ENVIRONMENTAL RESOURCE INVENTORY

ERI

JUNE 2010

for the township of:

GREENWICH

Cumberland County, New Jersey

by:

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

with:

The Environmental Commission of Greenwich Township

The Delaware Valley Regional Planning Commission is dedicated to uniting the region's elected officials, planning professionals, and the public with a common vision of making a great region even greater. Shaping the way we live, work, and play, DVRPC builds consensus on improving transportation, promoting smart growth, protecting the environment, and enhancing the economy. We serve a diverse region of nine counties: Bucks, Chester, Delaware, Montgomery, and Philadelphia in Pennsylvania; and Burlington, Camden, Gloucester, and Mercer in New Jersey. DVRPC is the federally designated Metropolitan Planning Organization for the Greater Philadelphia Region — leading the way to a better future.

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The impetus for the creation of this document, and its guidance and review, came from the Greenwich Township Environmental Commission.

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EXECUTIVE SUMMARY

The purpose of an Environmental Resource Inventory (ERI) is to identify and describe the natural resources of a community. A community's natural resources–its soil, water, air, forests, fields, and waterways–are fundamental to its character and its quality of life. The protection and wise use of those resources is essential to the public health, safety, and welfare of current and future residents.

The Environmental Resource Inventory provides the basis for the development of methods and steps to preserve, conserve, and utilize those resources, although it does not include specific recommendations to those ends. It is, instead, a compendium of all the existing information that can be found about a township's natural resources, presented in a form that is useful to a broad audience. The inventory reflects a particular moment in time, and it is assumed that it will be updated as new data becomes available.

Photo by Clifton Jones

Greenwich Township's Post Office

As development pressures increase in and around Greenwich, documentation of its natural resources will become a necessity. Special measures to protect and enhance the historic characteristics, traditional agricultural and water-based economies, and the natural environment become even more important when faced with the pressures of increased population and development. Greenwich's water, wetlands, forests, and grasslands provide significant high-quality habitat for a wide variety of plants and animals. These areas are critically important in maintaining the health and vitality of the township. Detailed documentation of these resources will aid Greenwich's citizens to balance the pressures of growth with conservation, maintaining and shaping the community's unique identity, while protecting its rich historic fabric and its exceptional natural environment.

Greenwich Township continues to have a rich diversity of resources. Its soils sustain a variety of agricultural products, including grain and vegetable crops, and nurseries of ornamental plants. Over 31.1% of Greenwich's 5,168 farmland assessed acres are permanently preserved through farmland easements.

The streams running through this bayside community branch out to wide waterways that provide rich aquatic and wetland habitat. These wide waterways also provide recreational opportunities, and two marinas are located along Greenwich's shores. Large waterways form the township's borders on nearly every side. Stow Creek forms its west border with Lower Alloways Creek Township. The Cohansey River

forms the township's eastern border with Fairfield Township. Smaller tributaries of Stow Creek constitute the northeast border with Stow Creek Township. And Maurice Creek, a tributary to the Cohansey River, forms the northwest border with Hopewell Township.

Wetlands, both fresh and saltwater, are the dominant vegetation in Greenwich Township, covering nearly one-third of the township's land area. A number of threatened and endangered species are documented in the township, as well as in the remaining upland forests and across the open agricultural lands of the community. These include endangered plants, such as swamp pink, and several bird species, such as the red-shouldered hawk, the peregrine falcon, and the upland sandpiper.

As a rural community, Greenwich Township relies on individual groundwater wells for residential and agricultural use. Its streams and lakes are also fed by groundwater. Greenwich Township sits atop the Kirkwood-Cohansey Aquifer, which is a rich source of water, although it is also an aquifer without any protective confining layers above it and is therefore easily contaminated from the surface. Fortunately, the number of contaminated sites in Greenwich is small. However, the surficial geology of the area does make the threat of radium contamination a potential hazard to residential wells.

Sources

Several documents and reports were utilized in preparing the *Environmental Resource Inventory (ERI) for Greenwich Township*. These reports and a number of reference works are listed at the end of this document.

The maps and data relating to natural resources are derived from the New Jersey Department of Environmental Protection's (NJDEP's) Geographic Information System mapping, *The Landscape Project* produced by the Endangered and Nongame Species Program of the New Jersey Division of Fish and Wildlife, reports by the U.S, Geologic Service and New Jersey Geologic Service, and mapping data compiled and prepared by the Delaware Valley Regional Planning Commission (DVRPC). Information from these sources that is specific to Greenwich Township has been included whenever it was available. Information from other reports about specific sites has also been incorporated, along with data provided by township and county staffs. The Environmental Resource Inventory has been reviewed and corrected by members of the Environmental Commission and other township officials.

Somewhat lengthy introductions to some topics, especially surface water monitoring and groundwater, have been included in the ERI to give readers background on these complex topics. The hope is that it will also assist the Environmental Commission and other township officials in obtaining additional data from state sources in the future and to determine the types of investigations that still need to be conducted.

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CHAPTER 1

BRIEF HISTORY

The **History** section is indebted to the excellent historical narratives written by Penelope Watson and Alan Carmen for the Greenwich Township Environmental Commission. They were completed in 2007 and 2009, respectively.

Early History and Lenape Settlement

Before the arrival of Europeans in North America, present-day Greenwich Township was a highly desirable area for Native American settlements, situated on high ground and surrounded by freshwater creeks. The streams, known today as Pine Mount Run, Wheaton Run, and the Cohansey River, provided the life-sustaining necessities, such as drinking water, fish, game, and wildlife. Archeological data indicates that two of the eight major areas of Native American occupation in South Jersey are in Greenwich Township along Pine Mount Run and Sheppards Mill Pond. The massive amount of recovered artifacts indicates that the two sites' population levels rivaled the current Greenwich Township population.

One of the main attractions to the area was a native stone called "Cohansey Quartzite," which was surface mined by the Native Americans at various locations. This stone is composed of silica sand, shell, and marine life fossils and was formed during the Miocene Period 23 million years ago. The Native American people utilized this lithic material for tools and weapon points.

The native people who settled in southern New Jersey were one of the 43 subdivisions of the Lenape culture. They were called the "Little Siconesse" and they occupied the full extent of the Cohansey River and its tributaries. The ancestors of the Lenape were Algonquin-speaking hunters and gatherers who migrated northward along the Atlantic seaboard around 1000 BC. They were seeking a land free of intertribal warfare. They were called the "Lenape," meaning "original people." History suggests that they were a peace-loving people wholly dependent on their natural world. Eventually, they became victims of an encroaching civilization. Some Native Americans signed indentures with the European settlers to transfer land ownership; others migrated quietly to other locations, or died from European disease. A number assimilated as farmers into the changing culture, or intermarried with the encroaching foreigners. Lenni Lenape descendants continue to reside in the Greenwich area.

The Cumberland County Prehistorical Museum is located in Greenwich. This noteworthy museum contains the Indian and fossil collection of Alan Ewing Carman. His work as an avocational archaeologist covers over 50 years. The hundreds of Native American artifacts and over 1,000 fossils on display in the museum were collected by Alan Carman in Greenwich Township and the vicinity.

European Settlement

In 1638, the Swedes established a colony at the confluence of the Delaware River and Raccoon Creek and settled homesteads throughout the region; however, the main interest of the Swedes was commerce, not colonization. The Swedish government lost interest in their southern colony around 1649, but many colonists remained. A larger colony founded by the Dutch in the New York area, known as New Amsterdam, was much more successful.

Photo by DVRPC

The Swedish Granary was built in 1650.

Another wave of European colonists came from England, and it was this group that would have the greatest effect on Cumberland County and Greenwich Township. The English seized control from the Dutch in 1664 and quickly sought to occupy the land and secure its control. Most of southern New Jersey and Warren, Hunterdon, and Mercer counties were in an area known as “West New Jersey.”

The area of present-day Salem and Cumberland counties was purchased by Sir John Berkeley in 1664 from James, the Duke of York, son of King Charles I. Berkeley sold his holdings to John Fenwick in 1675, who bought it in trust for Edward Byllinge (also spelled Billing), who was bankrupt and therefore unable to be named on a deed. Fenwick, however, claimed the land as his own, and the dispute between the two men was settled by William Penn. Penn decided that one-tenth of the land would belong to Fenwick, and Byllinge was entitled to the other nine-tenths.

After arriving in West New Jersey in 1675, Fenwick renamed part of his land Fenwick Colony and planned for the development of twin settlements, Salem and Greenwich. Fenwick originally called Greenwich “Cohanzie,” or “Cohansey,” after the river that runs through it. This river had been named after a local Native American Chief, whose name has also been interpreted as “Cohanzick” and “Canahockink,” among others. Early settlers of Greenwich came from other New England colonies, as well as England. Cohansey was quickly renamed after either Greenwich, Connecticut, or Greenwich on the Thames, in England. The town continued to be known as Cohansey for many years, and was also called Antioch.

Fenwick originally had grand plans for his land to be an independent colony separate from West New Jersey, and that he would be governor of the colony. However, questions over his rights of ownership and governance led to constant conflict with other colonists and Lord Edmund Andross, Royal Governor of New York. This opposition, in addition to his persistent financial problems, led Fenwick to convey most of his interest in West New Jersey to William Penn in 1682. Salem became an official port of entry for trade in the same year, followed by Greenwich in 1687. Both towns housed British customs houses, which collected tariffs from ships entering or leaving port. By the mid-1700s, Greenwich had become a thriving and important colonial port town.

Two early settlement areas in the township were Greenwich Village and a village called Head of Greenwich. In 1684, Richard Tindell laid out the streets and parcels of Greenwich Village. “Ye Greate Street” was and still is Greenwich’s main street, along which a total of 16 lots were assigned on either side for a distance of about one and one-half miles. This street was designed to be 80 feet wide at its northernmost point, widening to 90 feet, and then finally to 100 feet approaching the Cohansey River. The street was built at such a great width to accommodate the anticipated maritime trade. In addition to the lots along Ye Greate Street, a number of large tracts of land were also sold. This included a 260-acre parcel purchased in 1682 by Samuel Bacon and named Bacon’s Neck. One year later, Bacon purchased an additional 400 acres of Native American land, after which his vast property became known as “Bacon’s Adventure.” The Head of Greenwich, located near Ye Greate Street and Old Mill Road, was first settled by a group of Presbyterians in 1707. It was later named Othello by a local literary society after the Shakespearean character. A post office was once located in Othello, where today there remains a Presbyterian church and graveyard.

Fenwick envisioned his new colony to be democratic and based on Quaker beliefs. Indeed, most of the first settlers were Quakers who emigrated from England. Before the construction of the first Quaker Meeting House in Greenwich in 1737, Quaker meetings were held in private homes. Many other settlers in Greenwich came from New England and Long Island and were mostly Presbyterians and Baptists.

Photo by DVRPC

The Greenwich Friends Meeting House

In 1733, William Watson began operating a ferry in the Cohansey River, allowing for greater trade in and out of Greenwich. He had obtained a royal license to operate a ferry for a stretch of the river two miles above and below Greenwich. The ferry license passed from William Watson to the Butler family in 1742, and then to the Sheppard family in 1768. In 1838, John Sheppard III paid $300 to the freeholders of Greenwich and Fairfield to be released from the ferry contract for economic reasons.

In 1748, Fenwick’s colony, known as Salem County at the time, was divided in two, and the lower part was called Cumberland County in honor of the Duke of Cumberland. That year, a temporary jail was built in Greenwich. Court for the new county was held in Greenwich until December 1748, when an election determined that the less populous settlement of Cohansey Bridge, later called Bridgeton, would be the county seat.

Seeds of the American Revolution

In 1774, as turmoil and unrest brewed in the American colonies, a ship called the Greyhound was en route to Philadelphia to deliver a large quantity of tea. The ship decided that the political situation was too

dangerous for the delivery to be completed. Instead, the tea was secretly stored in the cellar of Dan Bowen, a British sympathizer in Greenwich. News of the tea and its location, however, became public, and a group of men met at the Howell House in Shiloh to discuss potential action. On December 22, 1774, nearly a year after the famous Boston Tea Party, approximately 40 men dressed as Native Americans raided Bowen's cellar and burned the tea in Greenwich's Market Square. A number of attempts to indict the tea burners in court were unsuccessful, as the jury was composed of mostly Whigs opposed to British rule. The audacity of the tea burning convinced many residents who sided with the British to move to Canada. In 1908, a monument dedicated to the Revolutionary tea burners was erected on the site of the burning through the efforts of the Daughters of the American Revolution (DAR) and the Cumberland County Historical Society.

One of the members of the tea-burning party, Phillip Vickers Fithian, would later become renowned as a chronicler of early colonial life. Born in Greenwich in 1747, he received his early education from ministers in Greenwich and nearby Deerfield before entering Princeton University. After graduation, he accepted a job as a private tutor at an estate in Virginia. In Virginia, he began writing a journal of observations on everyday life and customs. Princeton University published an abbreviated version of his journal in 1900, and the complete volume in 1934. His meticulous architectural descriptions were used during the restoration, reconstruction, and recreation of Williamsburg, Virginia.

Springtown and the Underground Railroad

Springtown was settled around the turn of the 19th century by African Americans, many of whom escaped from slavery. It became known as a refuge for fugitive slaves who crossed the Delaware Bay from Delaware and the Eastern Shore of Maryland. The Underground Railroad, the informal network that operated from approximately 1820 to 1860, had three routes into New Jersey, one of which entered through Greenwich. This route was the one apparently favored by Harriet Tubman, who led an estimated 300 slaves northward via Greenwich, according to her biographer, Earl Conrad. The predominance of antislavery Quakers and the area's network of waterways, as well as the pre-existing African American settlement of Springtown, were factors in Greenwich's role as a station on the Underground Railroad. Thomas R. Sheppard and J.R. Sheppard, residents of Greenwich, were the only two white Underground Railroad station masters in Cumberland County.[1] Five other station masters in Cumberland County were members of the Bethel AME church. However, in spite of the strong antislavery sentiment in Greenwich, slavery still existed in the township in the early 19th century.

Photo by DVRPC

The Bethel African Methodist Episcopal (AME) Church

The Bethel African Methodist Episcopal (AME) Church, located in the center of Springtown, is on

[1] Siebert, Wilbur. *The Underground Railroad: From Slavery to Freedom*. New York: Russell and Russell, 1967.

the national and state Registers of Historic Places. Like the Quakers, the Methodists were opposed to slavery, and white and African American Methodists worshipped together until the early 1800s. However, as the number of Methodists grew and more slave-holding whites became members, the congregation split along racial lines. The African Society of Methodists was formed in Greenwich and purchased land for a meeting house in 1810. Their first meeting house was destroyed by fire in the 1830s, and the current building was constructed between 1838 and 1841.[2] The Ambury Hill Cemetery, located near Ye Greate Street and Stathem's Neck Road, was the final resting place for many members of the African Society of Methodists in Greenwich and contains the remains of some of the earliest members of the congregation. The cemetery is also significant as the burial place of many African American veterans of the Civil War, whose graves are still decorated annually by the American Legion and others. Ambury Hill is currently in the care of the Bethel AME Church, although it is no longer used by the congregation.

Agriculture and Industry

Nearly all of Greenwich's early settlers were farmers who were self-sufficient. They developed small farms by clearing forested areas; the harvested wood was used as firewood or shipped to Philadelphia to be sold as lumber. In the early 1800s, farmers discovered that marl, or lime shale, could be used to fertilize the soil and alfalfa hay could replenish the soil with nitrogen. Farmers also built dikes on the marshes to increase the agricultural potential of the land. Evidence of these dikes can still be seen in some parts of the township, particularly on the Bayside tract. These methods, along with the use of crop rotation and transporting goods by steamboats, encouraged rapid growth and commercialization of agriculture throughout southern New Jersey.

Photo by DVRPC

Many farms in Greenwich grow horticultural crops.

