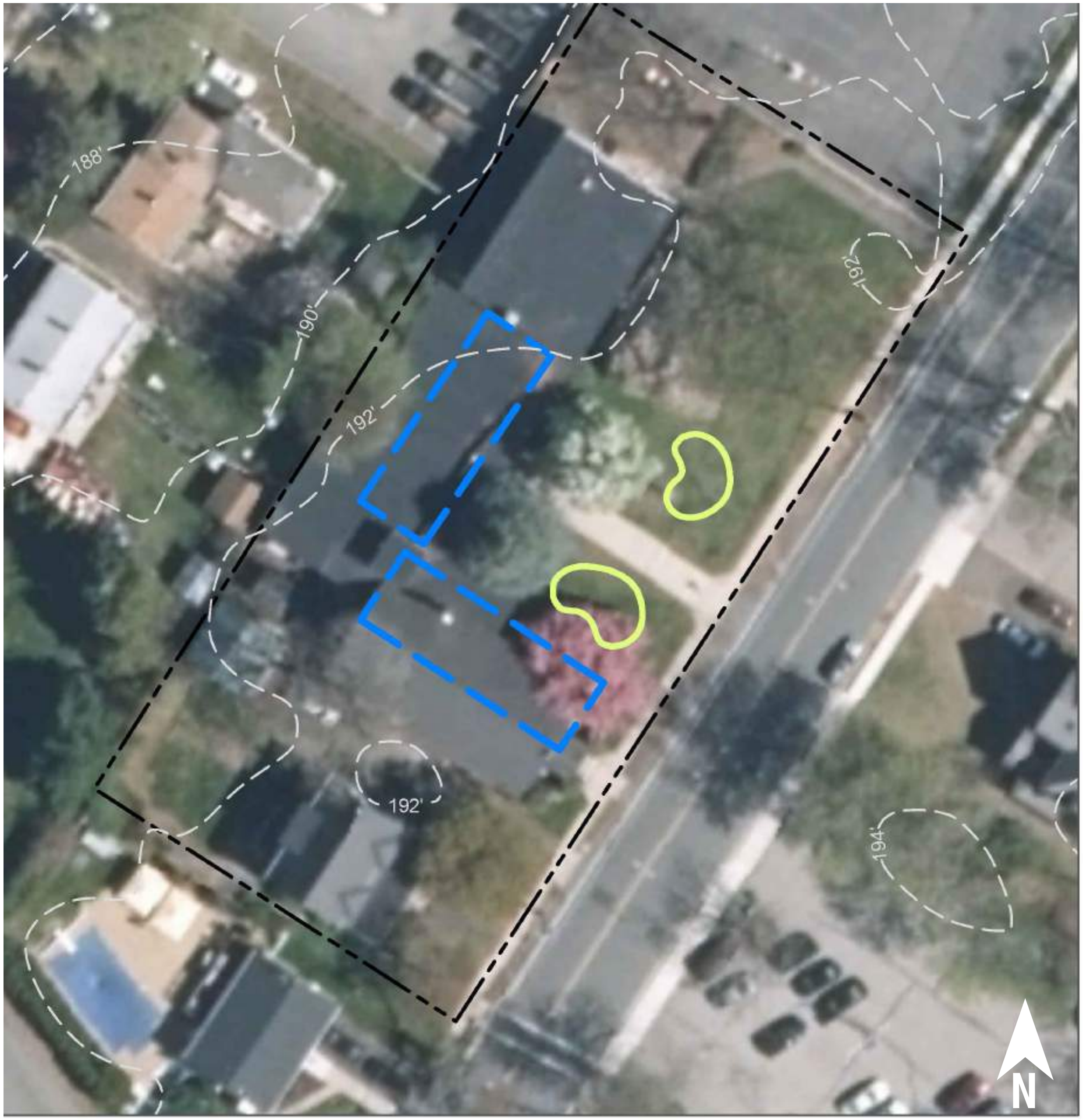
0' 50' 100'



Currently, water pools in the east section of the parking lot, and there are connected downspouts on the north and south side of the building. Parking spaces in the center of the east side and on the north side of the parking lot can be retrofitted with porous asphalt. A preliminary soil assessment suggests that the soils have suitable drainage characteristics for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs/yr)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	From the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
85	56,353	2.7	28.5	258.7	0.044	1.55

