Draft

Impervious Cover Reduction Action Plan for Warren Township, Somerset County, New Jersey

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

November 16, 2015

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Introduction

Located in Somerset County in central New Jersey, Warren Township covers approximately 19.6 square miles. Figures 1 and 2 illustrate that Warren Township is dominated by urban land uses. A total of 49.5% of the municipality's land use is classified as urban. Of the urban land in Warren Township, rural 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 Warren 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 Warren Township. Based upon the 2007 NJDEP land use/land cover data, approximately 12.4% of Warren Township has impervious cover. This level of impervious cover suggests that the streams in Warren Township are likely impacted.[1]

Methodology

Warren Township contains portions of six 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

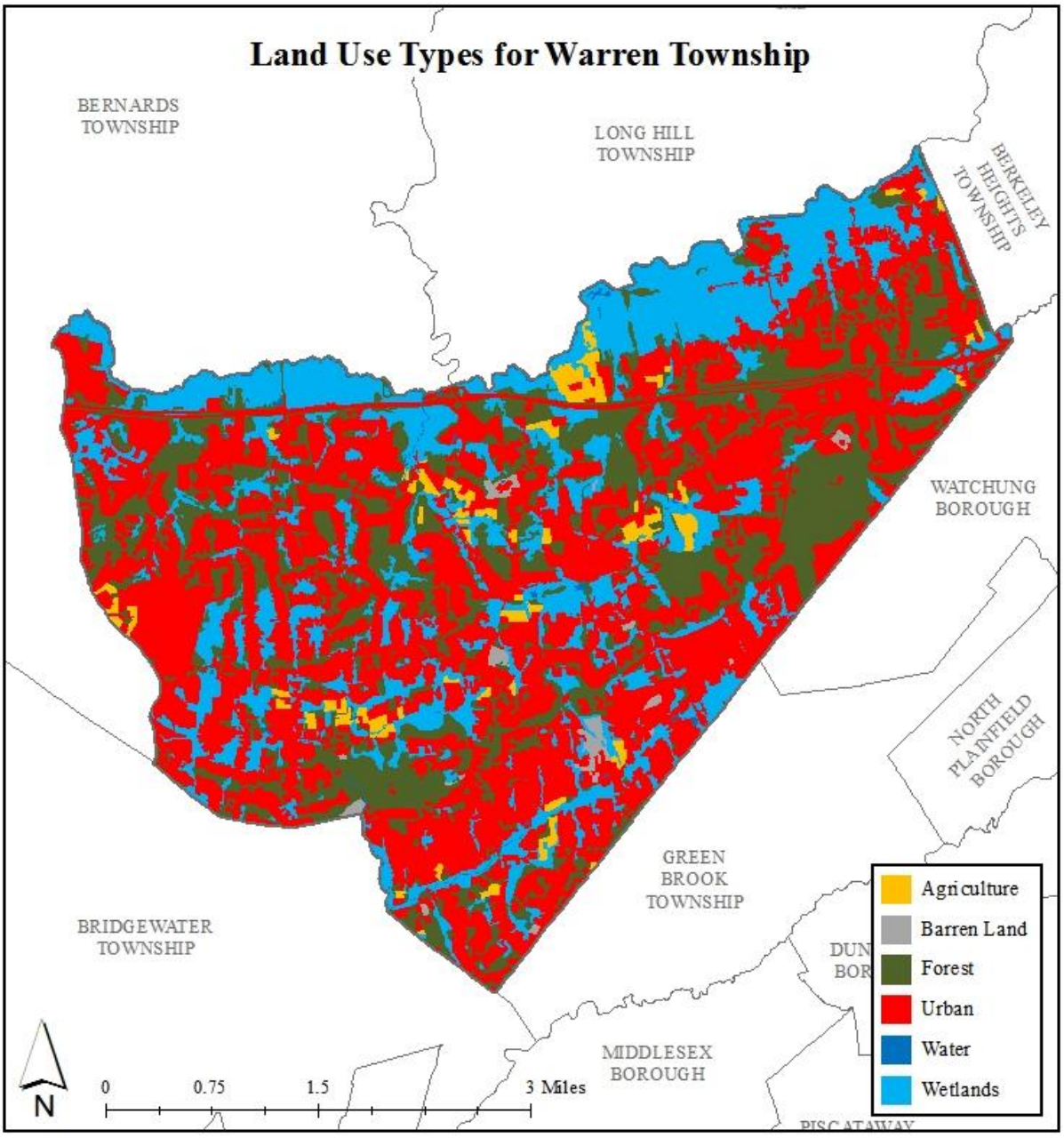


