ENVIRONMENTAL RESOURCE INVENTORY

ERI

JUNE 2019

For the Township of:

WOOLWICH

Gloucester County, New Jersey

by:
DELAWARE VALLEY REGIONAL PLANNING COMMISSION (dvrpc)

with:
WOOLWICH TOWNSHIP

The Delaware Valley Regional Planning Commission is the federally designated Metropolitan Planning Organization for a diverse nine-county region in two states: Bucks, Chester, Delaware, Montgomery, and Philadelphia in Pennsylvania; and Burlington, Camden, Gloucester, and Mercer in New Jersey.

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

DVRPC's vision for the Greater Philadelphia Region is a prosperous, innovative, equitable, resilient, and sustainable region that increases mobility choices by investing in a safe and modern transportation system; that protects and preserves our natural resources while creating healthy communities; and that fosters greater opportunities for all.

DVRPC's mission is to achieve this vision by convening the widest array of partners to inform and facilitate data-driven decision-making. We are engaged across the region, and strive to be leaders and innovators, exploring new ideas and creating best practices.

DVRPC is funded through a variety of funding sources including federal grants from the U.S. Department of Transportation's Federal Highway Administration (FHWA) and Federal Transit Administration (FTA), the Pennsylvania and New Jersey departments of transportation, as well as by DVRPC's state and local member governments. The authors, however, are solely responsible for the findings and conclusions herein, which may not represent the official views or policies of the funding agencies.

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The Environmental Planning Work Program assists local governments in completing plans and studies that balance the natural resources of communities in our region with transportation and development needs. The program identifies and addresses local environmental issues such as land use, water quality and quantity, flooding, wildlife habitat, natural vegetation, open space, and recreation.

The following individuals were instrumental in the development of this ERI:

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Executive Summary

An Environmental Resource Inventory (ERI) identifies and describes the natural resources of a community—its soil, water, air, plants, and animals—which are fundamental to its character. The protection and wise use of those resources is essential to the health, safety, and welfare of current and future residents. The ERI provides a basis for municipal actions to preserve and use those resources, although it does not include recommendations to those ends. It is, instead, a compendium of existing information about a community's natural resources, presented in a form that is useful to a broad audience.

The ERI is an important tool for environmental commissions, open space committees, planning boards, and zoning boards of adjustment, enabling these groups to identify and prioritize environmental challenges and opportunities. When adopted into the Master Plan, the ERI can support the development of resource protection ordinances and resource-based land use planning.

Each ERI reflects a particular moment in time. Woolwich Township's last ERI was published in 2004, and while some of the township's natural resource base has remained consistent since that time, much has changed.

Woolwich Township consists of a variety of landscapes and natural resources, including a multitude of freshwater creeks, freshwater wetlands, fields, and deciduous and coniferous forests. Located in the Inner Coastal Plain, the township contains expanses of flat land with high-quality soils that are ideal for agriculture. Historically, the township thrived as an agricultural center. More recently, with the construction of major highways through and near Woolwich, the township has faced environmental challenges from increased residential and commercial development, including loss of farmland, sprawled development patterns, conversion of forest lands to new development, water quality pollution, and site contamination.

Several documents were used to prepare this ERI, including Woolwich's 2004 ERI; 2016 Master Plan Reexamination; Master Plan Elements, including the 2016 Open Space and Recreation Plan and the Public Spaces Plan; Transfer of Development Rights (TDR) Plan; and other reference works. All resources are listed in the **References** section at the end of this report (page 126). The maps and geographic data in this report are primarily derived from the New Jersey Department of Environmental Protection's (NJDEP's) Geographic Information System mapping and from The Landscape Project produced by the Endangered and Nongame Species Program of the New Jersey Fish and Wildlife Division. This information is available on the NJDEP website, which provides access to data that may be updated in the future.

Woolwich Overview

Woolwich Township is located in southwestern Gloucester County, New Jersey. It encompasses 27 square miles of land area (16,973 acres) and about 1 square mile of water area (645 acres).

Its neighbors include Logan Township, Greenwich Township, East Greenwich Township, Harrison Township, and South Harrison Township in Gloucester County; and Pilesgrove Township and Oldmans Township in Salem County. Woolwich Township also surrounds Swedesboro Borough (**Figure 1: Basemap**).

The 2010 United States Census recorded 10,200 residents in Woolwich Township. Since then, the township has seen an increase in population by about 19.3 percent, with approximately 12,172 residents estimated in 2017 (2017 Five-Year American Community Survey). Through the five-year American Community Surveys, the United States Census has estimated the township's growth in more recent years to be increasing at an even higher rate, with an estimated rate of 20.4 percent between 2012 and 2017.

In 2017, Woolwich's median household income was $123,347 (2017 Five-Year American Community Survey) and the poverty rate was 4.6 percent (2017 Five-Year American Community Survey).

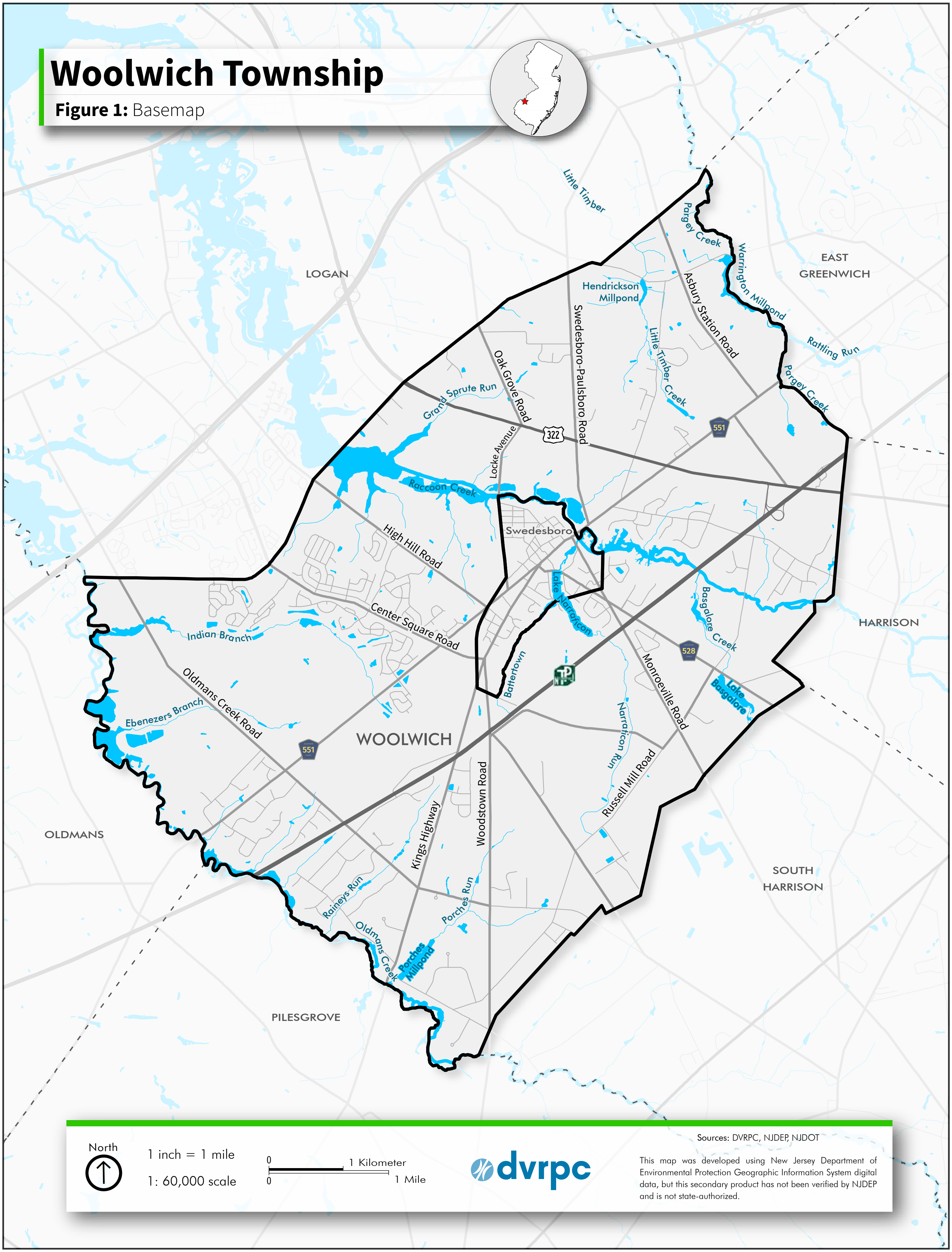
Woolwich Township is located within a major interstate transportation corridor that passes between southwest and northeast New Jersey and connects many of the major cities along the east coast of the United States. The New Jersey Turnpike passes through the center of the township, and Interstate 295 passes just outside of it to the north. US Highway 322, which stretches from Cleveland, Ohio to Atlantic City, New Jersey, also passes through the township. Woolwich Township also contains part of New Jersey Transit's bus network. Bus 401 connects Woolwich to Philadelphia and municipalities in Gloucester and Salem Counties. The township maintains trails in its parks and has constructed sidepaths for bicycle and pedestrian use along Center Square Road. It also has plans to construct additional sidepaths along Auburn Road and High Hill Road.

Woolwich Township contains many waterways, including Pargey Creek—also known as Pargey's, Pargay('s), Purgey('s), or Purgy Creek— Rattling Run, Little Timber Creek, Raccoon Creek, Oldmans Creek, and tributaries of these creeks. All of these waterways run through Woolwich Township on their way to the Delaware River, which is four miles to the northwest of the township. The township also contains woods, wetlands, and abundant farmland.

Protecting Woolwich's natural resources and agricultural character from development pressure is a high priority for the township's leaders, staff, and residents. The township's 2016 Master Plan, an important guiding document, outlines several objectives intended to protect and improve its natural resources. These objectives include strengthening landscaping and buffer regulations to enhance community character, preserving open space to retain community character and protect sensitive lands, exploring opportunities to conserve land during land subdivision, enforcing environmental policies, ensuring that all municipal policies protect and favor the environment, and developing a system of publicly accessible greenways through the township.

Woolwich Township

Figure 1: Basemap



Brief Township History

Woolwich Township was first incorporated on March 17, 1767 and takes its name from an English town on the Thames River famous for its naval school. The township was part of the Civil Organization of West Jersey, established in 1676, and was originally within Greenwich Township, one of the four incorporated jurisdictions in what is now Gloucester County. When Woolwich Township was first formed from Greenwich Township in 1750, before incorporation, it encompassed an area of 40,000 acres and was known as South Greenwich. Subsequent secessions reduced the land area, with Franklin Township being formed from Greenwich and Woolwich in 1820, and Harrison Township in 1844. In 1877, West Woolwich, which is now known as Logan Township, was set off from Woolwich, although in 1901, part of Logan was returned to Woolwich. In 1902, Swedesboro, the principal town of Woolwich, was incorporated as a separate municipality.

Recent archaeological finds show that humans have been present on the land within township boundaries for approximately 10,000 years. Two indigenous communities are known to have existed beside both the Raccoon and Oldmans Creeks. The Narraticons lived in the vicinity of the Raccoon Creek. Their name, which is a version of their word for "raccoon," survives in the names of the creek and the main lake in Woolwich, Narraticon Lake. The Kagkakaini Sakins lived along the Mosackas Creek, now called Oldmans Creek.

In 1638, Swedish settlement came to the Delaware Valley and a colony was established on the east side of the Delaware River that was referred to as "New Stockholm" (also "New Sweden"). This colony began to grow when the land was purchased by the Swedes from indigenous community members in 1641. The first Swedish settlement was located on the banks of Raccoon Creek and was called "Raccoon" until 1765 when the name was changed to "Swedesborough." Swedish and Finnish inhabitants moved into the area and created homesteads. They gave shelter to the passengers of the first English ship to arrive in 1677, which docked at the Raccoon Creek.

With English settlement in the region, Swedish place names began to be replaced with English names, including that of "Woolwich." Early settlers raised grain, fruit, and vegetables, and tended stock. Pehr Kalm, a Finnish botanist and one of the most famous recorders of botany in the colonies, traveled in the region between 1748 and 1751. He began his stay in Swedesboro and in his important account, *Travels in North America*, reported on the variety of fruit growing on local farms and "peaches so thick on the ground that one could hardly miss stepping on them." Some of New Jersey's richest farmland is located within Woolwich Township and farming has long been a principal industry of the area.

Waterways have also historically been important to Woolwich and Swedesboro. Farm products and timber from the rich forests were conveyed to markets along the wide tidal Raccoon and Oldmans Creeks. Later, during the nineteenth century, an early steamboat plied the Raccoon Creek from the wharves at Swedesboro to Philadelphia along with other vessels. The steamboat carried produce to a farmer's market along Dock Creek in Philadelphia, which served as an early boat landing and launch site. This creek is now covered and known as "Dock Street."

Early mills in and surrounding Woolwich and Swedesboro that ground flour and sawed lumber relied on tributaries to local streams to provide their power. Mills were established at Lake Narraticon next to Swedesboro, on Basgalore Creek, on Pargey Creek forming Warrington Millpond, and on Porches Mill Creek.

Travel on roads was nearly impossible during the 18th and early 19th centuries. Road quality was exceedingly poor and bridges were frequently in disrepair or nonexistent. However, the first highway to cross both Camden and Gloucester Counties, Kings Highway (also called Salem Road or the Great Road), was completed in 1702 and provided an alternative to water travel. The Kings Highway travels through the center of Woolwich Township and Swedesboro and has several historic houses and structures along its length.

Railroads became an important means of travel and transport of goods, especially farm produce, in the latter half of the 19th century. One of the earliest lines in the southern part of Gloucester County was the Swedesboro Railroad, established in 1854, and subsequently operated by the West Jersey Railroad Company and then the Pennsylvania-Reading Seashore Line. This line opened new markets for products from the Woolwich area. It also carried passengers until 1933. It continues to operate today as a freight line.

The railroad served new processing plants that were established in Gloucester County in the late 19th century. One of these, founded by Edgar Hurff, was the largest privately-owned processing plant in the world. Hurff also developed the largest seed business in the world and was the first to process canned asparagus in the eastern United States. The Hurff plant became the California Packing Corporation plant that packaged Del Monte vegetables for many years.

Highways and trucking began to replace railroad transport of both goods and people after World War II. Automobile transportation corridors provided the framework for land uses that exist today in the township. In the 1950s, the New Jersey Turnpike was built, with one of its exits on Route 322 in the northeast corner of Woolwich Township. The turnpike bisects the township on a northeast–southwest line. In the 1960s, the construction of Interstate 295 began to bring major changes to Woolwich. Although the road is west of Woolwich, in Logan Township, it provides easy access in and out of Woolwich.

Figure 2: Weatherby Development, 2017

Source: Matt Blake

In the 1970s, a major residential development called Beckett was planned for Logan and Woolwich Townships. It was later renamed “Weatherby.” When completed, Weatherby is planned to bring 4,300 housing units along Center Square Road and bisecting Auburn Road in the southwest quadrant of the township (See **Figure 2**). As of the publication of this ERI, about 2,240 of Weatherby’s housing units have been built.

The township’s population grew by 29 percent in the 1980s in response to this new development, and then increased more rapidly in the following decades, by 108 percent in the 1990s and by 236 percent in the 2000s. Between 2000 and 2010, Woolwich was the fastest-growing township in Gloucester County and in New Jersey.

Over the past several decades, Woolwich Township has become home to people from increasingly varied ethnic and social backgrounds. Residents hold a diverse set of occupations reflecting local and regional service and light manufacturing economies, though the township still supports an active farming community.

Many residents commute throughout the tri-state region for employment and for other basic services, making the township a residential community for the more urbanized portions of southern New Jersey.

In the mid-2000s, in response to the significant changes that this population increase brought, the township began expanding its programs to protect its open space, agricultural lands, natural resources, and historically quieter, more rural character. In 2008, the township was among the first in the state to create a TDR program, which is a land preservation and smart growth strategy in which development rights associated with a parcel of land are transferred from a landowner to another entity, enabling land to be permanently protected from development and providing compensation to the landowner for that protection. This program has enabled Woolwich to substantially grow its acreage of protected farms. Woolwich's residents have voted to tax themselves to create a consistent funding stream to protect and steward township parks.

Woolwich has received a variety of recognitions for these initiatives. In 2017, the township was handed the Governor's Environmental Excellence Award, which is given annually to about 17 residents, businesses, institutions, or communities each year that have made significant contributions to environmental protection in New Jersey. Woolwich was chosen for its work preserving 917 acres of land within the first eight months of the year, bringing the township's total count of permanently preserved acreage to over 3,000 acres. Not resting on these laurels, Woolwich continues to strive for more protection and better stewardship of its environmental assets while also encouraging and managing growth and development of its built environment.

Land Use and Land Cover

Land cover is a description of the landscape on the Earth's surface, such as pavement, forest, or grasslands. Land use is a description of society's use of the land, such as commercial or residential. Using aerial photography, both DVRPC and NJDEP have mapped Woolwich's land use, and NJDEP has mapped Woolwich's land cover. DVRPC's most recent land use map is from 2015, and NJDEP's most recent land cover map is from 2012.

The NJDEP and DVRPC datasets overlap in some of the land use types tracked, but there are apparent differences in acreage between the two datasets. These differences are generally small, and depending on the land use in question, they may be explained by changes that happened in Woolwich between 2012 (NJDEP's year of analysis) and 2015 (DVRPC's year of analysis). Differences in acreage may also come from data gathering or analysis. For example, the time of year when each organization captured its aerials may result in the land showing more or less forest or shrub cover, each organization's methods for identifying or categorizing land use types from the aerials may vary, or different interpretations of the aerials could have led to differences between the two datasets.

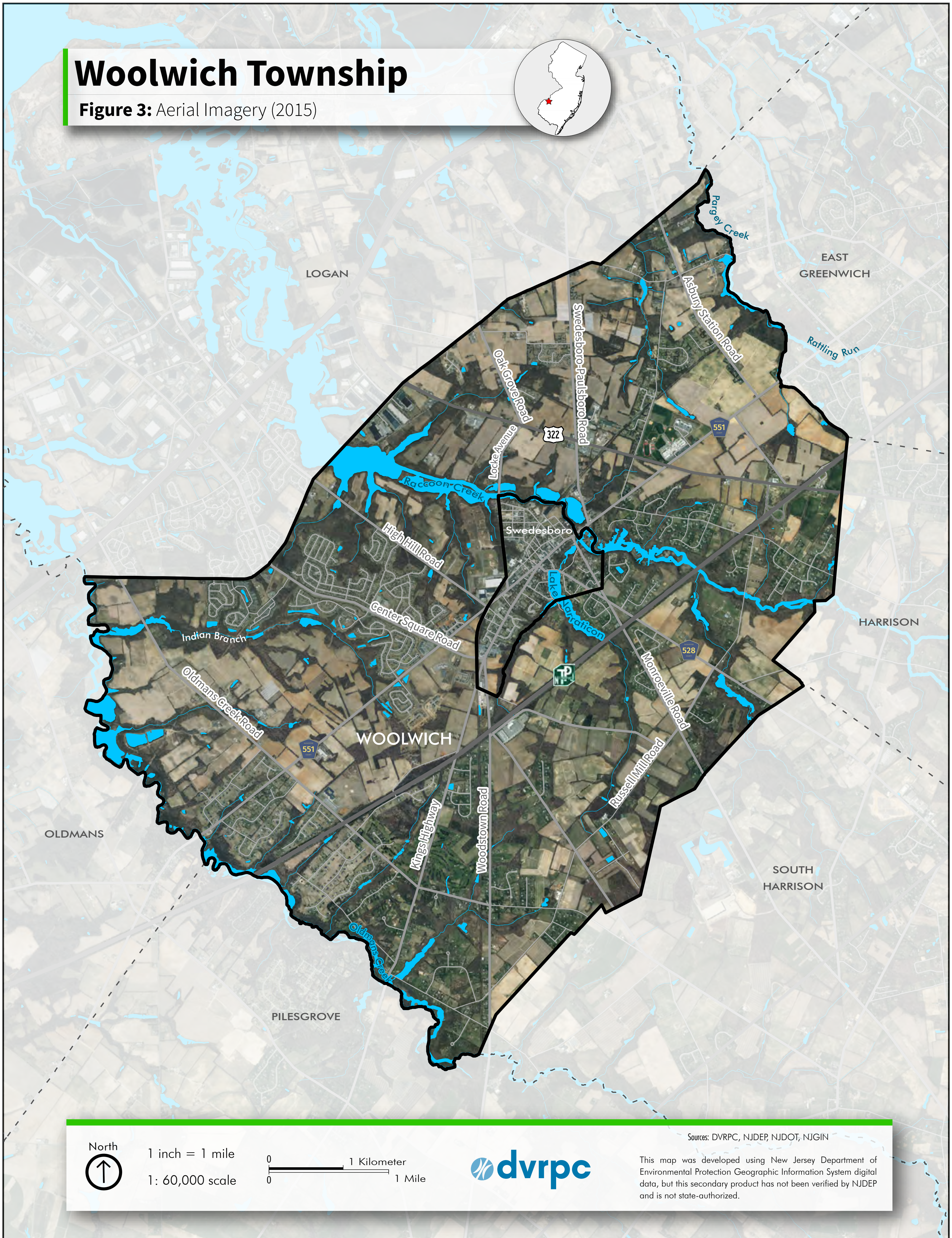
DVRPC Land Use Changes, 2000–2015

Every five years, DVRPC creates a new map of the land use in its nine-county planning region using aerial photography. The most recent aerials are from 2015, and **Figure 3: Aerial Imagery (2015)** shows the aerial map of Woolwich from that year. The corresponding land use map (**Figure 4: Land Use [2015]**) was developed soon after.

DVRPC has been mapping land use from its aerials since 1970, and the oldest version that has been digitized as a Geographic Information System (GIS) map is from 2000. Over the past four decades, land use classifications have changed, and it has become easier to identify and distinguish among land uses. However, especially between 2000 and 2015, the changes were minor enough that it is possible to observe trends in land use changes in Woolwich over the past 15 years.

Woolwich Township

Figure 3: Aerial Imagery (2015)

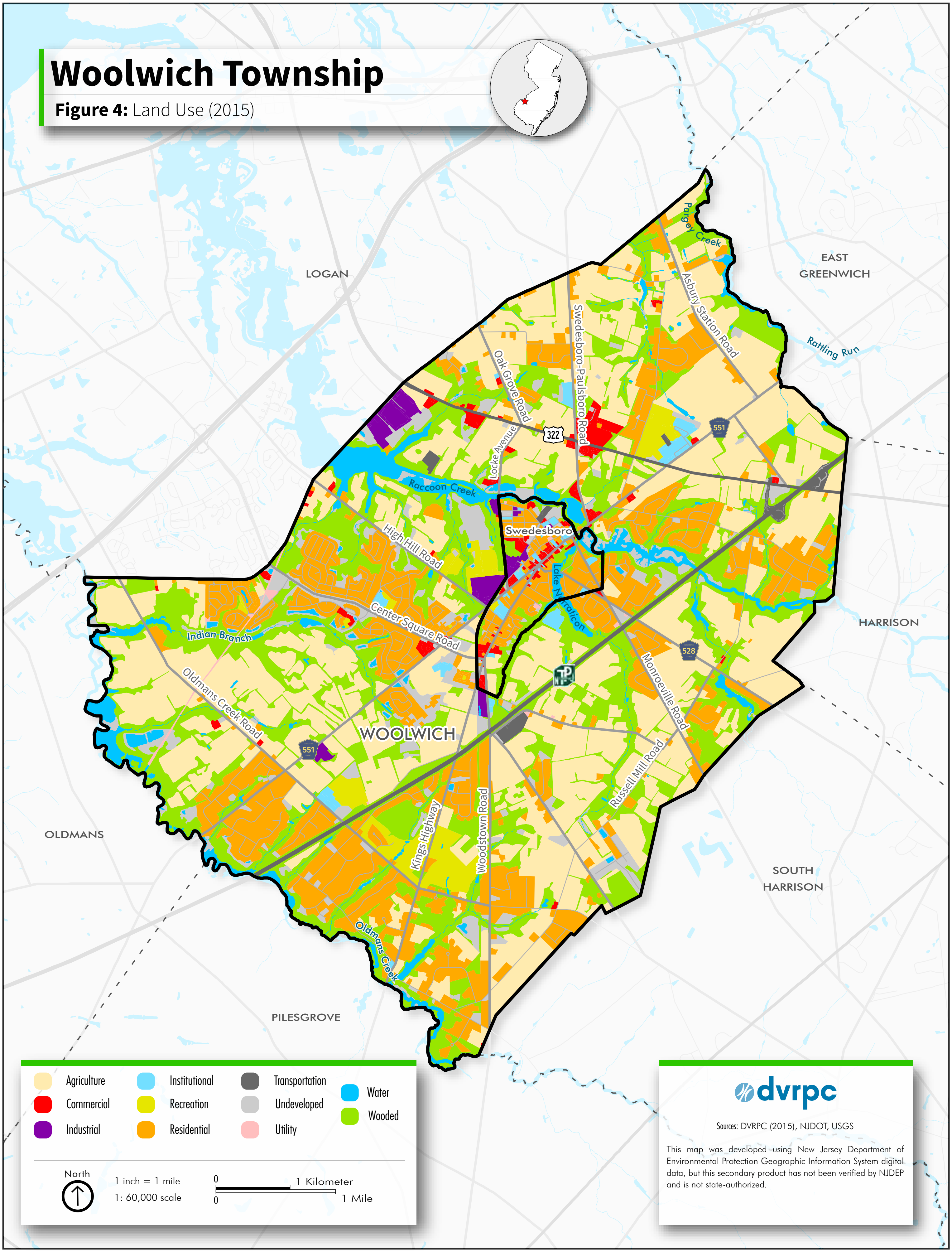


Sources: DVRPC, NJDEP, NJDOT, NJGIN

This map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state-authorized.

Woolwich Township

Figure 4: Land Use (2015)



dvrpc

Sources: DVRPC (2015), NJDOT, USGS

This map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state-authorized.

The two most notable changes visible between DVRPC's 2000 and 2015 land use datasets for Woolwich are the increase in residential land and the decrease in agricultural land (**Table 1: General Land Use Changes, 2000–2015**). During this time, DVRPC's analysis indicated that agricultural land decreased by about 30 percent, from about 7,670 acres to about 5,360 acres. Over the same time, the analysis indicated that residential land increased by about 76 percent, from about 1,560 acres to 2,750 acres. There is a direct connection between these changes: housing was constructed on agricultural land to accommodate population growth in the township.

Table 1: General Land Use Changes, 2000–2015

Land Use	Acreage (2000)	Percentage of Total Land (2000)	Acreage (2015)	Percentage of Total Land (2015)
Agriculture	7,668.83	56.14%	5,358.65	39.18%
Commercial	187.60	1.37%	148.55	1.09%
Industrial	111.58	0.82%	113.65	0.83%
Institutional	89.00	0.65%	89.68	0.66%
Recreation	185.84	1.36%	328.67	2.40%
Residential	1,555.59	11.39%	2,751.65	20.12%
Transportation	125.89	0.92%	144.82	1.06%
Undeveloped	311.49	2.28%	750.51	5.49%
Utility	2.42	0.02%	31.79	0.23%
Water	327.41	2.40%	478.32	3.50%
Wooded	3,094.10	22.65%	3,482.24	25.4%
Total	**13,659.74**	**100%**	**13,678.53**	**100%**

Source: DVRPC, 2000, 2015

The majority of DVRPC's land use types are intuitive, but a less familiar one is undeveloped land. DVRPC generally defines this land use classification as open space that is vacant, cleared, or in a natural state that is not wooded and is not connected to another use. In residential areas, undeveloped land includes undeveloped parcels in older subdivisions that are not owned by an adjacent landowner, or in newer subdivisions where construction has been halted or has completed.

NJDEP Land Use and Land Cover, 2012

Unlike DVRPC's dataset, NJDEP's land use dataset depicts land use and land cover characteristics (**Figure 5: Land Use/Land Cover [2012]**). NJDEP also divides broad groups of land use/land cover into detailed classes. **Table 2: General Land Use/Land Cover (2012)** and **Table 3: Detailed Land Use/Land Cover (2012)** list the land use/land cover classes in Woolwich, and are organized in both charts by alphabetical order. The key following **Table 3** contains definitions for select land use/land cover groups and classes.

Woolwich Township

Figure 5: Land Use/Land Cover (2012)

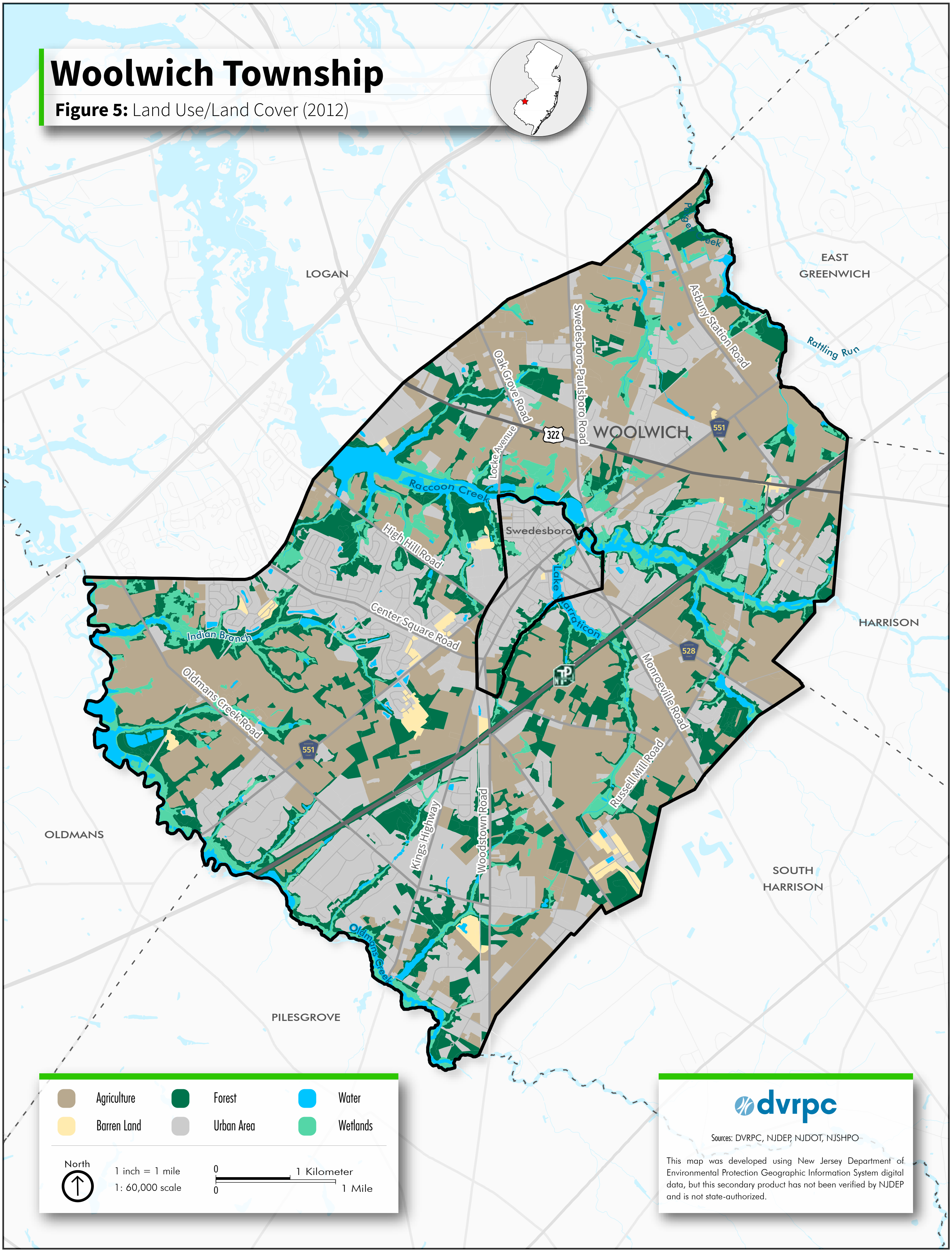


Table 2: General Land Use/Land Cover (2012)

Land Use	Area (Acres)	Percent
Agriculture	5,405.15	39.52
Barren Land	161.99	1.18
Forest	2,365.23	17.29
Urban	4,082.62	29.85
Water	418.92	3.06
Wetlands	1,244.32	9.10
Total	**13,678.23**	

Source: NJDEP, 2012

NJDEP's analysis of its aerials indicates that the most common general land use/land cover type in Woolwich is agricultural land, which makes up about 40 percent of the township's total land use/land cover. Cropland and pastureland makes up the majority of agricultural land, at 5,070 acres, or about 37 percent of the township's total land use/land cover (**Table 3**). Urban lands are also well represented in Woolwich, comprising about 30 percent of the township's total land use/land cover. Urban lands are lands that have been developed, and they may contain homes, businesses, industrial sites, roads, railroads, athletic fields, or other structures or human influence. Land with rural single-unit dwellings, a class of residential land, makes up the majority of Woolwich's urban land: 1,904 acres, or about 14 percent of Woolwich's total land use/land cover. About 2 percent of the township's land use/land cover is devoted to recreational land and school athletic fields, and about 2 percent is commercial or industrial.

Undeveloped lands, which here include the forest and wetlands categories, make up 26 percent of Woolwich's land (about 17 percent and 9 percent, respectively). Much of Woolwich's forest land is located along its streams, although there are forested parcels scattered through the township's upland areas as well. Deciduous upland habitat, including trees, brush, and shrubs, occurs more frequently than coniferous upland habitat. Deciduous upland habitat accounts for about 13 percent of total land use/land cover, while coniferous upland habitat accounts for about 0.70 percent of total land use/land cover.

Deciduous plant species are also common in Woolwich's wetlands; deciduous scrub/shrub wetlands and wooded wetlands together make up about 7 percent of the township's land use/land cover. Freshwater tidal marshes, the second most common wetland type, make up about 1 percent of total land use/cover. Open water is present throughout the township, which contains several creeks, but water makes up only about 3 percent of the township's total land use/land cover. The majority of water in the township is in tidal streams and artificial lakes.

Within the broader land use/land cover categories listed in **Table 2**, NJDEP identified 58 distinct land use and land cover types for Woolwich. These categories are listed in **Table 3**. Some of these land use/land cover types may be unfamiliar and require definition. The text box under **Table 3** on page 16 is a key for unfamiliar terms in that table.

Table 3: Detailed Land Use/Land Cover (2012)

General Land Use/Land Cover Class	Land Use Group	Detailed Land Use/Land Cover Class	Area (Acres)	Percent
Agriculture	Agricultural Upland	Cropland and Pastureland	5,070.53	37.07%
Agriculture	Agricultural Upland	Orchards/Vineyards/Nurseries/ Horticultural Areas	70.13	0.51%
Agriculture	Agricultural Upland	Other Agriculture	264.48	1.93%
Barren Land	Altered, Mixed, or Other Urban Land	Transitional Areas	136.23	1.00%
Barren Land	Altered, Mixed, or Other Urban Land	Extractive Mining	25.76	0.19%
Forest	Undeveloped Uplands: Brush/Shrubland	Coniferous Brush/Shrubland	25.43	0.19%
Forest	Undeveloped Uplands: Deciduous, Coniferous, or Mixed Forest	Coniferous Forest (>50% Crown Closure)	19.85	0.15%
Forest	Undeveloped Uplands: Deciduous, Coniferous, or Mixed Forest	Coniferous Forest (10-50% Crown Closure)	18.98	0.14%
Forest	Undeveloped Uplands: Brush/Shrubland	Deciduous Brush/Shrubland	151.92	1.11%
Forest	Undeveloped Uplands: Deciduous, Coniferous, or Mixed Forest	Deciduous Forest (>50% Crown Closure)	1,280.08	9.36%
Forest	Undeveloped Uplands: Deciduous, Coniferous, or Mixed Forest	Deciduous Forest (10-50% Crown Closure)	239.49	1.75%
Forest	Undeveloped Uplands: Brush/Shrubland	Mixed Deciduous/Coniferous Brush/Shrubland	255.89	1.87%
Forest	Undeveloped Uplands: Deciduous, Coniferous, or Mixed Forest	Mixed Forest (>50% Coniferous with >50% Crown Closure)	17.41	0.13%
Forest	Undeveloped Uplands: Deciduous, Coniferous, or Mixed Forest	Mixed Forest (>50% Coniferous with 10-50% Crown Closure)	12.24	0.090%
Forest	Undeveloped Uplands: Deciduous, Coniferous, or Mixed Forest	Mixed Forest (>50% Deciduous with >50% Crown Closure)	38.37	0.28%
Forest	Undeveloped Uplands: Deciduous, Coniferous, or Mixed Forest	Mixed Forest (>50% Deciduous with 10-50% Crown Closure)	31.52	0.23%
Forest	Undeveloped Uplands: Brush/Shrubland	Old Field (< 25% Brush Covered)	258.82	1.89%

General Land Use/Land Cover Class	Land Use Group	Detailed Land Use/Land Cover Class	Area (Acres)	Percent
Forest	Undeveloped Uplands: Deciduous, Coniferous, or Mixed Forest	Phragmites Dominate Old Field	10.59	0.077%
Forest	Undeveloped Uplands: Deciduous, Coniferous, or Mixed Forest	Plantation	4.66	0.034%
Urban	Public Open Space: Recreational Land	Athletic Fields (Schools)	80.42	0.59%
Urban	Public Open Space: Cemetery	Cemetery	29.36	0.21%
Urban	Commercial/Services	Commercial/Services	176.61	1.29%
Urban	Industrial	Industrial	114.63	0.84%
Urban	Transportation/Communication/ Utilities	Major Roadway	86.85	0.63%
Urban	Transportation/Communication/ Utilities	Mixed Transportation Corridor Overlap Area	0.13	0.0010%
Urban	Altered, Mixed, or Other Urban Land	Other Urban or Built-Up Land	436.99	3.19%
Urban	Transportation/Communication/ Utilities	Railroads	26.90	0.20%
Urban	Public Open Space: Recreational Land	Recreational Land	221.13	1.62%
Urban	Residential: High Density	Residential, High Density or Multiple Dwelling	152.74	1.12%
Urban	Residential: Low-Medium Density	Residential, Rural, Single Unit	1,904.38	13.92%
Urban	Residential: Low-Medium Density	Residential, Single Unit, Low Density	326.27	2.39%
Urban	Residential: Low-Medium Density	Residential, Single Unit, Medium Density	327.92	2.40%
Urban	Altered, Mixed, or Other Urban Land	Stormwater Basin	127.37	0.93%
Urban	Transportation/Communication/ Utilities	Transportation/Communication/	48.57	0.36%
Urban	Altered, Mixed, or Other Urban Land	Upland Rights-of-Way Undeveloped	10.18	0.074%

General Land Use/Land Cover Class	Land Use Group	Detailed Land Use/Land Cover Class	Area (Acres)	Percent
Urban	Commercial/Services	No Longer Military	1,904.38	13.92%
Water	Water	Artificial Lakes	138.49	1.01%
Water	Water	Bridge Over Water	0.54	0.0040%
Water	Water	Tidal Mud Flat	22.96	0.17%
Water	Water	Tidal Rivers, Inland Bays, and Other Tidal Waters	239.28	1.75%
Water	Water	Natural Lakes	1.11	0.0081%
Water	Water	Streams and Canals	16.53	0.12%
Wetlands	Wetlands: Disturbed or Managed	Agricultural Wetlands (Modified)	76.06	0.56%
Wetlands	Wetlands: Containing Typical Species	Deciduous Scrub/Shrub Wetlands	180.62	1.32%
Wetlands	Wetlands: Containing Typical Species	Deciduous Wooded Wetlands	743.38	5.43%
Wetlands	Wetlands: Disturbed or Managed	Disturbed Wetlands (Modified)	3.14	0.023%
Wetlands	Wetlands: Disturbed or Managed	Former Agricultural Wetland (Becoming Shrubby, Not Built-Up)	6.45	0.05%
Wetlands	Wetlands: Containing Typical Species	Freshwater Tidal Marshes	130.60	0.95%
Wetlands	Wetlands: Containing Typical Species	Herbaceous Wetlands	45.73	0.33%
Wetlands	Wetlands: Disturbed or Managed	Managed Wetland in Maintained Lawn Greenspace	2.73	0.02%
Wetlands	Wetlands: Containing Typical Species	Mixed Scrub/Shrub Wetlands (Coniferous Dominant)	0.72	0.0052%
Wetlands	Wetlands: Containing Typical Species	Mixed Scrub/Shrub Wetlands (Deciduous Dominant)	13.72	0.10%
Wetlands	Wetlands: Containing Typical Species	Mixed Wooded Wetlands (Deciduous Dominant)	2.21	0.016%

General Land Use/Land Cover Class	Land Use Group	Detailed Land Use/Land Cover Class	Area (Acres)	Percent
Wetlands	Wetlands: Disturbed or Managed	Phragmites Dominate Coastal Wetlands	16.36	0.12%
Wetlands	Wetlands: Disturbed or Managed	Phragmites Dominate Interior Wetlands	17.15	0.13%
Wetlands	Wetlands: Disturbed or Managed	Phragmites Dominate Urban Area	1.65	0.012%
Wetlands	Wetlands: Disturbed or Managed	Wetland Rights-of-Way	3.80	0.028%
Total			**13,678.23**	

Source: NJDEP, 2012

Selected Land Use/Land Cover Definitions with Reference to Table 3

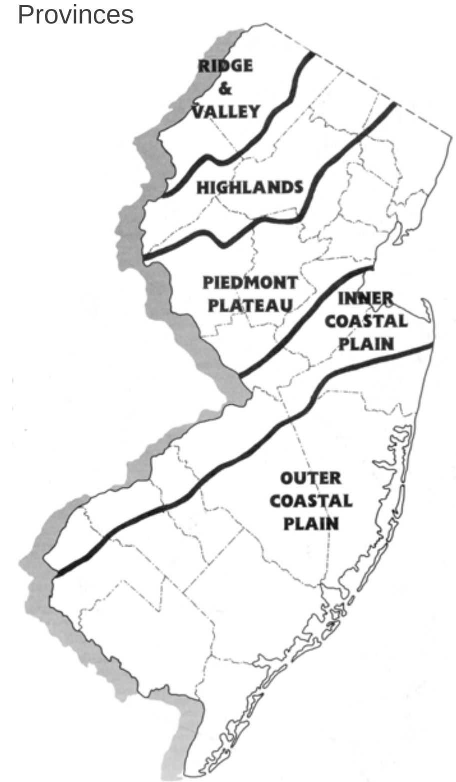
Undifferentiated Barren Lands: Cleared lands that have no apparent site preparation or indication of past activities.
Old Fields: Unused fields that contain an amount of brush cover that requires extensive brush removal before plowing.
Upland Rights-of-Way, Undeveloped Lands: Upland (not wetland) utility rights-of-way that exist in undeveloped non-urban areas. These areas may not support the typical natural vegetation found in adjacent unaltered natural areas.
Mixed Transportation Overlap Areas: Places where railroads and roads intersect, including at-grade crossings as well as railroad and road bridges.
Disturbed Wetlands (Modified): Former natural wetlands that have been altered by human activity, but which still exhibit signs of soil saturation. Because of the alterations, these areas do not generally support typical wetland vegetation and may be unvegetated.
Other Agriculture: Miscellaneous agricultural areas, including experimental fields, horse farms and isolated dikes and access roads.
Transitional Areas: Lands on which site preparation has begun but the future land use has not been realized. These areas are usually sparsely vegetated.
Plantation: Artificially planted conifer stands.
Other Urban or Built-Up Land: Included are undeveloped, open lands within, adjacent to, or associated with urban areas.