Recommended Infrastructure Practices	Recharge Potential (Mgal/yr)	TSS Removal Potential (lbs/yr)	Maximum Volume Reduction Potential (gal/storm)	Peak Discharge Reduction Potential (cu. ft./second)	Estimated Size (sq. ft.)	Estimated Cost
Pervious pavement	0.883	148	69,030	2.59	4,800	$120,000



bioretention system
drainage area
property line
2015 Aerial: NJOIT, OGIS

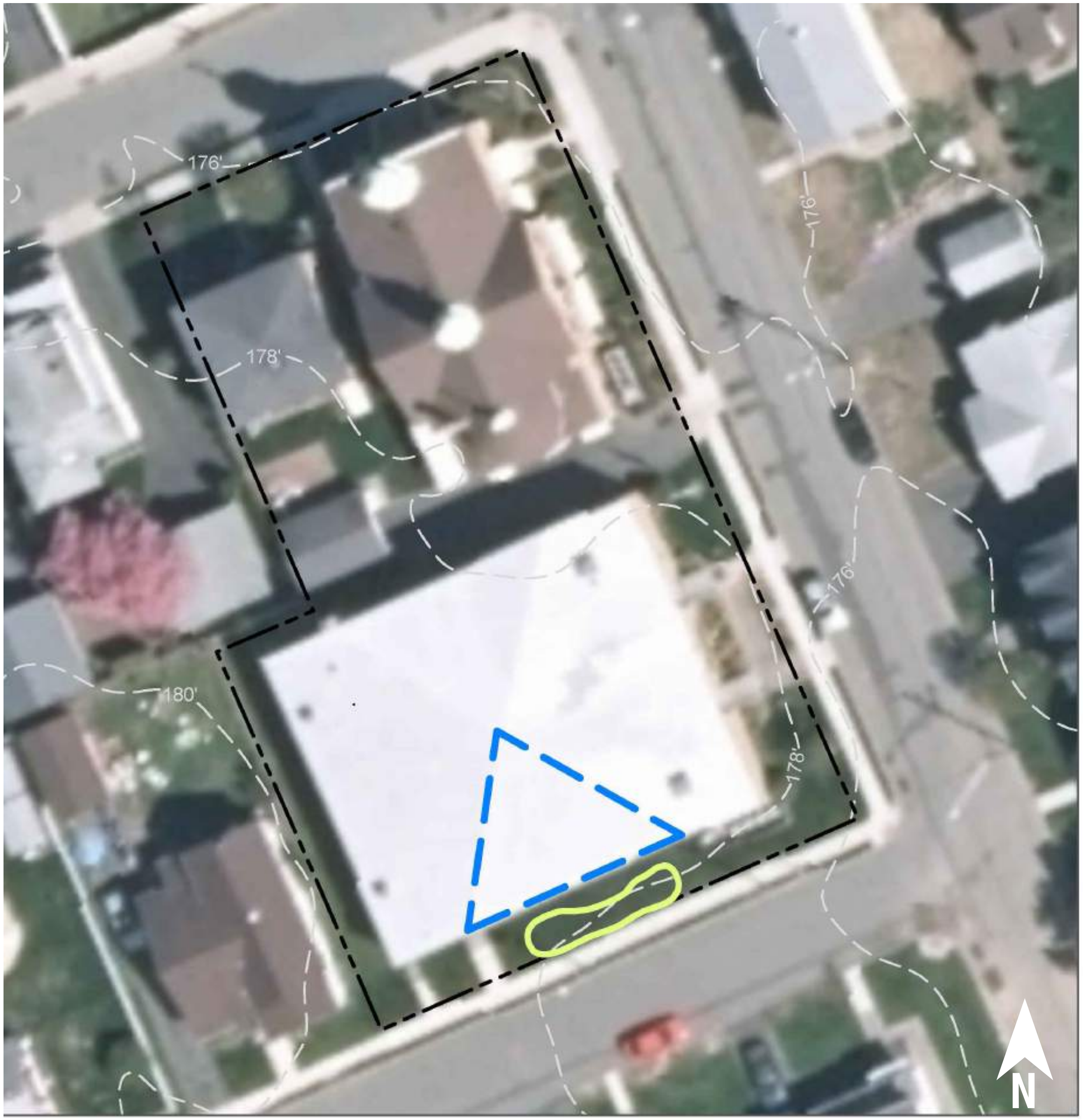
0' 25' 50'



The church has multiple disconnected downspouts that flow over the grass and landscaping in the front of the building. Rain gardens can be installed on either side of the front walkway to capture, treat, and infiltrate rooftop runoff. A preliminary soil assessment suggests that the soils have suitable drainage characteristics for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs/yr)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	From the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
69	20,462	1.0	10.3	93.9	0.016	0.56

