RUTGERS
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Experiment Station

Draft

Impervious Cover Reduction Action Plan
for
Washington Township, Morris County, New Jersey

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

June 22, 2020

Highlands Council
New Jersey

ACKNOWLEDGEMENTS:

This document has been prepared by the Rutgers Cooperative Extension Water Resources Program, with funding and direction from the New Jersey Highlands Water Protection and Planning Council and the New Jersey Agricultural Experiment Station, to highlight green infrastructure opportunities within Washington Township. We would like to thank the New Jersey Highlands Water Protection and Planning Council, the New Jersey Agricultural Experiment Station, and Washington Township for their input and support in creating this document.

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Introduction

Located in Morris County, New Jersey, Washington Township covers approximately 44.77 square miles. Figures 1 and 2 illustrate that Washington Township is dominated by forest land use. A total of 30.1% of the municipality's land use is classified as urban. Of the urban land in Washington Township, rural residential is the dominant land use (Figure 3).

The New Jersey Department of Environmental Protection's (NJDEP) 2015 land use/land cover geographical information system (GIS) data layer categorizes Washington 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 Washington Township. Based upon the 2015 NJDEP land use/land cover data, approximately 7.8% of Washington Township has impervious cover. This level of impervious cover suggests that the streams in Washington Township likely range from sensitive to impacted streams. [1]

Methodology

Washington contains portions of seven subwatersheds (Figure 4). For this impervious cover reduction action plan, projects have been identified in three of these watersheds. 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. Sites that already had stormwater management practices in place were not considered.

[1] Schuler, T.R., L. Fraley-McNeal, and K. Cappiella. 2009. Is Impervious Cover Still Important? Review of Recent Research. *Journal of Hydrologic Engineering* 14 (4): 309-315.