Physiography and Geology

Geography and geology, along with soils and water resources, are physical resources: the nonliving features on which Woolwich Township residents rely for a stable built environment and sustenance.

Physiography is the study of a location in relation to its underlying geology. New Jersey is characterized by four physiographic provinces (**Figure 6**). These provinces include the Ridge and Valley Province, the Highlands Province, the Piedmont Plateau Province, and the Coastal Plain Province. The Coastal Plain Province is further subdivided into the Inner Coastal Plain and the Outer Coastal Plain. The terrain of the four provinces is very diverse, with the rocky terrain of the northern provinces at one extreme and the sands of the coast at the other.

Figure 6: New Jersey's Physiographic Provinces



Source: NJGS

Woolwich Township is located entirely within the Inner Coastal Plain, just to the west of the hills that separate the Inner Coastal Plain from the Outer Coastal Plain that extends north and east to the Atlantic Ocean. In New Jersey, the Inner Coastal Plain is made up of interbedded sand and clay. Deposits originating in the breakdown of Appalachian and Catskill sedimentary, metamorphic, and igneous rocks are interbedded with layers formed by oceanic (marine) deposition, which occurred as the ocean shoreline advanced and receded over geologic time. The Inner Plain layers date from the Cretaceous Period, 135 to 65 million years ago. Generally, soils of the Inner Coastal Plain are quite fertile, and the topography of the area is mostly flat and low-lying.

Geologic Formations

Woolwich Township contains nine underlying geologic formations that run roughly southeast to northwest and extend beyond the borders of the township. They are visible in the **Figure 7: Geology**. They are also described in **Table 4: Geologic Formations in Woolwich Township** and are organized from the most recently formed (top of table) to the oldest (bottom of table). Aquifers containing groundwater that supports the region's farms, industries, businesses, and residents are located between these geological formations and are discussed in the **Groundwater** section (page 70).

Woolwich Township

Figure 7: Geology

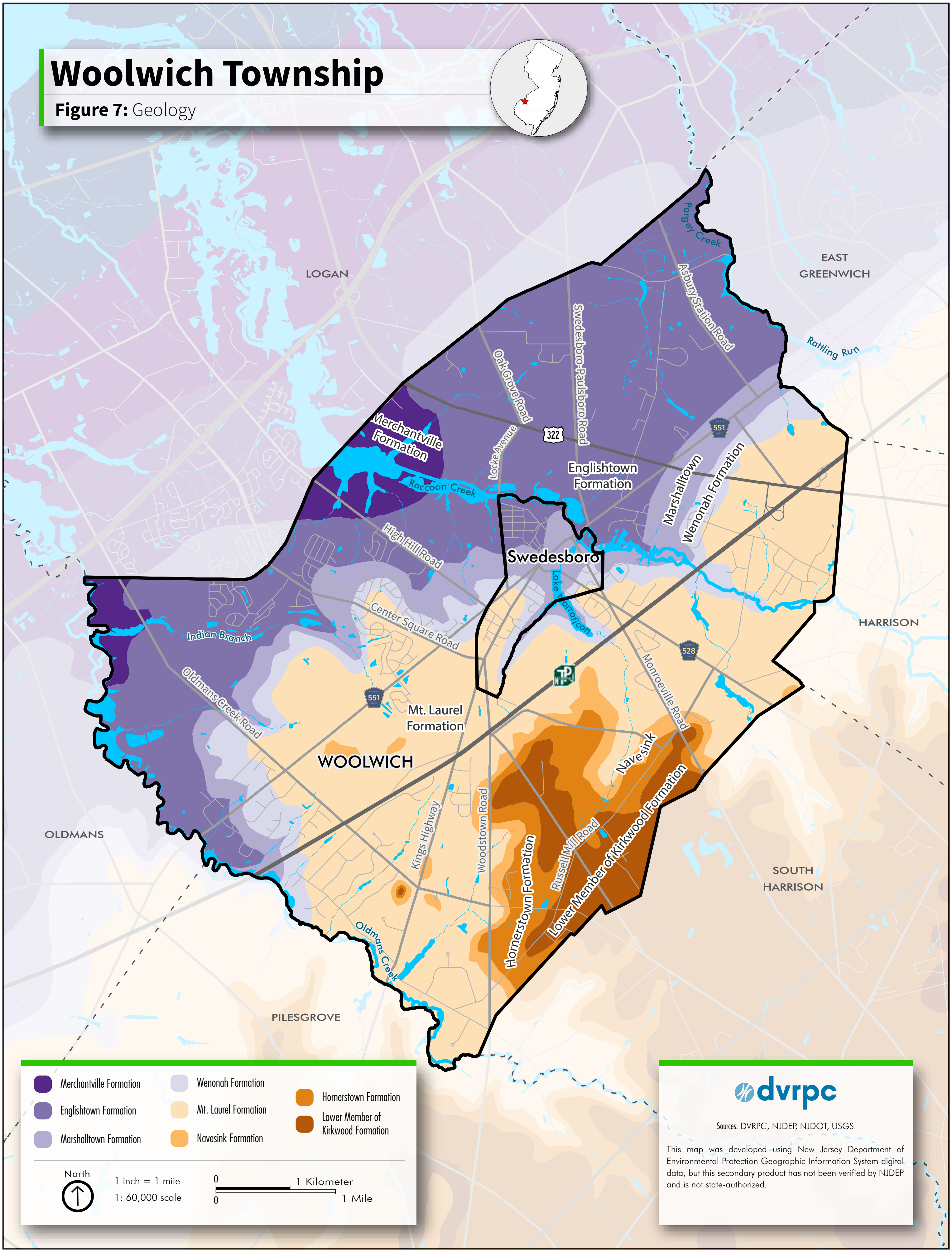


Table 4: Geologic Formations in Woolwich Township

Geologic Name	Abbreviation	Physiographic Province	Lithology	Geologic Age
Lower Member of Kirkwood Formation	Tkw	Coastal Plain	Quartz sand, fine to very fine-grained, micaceous, with thin beds of silt and clay	Tertiary: Miocene
Hornerstown Formation	Tht	Coastal Plain	Primarily fine- to medium-grained glauconite sand	Tertiary: Paleocene
Navesink Formation	Kns	Coastal Plain	Glauconite clayey sand, composed mainly of quartz, feldspar, and mica.	Late Cretaceous: Maastrichtian
Mount Laurel Formation	Kml	Coastal Plain	Quartz sand, fine- to coarse-grained, slightly glauconitic	Late Cretaceous: Campanian
Wenonah Formation	Kw	Coastal Plain	Quartz sand, fine-grained, silty, clayey micaceous	Late Cretaceous: Campanian
Marshalltown Formation	Kmt	Coastal Plain	Quartz and glauconite sand, silty, and clayey	Late Cretaceous: Campanian
Englishtown Formation	Ket	Coastal Plain	Quartz sand, fine- to coarse-grained, locally interbedded with thin- to thick beds of clay	Late Cretaceous: Campanian
Merchantville Formation	Kmv	Coastal Plain	Glauconite sand to quartz-glauconite sand, clayey and silty	Late Cretaceous: Campanian

Source: NJGS, 2009 Soils

Soils

Soil is the foundation for all land uses. Soil types vary in their physical, chemical, and biological properties, influencing the vegetation and development potential of a region. Soil properties also affect the location of wells and septic facilities, often determining development potential in certain areas. Soil is a natural resource that cannot be replenished on the human time scale.

Data on soil types derives from surveys conducted by the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS). The Gloucester County Department of Health and Senior Services tests soil properties and checks soil types for county property owners, and the Soil Testing

Laboratory at the Rutgers New Jersey Agricultural Experiment Station (NJAES) tests soil properties for residents throughout New Jersey. The Cooperative Extension of Gloucester County sells soil testing kits.

Septic Suitability

Soil type is a major determining factor in planning for the location of septic systems. A variety of negative community impacts can occur if a septic system is constructed in soils with low infiltration rates, steep slopes, or high water tables; or in areas that flood. These impacts may include contamination of groundwater, potentially leading to contamination of drinking water and pollution of nearby surface water, foul odors from unfiltered effluent, toilet and septic system failure, and high costs to property owners from installing and maintaining home disposal systems.

Agricultural Soils

Woolwich's soils are very rich in agricultural value and are among the finest, most productive soils in New Jersey. Woolwich historically was supported by its agricultural industry, and there are numerous active farms in the township today. Soils in the township support the growth of field crops (**Figure 8**), including corn, soy beans, tomatoes, squash, pumpkin, peppers, asparagus, and eggplant.

Figure 8: Corn Crops with Decorative Pumpkins in Woolwich Township

Source: Matt Blake

About 79 percent of Woolwich's soils are suitable for agriculture because of their slope, drainage rates, saturation, and chemical makeup. About 54 percent of the township's soils, located throughout the township, are considered Prime Farmland. Soils defined as Prime Farmland have the best combination of physical and chemical characteristics for producing high yields of crops. They do not substantially erode, are not saturated with water for long periods of time, and do not flood frequently.

About 22 percent of soils in Woolwich are defined as Farmland of Statewide Importance, and are slightly less conducive to crop production. However, they may still sustain high yields, sometimes matching those grown in Prime Farmland soil, when managed well and under favorable environmental conditions. Each state defines this category, and in New Jersey, Farmland of Statewide Importance includes soils that do not meet Prime Farmland criteria and have a Soil Capability Class of two ("moderate limitations that restrict the choice of plants or that require moderate conservation practices;" see **Table 5: Agricultural Soils**) or three ("severe limitations that restrict the choice of plants or that require special conservation practices, or both"). Like Woolwich's Prime Farmland soils, these soils are located throughout the township. Often, they are close, though generally not adjacent, to streams.

Woolwich Township also includes soils that fit under the category of Farmland of Unique Importance. These soils make up about 3 percent of the total found in the township. While these soil types do not share the conventional characteristics of prime soil, they have some combination of temperature, humidity, drainage, elevation, aspect, or locational characteristics that allow for successful growth and sale of a specialty crop, such as blueberries or cranberries.

In Woolwich Township, these soils are adjacent to tidal streams, most notably Oldmans Creek and Raccoon Creek. The remaining 21 percent of soils in Woolwich are classified as Other Soils and are not considered suitable for farming. They are typically highly saturated, have steep slopes, have been urbanized or otherwise disturbed, or do not have a chemical makeup that would facilitate the growth of crops.

The distribution of agricultural soils in Woolwich Township is listed in **Table 5: Agricultural Soils** and mapped in **Figure 9: Agricultural Soils (2010)**.

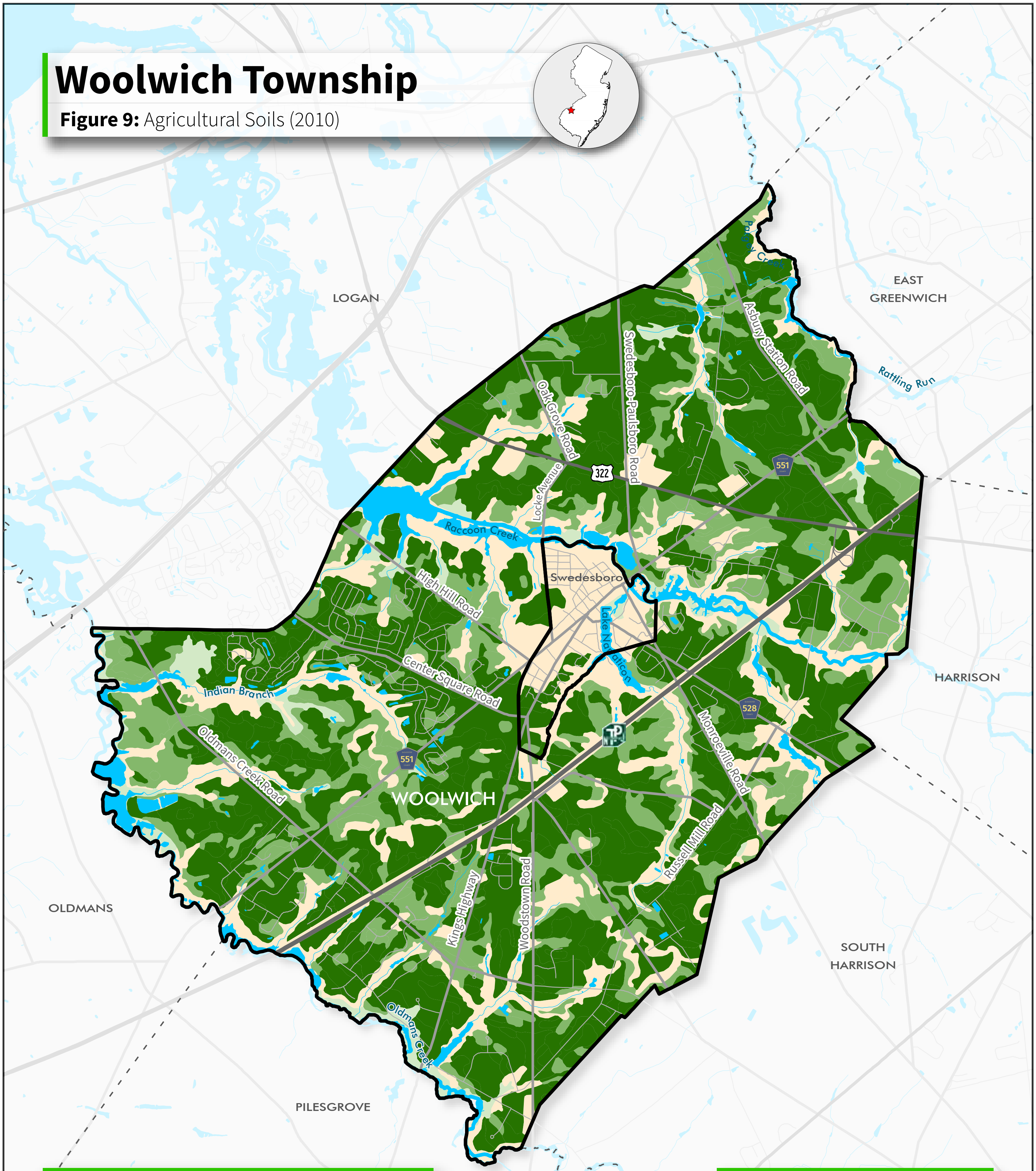
Table 5: Agricultural Soils

Soil Classification	Acreage	Percentage
Prime Farmland	7,361.78	53.90%
Farmland of Statewide Importance	2,988.75	21.88%
Farmland of Unique Importance	450.71	3.30%
Other Soils	2,857.37	20.92%
Total	**13,658.61**	

Source: NRCS, 2010

Woolwich Township

Figure 9: Agricultural Soils (2010)



Prime Farmland

Farmland of Unique Importance

Farmland of Statewide Importance

Other Soils

North

1 inch = 1 mile

1: 60,000 scale

0 1 Kilometer

0 1 Mile

dvrpc

Sources: DVRPC, NJDEP, NJDOT, USGS

This map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state-authorized.

Soil Types

Woolwich Township contains 67 soils identified by the Soil Conservation Service (not including the classification "Water"). All of the soil series and phases (subtypes) are mapped in **Figure 10: Soils**. The most common soil series in Woolwich are briefly described below.

Freehold Series

Forty-nine percent of Woolwich soils are a variation of the Freehold series. These soils formed from sandy marine deposits, are mostly gently sloping, and are well-drained. Around streambeds, these soils may be steeply sloping. Freehold soils occur in close association with Collington, Colts Neck, Marlton, Westphalia, Woodstown, and Dragston soils. With low to moderate natural fertility, these soils are easily worked for agricultural production. They are well-suited to many different vegetable crops and can support various seasonal crops, as the variations of soils warm at different times of the year. Different variations of soil are also well-suited to support upland forests of oaks and poplar and provide high-quality wildlife habitat.

Marlton Series

Marlton soils, which make up 9 percent of Woolwich's soils, are well-drained and are found on both gentle and steep slopes or adjacent to streams. These soils are moderately fertile and high in potassium, although that nutrient is not readily available for plants. They occasionally hold large amounts of water during wet seasons, which makes them unsuitable for early and late planting seasons.

Fluvaquent Series

Fluvaquents make up 6 percent of Woolwich soils and are found along the township's waterways. These soils are formed from *alluvium*, material deposited from different kinds of soils and geologic materials by streams that flow to the Delaware River. Most areas of alluvial land have large amounts of organic matter, and groundwater is close to the surface.

Colts Neck Series

Six percent of Woolwich soils are a part of the Colts Neck series. These well-drained soils occur around and in the Borough of Swedesboro. They occur in association with Freehold soils. Occasionally, ironstone can be found in the soil sub-surface layers, which deters cultivation. Colts Neck soils are well-drained and moderately fertile. The soils retain moisture and are moderately permeable, and are therefore well-suited to fruits and vegetables.

Woodstown Series

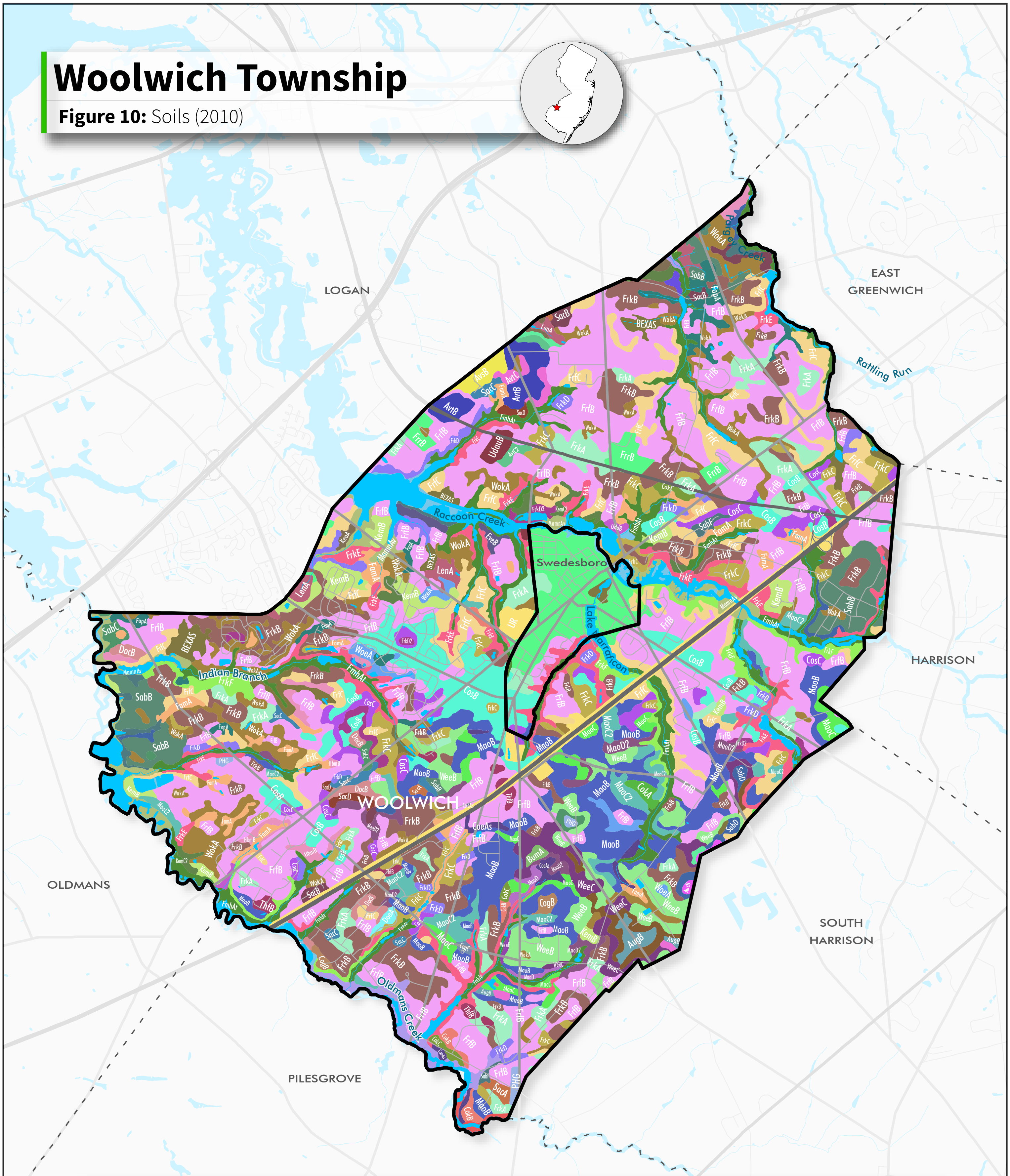
Variations of the Woodstown Series make up over slightly less than 5 percent of Woolwich Township. Historically, these soils have supported oak, beech, poplar, and pitch pine forests. This series is closely associated with Aura, Downer, Freehold and other soils, except that Woodstown is not well-drained. These soils occur on terraces along streams and in beds of gravel, where cultivation is hampered by saturated conditions.

Table 6: Soils provides basic information on these five soils and the others found in Woolwich Township, as well as their suitability for agriculture ("Soil Capability Class") and for development ("Development Capability"). The Soil Capability Class was developed by the USDA to determine the best agricultural use of lands by classifying and mapping erosion rates and potential in relation to both physical characteristics and agricultural capacity.

See the key following **Table 6** (page 32) for an explanation of the codes associated with Soil Capability Class and Development Capability.

Woolwich Township

Figure 10: Soils (2010)



North

1 inch = 1 mile

1: 60,000 scale

0 1 Kilometer

0 1 Mile

dvrpc

Sources: DVRPC, NJDEP, NJDOT

This map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state-authorized.

Table 6: Soils

Soil Code	Soil Name (Phase)	Acreage	Soil Capability Class	Development Capability		
				Building Without Basement	Building With Basement	Small Commercial
AucB	Aura loamy sand, 0 to 5 percent slopes	9.17	3s	B	A	B
AugB	Aura sandy loam, 2 to 5 percent slopes	37.15	2e	B	A	B
AvsB	Aura-Sassafras loamy sands, 0 to 5 percent slopes	36.71	Aura: 3s Sassafras: 2e	Aura: B Sassafras: A	A	Aura: B Sassafras: A
AvsC	Aura-Sassafras loamy sands, 5 to 10 percent slopes	10.47	Aura: 4e Sassafras: 3e	Aura: B Sassafras: A	A	B
AvtB	Aura-Sassafras sandy loams, 2 to 5 percent slopes	98.51	Aura: 2s Sassafras: 2e	Aura: B Sassafras: A	A	Aura: B Sassafras: A
AvtC	Aura-Sassafras sandy loams, 5 to 10 percent slopes	36.37	3e	Aura: B Sassafras: A	A	B
AvtC2	Aura-Sassafras sandy loams, 5 to 10 percent slopes, eroded	20.44	3e	Aura: B Sassafras: A	A	B
BEXAS	Berryland and Mullica soils, 0 to 2 percent slopes, occasionally flooded	157.55	Berryland: 5w Mullica: 4w	C	C	C
BumA	Buddtown-Deptford complex, 0 to 2 percent slopes	9.70	Buddtown: 2w Deptford: 3w	Buddtown: A Deptford: C	C	Buddtown: A Deptford: C

Soil Code	Soil Name (Phase)	Acreage	Soil Capability Class	Development Capability		
				Building Without Basement	Building With Basement	Small Commercial
ChsAt	Chicone silt loam, 0 to 1 percent slopes, frequently flooded	21.13	5w	C	C	C
CoeAs	Colemantown loam, 0 to 2 percent slopes, occasionally flooded	47.96	3w	C	C	C
CogB	Collington loamy sand, 0 to 5 percent slopes	22.69	2s	B	A	B
CogC	Collington loamy sand, 5 to 10 percent slopes	5.37	3s	B	A	B
CokA	Collington sandy loam, 0 to 2 percent slopes	16.53	1	B	A	B
CokB	Collington sandy loam, 2 to 5 percent slopes	35.22	2e	A	A	B
CokC	Collington sandy loam, 5 to 10 percent slopes	30.13	3e	A	A	C
CosB	Colts Neck sandy loam, 2 to 5 percent slopes	562.03	2s	A	A	A
CosC	Colts Neck sandy loam, 5 to 10 percent slopes	226.85	3e	A	A	B

Soil Code	Soil Name (Phase)	Acreage	Soil Capability Class	Development Capability		
				Building Without Basement	Building With Basement	Small Commercial
DocB	Downer loamy sand, 0 to 5 percent slopes	58.62	2e	A	A	A
DoeA	Downer sandy loam, 0 to 2 percent slopes	10.43	1	A	A	A
EveB	Evesboro sand, 0 to 5 percent slopes	26.35	7s	A	A	A
FamA	Fallsington sandy loam, 0 to 2 percent slopes	222.63	Undrained: 5w Drained: 3w	C	C	C
FapA	Fallsington loam, 0 to 2 percent slopes	126.96	Undrained: 5w Drained: 3w	C	C	C
FauB	Fallsington-Urban land complex, 0 to 5 percent slopes	0.01	Fallsington: 3w Urban: 8s	Fallsington: C Urban: Not rated	Fallsington: C Urban: Not rated	Fallsington: C Urban: Not rated
FmhAt	Fluvaquents, loamy, 0 to 3 percent slopes, frequently flooded	805.27	5w	C	C	C
FrfB	Freehold loamy sand, 0 to 5 percent slopes	3019.32	2s	A	A	A
FrfC	Freehold loamy sand, 5 to 10 percent slopes	714.19	3e	A	A	B
FrkA	Freehold sandy loam, 0 to 2 percent slopes	433.30	1	A	A	A
FrkB	Freehold sandy loam, 2 to 5 percent slopes	1117.40	2e	A	A	A

Soil Code	Soil Name (Phase)	Acreage	Soil Capability Class	Development Capability		
				Building Without Basement	Building With Basement	Small Commercial
FrkC	Freehold sandy loam, 5 to 10 percent slopes	362.00	3e	A	A	B
FrkD	Freehold sandy loam, 10 to 15 percent slopes	166.60	4e	B	B	C
FrkD2	Freehold sandy loam, 10 to 15 percent slopes, eroded	64.96	4e	B	B	C
FrkE	Freehold sandy loam, 15 to 25 percent slopes	501.67	6e	C	C	C
FrkF	Freehold sandy loam, 25 to 40 percent slopes	188.70	7e	C	C	C
FrrB	Freehold-Urban land complex, 0 to 5 percent slopes	424.05	Freehold: 2s Urban: 8s	Freehold: A Urban: Not rated	Freehold: A Urban: Not rated	Freehold: A Urban: Not rated
HbmB	Hammonton loamy sand, 0 to 5 percent slopes	81.87	2w	A	C	A
KemB	Keyport sandy loam, 2 to 5 percent slopes	191.82	2e	B	C	B
KemC2	Keyport sandy loam, 5 to 10 percent slopes, eroded	67.51	3e	B	C	B
KeoA	Keyport loam, 0 to 2 percent slopes	18.27	2w	B	C	B

Soil Code	Soil Name (Phase)	Acreage	Soil Capability Class	Development Capability		
				Building Without Basement	Building With Basement	Small Commercial
KeuB	Keyport-Urban land complex, 0 to 5 percent slopes	6.90	Keyport: 2e Urban: 8s	Keyport: B Urban: Not rated	Keyport: C Urban: Not rated	Keyport: B Urban: Not rated
LenA	Lenni loam, 0 to 2 percent slopes	67.49	4w	C	C	C
MakAt	Manahawkin muck, 0 to 2 percent slopes, frequently flooded	94.65	7w	C	C	C
MamnAv	Mannington-Nanticoke complex, 0 to 1 percent slopes, very frequently flooded	210.31	8w	C	C	C
MaoB	Marlton sandy loam, 2 to 5 percent slopes	766.10	2e	B	C	B
MaoC	Marlton sandy loam, 5 to 10 percent slopes	146.28	3e	B	C	B
MaoC2	Marlton sandy loam, 5 to 10 percent slopes, eroded	227.72	3e	B	C	B
MaoD	Marlton sandy loam, 10 to 15 percent slopes	20.69	4e	B	C	C
MaoD2	Marlton sandy loam, 10 to 15 percent slopes, eroded	119.79	4e	B	C	C
PHG	Pits, sand and gravel	20.82	8s	Not rated	Not rated	Not rated

Soil Code	Soil Name (Phase)	Acreage	Soil Capability Class	Development Capability		
				Building Without Basement	Building With Basement	Small Commercial
SabB	Sassafras loamy sand, 0 to 5 percent slopes	290.88	2e	A	A	A
SabC	Sassafras loamy sand, 5 to 10 percent slopes	39.82	3e	A	A	B
SabD	Sassafras loamy sand, 10 to 15 percent slopes	60.01	4e	B	B	C
SabF	Sassafras loamy sand, 15 to 40 percent slopes	54.68	7e	C	C	C
SacA	Sassafras sandy loam, 0 to 2 percent slopes	20.75	1	A	A	A
SacB	Sassafras sandy loam, 2 to 5 percent slopes	50.82	2e	A	A	A
SacC	Sassafras sandy loam, 5 to 10 percent slopes	47.52	3e	A	A	B
SacD	Sassafras sandy loam, 10 to 15 percent slopes	23.99	4e	B	B	C
ThfB	Tinton sand, 0 to 5 percent slopes	44.77	3s	A	A	A
UdauB	Udorthents-Urban land complex, 0 to 8 percent slopes	28.34	Udorthents: 3w Urban: 8s	Udorthents: A Urban: Not rated	Udorthents: A Urban: Not rated	Udorthents: B Urban: Not rated

Soil Code	Soil Name (Phase)	Acreage	Soil Capability Class	Development Capability		
				Building Without Basement	Building With Basement	Small Commercial
UddB	Udorthents, dredged materials, 0 to 8 percent slopes	13.75	3w	A	A	B
UR	Urban land	262.64	8s	Not rated	Not rated	Not rated
WATER	Water	342.90	-	Not rated	Not rated	Not rated
WeeB	Westphalia fine sandy loam, 2 to 5 percent slopes	324.67	2e	A	A	A
WeeC	Westphalia fine sandy loam, 5 to 10 percent slopes	146.04	3e	A	A	B
WeeD	Westphalia fine sandy loam, 10 to 15 percent slopes	63.58	4e	B	B	C
WeeF	Westphalia fine sandy loam, 15 to 40 percent slopes	4.95	7e	C	C	C
WoeA	Woodstown sandy loam, 0 to 2 percent slopes	65.99	2w	B	C	B
WokA	Woodstown-Glassboro complex, 0 to 2 percent slopes	600.44	Woodstown: 2w Glassboro: 3w	Woodstown: A Glassboro: C	C	Woodstown: A Glassboro: C
Total		**14,153.19**				

Source: NRCS, 2018

Table 6 Key

Capability Class	
1	Slight limitations that restrict their use.
2	Moderate limitations that restrict the choice of plants or that require moderate conservation practices.
3	Severe limitations that restrict the choice of plants or that require special conservation practices, or both.
4	Very severe limitations that restrict the choice of plants or that require very careful management, or both.
5	Subject to little or no erosion but have other limitations, impractical to remove, that restrict their use mainly to pasture, rangeland, forestland, or wildlife habitat.
6	Severe limitations that make them generally unsuitable for cultivation and that restrict their use mainly to pasture, rangeland, forestland, or wildlife habitat.
7	Very severe limitations that make them unsuitable for cultivation and that restrict their use mainly to grazing, forestland, or wildlife habitat.
8	Limitations that preclude commercial plant production and that restrict their use to recreational purposes, wildlife habitat, watershed, or aesthetic purposes.
Capability Subclasses	
e	The main hazard is the risk of erosion unless close-growing plant cover is maintained.
w	Water in or on the soil interferes with plant growth or cultivation (in some soils, the wetness can be partly corrected by artificial drainage).
s	Soil is limited mainly because it is shallow, droughty, or stony.
c	Chief limitation is climate that is very cold or very dry.
Key to Development Capability	
A = Not Limited	Little or no limitation(s) or easily corrected by use of normal equipment and design techniques.
B = Somewhat Limited	Presence of some limitation, which normally can be overcome by careful design and management at somewhat greater cost.
C = Very Limited	Limitations that, normally, cannot be overcome without exceptional, complex, or costly measures.

Soil Erosion

Soil erosion is one of the most important, yet least understood, environmental problems facing developing and agricultural communities alike. Geologic, or “background,” erosion occurs at approximately the same rate as soil formation, leading to neither a net loss nor gain of soil. Background erosion is an important process in which rock materials are carried and deposited by wind and water. In areas with vegetative cover, the rock mixes with decomposed vegetation and creates more nutrient-rich soil.

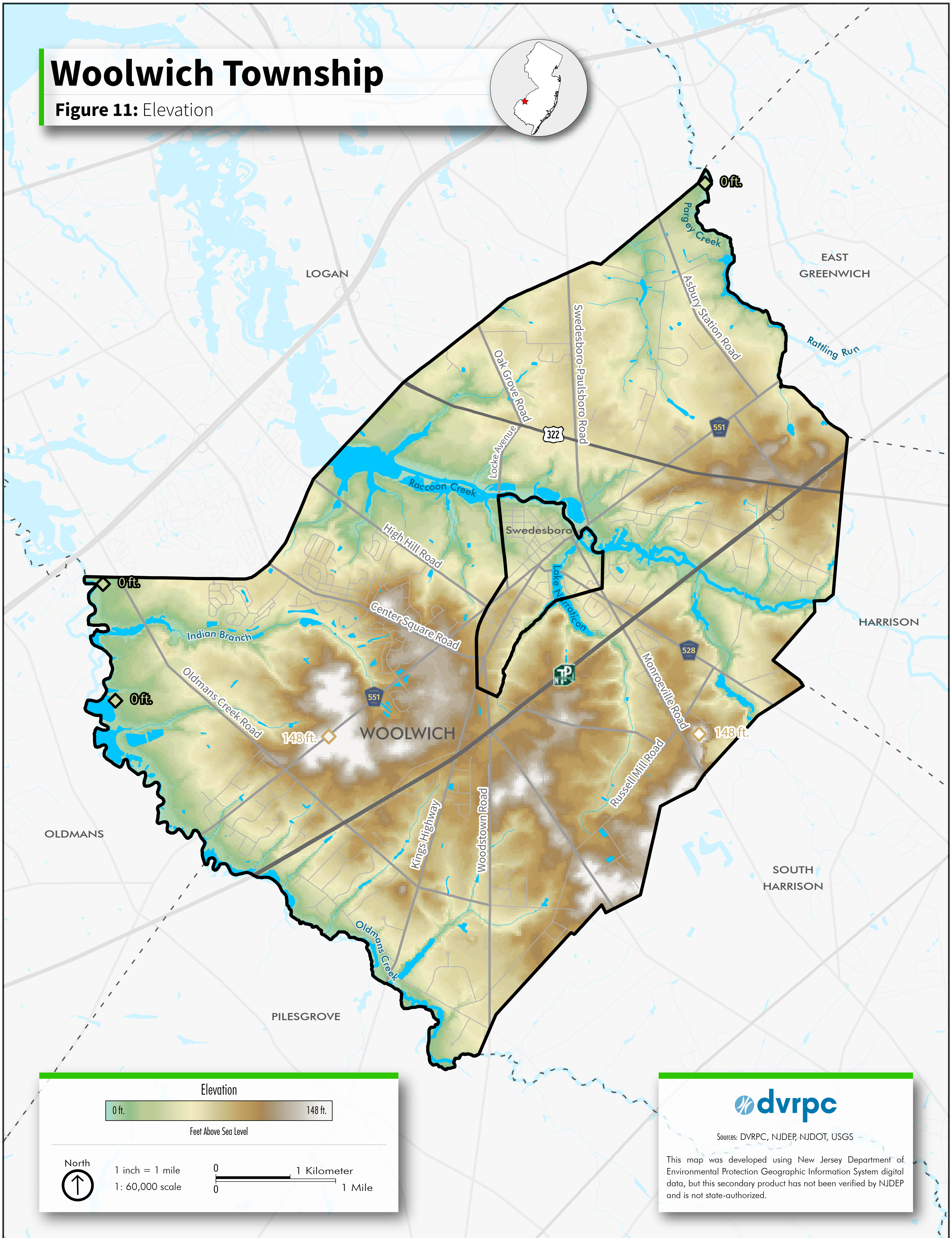
Conversely, erosion caused by human activity has greatly increased the volume and rate of soils lost. In the United States, the most significant effects are the loss of prime agricultural soils, increased flooding, and pollution of streams and rivers. Woolwich Township has soil erosion and sediment control requirements as part of its Stormwater Management ordinance and its Subdivision of Land ordinance, which are intended to reduce erosion and maintain sediments onsite during and after construction by reducing stormwater runoff and maximizing natural drainage techniques.

Topography

Topography relates to the surface terrain and features of an area. Generally, Woolwich Township has a fairly level topography that increases in elevation as one moves away from the township’s main waterways. The highest elevation in the township is 148 feet, which can be found along NJ Route 551/Auburn Road and east of the intersection between Monroeville Road and Russell Mill Road. The lowest elevation in the township is 0 feet (sea level) along Oldmans Creek in the west corner of the township, and along Pargey Creek at the north tip of the township. More details of Woolwich’s topography are visible in **Figure 11: Elevation**.

Woolwich Township

Figure 11: Elevation



Elevation

0 ft. — 148 ft.

Feet Above Sea Level

North

1 inch = 1 mile

1: 60,000 scale

0 — 1 Kilometer

0 — 1 Mile

dvrpc

Sources: DVRPC, NJDEP, NJDOT, USGS

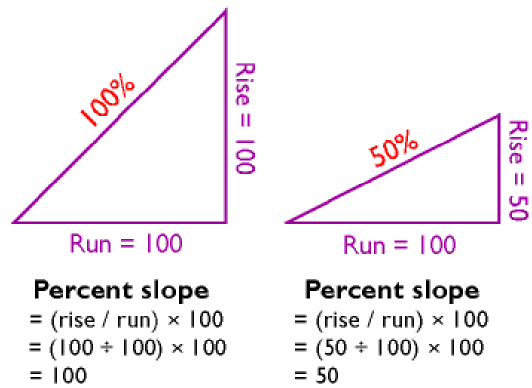
This map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state-authorized.

Slope

There are two methods for calculating slope: percent of vertical rise over run, or degrees from a flat plane. In this report, slope is defined using the first method, as the percent of vertical rise to horizontal distance. **Figure 12: Diagram of Percent Slope** demonstrates how slope is calculated. The majority of land within Woolwich Township—11,596 acres, or 85 percent of the township—has a slope of less than 5 percent. The township's abundance of relatively flat land makes much of it ideal for agricultural production, as well as for residential, commercial, and industrial development. See **Table 7: Slope** and **Figure 13: Slope**.

Some of the steepest slopes in Woolwich are located along waterways and water bodies; Lake Narraticon, Narraticon Run, Battertown Branch, Basgalore Creek, Raccoon Creek, Indian Branch, and Porches Run all contain adjacent steep slopes.