Starting in the mid-1800s, agriculture changed from subsistence farming to commerce, thanks to the advent of canning and preservation of produce and other food commodities. The earliest known commercial canning operation in Cumberland County was begun by John E. Sheppard out of his home in the 1840s. Between 1860 and 1890, about 23 canneries were located in Cumberland County. Most of these were in Bridgeton, although two were in Greenwich, including R.S. Watson and Son. During the first half of the 20th century, the Seabrook Farms plant in nearby Upper Deerfield Township also provided year-round employment for many local residents and served a large market for agricultural products.

[2] National Park Service. "Aboard the Underground Railroad: A National Register of Historic Places Travel Itinerary." http://www.nps.gov/nr/travel/underground/ugrrhome.htm, accessed 3/4/2008.

In addition to its agrarian economy, all aspects of the maritime industry have been important in Greenwich Township, especially shipbuilding and the harvesting of sturgeon and oysters. Greenwich was one of the premiere locations for shipbuilding along the Delaware Bay in colonial times; however, its dominance began to decline in the 1760s. Only 38 ships, called sloops (one mast) and schooners (two or more masts), were built in the township between 1852 and 1929.

In the late 1800s, a significant sturgeon fishery developed near the mouth of Stowe Creek and the port there became known as Caviar. In the 1870s and 1880s, this area supplied more caviar than any other place in the world. The height of Greenwich's sturgeon industry was 1888, when Delaware Bay fisherman caught six million pounds of sturgeon, while the rest of the East Coast caught one million pounds. Sturgeon meat and its caviar were shipped from the bay via boats, as well as by the railroad that terminated at the port of Caviar.

Although the sturgeon is an ancient species that has existed for over 200 million years, overfishing during the late 1800s reduced its numbers so greatly that it was feared that the species was close to extinction. With the end of the local sturgeon trade, the railroad stopped running to Caviar. The shortnose sturgeon was listed as an endangered species in 1966. Rebuilding the sturgeon population is a difficult task because a sturgeon can take up to 14 years to reach maturity. A recovery plan for the shortnose sturgeon was published in 1998 by the National Marine Fisheries Service, which included a fishing moratorium. However, many sturgeons are caught indirectly in nets meant to catch other fish and shellfish.

Photo by DVRPC

"Floating cabins" were used during the sturgeon season.

In addition to sturgeon and other types of fish, oysters were an important source of food for Native Americans, colonists, and early American citizens. Oysters' importance as a natural resource was recognized by the New Jersey colonial legislature as early as 1719, when a law was enacted banning overharvesting. In the 1800s, oystering was a major industry along the Delaware Bay; oysters were an extremely popular food item in the United States, and especially in Northeastern cities. The "oyster capital of the world" was an area aptly named Bivalve, located in present-day Commercial Township at the mouth of the Maurice River. In the 1920s, New Jersey produced about one-third of all oysters consumed in the United States, most of which came from the Delaware Bay. The oyster population was nearly destroyed by a number of diseases during the 20th century, particularly a devastating outbreak of a parasite called MSX in 1957.

The Bayside Tract

In the 1960s, about one-third of Greenwich Township was acquired gradually by a consortium of electric power companies through a straw company called Overland Realty. Overland purchased nearly 4,500 acres–now known as the Bayside Tract–from over 90 owners, mostly farmers, for about $2.5 million. Eventually, Greenwich Township and Cumberland County residents learned that the power companies intended to use this land for oil storage, refining, and nuclear-powered energy generation. Citizen opposition led to the township's first zoning ordinances in 1966, which created a historic district, but which zoned the Bayside Tract as industrial. A later revision in 1975 prohibited the specific types of uses that the companies originally sought for the Bayside Tract.

Photo by DVRPC

The Salem/Hope Creek Nuclear Power Plant is seen in the distance.

One result of the energy companies' efforts in Greenwich was the Salem Nuclear Power Plant, which first went on line in 1977. The Salem Nuclear Power Plant contains two units and shares an artificial island in the Delaware Bay with the Hope Creek Nuclear Generating Station. The three nuclear power units are currently owned and operated by Public Service Enterprise Group (PSEG)[3] and Exelon. In 1994, the NJDEP issued a Final New Jersey Pollutant Discharge Elimination System (NJPDES) permit for the Salem Nuclear Power Plant contingent on a number of special conditions regarding the station's impact on the environment. In addition to actions to protect fish populations, other special conditions included the implementation of a management plan regarding wetlands restoration and preservation. This resulted in the Estuary Enhancement Program, which is the largest privately funded wetlands preservation effort in the country. Today, the Bayside Tract is part of the Estuary Enhancement Program, which encompasses over 20,000 total acres along the Delaware Bay in both New Jersey and Delaware.

Some specific projects undertaken by the Estuary Enhancement Program include the construction of artificial reefs, fish ladders, and osprey nesting platforms. Additionally, New Jersey legislation protecting the environment of the coastal region, such as the Coastal Area Facility Review Act (CAFRA), the Wetlands Act of 1970, and the Waterfront Development Law, offers greater protection for the preservation of the Bayside Tract and surrounding areas. In addition to its rich natural resources, the largely undeveloped state of the Bayside Tract has made it a significant part of the local historical and cultural landscape.

Over its history spanning more than 300 years, Greenwich Township has changed many times, particularly as roadways have replaced waterways as the primary drivers of trade and development. The rise and fall of the sturgeon and oyster industries also had a great impact on the growth of Greenwich. Although once an important center for maritime trade and industry, Greenwich Township has evolved into a secluded village, intent on preserving its history, natural resources, and quality of life.

[3] Formerly Public Service Electric and Gas Company (PSE&G)

CHAPTER 2

LOCATION, SIZE, AND LAND USE

Greenwich, an incorporated township, is located in the northwest part of Cumberland County, New Jersey. The township is bordered by four municipalities: Stow Creek Township to the north, Hopewell Township to the east, and Fairfield Township to the south, all in Cumberland County, and Lower Alloways Creek to the west in Salem County. Additionally, several waterways create natural borders around Greenwich: the Delaware Bay to the south and southwest, Stow Creek to the west, Chestnut and Macanippuck Runs to the north, and the Cohansey River and Mounce Creek to the southeast. See **Map 1: Greenwich Township Base Map** and **Map 2: Greenwich Township Aerial Photo (2002).**

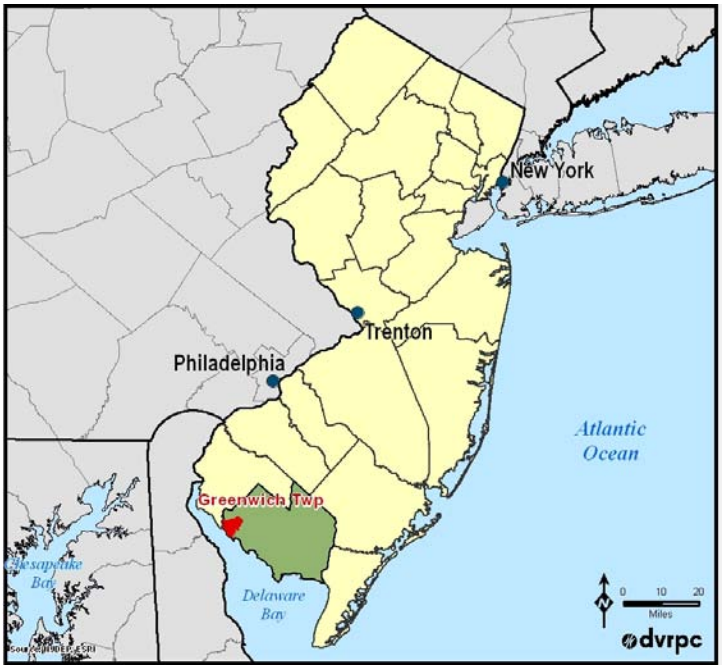


Figure 1: Location of Greenwich Township

The U.S. Census Bureau estimated that Greenwich Township had a population of 875 in 2005, up 3.4% from its 2000 population of 847. This is still less, however, than the township's 1990 population of 911.

Greenwich Township occupies 11,936 acres, or 19 square miles, on the coastal plain of New Jersey. Reflecting its natural setting and its long agricultural past, most of the township remains rural today. Residential development is scattered throughout Greenwich, with a concentration of residences located in the three original settlements of Greenwich Village, the Head of Greenwich (Othello), and Springtown. Greenwich Village is centered on Ye Greate Street (County Route 623), the township's first street. Many residences are located near Ye Greate Street between Bacons Neck Road and Market Lane and represent well-preserved examples of 18th and 19th century architecture. The Head of Greenwich is located at the intersection of Ye Greate Street, Sheppard's Mill Road (County Route 650), and Old Mill Road (County Route 703). Springtown is located near the intersection of Sheppards Mill Road and Springtown Road (County Route 620).

The nearest urban center is Bridgeton, a small city of about 24,000 located less than 10 miles to the northeast of Greenwich. Because Greenwich is not accessible by any major highway, it has enjoyed isolation. However, it is about an hour's drive from Philadelphia, Wilmington, Atlantic City, and Interstate 95. As national trends show greater willingness to commute longer distances to work, Greenwich's relative proximity to the urban and employment centers of the northeast corridor could mean greater demand for housing and development in the township.

Photo by DVRPC

The Phillip Dennis House on Bacons Neck Road

The most common type of land cover in Greenwich is wetlands, both fresh and saltwater, which cover over 43% of the township. Another 32% of land is used for agriculture. Greenwich's rural character is evidenced by the fact that a scant 4% of its land is considered urban, or developed. The entire township of Greenwich is within a Coastal Areas Facilities Review Act (CAFRA) planning area. The township's borders with Stow Creek, the Cohansey River, and the Delaware Bay are within CAFRA's Coastal Environmentally Sensitive Planning Area, and the center of the township is within the Coastal Rural Planning Area.

Table 1 shows Greenwich's land use/land cover, grouped into general categories. The categories are based on data collected from the New Jersey Department of Environmental Protection's (NJDEP's) 2002 color infrared digital imagery. See also **Map 4: NJDEP Land Cover (2002)** on page 20.

Table 1: Greenwich General Land Use/Land Cover Classes (2002)

General Land Use / Land Cover Class	Acres	Percent
Agriculture	3,837.3	32.2%
Barren Land	14.1	0.1%
Forest	1,443.5	12.1%
Urban	510.8	4.3%
Water	986.2	8.3%
Wetlands	5,143.7	43.1%
Total	**11,935.7**	**100.0%**

Source: NJDEP, Bureau of Geographic Information System, 2002

Table 2 breaks down the 2002 general land use/land cover categories into detailed land cover categories.

Table 2: Greenwich Detailed Land Use/Land Cover (2002)

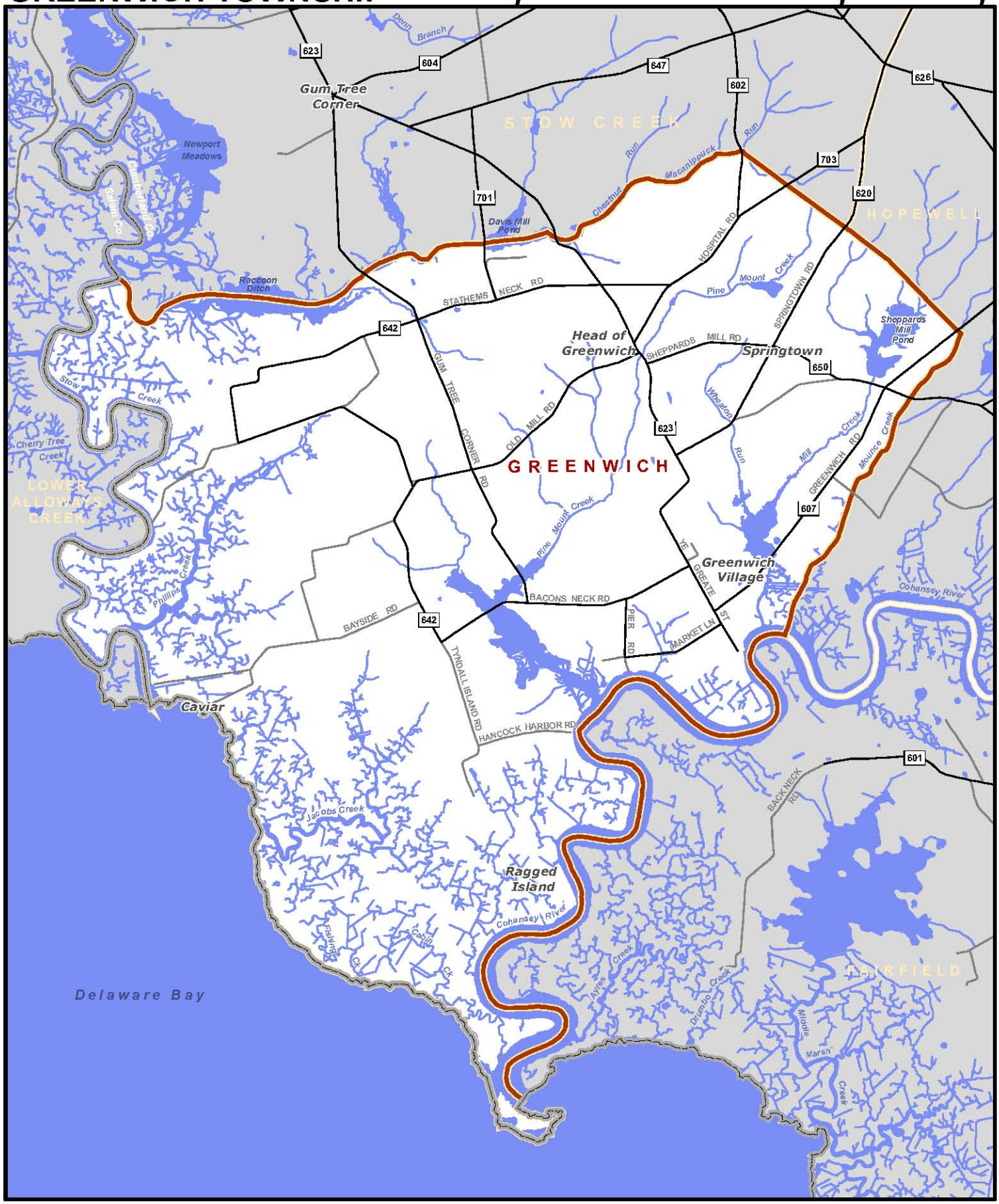
Land Use Category	Acres	Percent
Agricultural Wetlands (Modified)	215.7	1.8%
Artificial Lakes	84.8	0.7%
Athletic Fields (Schools)	3.7	0.0%
Beaches	14.1	0.1%
Bridge Over Water	0.4	0.0%
Cemetery	6.8	0.1%
Commercial/Services	14.2	0.1%
Coniferous Brush/Shrubland	39.0	0.3%
Coniferous Forest (10-50% Crown Closure)	25.6	0.2%
Coniferous Forest (>50% Crown Closure)	71.6	0.6%
Coniferous Scrub/Shrub Wetlands	1.4	0.0%
Coniferous Wooded Wetlands	7.0	0.1%
Cropland And Pastureland	3,467.3	29.1%
Deciduous Brush/Shrubland	57.1	0.5%
Deciduous Forest (10-50% Crown Closure)	88.1	0.7%
Deciduous Forest (>50% Crown Closure)	859.9	7.2%
Deciduous Scrub/Shrub Wetlands	109.2	0.9%
Deciduous Wooded Wetlands	835.9	7.0%
Disturbed Wetlands (Modified)	63.8	0.5%
Former Agricultural Wetland (Becoming Shrubby, Not Built-Up)	20.9	0.2%
Herbaceous Wetlands	27.8	0.2%
Mixed Deciduous/Coniferous Brush/Shrubland	104.4	0.9%
Mixed Forest (>50% Coniferous With 10-50% Crown Closure)	25.5	0.2%
Mixed Forest (>50% Coniferous With >50% Crown Closure)	62.2	0.5%
Mixed Forest (>50% Deciduous With 10-50% Crown Closure)	17.0	0.1%
Mixed Forest (>50% Deciduous With >50% Crown Closure)	38.1	0.3%
Mixed Scrub/Shrub Wetlands (Coniferous Dom.)	33.7	0.3%
Mixed Scrub/Shrub Wetlands (Deciduous Dom.)	43.9	0.4%
Mixed Wooded Wetlands (Coniferous Dom.)	112.6	0.9%
Mixed Wooded Wetlands (Deciduous Dom.)	120.8	1.0%
Old Field (< 25% Brush Covered)	41.8	0.4%
Open Tidal Bays	47.1	0.4%
Orchards/Vineyards/Nurseries/Horticultural Areas	343.8	2.9%
Other Agriculture	26.2	0.2%
Other Urban or Built-Up Land	1.6	0.0%
Phragmites Dominated Coastal Wetlands	194.3	1.6%
Phragmites Dominated Interior Wetlands	62.2	0.5%
Phragmites Dominated Old Field	0.6	0.0%
Plantation	12.7	0.1%
Recreational Land	24.0	0.2%
Residential, Rural, Single Unit	306.0	2.6%
Residential, Single Unit, Low Density	103.5	0.9%
Residential, Single Unit, Medium Density	19.8	0.2%
Saline Marsh (High Marsh)	39.3	0.3%
Saline Marsh (Low Marsh)	3,255.0	27.3%

Land Use Category	Acres	Percent
Tidal Rivers, Inland Bays, and Other Tidal Waters	853.9	7.2%
Transportation/Communication/Utilities	31.1	0.3%
Total	**11,935.7**	**100.0%**

Source: NJDEP, Bureau of Geographic Information System, 2002

GREENWICH TOWNSHIP

Map 1: Greenwich Township Base Map



Sources : NJDEP, NJDOT, DVRPC.
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.