Figure 1: Map illustrating the land use in Warren Township

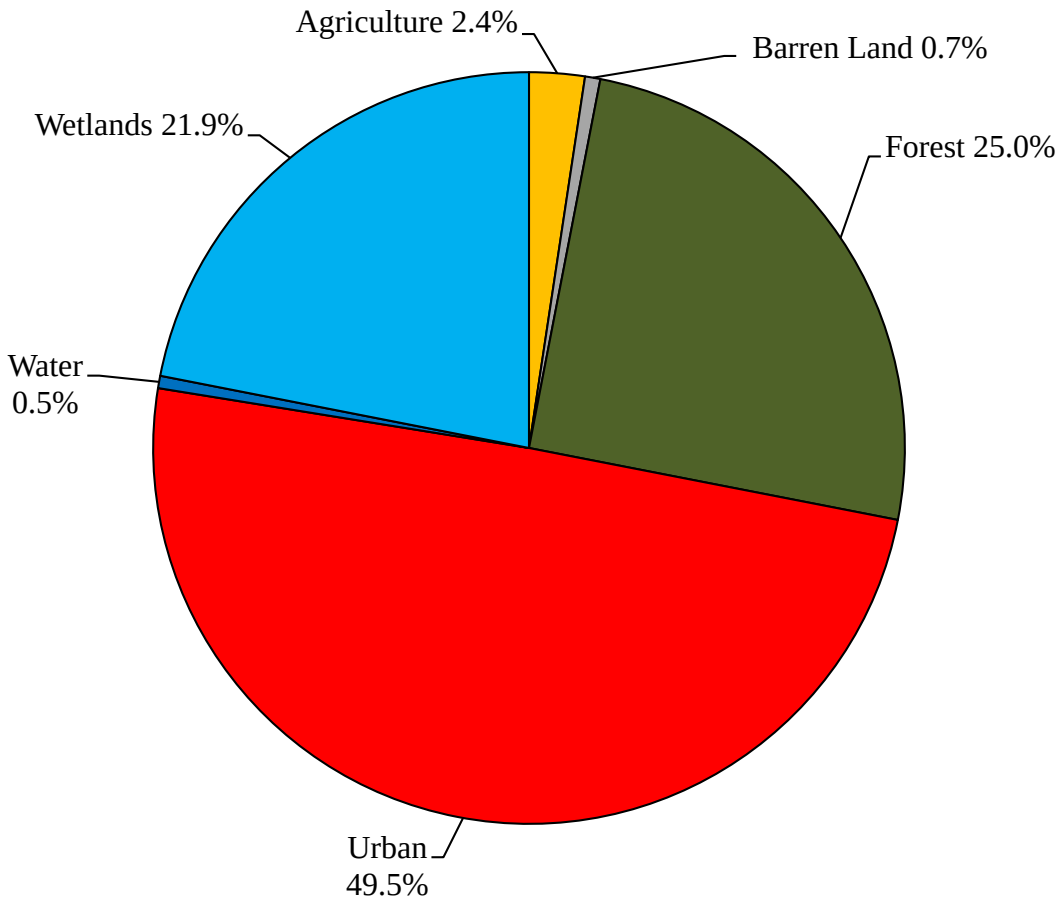


Figure 2: Pie chart illustrating the land use in Warren Township

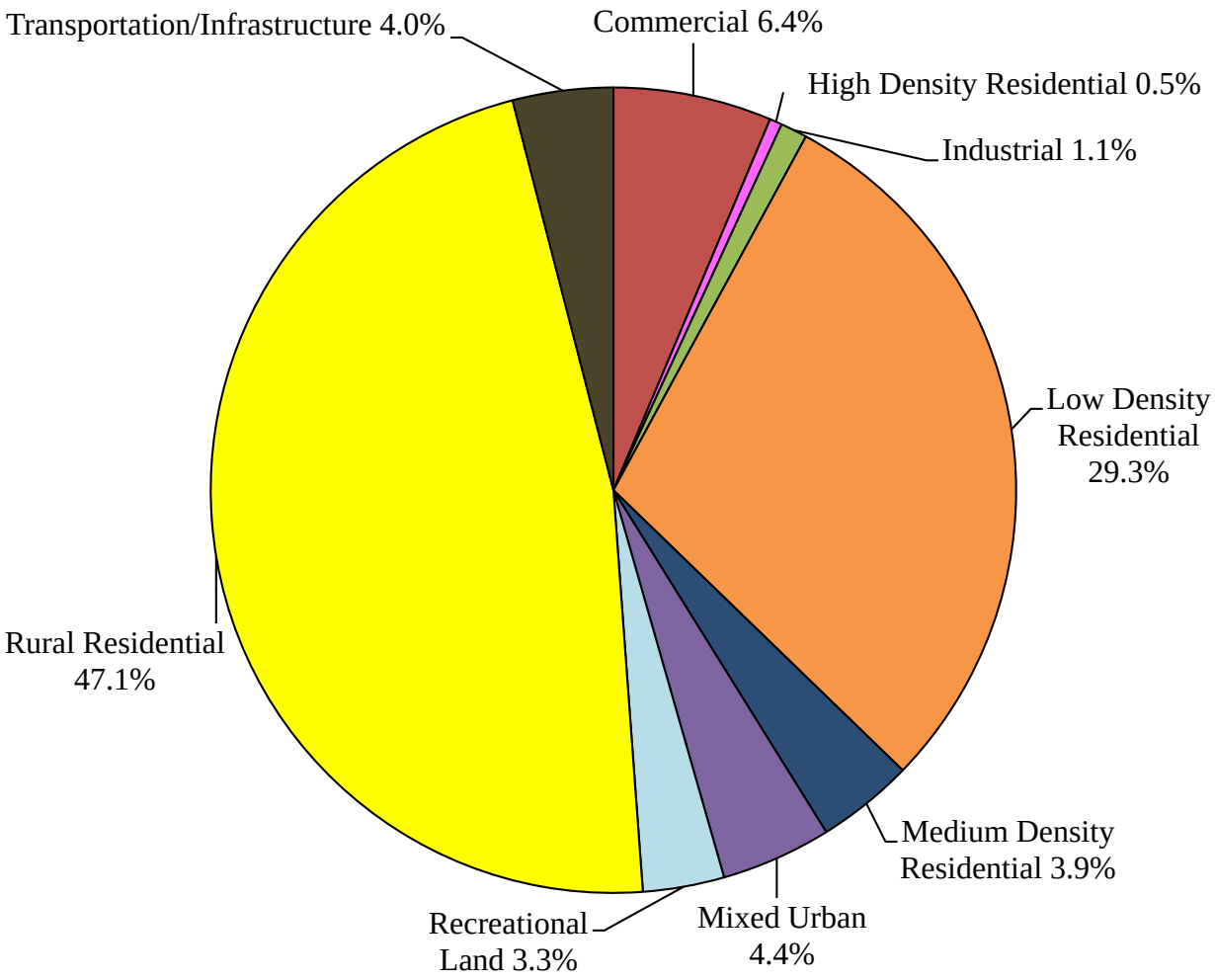


Figure 3: Pie chart illustrating the various types of urban land use in Warren Township

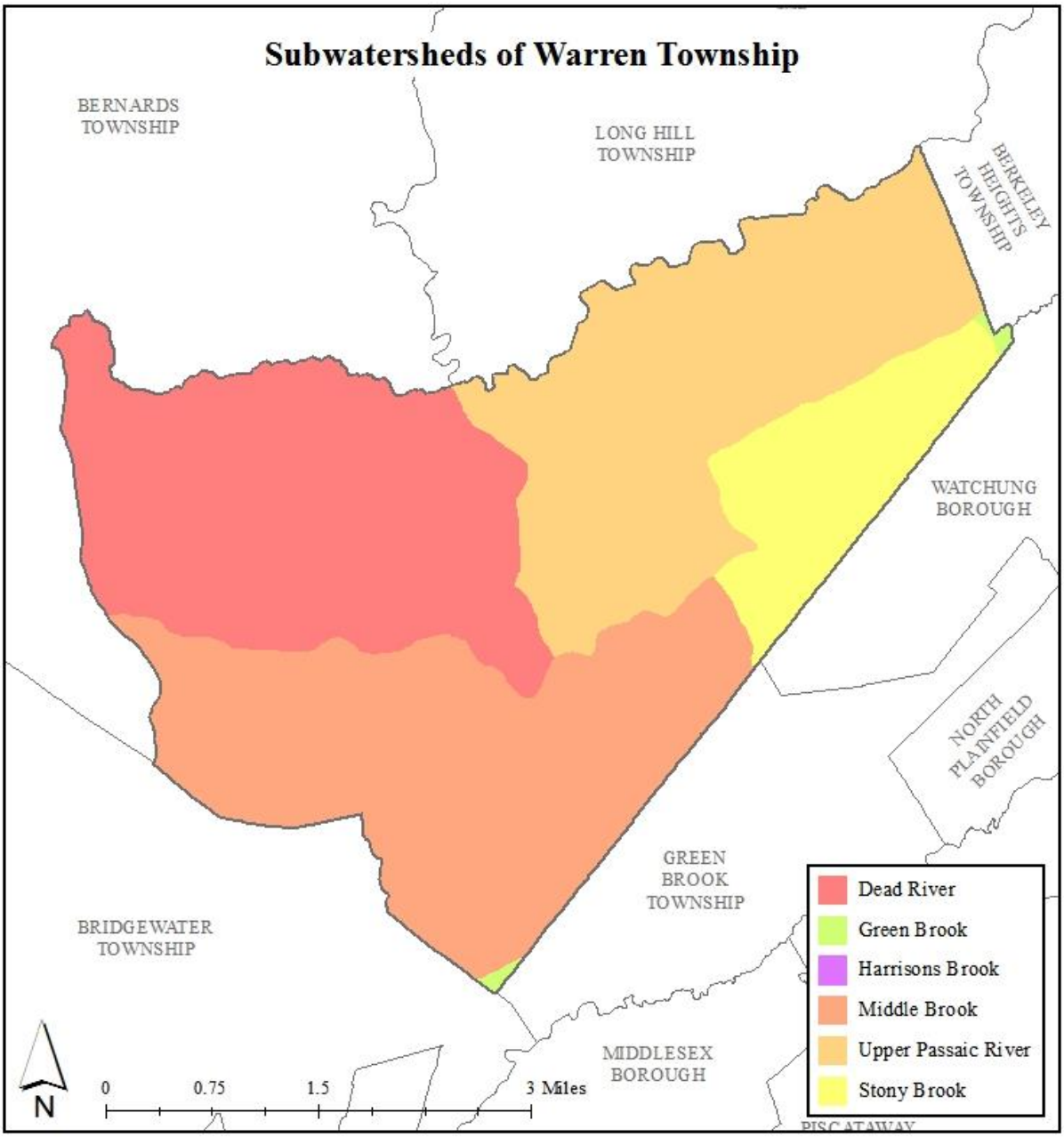


Figure 4: Map of the subwatersheds in Warren Township

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 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 Warren 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 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 Warren Township. 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

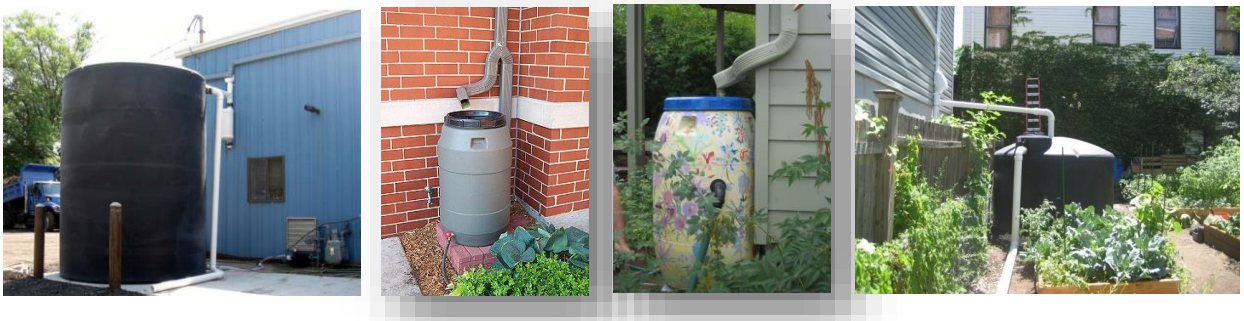
These are landscaped features that are designed to capture, treat, and infiltrate stormwater runoff. These systems can easily be incorporated into existing landscapes, improving aesthetics and creating a wildlife habitat while managing stormwater runoff. Bioretention systems also can be used in soils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