Figure 12: Diagram of Percent Slope



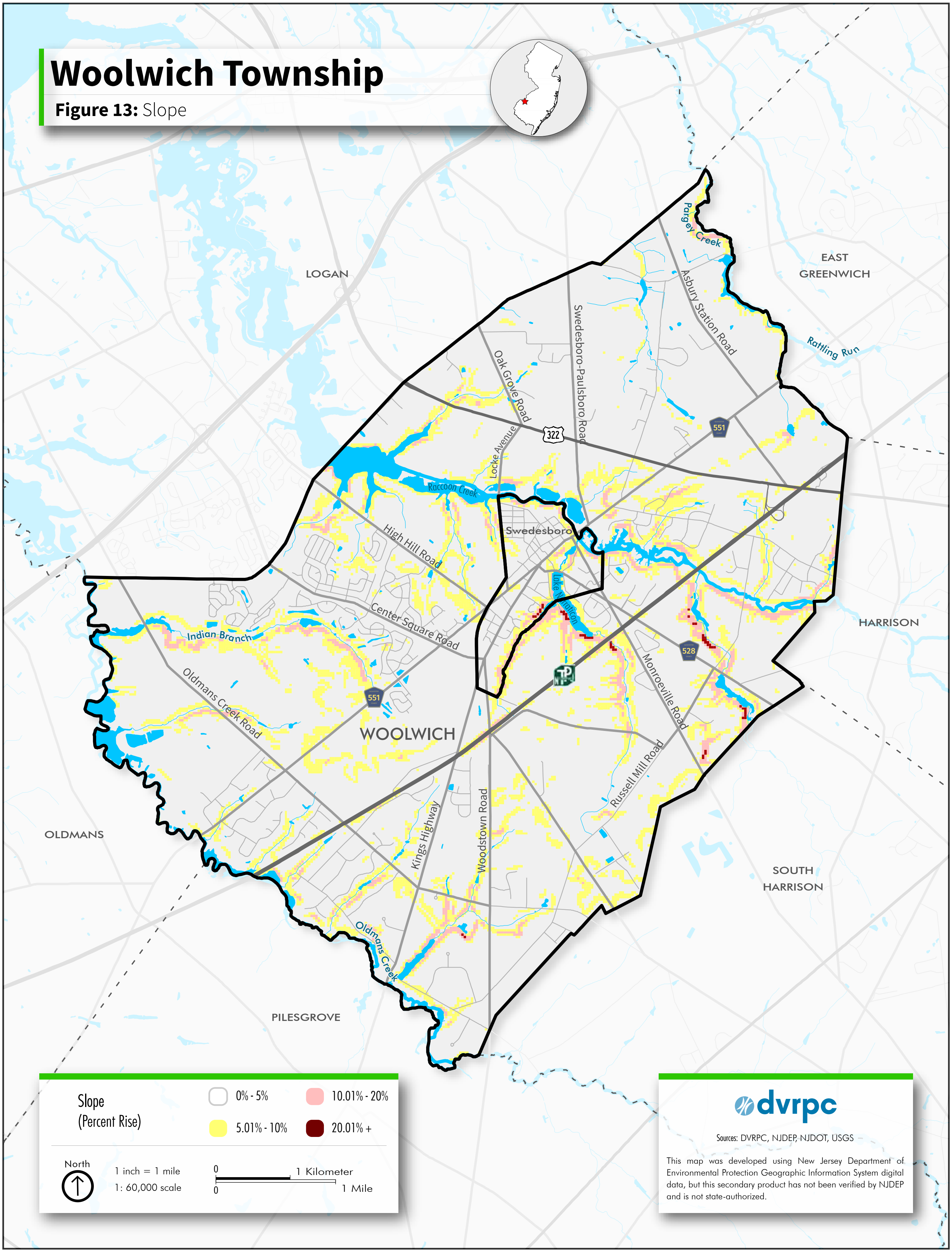
Source: Penn State University

Table 7: Slope

Slope (Percent Rise)	Acreage	Percentage
0%–5%	11,596.38	85.00%
5.01%–10%	1,700.99	12.47%
10.01%-20%	334.82	2.45%
20.01% and Above	11.12	0.08%
Total	**13,643.31**	

Woolwich Township

Figure 13: Slope



Steep Slopes

Steep slopes are fragile environmental features, and the development of these areas is inadvisable because it can result in soil instability, erosion, increased stormwater runoff, flooding, and sedimentation of the stream below. These effects in turn result in degradation of water quality, habitat destruction, and potential damage to property, as well as loss in aesthetic value of the landscape.

Table 7 indicates that 2.53 percent of Woolwich has steep slopes of over 10 percent. The steepest slopes are up to 40 percent in some cases. The vast majority of steep slopes in the township are located within forest habitat (**Figure 14**).

In some cases where steep slopes are not forested, farm fields or residential properties may extend to the edge of the plateau. For example, development has occurred on more moderate slopes, especially in the Back Creek Road area along the north side of Raccoon Creek and the small tributaries to it. Removal of forest habitat on the edge of a plateau may result in the erosion of soil, but natural buffers and other stormwater best management practices can be used to separate the slope from development and prevent additional erosion from occurring.

Figure 14: Wooded Slopes

Source: Matt Blake

Where steep slopes remain forested, some very old trees can be found in Woolwich Township, possibly even remnants of virgin (never cut) forest. In addition, certain rare herbaceous plants can be found on forested steep slopes having Marlton soils, because of their adaptation to the glauconitic nature of such soils. No detailed inventory of these sites exists at present, although NJDEP maintains records of endangered species that may be found in these habitats. An in-depth assessment of Woolwich's steep slope forests would be a valuable addition for helping the township understand the resources present in these habitats. Some forested steep slopes have been negatively affected by fertilizers from adjoining farm fields or by runoff from development, and a study would allow the township to determine the type and extent of these effects.

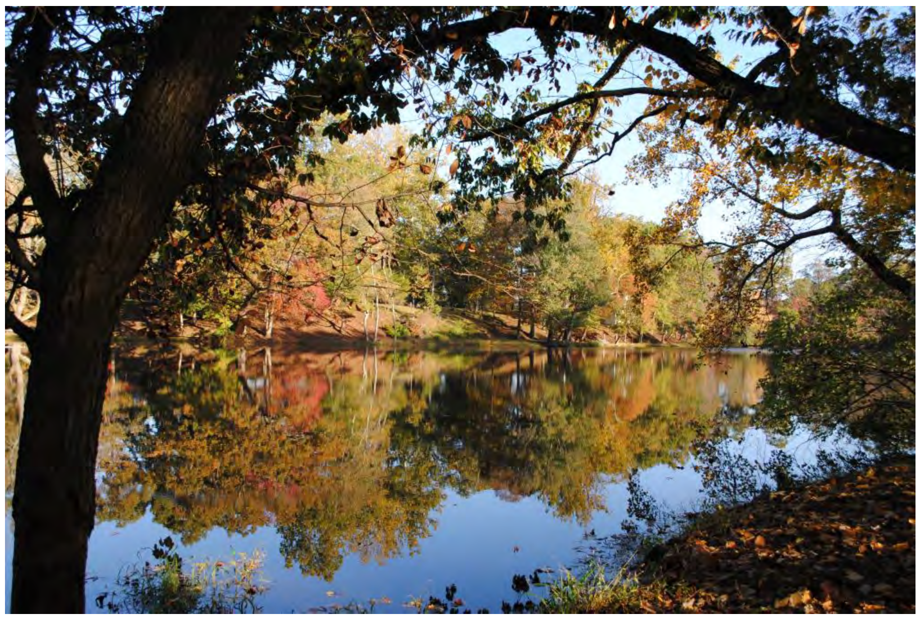
Woolwich Township has a Steep Slopes ordinance to protect these features. The ordinance defines steep slopes as any slope equal to or greater than 20 percent, as measured over a minimum run of 10 feet. Disturbance of steep slope areas is prohibited unless it is within the limits of existing impervious surfaces, or under unusual circumstances, such as to protect public health, safety, and welfare with no feasible alternative. However, as indicated in **Table 7**, this “steep slopes” area comprises only about 11 acres of the township.

Hydrology and Water Resources

Woolwich Township is physically defined by its water bodies, which form borders of the township and run through it. All of Woolwich's land drains to the Delaware River by way of three main stream systems: the Pargey Creek system on the north end of the township, the Raccoon Creek across the center, and the Oldmans Creek on the southern end. The start of the main channel of each of these streams lies outside of Woolwich, in the townships to the north, east, and south, although there are many tributaries that are wholly within Woolwich's boundaries. In addition to these three major creeks, Woolwich contains many named tributaries. Some of the most notable include Little Timber Creek; Rattling Run, which flows to Pargey Creek; Grand Sprute Run, Narraticon Run, and Basgalore Creek, which flow to Raccoon Creek; and Indian Branch, Ebenezer's Branch, Rainey's Run, and Porches Run, which flow to Oldmans Creek.

Several ponds and lakes also exist within Woolwich, including Lake Narraticon, Warrington Millpond, Porches Millpond (**Figure 15**), and Oliphants Millpond. None of these lakes are natural, but rather created from the act of damming to run mills.

Figure 15: Porches Millpond



Source: Matt Blake

Surface Water

Watersheds

A watershed is an area of land that resembles a basin in shape, surrounded by ridge-like areas of higher elevation. Any watershed drains all of its surface water bodies, groundwater, and rainfall to a common outlet such as the outflow of a reservoir, the mouth of a bay, or any point along a stream channel. Larger watersheds can contain many smaller watersheds, or "subwatersheds." For example, the Delaware River watershed contains all of the streams that drain into the Delaware River and then into the Delaware River Bay and Atlantic Ocean, but these individual streams also have their own watershed, where the common outlet is the point where that stream meets the Delaware River. Watersheds at the same scale are naturally divided ecological units with their own biotic and abiotic characteristics.

Each watershed has its own hydrologic unit code, or HUC (often pronounced as "huck"), which is a series of numbers determined by the United States Geological Survey (USGS) that defines that watershed. The fewer the number of digits in the HUC, the larger the size of the watershed: HUC-2 watersheds have two-digit codes and have areas of tens of thousands of square miles, while HUC-12 watersheds, with 12-digit codes, are often less than 50 square miles.

NJDEP monitors HUC-11 and HUC-14 watersheds in the state. New Jersey has 152 HUC-11 watersheds and over 900 HUC-14 watersheds. The HUC-11 watersheds in New Jersey range in size from 3 to 349 square miles, and average about 60 square miles. HUC-14 watersheds are 9.2 square miles on average.

Parts of three HUC-11 watersheds are located within Woolwich Township—the Cedar Swamp/Repaupo Creek/Clonmell Creek watershed, the Raccoon Creek/Birch Creek watershed, and the Oldmans Creek watershed. Each of these watersheds contains several HUC-14 watersheds. Within Woolwich, there are two HUC-14 watersheds in the Cedar Swamp/Repaupo Creek/Clonmell Creek watershed, three in the Raccoon Creek/Birch Creek watershed, and two in the Oldmans Creek watershed. Each HUC-11 and HUC-14 watershed is mapped in **Figure 16: Watersheds** and listed in **Table 8: HUC-11 and HUC-14 Watersheds**.

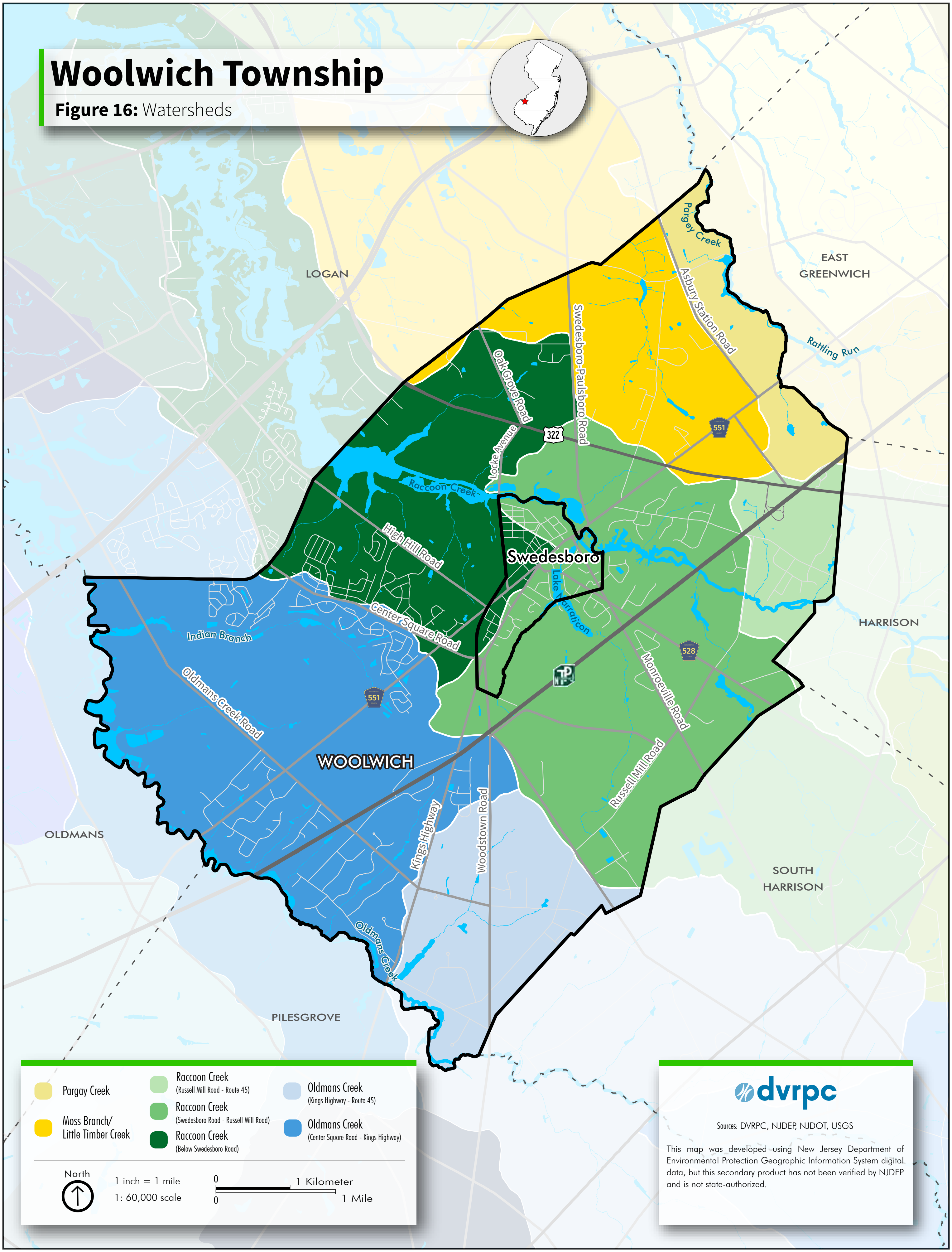
Table 8: HUC-11 and HUC-14 Watersheds

Watershed Name	Hydrologic Unit Code (HUC)	Acreage within Woolwich	Percentage of Woolwich
Cedar Swamp/Repaupo Creek/Clonmell Creek	**02040202140**	**2,102.71**	**14.84%**
Pargey Creek	02040202140030	649.56	4.58%
Moss Branch/Little Timber Creek	02040202140040	1,453.15	10.25%
Raccoon Creek/Birch Creek	**02040202150**	**6,646.24**	**46.89%**
Russell Mill Road–Route 45	02040202150040	589.50	4.16%
Swedesboro Road–Russell Mill Road	02040202150050	3,757.44	26.51%
Below Swedesboro Road	02040202150060	2,299.30	16.22%
Oldmans Creek	**02040202160**	**5,423.94**	**38.27%**
Kings Hwy–Route 45	02040202160030	1,375.97	9.71%
Center Square Road to Kings Highway	02040202160050	4,047.97	28.56%

Sources: NJDEP, 2000 (HUC-11 watersheds) and 2009 (HUC-14 watersheds)

Woolwich Township

Figure 16: Watersheds



Sources: DVRPC, NJDEP, NJDOT, USGS

This map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state-authorized.

Cedar Swamp/Repaupo Creek/Clonmell Creek Watersheds

Figure 17: Warrington Millpond

Source: DVRPC

Of the watersheds within the "Cedar Swamp/Repaupo Creek/Clonmell Creek" HUC-11 watershed, the Repaupo watershed—a complex of streams that drain a total of 41 miles of land—is the one that intersects Woolwich. In Woolwich, this watershed occupies 2,102 acres, most of which drain to Pargey Creek, which forms the northern border between Woolwich and East Greenwich Townships. Pargey Creek starts just inside the boundary of Woolwich, immediately east of Kings Highway. Within half a mile, it is joined by Rattling Run, which comes from Harrison and East Greenwich Townships. After running under the railroad line, it passes through Warrington Millpond (**Figure 17**) before becoming the border between Greenwich and Logan Townships. West of NJ Route 130, it is met by Still Run and, from there, the creek is called the Repaupo. The main creek channel empties into the Delaware River just below Flood Gate Road (the westward extension of Repaupo Road). There is extensive ditching at the mouth end of the Repaupo and the creek's discharge point at the Delaware has a tide gate on it. This and other tide gates were established in order to prevent incoming tides from flooding the lands adjoining the Repaupo. Dikes and other mechanisms to drain the rich soils of marshy areas were built by Dutch and Swedish settlers as early as the 1800s and remain as a legacy of those land drainage practices.

The Little Timber Creek, which rises (starts) in Woolwich northwest of the junction of Route 322 and Kings Highway, is considered part of the Repaupo watershed but is actually an independent stream. The Little Timber flows northwestward across Woolwich, travels west across Logan, and the meanders through the large Cedar Swamp in Logan, where it is joined by other tributaries that start on the western edge of Woolwich. It then empties directly into the Delaware River.

Raccoon Creek/Birch Creek Watersheds

The Raccoon Creek within this HUC-11 watershed intersects Woolwich Township (**Figure 18**). This creek is 19 miles long and flows from Elk and South Harrison Townships in the southeast, across Harrison, Woolwich, and Logan Townships, to the Delaware River. While there are several tributaries to the creek, the main one is the South Branch Raccoon Creek, which starts close to the western edge of the border between Elk and South Harrison Townships. It continues its northwestward flow into Harrison Township. The northern or main branch also begins in Elk Township and flows northward into Harrison Township, where it bends to the west before being joined by the South Branch. From there, the creek enters Woolwich and travels 4.4 miles across the center of the township.

One of two major tributaries to Raccoon Creek within Woolwich is Basgalore Creek, which rises in South Harrison Township. In Woolwich, Basgalore Creek was dammed near the junction of Route 538 and Russell Mill Road. This dam created the former Lake Basgalore, which is now a stream channel. The mill that was once at this lake has had several names, including Dilke's Mill and Russell's Mill. Route 538 was originally constructed in order to connect the mill to Swedesboro. The other major Raccoon tributary in Woolwich is Narraticon Run, also called Church Run. A dam on this tributary in Swedesboro forms Narraticon Lake, part of which is within Swedesboro and part in Woolwich Township. The name "Narraticon" was also the original name of the Raccoon Creek, in its extended form of "Narraticonsippus." Another smaller lake, which is called Little Lake but is also known as Battentown Lake, was formed by blocking the Battentown Branch of Narraticon Creek. It is filled with debris but its center marks the line between Swedesboro and Woolwich Township.

Figure 18: Raccoon Creek

Source: Matt Blake

There are a number of smaller, unnamed tributaries to Raccoon Creek in Woolwich, which enter the creek on both its north and south sides. A slightly larger named tributary, Grand Sprute, is located on the north side of the Raccoon near the western boundary of the township. It starts at Grove Road and flows under Route 322 before traveling southward to join the main creek.

Raccoon Creek is navigable from Kings Highway westward. It is also tidal up to three quarters of a mile east of the New Jersey Turnpike in Woolwich. The creek was a major transportation corridor to and from Swedesboro throughout the 18th and 19th centuries, and its Swedesboro length was once lined with wharves for loading barges and small ships. Along the creek today, there are still some industrial facilities, although most of these are situated closer to the Delaware.

Tidal wetlands are found along the main channel of the Raccoon, especially to the east and west of Swedesboro. These change to forested wetlands east of the New Jersey Turnpike. The tidal wetland area immediately east of Swedesboro up to the New Jersey Turnpike is visited by large numbers of migratory waterfowl in the spring and fall. Forested wetlands are also found along all of the Raccoon's tributary streams.

Oldmans Creek Watershed

Oldmans Creek (**Figure 19**) drains an area of 44 square miles and is 20 miles long. The creek marks the boundary between Gloucester and Salem Counties. Tidal marshes exist at the mouth of the creek and for a distance up its length. The creek is tidal for most of its extent in Woolwich, up to a point just past Rainey's Run.

Figure 19: Oldmans Creek

Source: Matt Blake

Oldmans Creek has one main channel without significant branching, but it has many tributaries. All tributaries in Woolwich begin north of Oldmans Creek Road and flow almost directly south to join the main channel. The largest Oldmans tributary in the township is Indian Branch, which flows through the heart of the land bounded by Center Square Road and Oldmans Creek Road on the north and south, and by Auburn Road and Township Line Road on the east and west.

Other Oldmans Creek tributaries in Woolwich are Ebenezers Branch, Rainey's Run, and Porches Run (or Oliphant Creek). Porches Run was dammed in the 19th century to power a grist mill, called Porches Mill and then Oliphants Mill. The original mill building can be seen in the town of Smithville, New Jersey, where it was moved for restoration in 1959.

The Oldmans corridor has wetlands along both sides for most of its length, including along most of the Woolwich extent, which is 4.4 miles long. At its lower end, closer to the Delaware River, there is an extremely large wetland area, the Pedricktown Marsh, which is one of the premier bird areas in the state of New Jersey and which thus attracts many bird watchers from throughout the region as visitors.

Watershed Management Area 18

NJDEP uses watersheds as a unit of area for managing natural resources. The agency has divided the state into 20 Watershed Management Areas (WMAs). Woolwich Township is within WMA 18, known as the Lower

Delaware Region, which includes 68 municipalities in 391 square miles of southwestern New Jersey. The main watersheds of this WMA include Oldmans Creek, Raccoon Creek, Repaupo Creek, Mantua Creek, Big Timber Creek, Cooper River, Pennsauken Creek, and Pompeston Creek, all of which drain to the Delaware River. The land in this WMA ranges from highly urbanized along the Delaware River, to forested and agricultural farther inland and to the south.

Streams

Woolwich contains about 49 stream miles within its boundaries, and about 33 of them (67 percent) are first- or second-order streams. First-order streams are the initial sections of stream channels with no contributing tributaries, and second-order streams are stream channels formed from only one branching section of tributaries above them. In Woolwich, only Narraticon Run (Church Run) is a first-order stream in its entirety. The remainder of the first-order streams in the township are tributaries of the other creeks.

First- and second-order streams are considered “headwater” streams. The headwaters are where a stream is “born” and actually begins to flow. Headwaters are of particular importance because they tend to contain a high diversity of aquatic species, and the condition of these waters affects the water quality found downstream.

Headwaters drain only a small area of land, usually no larger than one square mile (640 acres). Because of their small size, they are highly susceptible to pollution by human activities on the land. First- and second-order streams are narrow and often shallow. They are characterized by a relatively small base flow, which is the portion of stream flow that comes from groundwater seepage, not surface water runoff. These physical characteristics make first- and second-order streams subject to greater temperature fluctuations, especially when vegetation on their banks, particularly forest land, is removed. The quality of first- and second-order streams can also easily be degraded by siltation, which is water pollution that occurs when stormwater filled with soils and sediments (eroded or weathered sands and gravels) enters the water. In addition, first-order streams are greatly affected by changes in the local water table (see definition at right) because of their small base flows. Headwaters are important sites for the aquatic life that is at the base of the food chain, and often serve as spawning or nursery areas for fish.

Water table: The boundary between water-saturated ground and unsaturated ground. Below the water table, water fills all air pockets between soil particles or rocks.

Table 9: Woolwich Stream Orders records the length of streams in Woolwich by stream order.

Table 9: Woolwich Stream Orders

Stream Order	Total Length (Miles)
First (smallest)	27.33
Second	5.65
Third	10.98
Fourth	5.33
Total	**49.29**

As mentioned previously, Woolwich Township is also characterized by tidal waters on Raccoon Creek and Oldmans Creek. Tidal flows bring Delaware River water into those streams twice a day, as far inland as the eastern half of the township. Tidal flows both help and hinder maintenance of good water quality in affected streams. The flood (incoming) tide carries and leaves nutrients that are beneficial to aquatic organisms, but it also limits the regular flushing out of silt and pollutant-laden waters coming from upstream. Silt deposition within a stream tends to increase during flood tides, although deposition is also a function of stream shape, the presence of specific flow barriers, and the quantity of silt (the load) being carried by the stream.

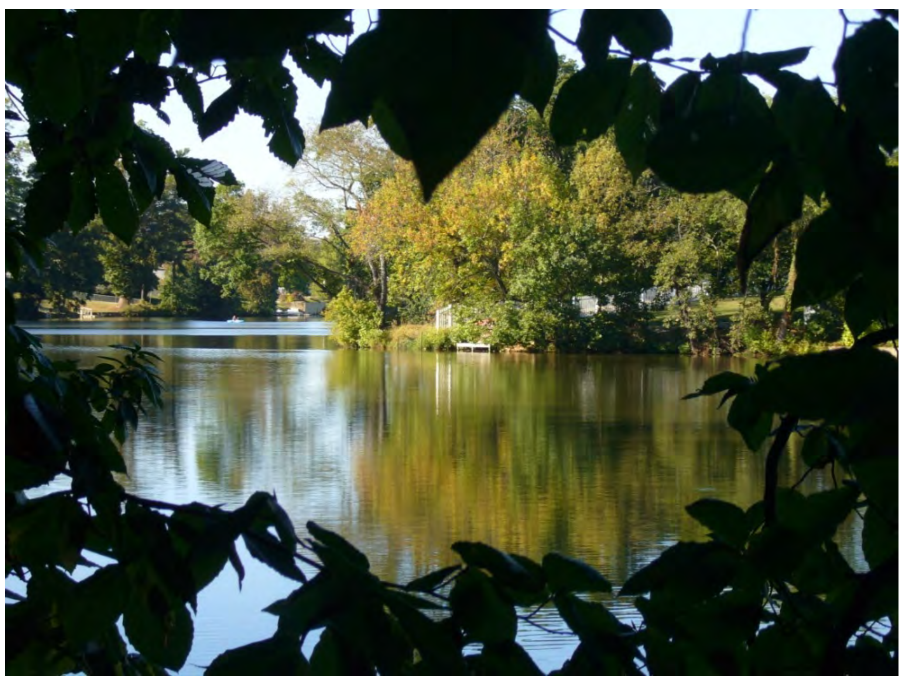
Oldmans Creek, Raccoon Creek, Pargey Creek, Little Timber Creek, Basgalore Creek, Porch Creek, and Rattling Run—streams that either run through Woolwich Township or are connected to streams that do—are monitored for biological life, nutrients, chemicals, and other parameters. More information on water quality in these creeks is located in the **Surface Water Quality** section (page 48).

Ponds and Lakes

The township's surface water resources also include ponds and lakes. They include permanent waters found along stream corridors and isolated ponds excavated for irrigation. Although they are classified as true lake systems by federal and state maps, all Woolwich lakes are artificial impoundments, and in fact, naturally-formed lakes do not exist in southern New Jersey. Most of these waterbodies were created in colonial and early industrial times by damming streams. Most were originally created for gristmill or sawmill power.

Most of Woolwich's lakes are used at present for public or private recreation, such as fishing and bird watching. Warrington Millpond is a private lake. The Oliphants Millpond dam was restored in the 1990s and the lake is again full and remains in private ownership. Lake Narraticon is part public and part private. Boating is permitted on Lake Narraticon (**Figure 20**), which is stocked by the state with trout. None of Woolwich's lakes are available for swimming.

Figure 20: Lake Narraticon



Source: DVRPC

Several former lakes are now restored streams. The dam at Hendrickson Millpond was recently decommissioned and removed, restoring the stream, and the lake is now wetland habitat. Similarly, the dam forming Lake Basgalore was decommissioned and what was formerly the lake bottom is now covered in non-woody native wetland plants. The removal of the Basgalore Creek dam will allow for the passage of fish that are *anadromous*, which means that they travel from the Delaware Bay or Atlantic Ocean upstream to Woolwich and beyond in order to spawn.

Wetlands

Wetlands have numerous definitions and classifications because of their diversity and the regulation of their uses. However, a basic definition of a wetland is an area that has enough water at some time during the year to stress plants and animals that are not adapted to life in water or saturated soils.

Wetland soils, which are also known as hydric soils, are areas where the land is saturated for at least seven consecutive days during the growing season. While wetlands almost always require the presence of hydric soils, hydric soils are not always wetlands. For land to be considered a wetland, it must have vegetation unique to wetlands and hydric soils.

Wetlands come in a wide range of types. For example, there are saline and freshwater wetlands; tidal and nontidal wetlands; and wetlands that were created through human activity, such as agricultural wetlands or stormwater basins. The most common wetland types in Woolwich are deciduous wooded wetlands, including the seasonally occurring vernal pool in **Figure 21**; deciduous scrub/shrub wetlands; and freshwater tidal wetlands. All of Woolwich's wetlands are freshwater, and the majority of them are associated with the township's streams.

Figure 21: Vernal Pool in Forest Along Indian Branch

Source: Matt Blake

Total wetland acreage in the township, based on NJDEP's land use/land cover data, is about 1,244 acres, of which about 1,117 acres (90 percent) feature natural wetlands vegetation. Wetlands that have experienced less human alteration are likely to contain typical or representative plants and animals that are native to that wetland type. Of Woolwich's naturally-vegetated wetlands, 746 acres are classified as forested wetlands, 195 acres are scrub/shrub wetlands, 131 acres are freshwater tidal marshes, and 46 acres are herbaceous wetlands. More information on Woolwich's naturally vegetated wetland areas is found in the **Natural Vegetation: Wetlands** section (page 87).

Woolwich Township also contains about 127 acres of disturbed or managed wetlands. These wetlands no longer support typical natural wetlands vegetation, but do show signs of soil saturation and exist in areas that the U.S. Soil Conservation Service has shown to have hydric soils. Woolwich's modified wetlands fall into the following categories: 76 acres of agricultural wetlands; six acres of former agricultural wetlands; four acres of wetland rights-of-way; three acres of wetlands found in maintained greenspace, recreational areas, or lawn;

and three acres of disturbed wetlands. Woolwich Township also contains 35 acres of wetlands dominated by the non-native invasive plant *Phragmites*.

New Jersey protects freshwater (interior) wetlands under the New Jersey Freshwater Wetlands Protection Act Rules: N.J.A.C. 7:7A. This law also protects transitional areas, or "buffers," around freshwater wetlands. The standard width of the transition area that is protected is 150 feet around a freshwater wetland of "exceptional resource value," which is defined as one that either discharges into trout-supporting waters or has been documented as habitat for a threatened or endangered species. The standard extent of transitional area that is protected around a freshwater wetland of "intermediate resource value" (one that is not of "exceptional resource value" *or* "ordinary") is 50 feet.

NJDEP's published freshwater wetland maps provide guidance on where wetlands are found in New Jersey, but they are not the final word on location. Only an official determination from NJDEP, called a "letter of interpretation" (LOI), can formally designate the presence of freshwater wetlands on a property. An LOI verifies the presence, absence, or boundaries of freshwater wetlands and transition areas on a site. The activities that are permitted to occur within wetlands are very limited, and permits are required for most of them. Violations of the wetland regulations will result in penalties determined by NJDEP. Additional information on wetland rules and permits is available through the NJDEP Division of Land Use Regulation and on their website under "Freshwater Wetlands." See **References** (page 126).

Vernal Pools

The New Jersey Division of Fish and Wildlife has been conducting a Vernal Pool Survey project since 2001, to identify, map, and certify vernal ponds through the state. Vernal pools are bodies of water that appear following snow melt and during spring rains but which disappear or are dry during the rest of the year. They are highly important sites for certain rare species of amphibians (obligate breeders). Particular types of frogs and salamanders will only breed in vernal pools, which provide their offspring with a measure of protection because the pool's impermanence prevents residence by predators who would consume the eggs and young. Vernal pools are so intermittent that their existence as wetlands has frequently not been recognized. Consequently, many of them have disappeared from the landscape, or have been substantially damaged. This, in turn, is a principal cause of the decline of their obligate amphibian species.

The state has identified twelve potential vernal habitat areas in Woolwich, but has not yet verified their location or status. Surveys of each vernal pool would determine what species are present and, indeed, if it is still in existence as a natural habitat.

Agricultural Wetlands

Woolwich Township has 40 agricultural wetland sites spread over 76 acres of the township. Agricultural wetlands are modified former wetland areas currently under cultivation. These areas have saturated soils like wetlands, but they no longer support natural wetland vegetation, being instead planted with commercial crops.

Agricultural wetlands were often created by a technique called "tile drainage." Tile drainage was a common method of removing excess water from farm fields that exhibited one or more of the following characteristics: (1) small areas of isolated wetlands, (2) very flat land that ponded in wet weather, (3) soils that were slow to warm in the spring because of a relatively high water table, or (4) soils that had a very high clay content and, therefore, drained slowly. Tile drainage was very labor-intensive, as it involved installing subsurface drainage pipes throughout a field at a depth of three to six feet. The existence of tile drainage strongly indicates a natural wetland hydrology. Drainage systems can be quite long-lived and require only the periodic maintenance of drainage ditches and outlets.

While tile drains have allowed more land to become farmable, they also tend to convey nitrogen from the fields into local streams more efficiently than is desired, which can have negative effects on stream health. Because little mapping exists identifying the location of tile lines, municipal, county, and state boards rarely address their existence as part of development approval processes. Yet, tile systems can pose health concerns when land is developed into residential or commercial uses, especially where septic systems are concerned. If a septic system leach field is installed near an unknown existing tile drainage system, discharge may seep into the tile line and directly into the local waterway. Lawn and agricultural chemicals carried through field drains are also a threat to water quality and wildlife and habitat.

As long as agricultural wetland areas remain in agricultural use, they are exempt from New Jersey Freshwater Wetlands Rules N.J.A.C. 7:7A. However, if an agricultural area is removed from agricultural production for more than five years, any wetlands located within that area lose their exempt status.

The Natural Resource Conservation Service sponsors the Agricultural Conservation Easement Program, a voluntary program that bundles multiple funding programs. The Wetland Reserve Enhancement Partnership is a sub-program that offers landowners an opportunity to receive payments for restoring and protecting wetlands on their property, including agricultural wetlands. Restoring agricultural wetlands requires removing them from agricultural use and restoring them to their natural state. This program provides technical and financial assistance to eligible landowners who can enroll eligible lands through different types of easements. NRCS prioritizes applications based the easement's potential for protecting and enhancing habitat for migratory birds and other wildlife.

Surface Water Quality

Woolwich's Stream Designations

Woolwich's streams are categorized to maintain surface water quality standards, which are established by federal and state governments to ensure that water is suitable for its intended use. The Federal Clean Water Act (P.L. 95-217) requires that, wherever possible, water quality standards provide water suitable for fish, shellfish, and wildlife to thrive and reproduce, and for people to swim and boat. Furthermore, the water quality for all streams must be able to support designated uses that are assigned to each water body classification by the State of New Jersey, as outlined in Surface Water Quality Standards N.J.A.C 7:9B-1.12. Each classification has a corresponding set of water-quality criteria, or numerical concentration values, that must be met.

All of the streams within Woolwich are classified by NJDEP as FW2-NT streams. The "FW2" code indicates that the streams are all freshwater, and none of them are wholly within federal or state lands. The "NT" code indicates that the waterbodies in Woolwich do not produce or maintain trout. According to NJDEP rules, FW2-NT waters must provide for (1) the maintenance, migration, and propagation of the natural and established plants and wildlife; (2) primary and secondary contact recreation (i.e., swimming and fishing/boating); (3) industrial and agricultural water supply; and (4) a drinkable water supply after conventional filtration and disinfection.

SE1, SE2, or SE3 is an additional NJDEP classification of waterways that identifies them as having a saltwater-freshwater interface from tides. These classifications are associated with lower water quality goals because the national goals are not currently believed to be attainable. Woolwich Township contains stream segments with SE1 and SE2 classifications. In Woolwich, Oldmans Creek and its tributaries are classified as FW2–NT/SE1 downstream of the Auburn Road Bridge. Raccoon Creek and its tributaries are FW2-NT/SE2 until they reach the Kings Highway Bridge in northern Swedesboro. Little Timber Creek and its tributaries are entirely FW2-NT/SE2 through Woolwich.

In addition to the classifications above, NJDEP has three tiers of surface water quality protection: Outstanding National Resource Waters, Category 1 Waters, and Category 2 Waters. Woolwich's waterways predominantly fit in the Category 2 tier, but the township also contains some Category 1 waters. Category 1 waters have additional requirements for protection, including 300-foot-wide riparian buffers, in order to better maintain their superior aesthetic value or ecological integrity. By contrast, Category 2 waters allow some reduction in water quality to accommodate necessary and important social and economic development.

Within Woolwich, upstream portions of Oldmans Creek and its tributaries (those close to South Harrison Township and/or bordering Pilesgrove Township) are classified as Category 1 waters. Pargey Creek as it runs through Woolwich is a Category 2 waterway, but farther downstream, in Logan Township, Pargey Creek contains a Category 1 segment. Because Woolwich's segments of Pargey Creek are in the same HUC-14 watershed as those of Logan Township and are upstream tributaries of the Category 1 segment in Logan, they are regulated as Category 1 waters.

The determination of whether or not water quality is sufficient to meet a water body's designated use(s) is based on whether the water body is within established limits for certain surface water quality parameters. Some examples of surface water quality parameters include fecal coliform, dissolved oxygen (the amount of oxygen in a body of water), pH, phosphorous, and toxic substances. NJDEP also evaluates water quality by examining the health of aquatic life in a stream. If there are documented exceedances of the human use criteria limits for a particular stream segment or lake, or if the segment/lake fails to meet the (lesser) criteria for support of aquatic life use, it must be included on a list of impaired waters: the 303d list. This, in turn, generates a requirement that the state develop a plan of action to improve the water quality.

New Jersey's Integrated Water Quality Monitoring and Assessment Report

The Federal Clean Water Act mandates that states submit biennial reports to the EPA describing the quality of their waters. States must submit two reports: the Water Quality Inventory Report or "305(b) Report," documenting the status of principal waters in terms of overall water quality and support of designated uses (see box on page 50 for definition), and a list of water bodies that are not attaining water quality standards determined by the state-–the "303(d) List."

States must also prioritize 303(d)-listed water bodies for Total Maximum Daily Load (TMDL) analyses. A TMDL is the amount of a pollutant that a water body can take in without violating water quality standards. The TMDL analysis identifies those high-priority water bodies for which the state anticipates establishing TMDLs in the next two years.

NJDEP integrates the 303(d) List and the 305(b) Report into a single report according to the EPA's guidance. The most recent draft Integrated Water Quality Monitoring and Assessment Report, released in 2014, places the state's waters on one of five "sublists." See the key on page 51, which follows **Table 10: Integrated Water Quality Monitoring and Assessment Report**, for more information on each sublist. The **TMDLs** subsection (page 55) contains additional information.

NJDEP bases the assessment of entire HUC-14 watersheds (which serve as "assessment units") on the results of one or more monitoring sites within the watershed. The results from monitoring sites located within each HUC-14 watershed are extrapolated to represent all of the water bodies within the entire HUC boundary. In practice, the HUC-14 approach provides a more conservative assessment since any impairment (a term similar to “pollution”) of any water body in a given HUC-14 watershed will result in that entire watershed being listed as impaired for that use (for example, recreation) or parameter (for example, aquatic life). In addition, where a HUC-14 watershed contains waters of different classification, the more stringent classification is used to look for impairment, and that impairment is then applied to the entire watershed. Because of the degree of extrapolation required for this approach, the NJDEP performs more detailed testing to determine the actual cause, source, and extent of impairment in the HUC-14 watershed before developing a TMDL or taking other regulatory action to address the impairment.

NJDEP identifies the designated uses (see box to the right) applicable to each HUC-14 watershed, which are also discussed in the **Surface Water Quality** section (page 48). NJDEP then determines whether the water meets the water-quality standards that correspond with designated uses in that watershed for each water quality monitoring station. Not all designated uses are applicable for all HUC-14 watersheds. The assessment unit (the HUC-14 watershed) is then placed on the appropriate sublist (Sublist 1-5) for each use.

See **Table 10: Integrated Water Quality Monitoring and Assessment Report** for the most recent published status of each of Woolwich’s HUC-14 watersheds. NJDEP conducted its most recent statewide assessment of water quality in 2014; the report was published in May 2017. In 2014, NJDEP began publishing assessment reports on regional rather than statewide water quality, dividing the state into five regions and initiating studies each year on a rotating basis. Woolwich is located in the Lower Delaware monitoring region, which NJDEP began to monitor in 2015 and then assess in 2018. Assessment is ongoing as of the publication of this ERI.

Designated uses refer to specific groups of species that rely on water or human uses of water. Each of these use types is associated with certain water quality standards that must be met. Designated uses include:

- Aquatic life (general)
- Aquatic life (trout)
- Recreation
- Drinking water supply
- Shellfish harvesting
- Fish consumption
- Industrial water supply
- Agricultural water supply

The definitions for the sublist numbers are listed in the key after **Table 10**. The designated uses “aquatic life (trout)” and “shellfish harvesting” are not applicable for any of the HUC-14 watersheds/assessment units in Woolwich, and are therefore not included in the table. Furthermore, NJDEP no longer assesses the designated uses “industrial water supply” and “agricultural water supply” independently, instead determining that if “aquatic life” and “public water supply” uses meet the standards for a HUC-14 watershed, then the industrial and agricultural water supply uses also do so.