Recommended Infrastructure Practices	Recharge Potential (Mgal/yr)	TSS Removal Potential (lbs/yr)	Maximum Volume Reduction Potential (gal/storm)	Peak Discharge Reduction Potential (cu. ft./second)	Estimated Size (sq. ft.)	Estimated Cost
Bioretention systems	0.083	14	6,516	0.24	800	$4,000



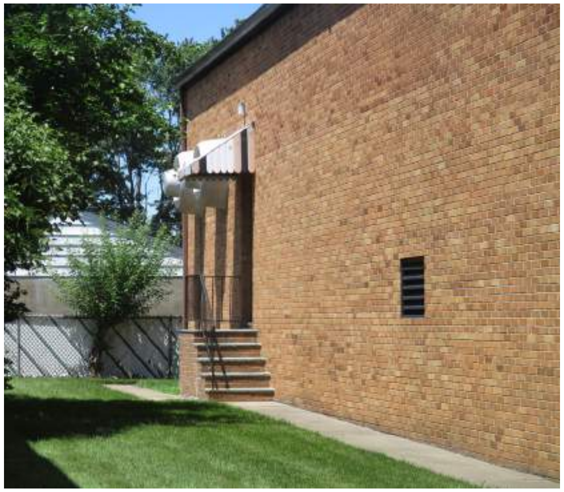
bioretention system

drainage area

property line

2015 Aerial: NJOIT, OGIS

0' 20' 40'

There are connected downspouts on the south side of the southern most building on the property. A rain garden can be installed on that side of the building to capture, treat, and infiltrate stormwater. A preliminary soil assessment suggests that the soils have suitable drainage characteristics for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs/yr)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	From the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