Greenwich Municipal Boundary
Municipal Boundary
County Boundary
Stream

N

0 0.25 0.5 1
Miles

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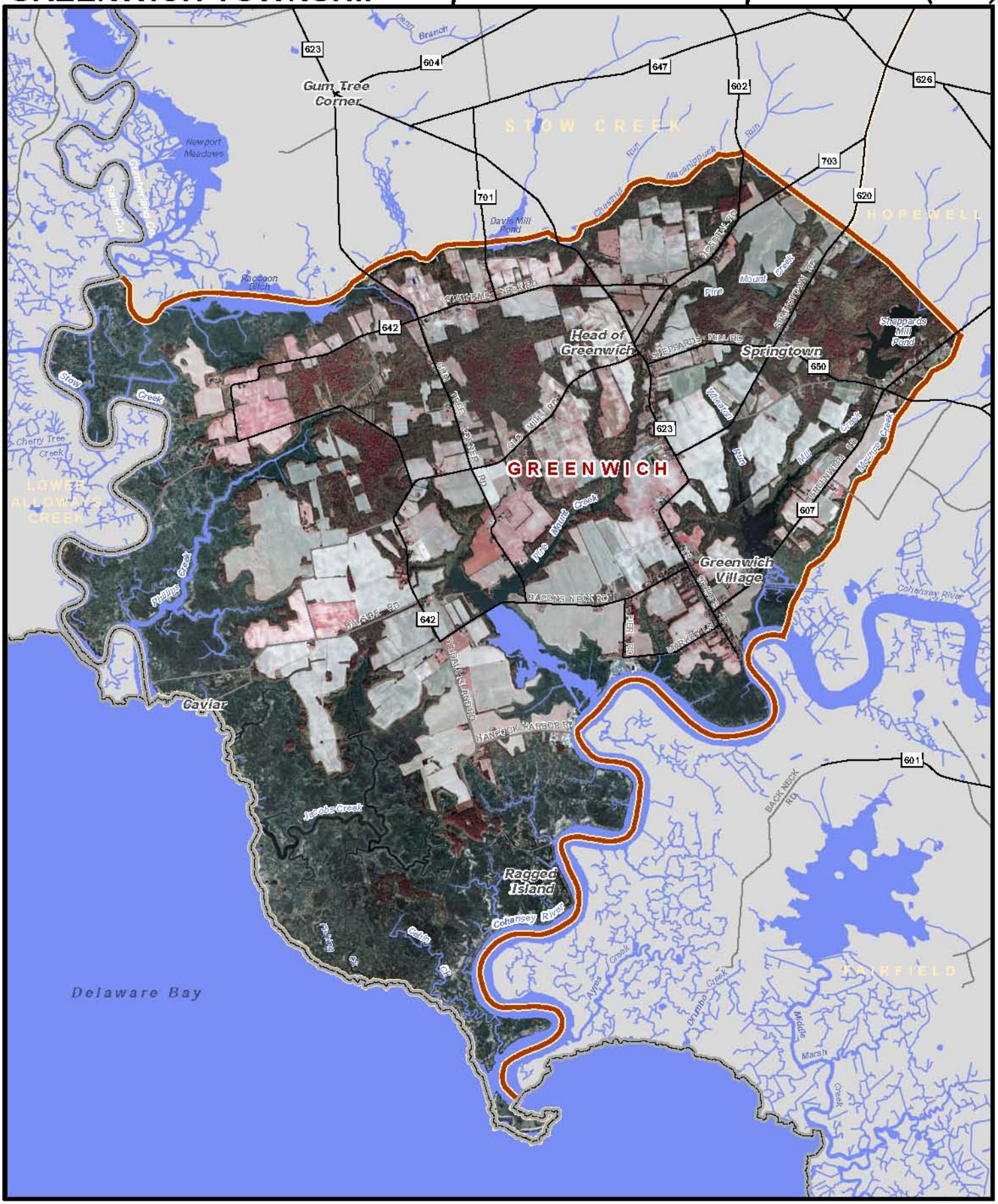
GREENWICH TOWNSHIP

Map 2: Greenwich Township Aerial Photo (2002)



Sources : NJDEP, NJDOT, DVRPC.
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.

Greenwich Municipal Boundary

Stream

N

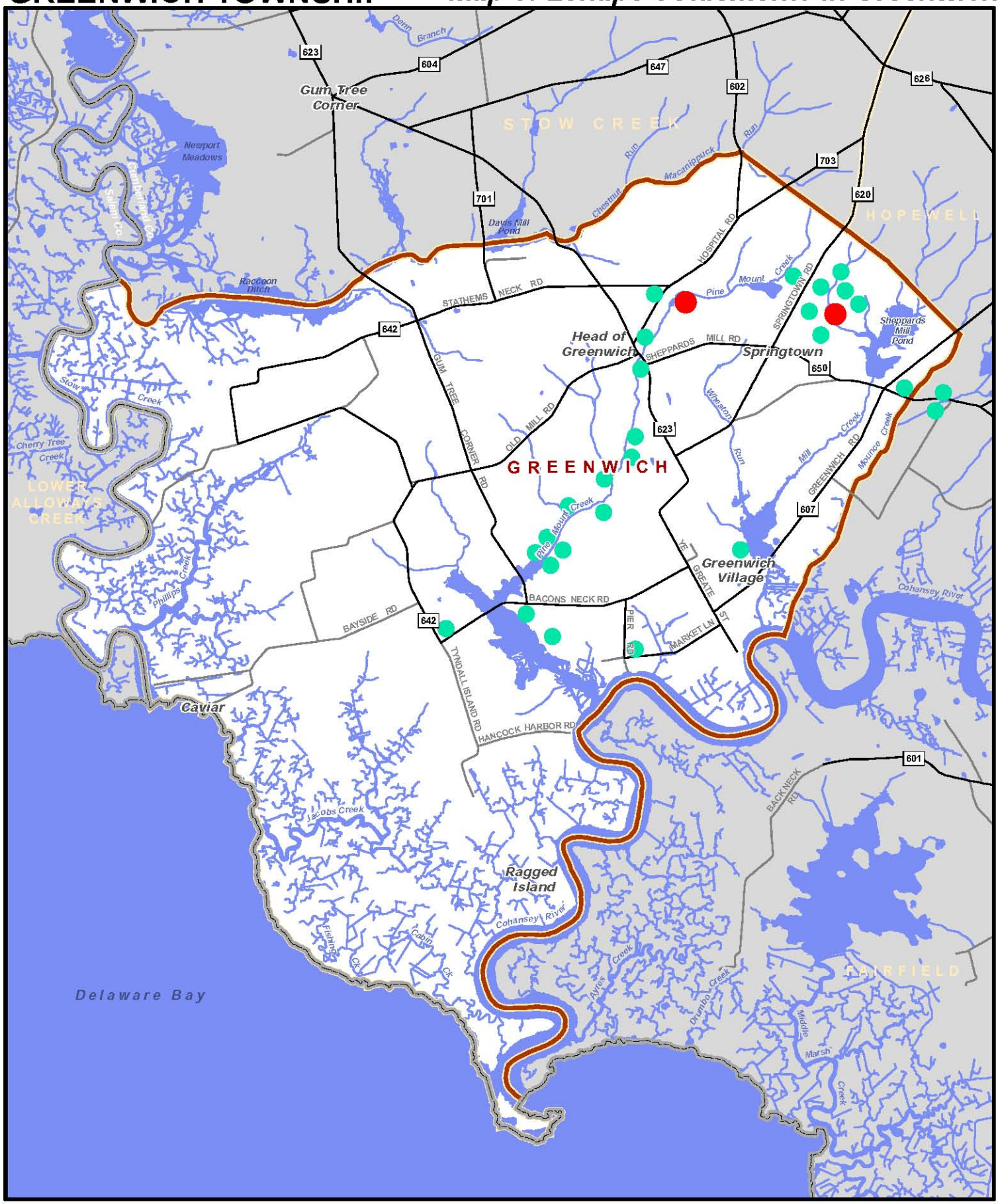
0 0.25 0.5 1

Miles

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

GREENWICH TOWNSHIP

Map 3: Lenape Settlements in Greenwich



Sources : NJDEP, NJDOT, DVRPC, Greenwich Township.
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.

Greenwich Boundary
Stream
Lake

Lenape Settlement
Site
Major Site

**Map was developed using information provided by Alan Carmen for the Greenwich Township Environmental Commission. Locations are approximate. More information on the township's Native American archeology can be found at the Cumberland County Prehistorical Museum.*

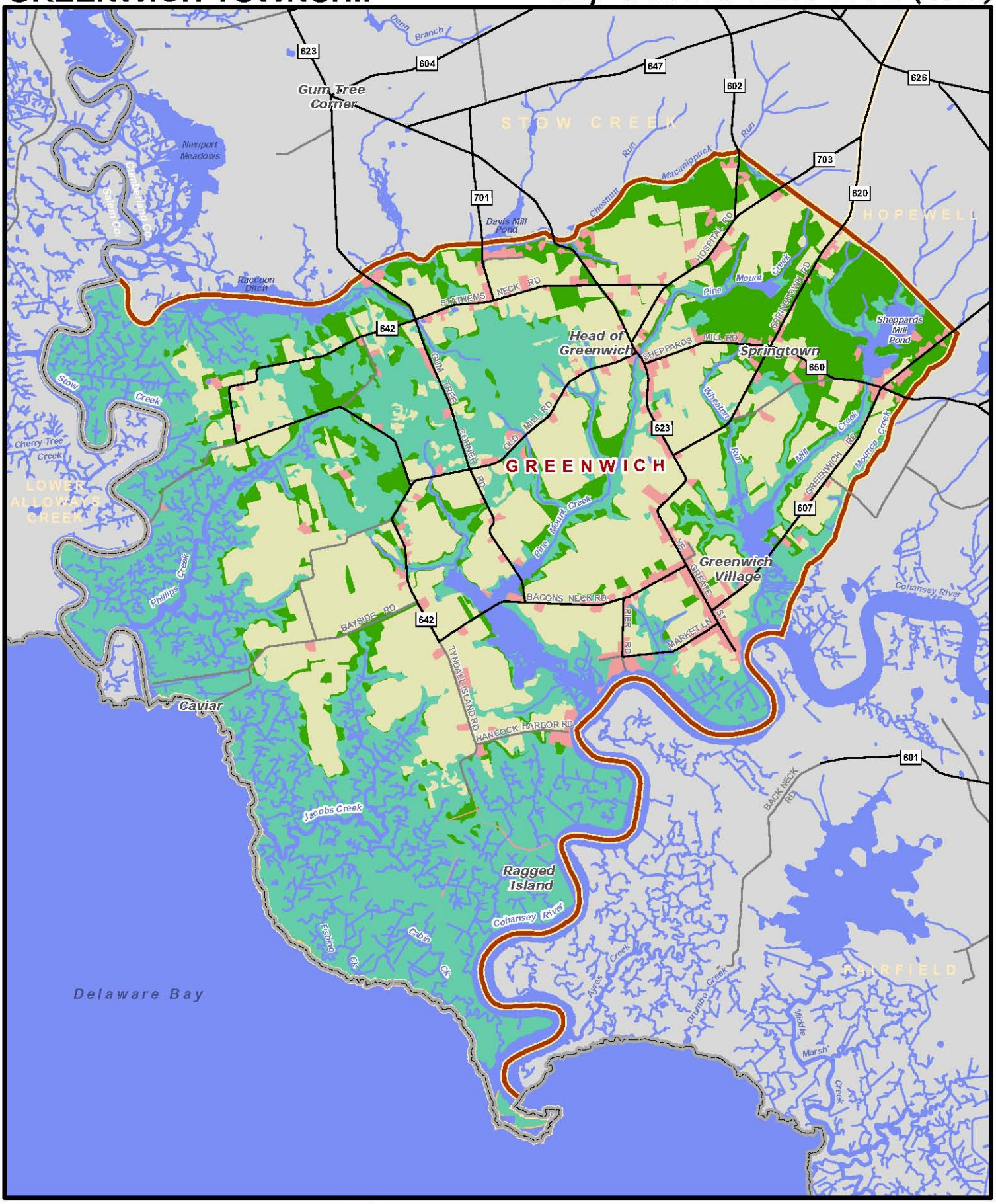
N

0 0.25 0.5 1
Miles

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

GREENWICH TOWNSHIP

Map 4: NJDEP Land Cover (2002)



Sources : NJDEP, NJDOT, DVRPC.
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.

- Greenwich Municipal Boundary
- Stream
- Agriculture
- Barren Land
- Forest
- Developed
- Water
- Wetlands

N

0 0.25 0.5 1
Miles

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

CHAPTER 3

NATURAL RESOURCES

Physiography

Physiography is the study of a location in relation to its underlying geology. New Jersey is characterized by five physiographic provinces. The rocky terrain of the Appalachian Province is at one extreme and the sands of the coast are at the other. Greenwich is located in the Outer Coastal Plain, the southernmost of these five provinces in New Jersey.

The Atlantic Coastal Plain landscape extends from Massachusetts to Texas and is divided into Inner and Outer sections. 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.

Figure 2: The Physiographic Regions of New Jersey

The Outer Coastal Plain was formed more recently than the Inner Coastal Plain. It was laid down by the ocean and developed during the mid-to-late part of the Cenozoic Period, 65 million years ago to the present. Outer Coastal Plain soils are sandier and less fertile than those of the Inner Plain and do not hold water as well.

In the general vicinity of the dividing line between the two segments of the Coastal Plain is a belt of low hills, which runs northeast and southwest through the southern half of New Jersey. These hills are the youngest of the Cretaceous formations and are largely made up of sand and marl formations. The hills taper to fairly low elevations in Gloucester County, but are visible in the Mullica Hill area. In Salem, the hills have declined to a rolling landscape, like that east of Woodstown. The Inner Coastal Plain lies to the west of this band of hilly formations and the Outer Coastal Plain lies to the east.

Greenwich is entirely in the Outer Coastal Plain. The township has abundant prime farmland, even though Outer Coastal Plain soils are generally regarded as less fertile than those in the Inner Coastal Plain.

Topography and Surface Landscapes

Greenwich Township is dominated by wetlands, water, and agricultural soils. Most wetlands occur adjacent to the Delaware Bay in a swath of land ranging from a quarter mile to nearly two miles wide. The Cohansey River and its tributaries on Greenwich's southeast border are also surrounded by wetlands. Another area of largely deciduous wooded wetlands is located in the center of the township, roughly between Stathems Neck Road (County Route 642) and Old Mill Road (County Route 703). About 12% of Greenwich's land is covered in upland forests, which are concentrated in the northeast portion of the township and which primarily support deciduous trees.