Table 10: Integrated Water Quality Monitoring and Assessment Report

Assessment Unit (HUC-14 Watershed)	HUC ID	Aquatic Life (General)	Recreation	Drinking Water Supply	Fish Consumption
Pargey Creek	02040202140030	5	5	1	3
Moss Branch/Little Timber Creek	02040202140040	5	3	3	5
Raccoon Creek: Russell Mill Rd–Rt 45	02040202150040	5	1	5	5
Raccoon Creek: Swedesboro Rd–Russell Mill Rd	02040202150050	5	3	1	3
Raccoon Creek: Below Swedesboro Rd	02040202150060	3	1	3	5
Oldmans Creek: Kings Hwy–Rt 45	02040202160030	5	5	1	3
Oldmans Creek: Center Sq Rd to Kings Hwy	02040202160050	5	5	1	5

Source: NJDEP, 2014

Table 10 Key

Sublist Number	Placement Conditions
1	The designated use (for example, Recreation) has been assessed by scientists and has attained the water quality standards set by the state, AND all other designated uses in the assessment unit (i.e., the HUC-14 watershed) have been assessed and attained. Fish consumption use is not factored into this determination based on EPA guidance.
2	The designated use has been assessed by scientists and has attained the water quality standards set by the state, BUT one or more designated uses in the assessment unit have not attained the water quality standards, and/or there is insufficient data to make a determination.
3	Insufficient data is available to determine if the designated use has attained the water quality standards set by the state.
4	The designated use has not attained the water quality standards set by the state, or the designated use is threatened; however, development of a TMDL is not required for one of the following reasons: 4A: A TMDL has been completed for the pollutant preventing the designated use from attaining water quality standards; 4B: Other enforceable pollution control requirements are reasonably expected to help meet the applicable water quality standard(s) in the near future and the designated use will attain its water quality standards through these means; or 4C; Nonattainment is caused by something other than a pollutant.

Sublist Number	Placement Conditions
5	The designated use has not attained its water quality standards or is threatened by at least one pollutant and a TMDL is required. Sublist 5 is equivalent to the 303(d) List.

As indicated in **Table 10**, an assessment unit may be listed on one or more sublists (i.e., on Sublist 2 for drinking water and on Sublist 3 for aquatic life). However, an assessment unit as a whole can only be placed on Sublist 1 if all uses for that assessment unit have attained the state's water quality standards. In order to determine whether an assessment unit supports a designated use, NJDEP identifies a suite of parameters (such as arsenic or *E. coli*) that serve as the minimum dataset associated with each designated use.

If one or more designated uses are assessed as "nonattainment" (Sublist 5), the pollutant(s) or impairment causing the non-attainment status is identified on the "303(d) List of Impaired Waters with Priority Ranking." When the pollutant causing nonattainment is unknown, the pollutant is listed as "pollutant unknown" or "toxic unknown." The ranking (Low, Medium, High) refers to the priority given a specific assessment unit when determining the schedule for a TMDL. **Table 11: 303(d) List of Impaired Waters with Priority Ranking** lists Woolwich's nonattaining assessment units, the water quality parameters that cause them to be nonattaining, and the their ranking.

Table 11: 303(d) List of Impaired Waters with Priority Ranking

Assessment Unit (HUC-14 Watershed)	HUC ID	Parameters	Ranking
Pargey Creek	02040202140030	*Escherichia coli*	Medium
		Phosphorus (Total)	Medium
Moss Branch/Little Timber Creek	02040202140040	Cause Unknown for Aquatic Life	Low
		Mercury in Fish Tissue	Low
		PCB in Fish Tissue	Low
Raccoon Creek: Russell Mill Road–NJ Route 45	02040202150040	Arsenic	Low
		Chlordane in Fish Tissue	Low
		DDT and its Metabolites in Fish Tissue	Low
		PCB in Fish Tissue	Low
		pH	Medium
		Phosphorus (Total)	Medium
		Turbidity	Medium
Raccoon Creek: Swedesboro Road–Russell Mill Road	02040202150050	Phosphorus (Total)	Medium

Assessment Unit (HUC-14 Watershed)	HUC ID	Parameters	Ranking
Raccoon Creek: Below Swedesboro Road	02040202150060	PCB in Fish Tissue	Low
Oldmans Creek: Center Square Road to Kings Highway	02040202160050	PCB in Fish Tissue	Low
		Total Suspended Solids (TSS)	Medium

Source: NJDEP, 2014

In 2014, all but one of the watersheds in which Woolwich is located were identified on the 303(d) List. The exception was Oldmans Creek between Kings Highway and NJ Route 45, despite its apparent impairment for Aquatic Life (General) and Recreation. It is unclear why this watershed was omitted, and further discussion with NJDEP may be warranted.

Among the watersheds listed in the 303(d) List, each has a different combination of pollutants that caused it to be impaired. The most frequently listed pollutant is polychlorinated biphenyl (PCB) found in fish tissue, which was found at high concentrations in four watersheds. PCBs were used as coolants and lubricants in electrical equipment from the 1940s until 1977, when their manufacture was stopped due to evidence of their harmful effect on the environment. PCBs do not break down quickly in the environment and accumulate in water, soil, air, and animal life. Exposure to PCBs can cause skin conditions and impair the liver and immune system in humans.

Water Quality Monitoring Networks

The determination of whether or not water quality is sufficient to meet an assessment unit's (HUC-14 watershed's) designated uses is based on testing results from various water quality monitoring networks. Information about these monitoring stations is included in **Table 12: Water Quality Sampling Stations within or Near Woolwich**. Water monitoring data from these stations is located within the Water Quality Portal at the National Water Quality Monitoring Council's website, the EPA's STOrage and RETrieval (STORET) central warehouse, or the USGS National Water Information System (see **References**, page 126). One can search these data portals to find historic and current water quality data for the sites listed in **Table 12**.

NJDEP's Monitoring Networks

Across the state, NJDEP primarily relies on two water quality monitoring networks: the Ambient Surface Water Quality Monitoring Network (ASWQMN) and the Ambient Biomonitoring Network (AMNET).

NJDEP runs the Ambient Surface Water Quality Monitoring Network in cooperation with USGS. This network contains 112 stations that monitor a set of selected sites in priority regions, basins, and watersheds for nutrients (i.e., phosphorous and nitrogen), bacteria, metals, sediments, dissolved oxygen, pH, or other parameters.

The Ambient Biomonitoring Network, which is administered solely by NJDEP, evaluates the health of aquatic life as a biological indicator of water quality. The network includes over 760 non-tidal monitoring stations located throughout the state. Each station is sampled once every five years and each site is tested only for the diversity of aquatic life. In testing this water quality parameter, the NJDEP samples streams for benthic (bottom-dwelling) macroinvertebrates, which include such insects as dragonfly and caddisfly larvae (**Figure 22**), clams, mussels, snails, worms, and crustaceans that are large enough to be seen by the naked eye. Macroinvertebrates are studied because they are good indicator species: if pollution harms a stream, their populations are adversely affected and require a significant amount of time to recover. While chemical tests measure water quality on a given day, the presence or absence of macroinvertebrates represents water quality changes over a longer period preceding the testing day. Water bodies are rated on the number of different species of organisms present as well as the number of individuals within those populations.

Figure 22: Caddisfly Larva (Unidentified Species)

Other Sampling Programs

Other programs, including Delaware River Basin Commission, the New Jersey Office of Science, EPA's Environmental Monitoring and Assessment Program, and the AmeriCorps NJ Watershed Ambassadors Program, have also historically maintained monitoring stations in New Jersey's watersheds. NJDEP tracks these locations on its NJ GeoWeb webmap service (see **References**, page 126). NJDEP uses all of these resources statewide, but does occasionally omit some years or types of sampling. Appendix E of NJDEP's *2014 New Jersey Integrated Water Quality Assessment Report* lists the stations used for monitoring surface waters throughout the state.

Table 12: Water Quality Sampling Locations Within or Near Woolwich

Station Name	Station ID	Program Name	Municipality
Pargey Creek near Gibbstown	1476630	ASWQMN	Woolwich Township
Pargey Creek at Swedesboro Avenue at Repaupo	1476640	ASWQMN	Woolwich Township
Little Timber Creek at Repaupo (samples are from 1984)	1477038	ASWQMN	Logan Township
Raccoon Creek near Swedesboro	1477120	ASWQMN	Harrison Township

Station Name	Station ID	Program Name	Municipality
Raccoon Creek Tributary 3 near Mullica Hill	1477123	ASWQMN	Harrison Township
Basgalore Creek at Russell Mill Road near Swedesboro	1477130	ASWQMN	Woolwich Township
Raccoon Creek Tributary 2 near Swedesboro (no data available online)	1477135	ASWQMN	Woolwich Township
Porch Creek at Porches Mill	1477509	ASWQMN	Woolwich Township
Rattling Run at Tomlin Road	AN0676	AMNET	East Greenwich Township
Pargy Creek at Swedesboro Avenue	AN0677	AMNET	East Greenwich Township
Little Timber Creek at Paulsboro Road	AN0678	AMNET	Logan Township
Raccoon Creek at NJ Route 45 (North Main Street)	AN0680	AMNET	Harrison Township
Raccoon Creek at Tomlin Station Road	AN0683	AMNET	Harrison Township
Oldmans Creek at Swedesboro Road	AN0686	AMNET	South Harrison Township
Oldmans Creek at Harrisonville Lake Road	AN0687	AMNET	South Harrison Township
Oldmans Creek at Kings Highway	AN0688	AMNET	Woolwich Township

Sources: USGS, NJDEP, National Water Monitoring Council

TMDLs

For impaired waters (waters on Sublist 5), the state is required by the EPA to establish a TMDL. As mentioned previously in the section on New Jersey's Integrated Water Quality Monitoring and Assessment Report, a TMDL is the amount of a pollutant that a water body can take in without violating water quality standards. The purpose of a TMDL is to start a management approach or restoration plan based on the sources of pollutants and the percentage reductions of each pollutant that must be achieved to attain water quality standards. These sources can be point sources, coming from a single "point" such as a sewage treatment plant, or nonpoint sources, which come from a collection of sources, such as runoff from various types of residential, commercial, or agricultural lands.

Table 10 indicates that all seven HUC-14 watersheds in Woolwich Township are listed on Sublist 5. Woolwich has 11 TMDLs, but none of its watersheds are scheduled to receive TMDL reports as per NJDEP's draft two-year TMDL schedule, which is listed in Appendix B of the most recent Integrated Water Quality Monitoring and Assessment Report (2014).

In general, implementation of a TMDL relies on actions mandated by the Municipal Stormwater Regulation Program, including the ordinances required to be adopted by municipalities under that permit (see the **Nonpoint Sources** subsection on page 61 for details of the statewide basic requirements of this program). It also depends on private landowners making voluntary improvements to their land.

Potential Causes of Water Quality Impairments

Point Sources

Point sources of discharge, which come from a single source or "point," such as an industrial pipe discharge, are regulated by NJDEP through the New Jersey Pollution Discharge Elimination System (NJPDES). New Jersey created NJPDES in response to the Federal Clean Water Act of 1972, which mandated that each state develop water quality standards and regulate the amount of pollution entering waterbodies. The act classified all water pollution into one of two categories: "point source" pollution coming from a single source, such as an industrial pipe; and "nonpoint source" pollution, which comes from many diffuse sources. Although the Federal Clean Water Act only required states to regulate point sources, New Jersey also regulates nonpoint sources through the authority of the NJPDES rules (see the **Nonpoint Sources** subsection on page 61).

NJDEP, through the Division of Water Quality and the Bureau of Point Source Permitting, administers the NJPDES program (N.J.A.C. 7:14A). Under NJPDES, any facility discharging domestic or industrial wastewater directly into surface water or groundwater (usually through a septic system) must apply for and obtain a permit for discharging. Rather than creating individually tailored permits for every facility, the Division of Water Quality uses scientific standards to create and issue general permits for different categories of dischargers. NJDEP enforces the terms of NJPDES permits by visiting discharging facilities and requiring facilities to periodically conduct water quality, biological and toxicological analyses, and thermal impact and cooling water assessments.

As of the publication of this report, 35 active NJPDES permits for point source discharge were issued to individual facilities in Woolwich. These facilities are shown in **Table 13: NJPDES Permits for Point Source Discharges**. Three facilities have expired permits, including two permits for the Villages 1, Section 4.1 on Hazel Boulevard and one for Wawa Convenience Store #974 on NJ-322 and Swedesboro-Paulsboro Road. More information on each facility's permit (or, for several sites, multiple permits) is available at NJDEP's DataMiner data portal.

Table 13: NJPDES Permits for Point Source Discharges

NJPDES Permit Number	Program Interest (PI) Number	Facility Name	Facility Address	Expiration Date	Discharge Category Description	Discharge Category Code
NJG0209015	588556	2012 Road Improvement Program	Various Roads	02/28/22	5G3	NJG0209015
NJG0265985	750126	Auburn & High Hill Roundabout	Auburn Road & High Hill Road	02/28/22	5G3	NJG0265985
NJG0257907	734251	Auburn Road	Auburn Road	02/28/22	5G3	NJG0257907
NJG0186317	545512	Casella Residence	24 Mill Road	02/28/22	5G3	NJG0186317

NJPDES Permit Number	Program Interest (PI) Number	Facility Name	Facility Address	Expiration Date	Discharge Category Description	Discharge Category Code
NJG0257664	733761	Dibella Farm Grading	693 Russell Mill Road, Swedesboro	02/28/22	5G3	NJG0257664
NJG0231240	653473	East Side Expansion Project	Various (Linear Project), Woolwich and Logan Townships	02/28/22	5G3	NJG0231240
NJG0115924	48287	Erdner Brothers, Inc.	31 Davidson Road	01/31/23	5G2	NJG0115924
NJG0247669	708955	Four Seasons Phase 3, Section 1	Auburn Road	02/28/22	5G3	NJG0247669
NJ0099732	46402	Grasso Foods	2111 Kings Highway	08/31/21	GW	NJ0099732
NJG0107719	46402	Grasso Foods	2111 Kings Highway	06/30/21	EG	NJG0107719
NJG0259691	738673	High Street Substation and Laydown Area (ACE)	440 Franklinville Road	02/28/22	5G3	NJG0259691
NJG0240869	683895	Kingsway–Solar	213 Kings Highway	02/28/22	5G3	NJG0240869
NJG0203149	574689	Kingsway Middle School Expansion	213 Kings Highway	02/28/22	5G3	NJG0203149
NJG0176451	514838	Kingsway Professional Building	1640 Route 322	02/28/22	5G3	NJG0176451
NJG0201821	572010	Kingsway Regional Schools Expansion	213 Kings Highway	02/28/22	5G3	NJG0201821

NJPDES Permit Number	Program Interest (PI) Number	Facility Name	Facility Address	Expiration Date	Discharge Category Description	Discharge Category Code
NJG0195413	562462	NJ Turnpike Int. 2 Route 322 Intersection #1801511	Interchange 2 & Route 322	02/28/22	5G3	NJG0195413
NJG0270199	757615	Paolella Tract	Swedesboro-Monroeville Road & Swedesboro-Franklinville Road	02/28/22	5G3	NJG0270199
NJG0242233	690971	Swedesboro Former MGP Site	98 Bridgeport Avenue	02/28/22	5G3	NJG0242233
NJG0262501	744336	Tenby Chase at Weatherby–Section 5 Apartments	Auburn Road	02/28/22	5G3	NJG0262501
NJG0184136	538081	The Oaks at Weatherby Park Area Fill Plan	Village Green Drive	02/28/22	5G3	NJG0184136
NJG0238856	672484	Turnpike Maintenance District 1	NJ Turnpike Milepost 13.0 NB	02/28/22	5G3	NJG0238856
NJG0171611	473982	U.S. Drop Forge Co.	1366 Auburn Road	01/31/23	5G2	NJG0171611
NJG0270181	757614	Village at Weatherby Place	Village Green Drive	02/28/22	5G3	NJG0270181
NJG0199184	567760	Villages 1, Section 4.1	Hazel Boulevard	02/28/17	5G3	NJG0199184
NJG0222984	567760	Villages 1, Section 4.1	Hazel Boulevard	02/28/17	5G3	NJG0222984
NJG0254967	726537	Villages at Weatherby	Hazel Boulevard & Auburn Road	02/28/22	5G3	NJG0254967

NJPDES Permit Number	Program Interest (PI) Number	Facility Name	Facility Address	Expiration Date	Discharge Category Description	Discharge Category Code
NJG0225291	628921	Villages at Weatherby–Sections 2.5a & 2.5b	Auburn Road	02/28/22	5G3	NJG0225291
NJG0279153	775374	Villages at Weatherby Place–TH	Bantry Street	02/28/22	5G3	NJG0279153
NJG0266418	750895	Villages II at Weatherby–Section 1	Auburn Road	02/28/22	5G3	NJG0266418
NJ0157091	239387	Wawa Convenience Store #974	Route 322 & Swedesboro-Paulsboro Road	09/30/17	GW	NJ0157091
NJG0235636	239387	Wawa Convenience Store #974	Route 322 & Swedesboro-Paulsboro Road	12/31/20	SXG	NJG0235636
NJG0188301	549680	Westbrook at Weatherby–Pond E	Center Square Road & Tavistock Drive	02/28/22	5G3	NJG0188301
NJG0258881	736271	Woodstown–High Street 69KV Trans Line (Gloucester)	Varies (Transmission Line), Swedesboro	02/28/22	5G3	NJG0258881
NJG0220582	619061	Woolwich Township Solar	120 Village Green Drive, Woolwich Township Municipal Building	02/28/22	5G3	NJG0220582
NJG0150738	168611	Woolwich Township	121 Woodstown Road	12/31/22	R10	NJG0150738

Source: NJDEP, 2018

Table 13 Key

Discharge Category Description	Explanation
5G2	Basic Industrial Stormwater General Permit: Available to regulated industrial facilities that have eliminated, or can eliminate within six months of authorization, all exposure of industrial materials or activities to stormwater discharges.
5G3	Construction Activity Stormwater General Permit: Authorizes point source discharges from certain construction activities. Permit holders are required to develop a soil erosion and sediment control plan to manage waterway pollution from construction sites.
A	Sanitary Wastewater: Issued to facilities that discharge primarily domestic sewage from residential and commercial properties.
B	Industrial Wastewater: Issued to facilities that discharge treated and non-treated wastewater derived from, among other sources, process and non-process wastewater, contact and non-contact cooling water, and stormwater runoff.
EG	Land Application of Food Processing By-Products General Permit: Authorizes the distribution and land application of food processing by-products for a class of food processing operations. These by-products include residuals (e.g. solids removed during wastewater treatment processes); and vegetative wastes such as peels, skins, and seeds from food processing operations.
GW	Discharge to Groundwater: Individual or general permit required for any facilities that discharge pollutants to groundwater.
RF	Industrial Stormwater Discharger Individual Permit: Issued to facilities that discharge stormwater that is directly related to manufacturing, processing, or raw materials storage areas at an industrial plant.
R10	Tier B Municipal Stormwater General Permit: Authorizes the discharge of stormwater from small municipal separate storm sewers. Tier B municipalities are generally located in more rural areas and in non-coastal regions. The Tier B permit focuses on new development and redevelopment projects and public education.
S4G	Sludge Quality Category 4 General Permit: Issued to public or private sewer treatment facilities with a permitted flow of over 5 million gallons per day to implement the provisions of the Sludge Quality Assurance Regulations for residual quality and quantity monitoring.

Discharge Category Description	Explanation
SM2	Scrap Metal Processing and Recycling General Permit: Issued to facilities that process and recycle scrap metal.
SXG	Sludge Quality Exempt: General permit issued to sewage treatment processing plants for domestic wastewater. The intent is to control sewage sludge quality, limiting high concentrations of contaminants in the sludge.

Although the NJPDES program has made progress in regulating point source discharges, NJDEP has allowed many minor discharges without regard to their cumulative impact on surface water quality. A municipality's permitting review process is an important opportunity to consider each applicant as part of a larger impact on municipal or regional water quality. Recipients of the information on applications can examine and evaluate the need for the permit, the location of the discharge, and the potential negative impacts to the township's water quality, and communicate their findings to NJDEP, the applicant, and the township.

Nonpoint Sources

Nonpoint source pollution, which comes from a wide variety of sources rather than from a single point, such as a discharge pipe, has a detrimental effect on the water quality and ecology of streams in most townships, including Woolwich. These sources are also the most difficult to identify and remediate because they are diffuse, widespread, and cumulative in their effect.

Nonpoint source pollution in Woolwich is derived from stormwater drainage off paved surfaces such as streets and parking lots, commercial or industrial areas, residential sites (with and without detention basins), lawns, and from agricultural fields that lack adequate vegetative buffers. Some of this runoff comes to the waterways from similar sources in upstream townships, and some of it derives from Woolwich land uses.

Some examples of nonpoint source pollutants contained in stormwater runoff include the following: excess fertilizers, herbicides, and insecticides from residential lawn areas and agricultural lands; oil, grease, rubber, and toxic chemicals from automobiles and improper disposal of household wastes; acid rain and mercury from fossil fuel-fired energy production; sediment from improperly managed construction sites, crop and forest lands, and eroding streambanks; salt from streets treated during winter precipitation events; nutrients from yard waste left to decompose on the street; and bacteria and nutrients from livestock, geese, pet wastes, and faulty septic systems.

NJDEP regularly issues updates to its Stormwater Management Rule, which is a rule required by the EPA's Phase II Stormwater Management Program for Municipal Separate Stormwater Sewer Systems (MS4s). The rule applies to several entities that contain stormwater sewer systems that are separated from regular sewer systems, including municipalities, county road departments, and public institutional facilities on large sites (such as hospitals and colleges). Each entity with this type of sewer system is required to obtain an NJPDES general permit for the stormwater system. The rule lays out guidance and requirements for the management of and education about stormwater at the local level.

Under the NJPDES permit, a municipality must meet certain specific requirements in planning, ordinance adoption, education, management of township facilities, and investigation of parts of the stormwater system.

Municipalities are classified as either Tier A or Tier B under the stormwater rules. Woolwich is listed among the Tier B municipalities, which have relatively low population levels and densities in the state, and less stringent requirements than Tier A municipalities.

Woolwich Township addressed the NJPDES permit requirements with its February 2006 Stormwater Management Plan, which adopted the performance standards set out in N.J.A.C. 7:8-5. The plan includes operation and maintenance measures for stormwater facilities for new major development projects, build-out analyses for the township and its HUC-11 watersheds, and low impact development recommendations for mitigating stormwater runoff, among other elements. In 2006, Woolwich also enacted its stormwater management ordinance, which regulates erosion and sedimentation on major construction sites.

The township has taken action to implement its stormwater management program, most notably working with South Jersey Land and Water Trust, Camden County Soil Conservation District, and Rutgers University in 2014 to retrofit three stormwater retention basins (**Figure 23**). The land around stormwater retention basins conventionally is mowed to the edge of the basin. However, the retrofitting process establishes a variety of trees, shrubs, or native plants around the retention basin. These species can absorb additional stormwater and recharge it to the ground, which can help prevent the basins from flooding. They can also trap nonpoint-source pollutants carried by stormwater that might otherwise enter the basins. The naturalized basins provide additional benefits in the form of site beautification, additional habitat for animal species, and reduced site management costs as less mowing is needed.

Figure 23: Volunteers Installing Plants in Naturalized Basin

Source: Matt Blake

The basins are located at the Woolwich Township Municipal Complex, General George Harker School, and Meadowlark Drive along Oldmans Creek. The first two basins include a native meadow plant mix of drought-resistant grasses and wildflowers for butterflies and other pollinator species. These basins were plowed and seeded by the township's Public Works Department. The third basin, along Meadowlark Drive, is owned by a Homeowner's Association and tapped local volunteers to install 230 trees and shrubs. The township hopes that these projects will demonstrate to other retention basin owners, especially Homeowner Associations, that these naturalization projects are valuable to the community and easy to build and maintain.

Woolwich has run several local public education initiatives around stormwater. The Department of Public Works has hung banners at Locke Avenue Park/High Hill Park with water quality information developed by NJDEP. The township hung a poster, also with water quality information developed by NJDEP, at Woolwich's municipal building. Woolwich also included an article on fertilizers and stormwater in its 2018 spring/summer mailing. The township has labeled stormwater drains in the Lexington Hill and Poplar Point neighborhoods to show residents where these drains are located and thereby reduce dumping. The township also partnered with the Boy Scouts of America in early 2019 to add labels to stormwater drains in High Hill Estates.

Municipalities may adopt more restrictive stormwater regulations than those required by New Jersey, which sets minimum requirements. All development, regardless of its size or how it is regulated, should have its effect on stormwater considered.

The following is a brief set of guidelines for municipal stormwater managers to ensure compliance with the Tier B Municipal Stormwater General Permit. Municipalities comply with this permit through a stormwater program to reduce the discharge of pollutants from the municipality's MS4s and a Stormwater Pollution Prevention Plan that helps implement a series of policies and programs, known as the Statewide Basic Requirements.

Stormwater Management Statewide Basic Requirements include the following:

1. Control post-construction stormwater management in new development and redevelopment through:

    - Adoption of a stormwater management plan in accordance with N.J.A.C. 7:8;
    - Adoption and implementation of a stormwater control ordinance in accordance with N.J.A.C. 7:8; this ordinance requires retention on site of 100 percent of preconstruction recharge, and use of low-impact design in stormwater facilities, among other features;
    - Ensuring compliance with Residential Site Improvement Standards for stormwater management; the RSIS has been revised to incorporate the low-impact design and other requirements of the stormwater control ordinance;
    - Ensuring long-term operation and maintenance of Best Management Practices on municipal property; and
    - Requiring that new storm drain inlets meet new design standards.

2. Conduct local public education:

    - Distribute educational information (about stormwater requirements, nonpoint source pollution, and stewardship) annually to residents and businesses and conduct a yearly “event” (such as a booth with these messages at a community day);
    - Have all municipal storm drain inlets labeled with some type of “don’t dump” message;
    - Distribute information annually regarding fertilizer/pesticide application, storage, disposal, and landscaping alternatives and regarding proper identification, handling, and disposal of wastes including pet waste and litter; and
    - Adopt specific ordinances to control waste disposal and other nonpoint sources.

Floodplains and Stormwater

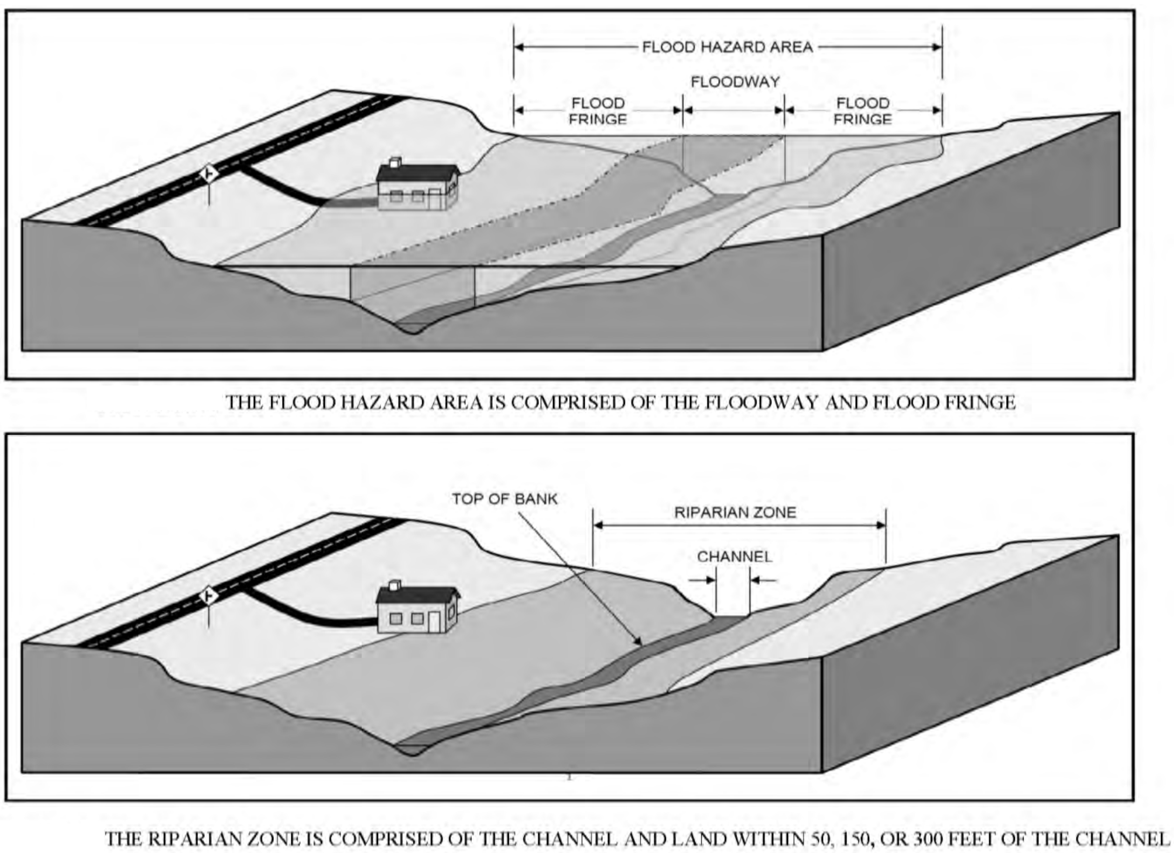
Floodplains

Areas naturally subject to flooding are called floodplains, or flood hazard areas. Floodplains encompass a floodway, which is the portion of a floodplain subject to high velocities of moving water, and the adjacent flood fringe, which helps to hold and carry excess water during overflow of the normal stream channel.

The 1-percent floodplain, also known as the 100-year floodplain, is defined as the land area that will be inundated by the overflow of water that has a 1 percent chance of occurring in any given year (the 100-year flood). The probability of flooding is computed based on historical river flows and flood events. At least ten years of data is required to calculate flood probabilities. This number represents a moving average and can be periodically recalculated to account for changes in flood trends in an area.

Floodplains require protection in order to prevent loss of or damage to property constructed on them. Equally important is the preservation of the aquatic communities that exist in floodplains. As food for many other species, these aquatic communities support the aquatic ecosystem as a whole. In addition, floodplains remove and mitigate various pollutants dissolved in stormwater, particularly fertilizer, when vegetation located within them absorbs the pollutants through their roots. The vegetation can also physically trap nutrients and sediments and prevent them from traveling farther downstream. All efforts to keep development out of floodplains will help to preserve the flood-carrying capacity of streams and their water quality.

Figure 24: Flood Hazard Area and Riparian Zone Definitions



Source: NJDEP, NJAC 7:13

New Jersey regulates construction in the flood hazard area under the Flood Hazard Area Control Act, N.J.S.A. 58:16A-50 et seq., and its implementing rules at N.J.A.C. 7:13. The areas of the floodplain regulated by this law are depicted in **Figure 24**. Full text of the revised Flood Hazard Area Control rules and other additional information on floodplain activities is available from NJDEP Division of Land Use Regulation and from its website under “Land Use.” See the **References** section (page 126).

Woolwich's floodplains are depicted in this study (**Figure 25: Floodplain [2010]**) using digitized coverage of the Federal Emergency Management Agency's (FEMA's) Flood Insurance Rate Maps (FIRMs). The boundaries of the 100-year and 500-year floodplains shown on the FIRMs were digitized from their original paper version by NJDEP in the late 1990s, and floodplain boundaries in New Jersey have been updated several times since then, including in 2010; **Figure 25** uses the boundaries from that year. This update indicates that 1,018 acres, or 7.2 percent of the township's land area, falls within the 100-year floodplain (see **Table 14: Floodplain Area**). An additional 27 acres, or 0.2 percent of the township's land area, falls within the 500-year floodplain.

Table 14: Floodplain Area

Floodplain Zone	Acreage	Percentage
None	12,614.14	92.35%
1 Percent/100-Year	1,017.55	7.19%
0.2 Percent/500-Year	26.86	0.20%
Total	13,658.55	

Source: FEMA, 2010

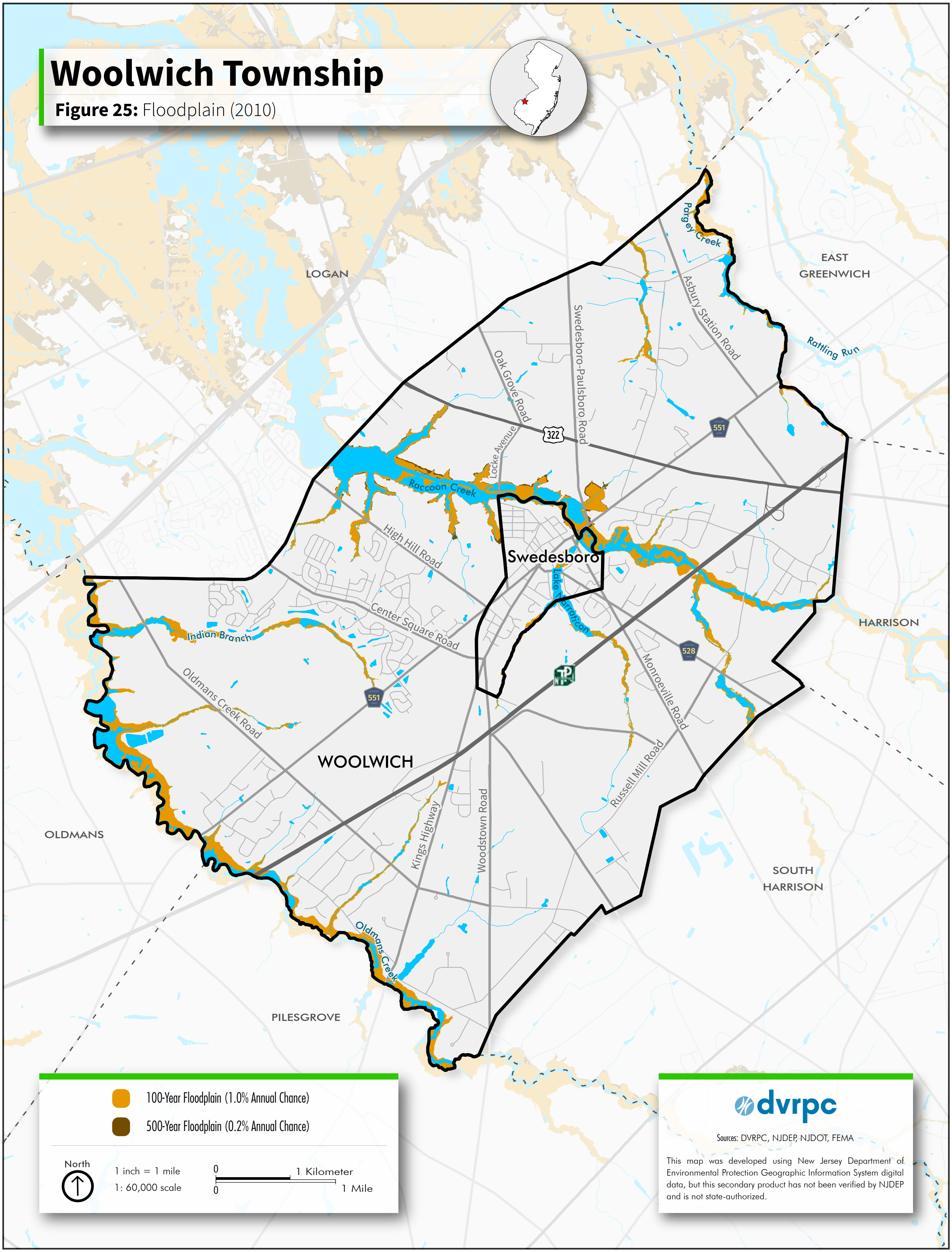
Woolwich's largest floodplain areas are located along Oldmans Creek, Raccoon Creek, Indian Branch Creek, and Pargey Creek. Most of the land in these floodplains is undeveloped, being occupied by forests, wetlands, and some farmland.

FEMA periodically calculates base flood elevations for water bodies throughout the United States. The agency defines *base flood elevations* as the height to which waters are expected to rise during a 100-year flood event. Within Woolwich, FEMA has developed base flood elevation estimates for tidal segments of Raccoon Creek and Oldmans Creek in the western half of the township, and for Indian Branch Creek. FEMA has calculated the base flood elevation as ranging between eight and nine feet within the examined sections of Raccoon Creek and Oldmans Creek, and as eight feet within Indian Branch Creek.

Municipalities can use the base flood elevation to anticipate typical flood heights expected for that water body as the result of a 100-year storm. Municipalities can also use the base flood elevation in regulations to ensure that development is constructed above that elevation.

Woolwich Township

Figure 25: Floodplain (2010)



Impervious Coverage

The volume of stormwater runoff that is carried to a stream also affects the condition of the stream channel. Increased volumes of stormwater usually result from increased impervious surface. As an area becomes developed, greater volumes of stormwater, flowing at higher speeds, are directed from neighborhood storm drains, residential and commercial stormwater facilities, and road drainage into streams. In general, scientists have found that levels of impervious cover of 10 percent or more within a watershed are directly linked to increased stormwater runoff, enlargement of stream channels, increased stream bank erosion, lower dry weather flows, higher stream temperatures, lower water quality, and declines in aquatic wildlife diversity. When impervious cover reaches 25 percent to 30 percent within a watershed, streams can become severely degraded.

Because development is not the dominant land use in Woolwich, impervious cover is a moderate rather than a major problem within the township. The majority of the township, or about 85 percent, has impervious surface coverage of 10 percent or less. See **Figure 26: Impervious Surface Coverage (2017)** and **Table 15: Acres at Impervious Surface Thresholds**. However, continued development in Woolwich that does not capture stormwater onsite and return it to the ground could further degrade the township's waterways.

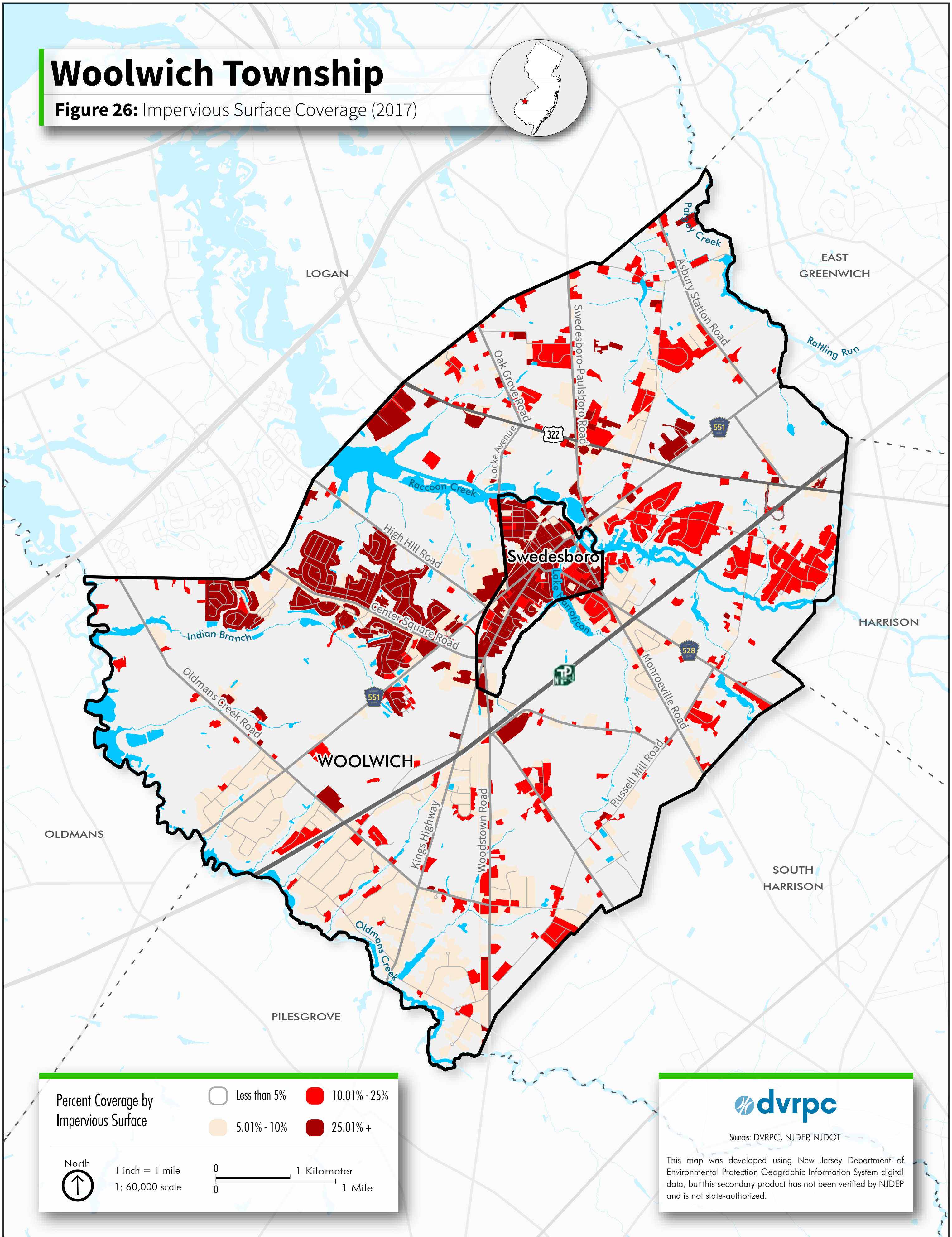
Table 15: Acres at Impervious Surface Thresholds

Impervious Surface Coverage	Acres	Percentage
Less than 5%	9,689.49	70.94%
5.01% to 10%	1,970.66	14.43%
10.01% to 25%	1,069.70	7.83%
Greater than 25.01%	928.15	6.80%
Total	13,658.00	

Source: NJDEP 2012

Woolwich Township

Figure 26: Impervious Surface Coverage (2017)



dvrpc

Sources: DVRPC, NJDEP, NJDOT

This map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state-authorized.