40	8,858	0.4	4.5	40.7	0.007	0.24

Recommended Infrastructure Practices	Recharge Potential (Mgal/yr)	TSS Removal Potential (lbs/yr)	Maximum Volume Reduction Potential (gal/storm)	Peak Discharge Reduction Potential (cu. ft./second)	Estimated Size (sq. ft.)	Estimated Cost
Bioretention system	0.029	5	2,237	0.08	275	$1,375

rainwater harvesting

drainage area

property line

2015 Aerial: NJOIT, OGIS

0' 15' 30'

170 Long Hill Road
Little Falls, NJ 07424

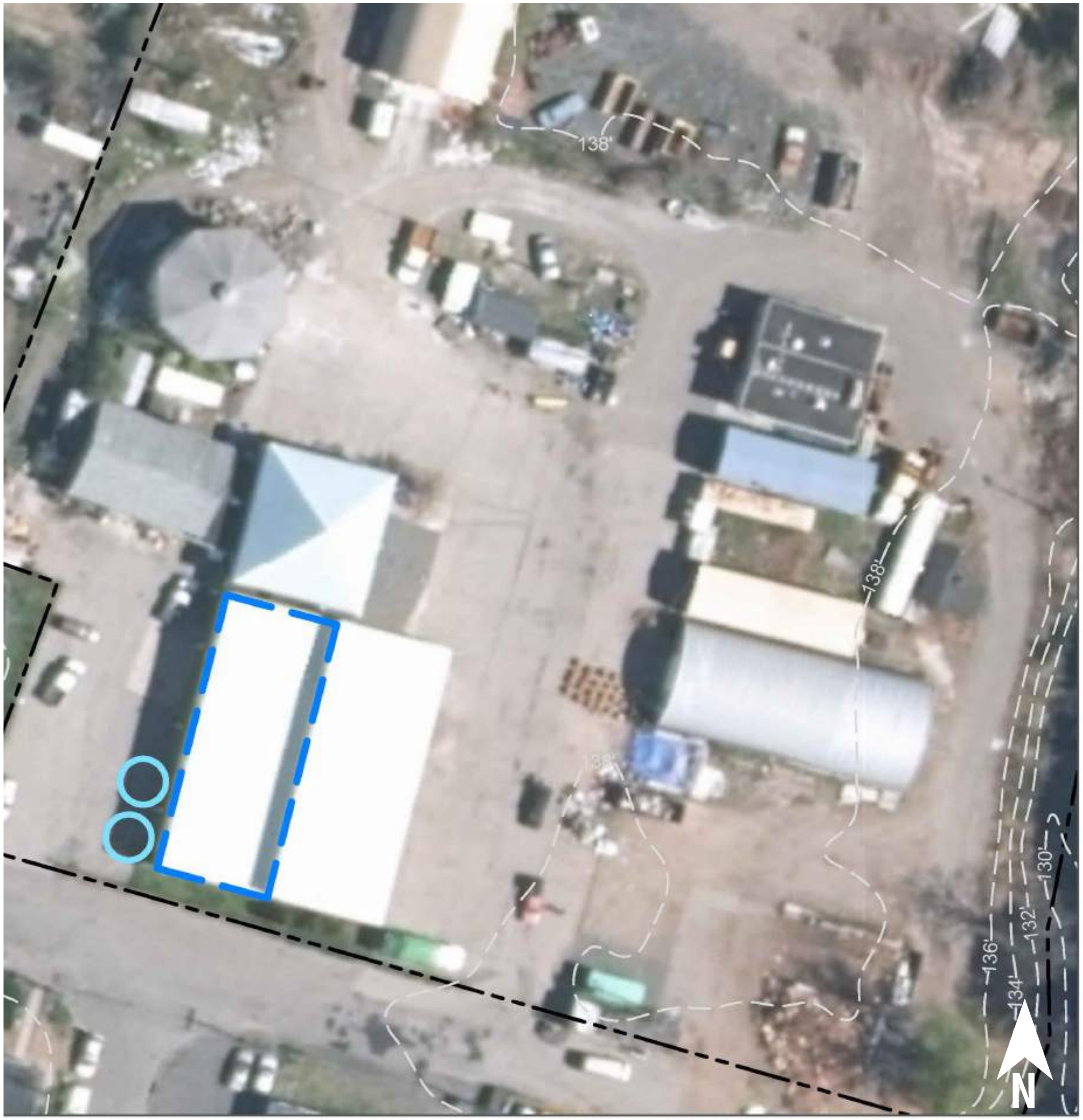
Stormwater is currently directed into the ground by connected downspouts on the north side of the building. This site can benefit from a rainwater harvesting system installed at one of these connected downspouts. These systems capture rainwater from the rooftop in cisterns or rain barrels. The water can then be used for watering gardens, washing vehicles, or for other non-potable uses.