There are a few steep slopes located on Greenwich's northern border along Chestnut Run and Macanippuck Run, as well as a few hilly areas in the northeast part of the township, as shown in **Map 5: Steep Slopes**, on page 31. The vast majority of Greenwich, however, is flat, with slopes of less than 10%. The south and west parts of the township are the flattest and have elevations between sea level and 30 feet. Because of its flat, coastal location, nearly half of Greenwich Township is located in the Federal Emergency Management Agency's (FEMA) 100-year floodplain. The U.S. Geological Survey (USGS) estimates that Greenwich Township is expected to experience between 20 and 40 hurricanes over a 100-year period. See the **Floodplains** section on page 46 and the **Hurricanes** section on page 108.

Soils

Soil is the foundation for all land uses. A region's soil defines what vegetation can survive, influencing agricultural uses. Soil properties also affect the location of wells and septic facilities, often determining development potential in certain areas. Soil is also a natural resource that cannot be replenished on the human time scale.

The soils in Greenwich are generally good for agriculture, although they are less suited for development due to a high seasonal water table. Greenwich Township soils consist of 20 series types and 32 variations within those series, as identified by the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS). These are listed in ***Table 3: Agricultural Value for Greenwich Soils*** on page 24 and shown on **Map 6: Soils (2004)** on page 32.

Soil Quality Classification

State and national agricultural agencies classify farmland soils into several categories. Greenwich contains Prime Farmland soils, Soils of Statewide Importance, and Unique Farmland soils. Over half of Greenwich's land, 56%, contains rich, arable, and valuable soil designated as either Prime Farmland or Soils of Statewide Importance, and an additional 35% is classified as Unique Farmland. Each category of farmland is explained on the following pages. See ***Table 3: Agricultural Value for Greenwich Soils*** for the acreage in each category and **Map 7**: **Agricultural Quality of Soils** on page 33.

Prime Farmland Soils

The most abundant of soils in Greenwich are those classified as Prime Farmland soils. About 38% (4,573 acres) of Greenwich's soils are considered Prime Farmland (P-1) soils. Prime Farmlands are lands that have the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops. They can sustain high yields of crops when managed with correct farming methods. Prime Farmlands are not excessively erodible or saturated with water for long periods of time and do not flood frequently.

The USDA outlines specific criteria for Prime Farmland classification. For example, according to Prime and Unique farmland federal regulations (7 C.F.R Part 657), soil horizons within a depth of 40 inches (or within the root zone if the root zone is less than 40 inches) must have a pH between 4.5 and 8.4. The soils must have an average temperature above 32 degrees Fahrenheit at a depth of 20 inches. The USDA outlines additional Prime Farmland requirements for mean summer soil temperature, erodibility factors, water-table depth, permeability rate, and more. When identifying qualifying prime soil mapping units within a state, state soil conservationists are allowed to deviate from the permeability standard or adopt more stringent criteria for the other requirements.

Photo by DVRPC

Over half of all land in Greenwich has rich, fertile soil.

Land classified as Prime Farmland does not have to be farmed but does have to be available for such use. Thus, water or urban or built-up land does not qualify as Prime Farmland.

Soils of Statewide Importance

Almost 18% (2,152 acres) of Greenwich's soils are classified as Soils of Statewide Importance (S-1). These soils are close in quality to Prime Farmland and can sustain high yields of crops when correctly managed under favorable conditions. Under such favorable conditions, these yields may be as high as Prime Farmland yields.

Criteria for establishing Soils of Statewide Importance are determined by state agencies. In New Jersey, soils that do not meet Prime Farmland criteria are rated as Soils of Statewide Importance.

Unique Farmland Soils

A significant amount, about 36% (4,235 acres), of Greenwich's soils is ranked as Unique Farmland (U-1) soils. In Greenwich, these are wetlands areas mostly consisting of saline marshes with low vegetation located along the township's borders with the Delaware Bay, Cohansey River, and Stow Creek. Certain

soil qualities, locations, growing seasons, and moisture supplies allow Unique Farmland to support specific specialized crops when properly managed. The USDA outlines specific Unique Farmland criteria: Unique Farmland exhibits specific conditions, including temperature, humidity, air drainage, elevation, aspect, or nearness to market, that support a particular food or fiber crop. In order for lands to be classified as Unique Farmland, the land must also be used for a specific high-value food or fiber crop and have an adequate moisture supply for that crop.

Soils Not Rated

Several of the soils that are present in Greenwich–Evesboro, in particular–have not been rated for agricultural use by NRCS and are labeled "NR." These soils may be best suited for uses other than agricultural crops, or NRCS may have not yet assessed their quality. NRCS created all of the Soil Quality Classifications in 1990, but in 2005, the agency created several new subtypes of soils, which are not yet rated for agricultural use. Soils that are not rated are not necessarily limited. Each soil type's land capability class and subclass describe how the soil is limited with respect to different uses, and for what reasons the soil is limited.

Table 3: Agricultural Value for Greenwich Soils

Designation	Type	Acres	Percent
P-1	Prime Farmland	4,572.8	38.3%
S-1	Statewide Importance	2,152.2	18.0%
U-1	Unique Farmland	4,235.0	35.5%
NR	Soils not classified for farmland use: wet soils, pits, steep slopes, made land, etc.	695.1	5.8%
Water	Water	280.5	2.4%
Totals		**11,935.6**	**100.0%**

Source: NJ Important Farmlands Inventory, USDA Natural Resources Conservation Service, 2004

Hydric Soils

Nearly 85% of Greenwich's soils are considered hydric soils. Hydric soils, as defined by the National Technical Committee of Hydric Soils, are those that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in their subsurface, and they support the development of hydrophytic vegetation. When drained, hydric soils can be classified as important farmland. Some hydric soil series have phases that are not hydric depending on water table, flooding, and ponding characteristics. Hydric soils have unique properties and they are an important element to wetland areas. If a soil is classified as hydric, land use may be restricted due to the relationship of hydric soils to the definition of wetlands and laws regarding wetland preservation. More detailed descriptions of Greenwich's wetland areas can be found in this section under **Wetlands** and **Agricultural Wetlands** (pages 43-44), and in the **Biological Resources** section under **Wetlands** (page 76).

Soil Series

Several soil series appear more frequently in Greenwich than others, and they are briefly described as follows, according to the Cumberland County Soil Survey and NRCS soil database.

Mattapex Series

The most abundant soil type in Greenwich is Mattapex soils, which comprise over 25% (3,051 acres) of all soils in the township. The soils are very deep, which means that the bedrock is far from the surface and there is a lot of room for roots to grow. Mattapex soils are moderately well drained, with a moderate to moderately slow rate of permeability. The seasonal high water table is 1.5 to three feet deep. Mattapex soils were formed from silty eolian deposits that were underlain by coarser fluvial or marine sediments and are found on marine terraces and uplands. While most Mattapex soils are used for growing crops such as corn, soybeans, and small grains, some sections are in urban areas or are used to grow vegetables or hay, or are used as pasture. When wooded, the soils support mixed hardwoods, including oaks, sweetgum, red maple, and holly. Second growth areas sometimes sustain loblolly pines. Mattapex soils are classified as Prime Farmland and are extremely to strongly acidic unless limed.

Appoquinimink-Transquaking-Mispillion Complex Series

The Appoquinimink-Transquaking-Mispillion complex soil series makes up over 17% (2,063 acres) of the soils in Greenwich. The complex is considered a Soil of Unique Importance and is located in wetlands areas bordered by the Delaware Bay and Cohansey River, south of Jacobs Creek. All soils in this complex are very deep and very poorly drained.

Appoquinimink soils are formed from loamy fluvial sediments high in silt and are found overlying organic materials derived from herbaceous plants. These soils are mainly used by wetland wildlife or as habitat for shellfish and small crustaceans. Appoquinimink soils support salt-tolerant natural vegetation, such as salt marsh cordgrass, salt hay, salt wort, and spike grass. These soils are very poorly drained and are slightly acidic to slightly alkaline when wet, although they are ultra to extremely acidic 20 inches below the surface after moist incubation.

Transquaking soils are explained in detail below.

Mispillion soils come from organic deposits of herbaceous plants, underlain by loamy fluvial or marine mineral sediments. Found in estuarine salt marshes, these soils, like the Appoquinimink series, are used by wetland wildlife and are habitat for shellfish and small crustaceans. Mispillion soils support salt-tolerant wetland herbaceous species, predominantly salt marsh cordgrass, salt hay, salt wort, and spike grass. Also like the Appoquinimink soils, these soils are very poorly drained and are slightly acidic to mildly alkaline, becoming ultra to extremely acidic after moist incubation.

Transquaking Mucky Peat Series

The third most common soil series type in Greenwich Township is the Transquaking mucky peat series, which comprises over 15% (1,840 acres) of all soils in the township. Within the township, these soils are only found in saline wetlands areas bordering the Delaware Bay, Phillips Creek, and Stow Creek north of

Jacobs Creek. Transquaking soils are formed by organic deposits formed from salt tolerant herbaceous plants and are underlain by loamy mineral sediments. They are typically found in brackish estuarine marshes along tidally influenced rivers and creeks and are used mainly as wetland wildlife habitat. Dominant vegetation on Transquaking soils includes olney threesquare, saltmeadow cordgrass, saltmarsh cordgrass, saltgrass, and marsh hibiscus. Transquaking soils are very poorly drained and flooded by tidal waters. These soils are slightly acidic to neutral in their natural state, although they become ultra acidic when drained. The Transquaking mucky peat series is considered a Soil of Unique Importance.

Hammonton Series

Hammonton soils comprise nearly 10% (1,147 acres) of all soils in Greenwich. Hammonton soils are very deep and moderately well drained. These soils are composed of loamy fluviomarine deposits. Typically, Hammonton soils can be found on low rolling hills or flats, as well as in depressions. Hammonton soils support a native mixed hardwood forest with pitch pine, shortleaf pine, and Virginia pine. These soils are moderately well drained and are extremely to strongly acidic unless limed. When cleared, the soils may be used to grow fruit, vegetables, row crops, and nursery crops. Hammonton sandy loam is a Soil of Statewide Importance.

Othello Series

The Othello series soils comprise about 8% of all soils found in Greenwich (969 acres). Othello soils are mostly located in the wetland area between Stathems Neck Road (Route 642) and Old Mill Road (Route 703). These are very deep, poorly drained hydric soils and typically can be found in the form of cultivated silt loams. Much of Othello soils support wetland hardwoods, such as wetland oaks, red maple, and sweetgum. Othello soils are wet in the springtime when crops are planted and are also usually wet in the fall when harvesting occurs. With adequate drainage, Othello soils can be used for pasture or to grow field crops, such as hay, corn, and soybeans. Othello soils are very suitable for ponds and can support irrigation, recreation, or wildlife habitat. The series is extremely to strongly acidic unless limed, and is considered a Soil of Statewide Importance.

Matapeake Series

The Matapeake soil series accounts for about 5% of all soils in Greenwich (570 acres). These soils are composed of silty eolian sediments underlain by coarser fluvial or marine sediments. The series consists of very deep, well drained soils on upland interfluves and side slopes. Occasionally, Matapeake soils are irrigated and are typically cultivated with such crops as corn, soybeans, and small grains. Native vegetation includes oaks, although loblolly, Virginia, or shortleaf pine may also grow in cutover areas. Matapeake silt loam is extremely to strongly acidic unless limed and is classified as either Prime Farmland or a Soil of Statewide Importance, depending on slope.

Table 4: Greenwich Soils

Description	Soil Type	Designation	Acres	% of Total Land Area	Hydric Soil
Appoquinimink-Transquaking-Mispillion complex, 0 to 1% slopes, very frequent	AptAv	U-1	2,063.2	17.29%	Yes
Atsion sand, 0 to 2% slopes, rarely flooded	AtsAr	U-1	8.4	0.07%	Yes
Aura loamy sand, 0 to 5% slopes	AucB	P-1	3.4	0.03%	No
Aura sandy loam, 2 to 5% slopes	AugB	P-1	42.5	0.36%	No
Berryland and Mullica soils, 0 to 2% slopes, occasionally flooded	BEXAS	U-1	22.8	0.19%	Yes
Chillum silt loam, 2 to 5% slopes	ChtB	P-1	82.6	0.69%	No
Downer loamy sand, 0 to 5% slopes	DocB	S-1	66.6	0.56%	Yes
Downer loamy sand, 5 to 10% slopes	DocC	S-1	61.0	0.51%	No
Downer sandy loam, 0 to 2% slopes	DoeA	P-1	75.6	0.63%	Yes
Downer sandy loam, 2 to 5% slopes	DoeB	P-1	88.0	0.74%	No
Evesboro sand, 0 to 5% slopes	EveB	NR	90.9	0.76%	Yes
Evesboro sand, 5 to 10% slopes	EveC	NR	165.8	1.39%	No
Fallsington sandy loam, 0 to 2% slopes	FamA	S-1	142.2	1.19%	Yes
Fort Mott loamy sand, 0 to 5% slopes	FodB	S-1	89.6	0.75%	No
Galloway loamy sand, 0 to 5% slopes	GamB	S-1	206.1	1.73%	Yes
Hammonton loamy sand, 0 to 5% slopes	HbmB	S-1	251.3	2.11%	Yes
Hammonton sandy loam, 0 to 2% slopes	HboA	P-1	467.2	3.91%	Yes
Hammonton sandy loam, 2 to 5% slopes	HboB	P-1	428.8	3.59%	Yes
Manahawkin muck, 0 to 2% slopes, frequently flooded	MakAt	U-1	300.2	2.52%	Yes
Matapeake silt loam, 0 to 2% slopes	MbrA	P-1	36.2	0.30%	No
Matapeake silt loam, 2 to 5% slopes	MbrB	P-1	197.8	1.66%	No
Matapeake silt loam, 5 to 10% slopes	MbrC	S-1	335.8	2.81%	No

Description	Soil Type	Designation	Acres	% of Total Land Area	Hydric Soil
Mattapex silt loam, 0 to 2% slopes	MbuA	P-1	1,748.0	14.65%	Yes
Mattapex silt loam, 2 to 5% slopes	MbuB	P-1	1,302.6	10.91%	Yes
Othello silt loam, 0 to 2% slopes	OthA	S-1	968.9	8.12%	Yes
Pits, sand and gravel	PHG	NR	9.7	0.08%	No
Psamments, sulfidic substratum, 0 to 3% slopes, frequently flooded	PstAt	NR	14.2	0.12%	Yes
Sassafras sandy loam, 0 to 2% slopes	SacA	P-1	12.3	0.10%	Yes
Sassafras sandy loam, 2 to 5% slopes	SacB	P-1	74.1	0.62%	Yes
Sassafras sandy loam, 5 to 10% slopes	SacC	S-1	30.7	0.26%	No
Transquaking mucky peat, 0 to 1% slopes, very frequently flooded	TrkAv	U-1	1,840.4	15.42%	Yes
Water	WATER	NR	695.1	5.82%	No
Woodstown sandy loam, 0 to 2% slopes	WoeA	P-1	13.7	0.12%	Yes
Total			**11,935.6**	**100.00%**	**84.60%**

Source: USDA Natural Resources Conservation Service, 2004

***Explanation of Designations**

P–1	Prime Farmland
S–1	Statewide Importance
U–1	Unique Farmland
NR	Soils not classified for farmland use: wet soils, pits, steep slopes, made land, etc.

Soil characteristics can severely restrict the use of sites for construction and development. ***Table 5*** below records the soils and their possible limitations for building foundations and septic systems. As indicated in the table, the township has some soils that are severely limited for onsite disposal fields for septic systems. Septic system disposal fields require soils that have a low water table (over five feet below the surface) and high permeability to allow for proper drainage of wastewater. Soils with high water tables (five feet or less from the surface) create a potential for erosion, wet basements, and low permeability, often allowing wastewater to collect near the surface. This table is a summary of a report on building suitability available from the NRCS 2006 database for Cumberland County soils. It is included here as a general guide and is not intended to eliminate the need for site analysis.