Stream Buffers and Greenways

Vegetated stream buffers (**Figure 27**) are one strategy for reducing the effects of stormwater runoff. The stream buffer is an area comprised of a stream channel and the land immediately adjacent to the channel. Stream buffers are quite effective at filtering substances that would otherwise be carried into streams by floods or stormwater; they can limit the entrance of sediment, pollutants, and nutrients into the stream itself. The vegetation located within the buffer area traps sediment and can absorb some of the nutrients in fertilizer that flows to the stream from lawns and farms. When a stream buffer contains enough trees and large shrubs to create a strong root system and shade, this vegetation can stabilize the stream banks and control the stream's water temperature.

The buffer can also serve as a green corridor (also known as a "greenway") that gives wildlife greater mobility between larger forested habitat areas, enabling it to find food, shelter, or other resources. People can also use greenways for recreation. The linear nature of greenways makes them well-suited for jogging, walking, and biking. They can also be used for fishing or boat launching if they contain access points to the water. In aesthetic terms, greenways can also help preserve the pre-industrial or pre-suburban character of a community, providing a sense of visual relief. Overall, protected greenways and riparian corridors can enhance a community's quality of life, improve water quality and reduce flooding, increase property values, provide tourism and recreation opportunities, encourage biodiversity, and increase the economic value of a community.

Figure 27: Riparian Buffers at Warrington Millpond

Source: DVRPC

The importance of a healthy, intact riparian buffer zone has been well documented scientifically over the past 20 years, especially for headwater streams. There is less agreement and much continuing research on the appropriate minimum width of a buffer. In addition to restrictions of development in the floodplain (discussed in the **Floodplains** subsection on page 63), New Jersey state law requires a 50-foot buffer along most streams, although municipalities can establish wider buffers. In the scientific literature on this issue, a recommended minimum buffer width of 100 feet is most common. Buffers of up to 300 feet are required in New Jersey for Category 1 waterways and are recommended for wildlife corridors and potential passive recreational use, such as walking trails.

NJDEP's 2012 Land Use and Land Cover map (**Figure 5**) shows that most of the streams in Woolwich Township are bordered by riparian buffers of a protective width. However, some stream buffers are very narrow or nonexistent, especially in more developed areas of the township and along some farm properties.

An Important Birding Area (IBA), the "Oldmans, Raccoon, Birch Creeks and Pedricktown Region," is located in Woolwich Township. Much of the habitat that makes it an IBA is located in Woolwich's creeks and riparian buffers. This IBA, which is defined by the National Audubon Society, is discussed further in the **Birds** subsection (page 95).

Environmental commissions can encourage the preservation of existing vegetation and replanting of native vegetation along bare stream banks. Use of native vegetation in landscaping minimizes the need for pesticide and fertilizer use, and requires less frequent watering and mowing.

Groundwater

The geology of the New Jersey Coastal Plain can be visualized as a tilted layer cake, with its "layers," or strata, formed of gravels, sands, silts, and clays. The saturated gravel and sand layers, with their large pore spaces, are the *aquifers* from which water is drawn. The silt and clay layers, which impede the movement of water, are called *confining beds*.

A cross section across southern New Jersey from west to east would show that the aquifers are not horizontal, but tilted toward the southeast, getting deeper as they cross the state toward the Atlantic Ocean. Because of this tilting, each aquifer emerges on the land surface in a sequential manner. The deepest and oldest strata emerge on the surface near the Delaware River. Where each individual layer emerges is called its outcrop area. The Potomac-Raritan-Magothy formation, the deepest and most abundant aquifer, is a major water source for Inner Coastal Plain communities and provides much of Woolwich Township's water.

Other smaller aquifers on top of the Potomac-Raritan-Magothy formation are the Englishtown and the Mount Laurel-Wenonah. The two thick layers that overlie these older formations, beginning east of the inner/outer coastal plain divide, are the Kirkwood (lower) and the Cohansey (on top), which are so similar to each other that they are usually given a combined, hyphenated name. See **Figure 7: Geology**.

Aquifers and Confining Units

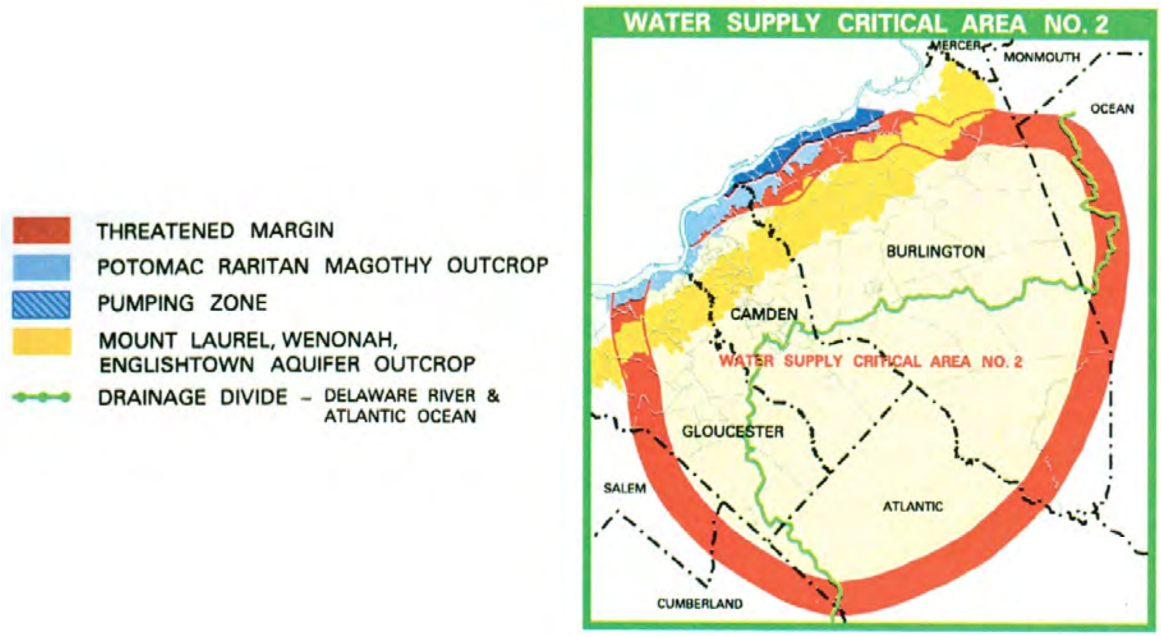
Potomac-Raritan-Magothy Aquifer

The Potomac-Raritan-Magothy is a principal geological formation underlying Woolwich Township and is the primary source of drinking water for Woolwich's public wells. This multiple aquifer is actually a large series of formations that have been combined and described as a single unit because the individual formations—the Potomac group and the Raritan and Magothy formations—are indistinguishable from one another over large areas of the Coastal Plain, as they are composed of materials of like kind and size laid down by both an advancing and retreating sea across southern New Jersey and by deposits of material that came from the breakdown and erosion of the Appalachian and Catskill Mountains beginning in the Cretaceous Period (60 to 150 million years ago).

In the Delaware Valley, three aquifers designated as lower, middle, and upper have been distinguished within the Potomac-Raritan-Magothy system. These aquifers are divided by two confining units. The aquifers are largely made up of sands and gravels, locally interbedded with silt and clay. The lower aquifer sits on the bedrock surface. The confining units are composed primarily of very fine-grained silt and clay sediments that are less permeable and thus reduce the movement of water between the aquifers. They also help to slow the entry of any contaminants on the surface down into the groundwater.

The Potomac-Raritan-Magothy is the primary source of drinking water to New Jersey residents from Burlington to Salem counties, as well as to communities in Delaware. Because of such high usage, the levels of water in this aquifer declined to such low levels that NJDEP established the region as a water supply critical area (Critical Area Number 2), as shown in **Figure 28: Extent of Water Supply Critical Area Number 2**. All water supply companies and authorities within this area have annual limits on water withdrawals from the Potomac-Raritan-Magothy aquifer.

Figure 28: Extent of Water Supply Critical Area Number 2



Source: DVRPC

Woolwich Township is outside the boundary of the Critical Area, but close to it. There is increased concern that additional pumping from the aquifer in the borderline areas will necessitate the expansion of the Critical Area boundaries. Thus, water supply companies in Gloucester and Salem counties have and will continue to have difficulty getting approvals from the NJDEP for any additional water allocations from the Potomac-Raritan-Magothy.

In Gloucester and Salem counties, use of the lower Potomac-Raritan-Magothy aquifer for drinking water is limited due to high chloride concentrations (salt water intrusion). This is thought to be very ancient seawater within the lower aquifer, resulting from movement from the southeastern side, which is in contact with ocean water. Whatever the cause, the lower aquifer is not usable for drinking supply in much of its extent.

Other Aquifers

There are other smaller aquifers on top of the Potomac-Raritan-Magothy in Woolwich. These include the Englishtown and the Mount Laurel-Wenonah aquifers. Both aquifers are shallow in the Woolwich vicinity and neither is a major source for drinking water by residents. However, individual private wells may use these aquifers, particularly if they are older, shallow wells. Many farms in Woolwich rely on the Mount Laurel-Wenonah aquifer to irrigate their crops.

Outcrops

The outcrop area of the Potomac-Raritan-Magothy, where it tilts upward to the surface, is under and immediately beside the Delaware River. River water actually enters and recharges the upper and middle Potomac-Raritan-Magothy aquifers. The Englishtown formation crops out to the east of the Potomac-Raritan-Magothy outcrop, on the west side of Woolwich. The Mount Laurel-Wenonah outcrops through the eastern two-thirds of the township. In addition, a small portion of the Kirkwood-Cohansey aquifer also outcrops in Woolwich, east of the New Jersey Turnpike.

These three aquifers above the Potomac-Raritan-Magothy are sources of irrigation water for agriculture in the township and they are a very significant drinking water supply to county residents living to the east of Woolwich. Because an outcrop is the area where the aquifer emerges on the land surface, preventing contamination of the land in outcrop areas is extremely important in order to maintain a safe drinking water supply.

Groundwater Recharge

Recharge of groundwater is an important issue in southern New Jersey because of the dependence on aquifers for drinking water supply and agricultural use. The amount of rainwater that actually enters an aquifer and reaches the saturated zone to become groundwater is a function of many factors, including the nature and structure of the aquifer itself, climatic conditions, the nature of the soil, and the vegetation of an area.

The New Jersey Geological Survey (NJGS) has developed a methodology for evaluating land areas for their ability to transmit water to the subsurface, using precipitation records, soil surveys, and land use/land cover data. NJDEP has used this methodology to map the groundwater recharge potential of land areas throughout the state. *Recharge* is equivalent to the amount of precipitation per year that could reach the water table in an area with a particular combination of soils and land use. It is expressed as inches per year.

It should be noted that the NJGS methodology is limited. The NJGS has stated that this method only evaluates groundwater recharge potential, not aquifer recharge, and should be considered accordingly. Groundwater recharge potential is not the same as aquifer recharge, which the NJGS has defined as the recharge rate for those geological formations that yield economically significant quantities of water to wells.

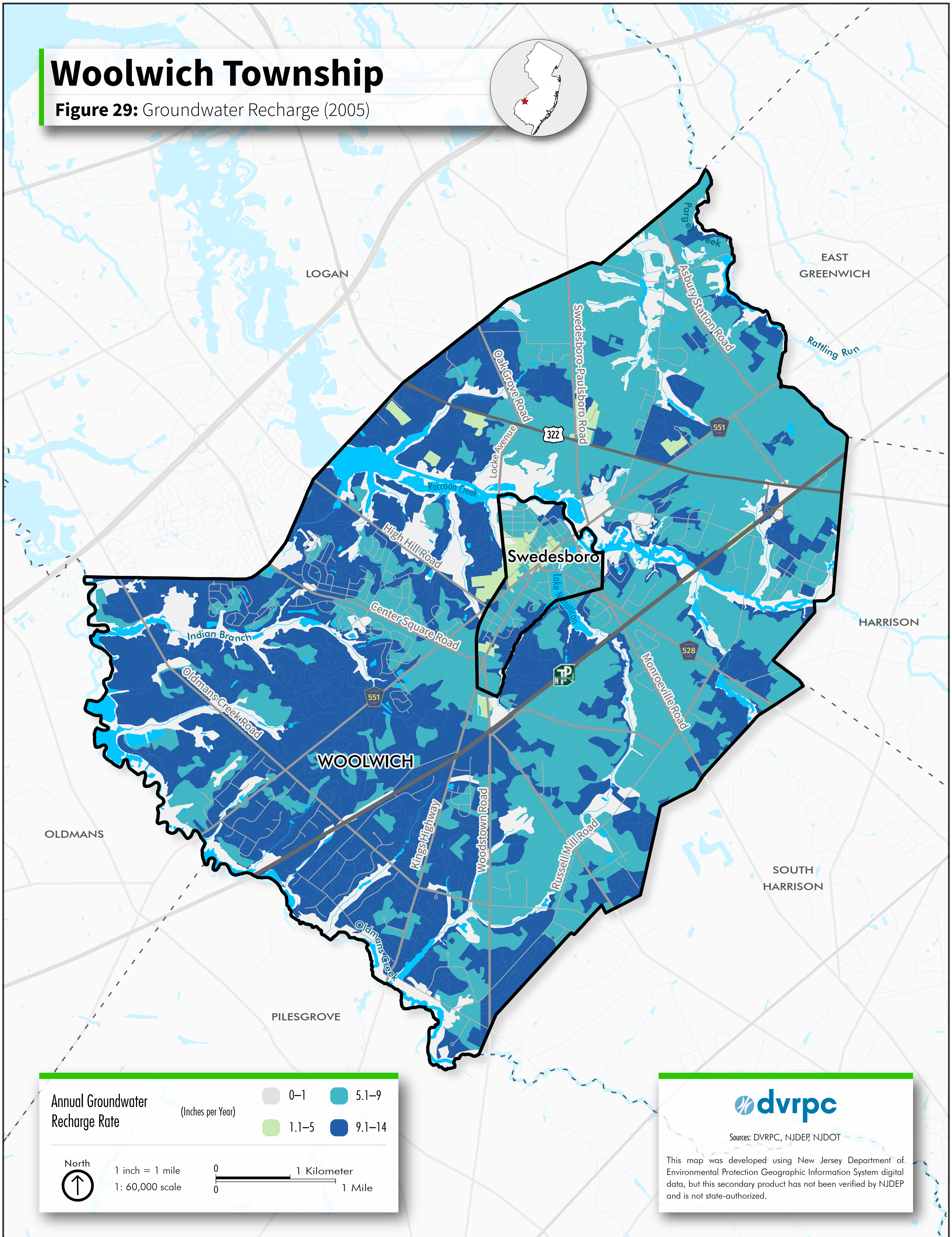
The majority of the land in Woolwich Township has a high groundwater recharge potential: 42 percent of the township has high potential recharge rates of between 10 and 14 inches per year and 41 percent of the township experiences moderate recharge rates of six to nine inches per year. Areas with high groundwater recharge rates often occur in undeveloped upland areas, especially those underlain by permeable soils. Sixteen percent of Woolwich, however, has no groundwater recharge. This land includes urban areas, which experience very low recharge because of their impervious surface cover. Wetlands are also low-recharge areas because they are already saturated. Further conversion of pervious land into impervious land in Woolwich would likely decrease the rate of possible groundwater recharge, especially if it occurred in the township's high-recharge areas. See **Figure 29: Groundwater Recharge (2005)**.

In general, on high recharge lands, large amounts of paving and high impervious cover will have the most detrimental impact, although they are also usually the places that are most suitable for building because they are on well-drained soils. These are also regions where the dilution of substances from septic systems, such as nitrates, may require a larger land area because the soils are usually more "porous." For example, minimum average lot sizes of two to four acres are often needed for proper nitrate dilution from septic systems in areas having ten or more inches per year of groundwater recharge.

While the surest way to protect groundwater recharge is to leave land undeveloped, there are ways in which urbanized areas can preserve ground and stormwater standards. Best Management Practices (BMPs), such as tree trenches, bioswales, rain gardens, rain barrels, and porous pavement, can be used with great success to capture, treat, and infiltrate precipitation in developed areas from all but the most significant storm events. Also referred to as “green stormwater infrastructure,” these techniques are used in more developed communities to manage stormwater and protect drinking water supplies.

Woolwich Township

Figure 29: Groundwater Recharge (2005)



Annual Groundwater Recharge Rate (Inches per Year)

- 0–1
- 1.1–5
- 5.1–9
- 9.1–14

North

1 inch = 1 mile
1: 60,000 scale

0 — 1 Kilometer
0 — 1 Mile

dvrpc

Sources: DVRPC, NJDEP, NJDOT

This map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state-authorized.

Over the last several decades, in spite of increased development, groundwater levels in the majority of observation wells within Woolwich Township have risen. As seen in **Table 16: USGS Groundwater Observation Wells**, which shows the wells in Woolwich that are still operational or were monitored relatively recently, the water level has risen each well, indicated by a decreased depth below the surface over time. These wells all monitor the upper, medium, or lower layers of the Potomac-Raritan Magothy system, which, as previously discussed in this section, has pumping restrictions.

Table 16: USGS Groundwater Observation Wells

Observation Site Number	Site Name	Depth of Well (feet)	Depth of Hole (feet)	Date of First Observation	Water Level (ft below land surface)	Date of Last Observation	Water Level (ft below land surface)
394132075192401	151841-- MW-1	242	270	8/22/2013	58.2	12/6/2018	49.15
394257075182502	151040-- Dom 2	87	93	4/20/1988	46.00	12/17/2013	39.44
394350075191001	150339-- Ind 1	267	Not listed	4/1/1969	110.0	12/7/2018	108.92
394350075191601	151104-- MW 3	40	40	11/10/1993	21.50	12/7/2018	13.80
394352075194101	151842-- MW-2	273	285	8/30/2013	122.00	12/6/2018	114.85
394433075201202	151487-- Woolwich MW-4	525	540	6/25/1998	122.00	12/5/2018	113.77
394434075201201	151484-- Woolwich MW-3	300	310	11/6/1998	118.44	12/5/2018	112.99
394518075164001	150344-- NJTA Int 2	83	Not listed	12/1/1998	12.95	2/4/2019	8.67
394523075161001	150378-- Maint 1	239	239	12/1/1988	125.60	12/19/2013	117.60
394553075192002	151031-- MW-1B	105	105	11/17/1988	56.29	11/28/2018	27.09

Source: USGS National Water Information System: Map View, 2018

Public Water Supply Wells

Public water supply wells, which may be publicly- or privately-owned, are defined as those that serve at least 25 people or 15 service connections for at least 60 days per year. According to the EPA, public water supply wells serve 90 percent of people in the United States with drinking water. Woolwich contains four public water supply wells, all of which are owned by Aqua New Jersey, Inc. and located on Center Square Road (**Figure 30: Public Water Supply Wells**). They are part of the Weatherby housing developments.

As required by federal and state regulations, public water supply wells in the state are monitored by NJDEP on a regular basis. Sampling requirements for a water system may change at any time for several reasons, including analytical results, changes in population, or inventory. It is generally the responsibility of the public water system and its licensed operator to make sure proper monitoring is performed for the entire distribution system and each point of entry for all parameters. Sampling requirements may be confirmed by referring to the Code of Federal Regulations (40 CFR 141) and the New Jersey Safe Drinking Water Act Regulations (N.J.A.C. 7:10).

Drinking Water

Until 1998, when residents first began moving into the Weatherby development, all water for residences and commercial properties in Woolwich was provided by private wells, most of which served a single user. Private wells are still used in the township, but the township also receives drinking water from community water-supply systems. Aqua New Jersey serves 6,206 Woolwich residents, primarily in the Weatherby developments. The Swedesboro Water Department serves about 240 Woolwich residents living near Swedesboro, for example in the Lakeside development on Route 538.

All public wells in Woolwich (**Figure 30: Public Water Supply Wells**) draw on the Potomac-Magothy-Raritan aquifer. Most private wells also probably do so. Other water-bearing formations that have their western edge in Woolwich are too shallow for municipal drinking water supply but may be used by individual, private well owners, particularly if a well is older. There is no comprehensive inventory of private wells available to municipalities. Well permits are held by the Gloucester County Health Department, but there are many gaps in the records due to various factors, including well age.

Safe Water Drinking Act

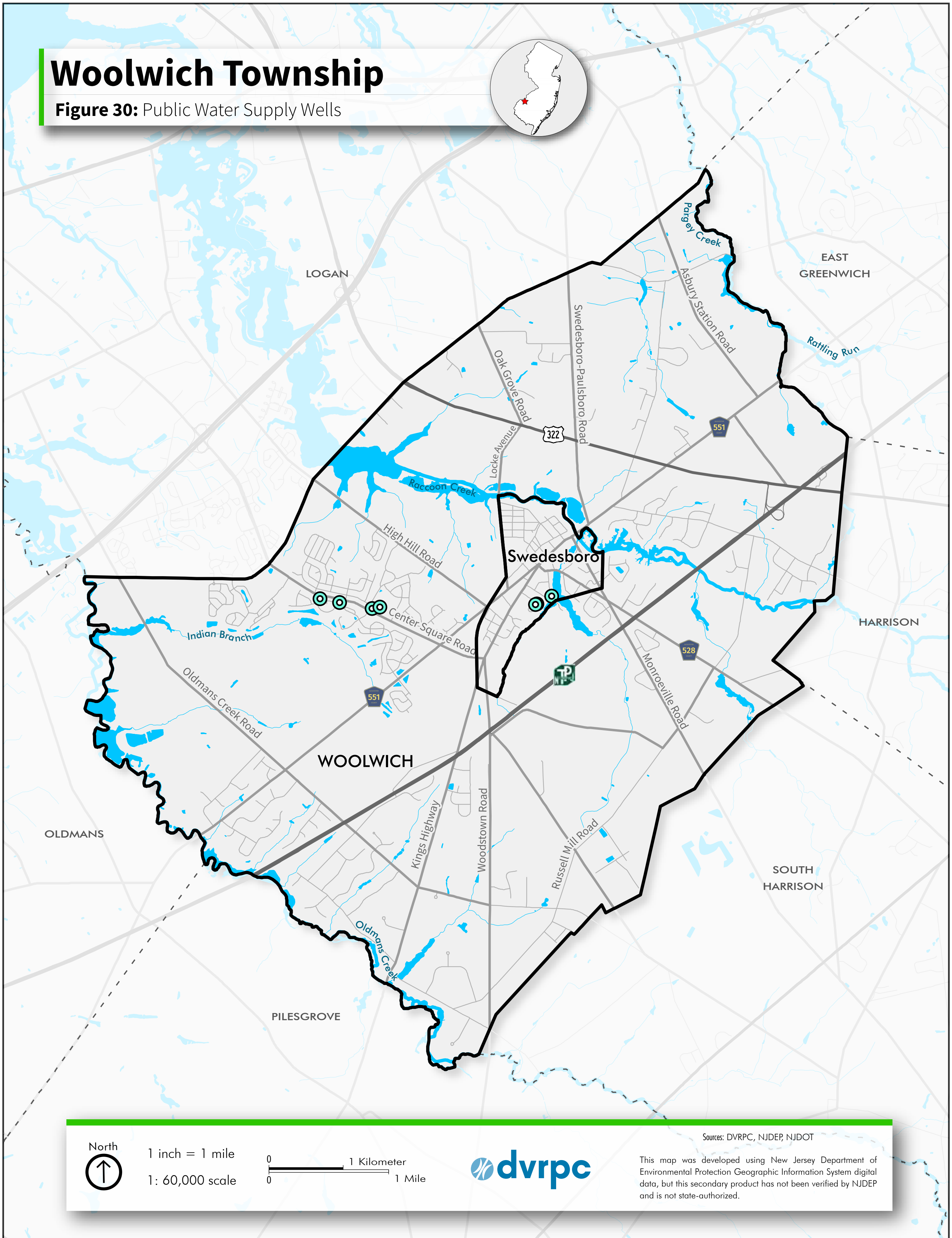
As required by state and federal regulations, most notably the 1974 federal Safe Drinking Water Act, the drinking water quality of all public water systems is regularly monitored for a variety of chemical and biological contaminants. Monitored chemical contaminants include inorganic compounds, radionuclides (i.e., radioactive compounds), and synthetic organic chemicals. The synthetic organic chemicals that are monitored include volatile organic chemicals (i.e., organic chemicals that readily become gases), pesticides, herbicides, and disinfection byproducts. Biological contaminants that are monitored include coliform and *Legionella* bacteria, as well as parasites such as *Giardia* and *Cryptosporidium*. Turbidity (or cloudiness) is also tested. Water is also tested for lead and copper at a sample number of household taps. Drinking water utilities are required to notify their customers if the levels of any monitored chemicals exceed the regulated standards.

New Jersey Drinking Water Watch, a database run by NJDEP, displays a variety of information about public water systems operating in New Jersey, including basic information about the water system; testing results for the parameters that are required to be monitored through the Safe Drinking Water Act; violations; and other data.

Since 1997, the NJDEP Division of Water Supply and Geoscience has published reports summarizing the violations of the Safe Drinking Water Act from public water systems statewide. The most recent report published online is from 2017. During this 20-year period, there was only one instance of Maximum Contaminant Level violation mentioned in the public water systems serving Woolwich Township (see **Table 17: Drinking Water Violations by Utilities**). The Maximum Contaminant Level is the national limit on contaminant level for a particular contaminant, as set by the EPA.

Woolwich Township

Figure 30: Public Water Supply Wells



Sources: DVRPC, NJDEP, NJDOT

This map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state-authorized.

Table 17: Drinking Water Maximum Contaminant Level Violations by Utilities

Utility	Public Water System Identification	Violation	Start Date of Violation	Date of Return to Compliance
Aqua New Jersey–Woolwich	NJ0824001	Coliform (Total Coliform Rule)	September 1, 2013	October 28, 2013
Swedesboro Water Department	NJ0817001	None	N/A	N/A

Source: NJDEP, 1997-2017

Aqua New Jersey was not alone in receiving the coliform violation in 2013. During that year, 362 public water systems had coliform rule violations for their concentrations of *E. coli*. Fortunately for Woolwich residents, the violation was addressed. Aqua New Jersey returned to compliance within two months after initial reporting.

Private Well Testing Act

New Jersey's Private Well Testing Act (PWTA), a state law that has been in effect since 2002, requires state-certified laboratory water testing in order to sell a residential property. It also requires landlords to test the private well water supplied to their tenants and provide their tenants with a written copy of the results. The data generated by these tests are provided to both the homeowners and the NJDEP Bureau of Safe Drinking Water. NJDEP uses the data to assess the quality of the water from private wells throughout the state. NJDEP's most recent online resource for PWTA testing data gathered for wells located in Woolwich Township is from September 2002 to April 2014. These data are summarized in **Table 18: Private Well Testing Act Data**. If the tests detect parameters in excess of the maximum contaminant level, the laboratory must notify various parties depending on the parameter, including the homeowner, public health authority, and NJDEP.

The PWTA does not require homeowners to treat private well water if an exceedance is identified. Furthermore, the secondary parameters that are tested—pH, iron, and manganese—have "recommended upper limits" rather than maximum contaminant levels. Treatment of secondary parameters may be recommended, but not required, to make the well water more aesthetically pleasing. However, for the primary contaminants listed in **Table 18**—nitrate, gross alpha particles, mercury, volatile organic compounds, and fecal coliform—local health authorities may require the installation of treatment equipment. In some instances of an acute parameter, such as coliform or nitrates, exceeding standards, the local health authority has the discretion to notify nearby homeowners and businesses.

Table 18: Private Well Testing Act Data

Parameter	Percentage of Wells that Exceeded a Maximum Contaminant Level	Number of Wells Tested Under PWTA
Nitrate	0.4%	696
Iron	82.6%	696
Manganese	19.1%	696
Gross Alpha Particle Radioactivity	0.6%	664
Mercury	0.0%	696
Volatile Organic Compounds	0.4%	696
Fecal Coliform/*E. Coli*	0.9%	696
pH	13.5%	695

Source: NJDEP, 2002-2014

Gloucester County Public Health Division

The Environmental Health Division of the Gloucester County Health and Human Services Department also contributes to local water quality protection by monitoring and certifying local drinking water sources. The county employs Registered Environmental Health Specialists, licensed by the New Jersey Department of Health and Senior Services, to periodically inspect septic systems and wells, both public and non-public, that serve as a source of drinking water. Staff also examine newly constructed drinking water wells. They determine whether all of these sources are in compliance with state and federal water quality standards, and are responsible for issuing certification for new wells after confirming compliance.

The Environmental Health Division also investigates possible water quality concerns, particularly regarding parameters that could negatively affect public health, such as mercury, volatile organic compounds, nitrates, lead, and total coliform bacteria.

Sewer

Although most of the township's residents live in areas that have sewer service, most of the land area in Woolwich is served by private septic systems for the disposal of sewage. However, some properties in the township use municipal utility authorities in neighboring municipalities. Units in the Weatherby development and the Commodore Business Park on Route 322 connect to the Logan Township Municipal Utility Authority treatment plant located on the Delaware River in Logan Township.

The township is having a new sewer collection and conveyance system constructed along the Route 322 corridor for the entirety of the King's Landing Regional Center; construction began in December 2018. Sewer flows will be transported to the Logan Township Municipal Utility Authority plant, which is currently being expanded to receive up to 500,000 gallons per day of additional approved flows. This increase is expected to meet the needs of both Logan and Woolwich.

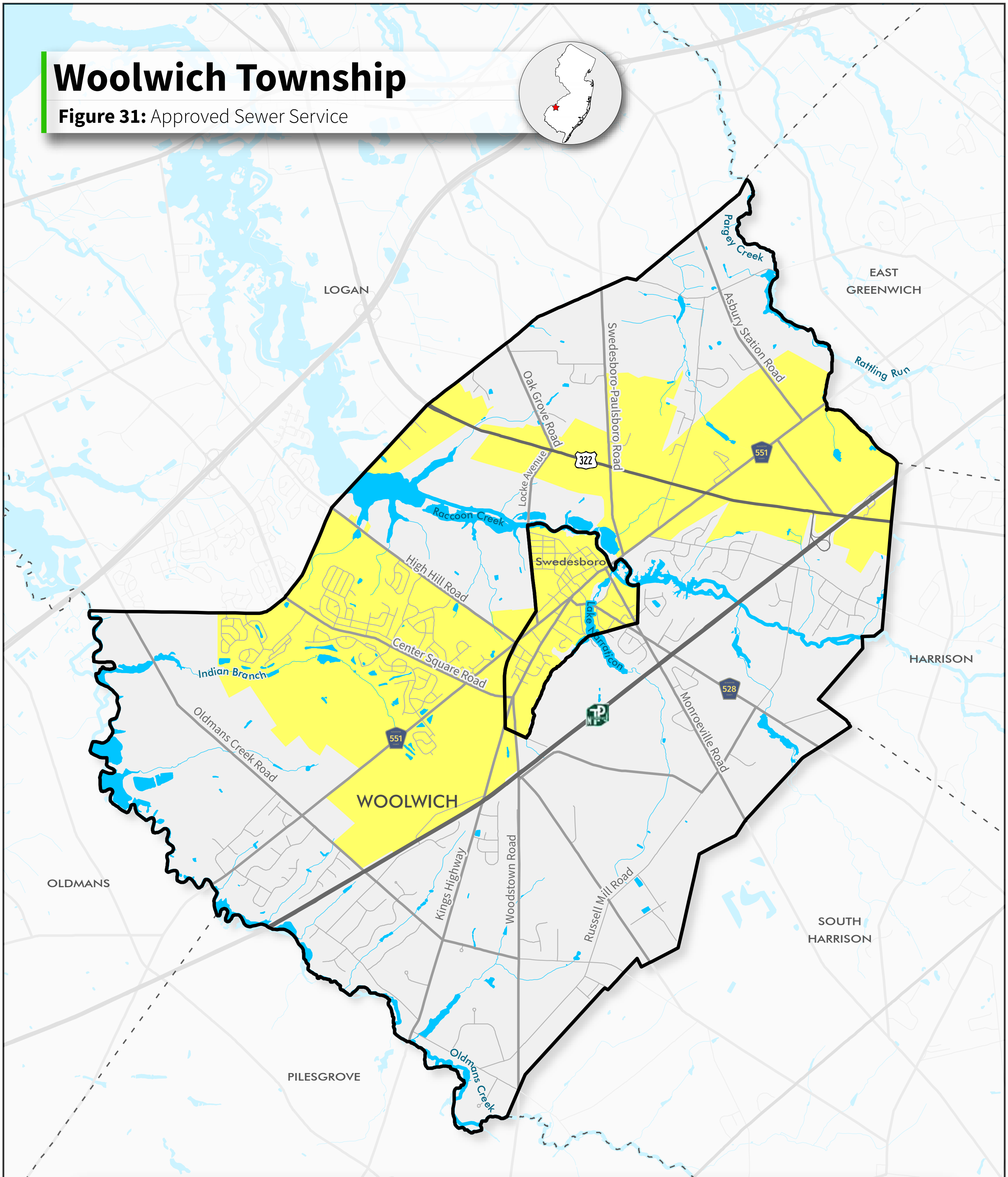
Developments along Center Square Road and Hill Road, east of Swedesboro; as well as the Kingsway Regional High School, north of Swedesboro; use the Swedesboro Municipal Utility Authority.

Figure 31: Approved Sewer Service Areas shows the location of the currently approved sewer service areas in Woolwich. The map includes existing sewer service and the pending system in the King's Landing Regional Center along Route 322. The new system will include the majority of the parcels along Route 322 that are approximately east of Grand Sprute Run, and west of the New Jersey Turnpike. Several additional parcels along Swedesboro Paulsboro Road, Kings Highway, and the New Jersey Turnpike—both north and south of Route 322—are also included in this expansion.

Among its various benefits, this sewer service expansion will enable development that will in turn make the King's Landing Regional Center function as a receiving area for transfers of development rights from farmland and open space. More farmland and open space will be permanently preserved in the township as a result. See the **TDR Plans** subsection (page 113) and accompanying figures for more information.

Woolwich Township

Figure 31: Approved Sewer Service



Sources: DVRPC, NJDEP, NJDOT

This map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state-authorized.

The Value of Biological Resources

When a community protects wildlife and habitat, it is also protecting biodiversity, which encompasses the variety of genetic material within a particular species population, the variety of species (plants, animals, microorganisms) within a community, and the variety of natural communities within a given region. Biodiversity allows species to adapt and evolve as their environment changes, improving their chances of survival, as well as those of the biological communities of which they are a part. A diversity of plant and animal species is also necessary to maintain healthy human environments, agricultural productivity, and ecosystem health. Other types of organisms, including fungi and bacteria—many of which are not well known—contribute to nutrient cycling, decomposition of organic matter, soil rehabilitation, pest and disease regulation, pollination, and water filtering. Once biodiversity declines, it is extremely hard for an ecosystem to recover or replace species.

Scientists have discovered and named somewhere between 1.5 and 1.8 million plant and animal species. Far more species—possibly ten to twenty times the number of known species—are unknown to science. Alarmingly, this great diversity of species is now diminishing at an unprecedented rate. Researchers generally agree that the extinction rate is now catastrophically high; somewhere between one thousand and ten thousand times the rate before human beings began to exert significant pressure on the environment. Given these trends, and barring significant increases in conservation efforts, approximately one-half of the world's species will be gone by the end of this century.

While the decline of biodiversity is indeed a global problem, conservation needs to occur on both global and local levels if it is to succeed. Woolwich contains numerous types of natural habitats, all of which are important for maintaining biodiversity; the most common are deciduous upland forest, deciduous dominated wooded wetlands, and old fields, but many others are represented in the township. The following sections will identify and describe in more detail the plant and animal communities that reside in these habitats within Woolwich Township.

Threatened and Endangered Species Habitat

The Landscape Project, developed by the Endangered and Nongame Species Program of the NJDEP Division of Fish and Wildlife, documents the value of various types of habitats within New Jersey. It categorizes these habitats into one of five groups according to their importance, with Rank 5 being the highest importance. Rank 3 through 5 includes habitats throughout the state that possess two exceptional conditions: (1) a documented occurrence of one or more species on either the federal or the state threatened and endangered species lists, and (2) a sufficient amount of habitat type to sustain these species. These habitats are collectively known as "critical habitat." Rank 1 and 2 includes habitats that either have a documented occurrence of a Species of Special Concern in New Jersey, or are deemed suitable for species on the state or federal threatened and endangered species lists, but for which there are no documented occurrences or sightings. These habitats are labeled "suitable habitats."

The Landscape Project identifies both critical and suitable habitat in Woolwich. It is important to preserve both suitable and critical habitats in order to maintain the diversity of species that still exist in the township and to improve the likelihood of survival for endangered and threatened species. See **Figure 32: Landscape Project Priority Habitat (2017)** and **Table 19: Landscape Project Priority Habitat**. Landscape Project areas in Woolwich Township have been observed to provide habitat for 23 rare species. These species are described in the following sections on plants and animals found in Woolwich.

Table 19: Landscape Project Priority Habitat

Rank	Rank Description	Acres
1	Habitat Specific Requirements	4,295.80
2	Special Concern	1,203.40
3	State Threatened	60.10
4	State Endangered	2,285.05
5	Federal Listed	919.63

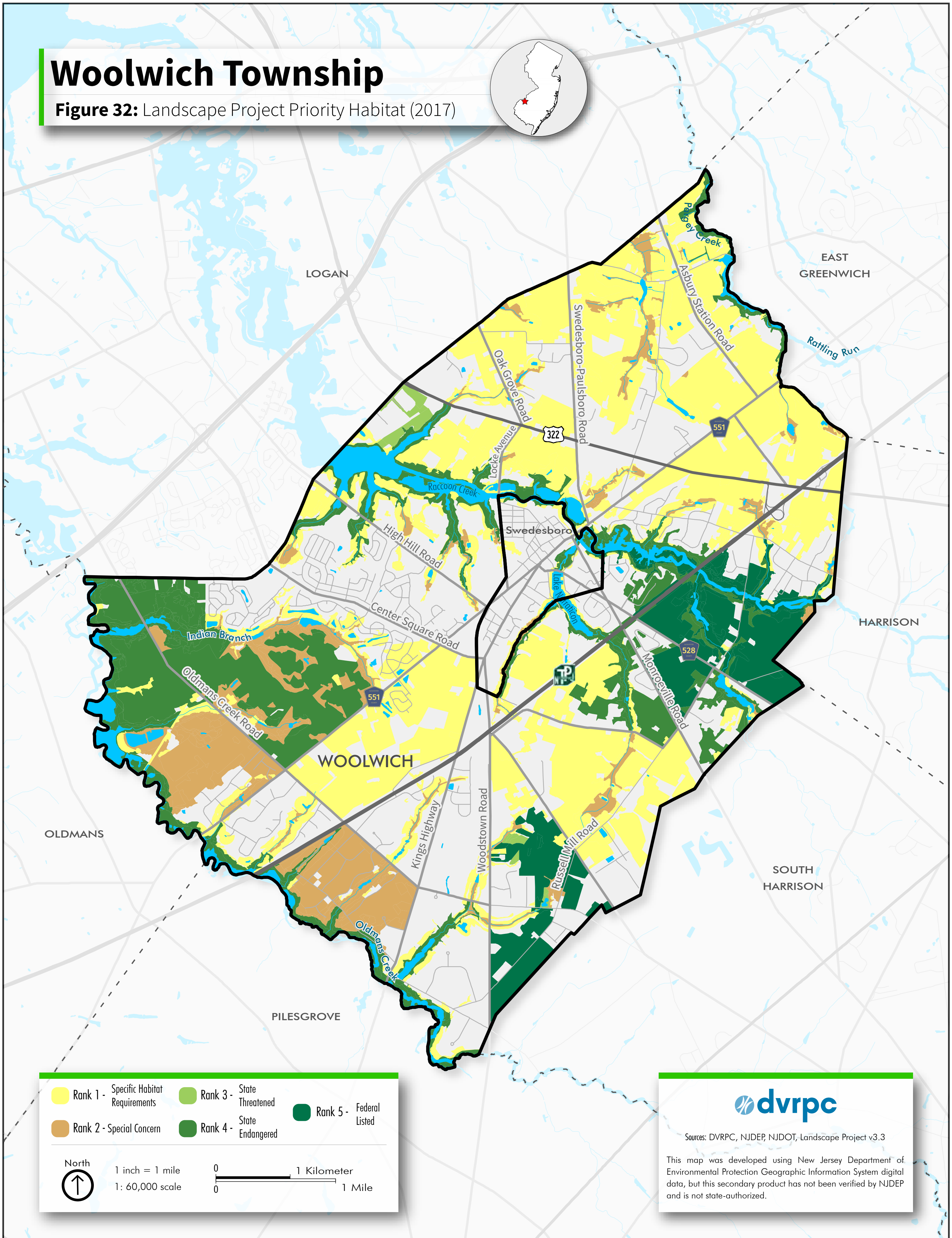
Source: NJDEP, 2017

Habitat Protection

Woolwich Township has prioritized preserving a variety of habitats within its boundaries, including forestland, wetlands and riparian areas, and farm and grassland. The township in particular is taking action to protect land on which listed endangered and threatened species, such as the bald eagle, rely. For more information on sites and areas that the township has protected or has prioritized for protection, see **Priority Sites for Protection and Stewardship** (page 118).