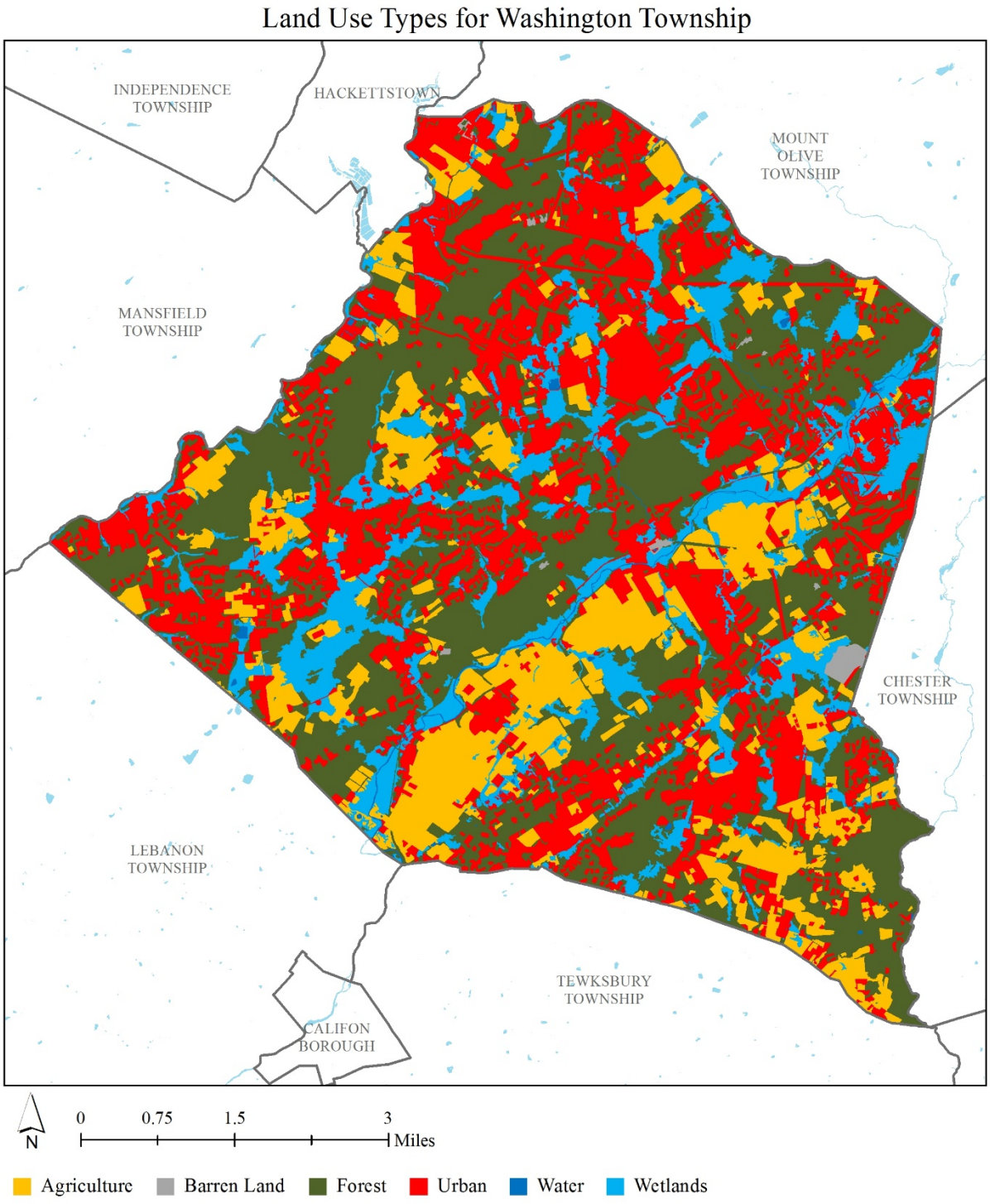


Figure 1: Map illustrating the land use in Washington Township

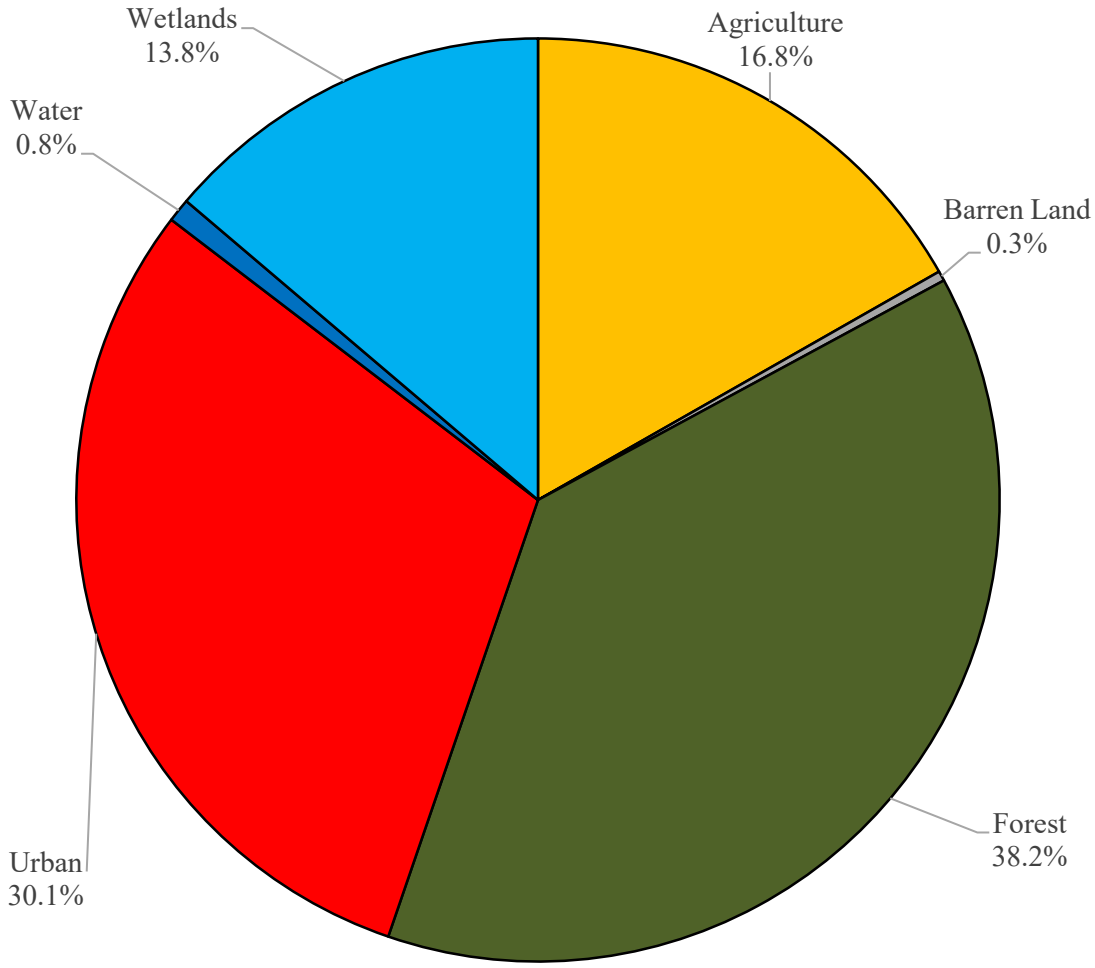


Figure 2: Pie chart illustrating the land use in Washington Township

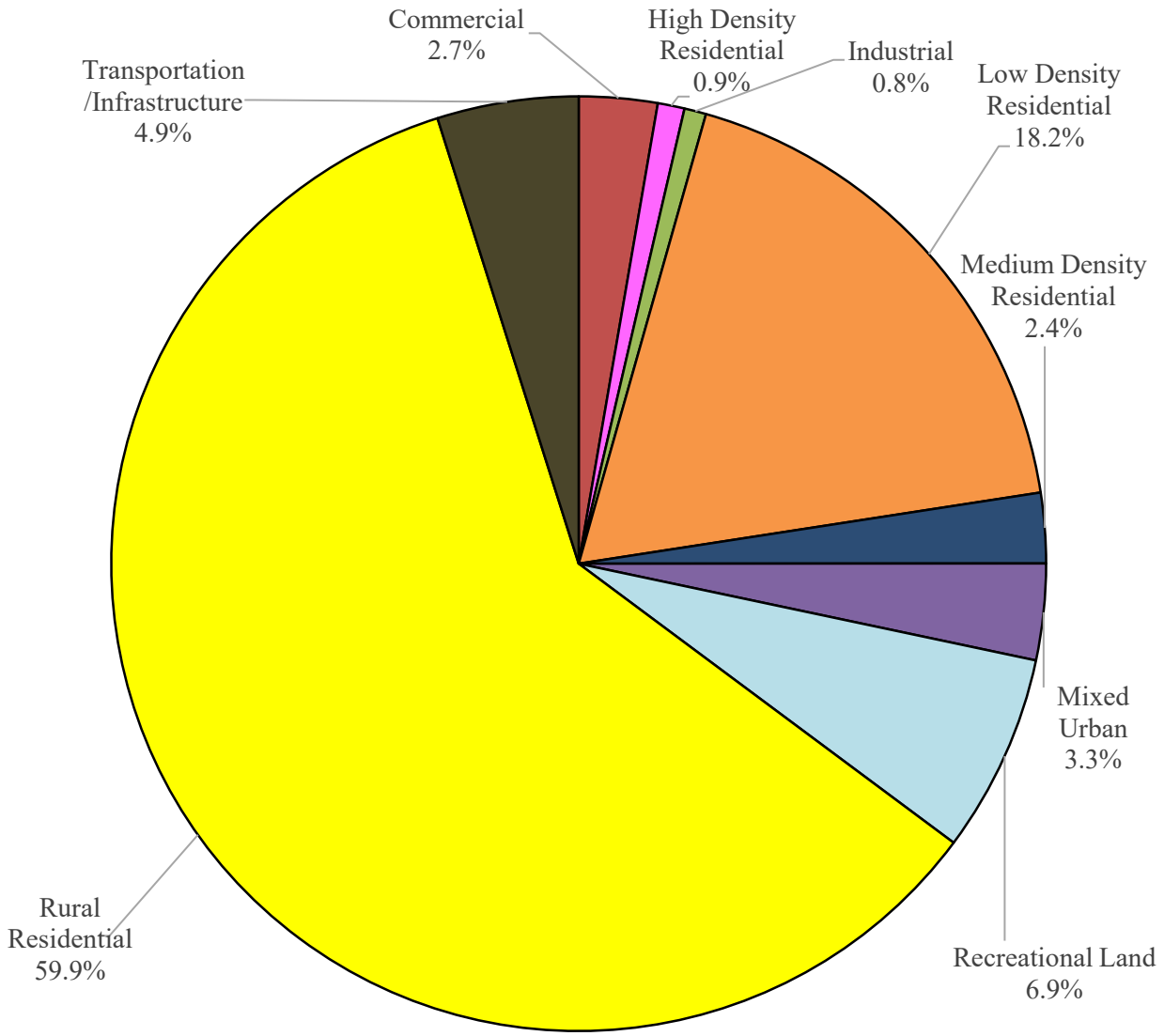


Figure 3: Pie chart illustrating the various types of urban land use in Washington Township

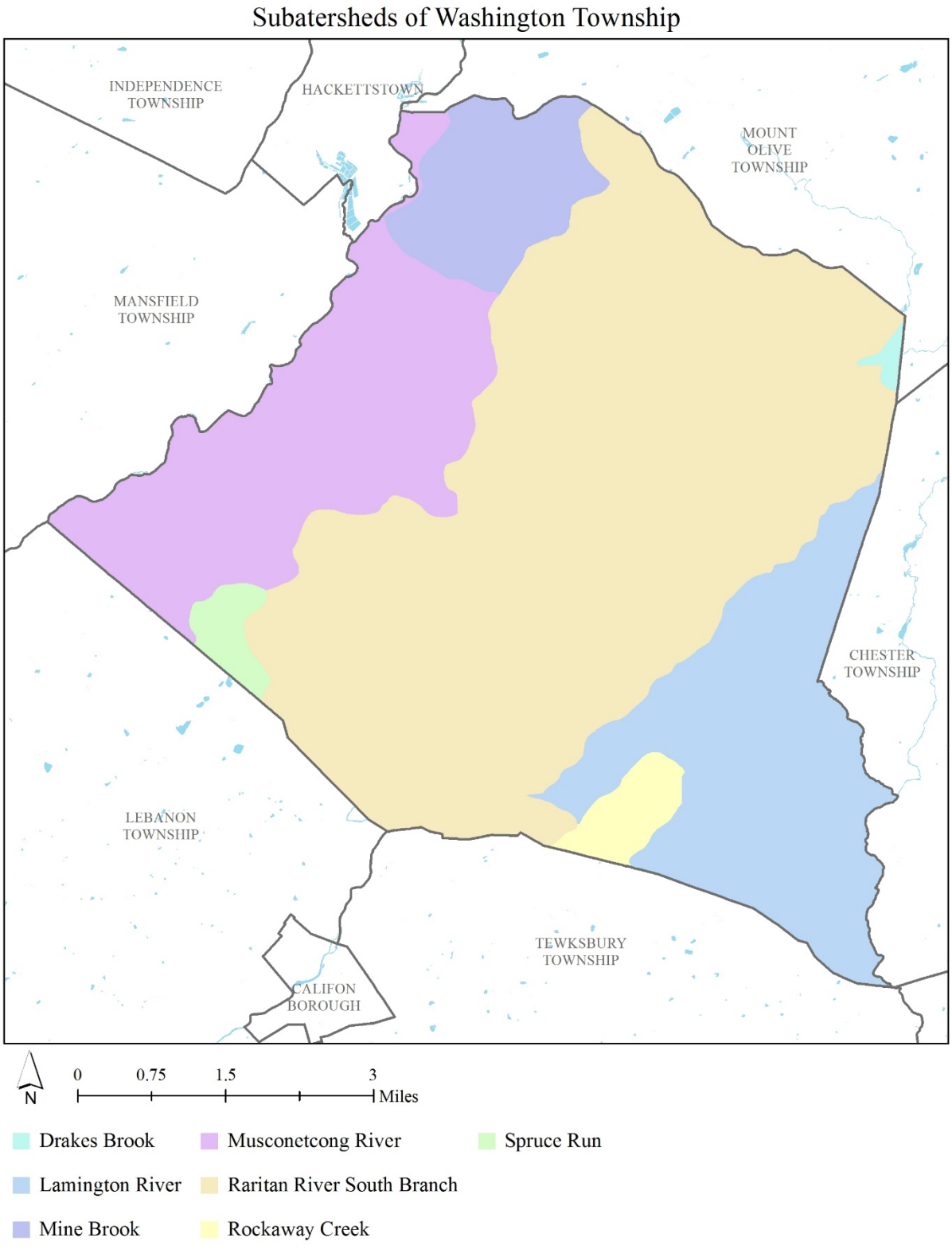


Figure 4: Map of the subwatersheds in Washington Township

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 in developing total maximum daily loads (TMDLs) for impaired waterways of the state. The percentage of impervious cover for each site was extracted from the 2015 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 Washington Township 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. Several key soil parameters were examined (e.g., natural drainage class, saturated hydraulic conductivity of the most limiting soil layer (K_{sat}), depth to water table, and hydrologic soil group) to evaluate the suitability of each site's soil for green infrastructure practices. In cases where multiple soil types were encountered, the key soil parameters were examined for each soil type expected at a site.

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.

Table 1: Aerial Loading Coefficients[2]

Land Cover	TP load (lbs/acre/yr)	TN load (lbs/acre/yr)	TSS load (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

[2] New Jersey Department of Environmental Protection (NJDEP), Stormwater Best Management Practice Manual, 2004.

Green Infrastructure Practices

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 practices 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[3]. A wide range of green infrastructure practices have been evaluated for the potential project sites in Washington Township. Each practice is discussed below.

Disconnected downspouts

This is often referred to as simple disconnection. A downspout is simply disconnected, prevented from draining directly to the roadway or storm sewer system, and directed to discharge water to a pervious area (i.e., lawn).

Pervious pavements

There are several types of permeable pavement systems including porous asphalt, pervious concrete, permeable pavers, and grass pavers. These surfaces are hard and support vehicle traffic but also allow water to infiltrate through the surface. They have an underlying stone layer to store stormwater runoff and allow it to slowly seep into the ground.

