RUTGERS
New Jersey Agricultural
Experiment Station

Draft

Impervious Cover Reduction Action Plan for Middlesex Borough, Middlesex County, New Jersey

Prepared for Middlesex Borough by the
Rutgers Cooperative Extension Water Resources Program

November 16, 2015

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Introduction

Located in Middlesex County in central New Jersey, Middlesex Borough covers approximately 3.51 square miles. Figures 1 and 2 illustrate that Middlesex Borough is dominated by urban land uses. A total of 80.3% of the municipality's land use is classified as urban. Of the urban land in Middlesex Borough, medium density residential is the dominant land use (Figure 3).

The New Jersey Department of Environmental Protection's (NJDEP) 2007 land use/land cover geographical information system (GIS) data layer categorizes Middlesex Borough 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 Middlesex Borough. Based upon the 2007 NJDEP land use/land cover data, approximately 36.8% of Middlesex Borough has impervious cover. This level of impervious cover suggests that the streams in Middlesex Borough are likely non-supporting streams.[1]

Methodology

Middlesex Borough contains portions of four subwatersheds (Figure 4). For this impervious cover reduction action plan, projects have been identified in each 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] Caraco, D., R. Claytor, P. Hinkle, H. Kwon, T. Schueler, C. Swann, S. Vysotsky, and J. Zielinski. 1998. Rapid Watershed Planning Handbook. A Comprehensive Guide for Managing Urbanizing Watersheds. Prepared by Center For Watershed Protection, Ellicott City, MD. Prepared for U.S. Environmental Protection Agency, Office of Wetlands, Oceans and Watersheds and Region V. October 1998