Woolwich Township

Figure 32: Landscape Project Priority Habitat (2017)



dvrpc

Sources: DVRPC, NJDEP, NJDOT, Landscape Project v3.3

This map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state-authorized.

Natural Vegetation

A region's vegetation is dependent on many factors, the most important of which are climate and soils. Woolwich's climate is temperate and rainfall averages about 44 inches per year. A majority of Woolwich's soils are generally well-drained, supporting a large diversity of native plant species. The township also contains poorly-drained soils that exhibit ponding and hydric characteristics, and which sustain wetland plants. For a detailed description of Woolwich's soils, see the **Soils** section on page 19.

Woolwich's natural vegetation types, along with human-influenced types of land cover, have been tabulated and mapped by NJDEP's 2012 land use/land cover analysis. The 2012 land use/land cover dataset, which is based on infrared aerial photography, is the most recent available. Each land cover type, including vegetation, is based on definitions provided by the Anderson Land Use Classification System, which was created by the US Geologic Survey. See **Figure 33: Natural Vegetation (2012)** and **Table 20: Natural Vegetation**. The main types of land cover in Woolwich are briefly described in the subsections following **Figure 33**.

Appendix A contains a record of the plant species that Natural Lands identified within the Raccoon Creek Corridor and listed in its 2013 *Stewardship Assessment Report*.

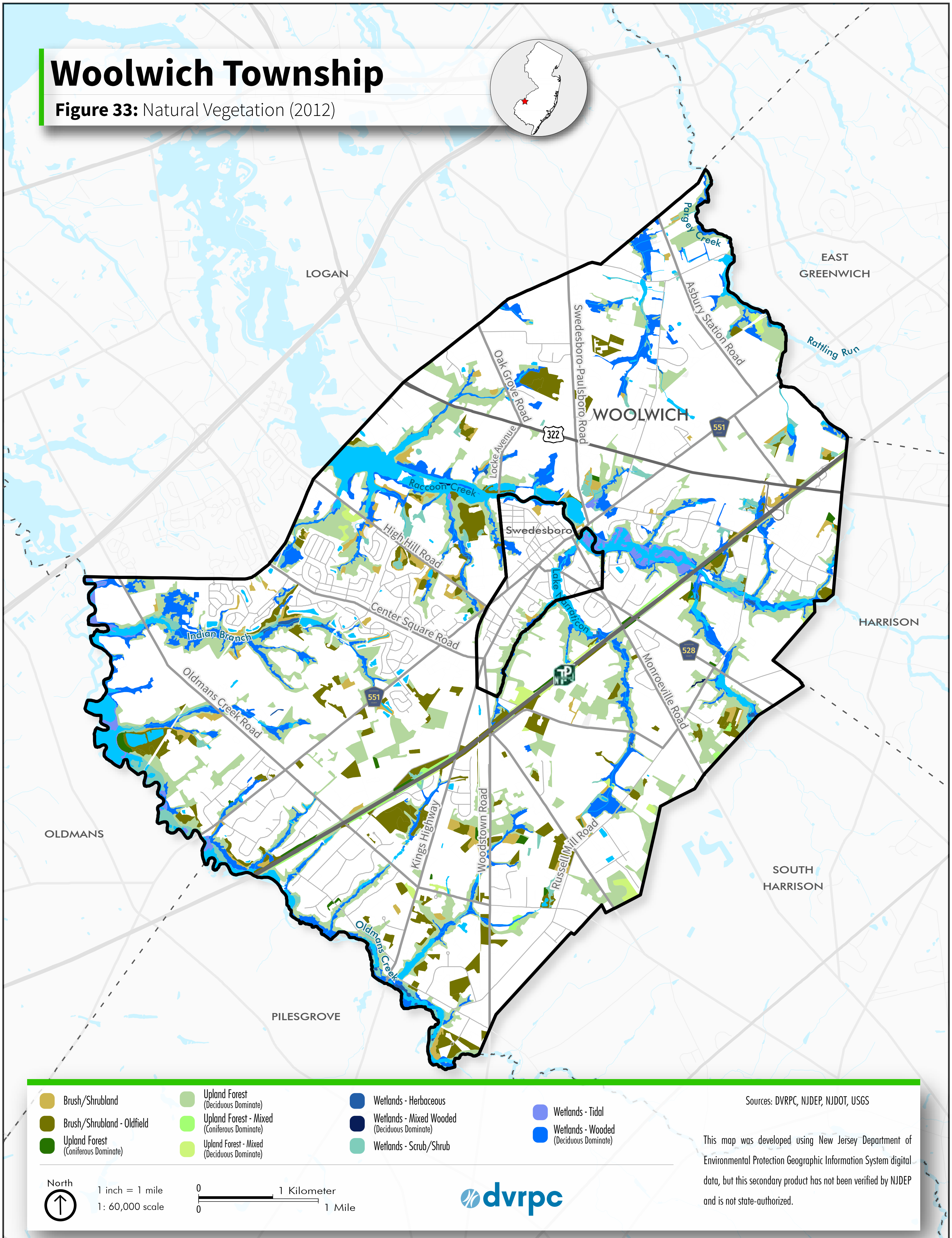
Table 20: Natural Vegetation

Type of Vegetation	Acres	Percentage of Total Land
Brush/Shrubland	177.35	1.30%
Brush/Shrubland–Old Field	525.29	3.84%
Upland Forest–Coniferous Dominate	38.82	0.28%
Upland Forest–Deciduous Dominate	1,519.57	11.11%
Upland Forest–Mixed (Coniferous Dominate)	29.65	0.22%
Upland Forest–Mixed (Deciduous Dominate)	69.89	0.51%
Wetlands–Herbaceous	45.73	0.33%
Wetlands–Mixed Wooded (Deciduous Dominate)	2.21	0.02%
Wetlands–Scrub/Shrub	201.51	1.47%
Wetlands–Tidal	153.57	1.12%
Wetlands–Wooded (Deciduous Dominate)	743.38	5.44%

Source: NJDEP, 2012

Woolwich Township

Figure 33: Natural Vegetation (2012)



Sources: DVRPC, NJDEP, NJDOT, USGS

This map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state-authorized.

Upland Forests

Forests are the third most abundant land cover type in Woolwich after agricultural land and urban land, and are the most abundant of the natural vegetation types. Upland forests (**Figure 34**) are dominated by tree cover and do not have water at or near the soil surface. The majority of Woolwich was covered with upland deciduous forests before human settlement, at which time residents began clearing forests for lumber and farmland. Most upland areas have been converted to development or to farmland, and 1,658 acres, or 12 percent of Woolwich, is now composed of natural upland forest habitat. Today's upland forests are generally second- or third-growth. They are found throughout the township, though they tend to be located near stream corridors, or are on soils or slopes less suited for agriculture or development.

Figure 34: Upland Forest

Source: Matt Blake

The composition of upland forests in the township is largely one of mixed oaks: white, black, red, chestnut, and scarlet oaks. The oaks are joined by beech, pignut and mockernut hickories, black walnut, tulip tree, and red maple. Virginia pine is also present and can be fairly extensive in some locations. The understory of upland forests is dominated by flowering dogwood, black cherry, ironwood, and sassafras. Vines are common, including Virginia creeper, wild grapes, Japanese honeysuckle, and poison ivy. Spicebush, arrowwood, and black haw are common shrubs in moister locations.

Wetlands

As was discussed in the **Surface Water: Wetlands** subsection (page 46), a wetland, in basic terms, is an area that has enough water at some time during the year to stress plants and animals that are not adapted to life in water or saturated soils. Wetlands are the fourth most common land use classification in Woolwich Township, and natural wetland habitat covers 8 percent of the township's total land, or 1,146 acres. The location and type of vegetation are key features for classifying wetlands.

Virtually all wetlands in Woolwich Township are found in association with the major streams and their tributaries. The majority of wetlands in Woolwich are forested and shrubby wetlands (scrub/shrub or herbaceous) that are located in upstream areas and along tributaries and their floodplains. These nontidal upstream wetlands are usually covered with deciduous trees or shrubs, although some evergreen trees or shrubs may be present. Woolwich's wetland forests are of three main types. Those on tidal floodplains are dominated by green ash, red maple, silver maple, and sycamore. River Birch may also be present. Smaller stream corridors and main channels above the head of tide contain forested wetlands dominated by red maple, green ash, and black gum. Wooded wetlands on upland terraces are dominated by sweet gum, with red maple also associated. Pin oak, swamp white oak, white oak, willow oak, tulip tree, and sweet bay magnolia may also be found in these forests, primarily in the nontidal regions. American Holly is frequently present as an understory tree. In some areas, pitch pine or American pine is also prevalent among the larger trees.

Figure 35: Wild Rice, Woolwich Township

Source: DVRPC

Woolwich also contains tidal wetlands, all of which are freshwater, that are associated with tidal portions of the Delaware River system. They are primarily found along the main channels of the Raccoon and Oldmans Creeks. Wild rice (**Figure 35**) is perhaps the most distinctive plant of the marshes in these regions. This annual grass can grow to be nine feet tall and is an important food source for migratory waterfowl. It is often found in association with broadleaf cattail. Other plants that grow with it are water hemp, jewelweed, pickerelweed, arrow arum, nodding beggar-ticks, sneezeweed, and spatterdock.

Wetlands are a critical ecological resource, supporting both terrestrial and aquatic animals and often boasting greater biodiversity than that found on dry land. Wetlands can play a vital role in maintaining water quality by filtering surface waters and groundwaters of contaminants and sediments. They also help regulate water quantity by serving as aquifer recharge areas. They help control flooding by storing and slowing down stormwater runoff. They also provide high-quality animal and plant habitat and food, and create picturesque and recreational landscapes that add immeasurably to the quality of life for area residents.

The physical ecological importance of wetlands, however, has not always been appreciated. For over three centuries, people have drained, dredged, filled, and leveled wetlands to make room for development and agriculture. Although the pace of wetland destruction has slowed markedly since the early 1980s, human activities have destroyed over 50 percent of the original 221 million acres of wetlands in the United States since the beginning of European settlement.

Grasslands and Agricultural Lands

Grasslands are considered to be one of the most endangered ecosystems globally. They are threatened by human development, new agricultural technology, grazing, desertification, soil erosion, and invasive species. Grasslands provide habitat for specialized species such as grassland birds and shade-intolerant herbaceous plants that cannot live elsewhere. Many species of increasingly rare grassland birds require large contiguous patches of grassland for successful breeding and roosting.

NJDEP defines grassland habitat as brushland, shrubland, or old fields that were cleared or disturbed at one time and then abandoned. Following abandonment, old fields are overgrown by perennial herbs and grasses. These pioneer plants remain the dominant species for 3 to 20 years. Later, woody plants take over in the process of habitat succession.

Grassland is often encountered along wood edges or roadsides, and in landscapes where mowing is infrequent and where woody plants are not yet the dominant vegetation. To be sustained, grasslands must be mowed every one or two years. Grasslands are also highly susceptible to invasive species.

Figure 36: Locke Avenue Park Meadow

Source: Matt Blake

Woolwich is rich in habitat for species that use grasslands and other open habitats (**Figure 36**). Five percent of Woolwich's land cover, or 703 acres, consists of brushland, shrubland, or old fields. Active agricultural cropland and pastureland is also considered suitable "grassland" habitat for wildlife, and in Woolwich, these agricultural land uses make up 40 percent, or 5,045 acres, of the township's total land area. These habitats give Woolwich a high proportion of land for grassland-dependent wildlife.

Rare Plant Species

According to the Natural Heritage Database, NJDEP's maintained list of documented sightings of threatened and endangered species, five rare plant species have been observed in Woolwich. Three additional rare species, though not listed in Woolwich in the Natural Heritage Database, have also been observed in Woolwich. They are not included in the Natural Heritage Database because the observances are considered "historic observances" or may have a less accurate recorded location.

As seen in **Table 21: Rare Plant Species**, none of the listed plant species have recorded observations in recent decades, or in some cases, in this or the past century. However, the habitat that supports these species remains, so the possibility that these species could again occur on those sites also remains.

Table 21: Rare Plant Species

Common Name	Scientific Name	Federal Status	State Status	State Rank	Last Observed
Low Rough Aster	*Aster radula*	-	Endangered	S2	1898
Chinquapin	*Castanea pumila*	-	Endangered	S1	8/1/1989
Robin-Run-Away	*Dalibarda repens*	-	Endangered	SH.1	10/1/1921
Smooth Tick-Trefoil	*Desmodium laevigatum*	-	-	S3	8/9/1985
Carolina Whitlow-Grass	*Draba reptans*	-	Endangered	SH	4/29/1918
Twisted Spike-Rush	*Eleocharis tortilis*	-	Endangered	S2	1897
Northern Manna Grass	*Glyceria laxa*	-	-	S1	8/9/1985
Climbing Fern	*Lygodium palmatum*	-	-	S2	9/9/1911

Source: NDJEP, 2017

State Rank	
S1	Critically imperiled in New Jersey (5 or fewer occurrences observed)
S2	Imperiled in New Jersey (6–20 occurrences observed)
S3	Rare in state (21–100 occurrences)

State Rank	
S4	Apparently secure in state
SH	Historically occurring but not known to be extent at the present
SH.1	Historically occurring but not known to be extent at the present; only ever documented from a single location.

Carolina Whitlow-Grass

Carolina whitlow-grass is in the mustard family (Brassica family) and is found through much of the lower 48 states. It prefers full sun and dry, sandy or rocky soil. In its short blooming period, it produces clusters of small white flowers that form flattened pods when fertilized. The leaves grow in clusters at the base of the plant, and contain many branching hairs. Unlike most Brassica plants, this grass's stem does not elongate over the plant's growing season, and is also notable for being purplish in color. Carolina Whitlow-grass is not endangered throughout the country, but it is a listed endangered species in New Jersey. Its last sighting in Woolwich was in 1918, making it a "historically occurring" species.

Chinquapin

The chinquapin (**Figure 37**), also known as "chinkapin" or "dwarf chestnut," is a deciduous small tree or shrub in the beech family. It can be found in mixed hardwood forests with well-drained soils, as well as on disturbed sites such as power line clearings, fence and hedgerows, and old fields. It produces nuts that have a sweet flavor and are edible to humans and wildlife, including squirrels, chipmunks, opossums, white-tailed deer, blue jays, woodpeckers, and other birds. This tree/shrub can be found in the eastern and southern US, but in New Jersey, it is listed as endangered and critically imperiled, with five or fewer occurrences. It was last recorded in Woolwich in 1989.

Figure 37: Chinquapin

Climbing Fern

Climbing ferns are confined to the east of the Mississippi River. This fern species is in the Lygodium family, which is a family of ferns typically located in tropical regions worldwide. The *Lygodium palmatum* species usually grows in wetlands, preferring open woods or thickets. Though a fern, it acts like a vine, growing around host plants up to eight feet. Individual fronds may grow up to 15 feet, and hand-shaped subleaflets grow along this length. The climbing fern is considered imperiled in New Jersey, but it is not a state-listed species. The last individual seen in Woolwich was recorded in 1911.

Low Rough Aster

Low rough asters, part of the large Asteraceae family, are found primarily in the northeast states. Its stems, which have a rough texture for which the plant is named, grow to a height of between 1 and 3 feet. Like other plants in the aster family, it produces tiny tube-shaped flowers on a disk, which are yellow; as well as ray flowers along the edge of the disk, which are blue to purple. This species thrives in wooded wetlands or along the edges of forests, wetlands, streams, or lakes. It is listed as endangered in New Jersey, and has not been recorded in Woolwich since 1898.

Northern Manna Grass

Northern manna grass is in the grass family (Poaceae) and grows along the eastern coast of the United States and into Canada. It is frequently found in wetlands but can grow in drier conditions. Like smooth tick-trefoil, northern manna grass is protected within the Highlands Preservation Area but not in Woolwich. It is critically imperiled in New Jersey and was last recorded in Woolwich in 1985.

Robin-Run-Away

Robin-run-away grows in the northeastern United States and around the Great Lakes, and is called by a variety of names throughout its range, including “dew-drop” in Connecticut and “false-violet” in Michigan. It is part of another large family, the Rose family. It develops small, white, sterile flowers—more noticeable than the fertile flowers located under the plant’s leaves—that resemble violet flowers, as well as dark green, heart-shaped leaves that also share a resemblance to the leaves of the violet. It is typically found in wetlands. Robin-run-away is listed as state endangered as well as historic, and it was last recorded in Woolwich in 1921.

Smooth Tick-Trefoil

Smooth tick-trefoil is non-woody perennial in the pea family (Fabaceae). It grows along wood edges, and can survive in disturbed conditions or dry or hydric soil conditions. In New Jersey, it is rare, with between 21 and 100 occurrences. It is not state-listed but is protected by the Highlands Water Protection and Planning Act within the jurisdiction of the Highlands Preservation Area. Woolwich Township is not included in this area, so the plant is not protected within Woolwich. Smooth Tick-Trefoil was last recorded in Woolwich in 1985.

Twisted Spike-Rush

Twisted spike-rush is a grass-like plant in the sedge (Cyperaceae) family. It primarily grows in the southeast United States, and prefers wetland habitat. It can grow in roadside ditches, and marshes with still or slow-moving water. It grows in clumps of long hollow stems (or “culms”) that are sometimes spirally twisted. The plant’s fruits grow as brown achenes—small, dry, one-seeded fruits. They also reproduce using rhizomes. The twisted spike-rush is listed as endangered in New Jersey and has not been recorded in Woolwich since 1897.

Animal Communities

Invertebrates

Invertebrates are the basis of a healthy environment and are part of every food chain; they provide food for amphibians and fish, and are part of the nutrient cycling systems that create and maintain fertile soils. Invertebrates consist of insects (beetles, butterflies [**Figure 38**], moths, dragonflies, ants, termites, bees, wasps, flies, and others); arachnids (spiders, ticks, and mites); crustaceans (crayfish, microscopic copepods); mollusks (mussels, clams, snails, and slugs); and worms.

Macroinvertebrates are invertebrates that are visible to the naked eye but are smaller than 50 millimeters. As mentioned in the **Water Quality Monitoring Networks** subsection (page 53), benthic macroinvertebrate communities can be monitored to track a water body's ecological health, and are relatively simple to collect from shallow freshwater stream beds. These communities consist largely of the juvenile stages of many insects, such as dragonflies and mayflies, as well as mollusks, crustaceans, and worms. Monitoring for diverse assemblages of macroinvertebrates reveals the effect of pollutants over a long period of time. The NJDEP's AMNET program surveys streams for macroinvertebrate communities, which indicate water quality levels.

Figure 38: Monarch Butterfly, Beckett Golf Club

Source: DVRPC

Municipal records of invertebrate species are rare, but are an opportunity to engage residents in monitoring the species in their backyards and neighborhoods through citizen scientist programming. Edie Dondero, Woolwich resident and chair of the Woolwich Green Team, observed and recorded butterfly species within Woolwich's 180-acre Tranquility Trails park on her own time. See **Appendix B** for this list.

Rare Invertebrates

There are ten invertebrate species listed as endangered in New Jersey. Woolwich contains one of these species, the eastern pondmussel, which was last observed in the township in 2000 (**Table 22**). The eastern pondmussel occurs from North Carolina to the St. Lawrence River Basin in Canada, and westward through northern parts of the continent's Interior Basin. In New Jersey, the species can be found in the Delaware River and several of its tributaries. It is generally found in tidewaters, and sometimes is found in ponds and lakes. Eastern pondmussels were listed as state threatened in late 2002.

Before New Jersey communities were as heavily developed as they are today, the eastern pondmussel and other freshwater mussels were abundant in the state's streams, and were a major food source, particularly for indigenous populations. Because of the destruction of suitable aquatic habitats by dams and pollution, the native mussel population has sharply declined. Federal and state enforcement of the Clean Water Act and Endangered Species Act, stream encroachment rules, and local environmental reviews of proposed development projects can help protect existing populations.

Table 22: Rare Invertebrate Species

Common Name	Scientific Name	Federal Status	State Status	State Rank	Last Observed
Eastern Pondmussel	*Ligumia nasuta*	N/A	Threatened	S2: Imperiled in New Jersey (6–20 occurrences observed)	2000

Source: NJDEP, 2017

Vertebrates

Vertebrates are less numerous than invertebrates, but their larger size makes them much more visible, and thus better studied and recorded. Fish, amphibians, reptiles, birds, and mammals are fairly well documented. A compilation of species that may be found in Woolwich Township is included in **Appendix C**.

Fish

Woolwich's rivers, creeks, and wetlands provide habitat and food to freshwater fish. Like mussels, fish were once abundant along the Delaware River and its tributaries. Water quality degradation from urban development and agricultural practices, as well as dam construction, has caused most fish populations to decline. Nevertheless, a variety of fish species, including the pond-dwelling Pumpkinseed (**Figure 39**), have been observed in Woolwich.

Figure 39: Pumpkinseed

Amphibians and Reptiles

Amphibians of some types, such as bullfrogs, are abundant. Other species are rare, in part because they depend on vernal ponds, which typically form on a seasonal basis. Amphibians may also be rare because they also depend on high-quality waterways. There are three state-listed endangered species of amphibians in New Jersey (two salamander species and one tree frog species) and three state-listed threatened species (again, two salamander species and one tree frog species). No species in these categories is known to reside in Woolwich.

Reptiles can also be quite elusive when surveys attempt to find and record them. There are eight state-listed endangered reptile species in New Jersey and three state-listed threatened species. The bog turtle, a species federally listed as threatened and state listed as endangered, is present in Woolwich Township (**Table 23: Rare Reptile Species**).

Table 23: Rare Reptile Species

Common Name	Scientific Name	Federal Status	State Status	State Rank
Bog Turtle	*Glyptemys muhlenbergii*	Threatened	Endangered	S1: Critically imperiled in New Jersey (5 or fewer occurrences observed)

Source: NJDEP, 2017

Figure 40: Bog Turtle

Bog turtles (**Figure 40**), which grow to about four inches in length, are one of the smallest turtles in North America. They have dark brown shells with brightly colored red, orange, or yellow spots on the sides of their head. They live in open, unpolluted emergent and scrub/shrub wetlands (i.e., non-wooded wetlands) in isolated areas ranging from South Carolina to upper-state New York. Bog turtles depend upon a diverse set of micro-habitats within and along wetlands for foraging, nesting, basking, hibernating, and sheltering. This habitat diversity is often lost through development, and bog turtles are vulnerable to the loss, degradation, and fragmentation of their habitat from development and from wetland alteration, pollution, invasive species, and natural habitat succession. They are also threatened by collection for illegal wildlife trade. Bog turtles were listed as a federally threatened species in 1997. They have been extirpated from much of New Jersey but have been observed within Woolwich and other communities in Gloucester County.

Birds

New Jersey is an important location for migratory birds heading south for the winter. Not only is the state an important rest stop for birds migrating to warmer climates in Central and South America, but the New Jersey Atlantic Coast and the Delaware Bay are major parts of the Eastern Flyway, an established migratory air route in North America. Common birds found in Woolwich include waterfowl, gulls, raptors, vultures, doves, sparrows, wrens, and finches.

Rare Bird Species

According to the Natural Heritage Database, thirteen vertebrate species of conservation concern exist in Woolwich, and all of them are bird species. They are listed in **Table 24: Rare Bird Species**. There are six state-listed species: one state-endangered species, the bald eagle; and five state-threatened species, including the grasshopper sparrow, bobolink, horned lark, American kestrel, and savannah sparrow. These listed species are described in greater detail after **Table 24**. There are also seven species of special concern, including the great blue heron, least flycatcher, wood thrush, yellow-breasted chat, Kentucky warbler, eastern meadowlark, and brown thrasher.

Table 24: Rare Bird Species

Common Name	Scientific Name	Federal Status	State Status	State Rank
Grasshopper Sparrow	*Ammodramus savannarum*	-	Threatened	S2B,S3N
Great Blue Heron	*Ardea herodias*	-	Special Concern	S3B, S4N
Bobolink	*Dolichonyx oryzivorus*	-	Threatened	S2B,S3N
Least Flycatcher	*Empidonax minimus*	-	Special Concern	S3B,S4N
Horned Lark	*Eremophila alpestris*	-	Threatened	S2B,S3N
American Kestrel	*Falco sparverius*	-	Threatened	S2B,S2N
Bald Eagle	*Haliaeetus leucocephalus*	-	Endangered	S1B, S2N
Wood Thrush	*Hylocichla mustelina*	-	Special Concern	S3B,S4N
Yellow-Breasted Chat	*Icteria virens*	-	Special Concern	S3B,S4N
Kentucky Warbler	*Oporornis formosus*	-	Special Concern	S3B,S3N
Savannah Sparrow	*Passerculus sandwichensis*	-	Threatened	S2B,S4N
Eastern Meadowlark	*Sturnella magna*	-	Special Concern	S3B,S3N
Brown Thrasher	*Toxostoma rufum*	-	Special Concern	S3B,S4N

Source: NJDEP, 2017

State Rank	
S1	Critically imperiled in New Jersey (5 or fewer occurrences observed)
S2	Imperiled in New Jersey (6–20 occurrences observed)
S3	Rare in state (21–100 occurrences)
S4	Apparently secure in state
B	Population number refers to the breeding population of the bird in the state
N	Population number refers to the non-breeding population of the bird in the state

American Kestrel

American kestrels live in New Jersey year-round. These birds prefer grassland and open land, including pastures and parkland in developed areas, where they hunt insects, other invertebrates, small rodents, and birds. They nest in cavities, but cannot excavate their own and so rely on natural or human-made hollows, or cavity nests created by other birds. Courting pairs may exchange gifts of food; usually the male feeds the female. The American kestrel population has declined by about 50 percent between 1966 and 2015 because of a variety of factors, including pesticides, which eliminate their food sources and affect hatching success; and clearing of nesting sites through development and farming.

Figure 41: Bald Eagle

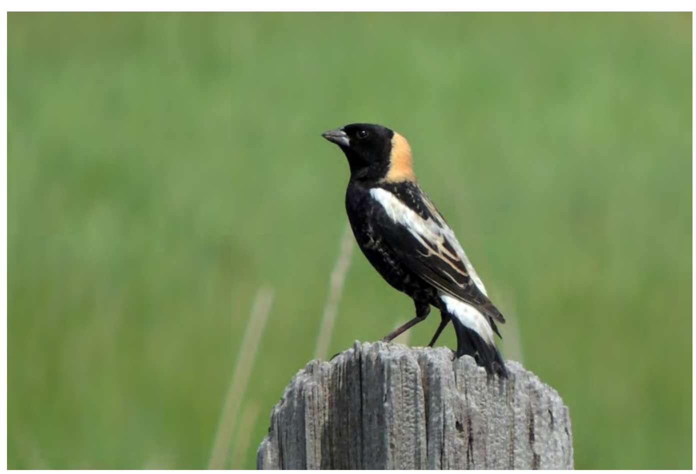
Bald Eagle

Bald eagles (**Figure 41**) can be found throughout the state year-round. They nest close to water, enabling them to hunt and eat fish and other aquatic species. According to the Conserve Wildlife Foundation of New Jersey, there are now 150 nesting pairs of eagles in the state after they were driven to the brink of extirpation (local extinction) in 1970 from the effects of the pesticide DDT. Eagles are very sensitive to human disturbance and will abandon their nest sites if people encroach on the area during the nesting season. They also continue to be affected by chemicals and heavy metals in their environment.

Bobolink

Woolwich is on the edge of the line between the bobolink's breeding territory and its migration territory. This long-distance migrant (**Figure 42**) travels between North and South America—about 12,500 miles—every year. Bobolinks breed in open areas, preferring large fields, and then move to freshwater marshes and coastal areas after breeding to prepare for migration. They eat seeds and insects in both of these habitats. Their population has declined 65 percent between 1966 and 2015, primarily due to conversion of meadows to other land cover. They are also killed or trapped along their migratory path for a variety of reasons, as people in different countries consider them pests, pets, or food sources.

Figure 42: Bobolink



Grasshopper Sparrow

Grasshopper sparrows breed in New Jersey and much of the mid-western and eastern U.S. This species lives in open grasslands and prairies, and primarily eats grasshoppers (which it paralyzes before eating), as well as other insects. Habitat loss, fragmentation, and degradation are the main causes of this sparrow's cumulative population decline of 75 percent between 1966 and 2014.

Horned Lark

Horned larks (**Figure 43**) live in New Jersey year-round. They live on prairies, deserts, airstrips, plowed fields, and other habitats or sites containing bare, dry ground. They travel in small groups during the breeding season, gleaning the ground of seeds and insects; and join large flocks, often with other species, in the winter. Horned larks are numerous, but their population has declined by 71 percent between 1966 and 2015, and the reason for this decline is not fully understood. Loss of and development upon their habitat are contributing factors, however.

Figure 43: Horned Lark

Savannah Sparrow

Woolwich is on the edge of the line between the savannah sparrow's breeding territory and its non-breeding territory. As its name suggests, this sparrow species (**Figure 44**) lives in various grasslands with few trees, including cultivated fields, grassy roadsides, and estuaries in coastal areas. They generally eat insects, which they stalk through grasses, but will eat seeds in winter. The population of this species has declined by 49 percent between 1966 and 2014, at first benefiting from the loss of forestland but then struggling from development and shifting agricultural practices from hayfields to row crops.

Figure 44: Savannah Sparrow

Important Bird Area

The Important Bird Area (IBA) is a global effort by the National Audubon Society to identify and conserve areas that are vital to birds and other species. Woolwich contains part of one IBA, the Oldmans, Raccoon, Birch Creeks and Pedricktown Region. This site includes Oldmans, Raccoon, and Birch Creeks; associated wetlands, wooded areas, and scrub/shrub habitat; and the Pedricktown Marsh. It is considered valuable because it is home to five species of conservation concern, as well as large numbers of northern pintail and other waterfowl. The site is under threat from development pressure, nonpoint source pollution, and *Phragmites*. Two nonprofit conservation organizations, New Jersey Conservation Foundation and the South Jersey Land and Water Trust, have targeted this region for land preservation, water testing, cleanups, and outreach.

Eastern Bluebird Conservation

The Swedesboro/Woolwich Joint Environmental Commission (SWJEC) has partnered with the New Jersey Bluebird Society to enhance the township's habitat for the eastern bluebird and provide educational outreach related to this species. This partnership has focused its efforts in the Oldmans, Raccoon, Birch Creeks and Pedricktown Region IBA. Members of the partnership have also established and are observing two bird houses designed for the eastern bluebird in the Tranquility Trails area and one near the Woolwich Township

Municipal Building. As of the writing of this report, SWJEC is seeking to establish more bird houses and educational signage.

Resident Canada Goose Populations

The State of New Jersey now has a "resident" Canada goose population of approximately 100,000 birds that no longer migrate to more southern locales, and may double in size in the next five to ten years. While geese can provide enjoyable wildlife viewing opportunities, they can also cause property and environmental damage. Goose droppings that wash into lakes during storms can elevate coliform bacteria to unhealthy levels, polluting surface waters and closing lakes to swimming. Also, because geese can be quite aggressive during the nesting season, they can potentially injure humans.

However, removing geese or preventing them from residing in park areas is a difficult task. Because geese move freely, the most effective management solutions are best conducted at the community level. Like all waterfowl, Canada geese are protected by the Migratory Bird Treaty Act. Therefore, a management program may require the U.S. Department of Agriculture's approval. Management techniques include planting shrubby vegetation around streams, lakes, and ponds to block waterfowl access; discouraging humans from feeding geese; and using fertility reduction techniques such as egg addling or removal.

Mammals

Mammals are more easily documented than other species because they tend to be larger and live in habitats also ideal for human development. There are over 50 mammal species in New Jersey, including the nocturnal striped skunk, a member of the weasel family and occasionally observed in Woolwich (see **Figure 45**). Nine mammals are listed by the state as endangered. Six of these state-listed species are whales, and of the three land-based species, none are known to exist within the borders of Woolwich. **Appendix C** contains a list of mammals that are likely to inhabit Woolwich.

Figure 45: Striped Skunk

Contamination and Known Contaminated Sites

The NJDEP New Jersey Known Contaminated Sites List includes former factory sites, landfills, locations of current or former leaking underground storage tanks, sites where chemicals or wastes were once routinely discharged, and places where accidents have resulted in spills and pollution. Contamination may have affected soil, groundwater, surface water, or a combination of site conditions. The most dangerous sites from a human health standpoint are those on the National Priorities List, commonly known as Superfund sites. Information on Superfund sites can be retrieved using the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS). Other sites are handled by state (NJDEP) or individual programs.

As of the publication of this report, there were twelve active known contaminated sites within Woolwich Township. Active sites have confirmed contamination of the soil, groundwater, and/or surface water, and have one or more active cases, potentially alongside additional pending and closed cases.

Figure 46: Swedesboro Exxon

Source: Google Street View, www.google.com/maps

Among the known contaminated sites in Woolwich Township are manufacturing and other industrial facilities; gas stations (**Figure 46**) and energy utilities; and farms and residential properties, the last two of which were omitted from this report's maps and text for the privacy of the landowners. Eleven of the township's contaminated sites are regulated at the state level and one, the Matlack, Inc. site, is an EPA designated Superfund site. See **Table 25: Known Contaminated Sites** and **Figure 48: Known Contaminated Sites**.

Matlack Superfund Site

The Matlack, Inc. site, a former industrial facility located on Route 322 East, is Woolwich's only Superfund site (**Figure 47**). Matlack owned this site between 1962 and 2001, when it filed for bankruptcy and ended its operations. Matlack's operations involved transporting liquids, including petrochemicals and food-grade liquid, in bulk using tankers. The company cleaned some of its tankers on this site using a variety of solvents. Some of these solvents, which included several volatile organic compounds, semi-volatile organic compounds, and PCB, can be hazardous for people and wildlife. During Matlack's earlier years on the site, between 1962 and 1976, the company disposed of the wastewater that came out of its tanker cleaning operation into an unlined surface impoundment. Because the impoundment was not lined, the wastewater gradually leached out of the impoundment and into the soil and groundwater. Some of this wastewater has been carried downstream and into Grand Sprute Run near the site. After 1976, Matlack began transporting its wastewater offsite to be treated, but the impoundment remained.

NJDEP investigated the site in 1982 after hazardous substances were identified in nearby potable water wells. NJDEP and Matlack worked between 1990 and 2001 to remediate and remove the contamination, including treating the site's groundwater, removing storage tanks for wastewater and petroleum that remained above ground and below ground, and excavating and disposing of contaminated soil onsite. In 2012, the US EPA absorbed the project and listed it on its National Priorities List in 2013. Over the course of three site investigation phases in 2015 and 2016, the US EPA identified several chemical compounds that were above suggested state limits for concentrations; i.e., that had a higher chance of posing a health risk.

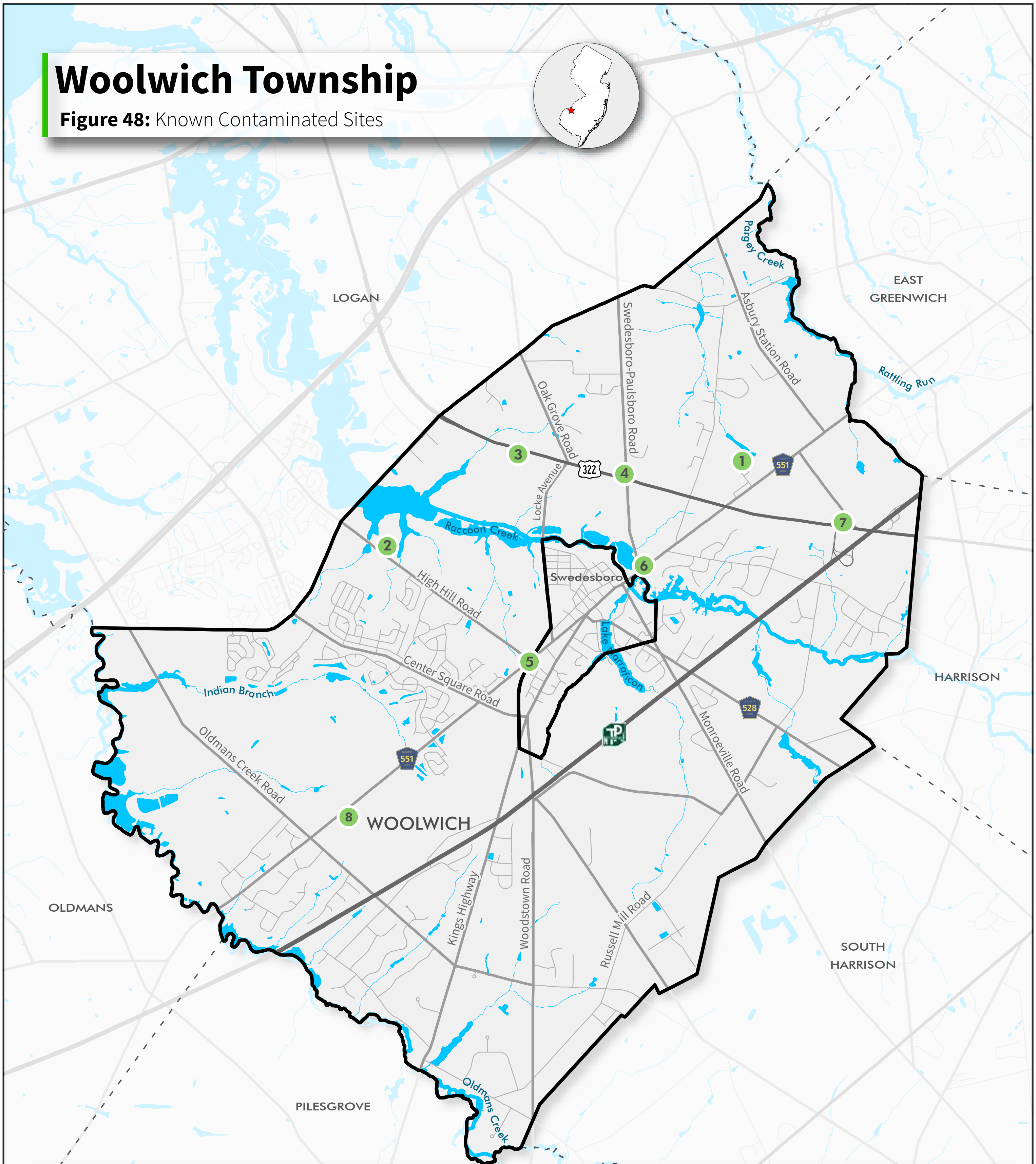
As of the publication of this report, the US EPA proposed to remediate these contaminants by removing sediment from Grand Sprute Run near the site, as well as removing additional soil from the impoundment. The US EPA will then construct permeable underground walls perpendicular to the flow of groundwater to trap contaminants as groundwater moves through them. The groundwater beyond this wall will be monitored to examine the success of the wall. This project is expected to cost $4 million.

Figure 47: Matlack Superfund Site

Source: Google Maps, www.google.com/maps

Woolwich Township

Figure 48: Known Contaminated Sites



1. Casella Brothers Inc.
2. Former Palladino Farm
3. Matlack Inc.
4. Route 322 Exxon
5. Swedesboro Coal Gas South Jersey Gas
6. Swedesboro Exxon
7. Swedesboro Shell
8. U.S. Drop Forge Co.

Sources: DVRPC, NJDEP, NJDOT

This map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state-authorized.

North

1 inch = 1 mile
1: 60,000 scale

0 — 1 Kilometer
0 — 1 Mile

dvrpc

Table 25: Known Contaminated Sites

Name	Address	Site ID	Program Interest Number	Remedial Level
Casella Brothers, Inc.	Kings Highway	127353	168587	None Listed (Project is Listed Under Remedial Action Permit)
Former Palladino Farm	371 High Hill Road	190656	667299	B
Matlack, Inc.	Route 322 East	43848	7390	C3
Swedesboro Sinclair (Formerly Known as Route 322 Exxon)	2011 Route 322—Paulsboro Swedesboro Road	7763	20494	C2
Swedesboro Coal Gas South Jersey Gas	Auburn and Bridgeport Avenues	63912	G000005448	C3
Swedesboro Exxon	541 Kings Highway	49594	25475	D
Swedesboro Shell	1111 Route 322	17226	31704	C2
U.S. Drop Forge Co.	1366 Auburn Road	24928	26310	C1

Sources: NJDEP and US EPA, 2016, 2018

Remedial Level	Explanation of Site Complexity
A	Emergency Action–Stabilization.
B	A single-phase remedial action with a single contaminant affecting only the soil.
C1	Remediation does not require a formal design. The source of the contamination is known or has been identified. There is a potential for groundwater contamination.
C2	Remediation requires a formal design. The source of the contamination is known OR the release has caused groundwater contamination.
C3	A multi-phased remediation action where the source of the contamination is either unknown or there is an uncontrolled discharge to soil and/or ground water.
D	A multi-phased remediation with multiple sources/releases to multiple media, including groundwater.
S	Should have a Remedial Level but this field was either Blank or designated as "N/A" in Pre-NJEMS data.