Impervious Cover		Existing Loads from Impervious Cover (lbs/yr)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	From the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
65	10,480	0.5	5.3	48.1	0.008	0.29

Recommended Infrastructure Practices	Recharge Potential (Mgal/yr)	TSS Removal Potential (lbs/yr)	Maximum Volume Reduction Potential (gal/storm)	Peak Discharge Reduction Potential (cu. ft./second)	Estimated Size (sq. ft.)	Estimated Cost
Rainwater harvesting	0.035	6	2,745	0.10	3,000 (gal)	$6,000

CURRENT CONDITION

CONCEPT DESIGN



rainwater harvesting

drainage area

property line

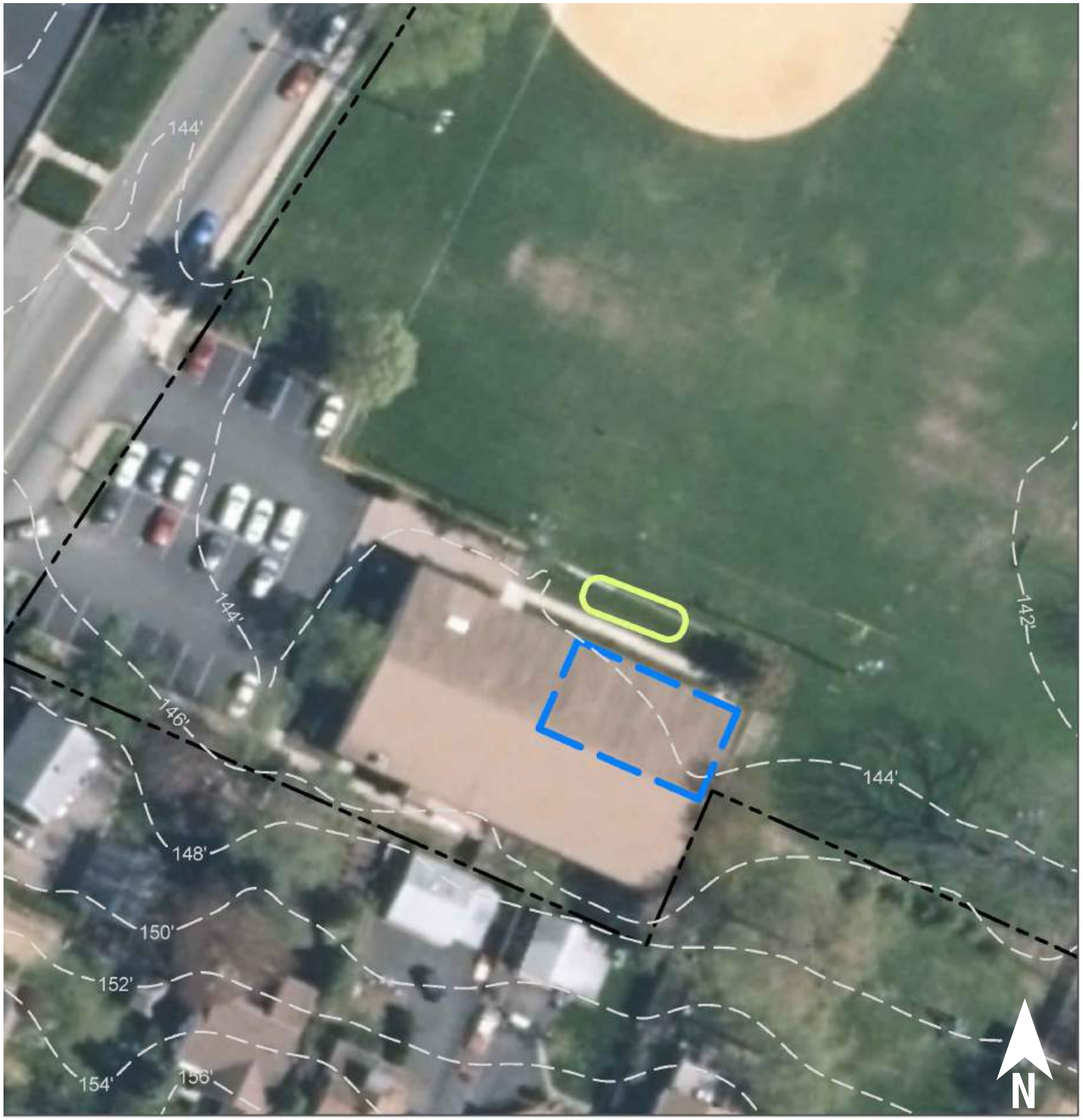
2015 Aerial: NJOIT, OGIS

0' 30' 60'

Stormwater is currently directed into the ground by connected downspouts. Two large cisterns can be installed under a downspout at the southwest corner of the building to collect rooftop runoff. The collected stormwater can then be used for various non-potable uses like washing the department vehicles.

Impervious Cover		Existing Loads from Impervious Cover (lbs/yr)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	From the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
43	98,704	4.8	49.9	453.2	0.077	2.71

Recommended Infrastructure Practices	Recharge Potential (Mgal/yr)	TSS Removal Potential (lbs/yr)	Maximum Volume Reduction Potential (gal/storm)	Peak Discharge Reduction Potential (cu. ft./second)	Estimated Size (sq. ft.)	Estimated Cost
Rainwater harvesting	0.104	17	8,146	0.31	10,000 (gal)	$20,000



bioretention system

drainage area

property line

2015 Aerial: NJOIT, OGIS

0' 30' 60'