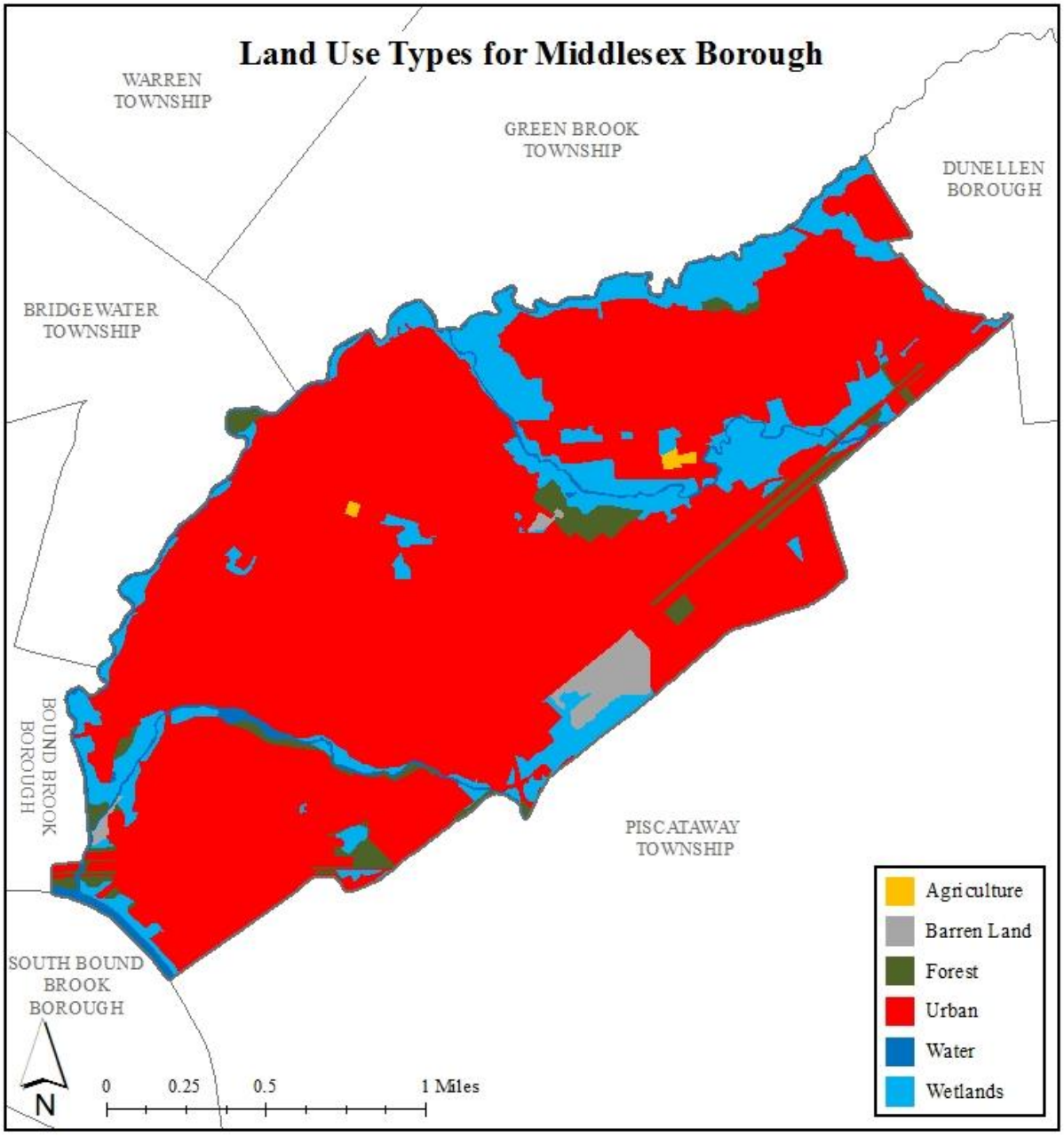


Figure 1: Map illustrating the land use in Middlesex Borough

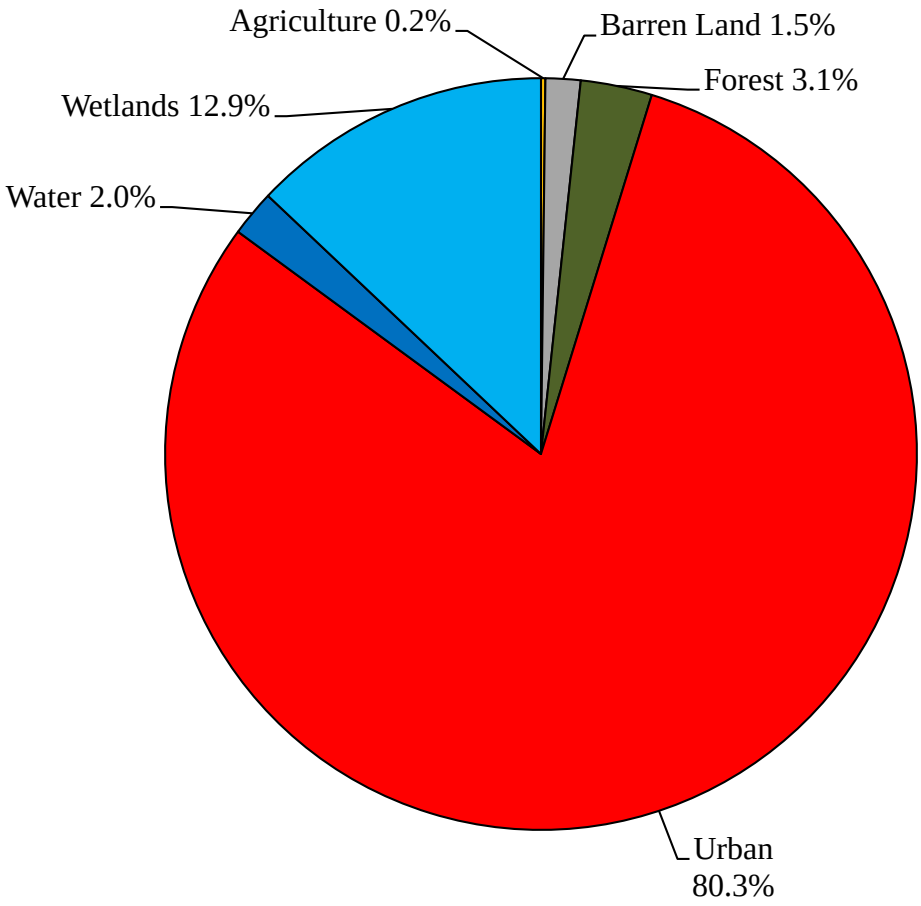


Figure 2: Pie chart illustrating the land use in Middlesex Borough

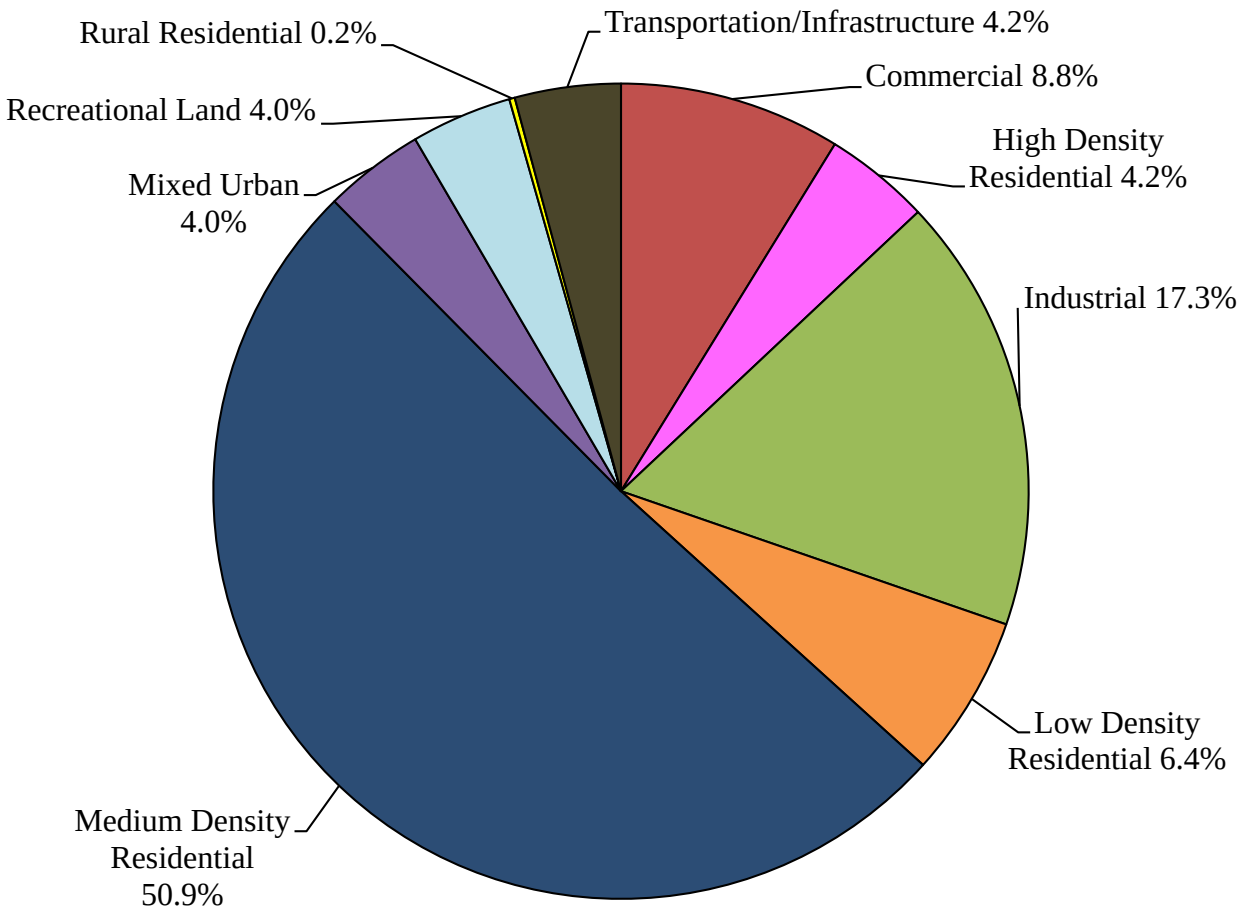


Figure 3: Pie chart illustrating the various types of urban land use in Middlesex Borough

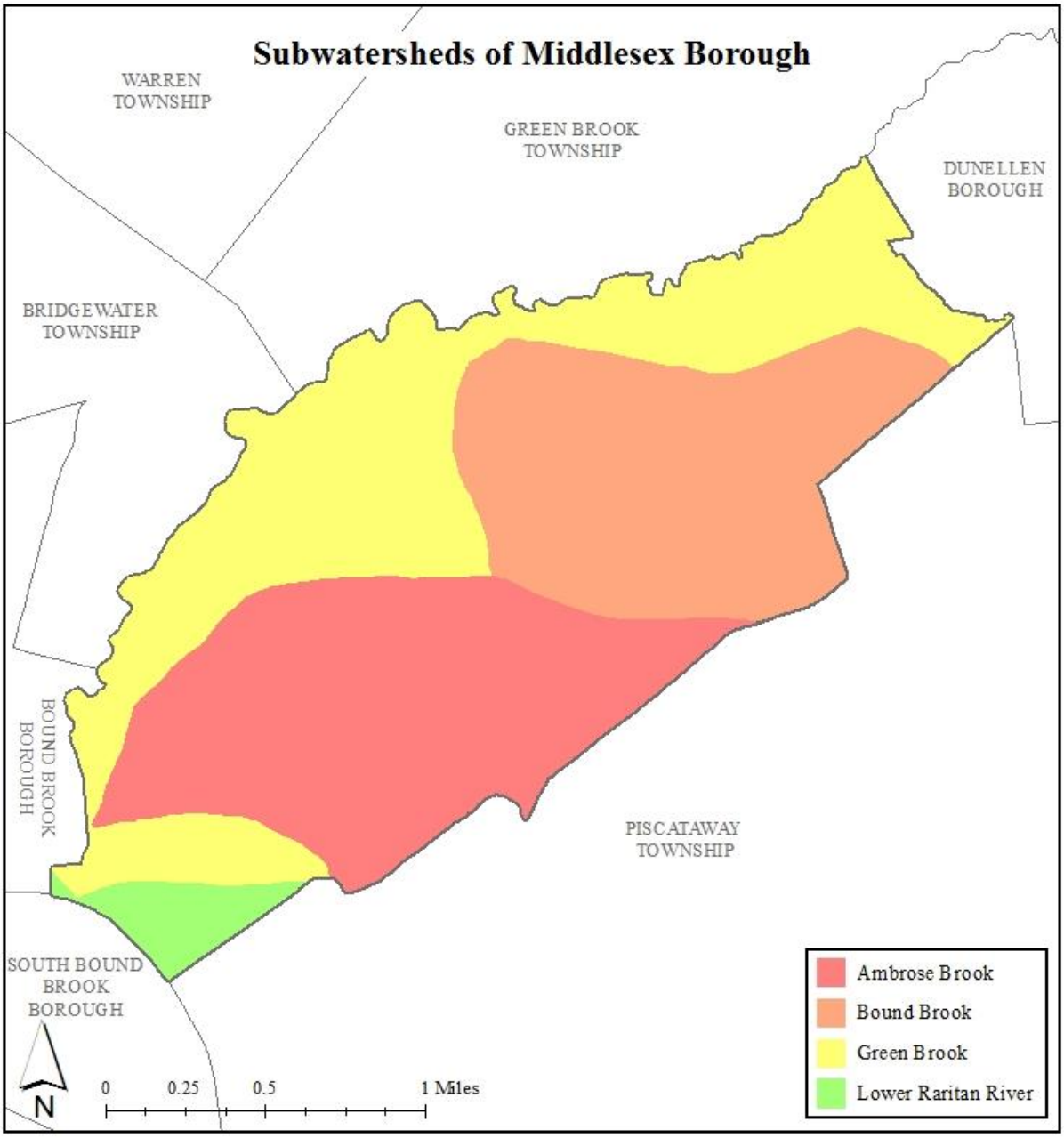


Figure 4: Map of the subwatersheds in Middlesex Borough

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 2007 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 Middlesex Borough 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 principal, green infrastructure practices use soil and vegetation to recycle stormwater runoff through infiltration and evapotranspiration. When used as components of a stormwater management system, green infrastructure practices such as bioretention, green roofs, porous pavement, rain gardens, and vegetated swales can produce a variety of environmental benefits. In addition to effectively retaining and infiltrating rainfall, these 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 Middlesex Borough. Each practice is discussed below.

Disconnected downspouts

This is often referred to as simple disconnection. A downspout is simply disconnected, and 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

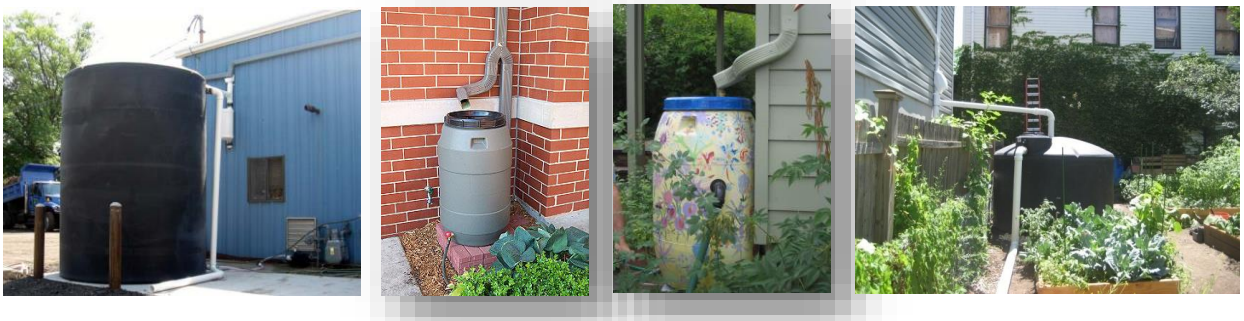
These are landscaped features that are designed to capture, treat, and infiltrate stormwater runoff. These systems can easily be incorporated into existing landscapes, improving aesthetics and creating a wildlife habitat while managing stormwater runoff. Bioretention systems also can be used in soils 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

Attachment 1 contains information on potential project sites where green infrastructure practices could be installed. The recommended green infrastructure practice and the drainage area that the green infrastructure practice can treat are identified for each potential project site. For each practice, the recharge potential, TSS removal potential, maximum volume reduction potential per storm, and the peak reduction potential 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.