Table 25 and **Figure 48** bring together information from two sources: The New Jersey Contaminated Sites Geographic Information Systems (GIS) dataset from the “State of New Jersey – GIS Open Data” site and a “Known Contaminated Sites by County” report from NJDEP DataMiner. The list of contaminated sites includes (1) active sites with Licensed Site Remediation Professional (LSRP) oversight and (2) “known” contaminated sites; i.e., sites where contamination has been detected.

Many contaminated sites have multiple names that may refer to past or present owners or uses. The site ID is the most reliable means of getting updates on the status of a contaminated site. Sites move relatively quickly on and off NJDEP’s known contaminated sites list, and the most updated version is located on DataMiner.

Underground Storage Tanks

Property owners in Woolwich may use storage tanks to store fuel oil, or in the case of service stations, gasoline or diesel fuel. Older storage tanks are increasingly likely to have outdated leak control and corrosion prevention measures and must be monitored for emissions. Corrosion and leakage of underground storage tanks can become a serious threat to the groundwater and soil surrounding it.

Sites with underground storage tanks are monitored under an NJDEP program called the Bureau of Underground Storage Tanks (BUST). Sites are registered, receive permits, and are monitored for leaks at regular intervals. There are two active sites in Woolwich Township with underground storage tanks that are undergoing remediation: Swedesboro Shell at 1111 Route 322 and Swedesboro Sinclair at 2011 Route 322/Paulsboro Swedesboro Road. These sites have a known release to soil and/or groundwater.

Some homeowners in Woolwich Township may also have underground storage tanks, which on residential properties are used primarily to hold home heating oil. Those private residences are not publicly listed by NJDEP unless they pose a health hazard.

Historic Landfills

As of 2014, when NJDEP most recently updated its landfill records, Woolwich was home to one historic landfill: the two-acre Garhs Solid Waste Disposal Area, located along Auburn Road. This landfill accepted waste from homes, businesses, and institutions in the township until its closure in 1975. According to NJDEP’s landfill records, it has not been marked as “Properly Closed,” which means it may have not been verified as properly closed in accordance with the Solid Waste Regulations by the Department’s Division of Solid & Hazardous Waste, or not all known waste has been removed from the site. In Woolwich’s 2013 ERI, the site is described as a “Pending” known contaminated site. As of the publication of this ERI, the landfill is included within the NJDEP DataMiner database for Closed Sites with Remediated Contamination, implying that this site has been remediated. However, a search within the NJDEP DataMiner Database using its PI number of G000026170 indicates that it is still actively ongoing remediation. Information is not readily accessible at this time to determine the true status of this landfill.

Table 26: Historic Landfills

Name	Address	Solid Waste Program Interest Number	Owner/ Operator Type	Sole Source?
Gahrs Solid Waste Disposal Area	Auburn Road	132210	Private	No

Source: NJDEP, 2014

Landfills pose a number of potential environmental problems, including groundwater contamination and harmful air emissions. Current EPA landfill regulations mandates at least thirty years of post-closure care and monitoring to ensure that the landfill's leachate (i.e., water that has passed through a landfill) is properly removed and treated so that it does not leak into its surroundings and contaminate the surrounding soil and groundwater. While current landfill regulations have greatly decreased the probability of landfill failure within the thirty-year post-closure window, it is likely that these systems will remain in danger of leaking and contaminating the outside environment well into the future, beyond the mandated post-closure period.

Radon

Radon is a radioactive gas that comes from the natural decay of uranium found in nearly all soils. It moves up through the ground to the air above, and into homes through cracks and other holes in foundations. A buildup of radon-contaminated air within a home can pose a long-term health hazard to residents, potentially causing lung cancer. The only method of detection is to conduct a test for alpha particles in the air within a home. Fortunately, radon testing is inexpensive. All radon test results conducted in the state are reported to NJDEP by certified companies, which perform the tests or manufacture the test kits. This data is used to classify municipalities into a three-tier system, which identifies the potential for homes with indoor radiation problems.

As of 2015, the most recent date listed on the NJDEP website, Woolwich was listed as a Tier 1 municipality; that is, a municipality with high potential of having high radon levels in homes. The criteria for a Tier 1 municipality designation is that of at least 25 homes tested in the municipality, at least 25 percent have radon concentrations greater than or equal to 4.0 picocuries per liter in the air. NJDEP's 2015 Radon Tier Assignment Report indicates that 700 homes in Woolwich were tested for radon, and 258, or 37 percent, exceeded the 4.0-picocurie level. A 4.0 picocurie measurement is the level at which homeowners should take immediate action to remove the radon in their homes. NJDEP maintains www.njradon.org as an information source on radon and radon mitigation for residents.

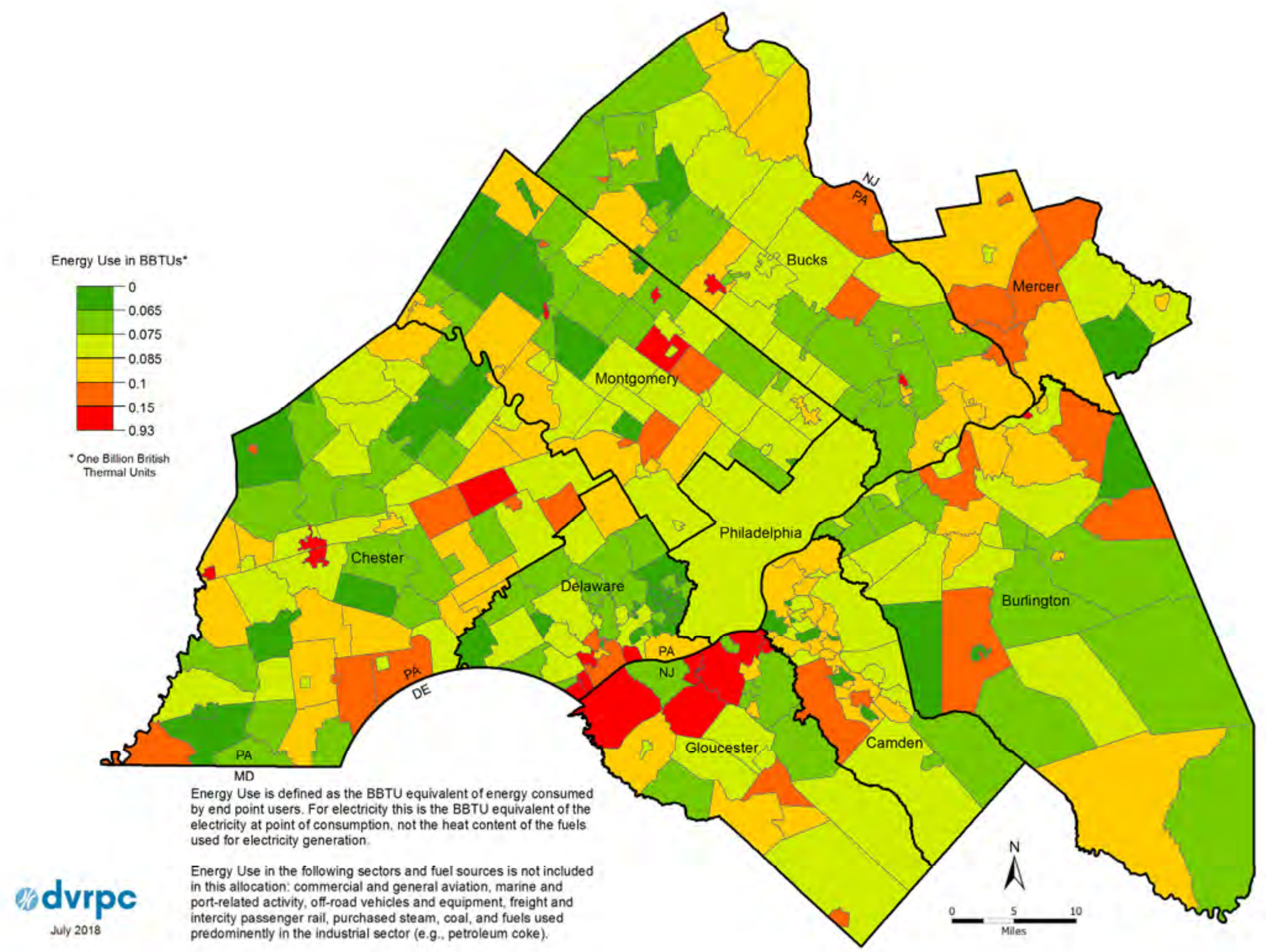
Woolwich's Energy Use

Every five years, DVRPC updates its greenhouse gas inventory for the nine-county Greater Philadelphia region. DVRPC estimates annual energy use in the entire region, as well as in each county and each municipality within this region, including Woolwich.

In its most recent estimation for Woolwich, using 2015 data, DVRPC calculated that Woolwich households and jobs consumed a combined 1,342 billion British thermal units (BBTUs) of energy in a year. A British Thermal Unit (BTU) is the amount of energy needed to cool or heat one pound of water by one degree Fahrenheit. A gallon of gasoline contains about 114,000 BTUs, so Woolwich's total energy use in 2015 was equivalent to about 11.8 million gallons of gasoline. Woolwich performed slightly worse in comparison with the average municipality in the region in terms of energy use per capita, which includes in-town residents and workers combined (**Figure 49**). The total cost of Woolwich's energy use was estimated to be about $26,700,000.

The combustion of fuels for this consumed energy, in combination with several non-energy sources of greenhouse gases, resulted in the estimated release of about 106,000 metric tons of CO_2-equivalent gases. The presence of forest habitat and other undeveloped open space in Woolwich serves as a "carbon sink," absorbing carbon and thus reducing the township's total emissions by about 16,000 metric tons of CO_2-equivalent gases.

Figure 49: Energy Use per Person and Job by Municipality (BBTUs)



Source: DVRPC

The energy use calculations include four main types of energy consumers located within Woolwich or traveling on Woolwich roads: residential buildings, commercial and industrial buildings, private on-road vehicles, and public transit vehicles. Energy use in buildings is described as being "stationary" and energy use in vehicles is described as being "mobile."

Of the sectors for which data was available and able to be allocated to the municipal level, the mobile-highway sector (in other words, private on-road vehicles driving through Woolwich) consumed the most energy in Woolwich. Their total consumption was 505 BBTUs of energy, or 38 percent of the total energy consumed in the township (see **Table 27: Energy Use and Cost**). The commercial and industrial building sector held the second-highest energy use, with an estimated consumption of 464 BBTUs, or 35 percent of the total. Residential buildings came in third, with 373 BBTUs consumed, or about 28 percent of the total. Energy use for mobile-transit was negligible.

The energy expenditures in Woolwich were highest for the mobile-highway sector, at about $10.5 million, or 39 percent of the total energy costs for the township. The second and third highest expenditures came from the residential sector ($9.2 million, or 34 percent of the total) and the commercial and industrial sector ($7.0 million, or 26 percent of the total).

Table 27: Energy Use and Cost

Sector	Energy Use (BBTU)	Percent of Total Energy Use	Energy Expenditures	Percent of Total Energy Expenditures
Residential	373	28%	$9,215,377	34%
Commercial & Industrial	464	35%	$6,978,602	26%
Mobile-Highway	505	38%	$10,542,067	39%
Mobile-Transit	0	<1%	N/A	0%
Total	1,342	100%	$26,736,046	100%

Source: DVRPC, 2018

Woolwich Township, its business owners, and its residents are taking steps to reduce energy consumption in the sectors that they can influence. The township recently initiated a Woolwich Home Energy Audit Program, selecting a contractor through a competitive bidding process to offer home energy assessments to residents at a discounted rate. These audits may then enable homeowners to receive additional rebates or zero-interest financing for home energy improvements. The township Business Development Action Committee and Green Team have taken additional actions to promote this program and share information on reduced energy consumption with residents and business owners.

For more information on where Woolwich's energy use fits into the region's consumption, DVRPC published an inventory report (November 2018) and an accompanying technical memorandum describing methods and sources (November 2018). See the **References** section (page 126).

Open Space

Preserved Open Space Inventory

Woolwich Township is a forerunner in the region for preserving open space to manage development and ensure a high quality of life for residents. Together, Woolwich and Swedesboro contain in their boundaries about 3,270 acres of preserved open space and recreation land, with all but four parcels located in Woolwich (see **Table 28: Protected Open Space and Farmland** and **Figure 50: Protected Open Space and Farmland**). The vast majority of this land was preserved in the past 15 years and represents an almost sevenfold increase from the 417 acres of preserved land that was recorded in Woolwich's 2004 *Open Space and Recreation Plan*.

Woolwich Township contains about 2,528 acres of privately-owned preserved farmland and 722 acres of public open space, yielding a total of 3,250 acres. Swedesboro Township contains about 20 acres of open space, and it also owns the 31-acre Lake Narraticon Park parcel that is located within Woolwich Township.

In Woolwich Township, the majority of preserved land (78 percent) is privately owned by farmers who have permitted the creation of conservation easements on their property. Woolwich Township owns an additional 493 acres of open space, much of which is open water or tidal and forested wetland areas. An additional 229 acres is owned by the State of New Jersey. Swedesboro contains a mixture of municipal, county, and nonprofit-owned open space parcels.

Funding Open Space Preservation

In 1997, and with resident approval, the township adopted its first resolution to create a trust fund that would enable them to purchase farmland and other open space with township funds. Since then, Woolwich Township has maintained a record of success in using varied funding sources to support its open space and farmland preservation efforts.

Municipal Open Space Tax

Since the establishment of its trust fund for farmland and open space preservation, Woolwich Township has continued to generate funding for open space preservation through a tax on the assessed value of residential property. During the 2002 elections, township residents voted to support a non-binding property tax of 5 cents per $100 of assessed value. Since then, the tax has changed to a tax of "up to" 5 cents per $100, enabling the township to vary the tax collected from year to year.

Woolwich residents continue to support this tax. In 2019, residents continued to approve the tax ceiling of 5 cents per $100. In the same year, based on current assessed property values, this tax produced $594,000 for open space protection. Woolwich has recently used the funds generated by the tax for acquiring Daybreak Farm on High Hill Road (35 acres), Locke Avenue Park waterfront property (20 acres), and the Palladino Property on High Hill Road (30 acres). It also uses the funds for the ongoing maintenance of open space properties.

With the adoption of an updated *Open Space and Recreation Plan* in 2016 (see the **Open Space and Recreation Plan** subsection on page 117), the township's funding focus has turned from private farmland and open space more towards parks in order to respond to observed deficiencies in available athletic space. Locke Avenue Park is at the top of the list for improvement and expansion. In early 2019, the township completed engineered plans to convert approximately 50 acres of vacant area at the park into several new athletic fields and other park amenities. Nevertheless, the township still maintains a goal to preserve at least one farm per year using funds from the municipal open space tax.

State and County Funding

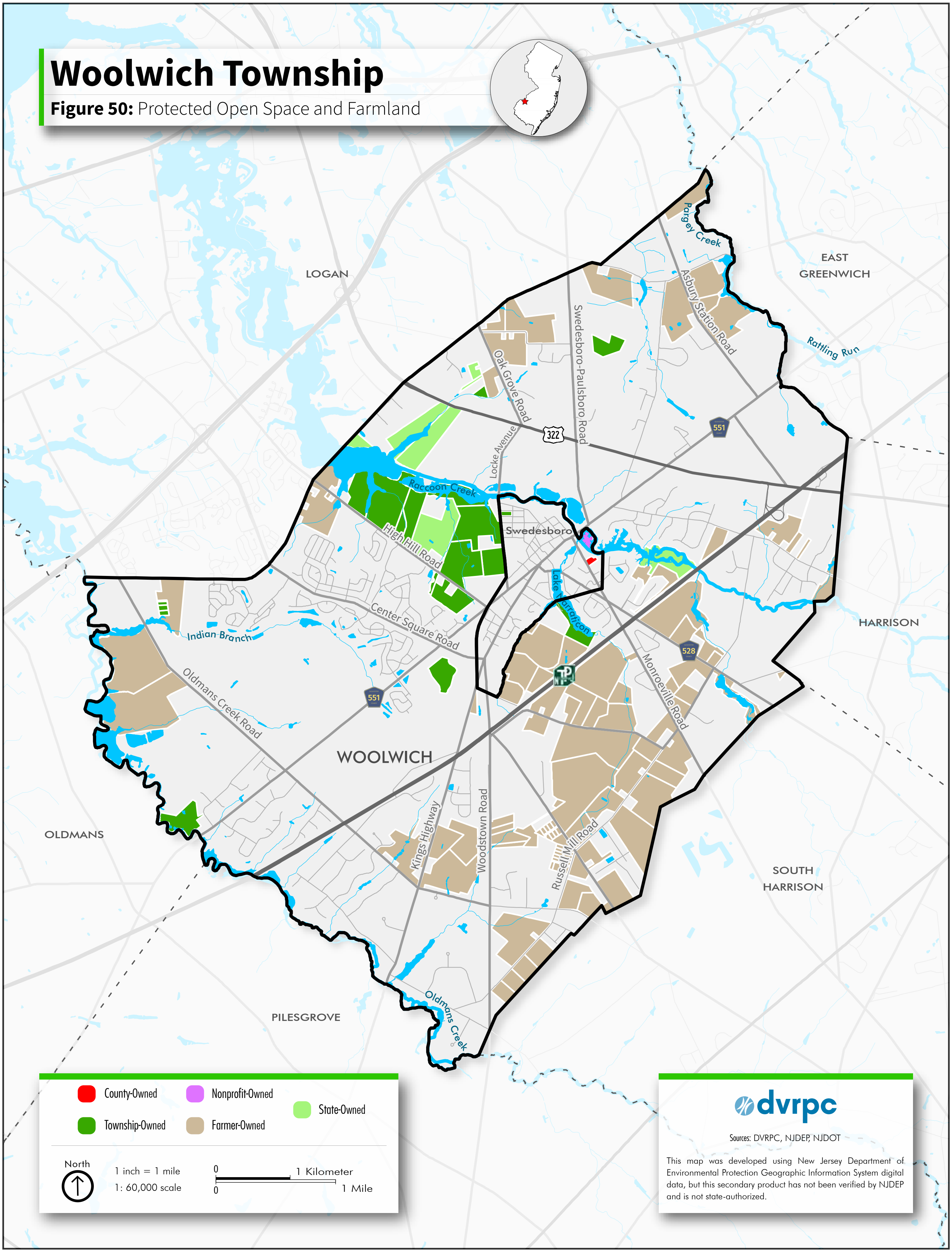
Woolwich has also used state funding sources for the protection of open space. The township has used funding from New Jersey's Green Acres program to acquire parcels for parks and open space, including Narraticon Lake Park, Lock Avenue Park/High Hill Road Park, and Palladino Field. The 50-acre Locke Avenue Park project mentioned previously is one of the most recent examples: in the spring of 2019, the township submitted a park development application to the Green Acres Program to secure a 2 percent loan with a 20-year payback, for $4,130,000, to finance park improvements.

For preserving farmland, the township uses funds from the Planning Incentive Grant program, which is overseen by the State Agricultural Development Committee. In 2017 and 2018, the township submitted an application for an additional $1,000,000 in grant funding for ongoing farmland preservation efforts under its approved farmland preservation plan. When the State Agricultural Development Committee allocates its funding, the township will have $1,042,497 in available state funding for municipal farmland preservation efforts.

Under the standard cost-share arrangement in the Planning Incentive Grant, the state typically contributes 60 percent of the per-acre cost associated with preserving private farmland, with the township and county each contributing 20 percent. As the cost to preserve farms in Woolwich can be hundreds of thousands of dollars per project, the ability to take advantage of an 80-percent cost-share from its state and county partners provides the township an incredible return on its investment.

Woolwich Township

Figure 50: Protected Open Space and Farmland



Sources: DVRPC, NJDEP, NJDOT

This map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state-authorized.

Table 28: Protected Open Space and Farmland

Landowner/Easement Holder	Acreage in Woolwich	Percent in Woolwich	Acreage in Swedesboro	Percent in Swedesboro
State of New Jersey	229.43	7.06%	0	0%
Gloucester County	0	0%	2.63	12.84%
Municipal	492.64	15.16%	11.60	56.64%
Nonprofit	0	0%	6.23	30.52%
Farmer	2,527.87	77.78%	0	0%
Total	3,249.94	-	20.48	-

Source: DVRPC, Woolwich Township, 2018

Preserved Working Farmland

Woolwich continues to retain a high concentration of farmland within its borders (**Figure 51**), in part because it has used regulatory and funding tools to protect its working farmland and rural character for almost 30 years. The township preserved its first farm using state funding in 1989. In 1992, the township adopted a right-to-farm ordinance that gives additional legal protections to farmers. It was strengthened in 2005 using the State Agriculture Development Committee's model ordinance, and was supplemented by a separate ordinance requiring buffers between residential districts and nonresidential districts.

Figure 51: Preserved Farm, Woolwich

Source: Matt Blake

Many of the township's preserved farms are located east of the New Jersey Turnpike, located within a contiguous belt of over 1,000 acres of preserved land. The township's TDR plan cites reports listing some of the benefits that such a cluster of preserved farms can yield. Benefits include fewer nuisance complaints from nearby homeowners about typical farming practices, more confidence from local farmers about the longevity of their and their peers' businesses, greater economic viability for local agricultural support businesses, and a greater appreciation from visitors for local agricultural heritage. Continuous belts of preserved of farms will also benefit wildlife, particularly grassland species that depend on open fields.

TDR Program

Woolwich's TDR program (see definition box to the right) is one of the primary vehicles responsible for permanently preserving Woolwich's farms and open space. Woolwich enacted its TDR program in 2008. The township was one of the first municipalities in New Jersey to make use of the state's Transfer of Development Rights Act (N.J.S.A. 40:55d-137 et seq.), which was enacted in 2004 and gave municipalities the authority to create and implement TDR programs.

In Woolwich, the TDR is used to redirect potential new development away from farmland and environmentally sensitive areas that are located outside of established sewer service areas, and into areas where development is already supported by sewer service areas, roads, and public utilities.

In Woolwich's TDR program, each sending area property is assigned a specific amount of TDR credits based on a formula that considers site constraints, acreage, and zoning in place prior to 2008. Through a private transaction, a sending area landowner or credit-holder voluntarily sells his or her credits to developers. The township has also purchased TDR credits itself, doing so through a township TDR bank with local and state funding. The developers who acquire TDRs can build at significantly higher residential development intensities in receiving areas designated by the township than would otherwise be permitted (see **TDR Plans** on page 113).

A **Transfer of Development Rights (TDR) program** is a land preservation and smart-growth strategy that helps municipalities accomplish goals and objectives critical to quality-of-life, economy and fiscal health, and community and environmental sustainability.

Under a TDR program, certain development rights associated with a parcel of land are transferred from the landowner to another entity. The transfer goes from a *sending area* property to a *receiving area* property. Through the transfer of these rights, other areas of the community can be developed at higher densities, while the original parcel is protected from development and the owner of that parcel is financially compensated for the removal of those development rights.

When a sending area landowner sells his or her TDRs for use by developers in a receiving area, his or her land is preserved under a deed of easement restriction, which runs with the land in perpetuity. This action is voluntary for landowners.

The vision of the township, through its TDR plan, is to preserve 5,000 acres of farmland and open space and to help direct the location of new development as the township's population continues to grow. In 2016, Woolwich made substantial progress toward this goal by directly purchasing 274 TDR credits through a reverse auction with the use of local and state funding, which resulted in the preservation of 820 acres of privately-owned farmland. The township is using several TDR plans and a TDR ordinance to implement this vision.

There have been several hurdles that have thus far slowed the implementation of Woolwich's TDR program. Since the program relies on the private market and development pressure to function, the Great Recession of 2008 represented a major setback, as did unanticipated delays to bringing public water and sewer infrastructure to the Route 322 Corridor receiving area. As of the publication of this report, the installation of sewer and water lines is underway, and the township feels optimistic about the emergence of a private market for TDRs. In the interim, the township intends to continue providing sending area landowners with the opportunity to sell credits and preserve their farms.

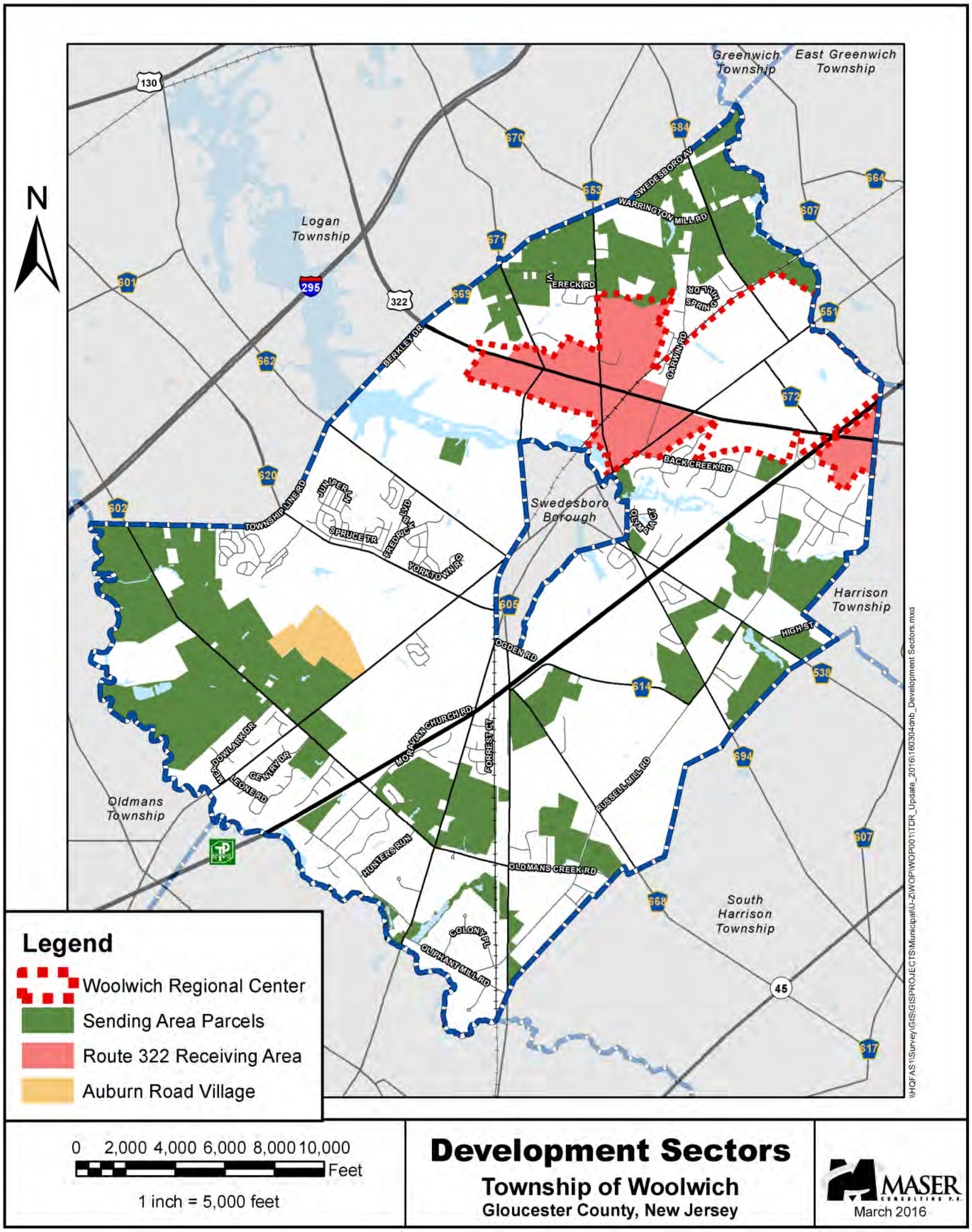
TDR Plans

The primary guidance document for Woolwich's TDR program is the *Woolwich Township TDR Plan*. The 2016 amendment is currently in use and was written by Maser Consulting P.A. The TDR program includes 2,005 acres (80 parcels) in undeveloped farmlands and fields that are located in residential zoning districts. This acreage is represented by the green parcels in **Figure 52**.

The development rights of landowners who agreed to participate in the program would be transferred to two other areas in the township. One is the 125-acre Auburn Road Village along Auburn Road, which is permitted to include residential, commercial, and mixed-use development (**Figure 52**). The other is a 683-acre receiving area within the 1,760-acre King's Landing Regional Center (**Figure 52** and **Figure 53**), which is located along Route 322. The township envisions the Regional Center as a walkable, mixed-use development that includes residential, commercial, institutional, and public land uses.

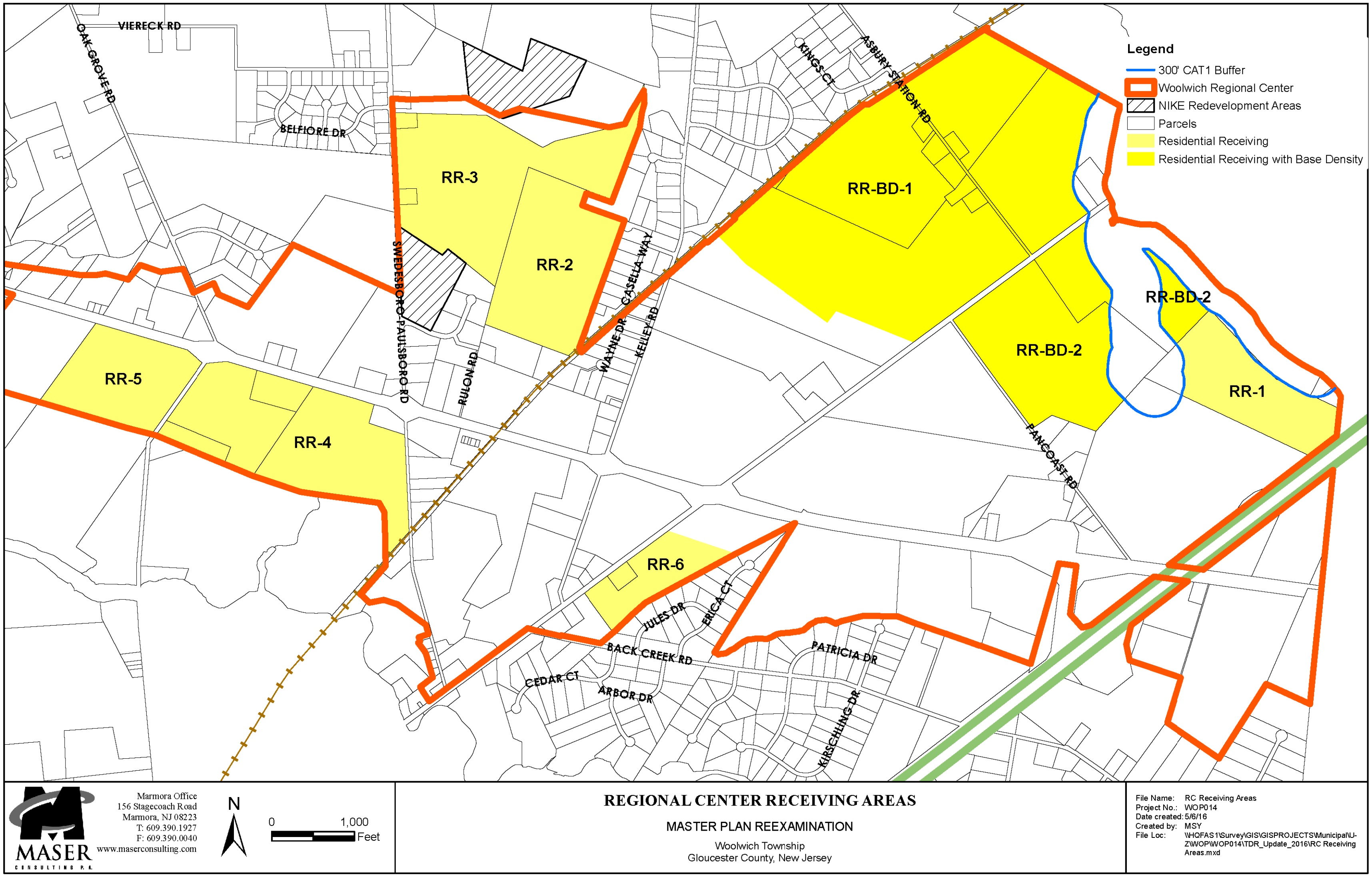
Both the King's Landing Regional Center and Auburn Road Village also contain conservation zones to protect environmentally sensitive land.

Figure 52: Development Sectors



Source: Maser Consulting P.A.

Figure 53: Regional Center Receiving Areas



Source: Maser Consulting P.A.

The TDR program has enabled Woolwich to preserve large contiguous areas of farmland and open space, thus protecting its agricultural economy and natural resources. The TDR program has also enabled the township to manage the location of new residential development.

Affiliated with the *Woolwich Township TDR Plan* is the *TDR Circulation Plan*, which proposes a multi-modal transportation system that will facilitate access to the Regional Center and Auburn Road Village. Part of the vision for this plan includes the creation of a trail and greenway network.

Another related plan is Woolwich's *TDR Public Spaces Plan*, which identifies important public open space, recreational, and institutional destinations in the Kings Landing Regional Center. There are four main open space destinations located within Kings Landing. "Neighborhood Parks" are traditional village greens of a few acres or less that support recreational and civic uses. "Plaza/Civic Spaces" are located at street intersections. "Allees/Green Links/Buffers" are linear green spaces between land uses or neighborhoods that accommodate footpaths. "Environmental Lands" include wetlands, stream corridors, steep slopes, or other habitats, particularly those that support bald eagles. The plan also proposes green stormwater infrastructure in public spaces. The Kings Landing Regional Center's overall stormwater management approach is outlined more generally in a separate stormwater management plan.

TDR Ordinance

Woolwich's TDR ordinance contains the rules and structure for Woolwich's TDR program. It establishes the total number of TDR credits available for purchase in the township's sending zone, which are allocated on a parcel-by-parcel basis. Credits are assigned according to the *development potential* of each parcel, which is the maximum number of dwelling units or square footage that could be constructed on that parcel. This number is dependent on factors that would otherwise be considered in the development of the parcel, including zoning, soil suitability, and the presence or absence of various infrastructure: for example, roadways and stormwater facilities. The ordinance allows landowners to appeal their allocation if they feel it does not accurately reflect the development potential of the property.

The ordinance also establishes the maximum development density allowed in the receiving zone in order to manage the ultimate population, intensity of use, and appearance of these areas. It requires the township to review a real estate market analysis of Woolwich at least every five years to determine whether the TDR program remains economically viable. The main indicator for this viability is whether at least 25 percent of the development transfer potential that existed at the beginning of the five-year period has been transferred from the sending area to the receiving area during that five-year period. As mentioned previously, Woolwich has established a TDR bank, enabling it to purchase TDR credits, so it can also convey development potential from sending areas to receiving areas and thus contribute to the economic viability of the TDR program.

Conservation Zoning

Woolwich also uses conservation zoning to protect open space in new residential developments. In zoning districts R-1, R-2, and R-3, applicants seeking to develop land can subdivide land into smaller residential lots in exchange for the preservation of land within the lot to be subdivided. In the R-1 and R-2 districts, lot sizes may be reduced from two acres (in the R-1 district) or 1.5 acres (in the R-2 district) to 20,000 square feet if at least 50 percent of the property is preserved. In the R-3 zone, lot sizes may be reduced from 20,000 square feet to 8,000 square feet if at least 40 percent of the property is preserved. This technique is effective for ensuring that important individual farms or vulnerable habitat is preserved. It can also be used to create recreational or civic space within a residential subdivision. Conservation zoning is currently not an option for TDR sending area properties, which are subject to a density of one unit per 15 acres.

Open Space and Recreation Plan

Woolwich's 2016 *Open Space and Recreation Plan*, which was authored by Simone Collins Landscape Architecture and The Reed Group, offers a vision and guidance for creating over 2,600 acres worth of parks, open space, trails, and other recreational facilities within Woolwich and Swedesboro over the next 10 to 20 years. The plan also outlines strategies to use these open space facilities, and events within them, as a way to promote the two municipalities to visitors.

The plan lists 46 parcels for possible acquisition and management as an open space or recreational facility. Woolwich can use this list as a reference for future acquisitions. The plan also suggests types of improvements that could be added to these parcels to make them better recreation facilities. The plan authors derived the listed improvements from local resident surveys and comparisons with the facilities of other nearby municipalities of similar population size.

Parks and Recreation

Woolwich Township and Swedesboro Borough share their recreation facilities. These facilities include two parks—Locke Avenue/High Hill Park and Lake Narraticon Park—and additional amenities within five local schools that are open to the public outside of school hours. Together, these facilities contain a variety of active and passive recreational opportunities for area residents. Amenities for active recreation in the township's parks include multi-use fields, soccer fields, baseball diamonds and coach pitch fields, basketball courts, and a softball field. Passive recreation encompasses most other park activities, including walking, fishing, birdwatching, bike riding, boating (**Figure 54**), and picnicking.

Figure 54: Kayaker, Raccoon Creek

Source: Matt Blake

The community benchmarking process in Woolwich's *Open Space and Recreation Plan* used population projections for Woolwich and Swedesboro to determine the two municipalities' predicted total population in 2040—approximately 26,000—and used that number to identify similar municipalities in the region that currently have populations of that size. The plan examined the recreation facilities of six selected municipalities in New Jersey and Pennsylvania: Randolph, Roxbury, and Scotch Plains in New Jersey; and Radnor, Upper Dublin, and Upper Moreland in Pennsylvania.

The Reed Group conducted a randomly sampled phone survey of over 400 residents of Woolwich, Swedesboro, and nearby municipalities to understand their desires for recreational amenities in Woolwich and Swedesboro parks. Residents commented on the amenities at 43 existing facilities in the area, which included active recreation parks, nature parks, local gyms, and school recreation facilities, described what they did at these sites, and shared what additional recreation amenities they wanted in the future. Residents observed that Woolwich and Swedesboro were most successful in providing youth sports leagues, walking and jogging, festivals, and playgrounds, and were least successful in providing swimming amenities, adult sports leagues, hunting, camping, motorized boating, and archery amenities. However, 72 percent of 200 survey respondents reported that their household's recreational needs were being met in the area.

The survey also gauged the receptivity of residents to parks and open space. Overall, 85 percent of 302 respondents felt that park and open space lands were very important to local well-being and quality of life, and 83 percent of 298 respondents believed that more park and open space areas should be preserved in Woolwich and Swedesboro.

In response to the survey results and further analysis, the plan offered recommendations for facilities that Woolwich and Swedesboro should add. These facilities included additional baseball, field hockey, football, soccer, and multi-use fields. Tennis was also highlighted as a sport with high additional demand among residents. In general, the plan recommended preserving 952 additional acres of park space prior to 2040 for parks and recreation land, and 76 miles of trails and on-road bicycle facilities. Woolwich is in the process of implementing recommendations from the plan, focusing in particular on a cluster of nine preserved parcels along Raccoon Creek.

Priority Sites for Protection and Stewardship

Woolwich has matched its natural resources protection goals to the presence of prized agricultural soils, steep slopes, streams and other water bodies, and the habitats of vulnerable species in the township. The areas around Raccoon Creek and Oldmans Creek are of particular high priority for protecting because of the presence of critical habitat for two listed species, bog turtles and bald eagles. Upland forest areas contiguous with stream corridors, as well as grassland areas on the western side of the township, have also been prioritized as areas for bald eagle nesting and foraging.

Many of the following sites were identified as important spaces in Woolwich's *TDR Public Spaces Plan* and *Open Space and Recreation Plan*. These plans provide additional information.

Pargey Creek/Rattling Run—Area Sites

Pargey Creek and Rattling Run together form part of the northern border of Woolwich. Rattling Run, located farther upstream, meets Warrington Millpond and then exits downstream as Pargey Creek. As these creeks run through Woolwich, they border a mixture of deciduous scrub/shrub and wooded wetlands, herbaceous wetlands, deciduous forest, agricultural land, and a small amount of developed land. The habitat along these creeks is identified as Rank 4 by NJDEP's Landscape Project in reference to the fact that bald eagles rely on it and have been observed within it.

More information on these creeks and the other major creeks in Woolwich is included in the **Brief Township History** section on page 5 and the **Surface Water** subsection on page 38.

Warrington Millpond

Warrington Millpond is located along Pargey Creek and south of West Wolfert Station Road. It was part of a mill since the 1790s and was operated by John Warrington and his descendants from 1825 to the 1920s.

Tomlin Station Natural Heritage Priority Site

Tomlin Station is located on the northeast township boundary with East Greenwich, and is located along Rattling Run and Warrington Millpond. The property is one of two Natural Heritage Priority Sites located within the township. The site contains a dry pine/oak woodland habitat. It is notable for containing Class 1 waters (for a definition, see **Woolwich's Stream Designations** on page 48). When last surveyed for plant life, it was found to contain four rare plant species, including chinquapin, low rough aster, twisted spike-rush, and climbing fern. See **Table 21** in the **Rare Plant Species** subsection for more information.