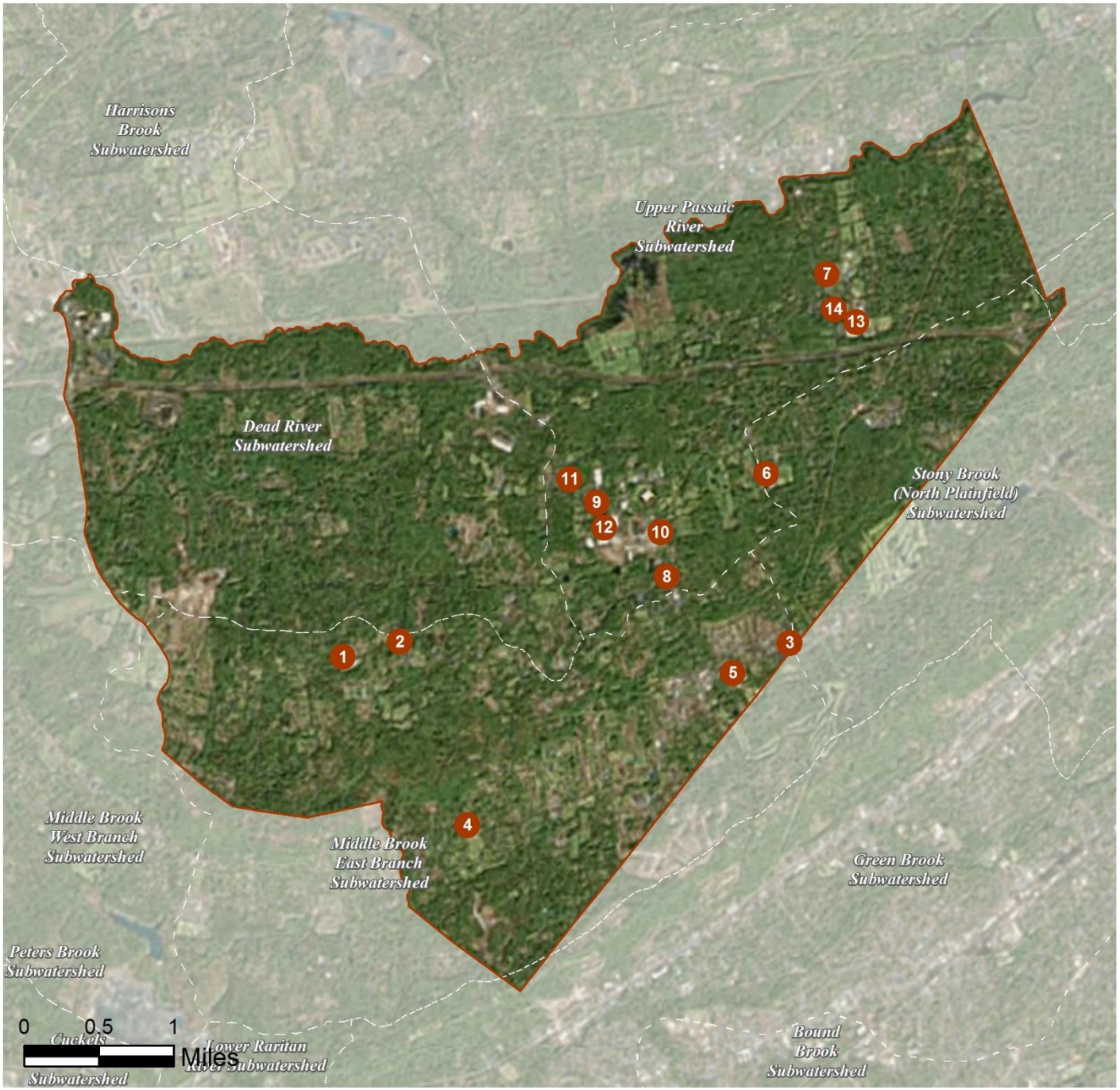
Additionally, development projects that are in need of providing off-site compensation for stormwater impacts can use the projects in this plan as a starting point. The municipality can quickly convert this impervious cover reduction action plan into a stormwater mitigation plan and incorporate it into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

a. Overview Map of the Project

WARREN TOWNSHIP: CLIMATE RESILIENT GREEN INFRASTRUCTURE FOR THE RARITAN BASIN

b. Green Infrastructure Sites

WARREN TOWNSHIP: GREEN INFRASTRUCTURE SITES



SITES WITHIN THE MIDDLE BROOK EAST BRANCH SUBWATERSHED:

1. Mount Horeb Elementary School
2. Mountain Top Road School
3. The Eye Care and Surgery Center
4. Tomaso Elementary School
5. Warren Municipal Building and Library

SITES WITHIN THE STONY BROOK SUBWATERSHED:

6. Warren Township Middle School

SITES WITHIN THE UPPER PASSAIC RIVER SUBWATERSHED:

7. Advent Lutheran Church
8. Central Elementary School
9. Mount Bethel Baptist Church
10. Mount Bethel Volunteer Fire Company
11. Our Lady of the Mount Roman Catholic Church
12. Warren Health and Racquet Club
13. Watchung Hills Regional High School
14. Woodland School

c. Proposed Green Infrastructure Concepts

MOUNT HOREB ELEMENTARY SCHOOL

Subwatershed: **Middle Brook East Branch**

Site Area: **521,569 sq. ft.**

Address: **80 Mount Horeb Road**
Warren, NJ 07059

Block and Lot: **Block 53, Lot 3**

Parking spaces around the school can be replaced 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	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
34	175,038	8.4	88.4	803.7	0.136	4.80

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	0.947	159	69,497	2.61	9,634	$240,850

GREEN INFRASTRUCTURE RECOMMENDATIONS

Mount Horeb Elementary School

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

0 50' 100'

MOUNTAIN TOP ROAD SCHOOL

Subwatershed: Middle Brook East Branch

Site Area: 298,513 sq. ft.

Address: 104 Mount Horeb Road
Warren, NJ 07059

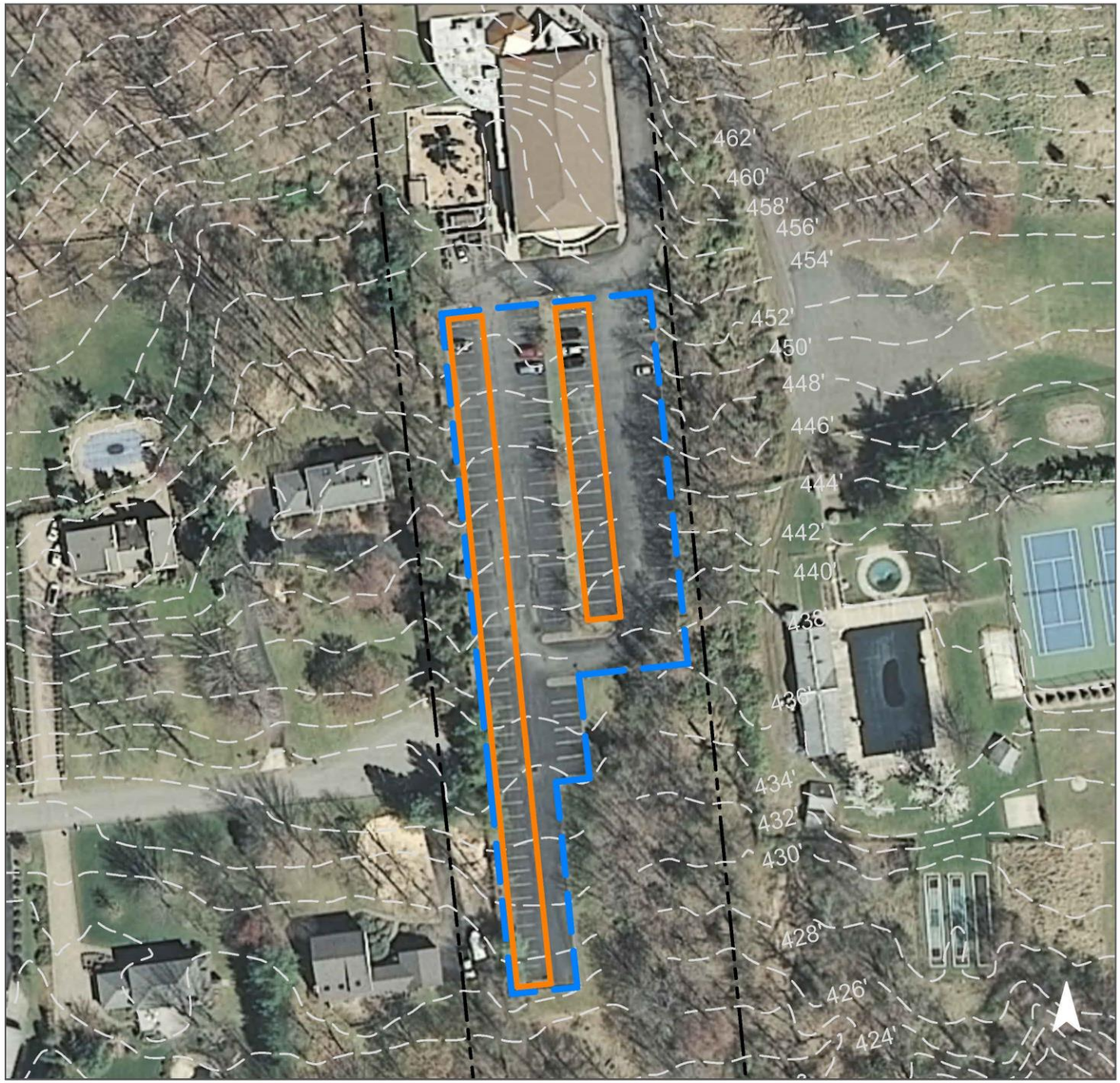
Block and Lot: Block 55, Lot 5

Two rows of parking spots south of the school 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"
39	116,323	5.6	58.7	534.1	0.091	3.19