[3] United States Environmental Protection Agency (USEPA), 2013. Watershed Assessment, Tracking, and Environmental Results, New Jersey Water Quality Assessment Report. http://ofmpub.epa.gov/waters10/attains_state.control?p_state=NJ

Bioretention systems/rain gardens

These are landscaped features that are designed to capture, treat, and infiltrate stormwater runoff. These systems can easily be incorporated into existing landscapes, improving aesthetics and creating wildlife habitat while managing stormwater runoff. Bioretention systems also can be used in soils that do not quickly infiltrate by incorporating an underdrain into the system.

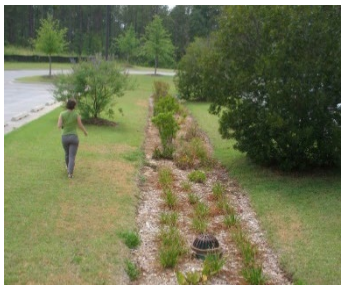
Downspout planter boxes

These are wooden boxes with plants installed at the base of a downspout that provide an opportunity to beneficially reuse rooftop runoff.

Rainwater harvesting systems (cistern or rain barrel)

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.

Bioswale



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

Stormwater planters

Stormwater planters are vegetated structures that are built into the sidewalk to intercept stormwater runoff from the roadway or sidewalk. Many of these planters are designed to allow the water to infiltrate into the ground while others are designed simply to filter the water and convey it back into the stormwater sewer system.

Tree filter boxes

These are pre-manufactured concrete boxes 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 sewer system.

Potential Project Sites

Appendix A contains information on potential project sites where green infrastructure practices could be installed as well as information on existing site conditions. The recommended green infrastructure practices and the drainage area that the green infrastructure practices can treat are identified for each potential project site. For each practice, the recharge potential, TSS removal potential, maximum volume reduction potential per storm, the peak reduction potential, and estimated costs are provided. This information is also provided so that proposed development projects that cannot satisfy the New Jersey stormwater management requirements for major development can use one of the identified projects to offset a stormwater management deficit. [4]

[4] New Jersey Administrative Code, N.J.A.C. 7:8, Stormwater Management, Statutory Authority: N.J.S.A. 12:5-3, 13:1D-1 et seq., 13:9A-1 et seq., 13:19-1 et seq., 40:55D-93 to 99, 58:4-1 et seq., 58:10A-1 et seq., 58:11A-1 et seq. and 58:16A-50 et seq., *Date last amended: April 19, 2010*.

Conclusion

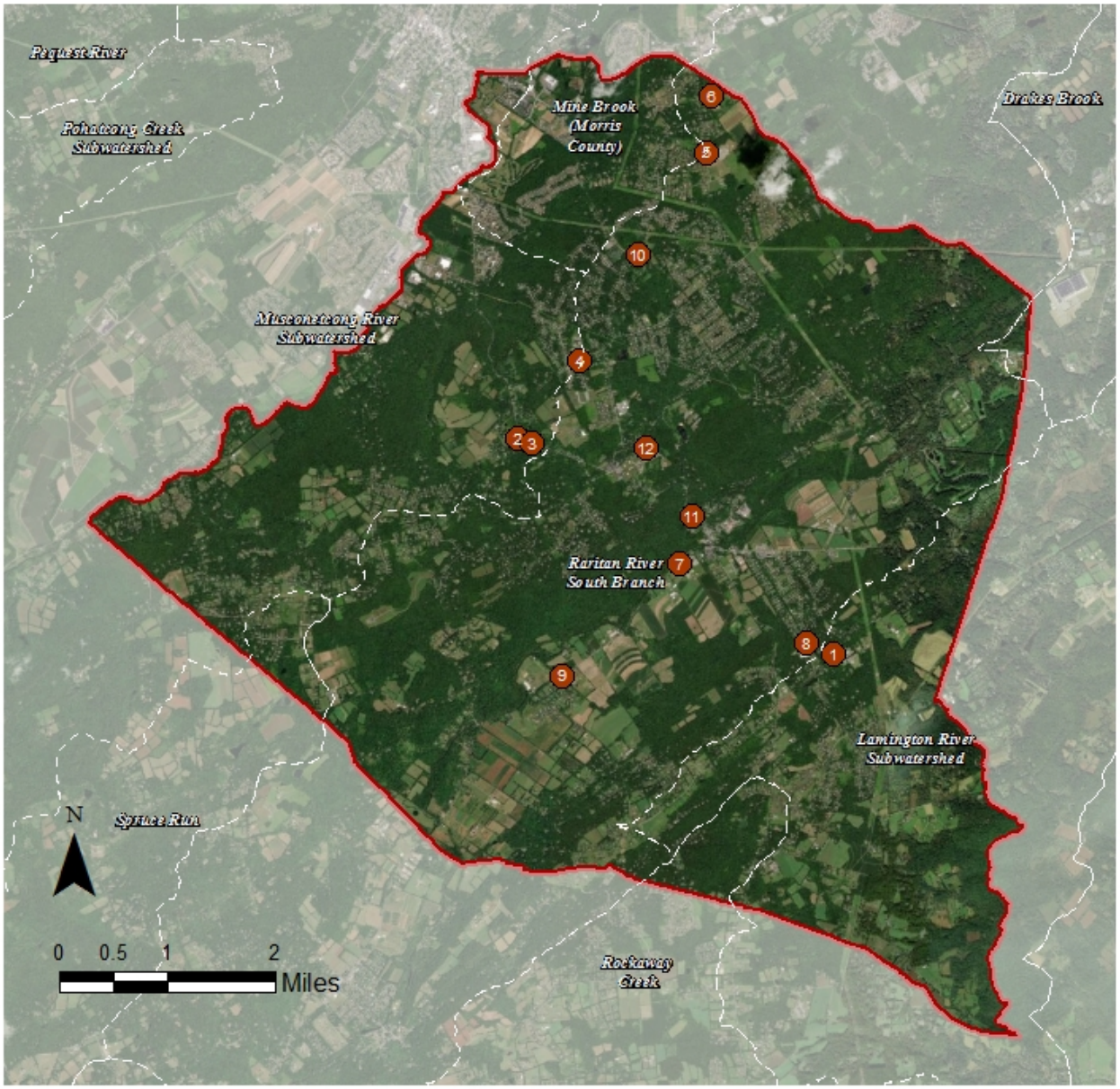
This impervious cover reduction action plan is meant to provide the municipality with a blueprint for implementing green infrastructure practices that will reduce the impact of stormwater runoff from impervious surfaces. These projects can be implemented by a wide variety of people such as boy scouts, girl scouts, school groups, faith-based groups, social groups, watershed groups, and other community groups.

Additionally, development projects that are in need of providing off-site compensation for stormwater impacts can use the projects in this plan as a starting point. The municipality can quickly convert this impervious cover reduction action plan into a stormwater mitigation plan and incorporate it into the municipal stormwater control ordinance.

Appendix A: Climate Resilient Green Infrastructure

a. Green Infrastructure Sites

WASHINGTON TOWNSHIP: GREEN INFRASTRUCTURE SITES



SITES WITHIN THE LAMINGTON RIVER SUBWATERSHED

1. Valley Brook Country Day School

SITES WITHIN THE MUSCONETCONG RIVER SUBWATERSHED

2. Emmanuel Bible Church
3. Schooleys Mountain Fire Protection
4. Walter J. Kossman School

SITES WITHIN THE RARITAN RIVER SOUTH BRANCH SUBWATERSHED

5. Benedict A. Cucinella School
6. Drakestown United Methodist Church
7. Long Valley Middle School
8. Old Farmers Road Elementary School
9. St. Luke Parish
10. St. Mark the Evangelist Roman Catholic Church
11. Washington Township Municipal Building
12. Washington Township Public Library