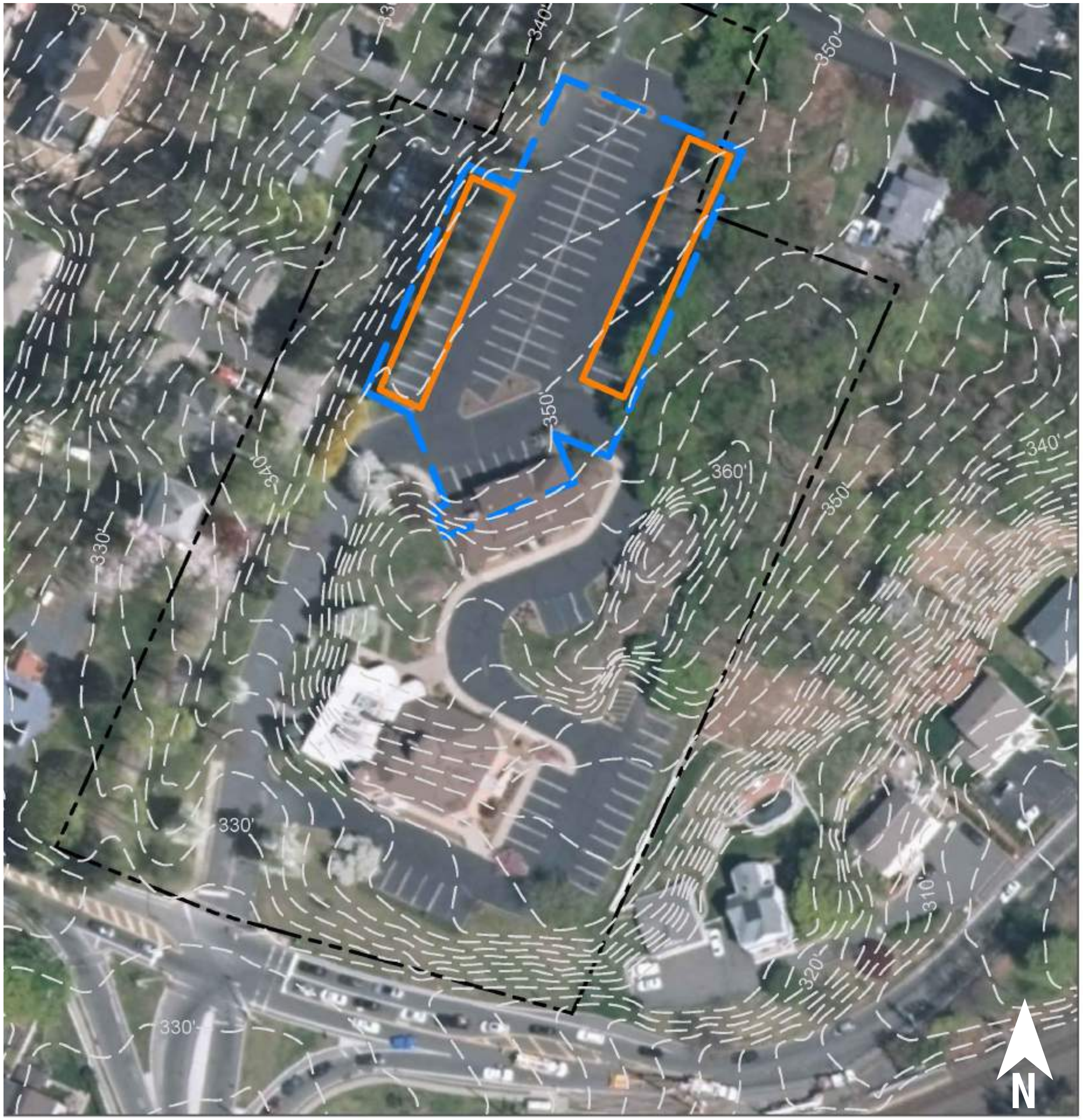

There are connected downspouts along the north side of the building. They can be disconnected and directed underneath the sidewalk to a turfgrass area on the other side where a rain garden can be installed. This way the rain garden can capture, treat, and infiltrate stormwater. A preliminary soil assessment suggests that the soils have suitable drainage characteristics for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs/yr)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	From the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
20	51,226	2.5	25.9	235.2	0.040	1.40

Recommended Infrastructure Practices	Recharge Potential (Mgal/yr)	TSS Removal Potential (lbs/yr)	Maximum Volume Reduction Potential (gal/storm)	Peak Discharge Reduction Potential (cu. ft./second)	Estimated Size (sq. ft.)	Estimated Cost
Bioretention system	0.055	9	4,279	0.16	525	$2,625

CURRENT CONDITION

CONCEPT DESIGN



pervious pavement

drainage area

property line

2015 Aerial: NJOIT, OGIS

In the parking lot on the north side of the property, water flows towards the east and west sides of the parking lot. Parking spaces on those sides of the lot can be retrofitted with porous asphalt to capture and infiltrate stormwater. A preliminary soil assessment suggests that the soils have suitable drainage characteristics for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs/yr)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	From the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
61	103,504	5.0	52.3	475.2	0.081	2.84

Recommended Infrastructure Practices	Recharge Potential (Mgal/yr)	TSS Removal Potential (lbs/yr)	Maximum Volume Reduction Potential (gal/storm)	Peak Discharge Reduction Potential (cu. ft./second)	Estimated Size (sq. ft.)	Estimated Cost
Pervious pavement	0.849	142	66,382	2.49	7,800	$195,000

pervious pavement

drainage area

property line

2015 Aerial: NJOIT, OGIS

0' 50' 100'

Stormwater flows towards parking spaces on the west side of the property where there is currently a large storm drain. Porous asphalt can be installed here to capture and store stormwater from the parking lot. There are connected downspouts on the north side of the main building that can be disconnected and redirected to the basketball court. Porous asphalt can be installed to retrofit the basketball court. A preliminary soil assessment suggests that the soils have suitable drainage characteristics for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs/yr)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	From the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
7	123,564	6.0	62.4	567.3	0.096	3.39