Table 5: Soil Limitations for Development

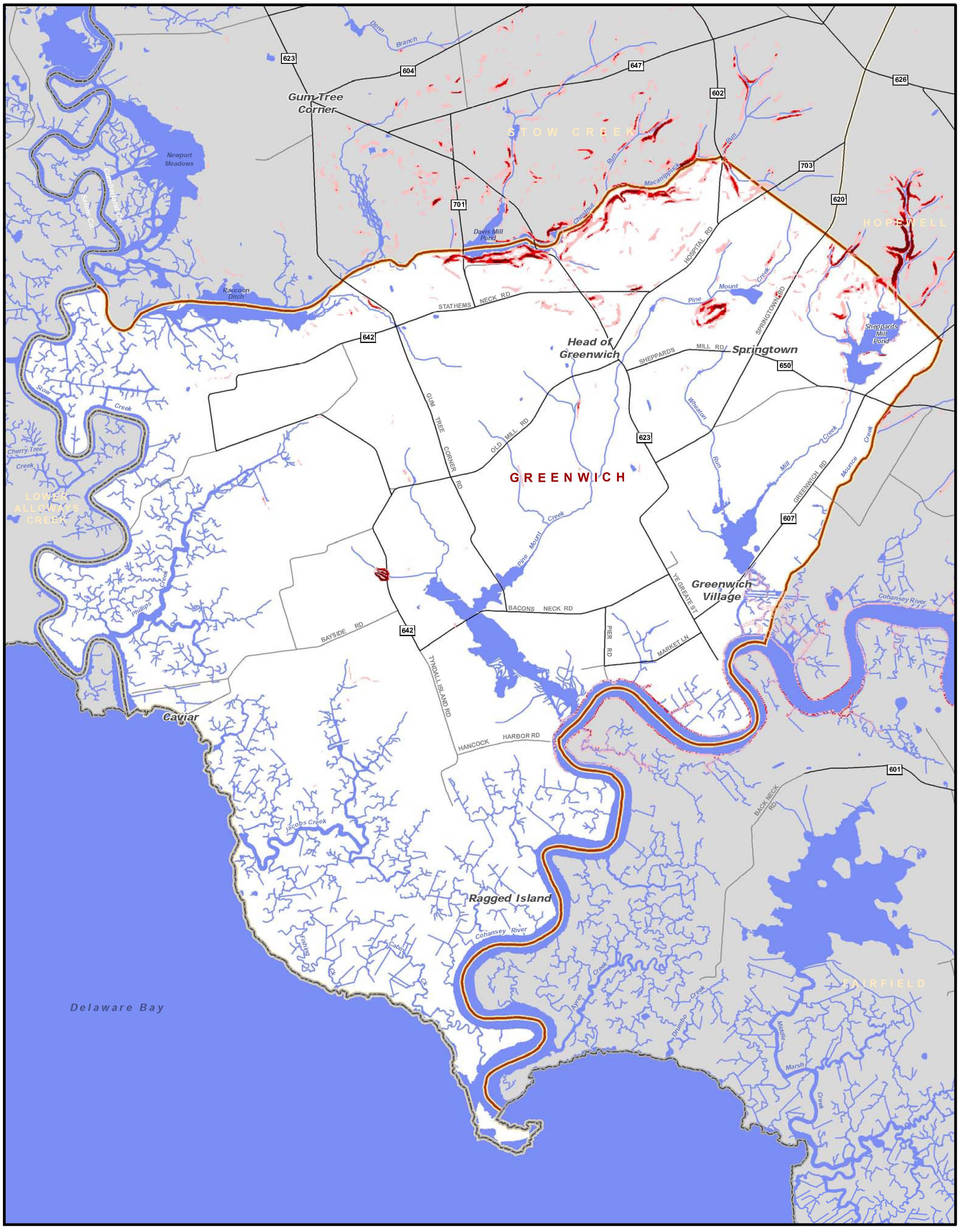
Soil Description	Soil Code	Acres	Land Use Implications		
			Building without Basement	Building with Basement	Septic Systems
Appoquinimink-Transquaking-Mispillion complex	AptAv	2,063.2	C	C	C
Atsion	AtsAr	8.4	C	C	C
Aura	AucB, AugB	45.9	A	A	C
Berryland and Mullica	BEXAS	22.8	C	C	C
Chillum	ChtB	82.6	A	A	C
Downer	DocB, DocC, DoeA, DoeB	291.2	A	A	C
Evesboro sand	EveB, EveC	256.7	A	A	C
Fallsington	FamA	142.2	C	C	C
Fort Mott	FodB	89.6	A	A	C
Galloway	GamB	206.1	C	C	C
Hammonton	HbmB, HboA, HboB	1,147.3	A	C	C
Manahawkin muck	MakAt	300.2	C	C	C
Matapeake	MbrA, MbrB, MbrC	569.8	A/B	A	C
Mattapex	MbuA, MbuB	3,050.6	A	C	C
Othello	OthA	968.9	C	C	C
Pits, sand and gravel	PHG	9.7	NR	NR	NR
Psamments, sulfidic substratum	PstAt	14.2	C	C	C
Sassafras	SacA, SacB, SacC	117.0	A	A	C
Transquaking	TrkAv	1,840.4	C	C	C
Woodstown	WoeA	13.7	A	C	C

Source: USDA Natural Resources Conservation Service, 2004

Key to Land Use Implications	
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.
NR = Not Rated	Limitations are not rated or listed.

GREENWICH TOWNSHIP

Map 5: Steep Slopes



Steep Slopes

- Slope <= 10%
- Slope = 10% - 14.99%
- Slope = 15% - 19.99%
- Slope >= 20%

N

0 0.25 0.5 1

Miles

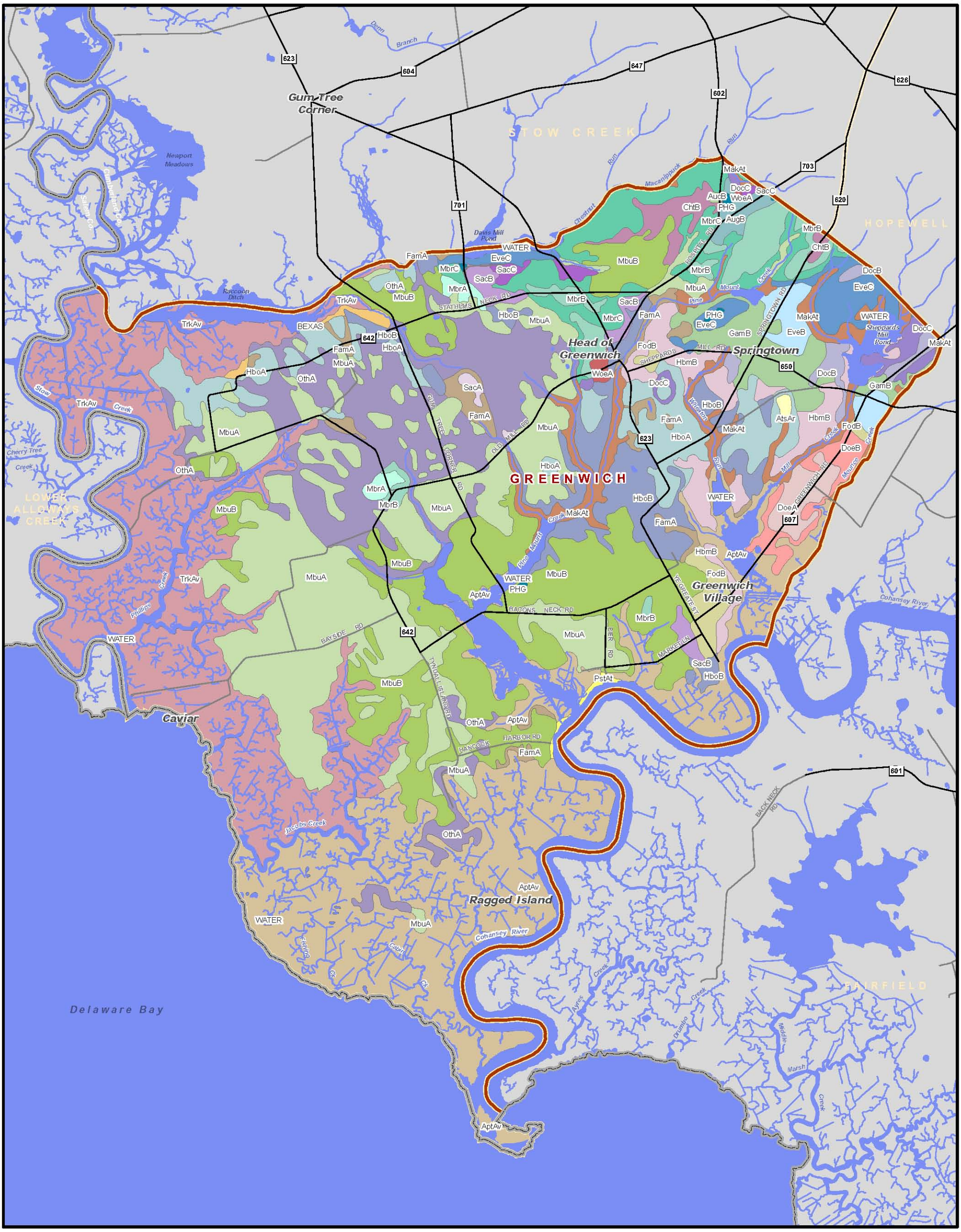
DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

Sources : NJDEP, NJDOT, DVRPC

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.

GREENWICH TOWNSHIP

Map 6: Soils (2004)



Soils

AptAv	ChtB	EveB	HbmB	MbrB	PHG	TrkAv	
AtsAr	DocB	EveC	HboA	MbrC	PstAt	WATER	
AucB	DocC	FamA	HboB	MbuA	SacA	WoeA	
AugB	DoeA	FodB	MakAt	MbuB	SacB		
BEXAS	DoeB	GamB	MbrA	OthA	SacC		

N

0 0.25 0.5 1

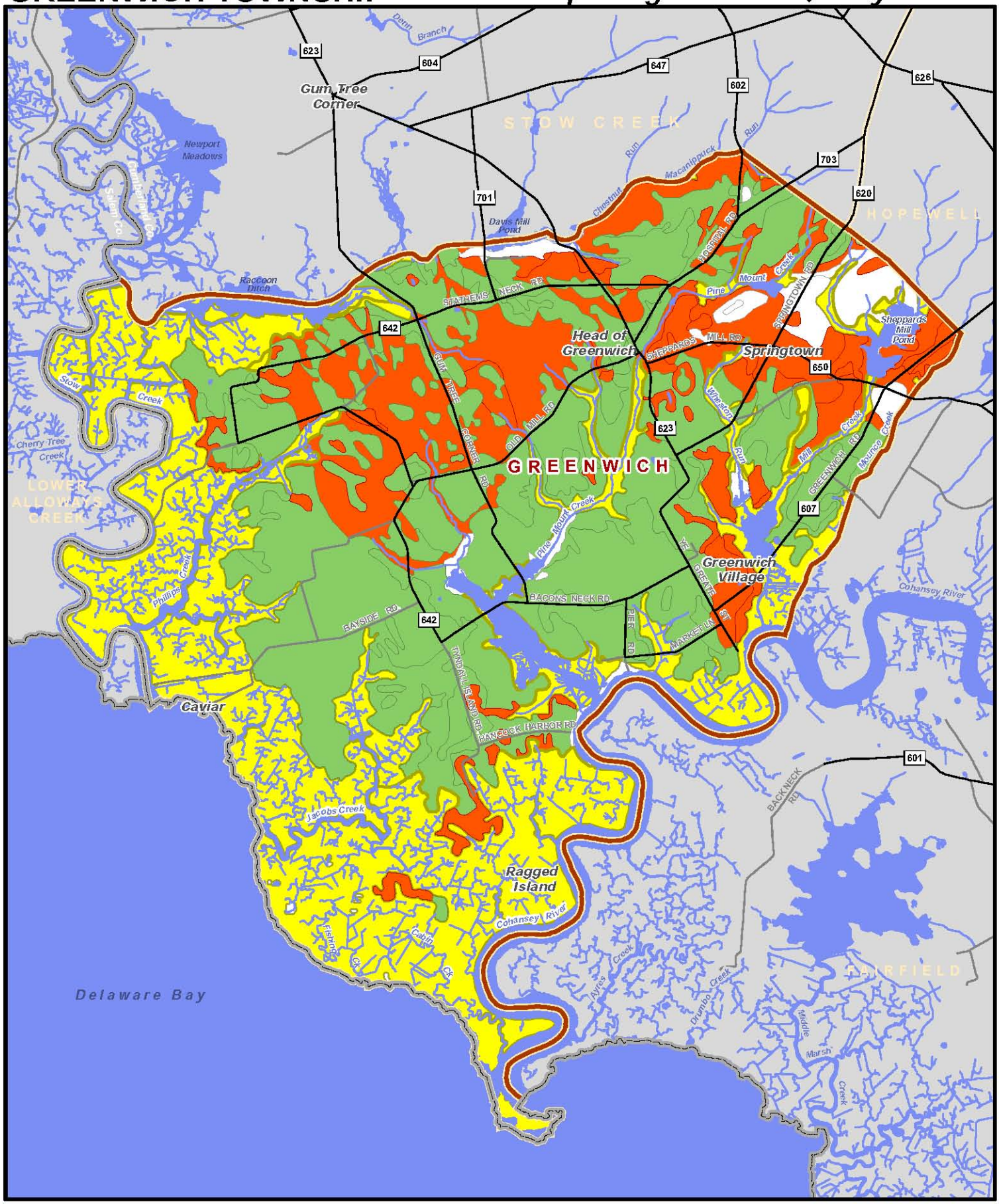
Miles

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

Sources : NJDEP, NJDOT, DVRPC, NRCS
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.

GREENWICH TOWNSHIP

Map 7: Agricultural Quality of Soils



Sources : NJDEP, NJDOT, DVRPC, NRCS. 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 Designation

- Prime Farmland
- Farmland of Statewide Importance
- Unique Farmland
- Not Rated for Agricultural Use

N

0 0.25 0.5 1

Miles

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

Soil Erosion

Soil erosion has become a problem in recent years, particularly near the mouth of the Cohansey River. The island at the mouth of the river has been eroding, allowing a greater volume of water to enter the river at high tide. As the tide recedes, it washes away more and more soil from the banks of the river.

Climate

Situated midway between the North Pole and the equator, New Jersey is influenced by hot, cold, dry, and humid airstreams that create highly changeable local weather. From May through September, New Jersey is dominated by moist, tropical air, originating in the Gulf of Mexico and carried by prevailing winds from the southwest. In winter, winds generally prevail from the west and northwest, bringing cold, polar air masses from subarctic Canada.

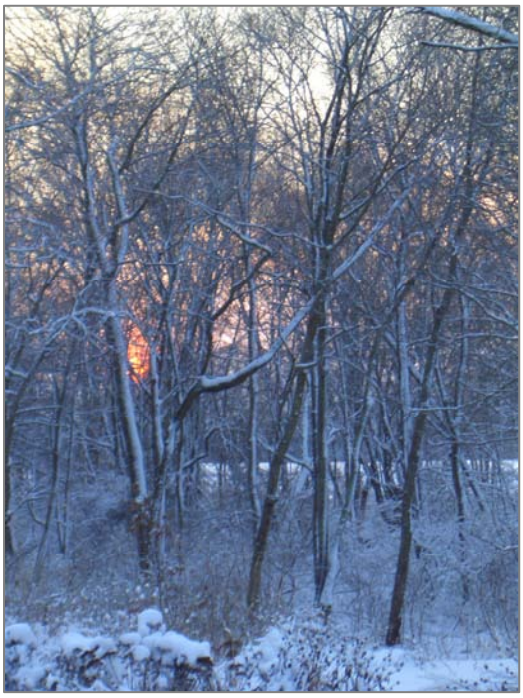


Photo by Carey Hedlund

A hardwood swamp in the snow

The climate in New Jersey varies within its five regions: North, Central, Southwest, Pine Barrens, and Coastal. Greenwich is in the Southwest zone, a region that registers some of the highest average daily and evening temperatures. The maritime influence of the Delaware Bay on Greenwich's coast is responsible in part for these higher temperatures. In addition, the soils of the Southwest region are less sandy than either the Pine Barrens or Coastal Zones, and so retain the day's warmth into the night, unlike sandier soils that exhibit a strong radiational cooling after sunset. Evening temperatures can be as much as 20 degrees lower in the Pine Barrens than in neighboring climate zones. In contrast, the Coastal Zone bordering the Atlantic Ocean is generally warmer in the autumn and winter and cooler in the spring and summer (coinciding with ocean water temperatures) than the Southwest Zone.