b. Proposed Green Infrastructure Concepts

VALLEY BROOK COUNTRY DAY SCHOOL

Subwatershed: **Lamington River**

Site Area: **1,079,999 sq. ft.**

Address: **73 East Valley Brook Road**
Long Valley, NJ 07853

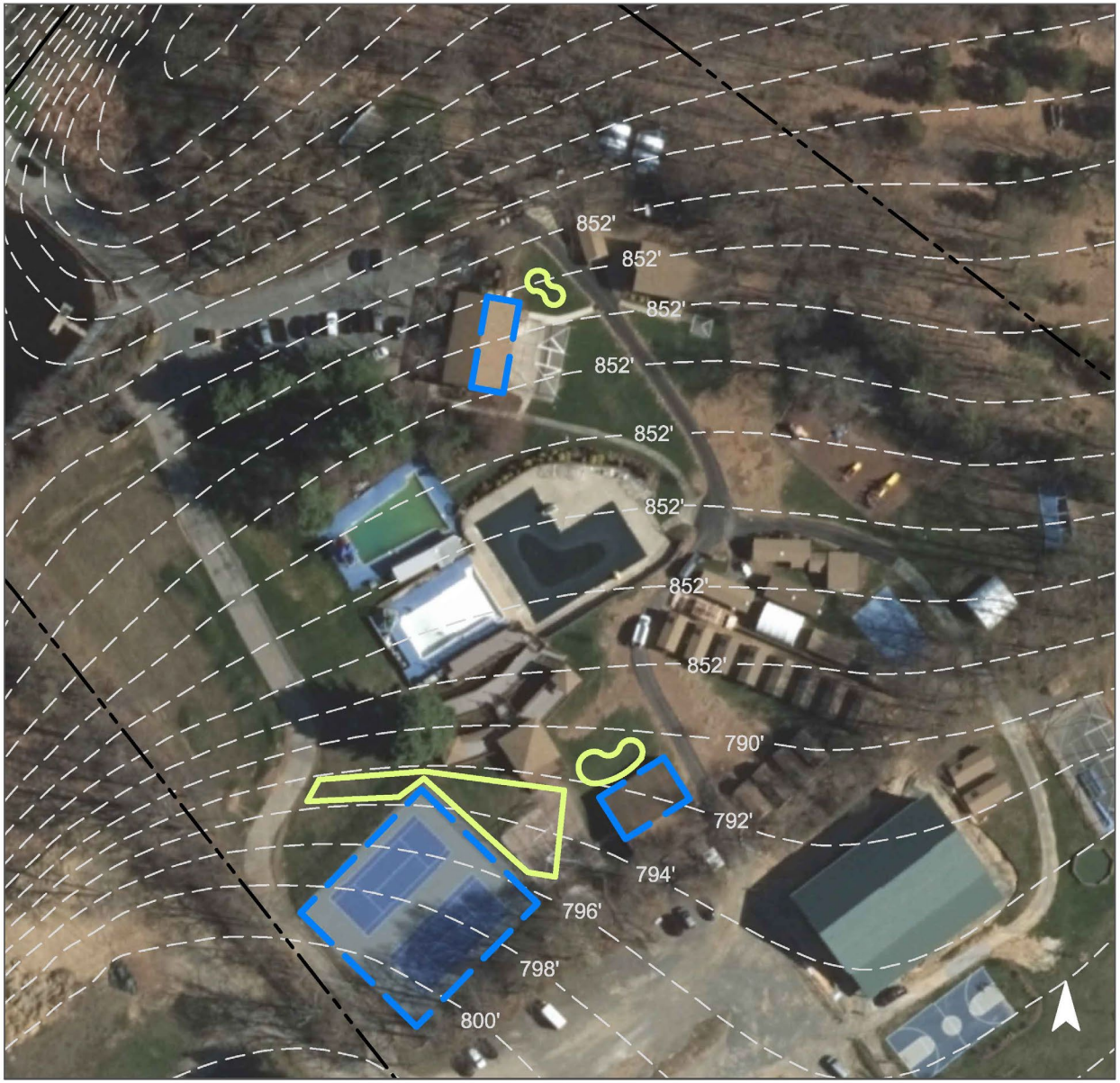
Block and Lot: **Block 37, Lot 25**

Rain gardens can be installed adjacent to buildings and impervious surfaces like the tennis courts to capture stormwater runoff. A preliminary soil assessment suggests that more soil testing would be required before determining the soil's suitability for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs/yr)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
19	4.76	207,492	10.0	104.8	952.7	0.162

Recommended Green 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	0.389	65	30,430	1.07	3,740	$18,700

GREEN INFRASTRUCTURE RECOMMENDATIONS



VALLEY BROOK COUNTRY DAY SCHOOL

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

0 50' 100'

EMMANUEL BIBLE CHURCH

Subwatershed: **Musconetcong River**

Site Area: **622,785 sq. ft.**

Address: **3 Pleasant Grove Road Schooleys Mountain, NJ 07870**

Block and Lot: **Block 31 Lot 26**

A rain garden and downspout planter boxes can be installed adjacent to the main building to capture, treat, and infiltrate stormwater runoff from the roof. Pervious pavement is proposed to treat runoff in the southeast parking lot. Planter boxes can also be installed to treat the rooftop drainage area. A preliminary soil assessment suggests that more soil testing would be required before determining the soil's suitability for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs/yr)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
18	2.54	110,514	5.3	55.8	507.4	0.086

Recommended Green 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	0.021	4	1,670	0.06	205	$1,025
Pervious pavement	0.269	45	21,030	0.74	1,845	$46,125
Planter boxes	n/a	2	n/a	n/a	2 (boxes)	$2,000

GREEN INFRASTRUCTURE RECOMMENDATIONS

Emmanuel Bible Church

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

0 50' 100'

SCHOOLEYS MOUNTAIN FIRE PROTECTION

Subwatershed: **Musconetcong River**

Site Area: **69,972 sq. ft.**

Address: **231 Schooleys Mountain Road**
Long Valley, NJ 07870

Block and Lot: **Block 31 Lot 27**

Runoff from different sections of the parking lot can be treated by a rain garden and also a section of porous parking spaces. A cistern can be installed adjacent to the building to capture runoff from the roof. The water can then be reused for washing vehicles or watering the lawn. Additionally, downspout planters can be installed to treat the northeast rooftop drainage area. Preliminary soil assessment suggests that more soil testing would be required before determining the soil's suitability for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs/yr)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
36	0.58	25,147	1.2	12.7	115.5	0.020

Recommended Green 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	0.248	42	20,031	0.88	2,385	$11,925
Pervious pavement	0.348	58	27,160	1.19	2,570	$64,250
Planter boxes	n/a	2	n/a	n/a	2 (boxes)	$2,000
Rainwater harvesting	0.033	6	2,446	0.11	1,000 (gal)	$2,000

GREEN INFRASTRUCTURE RECOMMENDATIONS

Schooleys Mountain Fire Protection

- bioretention system
- rainwater harvesting
- pervious pavement
- planter box
- drainage area
- property line
- 2015 Aerial: NJOIT, OGIS

0 30' 60'

WALTER J. KOSSMAN SCHOOL

Subwatershed: Musconetcong River

Site Area: 500,616 sq. ft.

Address: 90 Flocktown Road
Long Valley, NJ 07853

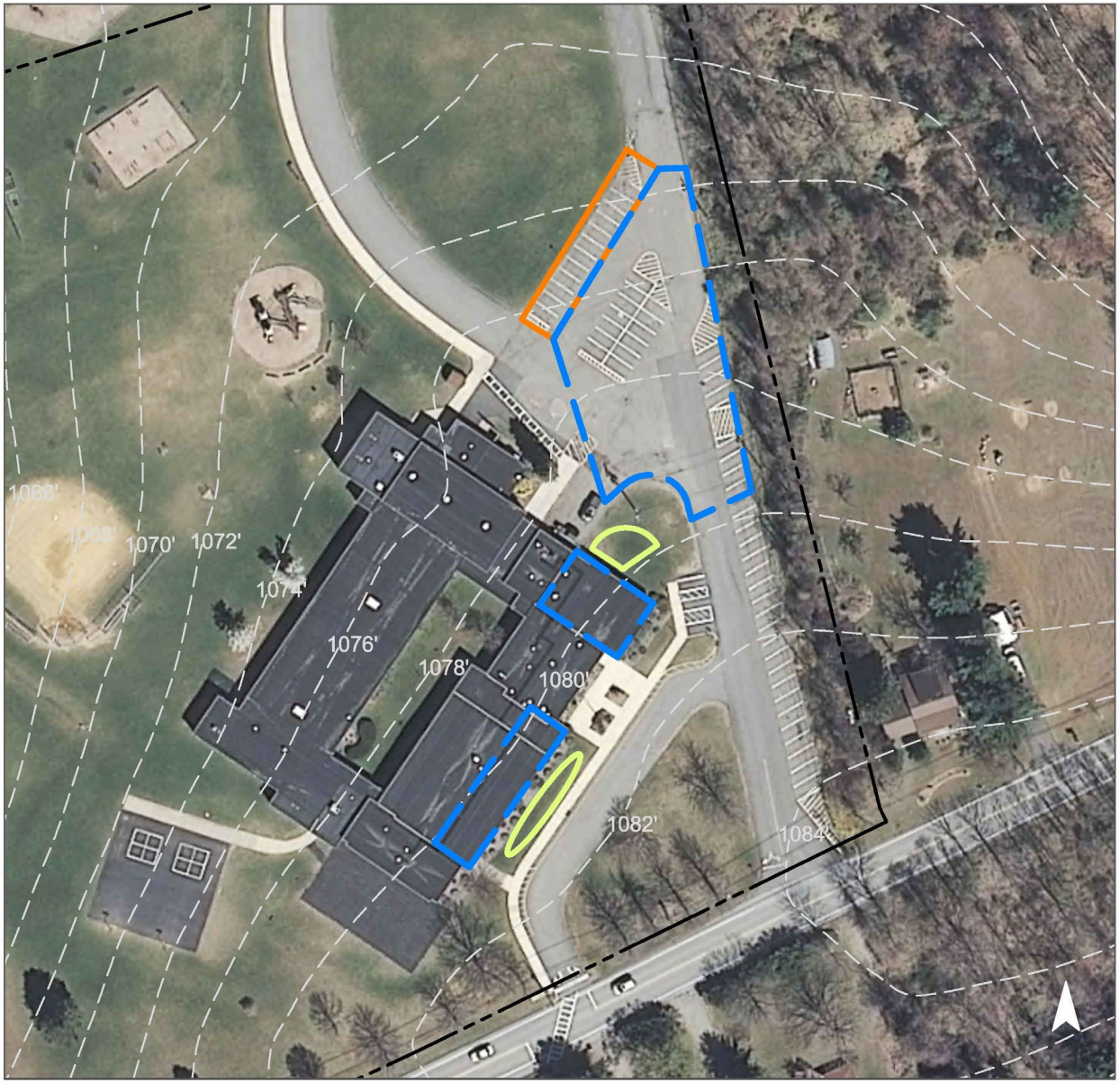
Block and Lot: Block 20 Lot 23

Two rain gardens can be installed to capture, treat, and infiltrate runoff from the roof of the building. A section of parking spaces can be converted to porous pavement to capture and infiltrate runoff from the parking lot. A preliminary soil assessment suggests that more soil testing would be required before determining the soil's suitability for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs/yr)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
28	3.24	141,224	6.8	71.3	648.4	0.110

Recommended Green 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	0.238	40	18,570	0.66	2,280	$11,400
Pervious pavement	0.466	78	36,430	1.29	3,195	$79,875

GREEN INFRASTRUCTURE RECOMMENDATIONS



Walter J. Kossmann School

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

0 50' 100'

BENEDICT A. CUCINELLA SCHOOL

Subwatershed: Raritan River South Branch

Site Area: 1,278,641 sq. ft.