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	1.142	191	83,798	3.15	14,241	$356,025

GREEN INFRASTRUCTURE RECOMMENDATIONS



Mountain Top Road School

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

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THE EYE CARE AND SURGERY CENTER

Subwatershed: **Middle Brook East Branch**

Site Area: **51,542 sq. ft.**

Address: **10 Mountain Boulevard**
Warren, NJ 07059

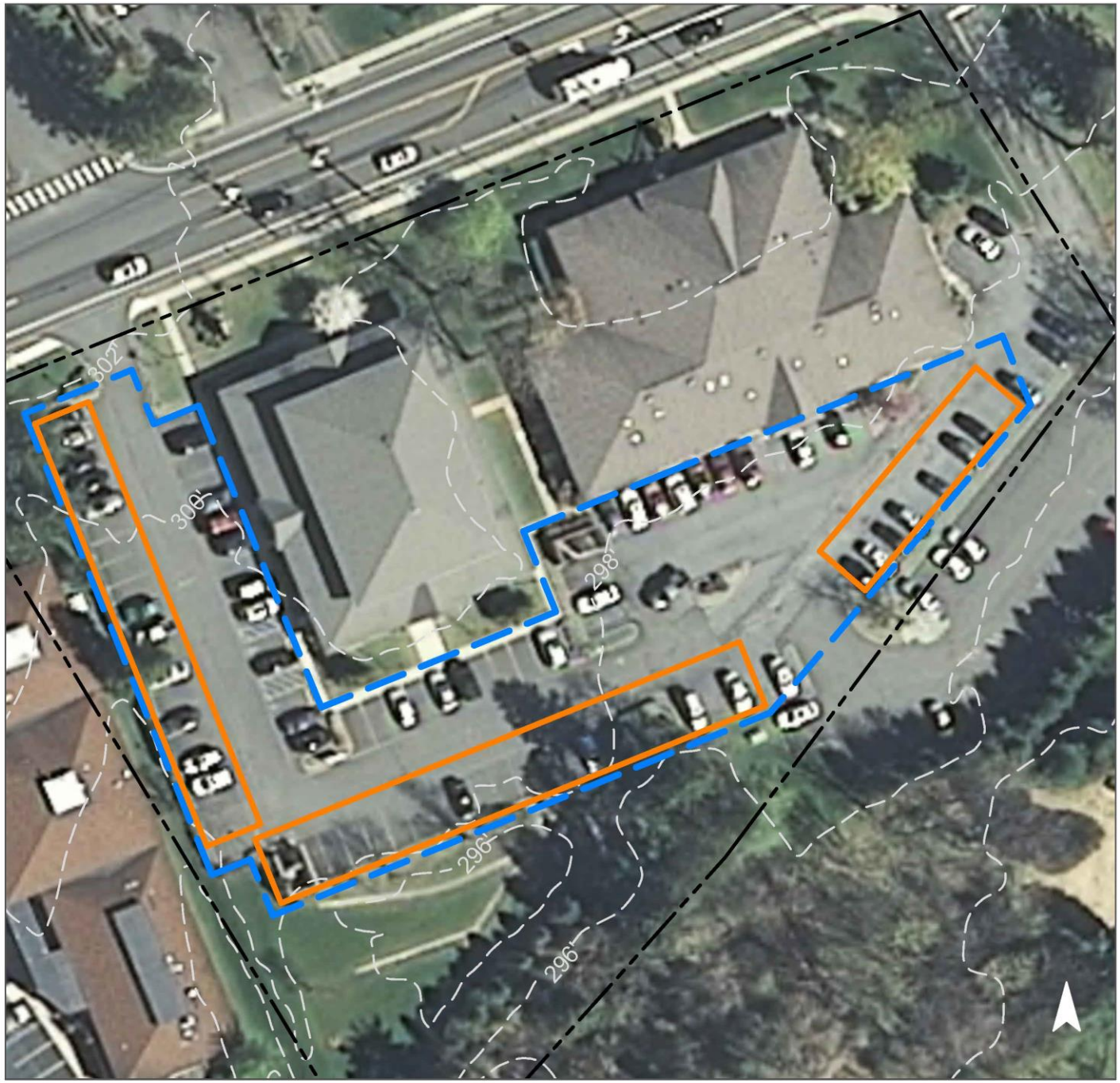
Block and Lot: **Block 91, Lot 1.02**

Stormwater is currently directed to an existing trench. Parking spots west and south of the building 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"
76	39,203	1.9	19.8	180.0	0.031	1.08

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	0.937	157	68,726	2.58	11,905	$297,625

GREEN INFRASTRUCTURE RECOMMENDATIONS



The Eye Care and Surgery Center

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

0 30' 60'

TOMASO ELEMENTARY SCHOOL

Subwatershed: **Middle Brook East Branch**

Site Area: **556,030 sq. ft.**

Address: **46 Washington Valley Road**
Warren, NJ 07059

Block and Lot: **Block 61, Lot 10**

Rows of parking spots around the school can be replaced with porous asphalt to capture and infiltrate stormwater. In the turf grass on the northeast side of the school a rain garden can be installed to capture, treat, and infiltrate roof 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"
32	175,999	8.5	88.9	808.1	0.137	4.83

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	0.045	8	3,306	0.12	500	$2,500
Pervious pavements	1.254	210	92,034	3.46	13,482	$337,050

GREEN INFRASTRUCTURE RECOMMENDATIONS

Tomaso Elementary School

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

0 40' 80'

WARREN MUNICIPAL BUILDING AND LIBRARY

Subwatershed: Middle Brook East Branch

Site Area: 1,557,681 sq. ft.

Address: 44 Mountain Boulevard
Warren, NJ 07059

Block and Lot: Block 89, Lot 3.01

Parking spots around the complex can be replaced 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	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
23	358,876	17.3	181.3	1,647.7	0.280	9.84

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	1.675	280	103,755	3.90	11,477	$286,925

GREEN INFRASTRUCTURE RECOMMENDATIONS

Warren Municipal Building and Library

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

0 50' 100'

WARREN TOWNSHIP MIDDLE SCHOOL

Subwatershed: Stony Brook

Site Area: 3,562,527 sq. ft.

Address: 100 Old Stirling Road
Warren, NJ 07059

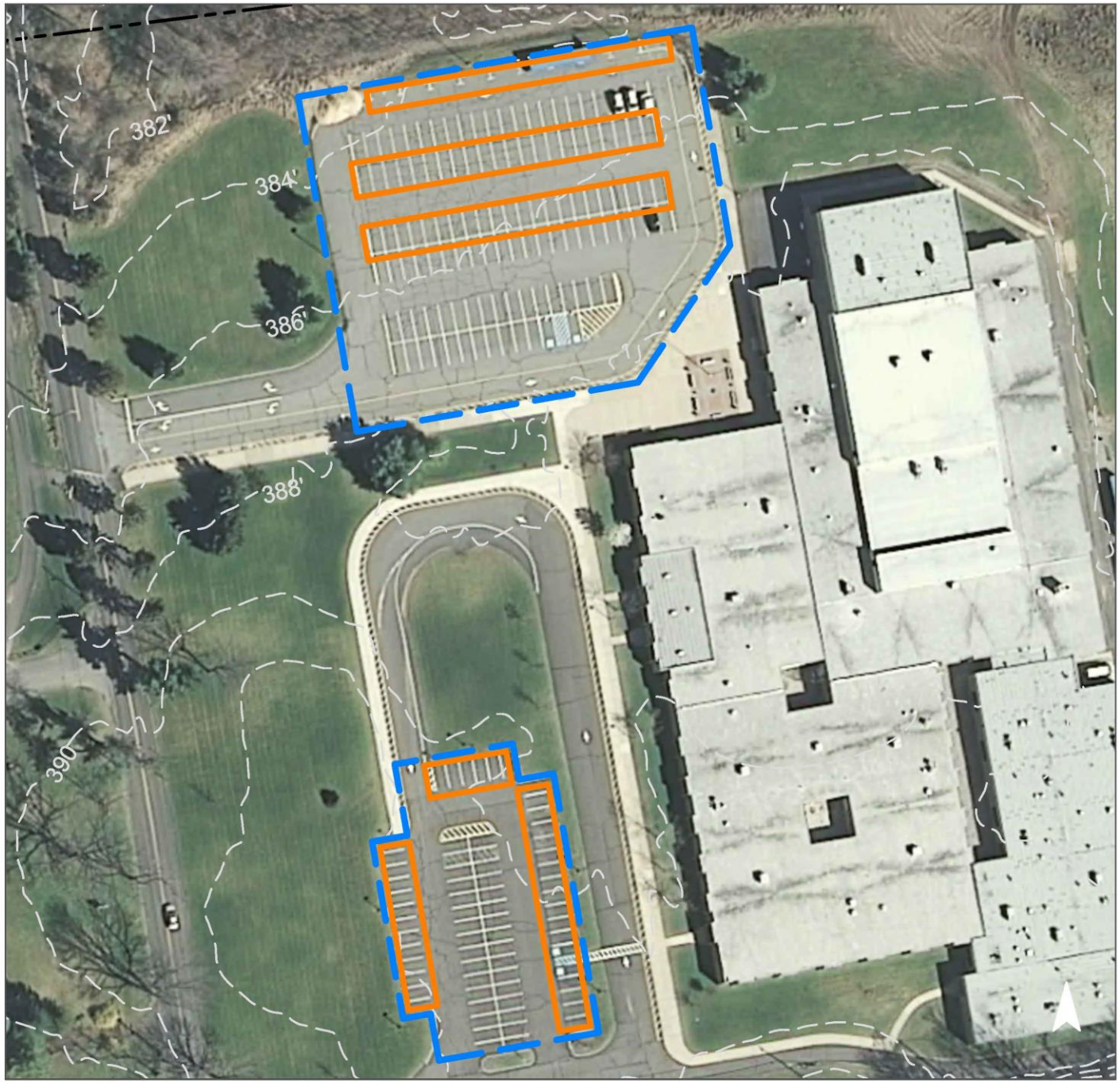
Block and Lot: Block 86.01, 97 Lot 8.02, 4