Detailed weather data from a station at the nearby Millville Municipal Airport is available from the Office of the New Jersey State Climatologist, which monitors 61 stations in the state. The Greenwich area experiences a normal maximum temperature of 85.9°F in July and a normal minimum temperature in January of 24.1°F. The extreme temperatures recorded at the nearby Millville station are a low of -10°F on January 28, 1987, and a high of 102°F on July 3, 1966.

The region's annual mean temperature is 54.4°F, higher than the statewide mean temperature of 52.3°F. The Millville Airport station is exceeded by five other stations in the state for annual mean temperature. The mean temperature in the Greenwich area for July is 76.3°F, surpassed only by Woodstown (76.9°F) and Newark (77.2°F), a city that experiences the urban heat island effect. The monthly mean temperature

for January is 32.7°F; the Atlantic City Marina, Belleplain, Cape May, and Woodstown stations have higher average temperatures for January.

Precipitation and Storm Events

The Southwest climate zone, where Greenwich is located, receives less precipitation than the North, Central, and Coastal regions, but more than the Pine Barrens region. The normal average annual precipitation for the area between 1971 and 2000 was 43.20 inches, less than the statewide normal annual precipitation of 47.87 inches. The region's lack of orographic features (elevated terrain) and its greater distance from the Great Lakes-St. Lawrence storm track may explain the lower precipitation. However, Greenwich's location on the Delaware Bay does make it more susceptible to the heavy rains associated with coastal storms. The Greenwich area receives the most precipitation in March, normally 4.38 inches, and the least in October, normally 3.04 inches.

Snowfall typically occurs in New Jersey when moist air from the south converges with cold air from the north. In Greenwich, snowfall may occur from November to mid-April, but is most likely to occur from December to March. From data gathered between 1948 and 1999, the average monthly snowfall is greatest in January, which has a historic mean of 5.3 inches.

Severe storm events, including thunderstorms, tropical storms, blizzards, ice storms, hail storms, and tornadoes occur in Cumberland County with varying frequency. Tornadoes are infrequent, and only about five generally weak tornadoes occur in New Jersey each year. Most areas in the state experience about 25 to 30 thunderstorms a year, although they strike coastal areas such as Greenwich less often than more inland areas. In recent history, hurricanes are the only severe storm events to have caused significant damage in Greenwich. See the section on **Hurricanes** on page 108 for a description of hurricanes that have impacted Greenwich in recent years.

While not climate-related, earthquakes are another natural hazard that warrants a brief discussion. Earthquakes in New Jersey are very infrequent and very small on average. There have been no reported deaths caused by an earthquake in the state. Cumberland and Union counties are the only two counties in New Jersey not to have been at the epicenter of an earthquake in recorded state history.

Photo by DVRPC

A father and son enjoy a game of catch on their farm.

Growing Seasons

Greenwich Township is within U.S. Department of Agriculture (USDA) Plant Hardiness Zone 7, where annual minimum temperatures are typically between 0°F and 5°F. In New Jersey, all of Salem County, adjacent portions of Cumberland

County and Gloucester County, and areas along the Atlantic coastline are designated as Zone 7, which is the warmest USDA Plant Hardiness Zone in New Jersey.

Greenwich's agricultural growing season is approximately six months, or 180 days, from mid-April to mid-October. This is the period between the last spring frost and the first autumn frost. However, harvesting of grain crops typically continues throughout November, and winter crops, such as broccoli, cauliflower, and cabbage, are grown until the first hard freeze, usually in early January. The frost-free growing season in Greenwich is about 60 days longer than in northern New Jersey, where frosts generally end in May and begin in October.

Surface Water Resources

Surface water is a very important resource in Greenwich Township. Greenwich's agricultural industry relies on the township's surface water resources for irrigation purposes. Because of its location along the Delaware Bay, Greenwich is vulnerable to ocean storms, and its freshwater waterbodies and groundwater can be contaminated by saltwater. All of Greenwich's land drains to the Delaware Bay, either by way of the Cohansey River or Stow Creek. There are three subwatersheds that drain to Stow Creek and three that drain to the Cohansey River.

Watersheds

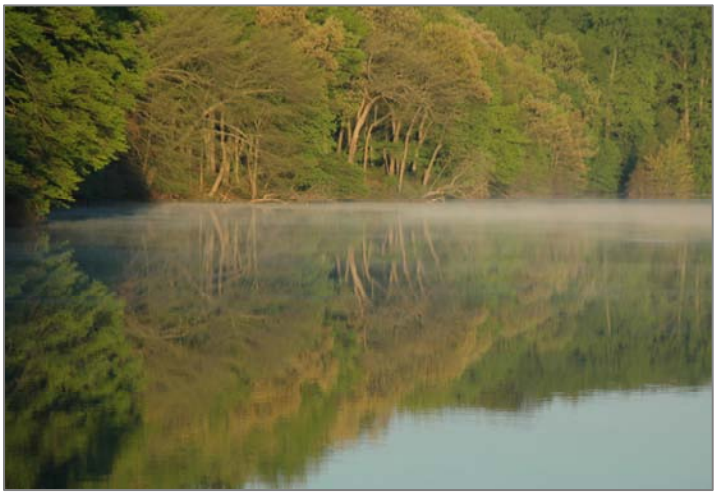


Photo by Mike Ivanick

There are six subwatersheds in Greenwich.

A watershed is all the land that drains to a particular waterway, such as a river, stream, lake, or wetland. A watershed's boundaries are defined by the high points in the terrain, such as hills and ridges. Large watersheds are made up of smaller ones, down to the catchment level of a local site. So, for example, the Delaware River watershed is made up of many smaller watersheds, such as the Cohansey River watershed. The Cohansey River watershed, in turn, is made up of several subwatersheds, consisting of the land that drains to a major tributary or branch of the river, such as the Pine Mount Creek subwatershed. These subwatersheds can be further subdivided into smaller ones, each surrounding the smaller tributaries that flow to the larger channel, and so on down to the catchment level. Each watershed corresponds to a hydrological unit code, or HUC, as delineated by the United States Geological Survey (USGS). A HUC-11 watershed (identified by an 11-digit code) contains a number of HUC-14 subwatersheds (identified by a 14-digit code). The State of New Jersey has 152 HUC-11 watersheds and over 900 HUC-14 subwatersheds.

Watershed Management Area 17

NJDEP manages natural resources on a watershed basis. The state has been divided into 20 Watershed Management Areas (WMAs). Greenwich Township is within WMA 17, which covers the 39 municipalities over 885-square miles in the southwest corner of the state. This WMA is called the Maurice, Salem, and Cohansey Watershed Management Area, and includes the subwatersheds of the Cohansey River, the Maurice River, the Salem River, as well as the Alloway, Dividing, Manantico, Manumuskin, Miles, Mill, Stow, and Whooping creeks subwatersheds. All subwatersheds in WMA 17 drain to the Delaware Bay. The principal land uses in WMA 17 are agriculture, forests, and wetlands.

Watersheds are natural ecological units, where soil, water, air, plants, and animals interact in a complex relationship. Greenwich contains two Hydrological Unit Code 11 (HUC-11) watersheds –the Cohansey below Cornwell Run and Stow Creek–both of which empty into the Delaware Bay.

The percentage of land that is within each watershed in Greenwich is listed in ***Table 6***. See also **Map 8: Watersheds** on page 41 and **Figure 3: Cohansey River Watershed in Context** on page 38 and **Figure 4: Stow Creek Watershed in Context** on page 39.

Cohansey River Watershed

The Cohansey River drains an area of 105 square miles in Cumberland and eastern Salem counties. About 53% of the land in Greenwich Township drains to the Cohansey River. This watershed covers a very low-lying area that is mostly used for agriculture. It also contains many forested areas, such as the large wooded area around Sheppards Mill Pond in the northeast corner of Greenwich.

The Cohansey River flows nearly 30 miles from eastern Salem County, south to Bridgeton, and then west through Greenwich, where it flows through wetlands and salt marshes before emptying into the Delaware Bay. The Cohansey River has many small, unnamed tributaries. Major tributaries within Greenwich include Pine Mount Creek, Wheaton Run, Mill Creek, and Mounce Creek.

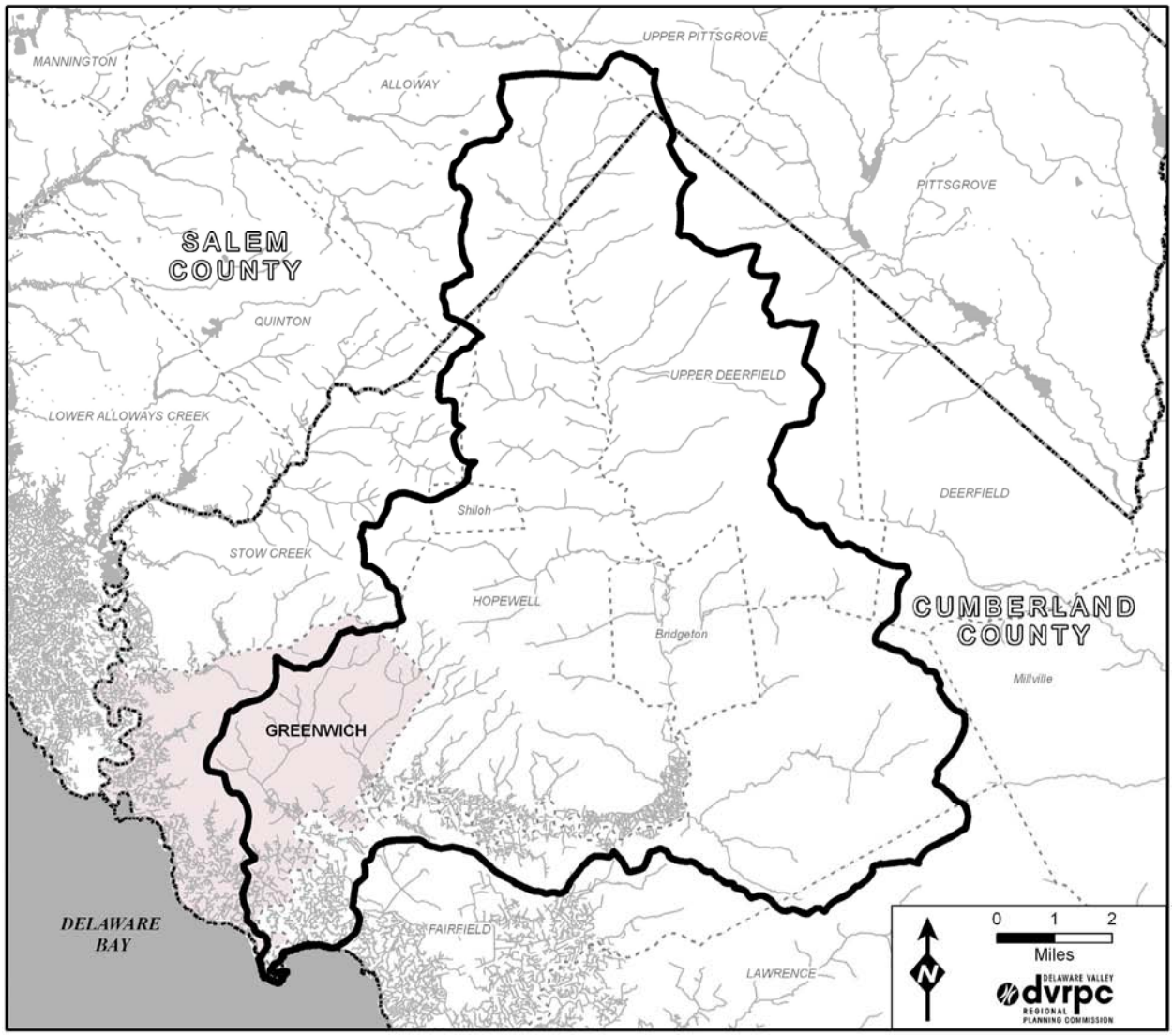
Due to its extensive freshwater and tidal wetlands and marshes, the Cohansey River watershed provides critical habitat for many rare, threatened, and endangered species. The NJDEP Division of Fish and Wildlife has established the Cohansey River Wildlife Management Area along the river in Hopewell Township, and this area covers over 600 acres. In addition, the Dix State Wildlife Management Area covers an area of over 2,600 acres, bordering the Cohansey Cove in Fairfield Township, directly across the Cohansey River from Greenwich Township.

Photo by Carey Hedlund

Over half of Greenwich's land drains to the Cohansey River.

The National Park Service has designated 16 miles of the Cohansey River, from the Delaware Bay upstream to Rocap's Run in Bridgeton, as part of the Nationwide Rivers Inventory (NRI),[4] based on its historic significance for contributing to early colonial shipping and trade, as well as its undisturbed salt marshes. The NRI is a register of river segments that potentially qualify as national wild, scenic, or recreational river areas. See ***Sources of Information*** for the National Park Service/NRI website for more details.

Figure 3: Cohansey River Watershed in Context



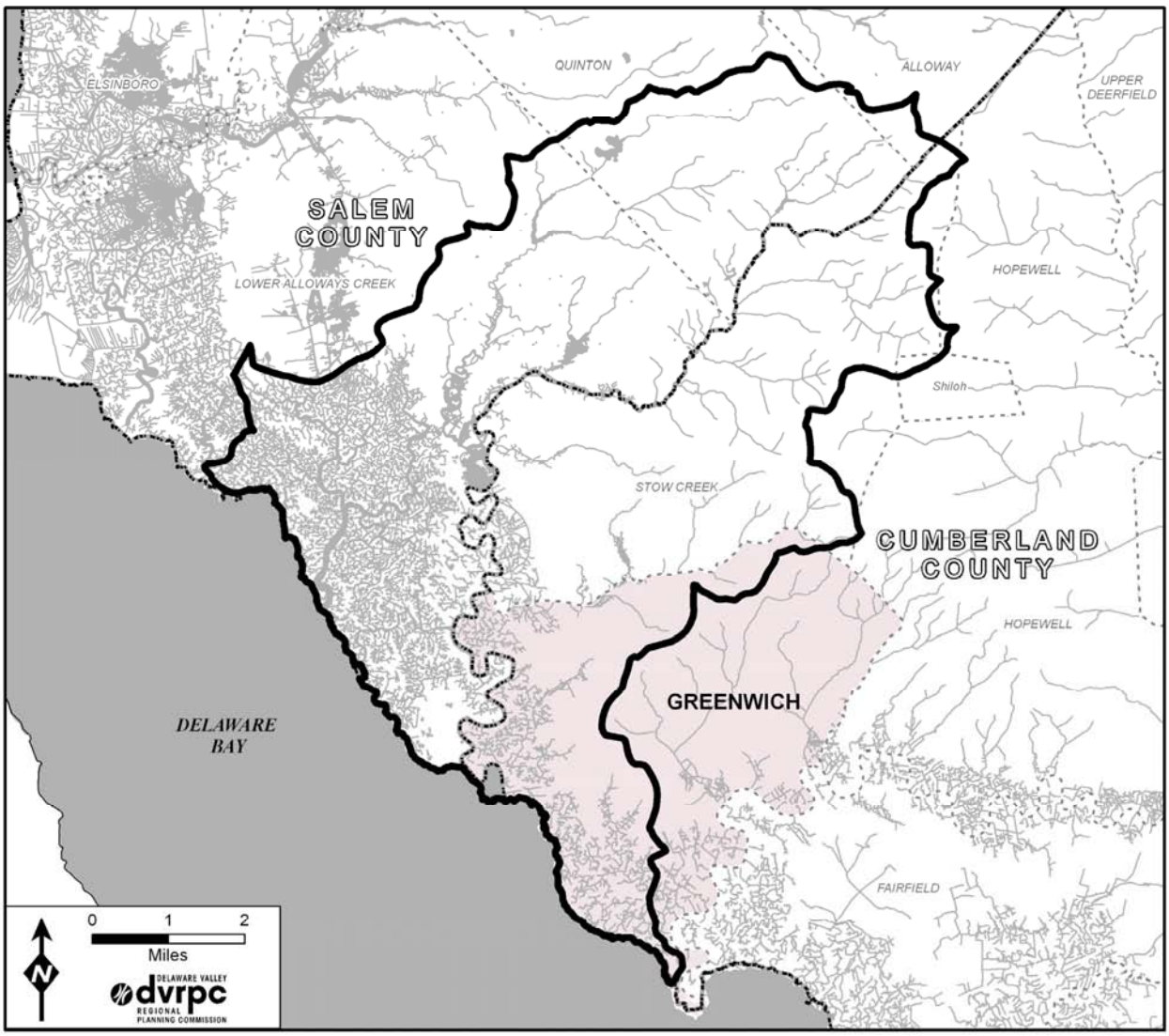
Source: DVRPC 2010

[4] It is a requirement that each federal agency, as part of its normal planning and environmental review processes, take care to avoid or mitigate adverse effects on rivers identified in the Nationwide Rivers Inventory. Furthermore, all agencies are required to consult with the National Park Service prior to taking actions that could effectively foreclose wild, scenic, or recreational status for rivers on the inventory.