Address: 470 Naughright Road
Long Valley, NJ 07853

Block and Lot: Block 12 Lot 37

Downspout planter boxes are suggested at the entrance of the school to promote green infrastructure awareness. A section of parking spaces can be converted to pervious pavement to capture and infiltrate runoff from the parking lot. Tree filter boxes can be installed in islands in the parking lot to capture runoff from other spaces in the parking lot. A preliminary soil assessment suggests that more soil testing would be required before determining the soil's suitability for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs/yr)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
23	6.61	287,755	13.9	145.3	1,321.2	0.224

Recommended Green 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	0.230	38	17,960	0.63	2,715	$67,875
Planter boxes	n/a	2	n/a	n/a	2 (boxes)	$2,000
Tree filter boxes	n/a	116	n/a	n/a	3 (boxes)	$30,000

GREEN INFRASTRUCTURE RECOMMENDATIONS

Benedict A. Cucinella School

- pervious pavement
- planter box
- tree filter box
- drainage area
- property line
- 2015 Aerial: NJOIT, OGIS

0 50' 100'

DRAKESTOWN UNITED METHODIST CHURCH

Subwatershed: Raritan River South Branch

Site Area: 42,024 sq. ft.

Address: 6 Church Road
Hackettstown, NJ 07840

Block and Lot: Block 10 Lot 11

Downspout planter boxes can be installed to capture and retain runoff from the rooftop. Pervious pavement is proposed along the south edge of the parking lot to treat the entire parking lot's drainage area. A preliminary soil assessment suggests that more soil testing would be required before determining the soil's suitability for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs/yr)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
39	0.38	16,468	0.8	8.3	75.6	0.013

Recommended Green 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	0.168	28	13,090	0.46	1,630	$40,750
Planter boxes	n/a	1	n/a	n/a	2 (boxes)	$2,000

GREEN INFRASTRUCTURE RECOMMENDATIONS

Drakestown United Methodist Church

- pervious pavement
- planter box
- drainage area
- property line
- 2015 Aerial: NJOIT, OGIS

0 25' 50'

LONG VALLEY MIDDLE SCHOOL

Subwatershed: Raritan River South Branch

Site Area: 1,089,160 sq. ft.

Address: 51 West Mill Road
Long Valley, NJ 07853

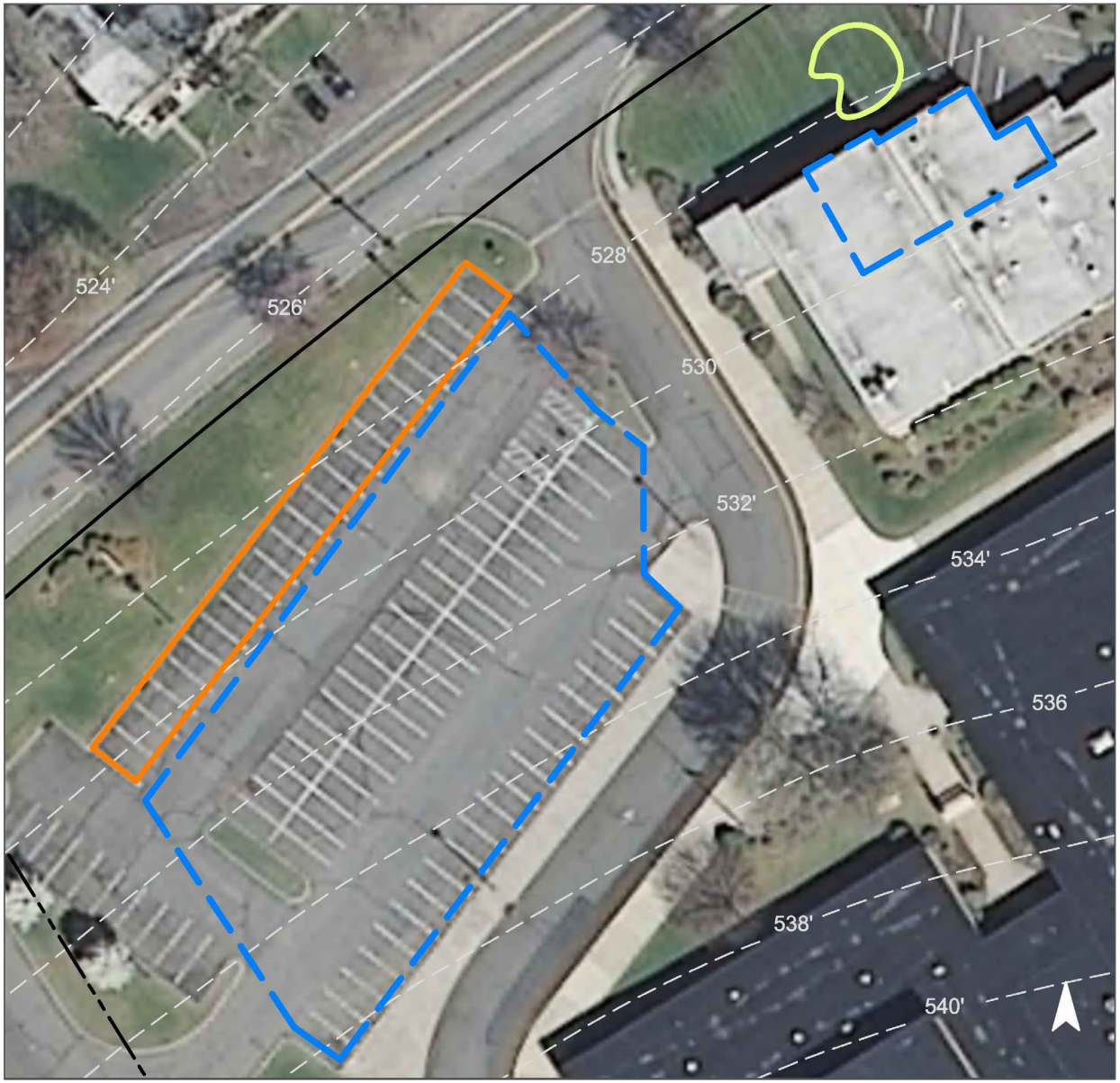
Block and Lot: Block 34 Lot 49

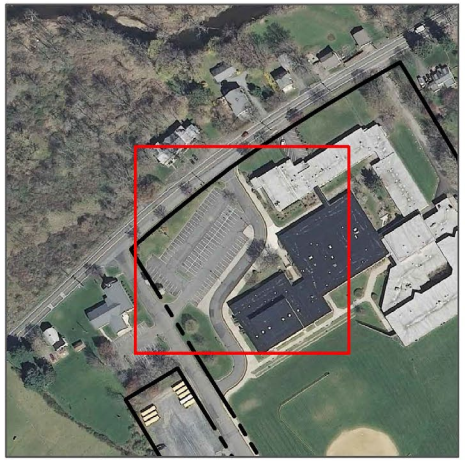
Pervious pavement is proposed in a section of parking spaces to capture and infiltrate runoff from the parking lot. A bioretention system is proposed in the north turfgrass area to capture runoff from the roof of the school. A preliminary soil assessment suggests that more soil testing would be required before determining the soil's suitability for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs/yr)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
32	8.03	349,813	16.9	176.7	1,606.1	0.273

Recommended Green 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	0.062	10	4,870	0.17	600	$3,000
Pervious pavement	0.527	88	41,160	1.45	3,610	$90,250

GREEN INFRASTRUCTURE RECOMMENDATIONS





Long Valley Middle School

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

0 25' 50'

OLD FARMERS ROAD ELEMENTARY SCHOOL

Subwatershed: Raritan River South Branch

Site Area: 636,598 sq. ft.