Multiple rows of parking spots in the parking lots 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"
13	448,301	21.6	226.4	2,058.3	0.349	12.30

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	2.027	339	148,702	5.59	18,623	$465,575

GREEN INFRASTRUCTURE RECOMMENDATIONS



Warren Township Middle School

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

0 50' 100'

ADVENT LUTHERAN CHURCH

Subwatershed: Upper Passaic River

Site Area: 134,151 sq. ft.

Address: 128 Stirling Road
Warren, NJ 07059

Block and Lot: Block 198, Lot 1

Parking spots at the church can be replaced 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	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
17	22,987	1.1	11.6	105.5	0.018	0.63

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	0.415	69	30,459	1.15	4,379	$109,475

GREEN INFRASTRUCTURE RECOMMENDATIONS

Advent Lutheran Church

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

0 25' 50'

CENTRAL ELEMENTARY SCHOOL

Subwatershed: Upper Passaic River

Site Area: 798,877 sq. ft.

Address: 109 Mount Bethel Road
Warren, NJ 07059

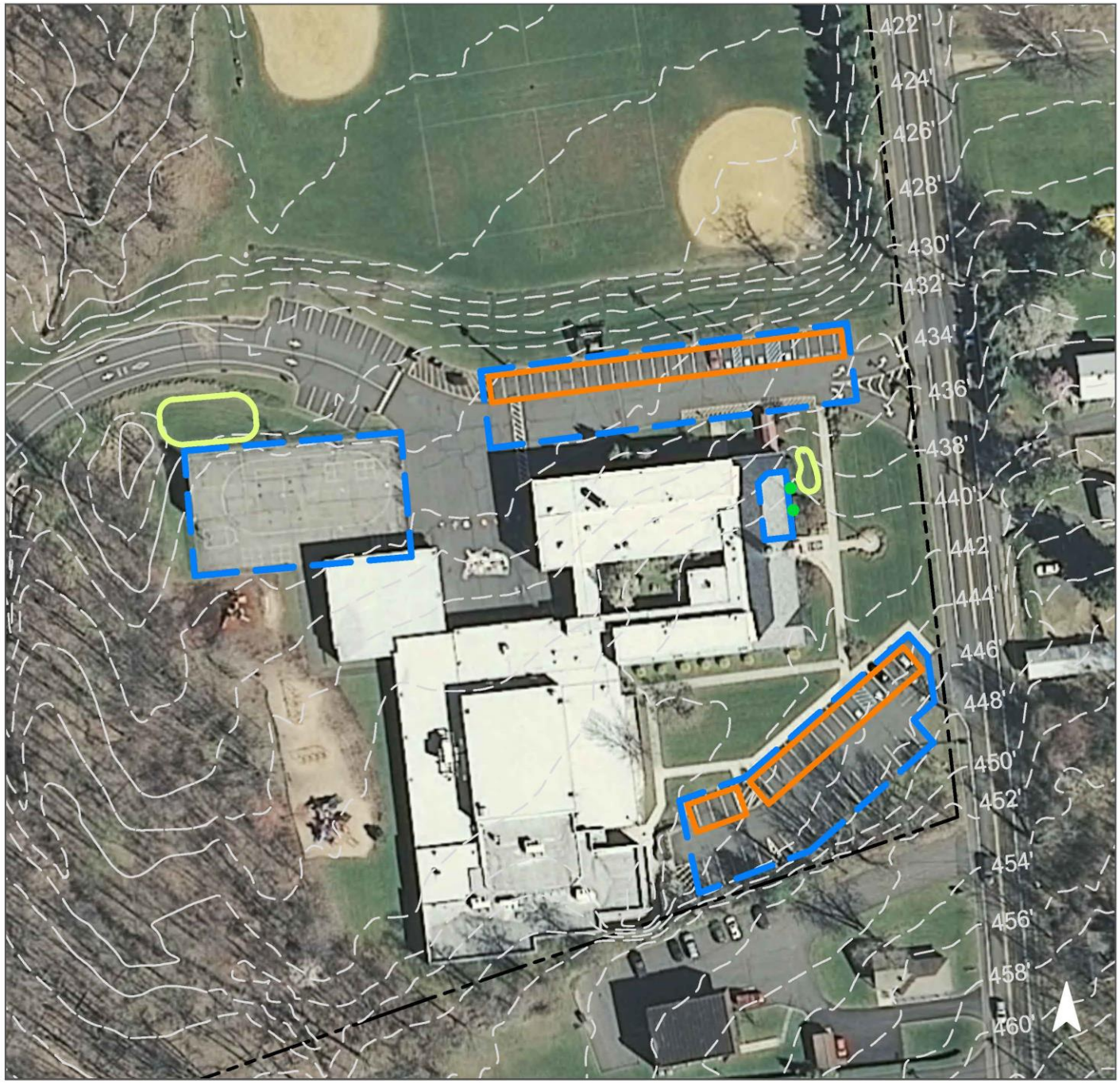
Block and Lot: Block 78, Lot 20, 21.01

Parking spots can be replaced with porous asphalt to capture and infiltrate stormwater generated by the parking lots. Bioretention systems can be installed to capture, treat, and infiltrate rooftop runoff from the northeast side of the school and playground runoff from the northwest side of the site. Two downspouts can be disconnected and redirected into a rain garden. 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	186,635	9.0	94.3	856.9	0.145	5.12

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	0.325	54	23,876	0.90	2,013	$10,065
Pervious pavements	0.633	106	46,458	1.75	7,297	$192,490

GREEN INFRASTRUCTURE RECOMMENDATIONS



Central Elementary School

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

0 50' 100'

MOUNT BETHEL BAPTIST CHURCH

Subwatershed: Upper Passaic River

Site Area: 43,882 sq. ft.