Stow Creek Watershed

Stow Creek forms the boundary between Salem and Cumberland counties and is a tributary of the Delaware Bay. About 47% of land in Greenwich Township drains to Stow Creek by way of Macanippuck Run, Chestnut Run, and Phillips Creek. This watershed drains an area of 65 square miles in the border area of Salem and Cumberland counties, as well as along the coast of the Delaware Bay in both counties. It mostly encompasses low-lying wetlands, some agricultural land and, to a lesser extent, forest land and developed land. The Bayside Tract in Greenwich Township, currently preserved under PSE&G's ownership, is bordered to the west by Stow Creek.

Figure 4: Stow Creek Watershed in Context



Source: DVRPC 2010

Table 6: Watersheds and Subwatersheds in Greenwich

Watershed Name (HUC 11 Number)	Subwatershed Name	Stream Classification	HUC14	Acreage within Greenwich	Percent of Greenwich Land
Cohansey River (above Sunset Lake) (02040206080)					
		FW2-NT/SE1	Nine HUC 14s within this HUC 11	0.0	0%
Cohansey River (below Cornwell Run) (02040206090)					
	Cohansey R (Greenwich to 75d17m50s)	FW2-NT/SE1	02040206090080	1,798.9	15.1%
	Pine Mount Creek	FW2-NT/SE1	02040206090090	3,030.0	25.4%
	Cohansey R (below Greenwich)	FW2-NT/SE1	02040206090100	1,449.2	12.1%
Stow Creek (02040206070)					
	Raccoon Ditch (Stow Creek)	FW2-NT/SE1	02040206070070	1,462.3	12.3%
	Stow Creek (below Canton Rd)	FW2-NT/SE1	02040206070080	667.5	5.6%
	Phillips Creek/Jacobs Creek	FW2-NT/SE1	02040206070090	3,527.8	29.6%
			Total	**11,935.7**	**100.0%**

Source: NJDEP, 2000

Streams

Greenwich Township contains over 187 miles of streams. Of these, 102 miles are first- or second-order (headwater) streams. That is, they are the initial sections of stream channels with no contributing tributaries (first-order streams), or they are stream channels formed from only one branching section of tributaries above them (second-order streams). The headwaters are where a stream is “born” and actually begins to flow.

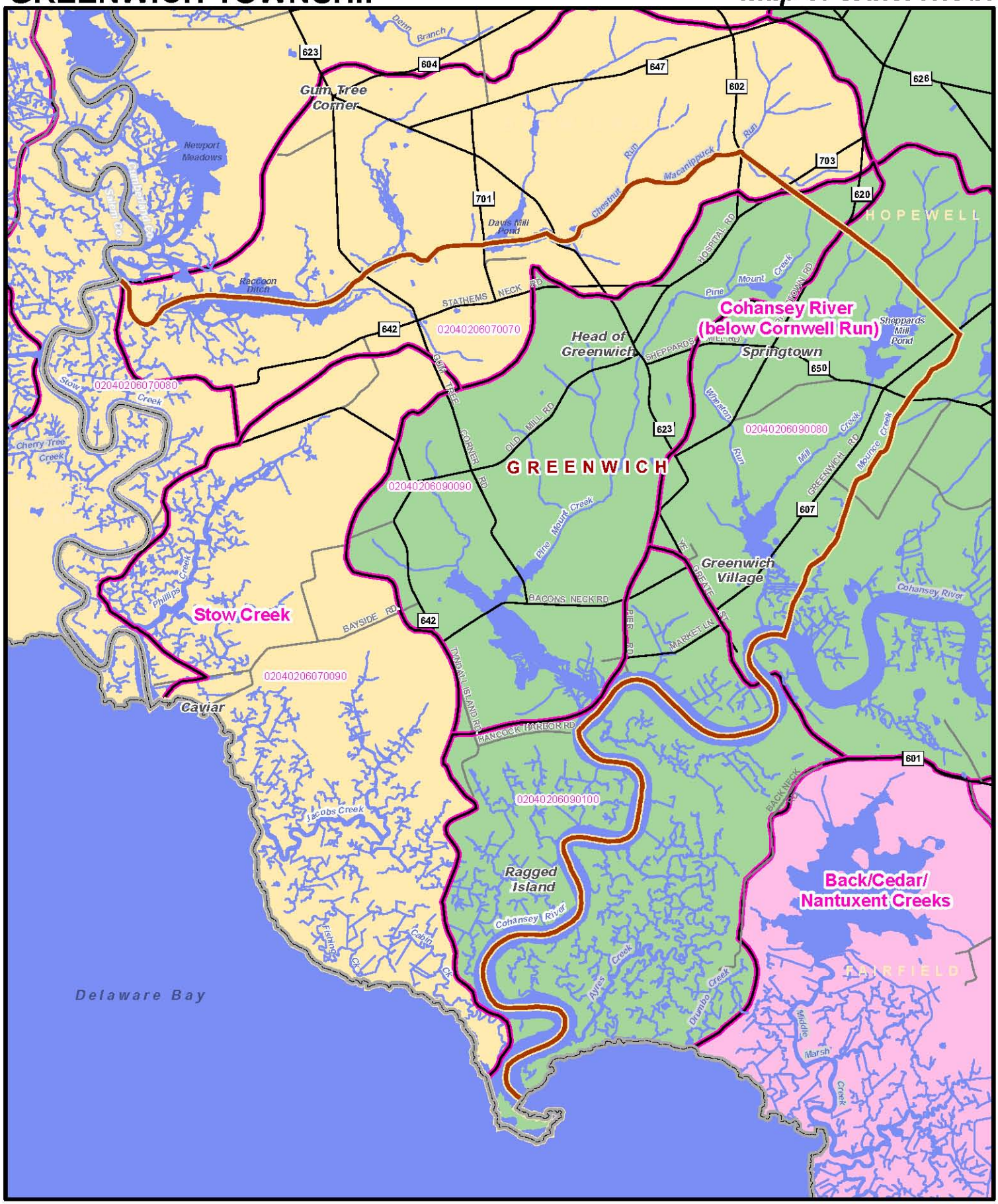
Table 7: Greenwich Streams

Stream Order	Miles
First (smallest)	102.3
Second	33.3
Third	25.9
Fourth, Fifth, and Sixth	25.8
Total	**187.3**

Source: NJDEP, 2002

GREENWICH TOWNSHIP

Map 8: Watersheds



Sources : NJDEP, NJDOT, DVRPC.
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.

Subwatershed Boundary (HUC 14)

Watersheds (HUC 11)

- Back / Cedar / Nantuxent Creeks
- Cohansey River (below Cornwell Run)
- Stow Creek

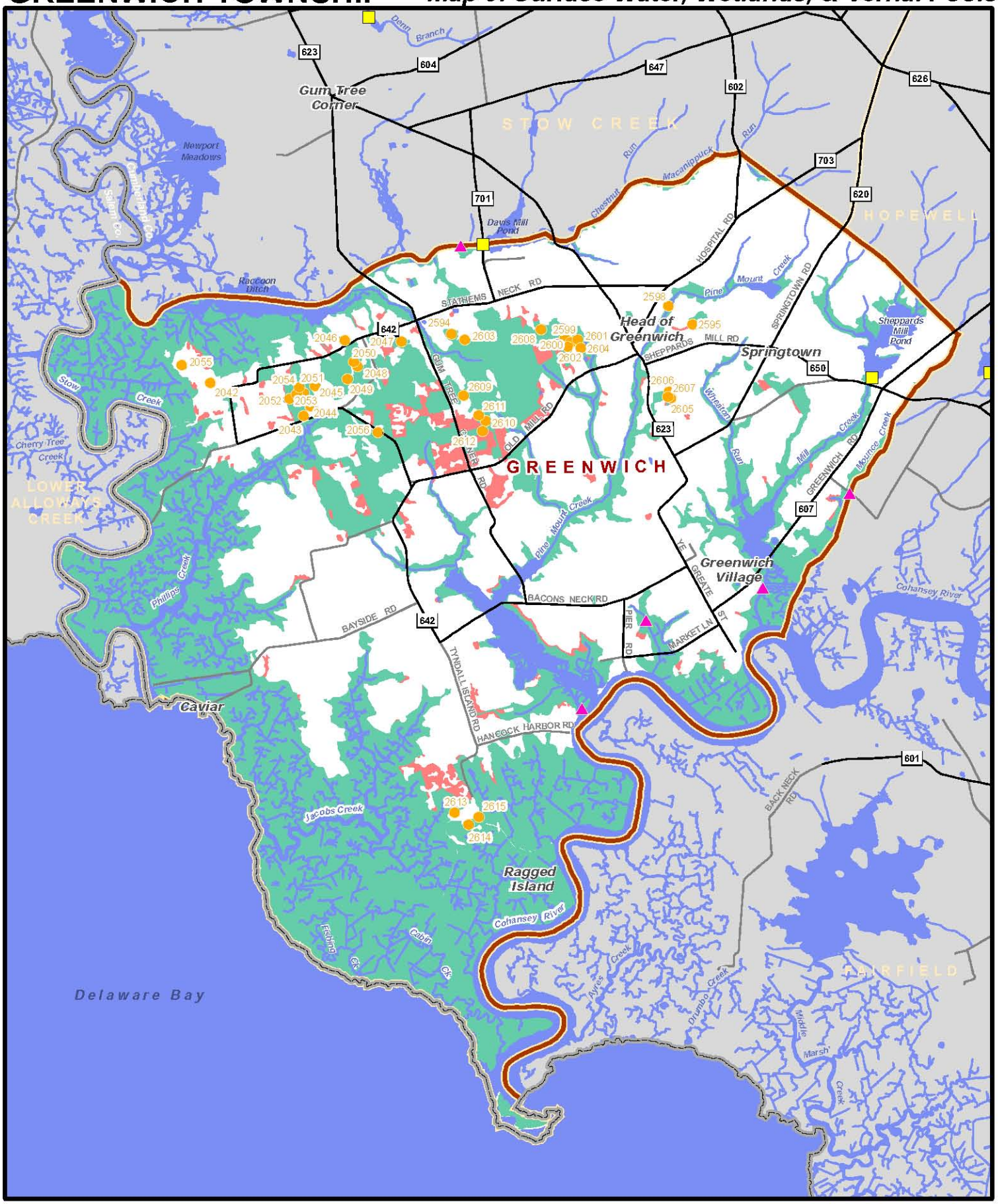
N

0 0.25 0.5 1
Miles

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

GREENWICH TOWNSHIP

Map 9: Surface Water, Wetlands, & Vernal Pools



Sources : NJDEP, NJDOT, DVRPC.
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.

- Vernal Pool
- Head of Tide
- Dam
- Agricultural Wetlands
- Wetlands

N

0 0.25 0.5 1
Miles

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

Headwaters are of particular importance because they tend to contain a diversity of aquatic species, and their condition affects downstream water quality. Because of their small size, they are highly susceptible to impairment by human activities on the land. First- and second-order streams are narrow and often shallow, and are characterized by relatively small base flows. This makes them subject to greater temperature fluctuations, especially when forested buffers on their banks are removed. They are also easily oversilted by sediment-laden runoff and their water quality can be rapidly degraded. In addition, first-order streams are greatly affected by changes in the local water table because they are fed by groundwater sources. 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.

Tidal flows bring Delaware River water into the lower reaches of Greenwich streams twice a day. Tidal flows both help and hinder maintenance of water quality in affected streams. The flood (incoming) tide carries leaves and 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. Deposition is also a natural function of stream shape, although the presence of barriers can detrimentally increase the quantity of silt (the load) being carried by the stream. See **Map 9: Surface Water, Wetlands, and Vernal Pools** on page 42.

Lakes and Ponds

There are 85 acres of artificial ponds and lakes in Greenwich, including Sheppards Mill Pond on Mill Creek, as well as part of Raccoon Ditch, which is part of the township's northern border, formed by Macanippuck Run. All lakes in Greenwich are classified as artificial water bodies by NJDEP, as naturally occurring lakes do not exist in southern New Jersey. Artificial lakes and ponds are man-made impoundments of water that are one acre or larger, formed by damming or as the result of an active or inactive extractive operation. They are often used for irrigation and flood control. See **Map 9: Surface Water, Wetlands, and Vernal Pools** on page 42.

Wetlands

Wetlands support unique communities that serve as natural water filters and as incubators for many beneficial species. The term "wetland" is applied to areas where water meets the soil surface and supports a particular biological community. The source of water for a wetland can be an estuary, a river, a stream, a lake edge, or groundwater that rises close to the land surface. Under normal circumstances, wetlands are those areas that support a prevalence of defined wetland plants on a wetland soil. The U.S. Fish and Wildlife Service designates all large vascular plants as wetland (hydric), nonwetland (nonhydric) or in-between (facultative). Wetland soils, also known as

Photo by Carey Hedlund

Wetlands serve as natural filters, absorbing and cleansing stormwater runoff.

hydric soils, are areas where the land is saturated for at least seven consecutive days during the growing season.

Wetlands are classified as either tidal or nontidal. Tidal wetlands can be either saline or freshwater. There are also special wetland categories to denote saturated areas that have been altered by human activities. For legal definitions of wetlands, ANJEC's publication *Freshwater Wetlands Protection in New Jersey* is recommended (see ***Sources of Information***).

New Jersey protects freshwater (interior) wetlands under the New Jersey Freshwater Wetlands Protection Act Rules: N.J.A.C. A 7:7A. The law also protects transition areas, or "buffers," around freshwater wetlands. The New Jersey freshwater wetlands maps provide guidance on where wetlands are found in New Jersey, but they are not the final word. Only an official determination from DEP, called a "letter of interpretation" (LOI) can determine for sure if there are freshwater wetlands on a property. An LOI verifies the presence, absence, or boundaries of freshwater wetlands and transition areas on a site. Activities permitted to occur within wetlands are very limited, and permits are required for most of them. Additional information on wetlands rules and permits is available through NJDEP and on its website under "land use." See ***Sources of Information***.

Natural wetlands of all types cover 41% of Greenwich and total 4,843 acres, of which 3,294 acres are saline marshes. The next largest category of natural wetlands is deciduous wooded wetlands, which cover 836 acres in the township. See **Map 9: Surface Water, Wetlands, and Vernal Pools** on page 42.

Greenwich also has 64 acres of wetland areas that have been disturbed by human activities and no longer support typical wetland vegetation, or are not vegetated at all. These modified wetland areas do, however, show obvious signs of soil saturation and exist in areas shown to have hydric soils on U.S. Soil Conservation Service soil surveys. A more detailed description of all Greenwich's wetland areas is found in the **Biological Resources** section, under **Wetlands** on page 76.