Address: 51 Old Farmers Road
Long Valley, NJ 07853

Block and Lot: Block 35, Lot 3.01

Two rain gardens can be installed to capture, treat, and infiltrate stormwater runoff from the building's roof as well as the adjacent 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	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
24	151,534	7.3	76.5	695.7	0.118	4.16

Recommended Green 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	0.349	58	27,290	0.96	3,350	$16,750

GREEN INFRASTRUCTURE RECOMMENDATIONS

OLD FARMERS ROAD ELEMENTARY SCHOOL

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

0 50' 100'

ST. LUKE PARISH

Subwatershed: Raritan River South Branch

Site Area: 494,989 sq. ft.

Address: 265 West Mill Road
Long Valley, NJ 07853

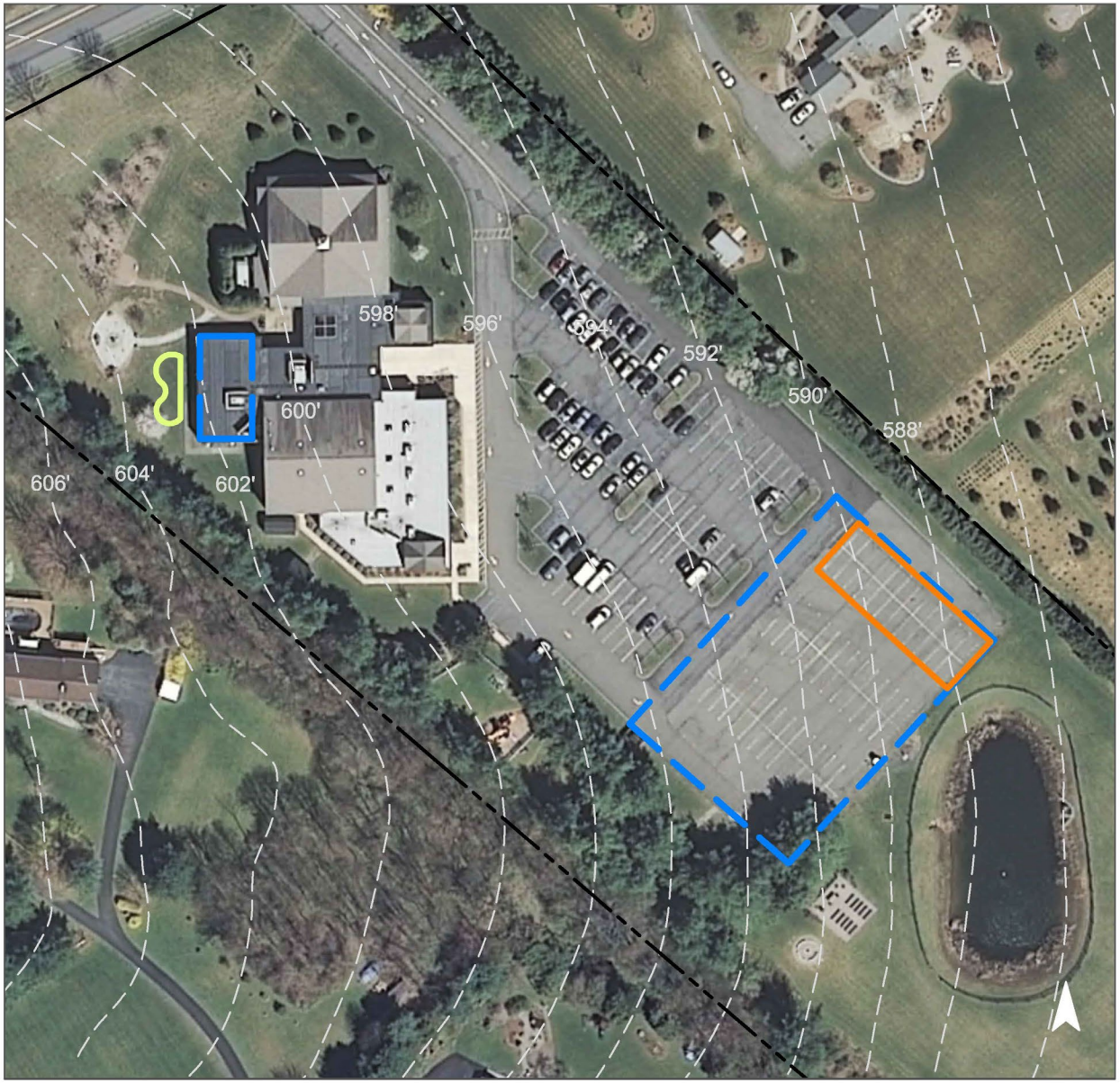
Block and Lot: Block 34 Lot 38

A bioretention system can be installed to infiltrate the water from three disconnected downspouts on the west side of the building. In addition, pervious pavement is proposed along the southeast corner of the parking lot to the parking lot's drainage area. 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	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
28	136,492	6.6	68.9	626.7	0.106	3.74

Recommended Green 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	0.060	10	4,710	0.17	580	$2,900
Pervious pavement	0.700	117	54,730	1.93	4,800	$120,000

GREEN INFRASTRUCTURE RECOMMENDATIONS



St. Luke Parish

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

0 50' 100'

ST. MARK THE EVANGELIST ROMAN CATHOLIC CHURCH

Subwatershed: Raritan River South Branch

Site Area: 366,270 sq. ft.

Address: 59 Spring Lane
Long Valley, NJ 07853

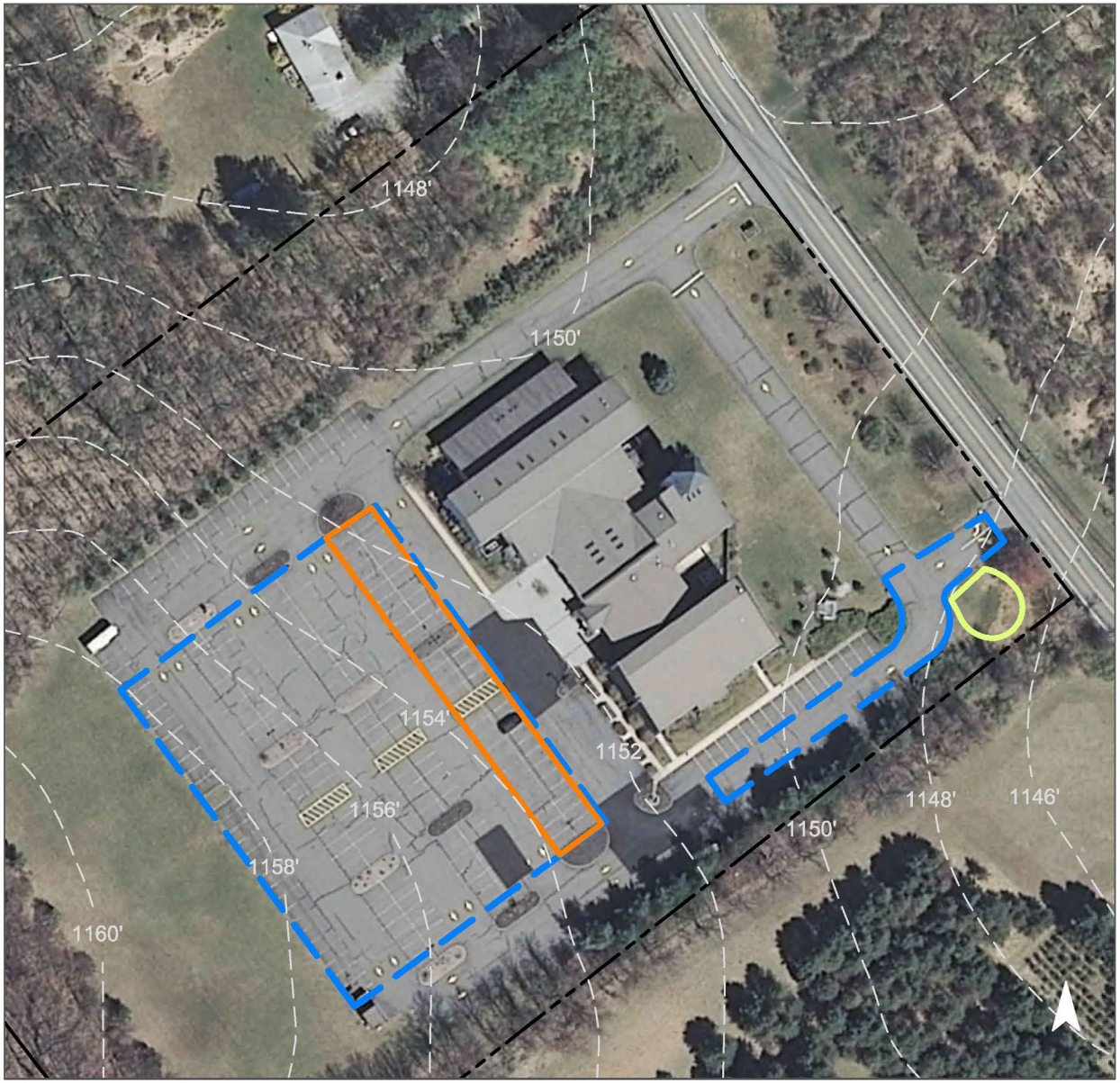
Block and Lot: Block 20 Lot 90

A bioretention system can be installed in the southeast corner of the property to mitigate flooding. Additionally, pervious pavement is suggested adjacent to the southwest edge of the building to capture and infiltrate stormwater runoff from the parking lot. A preliminary soil assessment suggests that more soil testing would be required before determining the soil's suitability for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs/yr)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
43	158,478	7.6	80.0	727.6	0.123	4.35

Recommended Green 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	0.159	27	12,420	0.44	1,525	$7,625
Pervious pavement	1.473	247	115,100	4.06	8,910	$222,750

GREEN INFRASTRUCTURE RECOMMENDATIONS



St. Mark the Evangelist Roman Catholic Church

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

0 50' 100'

WASHINGTON TOWNSHIP MUNICIPAL BUILDING

Subwatershed: Raritan River South Branch

Site Area: 42,944 sq. ft.