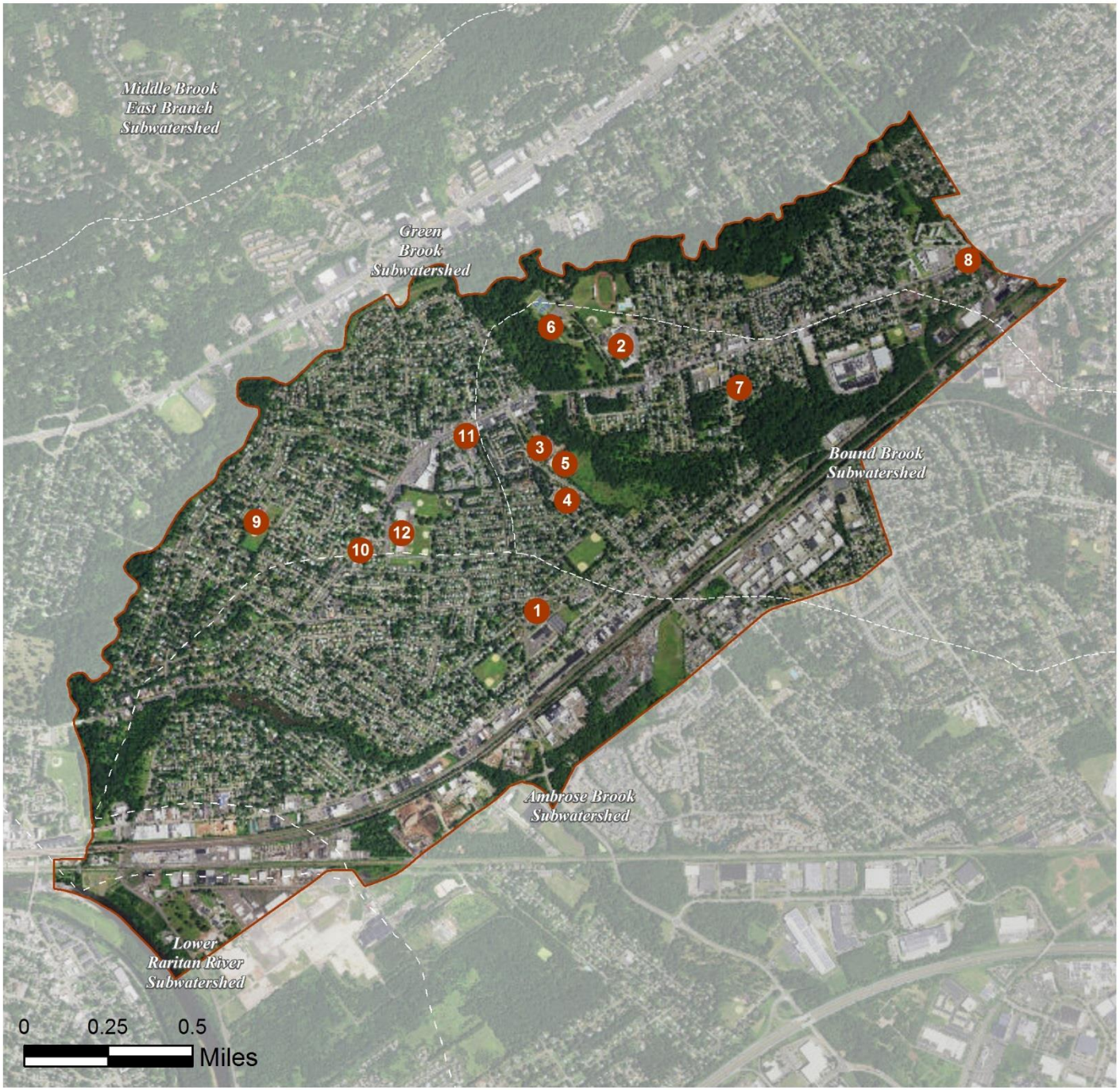
Additionally, development projects that are in need of providing off-site compensation for stormwater impacts can use the projects in this plan as a starting point. The municipality can quickly convert this impervious cover reduction action plan into a stormwater mitigation plan and incorporate it into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

a. Overview Map of the Project

MIDDLESEX BOROUGH: CLIMATE RESILIENT GREEN INFRASTRUCTURE FOR THE RARITAN BASIN

b. Green Infrastructure Sites

MIDDLESEX BOROUGH: GREEN INFRASTRUCTURE SITES



SITES WITHIN THE AMBROSE BROOK SUBWATERSHED:

1. Our Lady of Mount Virgin Church and School

SITES WITHIN THE BOUND BROOK SUBWATERSHED:

2. Middlesex High School
3. Middlesex Library & Municipal Building
4. Middlesex Police Department
5. Middlesex Presbyterian Church
6. Mountainview Park
7. Parker Elementary School

SITES WITHIN THE GREEN BROOK SUBWATERSHED:

8. Freedom In Christ Baptist Church
9. Hazelwood Elementary School
10. The Church of Jesus Christ of Latter-Day Saints
11. U.S. Post Office
12. Von E. Mauger Middle School

c. Proposed Green Infrastructure Concepts

OUR LADY OF MOUNT VIRGIN CHURCH AND SCHOOL

Subwatershed: Ambrose Brook

Site Area: 142,249 sq. ft.

Address: 450 Drake Avenue
Middlesex, NJ 08846

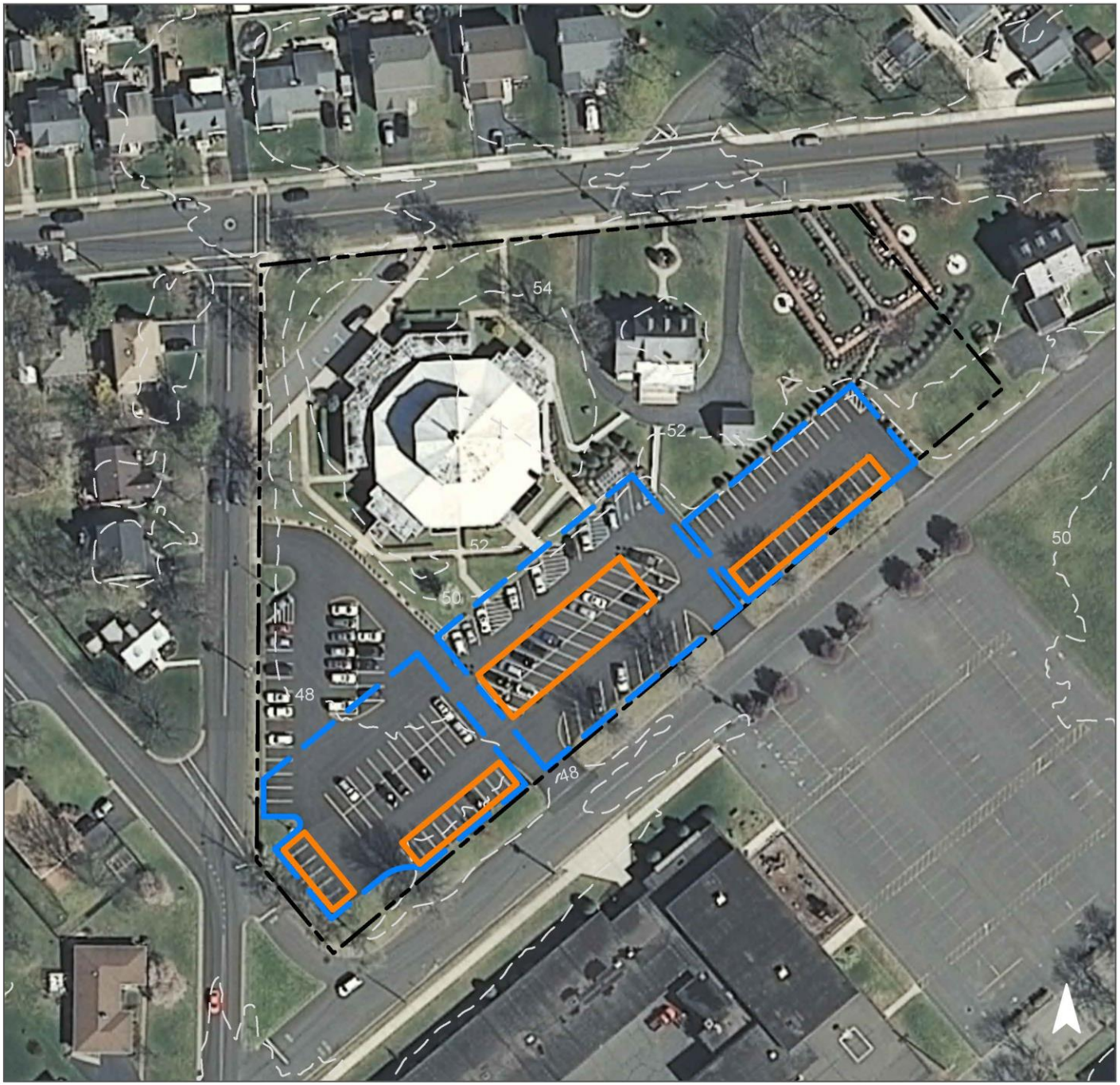
Block and Lot: Block 296, Lot 1

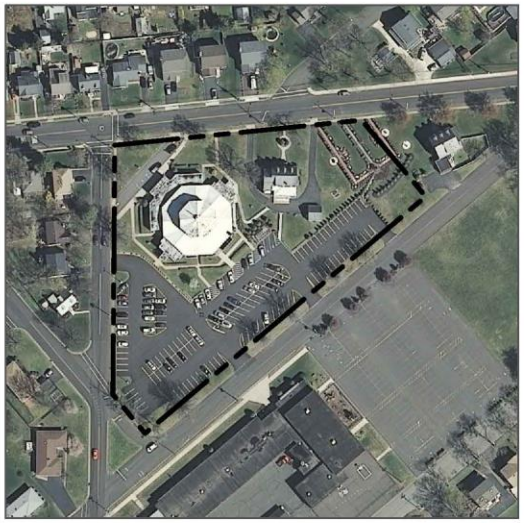
Parking spots can be replaced with porous asphalt to capture and infiltrate stormwater. A preliminary soil assessment suggests that more soil testing would be required before determining the soil's suitability for green infrastructure.