Raccoon Creek—Area Sites

Raccoon Creek and its many tributaries meander through the center of Woolwich and form several of the borders of Swedesboro. The creek widens as it passes from east to west through Woolwich. Its head of tide is located at Russell Mill Road, enabling it to serve as a foundation for multiple types of freshwater habitats (**Figure 55**). Within Woolwich, Raccoon Creek is bordered by deciduous wooded wetlands, deciduous forest, crop land and old fields, and tidal marshes and mud flats south of Russell Mill Road. In Swedesboro, land use adjacent to the creek is more developed, with industrial and residential uses, among other, more developed, land uses.

Figure 55: Raccoon Creek, Emergent Wetlands

Source: Matt Blake

Raccoon Creek and its tributaries are notable for containing more than 570 acres of Rank 5 habitat as identified through the Landscape Project. This habitat contains a federally listed endangered species, the bog turtle. There is also an abundance of Rank 4 and Rank 3 habitat adjacent to the creek and its tributaries. One species that has been observed in this habitat is the bald eagle, and the township has taken steps to set aside permanently protected land for bald eagles to nest and forage in this area.

Residents of Woolwich and surrounding municipalities consider Raccoon Creek a destination for kayaking and canoeing, but to date, Woolwich Township does not operate a publicly accessible boat launch along the creek. The closest boat launch outside of Woolwich is within the Raccoon Creek Wildlife Management Area (WMA). The Borough of Swedesboro plans to construct a launch site within a property it recently acquired at

5 Glen Echo Avenue. The South Jersey Land and Water Trust also plans to construct a launch at the Oldmans Creek Preserve in Oldmans Township.

Stewardship Assessment Report

In 2013, Woolwich Township commissioned Natural Lands (then Natural Lands Trust) to develop a stewardship assessment report for 398 acres of land on nine permanently preserved properties within the "Raccoon Creek Corridor." Natural Lands defined this corridor as the parcels Block 5, Lots 3, 4, 5, 6.02, 6.07, 7, 10, 11, and 11.01, which are located on the south side of Raccoon Creek and immediately west of Swedesboro Borough. The parcels hold a mixture of habitat (farmland, upland and wetland forests, meadows, and tidal marshes) as well as mowed grass fields. Eight of the parcels, which include Locke Avenue Park and High Hill Park, are owned and preserved by the township. One parcel is owned by the state and is part of NJDEP's Raccoon Creek WMA.

Natural Lands staff conducted an inventory of topography, geology, soils, water resources, plant species, and wildlife, and highlighted stewardship issues, opportunities, and recommendations. **Appendix A** of this ERI contains a record of the plant species that Natural Lands identified within the Raccoon Creek corridor and listed in the report.

High-level recommendations from the report included constructing new trails, adding interpretive signage and boundary markers, installing boat launches, controlling non-native plants and browsing deer populations that negatively affect native plants, managing stormwater, improving habitat, providing nesting boxes, and leaving dead trees for species observed on one or more of the nine parcels.

Raccoon Creek WMA

The NJDEP Division of Fish and Wildlife manages a 273-acre WMA along Raccoon Creek and Grand Sprute Run, a tributary of Raccoon Creek. There are 122 WMAs in New Jersey, and each one consists of public lands that the state has preserved for wildlife-focused public recreation. The Raccoon Creek WMA consists of three parcels: two to the north of Raccoon Creek and one to the south. It contains marshlands for a variety of waterfowl; active farmland for grassland species; and successional forest habitat for songbirds, deer, and other mammals. The WMA is optimal for birdwatching, hiking, and scenic driving, and also permits hunting. It provides public access to Raccoon Creek at the end of Berkley Drive, where there is a dirt road across WMA land that leads to a boat launch site for craft driven in by car. This site affords easy access to paddle up Grand Sprute Run.

Tranquility Trails

Tranquility Trails (**Figure 56**), also known as "Tranquility Trails at LaPalamento Family Park," is a 180-acre park located on the north side of High Hill Road, across from Frederick Boulevard. The township asked students from the Swedesboro-Woolwich School District to suggest names for the park and chose "Tranquility Trails," the submission of two Harker School fifth graders, Savannah and Sophia McKay. The park spans four parcels in total. The township has prioritized this land for future park amenities; currently, a two-mile loop trail passes among woodlands and meadows, and provides views of Raccoon Creek. The Tranquility Trails supports a variety of wildlife; see **Appendix B** and **Appendix C** for records of species observed in the park. Bald eagles in particular have been seen foraging in this park.

The park contains two back fields sown with wildflower mix that are bordered by forestland. The wildflower mix is intended to attract and support pollinators. Some of the most common flowers included in the original seed mix were little bluestem, purple coneflower, butterfly milkweed, and Maximilian's sunflower.

Figure 56: Forested Trail in Tranquility Trails Park

Source: Matt Blake

The wildflower mix, and the maintenance of the mix after establishment, was recently funded by two grants, including one by the U.S. Department of Agriculture. Maintenance requirements of the wildflowers involve relatively minimal mowing of only one-third of the meadow in the late fall, with the portion to be mowed rotated annually.

Locke Avenue Park and High Hill Park

The Locke Avenue Park and High Hill Park complex is located between Locke Avenue and High Hill Road and serves as a recreational resource for Woolwich and Swedesboro. The park complex currently encompasses several baseball and softball fields, multi-use sports fields, basketball courts, paved and unpaved walking paths, a playground, and a concession area. The park serves several youth sports leagues and is some to several major annual events such as Fun Day, a family-friendly community event held in June.

Figure 57: Natural Area in Locke Avenue Park

Source: Matt Blake

There are three entrances and associated parking areas at the park. The main entrance is accessed from Locke Avenue, and the other two from High Hill Road. The entrance closest to the roundabout with Auburn Road is called High Hill East, which serves as a back entrance into Locke Avenue Park. Immediately to the west is another parking area, which is called High Hill

West. There is no vehicular access into Locke Avenue Park from High Hill West, although there is a paved pathway through the woods that provides a connection for pedestrians and people on bicycles.

The township intends to expand the complex by developing multiple township-owned parcels, including a former shooting range with a history of industrial use. This land has been fully remediated through the demolition and removal of several abandoned structures, related debris piles, and illegal dumps. Planned park improvements will be constructed in two phases over the course of the next few years. Construction of Phase 1 will likely be undertaken in fall of 2019. Current plans call for the extension of park facilities onto approximately 50 acres of vacant land, with landscaping elements that highlight native plants; and a variety of recreational amenities, including four large multi-use athletic fields, concession area, a paved pathway, and picnic pavilions. About 20 wooded acres of the waterfront along the Raccoon Creek will remain in its current natural condition to preserve the riparian buffer and an existing nature trail through this area (**Figure 57**).

Grand Sprute Run

The Grand Sprute Run site is the second of the two Natural Heritage Priority sites in Woolwich. The site is located along Grand Sprute Run and is bordered by Raccoon Creek to the south and Route 322 to the north. It consists of two parcels, which contain woods and open and emergent wetland habitat, as well as a steep ravine. Four plant species of concern were historically observed at Grand Sprute Run, including chinquapin, northern manna grass, robin-run-away, and smooth tick-trefoil. See **Table 21** in the **Rare Plant Species** subsection for more information. Bald eagle and great blue heron have been observed on the site.

Figure 58: Lake Narraticon Park

Source: DVRPC

Lake Narraticon Park

Lake Narraticon Park (**Figure 58**) surrounds Lake Narraticon, an artificial lake of about two acres. The entire park is about 41 acres, and it is located in Swedesboro near the intersection of Park Avenue and East Avenue. Lake Narraticon Park is the only park shared between Woolwich and Swedesboro that offers water recreation opportunities in the form of canoeing, kayaking, and fishing. The lake is stocked with trout and also contains bass, carp, perch, and sunfish species. There are two docks in the park: a 30-foot fishing dock and a kayak launch dock that includes a rolling ramp to help kayaks launch directly from the dock into the water. The park also has a playground, picnicing amenities, and a 1.5-mile trail.

Kings Landing Regional Center

As mentioned previously, the Kings Landing Regional Center plays an important role as a receiving area in Woolwich's TDR plan. The township's adopted Public Spaces Plan, described in the **TDR Plans** subsection (page 113), identifies various open space areas, parks, and recreational sites to be established alongside future development.

As of the publication of this report, the Regional Center is undeveloped greenfield land. This land contains and is bordered by riverine habitat, wetlands, grassland, and forest land that supports bald eagles and other species. The township will be preserving a 1,200-foot buffer along the north side of Raccoon Creek and just outside of the Regional Center's sewer service area that includes each of these habitats. This land is intended to protect a designated bald eagle foraging area. The NJDEP-owned Raccoon Creek WMA is immediately to the west of this habitat buffer and it is possible that the state could purchase this land, as well as the Grand Sprute Run site, to expand the boundaries of the WMA.

Other smaller pieces of habitat that border the Regional Center are also slated for protection. To the north of the Regional Center, "Environmental Area B" is a planned 45-acre greenway along a tributary of Little Timber Creek that will be connected to residential areas by trails. "Environmental Area C1" and "C2" will be relatively small parks connected by a green corridor. C1 will contain a pond and riparian habitat that is adjacent to the Kingsway Regional School, and it is planned to hold a loop trail and bridge over the pond. C2 will be a five-acre "C"-shaped park containing riparian habitat along Rattling Run, and it is planned to surround a community center. Planned "Environmental Area E" is adjacent to the Tomlin Station Natural Heritage Priority site to the north, and it is also planned to link to a planned one-acre neighborhood park. Environmental Area E contains riparian habitat, environmentally sensitive soils, and C1 waters. It will be protected by the 300-foot buffers that are required by NJDEP regulations for C1 waterways. The township is also protecting this area using a conservation zoning district. Because of its environmental value, Environmental Area E will primarly be intended as conservation land, possibly with a passive recreational path.

Developers will protect and establish these environmental areas as the Regional Center is implemented. These areas will then be owned and managed by homeowners associations. Construction of the Regional Center and the creation of the environmental areas will begin after public sewer and water lines are extended to the area.

Oldmans Creek—Area Sites

Oldmans Creek forms the southern border of Woolwich. Like Raccoon Creek to the north, Oldmans Creek widens as it moves through Woolwich, forming part of the multi-municipal Pedricktown Marsh complex to the east as it approaches Logan Township. Also similarly to Raccoon Creek, Oldmans Creek contains multiple tributaries, most notably Indian Branch Creek, which stretches almost three miles into the center of Woolwich.

Oldmans Creek is predominantly adjacent to freshwater tidal marsh habitat, as well as some deciduous wooded and scrub/shrub wetlands. Its head of tide is located upstream of the New Jersey Turnpike. Beyond that point, the creek is mainly bordered by deciduous wooded and scrub/shrub wetlands, herbaceous wetlands, and deciduous forest. Like the Raccoon Creek, the Oldmans Creek supports bog turtles and bald eagles, and therefore contains abundant Rank 4 and Rank 2 wildlife habitat, as defined by NJDEP's Landscape Project. Oldmans Creek contains C1 waters, which support a variety of wildlife. At least one bald eagle nest has been identified in the area, along Indian Branch Creek.

Pedricktown Marsh

Pedricktown Marsh is a 1,900-acre tidal marsh along Oldmans Creek that is shared between Woolwich Township, Logan Township, Oldmans Township, and Pilesgrove Township. Woolwich has preserved several working farms adjacent to this marsh area.

Petricktown Marsh is well known as a birding destination, containing habitat for a variety of migratory shorebirds, waterfowl, and raptors. The New Jersey Conservation Foundation, which along with the South Jersey Land and Water Trust is working to protect this area, refers to the marsh as the "Ruff Capital of the

East Coast." Ruffs are Eurasian birds that are rarely found in the United States outside of Alaska. The New Jersey Conservation Foundation also cites the marsh as hosting the highest concentration of northern pintail ducks in New Jersey, as well as several threatened and endangered species, including bald eagles and short-eared owls. Birders using Ebird.com, a user-generated site overseen by the Cornell Lab of Ornithology, have recorded sightings of 176 different species of birds at Pedricktown Marsh. Because of its abundance of species, this site makes up a key part of Audubon's designated Oldmans, Raccoon, Birch Creeks and Pedricktown IBA, as discussed in the **Birds** subsection (page 95).

Indian Branch Greenway

The vision of the township's *Open Space and Recreation Plan* is to develop a trail network within a greenway of preserved land in its western corner along the Indian Branch Creek. The entire greenway has not been preserved, but it is a high priority for protection for both open space and recreation. Several of the parcels are farms that are registered as sending areas in Woolwich's TDR program, and the township recently preserved easements on two farmland parcels within the Indian Branch Forest that will contribute to its natural resource goals along the greenway.

The trail, in its current design, would pass through several preserved farm properties along Indian Creek, starting with the creek's confluence with Oldmans Creek. The trail would then proceed southeast to the proposed Auburn Road Village site, and then pass through that site and terminate at Auburn Road. The parcels making up the planned greenway contain forests (**Figure 59**) that hold several old-growth beech specimens, fields, seasonal ponds, and bald eagle habitat. The township has also considered constructing athletic fields and a bird viewing station along parts of the greenway.

Figure 59: Beech Grove at Indian Branch Swamp

Source: Matt Blake

Beckett Country Club

Beckett Country Club, located along Kings Highway, is a 220-acre, 19-hole private golf club. Two-thirds of the property is deed-restricted through the township's TDR program. The property contains streams (two tributaries to Oldmans Creek), forestland, grassland habitat, wetlands, and ponds. The township is currently exploring possible acquisition as municipal parkland.

Weatherby Development

The Weatherby Development is located adjacent to Center Square Road and High Hill Road, and spans both sides of Indian Branch Creek. Although the majority of the land uses in the development are residential, the landowners also dedicated individual parcels within the larger development to the township. These individual township-owned parcels are permanently preserved and contain forest habitat and stormwater basins. The forested land plays an important role as a riparian buffer along the Indian Branch Creek and several other tributaries. The township's *Open Space and Recreation Plan* notes that this forestland could also accommodate trails, which could connect Weatherby to Locke Avenue and High Hill Park.

Former NIKE Missile Launch Site

The NIKE Missile Launch site (**Figure 60**), located along Paulsboro-Swedesboro Road close to the township's border with Logan Township, is comprised of two parcels. The township purchased the 14-acre administrative control site adjacent to Paulsboro-Swedesboro Road from the federal government, which also donated the interior (non-street-facing) NIKE missile launch site as part of the deal. The two parcels were part of an active missile launch site between 1954 and 1975. During this period, the site was one of 12 regional launch sites constructed to defend the Philadelphia region against a potential Soviet missile attack. The site is currently not open for public access, but the township has plans for its eventual use as a resource for township residents. The township plans to convert the launch site into dedicated open space; and, using an existing site redevelopment plan as guidance, facilitate the development of the control site for commercial and industrial uses.

Figure 60: Radar Tower at Former NIKE Site

Source: Matt Blake

Oliphants Millpond

Oliphants Millpond is a 30-acre pond located north of Oliphant's Mill Road and was formed from Porches Run, a tributary of Oldmans Creek. This waterway, and the millpond itself, is notable for containing C1 waters. The pond was formerly a destination for fox hunting and kayaking in the township, but it is currently privately owned, and there are no opportunities for public access at present. Oliphants Millpond is identified in Woolwich's *Open Space and Recreation Plan* as a priority site for acquisition if it becomes available. If the pond is preserved, the plan recommends that it be converted into a neighborhood park.

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Appendix A

Appendix A: Plant Species in Woolwich Stewardship Assessment Report

In 2013, Woolwich Township commissioned Natural Lands to create a stewardship assessment report for nine preserved parcels on the south border of Raccoon Creek and west of Swedesboro Borough. The report authors observed the following plant species on those assessed parcels (Block 5, Lots 3, 4, 5, 6.02, 6.07, 7, 10, 11 & 11.01). Species are organized alphabetically by scientific name.

Common Name	Scientific Name
TREES	
Box Elder	*Acer negundo*
Red Maple	*Acer rubrum*
Silver Maple	*Acer saccharinum*
Tree of Heaven	*Ailamthus altissima*
Mimosa	*Albizia julibrissin*
Bitternut Hickory	*Carya cordiformis*
Mockernut Hickory	*Carya alba*
Chinese Chestnut	*Castanea mollissima*
Catalpa	*Catalpa bignonioides*
Hackberry	*Celtis occidentalis*
Flowering Dogwood	*Cornus florida*
Hawthorn	*Crataegus coccirea*
Persimmon	*Diospyros virginiana*
American Beech	*Fagus americana*
Green Ash	*Fraxinus americana*
American Holly	*Ilex opaca*
Black Walnut	*Juglans nigra*
Red Cedar	*Juniperus virginiana*
Sweet Gum	*Liquidambar styraciflua*
Tulip Tree	*Lirodendron tulipifera*
Sweet-Bay Magnolia	*Magnolia virginiana*
Crab Apple	*Malus cornaria*
White Mulberry	*Morus alba*
Red Mulberry	*Morus rubra*
Black Gum	*Nyssa sylvatica*
Sycamore	*Platanus occidentalis*
Bird Cherry	*Prunus padus*
Black Cherry	*Prunus serotina*

Common Name	Scientific Name
White Oak	*Quercus alba*
Swamp White Oak	*Quercus bicolor*
Southern Red Oak	*Quercus falcata*
Hybrid Oak	*Quercus falcata x phellos*
Blackjack Oak	*Quercus marilandica*
Pin Oak	*Quercus palustris*
Willow Oak	*Quercus phellos*
Chestnut Oak	*Quercus prinus*
Northern Red Oak	*Quercus rubra*
Post Oak	*Quercus stellata*
Black Oak	*Quercus velutina*
Winged Sumac	*Rhus copallinum*
Black Locust	*Robinia pseudoacacia*
Sassafras	*Sassafras albidum*
SHRUBS	
Shadbush (Serviceberry)	*Amelanchier canadensis*
Groundselbush	*Baccharis halimifolia*
Sweet Pepperbush	*Clethra alnifolia*
Silky Dogwood	*Cornus amomum*
Autumn Olive	*Elaeagnus umbellata*
Witch Hazel	*Hamamelis virginiana*
Mountain Laurel	*Kalmia latifolia*
Privet	*Ligustrum amurense*
Spicebush	*Lindera benzoin*
Swamp Azalea	*Rhododendron viscosum*
Black Willow	*Salix nigra*
Elderberry	*Sambucus nigra*
High-Bush Blueberry	*Vaccinium corymbosum*
Low-Bush Blueberry	*Vaccinium pallidum*
Arrowwood	*Viburnum dentatum*
VINES	
English Ivy	*Hedera helix*
Japanese Honeysuckle	*Lonicera japonia*
Virginia Creeper	*Parthenocissus quinquefolia*
Cultivated Rose	*Rosa glanteria*
Multiflora Rose	*Rosa multiflora*

Common Name	Scientific Name
Dewberry	*Rubus flagellaris*
Blackberry	*Rubus frondosus*
Black Raspberry	*Rubus occidentalis*
Fox Grape	*Vitis labrusca*
Frost Grape	*Vitis vulpina*
Bulbriar	*Smilax rotundifolia*
Poison Ivy	*Toxicodendron radicans*
Japanese Wisteria	*Wisteria floribunda*
HERBACEOUS	
Common Corncockle	*Agrostemma githago*
Garlic Mustard	*Alliaria petiolata*
Field Garlic	*Allium vineale*
Virginia Broom Grass	*Andropogon virginicus*
Chamomile	*Anthemis* species
Sweet Vernal Grass	*Anthoxanthum odoratum*
Dogbane	*Apocynum cannabinum*
Jack-in-the-Pulpit	*Arisaema triphyllum*
Mugwort	*Artemisia vulgaris*
Common Milkweed	*Asclepsis syriaca*
Spleenwort	*Asplenium playtneuron*
False Nettle	*Boehmeria cylindrica*
Rye Broome	*Broomus secalinus*
Yellow-Fruit Sedge	*Carex annectens*
Pointed-Broom Sedge	*Carex scoparia*
Straw Flower	*Centaurea* species
Chickory	*Cichorium intybus*
Wood Reed	*Cinna arundinacea*
Enchanters Nightshade	*Circaea quadrisulcata*
Orchard Grass	*Dactylis glomerata*
Poverty Wild Oat Grass	*Danthonia spicata*
Flattened Wild Oat Grass	*Danthonia compressa*
Showy Tick-Trefoil	*Desmodium canadense*
Tick-Trefoil	*Desmodium canascens*
Panicled-Leaf Tick-Trefoil	*Desmodium paniculatum*
Naked Pink	*Dianthus* species
Deptford Pink	*Dianthus armeria*

Common Name	Scientific Name
Smooth Panic Grass	*Dichanthelium acuminatum v. lindheimeri*
Deer-Tongue	*Dichanthelium clandestinum*
Starved Rosette Grass	*Dichanthelium depauperatum*
Rosette Grass	*Dichanthelium microcarpon*
Egg-Leaf Rosette Grass	*Dichanthelium ovale v. addisonii*
Round-Seed Rosette Grass	*Dicanthilium sphaerocarpon*
Weeping Love Grass	*Eragrostis curvula*
Prairie Fleabane	*Erigeron strigosus*
Hyssop-Leaf Thoroughwort	*Eupaturium hyssopifolium*
Late Thoroughwort	*Eupatorium serotinum*
Cold Season Grasses	*Fescue* species
Wild Strawberry	*Fragaria viginiana*
Hairy Bedstraw	*Galium pilosum*
Carolina Crane's-Bill	*Geranium carolinianum*
White Avens	*Geum canadensis*
Gil-Over-the-Ground	*Glechoma hederacea*
Day Lily	*Hemerocallis fulva*
Grover's Cats Paw	*Hieracium gronovii*
Cat's Ear	*Hypochaeris radicata*
Touch-Me-Not	*Impatiens capensis*
Morning Glory	*Ipomoea purpurea*
Toad Rush	*Juncus bufonius*
Soft Rush	*Juncus effusus*
Poverty Rush	*Juncus tenuis*
Pinebarrens Dandelion	*Krigia virginica*
Sprangletop	*Leptoloma cognatum*
Bastard Toad Flax	*Linaria canadensis*
Perennial Rye Grass	*Lolium perenne*
Virginia Water-Horehound	*Lycopodium virginicus*
False Solomon's Seal	*Maianthemum racemosum*
Stilt Grass	*Microstegium vimineum*
Pennycress	*Microthlaspi perfoliatum*
Common Evening-Primrose	*Oenothera biennis*
Sensitive Fern	*Onoclea sensibilis*
Cinnamon Fern	*Osmunda cinnamomea*
Golden Groundsel	*Packera aurens*

Common Name	Scientific Name
Switch Grass	*Panicum virgatum*
Crown Grass	*Paspalum* species
Common Reed Grass	*Phragmites australis*
Pokeweed	*Phytolacca americana*
English Plantain	*Plantango lanceolata*
Virginia Plantain	*Plantago virginica*
Japanese Knotweed	*Polygonum cuspidatum*
Solomon's Seal	*Polygonatum biflorum*
Norwegian Cinquefoil	*Potentilla norvegica*
Sulfur Cinquefoil	*Potentilla recta*
Oldfield Cinquefoil	*Potentilla simplex*
Bracken Fern	*Pteridium aquilinum*
Common Sheep Sorrel	*Rumex acetosella*
Curled Dock	*Rumex crispus*
Bitter Dock	*Rumex obstusifolius*
Black Snakeroot	*Sanicula canadensis*
Gray's Bulrush	*Scirpus cyperinus*
Mossy Stonecrop	*Sedum acre*
Oldfield Goldenrod	*Solidago*
Canada Goldenrod	*Solidago canadensis*
Grass-Leaf Goldenrod	*Solidago graminiflora*
Early Goldenrod	*Solidago juncea*
Rough Goldenrod	*Solidago rugosa*
Skunk Cabbage	*Symplocarpus foetidus*
New York Fern	*Thelypteris noveboracensis*
Goat's Beard	*Tragopogon dubius*
Rabbit-Foot Clover	*Trifolium arvense*
Venus'-Looking-Glass	*Triodanis perfoliata*
Gramma Grass	*Tripsacum dactyloides*
White Vervain	*Verbena urticifolia*
Garden Vetch	*Vicia sativa*
Purple Vetch	*Vicia villosa*
Violet Species	*Viola* species
Eight-Flowered Fescue	*Vulpia octoflora*

Source: Woolwich Township, 2013.

Appendix B

Appendix B: Butterfly Species Observed in the Tranquility Trails

Edie Dondero (Woolwich Green Team) recorded the following list of butterfly species in Woolwich's Tranquility Trails park between August and November 2017. It is not a complete list of all of the butterfly species that would likely be found in Woolwich. For example, no skippers were observed and noted. Species are organized alphabetically by scientific name.

Common Name	Scientific Name
Meadow Fritillary	*Boloria bellona*
Orange Sulphur	*Colias eurytheme*
Clouded Sulphur	*Colias philodice*
Eastern Tailed Blue	*Cupido comyntas*
Monarch	*Danaus plexippus*
Common Buckeye	*Junonia coenia*
Red-Spotted Purple	*Limenitis arthemis*
Mourning Cloak	*Nymphalis antiopa*
Eastern Tiger Swallowtail	*Papilio glaucus*
Black Swallowtail	*Papilio polyxenes*
Pearl Crescent	*Phyciodes tharos*
Cabbage White	*Pieris rapae*
Eastern Comma	*Polygonia comma*
Painted Lady	*Vanessa cardui*
American Lady	*Vanessa virginiensis*

Source: Edie Dondero, 2017

Appendix C

Appendix C: Vertebrate Animals Known or Probable in Woolwich

Species are organized alphabetically by common name. Most species are probable in Woolwich rather than known because they were observed near the township but outside its borders. However, there are two datasets that contain observations within Woolwich. The observed species are marked as follows:

A star (*) indicates a bird species that Edie Dondero observed in the Tranquility Trails.

A double star (**) indicates a fish species that Academy of Natural Sciences researchers observed in the Raccoon Creek near the Locke Avenue bridge in Woolwich.

Common Name	Preferred Habitat in Southern New Jersey	Likely Locations in Woolwich
MAMMALS		
Brown Rat	Wetlands, homes, farms	Throughout
Coyote	Woodlands and fields	Throughout
Eastern Chipmunk	Woodlands	Throughout
Eastern Cottontail	All habitats	Throughout; common
Eastern Mole	Uplands	Throughout
Eastern Pipistrel	Uplands	Throughout
Gray Squirrel	Woodlands	Throughout
House Mouse	Homes and villages	Throughout
Jumping Mouse	Fields	Throughout
Little Brown Bat	Uplands	Throughout
Long-Tailed Weasel	Wetlands	Throughout
Meadow Vole	Open fields	Throughout
Mink	Wetlands	Throughout
Muskrat	Wetlands	Throughout
Opossum	All habitats	Throughout
Raccoon	All habitats	Throughout
Red Fox	All habitats	Throughout
Red-Backed Vole	Woodlands	Throughout
River Otter	Large streams	Oldmans and Raccoon Creeks
Short-Tailed Shrew	Woodlands	Throughout
Star-Nosed Mole	Uplands	Throughout; occasional
Striped Skunk	Uplands	Throughout
White-Footed Mouse	Woodlands	Throughout
White-Tailed Deer	All habitats	Throughout
Woodchuck	Woodlands and fields	Throughout

Common Name	Preferred Habitat in Southern New Jersey	Likely Locations in Woolwich
BIRDS		
American Black Duck*	Marsh, lakes	Throughout
American Crow*	All habitats	Throughout; common
American Coot	Open water, wetlands	Throughout
American Goldfinch*	Open areas, old fields	Throughout
American Kestrel*	Open fields	Throughout
American Pipit	Open areas	Migrant
American Redstart	Rich woodlands	Throughout
American Robin*	All habitats	Throughout; common
American Tree Sparrow	Open woodlands, fields	Throughout
American Wigeon	Lakes and ponds	Winter migrant
American Woodcock	Wetland forests	Throughout
Ash-Throated Flycatcher	Open woodlands	Rare
Bald Eagle*	Open water	Stream corridors
Barn Owl	Farmland	Throughout
Barn Swallow	Buildings, bridges	Throughout
Barred Owl	Wetland forests	Wooded wetlands
Belted Kingfisher*	Wetlands	Throughout
Black and White Warbler*	Pine woodlands	Migrant
Black Vulture*	Open fields	Throughout
Black-Billed Cuckoo	Woodlands	Occasional
Black-Crowned Night-Heron	Wetlands	Throughout
Black-Throated Blue Warbler	Woodlands	Migrant
Blue Grosbeak*	Shrubby areas	Throughout
Blue Jay*	Woodland	Throughout; common
Blue-Gray Gnatcatcher*	Woodlands, shrubby areas	Throughout
Blue-Winged Teal	Wetlands	Winter migrant
Bonaparte’s Gull	Lakes and ponds	Waterfront areas
Broad-Winged Hawk	Woodlands	Throughout
Brown Creeper	Woodlands	Throughout
Brown Thrasher*	Woodlands	Throughout
Brown-Headed Cowbird*	Open areas	Throughout
Bufflehead	Open water	Winter migrant
Canada Goose*	Open water, fields	Throughout
Canvasback	Lakes and ponds	Throughout

Common Name	Preferred Habitat in Southern New Jersey	Likely Locations in Woolwich
Carolina Chickadee*	Woodlands	Throughout; common
Carolina Wren*	Edges, yards	Throughout
Cedar Waxwing*	Old fields, young woodlands	Throughout
Chestnut-Side Warbler	Woodlands	Migrant
Chimney Swift	Bridges, house chimneys	Villages
Chipping Sparrow*	Woodlands	Throughout
Common Grackle	All habitats	Throughout
Common Loon	Lakes and ponds	Migrant
Common Merganser*	Marsh, lakes	Throughout
Common Nighthawk	Upland woodlands	Summer night sky
Common Raven	All habitats	Rare
Common Tern	Open water	Summer on larger lakes
Common Yellowthroat*	Shrubby areas	Throughout
Cooper's Hawk*	Woodlands	Throughout
Dark-Eyed Junco*	Woodlands	Winter migrant
Double-Crested Cormorant*	Open water	Lakes and ponds; tidal waters
Downy Woodpecker*	Woodlands	Throughout; common
Dunlin	Shorelines	Migrant, rare
Eastern Bluebird*	Edges	Throughout
Eastern Kingbird*	Fields, farmland	Throughout
Eastern Meadowlark	Grasslands	Throughout
Eastern Phoebe*	Woodlands	Throughout
Eastern Screech Owl	Woodlands	Throughout
Eastern Towhee*	Woodlands, edges	Throughout
Eastern Tufted Titmouse*	Woodlands	Throughout; common
Eastern Wood-Pewee*	Woodlands	Upland woods
European Starling*	Villages	Throughout
Field Sparrow	Old fields	Throughout
Fish Crow	Shorelines	Throughout
Forster's Tern	Open water, marshes	Migrant
Fox Sparrow	Woodlands	Throughout
Gadwall	Wetlands	Throughout
Golden and Ruby crowned Kinglets*	Woodlands	Winter migrant
Gray Catbird*	Woodlands, edges	Throughout
Great Black-Backed Gull	Shorelines, open areas	Close to water

Common Name	Preferred Habitat in Southern New Jersey	Likely Locations in Woolwich
Great Blue Heron*	Open marsh, lake edges	Throughout
Great Crested Flycatcher	Woodlands	Throughout
Great Egret	Open marsh, lake edges	Throughout
Great Horned Owl	Woodlands	Throughout
Greater & Lesser Scaup	Open water	Winter migrant
Greater Yellowlegs*	Lake edges	Throughout
Green-Backed Heron	Open marsh, lake edges	Throughout
Green-Winged Teal*	Wetlands	Winter migrant
Hairy Woodpecker	Woodlands	Throughout
Hermit Thrush*	Edges	Throughout
Herring Gull	Open water, dumps	Winter visitor
Hooded Merganser	Open water	Winter migrant
Horned Grebe	Lakes and ponds	Migrant
Horned Lark	Grasslands	Throughout
House Finch	Open areas	Throughout
House Sparrow	Villages, old fields	Throughout
House Wren	Villages, edges	Throughout
Indigo Bunting*	Edges, old fields	Throughout
Killdeer	Bare ground, lake edges	Throughout
Lapland Longspur	Grasslands	Throughout
Laughing Gull	Open water, parking lots	Summer visitor
Lesser Yellowlegs	Lake edges	Throughout
Long-Eared Owl	Woodland, grassland	Throughout
Long-Tailed Duck	Lakes and ponds	Migrant
Mallard*	Wetlands	Throughout
Marsh Wren	Tidal marsh	Raccoon and Oldmans Creeks
Merlin	Woodlands, urban areas	Throughout
Mourning Dove*	Woodlands	Throughout
Mute Swan	Open water	Large lakes
Northern Bobwhite	Old field, woodlands	Throughout
Northern Cardinal*	Edges	Throughout; common
Northern Flicker*	Woodlands	Throughout; common
Northern Goshawk	Woodlands	Throughout
Northern Harrier	Open fields	Throughout
Northern Mockingbird*	Hedgerows, yards	Throughout

Common Name	Preferred Habitat in Southern New Jersey	Likely Locations in Woolwich
Northern Pintail*	Marsh, lakes, open fields	Throughout
Northern Shoveler Duck	Open water	Winter migrant
Orioles: Orchard, Baltimore	Woodlands	Throughout
Osprey	Open water	Lakes and ponds; tidal waters
Ovenbird*	Woodlands	Throughout; common
Painted Bunting	Scrub, edges	Rare
Palm Warbler*	Pine woodlands	Throughout
Peregrine Falcon	Shorelines, open habitat	Throughout
Philadelphia Vireo	Woodlands	Migrant
Pied-Billed Grebe	Open water	Lakes and ponds; tidal waters
Pine Siskin	Woodlands	Winter migrant
Pine Warbler	Woodlands	Throughout
Prairie Warbler	Shrubby areas	Throughout
Purple Finch	Woodlands, backyards	Throughout
Purple Martin	Open fields, wetlands	Villages
Red Crossbill	Pine woodlands	Winter migrant
Red Eyed Vireo	Woodlands	Wetland forests
Red-Bellied Woodpecker*	Woodlands	Throughout
Red-Breasted Merganser	Open water	Migrant
Red-Breasted Nuthatch	Woodlands	Throughout
Red-Shouldered Hawk	Woodlands	Throughout
Red-Tailed Hawk	All habitats	Throughout
Red-Throated Loon	Lakes and ponds	Rare
Red-Winged Blackbird	Open wetlands, marsh	Throughout
Ring-Billed Gull	Open water, parking lots	Throughout
Ringed-Neck Pheasant	Old fields, farms	Released; throughout
Ring-Necked Duck	Open water	Winter migrant
Rock Dove (Rock Pigeon)	Houses and bridges	Villages
Ruby-Throated Hummingbird	Woodlands and fields	Throughout; common
Ruddy Duck	Open water	Winter migrant
Rusty Blackbird	Woodlands, wetlands, ponds	Throughout
Rufus Sided Towhee	Pine woodlands	Throughout
Sandhill Crane	Wetlands	Rare
Savannah Sparrow	Grasslands	Throughout
Saw-Whet Owl	Wetland forests	Wooded wetlands

Common Name	Preferred Habitat in Southern New Jersey	Likely Locations in Woolwich
Scarlet Tanager	Woodlands	Throughout
Sharp-Shinned Hawk	Woodlands	Throughout
Short-Eared Owl	Grasslands, open space	Throughout
Snow Bunting	Grasslands, open space	Throughout
Snow Goose	Winter migrant in fields	Open farms
Snowy Egret	Open marsh, lake edges	Throughout
Snowy Owl	Open habitat	Rare
Solitary Sandpiper*	Lake edges	Throughout
Song Sparrow*	Old fields	Throughout
Spotted Sandpiper	Lake edges	Throughout
Swamp Sparrow	Wetlands	Throughout
Tree Swallow*	Wetlands	Throughout
Tundra Swan	Lakes and ponds	Throughout
Turkey Vulture*	All habitats	Throughout
White Breasted Nuthatch*	Woodlands	Throughout
White-Crowned Sparrow	Open habitat	Throughout
White-Eyed Vireo*	Woodlands	Throughout
White-Throated Sparrow*	Woodlands	Winter migrant
Wild Turkey*	Woodlands	Throughout
Wilson's Snipe	Wetlands	Throughout
Wilson's Warbler	Woodlands, scrub lands	Migrant; near streams
Winter Wren	Woodlands	Throughout
Wood Duck*	Forested wetlands	Throughout
Wood Thrush*	Woodlands	Throughout
Yellow Warbler	Upland forest	Throughout
Yellow-Bellied Sapsucker	Woodlands	Fall migrant
Yellow-Billed Cuckoo	Woodlands	Throughout
Yellow-Rumped Warbler*	Woodlands	Throughout
REPTILES		
Black Rat Snake	All habitats	Throughout
Bog Turtle	Muddy agricultural fields/wetlands	Endangered
Common Snapping Turtle	Ponds and lakes	Throughout
Eastern Box Turtle	Uplands	Throughout
Eastern Painted Turtle	Lakes and ponds	Throughout
Eastern Ribbon Snake	Wetlands	Throughout

Common Name	Preferred Habitat in Southern New Jersey	Likely Locations in Woolwich
Garter Snake	All habitats	Throughout
Northern Black Racer	Edges	Throughout
Northern Fence Lizard	Uplands	Throughout
Northern Water Snake	Wetlands	Throughout
Red-Bellied Turtle	Lakes and ponds	Throughout
Rough Green Snake	Woodlands	Throughout
Southern Ringneck Snake	Woodlands	Throughout
Spotted Turtle	Freshwater wetlands and ponds	Throughout
Stinkpot Turtle	Wetlands	Throughout
AMPHIBIANS		
Bullfrog	Lakes and ponds	Throughout
Fowlers Toad	Uplands	Throughout
Green Frogs	Wetlands	Throughout
Red-Backed Salamander	Woodlands	Throughout
Southern Leopard Frog	Wetlands	Throughout
Spring Peeper	Wetlands	Throughout
Wood Frog	Woodlands	Throughout
FISH		
Alewife	Tidal streams	Possible
American Eel	All waters	Throughout
American Brook Lamprey	Streams	Possible
American Shad	Tidal rivers and streams	Possible
Atlantic Menhaden	Tidal rivers and streams	Possible
Atlantic Needlefish**	Tidal rivers and streams	Possible
Atlantic Silverside	Tidal rivers and streams	Possible
Banded Killifish	Lakes and streams	Throughout
Blueback Herring	Tidal streams	Possible
Bluefish**	Tidal rivers and streams	Possible
Bluegill	All waters	Throughout
Blue-Spotted Sunfish	Swamps and streams	Throughout
Brown Bullhead	Rivers, lakes, and streams	Throughout
Chain Pickerel	Lakes and streams	Throughout
Channel Catfish	River and tidal streams	Throughout
Comely Shiner	Rivers and streams	Throughout
Common Carp	Rivers, lakes, and streams	Throughout

Common Name	Preferred Habitat in Southern New Jersey	Likely Locations in Woolwich
Common Shiner	Rivers and streams	Throughout
Creek Chub-Sucker	Streams	Throughout
Eastern Mudminnow	Streams	Throughout
Eastern Silvery Minnow	Rivers and streams	Throughout
Fallfish	Rivers and lakes	Throughout
Gizzard Shad	All waters	Throughout
Golden Shiner	Streams	Throughout
Green Sunfish	Streams and lakes	Throughout
Hogchoker (Sole)	Tidal streams	Possible
Iron Colored Shiner	Lakes and streams	Possible
Largemouth Bass	Lakes	Throughout
Mud Sunfish	Streams and swamps	Possible
Mummichog	Tidal wetlands and tidal streams	Throughout
Pirate Perch	Streams	Throughout
Pumpkinseed	All waters	Throughout
Redbreast Sunfish	Rivers, lakes, and streams	Throughout
Redfin (American) Pickerel	Wetlands, lakes, streams	Throughout
Satinfin Shiner	Rivers and streams	Throughout
Sea Lamprey	All waters	Throughout
Spot	Tidal rivers and streams	Possible
Spottail Shiner**	Rivers, lakes, and streams	Throughout
Striped Bass**	Tidal streams	Possible
Swallowtail Shiner	Rivers and streams	Throughout
Swamp Darter	Swamps	Throughout
Tadpole Madtom	Lakes and streams	Throughout
Tessellated Johnny Darter	Lakes	Throughout
White Catfish	Rivers, lakes, and streams	Throughout
White Perch**	Rivers and streams	Throughout
White Sucker	Streams	Throughout
Yellow Perch**	Lakes	Possible

Sources: Modified version of Table 11 of the Environmental Resource Inventory for Franklin Township, Gloucester County New Jersey, in the 2013 Woolwich ERI, 2013; Edie Dondero, October 2017–September 2018; Audubon Christmas Bird Count, Northwestern Gloucester County, 2007–2017; The Cornell Lab of Ornithology; USGS New Jersey Water Science Center, 1999–2001; The Academy of Natural Sciences of Drexel University, 1998–2011; FishBase.org.

Environmental Resources Inventory for Woolwich Township

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Abstract:
This publication documents the natural and community resources of Woolwich Township, Gloucester County, New Jersey. The natural resource information includes descriptions, tables, and maps of: land use; soils; drinking water, aquifers, and wells; surface waters, including watersheds, streams, lakes, wetlands, and floodplains; impacts on water resources and surface water quality; impervious coverage; vegetation, including wetlands, forests, and grasslands; animal communities; threatened and endangered species; Landscape Project Priority Habitats; and known contaminated sites. Community resources in the form of protected open space and recreation facilities are also briefly described. A short history of the community is also included.

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