Address: 43 Schooleys Mountain Road
Long Valley, NJ 07853

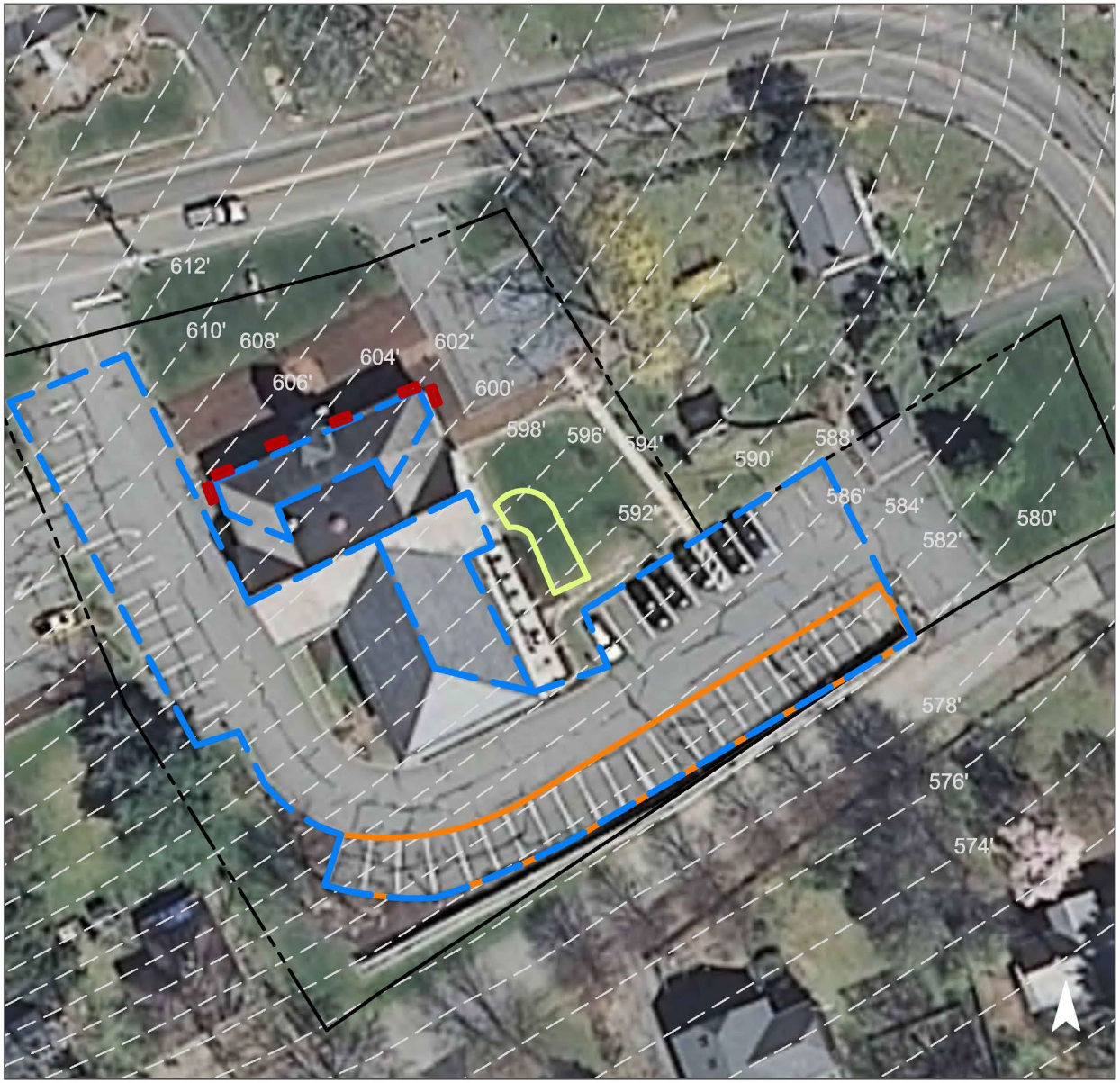
Block and Lot: Block 26 Lot 2

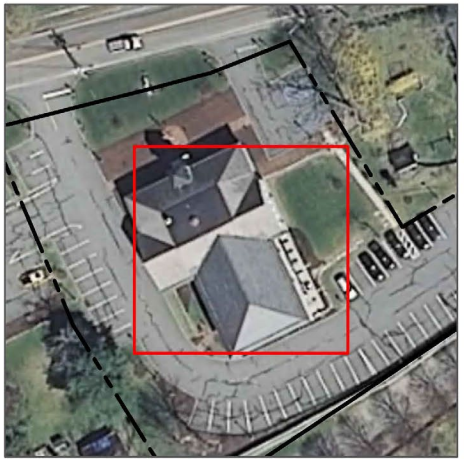
A rain garden can be installed adjacent to the building to infiltrate water from two connected downspouts. Additionally, pervious pavement can capture and infiltrate the stormwater runoff from the entire parking lot and a portion of the roof. Downspout planter boxes can be installed at downspouts to capture runoff from the roof as well. A preliminary soil assessment suggests that more soil testing would be required before determining the soil's suitability for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs/yr)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
60	34,223	2.3	24.2	220.0	0.027	0.94

Recommended Green 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	0.039	7	3,050	0.11	400	$2,000
Pervious pavement	0.519	87	40,560	1.43	4,020	$100,500
Planter boxes	n/a	5	n/a	n/a	6 (boxes)	$6,000

GREEN INFRASTRUCTURE RECOMMENDATIONS





Washington Township Municipal Building

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

0 25' 50'

WASHINGTON TOWNSHIP PUBLIC LIBRARY

Subwatershed: Raritan River South Branch

Site Area: 3,276,100 sq. ft.

Address: 37 East Springtown Road
Long Valley, NJ 07853

Block and Lot: Block 24 Lot 7

A bioretention system can be installed to infiltrate the water from four disconnected downspouts. Parking spaces can be converted to porous pavement to capture and infiltrate runoff from the parking lot. Four downspout planter boxes are proposed near the entrance of the building to treat the rooftop drainage area. A preliminary soil assessment suggests that more soil testing would be required before determining the soil's suitability for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs/yr)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
10	330,030	15.9	166.7	1,515.3	0.257	9.05

Recommended Green 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	0.081	14	6,310	0.22	775	$3,875
Pervious pavement	0.269	45	21,060	0.74	2,880	$72,000
Planter boxes	n/a	3	n/a	n/a	4 (boxes)	$4,000

GREEN INFRASTRUCTURE RECOMMENDATIONS

Washington Township Public Library

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

0 25' 50'

c. Summary of Existing Conditions

Summary of Existing Conditions

	Subwatershed/Site Name/Total Site Info/GI Practice	Area (ac)	Area (SF)	Block	Lot	I.C. %	I.C. Area (ac)	I.C. Area (SF)	Existing Annual Loads (Commercial)			Runoff Volumes from I.C.		Runoff Volumes from I.C.	
									TP (lb/yr)	TN (lb/yr)	TSS (lb/yr)	Water Quality Storm (1.25" over 2-hours) (cu.ft.)	Annual (cu.ft.)	Water Quality Storm (1.25" over 2-hours) (Mgal)	Annual (Mgal)
	Lamington River Subwatershed sites	**24.79**	**1,079,999**				**4.76**	**207,492**	**10.0**	**104.8**	**952.7**	**21,614**	**760,804**	**0.162**	**5.69**
1	**Valley Brook Country Day School**														
	Total Site Info	24.79	1,079,999	37	25	19	4.76	207,492	10.0	104.8	952.7	21,614	760,804	0.162	5.69
	Musconectong River Subwatershed sites	**27.40**	**1,193,372**				**6.36**	**276,885**	**13.3**	**139.8**	**1,271.3**	**28,842**	**1,015,244**	**0.216**	**7.59**
2	**Emmanuel Bible Church**														
	Total Site Info	14.30	622,785	31	26	18	2.54	110,514	5.3	55.8	507.4	11,512	405,217	0.086	3.03
3	**Schooleys Mountain Fire Protection**														
	Total Site Info	1.61	69,972	31	27	36	0.58	25,147	1.2	12.7	115.5	2,619	92,206	0.020	0.69
4	**Walter J. Kossman School**														
	Total Site Info	11.49	500,616	20	23	28	3.24	141,224	6.8	71.3	648.4	14,711	517,821	0.110	3.87
	Raritan River South Branch sites	**165.90**	**7,226,724**				**33.94**	**1,464,791**	**71.3**	**746.7**	**6,788.3**	**152,582**	**5,370,900**	**1.141**	**40.17**
5	**Benedict A. Cucinella School**														
	Total Site Info	29.35	1,278,641	12	37	23	6.61	287,755	13.9	145.3	1,321.2	29,974	1,055,101	0.224	7.89
6	**Drakestown United Methodist Church**														
	Total Site Info	0.96	42,024	10	11	39	0.38	16,468	0.8	8.3	75.6	1,715	60,381	0.013	0.45
7	**Long Valley Middle School**														
	Total Site Info	25.00	1,089,160	34	49	32	8.03	349,813	16.9	176.7	1,606.1	36,439	1,282,646	0.273	9.59
8	**Old Farmers Road Elementary School**														
	Total Site Info	14.61	636,598	35	3.01	24	3.48	151,534	7.3	76.5	695.7	15,785	555,624	0.118	4.16
9	**St. Luke Parish**														
	Total Site Info	11.36	494,989	34	38	28	3.13	136,492	6.6	68.9	626.7	14,218	500,469	0.106	3.74
10	**St. Mark the Evangelist RCC**														
	Total Site Info	8.41	366,270	20	90	43	3.64	158,478	7.6	80.0	727.6	16,508	581,087	0.123	4.35
11	**Washington Township Municipal Building**														
	Total Site Info	0.99	42,944	26	2	60	1.10	34,223	2.3	24.2	220.0	3,565	125,483	0.027	0.94
12	**Washington Township Public Library**														
	Total Site Info	75.21	3,276,100	24	7	10	7.58	330,030	15.9	166.7	1,515.3	34,378	1,210,109	0.257	9.05