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"
69	98,097	4.7	49.5	450.4	0.076	2.69

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 pavements	1.133	190	83,163	3.13	8,800	$220,000

GREEN INFRASTRUCTURE RECOMMENDATIONS





Our Lady of Mount Virgin Church and School

- pervious pavements
- drainage areas
- property line
- 2012 Aerial: NJOIT, OGIS

0 50' 100'

MIDDLESEX HIGH SCHOOL

Subwatershed: **Bound Brook**

Site Area: **696,854 sq. ft.**

Address: **300 John F. Kennedy Drive**
Middlesex, NJ 08846

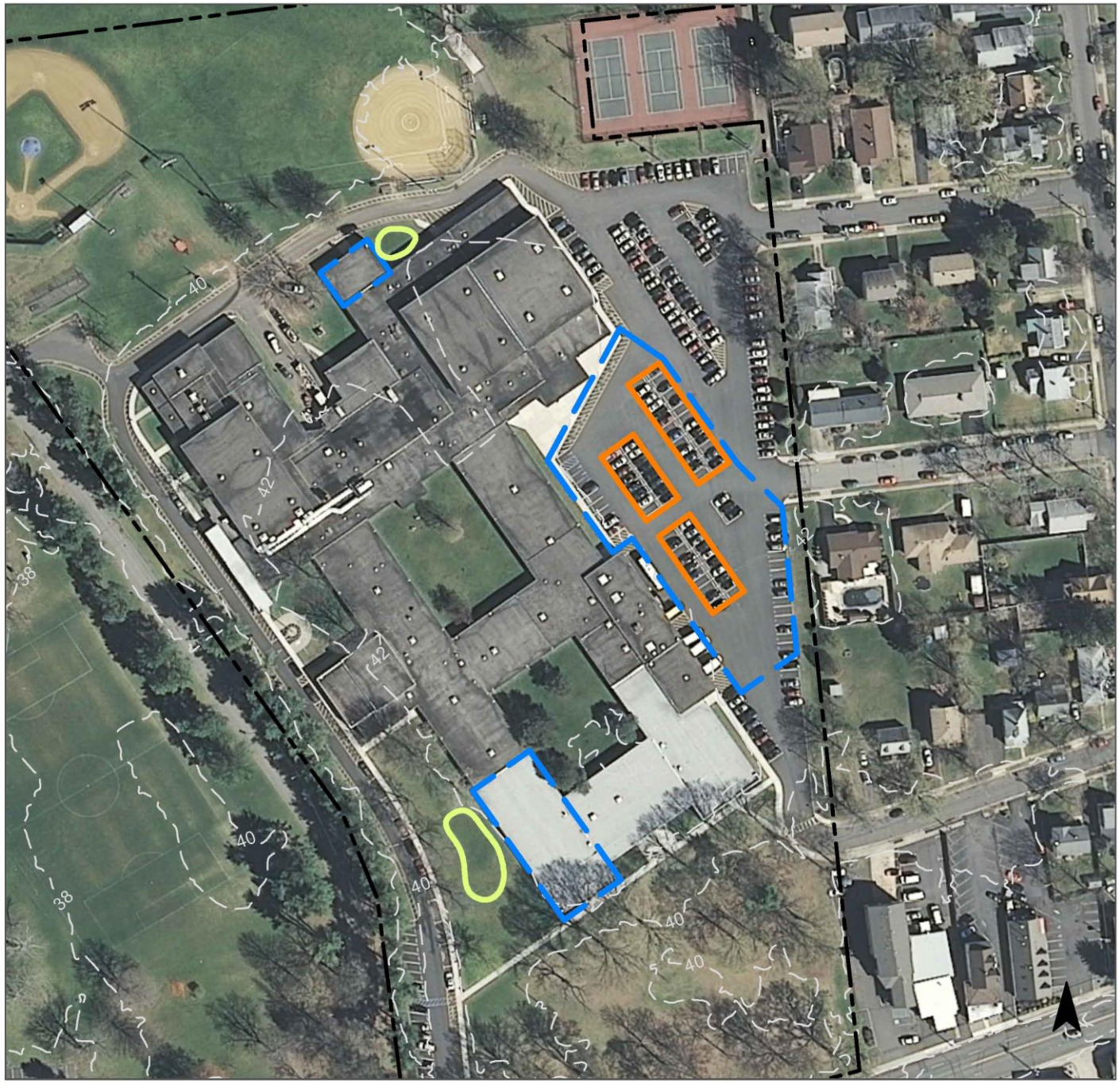
Block and Lot: **Block 53, Lot 1.01**

Parking spots by the east side of the building can be replaced with porous asphalt to capture and infiltrate stormwater. Installing rain gardens adjacent to the north and south sides of the building can capture, infiltrate, and treat roof 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	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
50	346,443	16.7	175.0	1,590.6	0.270	9.50

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	0.339	57	24,856	0.93	3,800	$19,000
Pervious pavements	1.107	185	81,255	3.05	10,900	$272,500

GREEN INFRASTRUCTURE RECOMMENDATIONS



Middlesex High School

- pervious pavements
- bioretention / rain gardens
- drainage areas
- property line
- 2012 Aerial: NJOIT, OGIS

0 75' 150'

MIDDLESEX LIBRARY & MUNICIPAL BUILDING

Subwatershed: Bound Brook

Site Area: 300,646 sq. ft.

Address: 1200 Mountain Avenue
Middlesex, NJ 08846

Block and Lot: Block 216, Lot 1

Parking spots can be replaced with porous asphalt to capture and infiltrate stormwater. A bioretention systems can be installed to capture, treat, and infiltrate roof 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	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
31	92,494	4.5	46.7	424.7	0.072	2.54

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	0.018	3	1,339	0.05	200	$1,000
Pervious pavements	1.001	167	73,416	2.76	6,400	$160,000

GREEN INFRASTRUCTURE RECOMMENDATIONS

Middlesex Library & Municipal Building

- pervious pavements
- bioretention / rain gardens
- drainage areas
- property line
- 2012 Aerial: NJOIT, OGIS

0 50' 100'

MIDDLESEX POLICE DEPARTMENT

Subwatershed: Bound Brook

Site Area: 74,758 sq. ft.

Address: 1101 Mountain Avenue
Middlesex, NJ 08846

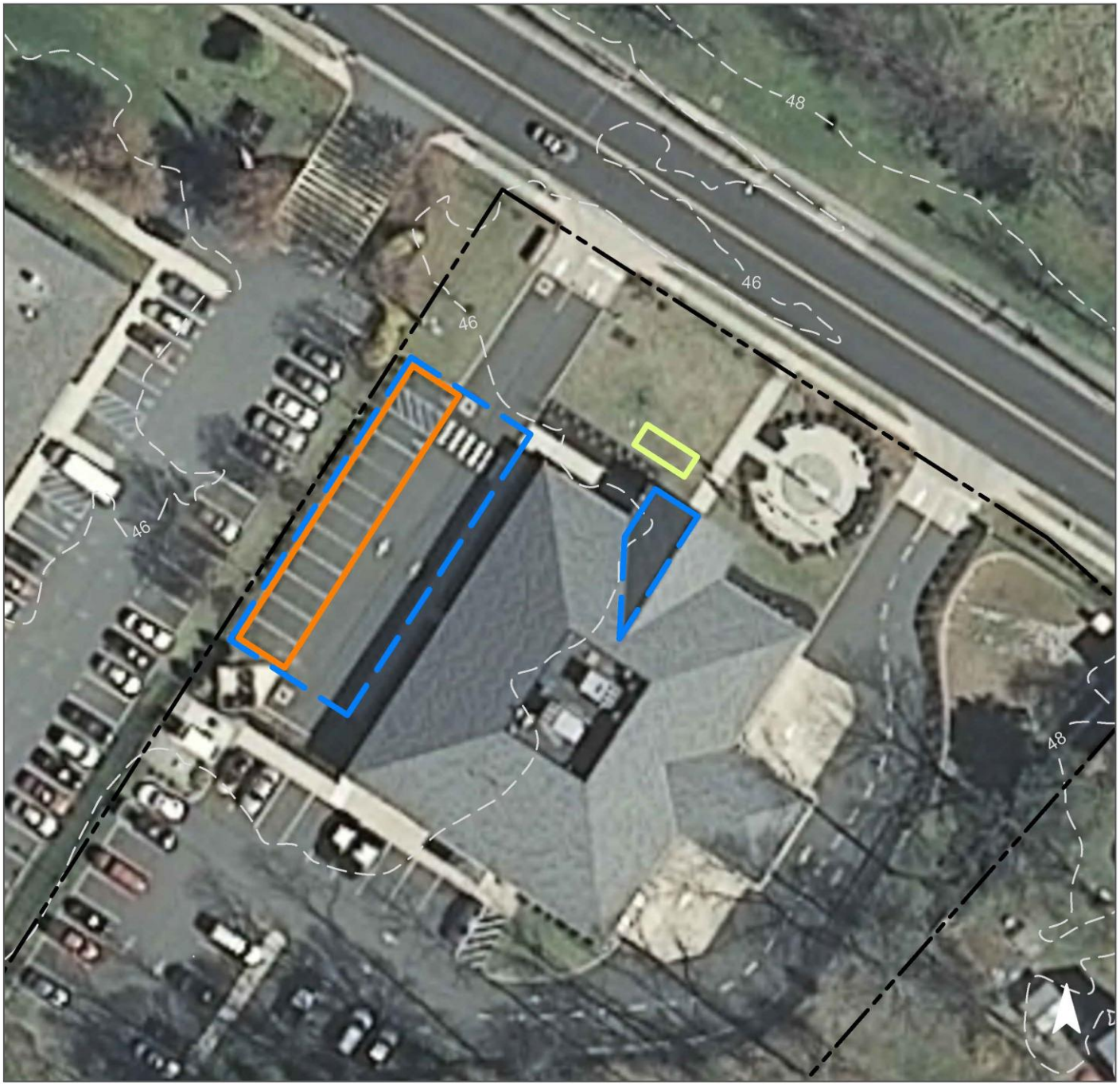
Block and Lot: Block 222, Lot 1.01

Parking spots on the northwest side of the building can be replaced with porous asphalt to capture and infiltrate stormwater. A rain garden can also be installed north of the building to capture, treat, and infiltrate roof 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	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
64	47,750	2.3	24.1	219.2	0.037	1.31

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	0.013	2	957	0.04	150	$750
Pervious pavements	0.130	22	9,559	0.36	1,900	$47,500

GREEN INFRASTRUCTURE RECOMMENDATIONS



Middlesex Police Department

- pervious pavements
- bioretention / rain gardens
- drainage areas
- property line
- 2012 Aerial: NJOIT, OGIS

0 25' 50'

MIDDLESEX PRESBYTERIAN CHURCH

Subwatershed: Bound Brook

Site Area: 205,915 sq. ft.