Address: 147 Mount Bethel Road
Warren, NJ 07059

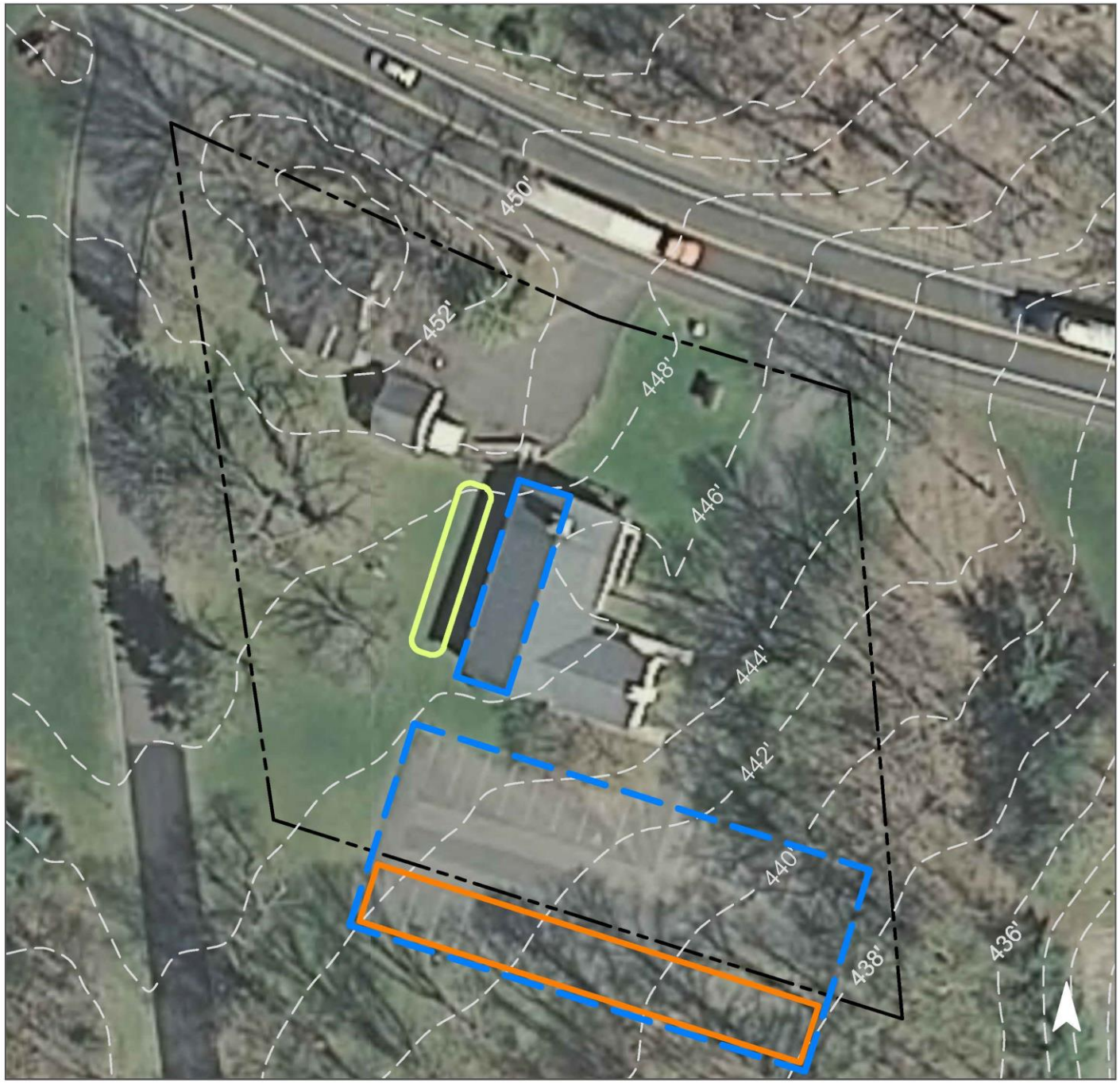
Block and Lot: Block 78, Lot 17.02

Installing a rain garden adjacent to the west side of the church can capture, treat, and infiltrate roof runoff. The row of parking spaces furthest south of the church can be replaced with pervious pavement to provide stormwater an opportunity to infiltrate. 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	28,273	1.4	14.3	129.8	0.022	0.78

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	0.031	5	2,281	0.09	615	$3,075
Pervious pavements	0.284	47	20,802	0.78	2,969	$74,225

GREEN INFRASTRUCTURE RECOMMENDATIONS



Mount Bethel Baptist Church

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

0 25' 50'

MOUNT BETHEL VOLUNTEER FIRE COMPANY

Subwatershed: Upper Passaic River

Site Area: 81,140 sq. ft.

Address: 128 Mount Bethel Road
Warren, NJ 07059

Block and Lot: Block 79, Lot 8

Rainwater can be harvested by installing a cistern at the fire company. The water can be used for cleaning emergency vehicles or for conducting car wash fundraisers. 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"
45	36,716	1.8	18.5	168.6	0.029	1.01

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
Rainwater harvesting systems	0.035	6	1,300	0.10	1,300 (gal)	$2,600

GREEN INFRASTRUCTURE RECOMMENDATIONS

Mount Bethel Volunteer Fire Company

- rainwater harvesting
- drainage areas
- property line
- 2012 Aerial: NJOIT, OGIS

0 30' 60'

OUR LADY OF THE MOUNT ROMAN CATHOLIC CHURCH

Subwatershed: Upper Passaic River

Site Area: 831,376 sq. ft.

Address: 167 Mount Bethel Road
Warren, NJ 07059

Block and Lot: Block 80, Lot 2

Multiple rows of parking spots can be replaced with pervious pavement to provide stormwater an opportunity to infiltrate. Building a rain garden adjacent to the northwest corner of the church 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"
18	146,364	7.1	73.9	672.0	0.114	4.01

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	0.041	7	3,029	0.11	397	$1,985
Pervious pavements	1.897	318	139,225	5.23	17,741	$443,525

GREEN INFRASTRUCTURE RECOMMENDATIONS

Our Lady of the Mount Roman Catholic Church

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

0 30' 60'

WARREN HEALTH AND RACQUET CLUB

Subwatershed: Upper Passaic River

Site Area: 325,294 sq. ft.

Address: 149 Mount Bethel Road
Warren, NJ 07059

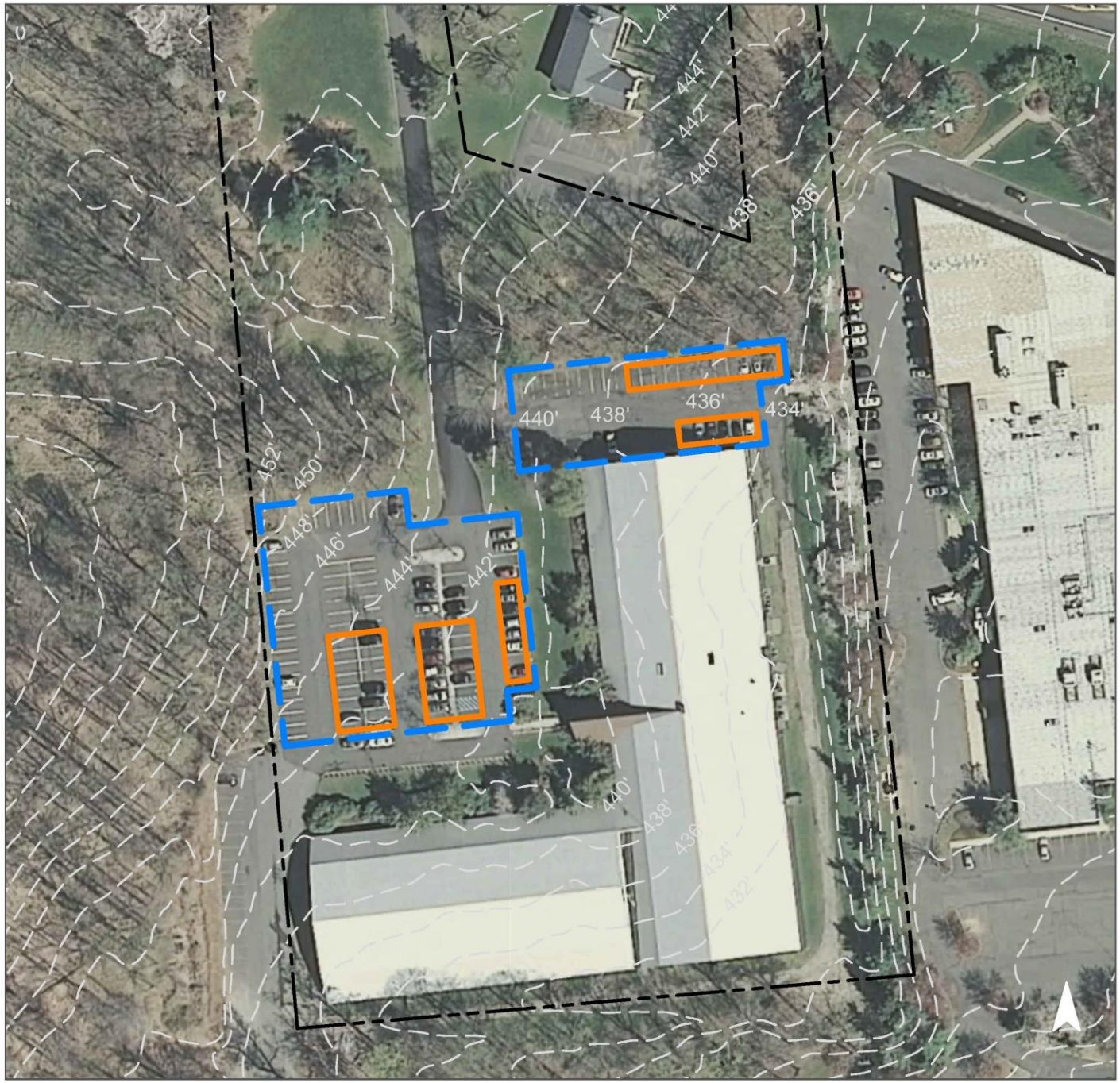
Block and Lot: Block 78, Lot 17.01

Parking spots north and west of the building can be replaced 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	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
50	162,815	7.8	82.2	747.5	0.127	4.47

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	1.143	191	83,843	3.15	9,836	$245,900

GREEN INFRASTRUCTURE RECOMMENDATIONS



Warren Health and Racquet Club

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

0 50' 100'

WATCHUNG HILLS REGIONAL HIGH SCHOOL

Subwatershed: Upper Passaic River

Site Area: 2,745,844 sq. ft.