Recommended Infrastructure Practices	Recharge Potential (Mgal/yr)	TSS Removal Potential (lbs/yr)	Maximum Volume Reduction Potential (gal/storm)	Peak Discharge Reduction Potential (cu. ft./second)	Estimated Size (sq. ft.)	Estimated Cost
Pervious pavement	1.053	176	82,263	3.08	9,100	$227,500


Jersey TREE
TREE
PLANTING

APPENDIX A:
COMMUNITY ENGAGEMENT & EDUCATION

BUILD A RAIN BARREL WORKSHOP

With the *Build a Rain Barrel* workshop, community members participate in a short presentation on stormwater management and water conservation and then learn how to build their own rain barrel. Workshop participants work with trained experts to convert 55 gallon plastic food-grade drums into rain barrels. They are able to take an active role in recycling rainwater by installing a rain barrel at their house! Harvesting rainwater has many benefits including saving water, saving money, and preventing basement flooding. By collecting rainwater, homeowners are helping to reduce flooding and pollution in local waterways. When rainwater flows across hard surfaces like rooftops, driveways, roadways, parking lots, and compacted lawns, it carries pollution to our local waterways. Harvesting the rainwater in a rain barrel is just one of the ways homeowners can reduce the amount of rainwater draining from their property and help reduce neighborhood flooding problems.

STORMWATER MANAGEMENT IN YOUR SCHOOLYARD

The *Stormwater Management in Your Schoolyard* program provides educational lectures, hands-on activities, and community-level outreach for students on the topics of water quality issues and stormwater management practices such as rain gardens and rain barrels. Program objectives include the exploration of various aspects of the natural environment on school grounds, the detailed documentation of findings related to these explorations, and the communication of these findings to the school community. As part of this program, several New Jersey State Core Curriculum Content Standards for science (5.1, 5.3, and 5.4), 21st-century life and careers (9.1, 9.3, and 9.4), and social studies (6.3) are addressed. Every school is unique in its need for stormwater management, so each school's *Stormwater Management in Your Schoolyard* program can be delivered in a variety of ways. This program can be tailored for grades K-8 or 9-12 and can be offered to meet a variety of schedules.

APPENDIX B: MAINTENANCE PROCEDURES

MAINTAINING LITTLE FALLS'S GREEN INFRASTRUCTURE SYSTEMS

1. Rain Garden
   Stormwater Planter
   Tree Filter Box

2. Rain Barrel
   Cistern

3. Porous Asphalt
   Underground Detention

RAIN GARDEN / STORMWATER PLANTER / TREE FILTER BOX

Weekly

- Water
- Weed
- Inspect for invasive plants, plant health, excessive sediment, and movement of sediment within the rain garden
- Observe the rain garden during rain events and note any successes (Example of success: stormwater runoff picks up oil and grease from the parking lot, flows through a curb cut, and into a rain garden; the rain garden traps the nonpoint source pollutants before they reach the nearby waterway)

Annually

- Mulch in the spring to retain a 3-inch mulch layer in the garden
- Prune during dormant season to improve plant health
- Remove sediment
- Plant
- Test the soil (every 3 years)
- Harvest plants to use in other parts of the landscape
- Clean debris from gutters connected to rain garden
- Replace materials (such as river rock and landscape fabric) where needed

RAIN BARREL

- Keep screen on top and a garden hose attached to the overflow to prevent mosquitoes; change screen every two years
- Remove debris from screen after storms
- Disconnect the barrel in winter; store inside or outside with a cover
- Clean out with long brush and water/dilute bleach solution (~3%)