Address: 1190 Mountain Avenue
Middlesex, NJ 08846

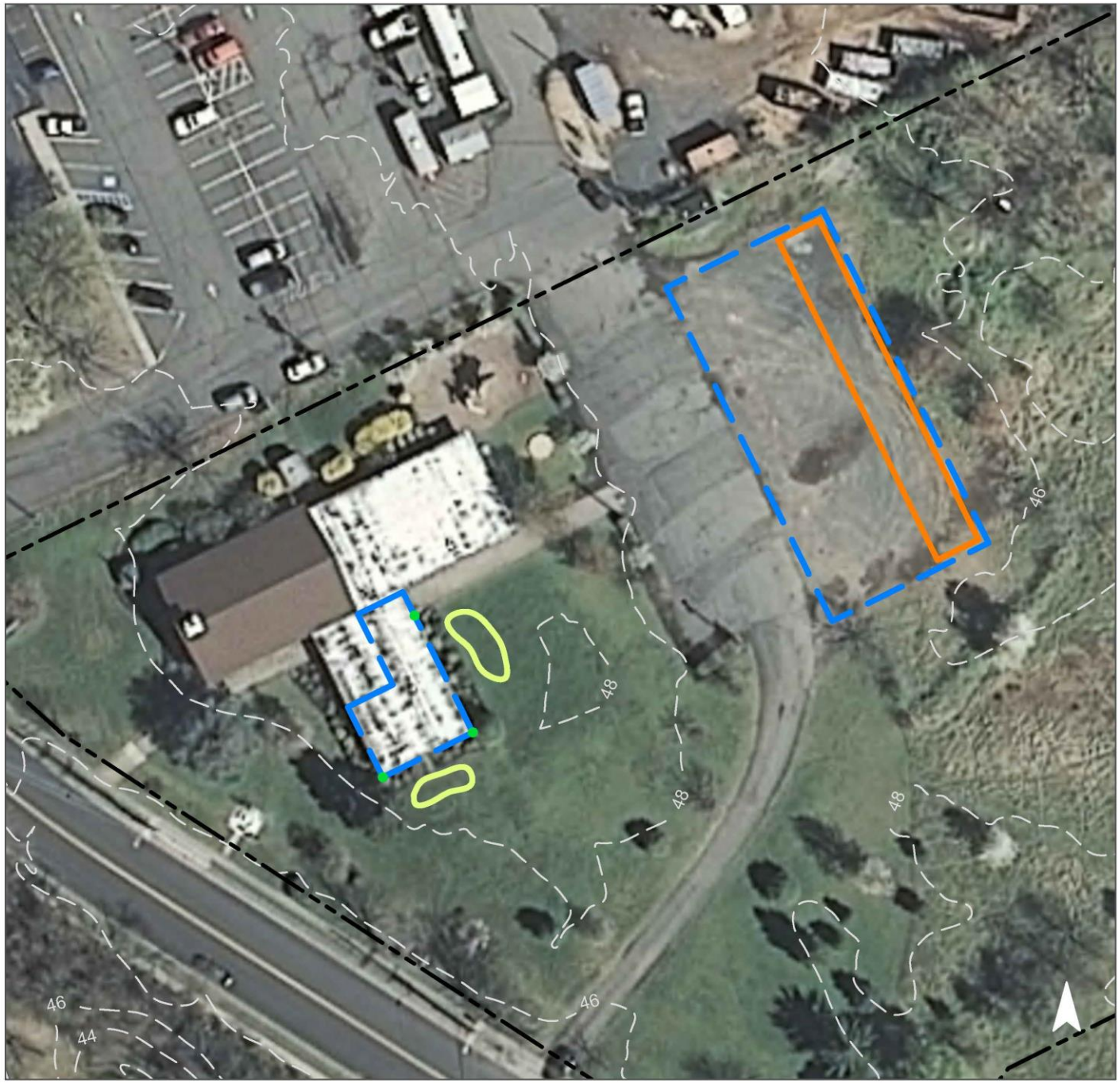
Block and Lot: Block 219, Lot 1

Parking spots east of the building can be replaced with porous asphalt to capture and infiltrate stormwater. Rain gardens can be installed in the turf grass on the south and southeast sides of the building to capture, treat, and infiltrate roof 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	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
23	46,799	2.3	23.6	214.9	0.036	1.28

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	0.047	8	3,441	0.13	500	$2,500
Pervious pavements	0.261	44	19,119	0.72	2,500	$62,500

GREEN INFRASTRUCTURE RECOMMENDATIONS



Middlesex Presbyterian Church

- disconnected downspouts
- pervious pavements
- bioretention / rain gardens
- drainage areas
- property line
- 2012 Aerial: NJOIT, OGIS

0 30' 60'

MOUNTAINVIEW PARK

Subwatershed: **Bound Brook**

Site Area: **3,216,449 sq. ft.**

Address: **300 John F. Kennedy Drive**
Middlesex, NJ 08846

Block and Lot: **Block 53, Lot 1**

Sections of parking can be replaced with porous asphalt to capture and infiltrate stormwater. 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"
8	249,926	12.0	126.2	1,147.5	0.195	6.85

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 pavements	0.753	126	55,255	2.08	7,600	$190,000

GREEN INFRASTRUCTURE RECOMMENDATIONS

Mountainview Park

- pervious pavements
- drainage areas
- property line
- 2012 Aerial: NJOIT, OGIS

0 50' 100'

PARKER ELEMENTARY SCHOOL

Subwatershed: **Bound Brook**

Site Area: **63,074 sq. ft.**

Address: **150 S Lincoln Avenue**
Middlesex, NJ 08846

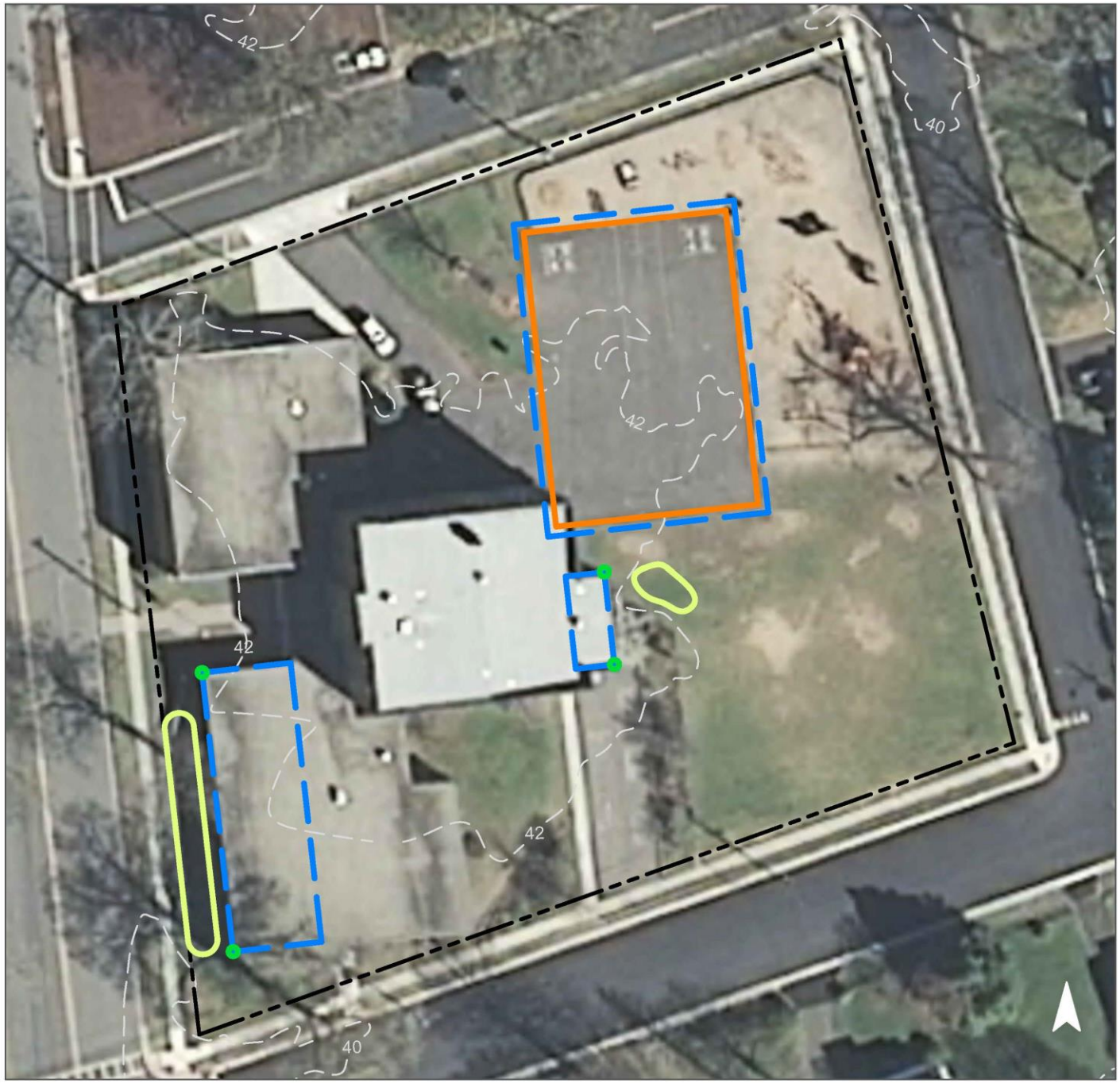
Block and Lot: **Block 243, Lot 1**

The playground north of the school can be replaced with porous asphalt to capture and infiltrate stormwater. Installing rain gardens adjacent to the southwest and east sides of the building can capture, treat, and infiltrate roof 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	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
70	44,152	2.1	22.3	202.7	0.034	1.21

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	0.078	13	5,737	0.22	930	$4,650
Pervious pavements	0.169	28	12,424	0.47	6,500	$162,500

GREEN INFRASTRUCTURE RECOMMENDATIONS



Parker Elementary School

- disconnected downspouts
- pervious pavements
- bioretention / rain gardens
- drainage areas
- property line
- 2012 Aerial: NJOIT, OGIS

0 25' 50'

FREEDOM IN CHRIST BAPTIST CHURCH

Subwatershed: Green Brook

Site Area: 8,090 sq. ft.