Address: 114 Stirling Road
Warren, NJ 07059

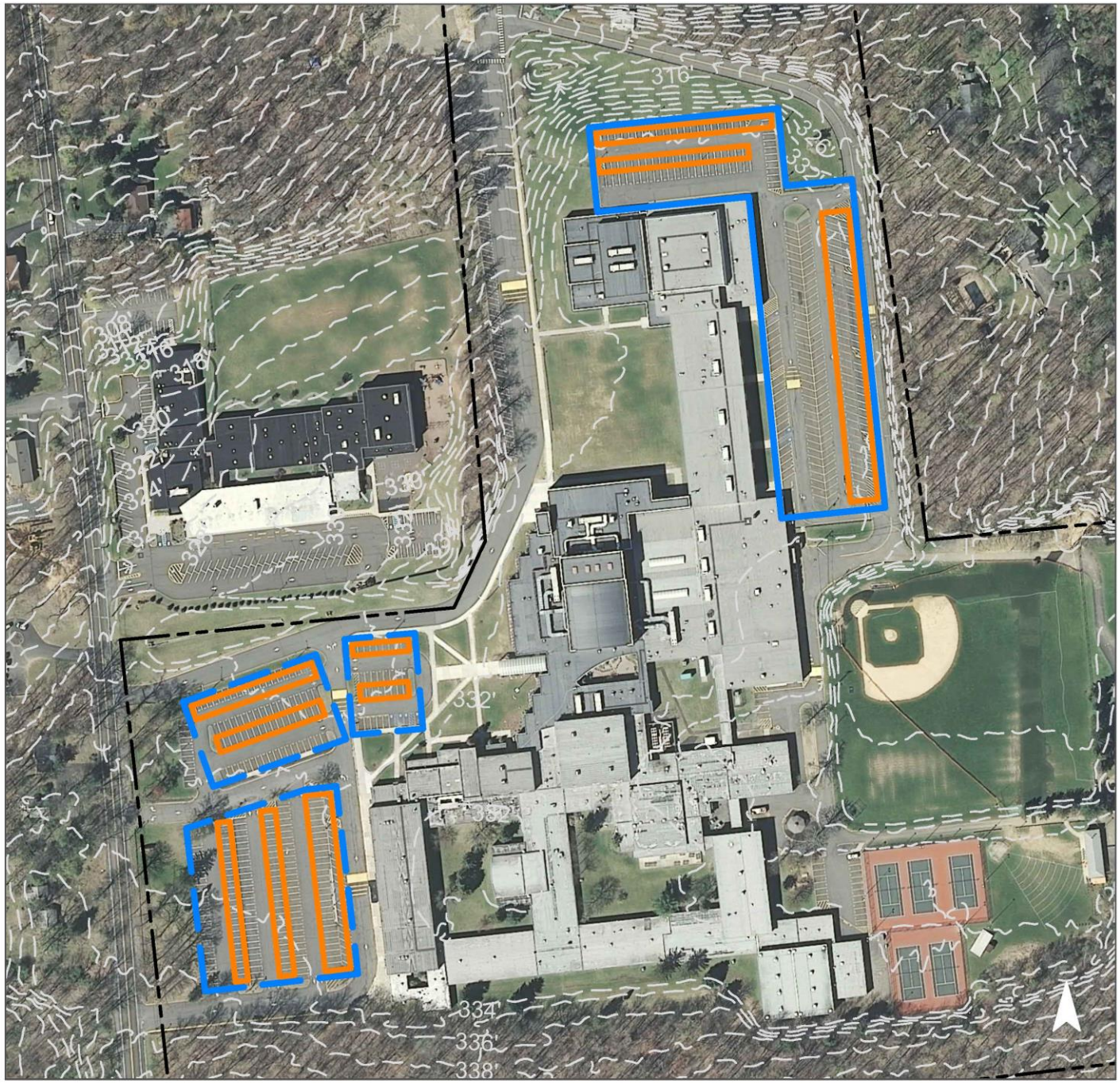
Block and Lot: Block 201, Lot 3.01

Rows of parking spots north and west of the school can be replaced with pervious pavement to provide stormwater being generated by the parking lots an opportunity to infiltrate. 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	959,675	46.3	484.7	4,406.2	0.748	26.32

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	1.126	188	80,864	2.20	54,216	$1,355,400

GREEN INFRASTRUCTURE RECOMMENDATIONS



Watchung Hills Regional High School

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

0 110' 220'

WOODLAND SCHOOL

Subwatershed: Upper Passaic River

Site Area: 671,379 sq. ft.

Address: 114 Stirling Road
Warren, NJ 07059

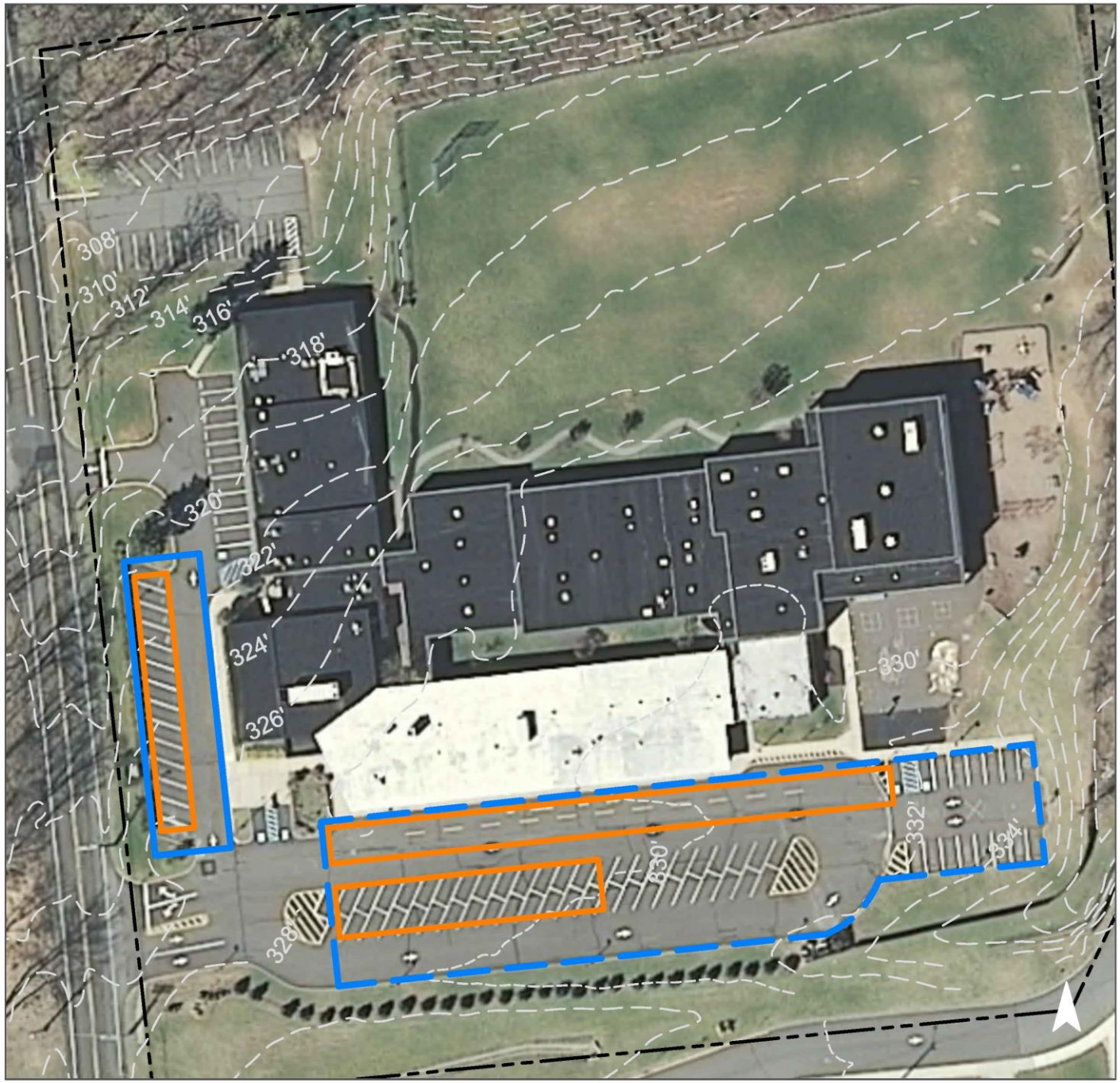
Block and Lot: Block 201, Lot 2

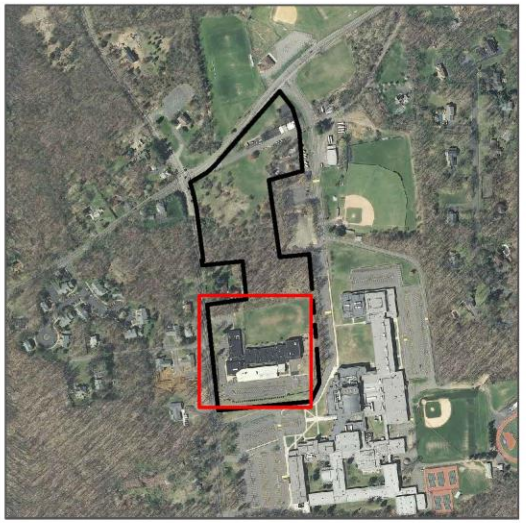
Parking spaces can be replaced with pervious pavement to capture and infiltrate stormwater. A preliminary soil assessment suggests that the soils have suitable drainage characteristics for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs/yr)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
26	175,968	8.5	88.9	807.9	0.137	4.83