d. Summary of Proposed Green Infrastructure Practices

Summary of Proposed Green Infrastructure Practices

	Subwatershed/Site Name/Total Site Info/GI Practice	Potential Management Area Area (SF)	Potential Management Area Area (ac)	Recharge Potential (Mgal/yr)	TSS Removal Potential (lbs/yr)	Max Volume Reduction Potential (gal/storm)	Peak Discharge Reduction Potential (cfs)	Size of BMP	Unit Cost ($/unit)	Unit	Total Cost ($)	I.C. Treated %
	Lamington River Subwatershed sites	**14,945**	**0.34**	**0.389**	**65**	**5,902**	**0.26**				**$18,700**	**7.2%**
1	**Valley Brook Country Day School**											
	Bioretention systems	14,945	0.34	0.389	65	5,902	0.26	3,740	$5	SF	$18,700	7.2%
	Total Site Info	**14,945**	**0.34**	**0.389**	**65**	**5,902**	**0.26**				**$18,700**	**7.2%**
	Musconectong River Subwatershed sites	**63,175**	**1.45**	**1.624**	**275**	**191,346**	**8.40**				**$220,600**	**22.8%**
2	**Emmanuel Bible Church**											
	Bioretention system	820	0.02	0.021	4	2,461	0.11	205	$5	SF	$1,025	0.7%
	Pervious pavement	10,330	0.24	0.269	45	70,656	3.10	1,845	$25	SF	$46,125	9.3%
	Planter boxes	430	0.01	n/a	2	n/a	n/a	2	$1,000	box	$2,000	0.4%
	Total Site Info	**11,580**	**0.27**	**0.291**	**50**	**73,117**	**3.21**				**$49,150**	**10.5%**
3	**Schooleys Mountain Fire Protection**											
	Bioretention system	9,530	0.22	0.248	42	20,031	0.88	2,385	$5	SF	$11,925	37.9%
	Pervious pavement	13,340	0.31	0.348	58	27,160	1.19	2,570	$25	SF	$64,250	53.0%
	Planter boxes	430	0.01	n/a	2	n/a	n/a	2	$1,000	box	$2,000	1.7%
	Rainwater harvesting	1,285	0.03	0.033	6	2,446	0.11	1,000	$2	gal	$2,000	5.1%
	Total Site Info	**24,585**	**0.56**	**0.629**	**107**	**49,637**	**2.18**				**$80,175**	**97.8%**
4	**Walter J. Kossman School**											
	Bioretention systems	9,120	0.21	0.238	40	6,156	0.27	2,280	$5	SF	$11,400	6.5%
	Pervious pavement	17,890	0.41	0.466	78	62,436	2.74	3,195	$25	SF	$79,875	12.7%
	Total Site Info	**27,010**	**0.62**	**0.704**	**118**	**68,592**	**3.01**				**$91,275**	**19.1%**
	Raritan River South Branch sites	**210,558**	**4.83**	**4.636**	**903**	**536,430**	**23.58**				**$794,275**	**14.4%**
5	**Benedict A. Cucinella School**											
	Pervious pavement	8,820	0.20	0.230	38	133,608	5.87	2,715	$25	SF	$67,875	3.1%
	Planter boxes	430	0.01	n/a	2	n/a	n/a	2	$1,000	box	$2,000	0.1%
	Tree filter boxes	29,630	0.68	n/a	116	n/a	n/a	3	$10,000	box	$30,000	10.3%
	Total Site Info	**38,880**	**0.89**	**0.230**	**156**	**133,608**	**5.87**				**$99,875**	**13.5%**

Summary of Proposed Green Infrastructure Practices

	Subwatershed/Site Name/Total Site Info/GI Practice	Potential Management Area Area (SF)	Potential Management Area Area (ac)	Recharge Potential (Mgal/yr)	TSS Removal Potential (lbs/yr)	Max Volume Reduction Potential (gal/storm)	Peak Discharge Reduction Potential (cfs)	Size of BMP	Unit Cost ($/unit)	Unit	Total Cost ($)	I.C. Treated %
6	**Drakestown United Methodist Church**											
	Pervious pavement	6,430	0.15	0.168	28	13,090	0.58	1,630	$25	SF	$40,750	39.0%
	Planter boxes	408	0.01	n/a	1	n/a	n/a	2	$1,000	box	$2,000	2.5%
	Total Site Info	**6,838**	**0.16**	**0.168**	**30**	**13,090**	**0.58**				**$42,750**	**41.5%**
7	**Long Valley Middle School**											
	Bioretention system	2,390	0.05	0.062	10	4,862	0.21	600	$5	SF	$3,000	0.7%
	Pervious pavement	20,215	0.46	0.527	88	30,429	1.34	3,610	$25	SF	$90,250	5.8%
	Total Site Info	**22,605**	**0.52**	**0.589**	**99**	**35,291**	**1.55**				**$93,250**	**6.5%**
8	**Old Farmers Road Elementary School**											
	Bioretention systems	13,400	0.31	0.349	58	27,287	1.20	3,350	$5	SF	$16,750	8.8%
	Total Site Info	**13,400**	**0.31**	**0.349**	**58**	**27,287**	**1.20**				**$16,750**	**8.8%**
9	**St. Luke Parish**											
	Bioretention system	2,315	0.05	0.060	10	6,156	0.27	580	$5	SF	$2,900	1.7%
	Pervious pavement	26,880	0.62	0.700	117	151,029	6.63	4,800	$25	SF	$120,000	19.7%
	Total Site Info	**29,195**	**0.67**	**0.761**	**127**	**157,185**	**6.90**				**$122,900**	**21.4%**
10	**St. Mark the Evangelist Roman Catholic Church**											
	Bioretention system	6,100	0.14	0.159	27	12,417	0.55	1,525	$5	SF	$7,625	3.8%
	Pervious pavement	56,530	1.30	1.473	247	107,248	4.71	8,910	$25	SF	$222,750	35.7%
	Total Site Info	**62,630**	**1.44**	**1.632**	**273**	**119,665**	**5.26**				**$230,375**	**39.5%**
11	**Washington Township Municipal Building**											
	Bioretention system	1,500	0.03	0.039	7	2,177	0.10	400	$5	SF	$2,000	4.4%
	Pervious pavement	19,920	0.46	0.519	87	25,896	1.14	4,020	$25	SF	$100,500	58.2%
	Planter boxes	1,290	0.03	n/a	5	n/a	n/a	6	$1,000	box	$6,000	3.8%
	Total Site Info	**22,710**	**0.52**	**0.558**	**98**	**28,073**	**1.24**				**$108,500**	**66.4%**
12	**Washington Township Public Library**											
	Bioretention system	3,100	0.07	0.081	14	6,321	0.28	775	$5	SF	$3,875	0.9%
	Pervious pavement	10,340	0.24	0.269	45	15,910	0.70	2,880	$25	SF	$72,000	3.1%
	Planter boxes	860	0.02	n/a	3	n/a	n/a	4	$1,000	box	$4,000	0.3%

Summary of Proposed Green Infrastructure Practices

Subwatershed/Site Name/Total Site Info/GI Practice	Potential Management Area		Recharge Potential (Mgal/yr)	TSS Removal Potential (lbs/yr)	Max Volume Reduction Potential (gal/storm)	Peak Discharge Reduction Potential (cfs)	Size of BMP	Unit Cost ($/unit)	Unit	Total Cost ($)	I.C. Treated %
	Area (SF)	Area (ac)									
Total Site Info	**14,300**	**0.33**	**0.350**	**62**	**22,231**	**0.98**				**$79,875**	**4.3%**