Address: 100 Bound Brook Road
Middlesex, NJ 08846

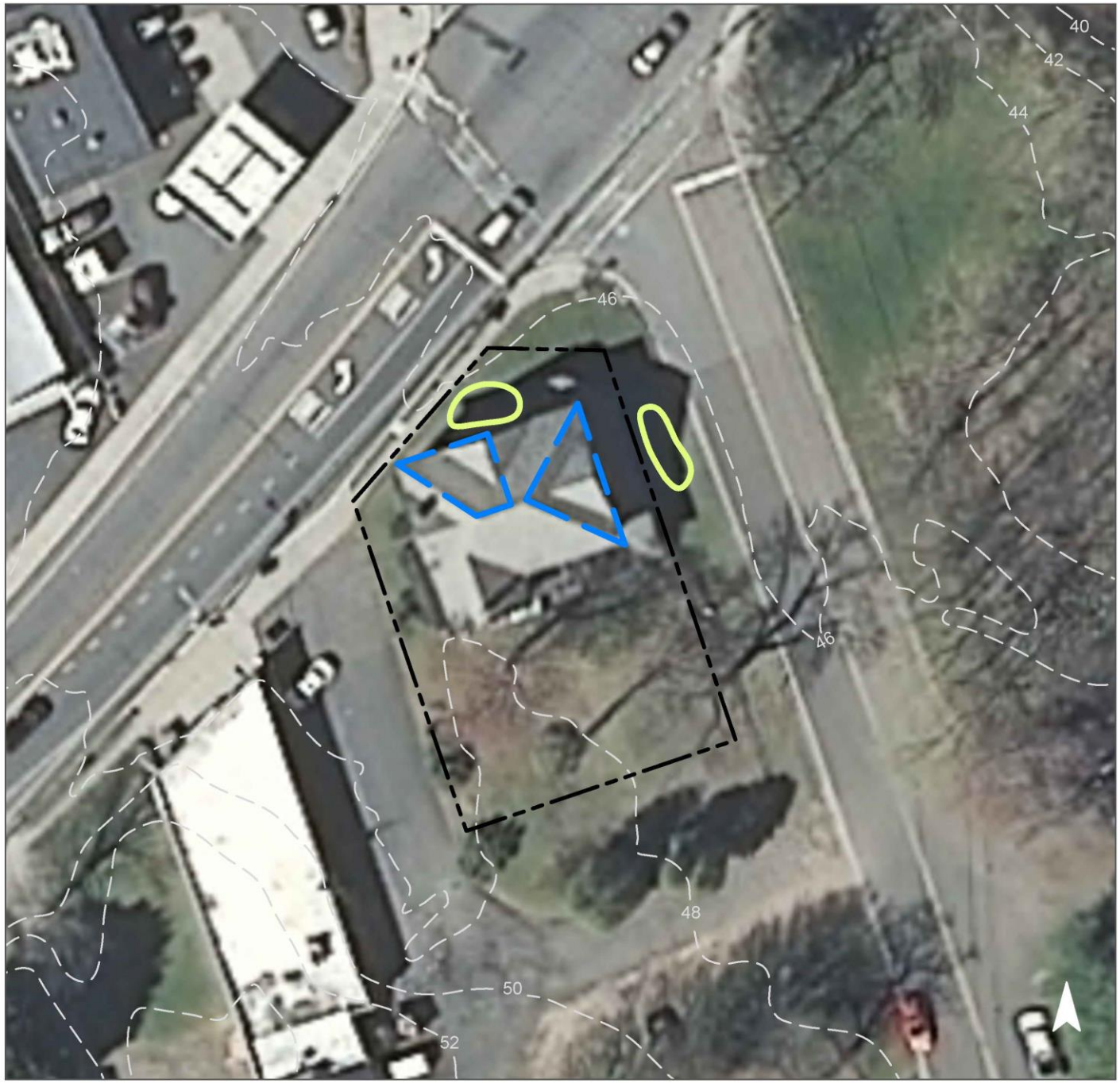
Block and Lot: Block 263, Lot 22.01

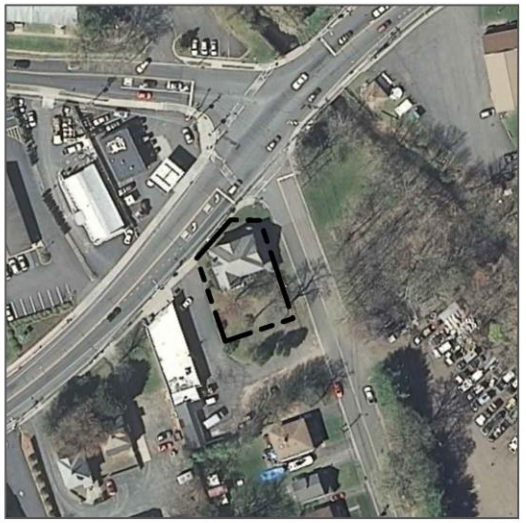
Stormwater is directed into the road east of the building. Rain gardens can be built adjacent to the north and east sides of the building to capture, treat, and infiltrate roof runoff. A preliminary soil assessment suggests that the soils have suitable drainage characteristics for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs/yr)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
90	7,281	0.4	3.7	33.4	0.006	0.20

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	0.021	3	1,526	0.06	300	$1,500

GREEN INFRASTRUCTURE RECOMMENDATIONS





Freedom in Christ Baptist Church

- bioretention / rain gardens
- drainage areas
- property line
- 2012 Aerial: NJOIT, OGIS

0 20' 40'

HAZELWOOD ELEMENTARY SCHOOL

Subwatershed: Green Brook

Site Area: 369,655 sq. ft.

Address: 800 Hazelwood Avenue
Middlesex, NJ 08846

Block and Lot: Block 89, Lot 1

Parking spots south of the building can be replaced with porous asphalt to capture and infiltrate stormwater. Rain gardens can be installed on the northeast side of the building to capture, treat, and infiltrate roof 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	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
24	88,605	4.3	44.8	406.8	0.069	2.43

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	0.076	13	5,580	0.21	800	$4,000
Pervious pavements	0.370	62	27,145	1.02	2,750	$68,750

GREEN INFRASTRUCTURE RECOMMENDATIONS

Hazelwood Elementary School

- disconnected downspouts
- pervious pavements
- bioretention / rain gardens
- drainage areas
- property line
- 2012 Aerial: NJOIT, OGIS

0 50' 100'

THE CHURCH OF JESUS CHRIST OF LATTER-DAY SAINTS

Subwatershed: Green Brook

Site Area: 9,367 sq. ft.