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	0.945	158	69,370	2.61	11,615	$290,375

GREEN INFRASTRUCTURE RECOMMENDATIONS





Woodland School

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

0 40' 80'

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)
MIDDLE BROOK EAST BRANCH SUBWATERSHED	**68.53**	**2,985,335**			**41.7**	**437.1**	**3,973.6**		**19.87**	**865,439**	**0.674**	**23.74**
Mount Horeb Elementary School												
Total Site Info	11.97	521,569	53	3	8.4	88.4	803.7	34	4.02	175,038	0.136	4.80
Mountain Top Road School												
Total Site Info	6.85	298,513	55	5	5.6	58.7	534.1	39	2.67	116,323	0.091	3.19
The Eye Care and Surgery Center												
Total Site Info	1.18	51,542	91	1.02	1.9	19.8	180.0	76	0.90	39,203	0.031	1.08
Tomaso Elementary School												
Total Site Info	12.76	556,030	61	10	8.5	88.9	808.1	32	4.04	175,999	0.137	4.83
Warren Municipal Building and Library												
Total Site Info	35.76	1,557,681	89	3.01	17.3	181.3	1,647.7	23	8.24	358,876	0.280	9.84
STONY BROOK SUBWATERSHED	**81.78**	**3,562,527**			**21.6**	**226.4**	**2,058.3**		**10.29**	**448,301**	**0.349**	**12.30**
Warren Township Middle School												
Total Site Info	81.78	3,562,527	86.01, 97	8.02, 4	21.6	226.4	2,058.3	13	10.29	448,301	0.349	12.30
UPPER PASSAIC RIVER SUBWATERSHED	**211.08**	**9,194,470**			**104.5**	**1,094.8**	**9,952.9**		**49.76**	**2,167,734**	**1.689**	**59.45**
Advent Lutheran Church												
Total Site Info	3.08	134,151	198	1	1.1	11.6	105.5	17	0.53	22,987	0.018	0.63
Central Elementary School												
Total Site Info	18.34	798,877	78	20, 20.01	9.0	94.3	856.9	23	4.28	186,635	0.145	5.12
Mount Bethel Baptist Church												
Total Site Info	1.01	43,882	78	17.02	1.4	14.3	129.8	64	0.65	28,273	0.022	0.78
Mount Bethel Volunteer Fire Company												
Total Site Info	1.86	81,140	79	8	1.8	18.5	168.6	45	0.84	36,716	0.029	1.01

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)
Our Lady of the Mount Roman Catholic Church												
Total Site Info	19.09	831,376	80	2	7.1	73.9	672.0	18	3.36	146,364	0.114	4.01
Warren Health and Racquet Club												
Total Site Info	7.47	325,294	78	17.01	7.8	82.2	747.5	50	3.74	162,815	0.127	4.47
Watchung Hills Regional High School												
Total Site Info	63.04	2,745,844	201	3.01	46.3	484.7	4,406.2	35	22.03	959,675	0.748	26.32
Woodland School												
Total Site Info	15.41	671,379	201	2	8.5	88.9	807.9	26	4.04	175,968	0.137	4.83

e. Summary of Proposed Green Infrastructure Practices

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 (SF)	Unit Cost ($)	Unit	Total Cost ($)	I.C. Treated %
		Area (SF)	Area (ac)									
	MIDDLE BROOK EAST BRANCH SUBWATERSHED	**230,264**	**5.29**	**6.000**	**1,004**	**421,116**	**15.82**	**61,239**			**$1,520,975**	**26.6%**
1	**Mount Horeb Elementary School**											
	Pervious pavements	36,349	0.83	0.947	159	69,497	2.61	9,634	25	SF	$240,850	20.8%
	Total Site Info	**36,349**	**0.83**	**0.947**	**159**	**69,497**	**2.61**	**9,634**			**$240,850**	**20.8%**
2	**Mountain Top Road School**											
	Pervious pavements	43,832	1.01	1.142	191	83,798	3.15	14,241	25	SF	$356,025	37.7%
	Total Site Info	**43,832**	**1.01**	**1.142**	**191**	**83,798**	**3.15**	**14,241**			**$356,025**	**37.7%**
3	**The Eye Care and Surgery Center**											
	Pervious pavements	35,947	0.83	0.937	157	68,726	2.58	11,905	25	SF	$297,625	91.7%
	Total Site Info	**35,947**	**0.83**	**0.937**	**157**	**68,726**	**2.58**	**11,905**			**$297,625**	**91.7%**
4	**Tomaso Elementary School**											
	Bioretention systems	1,728	0.04	0.045	8	3,306	0.12	500	5	SF	$2,500	1.0%
	Pervious pavements	48,138	1.11	1.254	210	92,034	3.46	13,482	25	SF	$337,050	27.4%
	Total Site Info	**49,866**	**1.14**	**1.299**	**218**	**95,340**	**3.58**	**13,982**			**$339,550**	**28.3%**
5	**Warren Municipal Building and Library**											
	Pervious pavements	64,270	1.48	1.675	280	103,755	3.90	11,477	25	SF	$286,925	17.9%
	Total Site Info	**64,270**	**1.48**	**1.675**	**280**	**103,755**	**3.90**	**11,477**			**$286,925**	**17.9%**
	STONY BROOK SUBWATERSHED	**77,780**	**1.79**	**2.027**	**339**	**148,702**	**5.59**	**18,623**			**$465,575**	**17.3%**
6	**Warren Township Middle School**											
	Pervious pavements	77,780	1.79	2.027	339	148,702	5.59	18,623	25	SF	$465,575	17.3%
	Total Site Info	**77,780**	**1.79**	**2.027**	**339**	**148,702**	**5.59**	**18,623**			**$465,575**	**17.3%**
	UPPER PASSAIC RIVER SUBWATERSHED	**500,868**	**11.50**	**8.902**	**1,490**	**650,209**	**23.66**	**131,001**			**$3,110,400**	**23.1%**
7	**Advent Lutheran Church**											
	Pervious pavements	15,933	0.37	0.415	69	30,459	1.15	4,379	25	SF	$109,475	69.3%
	Total Site Info	**15,933**	**0.37**	**0.415**	**69**	**30,459**	**1.15**	**4,379**			**$109,475**	**69.3%**

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 (SF)	Unit Cost ($)	Unit	Total Cost ($)	I.C. Treated %
8	**Central Elementary School**											
	Bioretention systems/rain gardens	12,488	0.29	0.325	54	23,876	0.90	2,013	5	SF	$10,065	6.7%
	Pervious pavements	24,299	0.56	0.633	106	46,458	1.75	7,297	25	SF	$182,425	13.0%
	Total Site Info	**36,787**	**0.84**	**0.958**	**160**	**70,334**	**2.65**	**9,310**			**$192,490**	**19.7%**
9	**Mount Bethel Baptist Church**											
	Bioretention systems/rain gardens	1,193	0.03	0.031	5	2,281	0.09	615	5	SF	$3,075	4.2%
	Pervious pavements	10,882	0.25	0.284	47	20,802	0.78	2,969	25	SF	$74,225	38.5%
	Total Site Info	**12,075**	**0.28**	**0.315**	**53**	**23,083**	**0.87**	**3,584**			**$3,075**	**42.7%**
10	**Mount Bethel Volunteer Fire Company**											
	Rainwater harvesting systems	1,338	0.03	0.035	6	1,300	0.10	1,300	2	gal	$2,600	3.6%
	Total Site Info	**1,338**	**0.03**	**0.035**	**6**	**1,300**	**0.10**	**1,300**			**$2,600**	**3.6%**
11	**Our Lady of the Mount Roman Catholic Church**											
	Bioretention systems/rain gardens	1,584	0.04	0.041	7	3,029	0.11	397	5	SF	$1,985	1.1%
	Pervious pavements	72,823	1.67	1.897	318	139,225	5.23	17,741	25	SF	$443,525	49.8%
	Total Site Info	**74,407**	**1.71**	**1.939**	**325**	**142,254**	**5.34**	**18,138**			**$445,510**	**50.8%**
12	**Warren Health and Racquet Club**											
	Pervious pavements	43,853	1.01	1.143	191	83,843	3.15	9,836	25	SF	$245,900	26.9%
	Total Site Info	**43,853**	**1.01**	**1.143**	**191**	**83,843**	**3.15**	**9,836**			**$245,900**	**26.9%**
13	**Watchung Hills Regional High School**											
	Pervious pavements	202,410	4.65	1.126	188	80,864	2.20	54,216	25	SF	$1,355,400	21.1%
	Total Site Info	**202,410**	**4.65**	**1.126**	**188**	**80,864**	**2.20**	**54,216**			**$1,355,400**	**21.1%**
14	**Woodland School**											
	Pervious pavements	36,285	0.83	0.945	158	69,370	2.61	11,615	25	SF	$290,375	20.6%
	Total Site Info	**36,285**	**0.83**	**0.945**	**158**	**69,370**	**2.61**	**11,615**			**$290,375**	**20.6%**