CISTERN

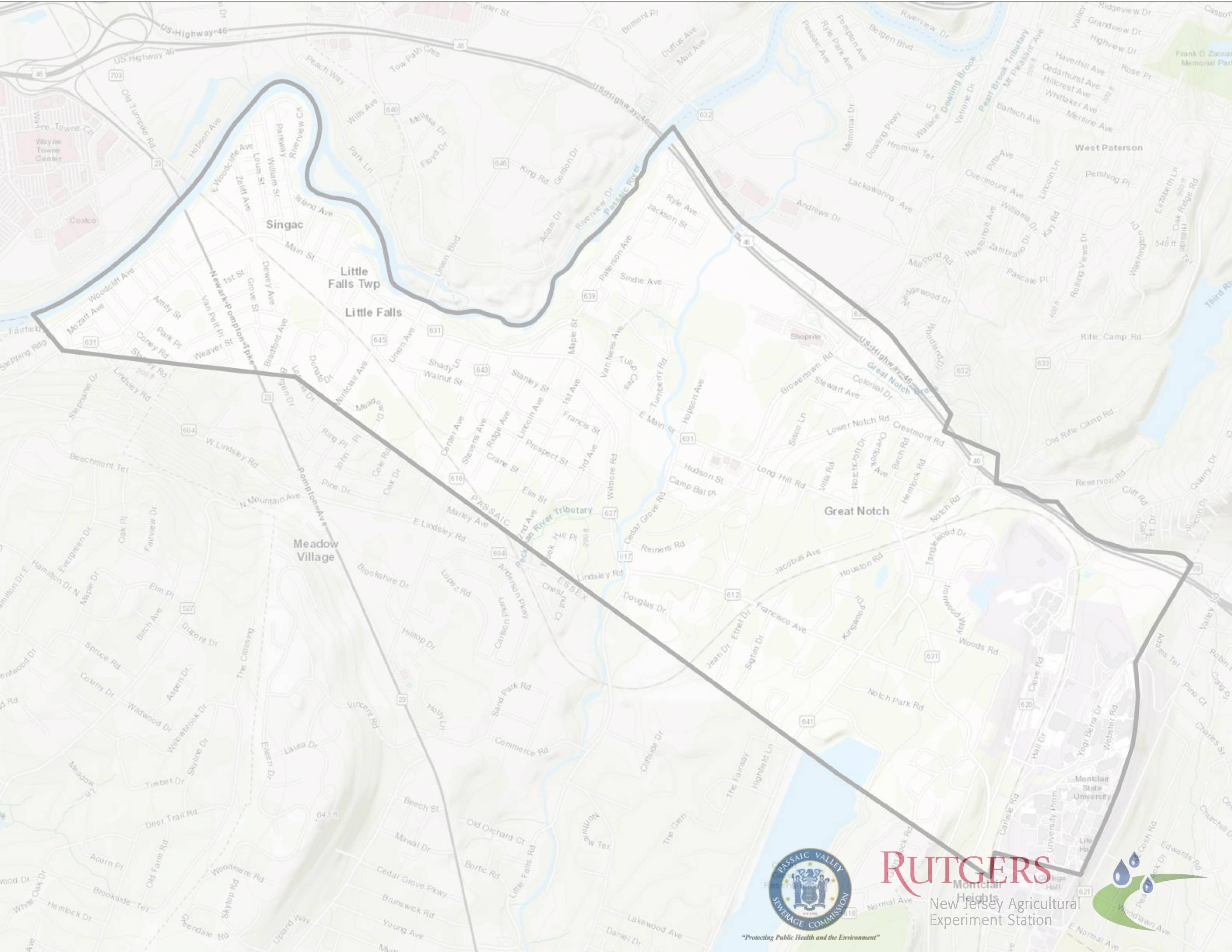
- In the fall prepare your cistern for the winter by diverting flow so no water can enter and freeze within the barrel
- Weekly check: Check for leaks, clogs and other obstructions, holes and vent openings where animals, insects, and rodents may enter; repair leaks with sealant; drain the first flush diverter/ roof washer after every rainfall event
- Monthly check: Check roof and roof catchments to make sure no debris is entering the gutter and downspout directed into the cistern; keep the roof, gutters, and leader inlets clear of leaves; inspect the first flush filter and all of its attachments and make any necessary replacements; inspect cistern cover, screen, overflow pipe, sediment trap and other accessories and make any necessary replacements

POROUS ASPHALT

- Materials cost is ~20-25% more than traditional asphalt
- Long-term maintenance is required by routine quarterly vacuum sweeping
- Sweeping cost may be off-set by reduced deicing costs
- Asphalt repairs can be made with standard asphalt not to exceed 10% of surface area
- Concrete repairs can be made with standard concrete not to exceed 10% of the surface area

UNDERGROUND DETENTION

- Periodic inspections of the inlet and outlet areas to ensure correct operation of system
- Clean materials trapped on grates protecting catch basins and inlet area monthly
- Primary maintenance concerns are removal of floatables that become trapped and removal of accumulating sediments within the system; this should be done at least on an annual basis
- Proprietary traps and filters associated with stormwater storage units should be maintained as recommended by the manufacturer
- Any structural repairs required to inlet and outlet areas should be addressed in a timely manner on an as needed basis
- Local authorities may require annual inspection or require that they carry out inspections and maintenance



Singac
Little Falls Twp
Little Falls
Meadow Village
Great Notch
West Paterson
Montclair State University
Montclair Heights
Wayne Towne Center
Costco
Passaic River
US-Highway 46
PASSAIC
ESSEX
Peckman River Tributary
Great Notch Brook
Passaic Valley Sewerage Commission
"Protecting Public Health and the Environment"
RUTGERS
New Jersey Agricultural Experiment Station