Address: 111 Howard Avenue
Middlesex NJ 08846

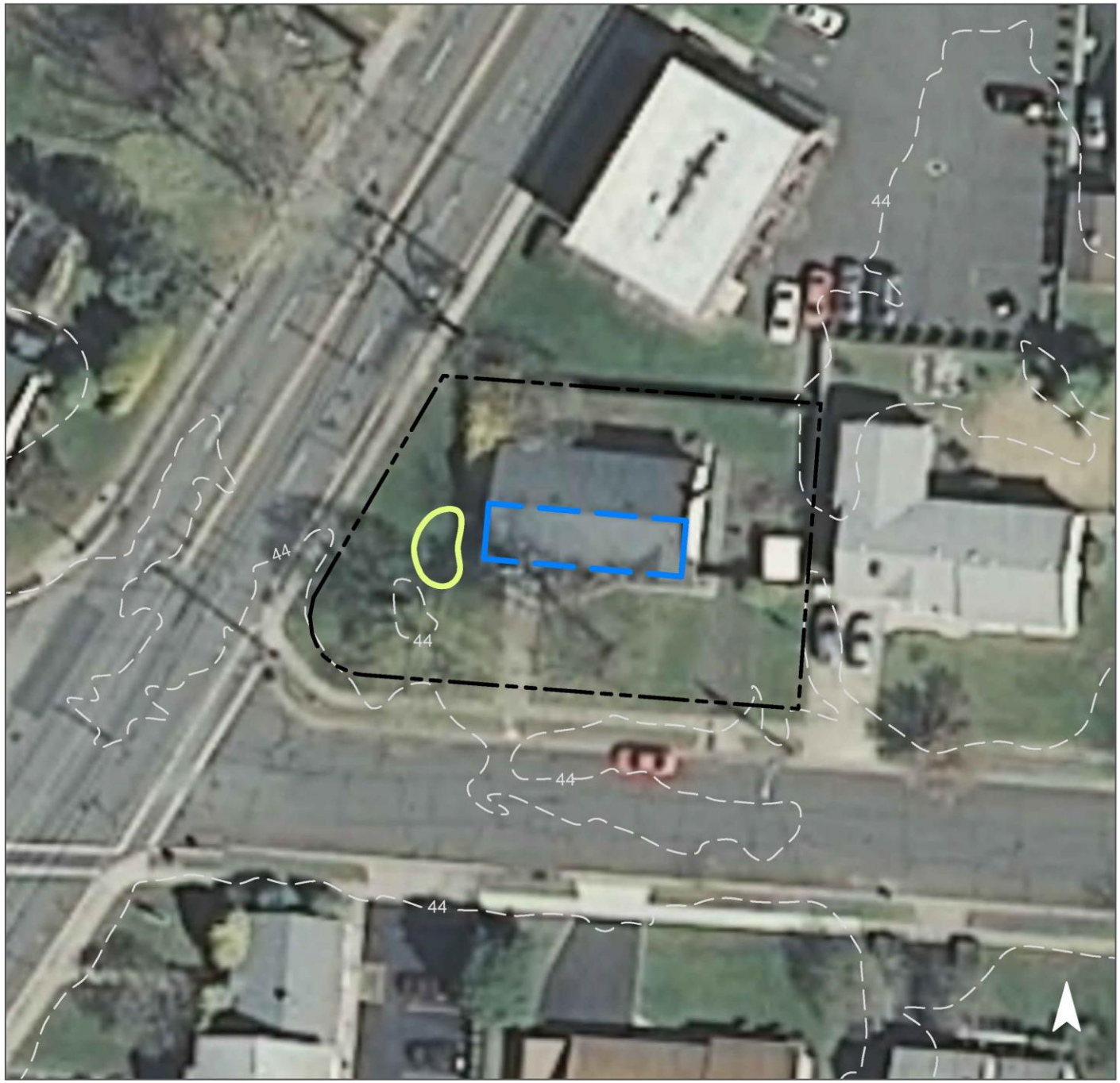
Block and Lot: Block 176, Lot 6

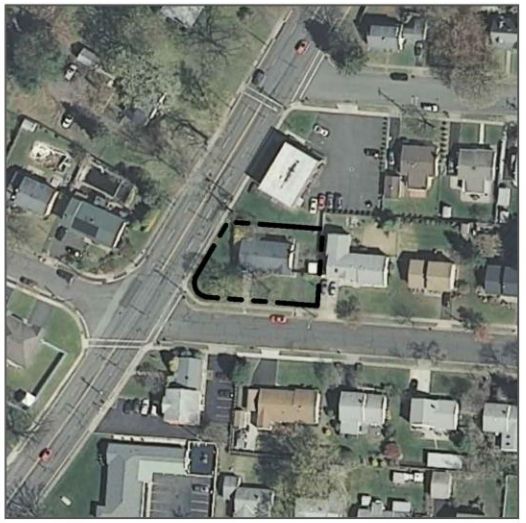
A rain garden adjacent to the west side of the building can capture, treat, and infiltrate roof runoff. A preliminary soil assessment suggests that the soils have suitable drainage characteristics for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs/yr)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
35	3,278	0.2	1.7	15.1	0.003	0.09

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	0.020	3	1,451	0.05	200	$1,000

GREEN INFRASTRUCTURE RECOMMENDATIONS





The Church of Jesus Christ of Latter-Day Saints

- bioretention / rain gardens
- drainage areas
- property line
- 2012 Aerial: NJOIT, OGIS

0 20' 40'

U.S. POST OFFICE

Subwatershed: Green Brook

Site Area: 40,166 sq. ft.

Address: 95 Marlborough Avenue
Middlesex, NJ 08846

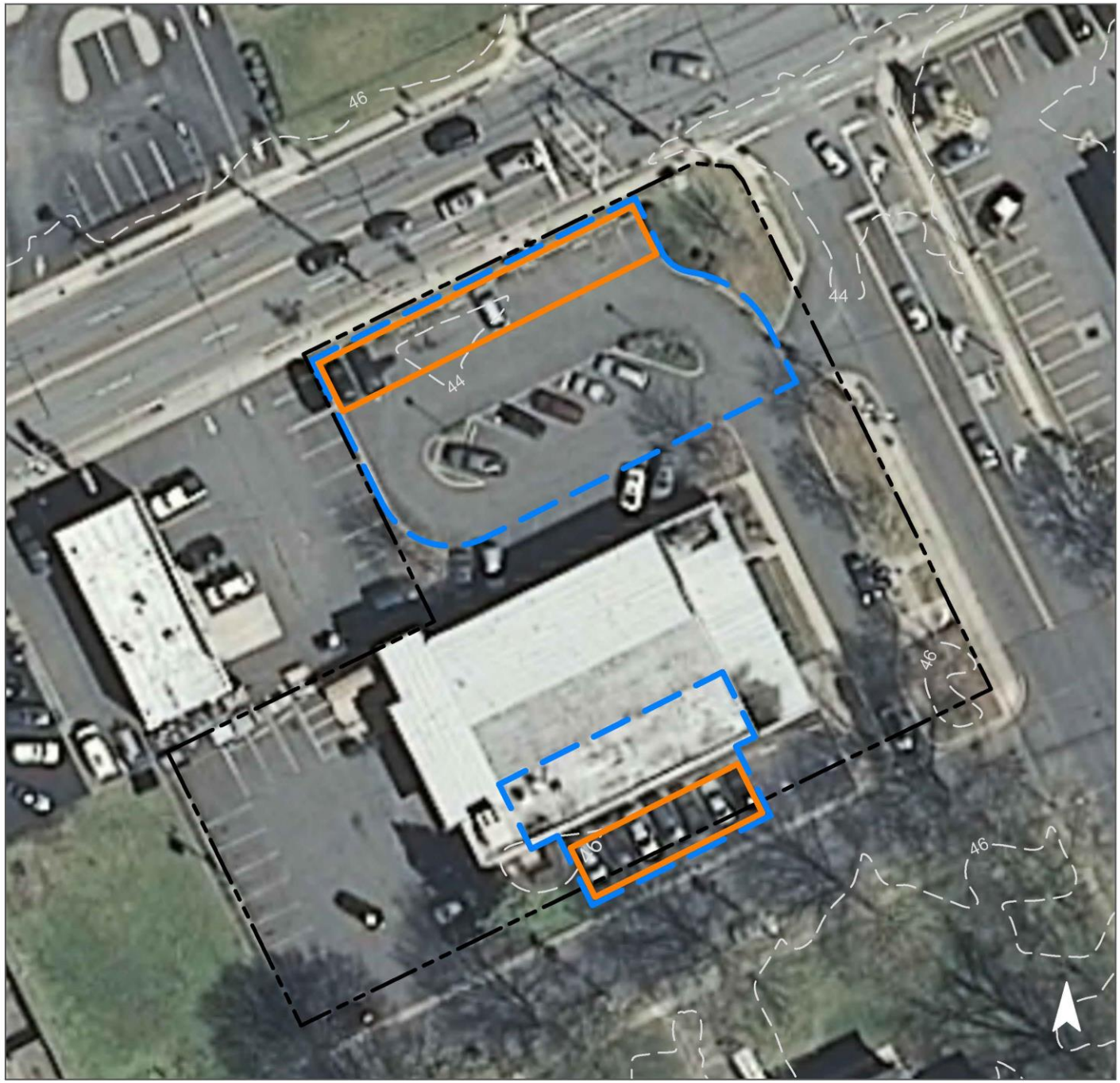
Block and Lot: Block 206, Lot 12

Parking spots by the north and south sides of the building can be replaced with porous asphalt to capture and infiltrate 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	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
90	36,150	1.7	18.3	166.0	0.028	0.99

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 pavements	0.352	59	25,813	0.97	3,100	$77,500

GREEN INFRASTRUCTURE RECOMMENDATIONS



U.S. Post Office

- pervious pavements
- drainage areas
- property line
- 2012 Aerial: NJOIT, OGIS

0 25' 50'

VON E. MAUGER MIDDLE SCHOOL

Subwatershed: Green Brook

Site Area: 556,459 sq. ft.

Address: Fisher Avenue
Middlesex, NJ 08846

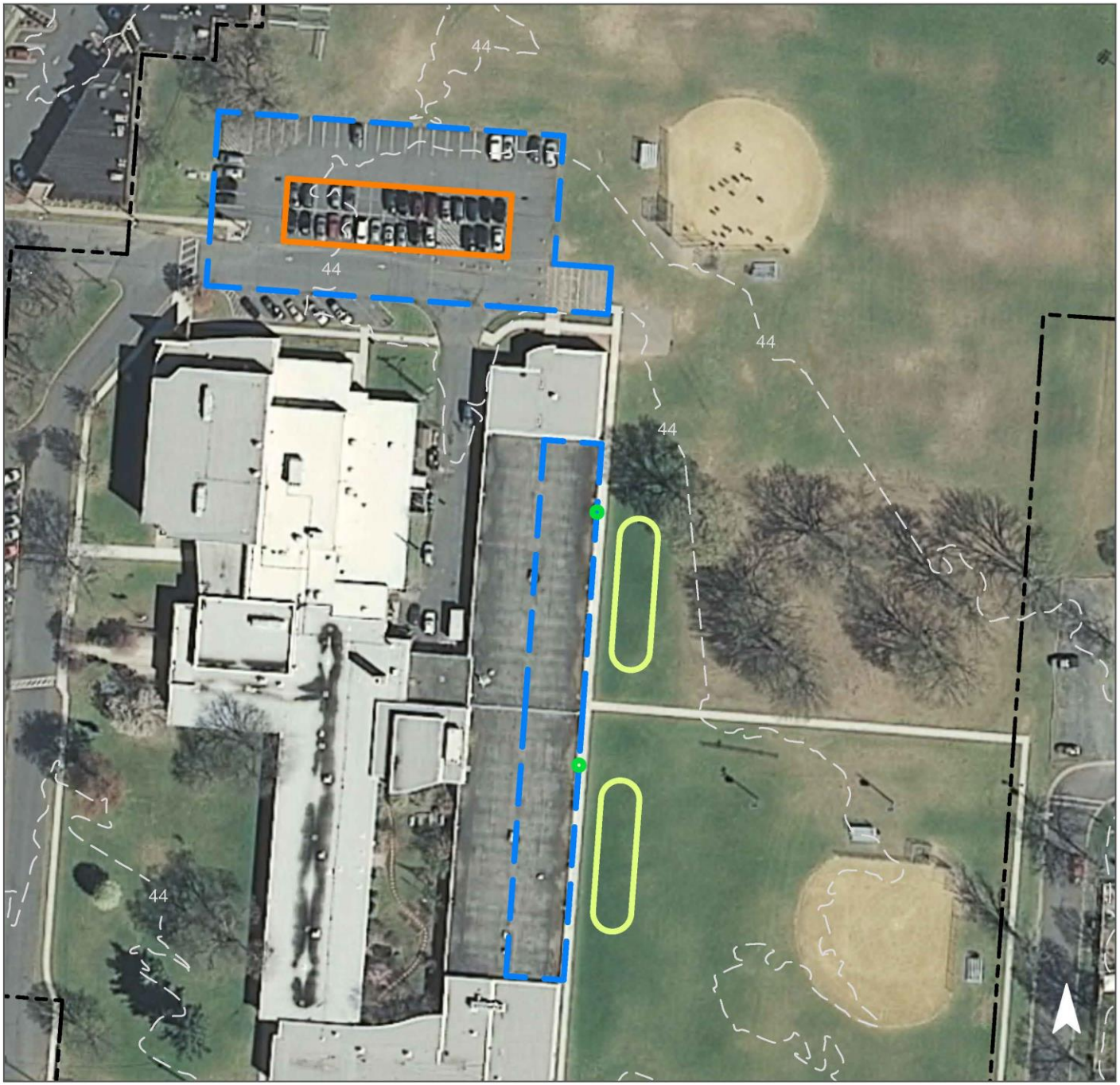
Block and Lot: Block 183, Lot 1.02

Parking spots to the north can be replaced with porous asphalt to capture and infiltrate stormwater. Installing a rain garden adjacent to the east side of the building can also capture, treat, and infiltrate roof 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	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
37	204,264	9.8	103.2	937.9	0.159	5.60

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	0.347	58	25,425	0.96	4,700	$23,500
Pervious pavements	0.703	118	51,619	1.94	6,000	$150,000

GREEN INFRASTRUCTURE RECOMMENDATIONS



Von E. Mauger Middle School

- disconnected downspouts
- pervious pavements
- bioretention / rain gardens
- drainage areas
- property line
- 2012 Aerial: NJOIT, OGIS

0 50' 100'

d. Summary of Existing Conditions

Summary of Existing Site Conditions

Subwatershed/Site Name/Total Site Info/GI Practice	Area (ac)	Area (SF)	Block	Lot	Existing Annual Loads TP (lb/yr)	Existing Annual Loads TN (lb/yr)	Existing Annual Loads TSS (lb/yr)	I.C. %	I.C. Area (ac)	I.C. Area (SF)	Runoff Volumes from I.C. Water Quality Storm (1.25" over 2-hours) (Mgal)	Runoff Volumes from I.C. Annual (Mgal)
BOUND BROOK SUBWATERSHED	**104.63**	**4,557,695**			**39.9**	**418.0**	**3,799.7**		**19.00**	**827,564**	**0.645**	**22.70**
Middlesex High School												
Total Site Info	16.00	696,854	53	1.01	16.7	175.0	1,590.6	50	7.95	346,443	0.270	9.50
Middlesex Library & Municipal Building												
Total Site Info	6.90	300,646	216	1	4.5	46.7	424.7	31	2.12	92,494	0.072	2.54
Middlesex Police Department												
Total Site Info	1.72	74,758	222	1.02	2.3	24.1	219.2	64	1.10	47,750	0.037	1.31
Middlesex Presbyterian Church												
Total Site Info	4.73	205,915	219	1	2.3	23.6	214.9	23	1.07	46,799	0.036	1.28
Mountainview Park												
Total Site Info	73.84	3,216,449	53	1	12.0	126.2	1,147.5	8	5.74	249,926	0.195	6.85
Parker Elementary School												
Total Site Info	1.45	63,074	243	1	2.1	22.3	202.7	70	1.01	44,152	0.034	1.21
GREEN BROOK SUBWATERSHED	**22.58**	**983,737**			**16.4**	**171.5**	**1,559.1**		**7.80**	**339,578**	**0.265**	**9.31**
Freedom in Christ Baptist Church												
Total Site Info	0.19	8,090	263	22.01	0.4	3.7	33.4	90	0.17	7,281	0.006	0.20
Hazelwood Elementary School												
Total Site Info	8.49	369,655	89	1	4.3	44.8	406.8	24	2.03	88,605	0.069	2.43
The Church of Jesus Christ of Latter-Day Saints												
Total Site Info	0.22	9,367	176	6	0.2	1.7	15.1	35	0.08	3,278	0.003	0.09
U.S. Post Office												
Total Site Info	0.92	40,166	206	12	1.7	18.3	166.0	90	0.83	36,150	0.028	0.99
Von E. Mauger Middle School												
Total Site Info	12.77	556,459	183	1.02	9.8	103.2	937.9	37	4.69	204,264	0.159	5.60

e. Summary of Proposed Green Infrastructure Practices

Summary of Proposed Green Infrastructure Practies

	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 (SF)	Unit Cost ($)	Unit	Total Cost ($)	I.C. Treated %
		Area (SF)	Area (ac)									
	AMBROSE BROOK SUBWATERSHED	**43,500**	**1.00**	**1.133**	**190**	**83,163**	**3.13**	**8,800**			**$220,000**	**44.3%**
1	**Our Lady of Mount Virgin Church and School**											
	Pervious pavements	43,500	1.00	1.133	190	83,163	3.13	8,800	25	SF	$220,000	44.3%
	Total Site Info	**43,500**	**1.00**	**1.133**	**190**	**83,163**	**3.13**	**8,800**			**$220,000**	**44.3%**
	BOUND BROOK SUBWATERSHED	**150,300**	**3.45**	**3.916**	**656**	**287,359**	**10.81**	**41,380**			**$922,900**	**18.2%**
2	**Middlesex High School**											
	Bioretention systems/rain gardens	13,000	0.30	0.339	57	24,856	0.93	3,800	5	SF	$19,000	3.8%
	Pervious pavements	42,500	0.98	1.107	185	81,255	3.05	10,900	25	SF	$272,500	12.3%
	Total Site Info	**55,500**	**1.27**	**1.446**	**242**	**106,111**	**3.98**	**14,700**			**$291,500**	**16.0%**
3	**Middlesex Library & Municipal Building**											
	Bioretention systems/rain gardens	700	0.02	0.018	3	1,339	0.05	200	5	SF	$1,000	0.8%
	Pervious pavements	38,400	0.88	1.001	167	73,416	2.76	6,400	25	SF	$160,000	41.5%
	Total Site Info	**39,100**	**0.90**	**1.019**	**171**	**74,755**	**2.81**	**6,600**			**$161,000**	**42.3%**
4	**Middlesex Police Department**											
	Bioretention systems/rain gardens	500	0.01	0.013	2	957	0.04	150	5	SF	$750	1.0%
	Pervious pavements	5,000	0.11	0.130	22	9,559	0.36	1,900	25	SF	$47,500	10.5%
	Total Site Info	**5,500**	**0.13**	**0.143**	**24**	**10,517**	**0.40**	**2,050**			**$48,250**	**11.5%**
5	**Middlesex Presbyterian Church**											
	Bioretention systems/rain gardens	1,800	0.04	0.047	8	3,441	0.13	500	5	SF	$2,500	3.8%
	Pervious pavements	10,000	0.23	0.261	44	19,119	0.72	2,500	25	SF	$62,500	21.4%
	Total Site Info	**11,800**	**0.27**	**0.307**	**51**	**22,560**	**0.85**	**3,000**			**$65,000**	**25.2%**
6	**Mountainview Park**											
	Pervious pavements	28,900	0.66	0.753	126	55,255	2.08	7,600	25	SF	$190,000	11.6%
	Total Site Info	**28,900**	**0.66**	**0.753**	**126**	**55,255**	**2.08**	**7,600**			**$190,000**	**11.6%**
7	**Parker Elementary School**											
	Bioretention systems/rain gardens	3,000	0.07	0.078	13	5,737	0.22	930	5	SF	$4,650	6.8%
	Pervious pavements	6,500	0.15	0.169	28	12,424	0.47	6,500	25	SF	$162,500	14.7%
	Total Site Info	**9,500**	**0.22**	**0.248**	**41**	**18,161**	**0.69**	**7,430**			**$167,150**	**21.5%**

Summary of Proposed Green Infrastructure Practies

	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 (SF)	Unit Cost ($)	Unit	Total Cost ($)	I.C. Treated %
	GREEN BROOK SUBWATERSHED	**72,480**	**1.66**	**1.888**	**316**	**138,560**	**5.21**	**17,850**			**$326,250**	**21.3%**
8	**Freedom in Christ Baptist Church**											
	Bioretention systems/rain gardens	800	0.02	0.021	3	1,526	0.06	300	5	SF	$1,500	11.0%
	Total Site Info	**800**	**0.02**	**0.021**	**3**	**1,526**	**0.06**	**300**			**$1,500**	**11.0%**
9	**Hazelwood Elementary School**											
	Bioretention systems/rain gardens	2,920	0.07	0.076	13	5,580	0.21	800	5	SF	$4,000	3.3%
	Pervious pavements	14,200	0.33	0.370	62	27,145	1.02	2,750	25	SF	$68,750	16.0%
	Total Site Info	**17,120**	**0.39**	**0.446**	**75**	**32,725**	**1.23**	**3,550**			**$72,750**	**19.3%**
10	**The Church of Jesus Christ of Latter-Day Saints**											
	Bioretention systems/rain gardens	760	0.02	0.020	3	1,451	0.05	200	5	SF	$1,000	23.2%
	Total Site Info	**760**	**0.02**	**0.020**	**3**	**1,451**	**0.05**	**200**			**$1,000**	**23.2%**
11	**U.S. Post Office**											
	Pervious pavements	13,500	0.31	0.352	59	25,813	0.97	3,100	25	SF	$77,500	37.3%
	Total Site Info	**13,500**	**0.31**	**0.352**	**59**	**25,813**	**0.97**	**3,100**			**$77,500**	**37.3%**
12	**Von E. Mauger Middle School**											
	Bioretention systems/rain gardens	13,300	0.31	0.347	58	25,425	0.96	4,700	5	SF	$23,500	6.5%
	Pervious pavements	27,000	0.62	0.703	118	51,619	1.94	6,000	25	SF	$150,000	13.2%
	Total Site Info	**40,300**	**0.93**	**1.050**	**176**	**77,044**	**2.90**	**10,700**			**$173,500**	**19.7%**