Agricultural Wetlands

In addition to those 64 acres of modified wetlands, Greenwich Township contains 216 acres of agricultural wetlands. These "quasi-wetlands" tend to border natural wetlands or streams and are modified, former wetland areas that are under cultivation. These areas still exhibit evidence of soil saturation in aerial infrared photo surveys, but they do not support natural wetland vegetation. See **Map 9: Surface Water, Wetlands, and Vernal Pools** on page 42.

As long as agricultural wetland areas remain in agricultural use, they are exempt from New Jersey's 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. Also, according to N.J.A.C. 7:7A-2.8(b)2, "the exemptions apply only as long as the area is used for the exempted activity." Therefore, if the area is used for anything other than farming, the exemption no longer applies.

Additionally, if hydric soils are present, certain activities on drained farmland may be regulated by the State of New Jersey. While the Freshwater Wetlands Protection Rules set forth several specific farming, ranching, and silviculture (forest maintenance) exemptions, those exemptions are subject to another limitation:

> If an area with hydric soils has been drained for farming purposes through the use of drainage structures such as tiles or ditches, the Department shall presume that the area has wetlands hydrology for the purpose of identifying a freshwater wetland under N.J.A.C. 7:7A-2.3. To rebut this presumption of wetlands hydrology, all drainage structures shall be removed or completely disabled and the area shall be left undisturbed for at least one normal rainfall year, after which the presence or absence of wetlands hydrology shall be determined through use of technical criteria, field indicators, and other information, in accordance with the 1989 Federal manual. [7:7A-2.8(b)5]

The Natural Resources Conservation Service sponsors the Wetlands Reserve Program (www.nrcs.usda.gov/programs/wrp), a voluntary program that offers landowners an opportunity to receive payments for restoring and protecting wetlands, including agricultural wetlands, on their property. 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 permanent easements, 30-year easements, or restoration cost-share agreements. See **Appendix B: Federal and State Conservation Programs for Farmers**, for additional information.

Vernal Pools

Vernal pools are bodies of water that appear following snowmelt and during spring rains, but disappear or are dry during the rest of the year. They are highly important sites for certain rare species of frogs and salamanders, called obligate breeders. Obligate breeders will only breed in vernal pools because the pool's impermanence prevents residence by predators who would consume the eggs and young. Vernal pools also provide habitat for amphibians and reptiles that may breed in them, though not exclusively (called facultative breeders), or may use the pools at some point in their life cycles.

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 New Jersey Division of Fish and Wildlife has been conducting a Vernal Pool Survey project since 2001 to identify, map, and certify vernal pools throughout the state. Once a vernal pool is certified, regulations require that a 75-foot buffer be maintained around the pool. NJDEP's Division of Land Use Regulation oversees this designation and restricts development around vernal pools by denying construction permits. Local municipalities can provide additional protection by instituting restrictive zoning or negotiating conservation easements on the land surrounding the pool.

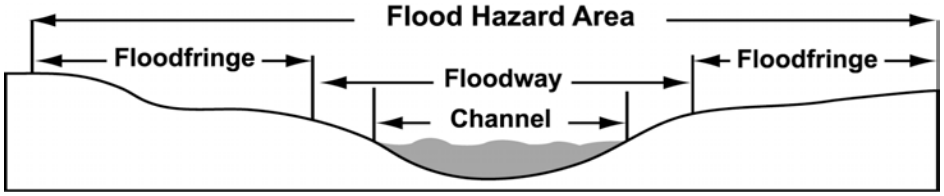
The state has identified 35 possible vernal pools within Greenwich. These pools are concentrated mainly in the northern portion of the township in the wetlands area bordered by Stathems Neck Road (County Route 642) and Old Mill Road (County Route 703). Surveys of each vernal pool are needed in order to determine what species are present and if the vernal pool is still in existence as a natural habitat. A certified vernal pool is defined as one that occurs in a confined basin without a permanently flowing outlet, has habitat documented for one obligate or two facultative herptile species (amphibian or reptile), maintains ponded water for at least two continuous months between March and September, and is free of fish populations throughout the year. See **Map 9: Surface Water, Wetlands, and Vernal Pools** on page 42, and **Appendix G: Possible Vernal Pools in Greenwich Township,** where the pools are listed, along with their Geographic Positioning System coordinates

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 100-year floodplain is defined as the land area that will be inundated by the overflow of water resulting from a 100-year flood (a flood that has a one percent chance of occurring in any given year).

Although the terms “flood hazard area” and “100-year floodplain” denote similar concepts, NJDEP defines them in slightly different ways. New Jersey’s regulations define the flood hazard area as the area inundated by a flood resulting from the 100-year discharge increased by 25%. This type of flood is called the “flood hazard area design flood” and it is the flood regulated by NJDEP.

Figure 5: Parts of a Flood Hazard Area



Source: The Streams of Washington Township

Floodplains require protection in order to prevent loss to residents, especially within the boundaries of the floodway. Equally important is the preservation of the environmentally sensitive aquatic communities that exist in floodplains. These communities are often the first link in the food chain of the aquatic ecosystem. In addition, floodplains serve the function of removing and mitigating various pollutants through the uptake by their vegetation of excess chemical loads in the water and by the filtering of sediments generally. All efforts to keep development out of floodplains will help to preserve the flood-carrying capacity of streams and their water quality.

In New Jersey and throughout the country, building in areas subject to flooding is regulated to protect lives, property, and the environment. 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. Activities that are proposed to occur in a flood hazard area will require issuance of a stream encroachment permit or a letter of nonapplicability from NJDEP. Additional information on floodplain activities is available from NJDEP and from its website under “Land Use.”

New Jersey’s flood hazard area maps are not available in digital form. Consequently, it is only possible to approximate the spatial extent of the flood hazard area in Greenwich by using the Federal Emergency Management Agency’s (FEMA’s) 100-year floodplain maps. FEMA’s maps show that 5,642 acres, or 47% of the township’s land area, fall within the 100-year floodplain. Presumably, the flood hazard area would be slightly larger.[5] Greenwich’s floodplain areas are mostly located along water bodies. A continuous stretch of floodplain extends from a thin area along Chestnut Run and Macanippuck Run on the northern border, widening along Stow Creek and the Delaware Bay to the west, becoming very large approaching the Cohansey River, and continuing along the eastern border with the Cohansey River and Mounce

[5] Site plan and subdivision applications require detailed engineering studies that depict the boundaries of the flood hazard area at a large scale.

Creek. Interior areas of the township flanking numerous minor waterways, such as Phillips Creek and Pine Mount Creek, are within FEMA's 100-year floodplain. The 500-year floodplain extends the 100-year floodplain along the entirety of its edge. Low-lying grasslands areas near the two ponded areas of Wheaton Run/Mill Creek and Pine Mount Creek in particular have large swaths in the 500-year floodplain. See **Map 10: Flood Hazard Areas (1996)** on page 59.

Table 8: Flood Hazard Area Acreage

Flood Plain	Area (Acres)	% of Greenwich in Flood Plain
100-Year Flood Plain	5641.5	47.3%
500-Year Flood Plain	1497.5	12.5%
Total	**7139.0**	**59.8%**
Total Greenwich Area	**11935.7**	

Source: FEMA, 1996

Tidelands

Greenwich Township lies entirely within the boundaries of the Coastal Areas Facilities Review Act (CAFRA) planning area, which is one of the legislative acts (NJSA 13:19-1, et seq.) that authorize New Jersey's coastal management program. Other such programs include the Wetlands Act of 1970, the Waterfront Development Law of 1914, and the common law Public Trust Doctrine concerning riparian lands. CAFRA guides development along New Jersey's coastline bordering the Atlantic Ocean, Delaware Bay, and Delaware River. Most construction in the coastal zone requires a permit under one or more of the laws listed above. See **Map 10: Flood Hazard Areas (1996) on page 59** for a depiction of the CAFRA area.

CAFRA gives the NJDEP review power over the placement and construction of coastal area facilities, including manufacturing plants, power stations, landfills, highways, housing developments over 24 units, and other large projects. The Wetlands Act of 1970 regulates activities on coastal lands that are located at or below high water that would alter or pollute those areas, and it applies to virtually any coastal wetlands project, including all dredging, filling or excavation, maintenance or construction of structures, harvesting natural products, diversion/use of water, application of pesticides, and alteration of marsh contours. The Waterfront Development Law applies to tidal waterways and adjacent upland outside of the CAFRA area, but does not apply in Greenwich Township because all of its tidal waters are within the CAFRA area. Any application for a Waterfront Development Permit requires legal proof of the right to use the riparian land under the "Public Trust Doctrine." Any construction must also meet municipal requirements.

Surface Water Quality

Water-quality standards 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.

All water bodies in New Jersey are classified by NJDEP as either freshwater (FW), pinelands water (PL), saline estuarine water (SE), or saline coastal water (SC). Freshwater is further broken down into freshwater that originates and is wholly within federal or state parks, forests, or fish and wildlife lands (FW1), and all other freshwater (FW2). In addition to being classified as FW1 and FW2, fresh water bodies are classified as trout-producing (TP), trout-maintaining (TM), or nontrout waters (NT). The water quality for each of these groups must be able to support designated uses that are assigned to each water body classification (see *Surface Water Quality Standards N.J.A.C. 7:9B-1.12*). Each of these classifications may also be subject to different water-quality standards.

The two major rivers in Greenwich, Stow Creek and the Cohansey River, are classified as FW2–NT/SE, which means that they are both freshwater and saltwater streams that are neither trout-producing nor trout-maintaining.

Tributary streams that are not explicitly classified by NJDEP take the classification of the river into which they flow. All streams in Greenwich are tributaries of either Stow Creek or the Cohansey River and are not classified by the NJDEP. Therefore, tributary streams in Greenwich are either FW2-NT or FW2-NT/SE1 waters, depending on whether or not the section they meet is estuarine.

Table 9: Water Quality Classifications of Streams in Greenwich

Stream	Classification
Cohansey River	FW2-NT/SE1
Stow Creek	FW2-NT/SE1

Source: NJDEP, Surface Water Quality Standards, N.J.A.C. 7:9b;

According to NJDEP rules, FW2-NT waters must provide for (1) the maintenance, migration, and propagation of the natural and established biota; (2) primary and secondary contact recreation (i.e., swimming and fishing/boating); (3) industrial and agricultural water supply; (4) public potable water supply after conventional filtration and disinfection; and (5) any other reasonable uses.

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, pH, phosphorous, and toxic substances. NJDEP also evaluates water quality by examining the health of aquatic life in a stream.

New Jersey's Integrated Water-Quality Monitoring and Assessment Report

The Federal Clean Water Act (Act) mandates that states submit biennial reports to the U.S. Environmental Protection Agency (US 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, and a list of water bodies that are not attaining water-quality standards–the "303(d) List." States must also prioritize 303(d)-listed water bodies for Total Maximum Daily Load (TMDL) analyses and identify those high-priority water bodies for which they anticipate establishing TMDLs in the next two years. See page 54 for an explanation of TMDLs.

In 2002, 2004, 2006, and again in 2008, NJDEP integrated the 303(d) List and the 305(b) Report into a single report, according to US EPA's guidance. The 2008 *Integrated Water Quality Monitoring and Assessment Report* (www.state.nj.us/dep/wmm/sgwqt), the most recent available, places the state's waters on one of five "sublists." Sublists 1 and 2 contain waters that are attaining standards. Sublist 3 contains waters for which there is insufficient data to determine their status. Sublist 4 contains waters that do not attain water-quality standards, but that meet one of the following three conditions: (1) a TMDL has been completed for the pollutant causing nonattainment; (2) other enforceable pollution control requirements are reasonably expected to result in conformance with the applicable water-quality standards; or (3) nonattainment is caused by something other than a pollutant. Sublist 5 contains waters that do not attain their designated use and for which a TMDL is required. Sublist 5 is equivalent to the 303(d) List.

Photo by DVRPC

A scenic view of Greenwich's coastline

In the Integrated Report, NJDEP identifies the designated uses applicable to each HUC-14 subwatershed (assessment unit) and assesses the status of use attainment for each applicable designated use. Designated uses include:

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

The assessment unit is then placed on the appropriate sublist for each use. (Note: not all designated uses are applicable for all HUC-14 subwatersheds).

NJDEP bases the assessment of entire HUC-14 subwatersheds on the results of one or more monitoring site(s) within the watershed. The results from monitoring site(s) located within the HUC-14 subwatershed are extrapolated to represent all the waters within the entire HUC boundary. In practice, the HUC-14 approach provides a more conservative assessment since any impairment of any water body (stream, river, etc.) in a given HUC-14 subwatershed will result in that entire watershed being listed as impaired for that use/parameter. In addition, where a HUC-14 subwatershed contains waters of different classification, the more stringent classification is used to assess impairment, and that impairment is then applied to the entire subwatershed. Because of the extent of extrapolation required for this approach, NJDEP performs more detailed testing to determine the actual cause, source, and extent of impairment in the HUC-14 subwatershed before developing a TMDL or taking other regulatory action to address the impairment.

See ***Table 10: New Jersey Integrated Water-Quality Monitoring and Assessment Report (2008)***, for the status of each of Greenwich's HUC-14 subwatersheds.

Table 10: New Jersey Integrated Water-Quality Monitoring and Assessment Report (2008)

Assessment Unit ID	Assessment Unit Name	Aquatic Life General	Aquatic Life (trout)	Recreation	Drinking Water Supply	Agri. Water Supply	Indus. Water Supply	Shellfish Consump.	Fish Consump.
02040206090080	Cohansey R (Greenwich to 75d17m50s)	2	N/A	3	N/A	N/A	N/A	2	5
02040206090090	Pine Mount Creek	5	N/A	3	N/A	N/A	N/A	2	3
02040206090100	Cohansey R (below Greenwich)	2	N/A	3	N/A	N/A	N/A	4	5
02040206070070	Raccoon Ditch (Stow Creek)	5	N/A	3	2	2	2	2	5
02040206070080	Stow Creek (below Canton Rd)	2	N/A	3	N/A	N/A	N/A	2	5
02040206070090	Phillips Creek/Jacobs Creek	3	N/A	3	N/A	N/A	N/A	2	5
02040204910040	Delaware Bay (Cohansey R to FishingCk)	5	N/A	2	N/A	N/A	N/A	1	5

Source: NJDEP, 2010

Key to Integrated Report Sublists

Sublist	Placement Conditions
Sublist 1	The designated use is assessed and attained AND all other designated uses in the assessment unit area are assessed and attained. (Fish consumption use is not factored into this determination based on EPA guidance)
Sublist 2	The designated use is assessed and attained BUT one or more designated uses in the assessment unit are not attained and/or there is insufficient data to make a determination.
Sublist 3	Insufficient data is available to determine if the designated use is attained.
Sublist 4	The designated use is not attained or is threatened; however, development of a TMDL is not required for one of the following reasons: 1) A TMDL has been completed for the pollutant causing nonattainment; 2) Other enforceable pollution control requirements are reasonably expected to result in the conformance with the applicable water-quality standard(s) in the near future and the designated use will be attained through these means; or 3) nonattainment is caused by something other than a pollutant.
Sublist 5	The designated use is not attained or is threatened by a pollutant or pollutants and a TMDL is required.

In summary, in the 2008 report, every water body in Greenwich Township was listed as threatened or impaired for at least one parameter.

Additionally, six subwatersheds were listed as impaired or threatened for polychlorinated biphenyls (PCBs) in 2006. 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.

Three subwatersheds were listed as threatened or impaired for chlordane, DDX, and mercury. Chlordane is a man-made chemical that was used as a pesticide from 1948 to 1988, when it was banned due to concern over its damage to the environment and human health. Like PCBs, chlordane does not break down easily and builds up in animal life and the environment. In humans, exposure to chlordane can affect the nervous system, digestive system, and liver. Small amounts can cause pain, sickness, and vision problems; large amounts can cause convulsions and death.

DDX is the ethylene metabolite equivalent of DDT, the pesticide used extensively in the 1940s and 1950s. DDT was effective in nearly eliminating typhus during World War II and has successfully combated malaria in many parts of the world, although it has been shown to have harmful effects on plant and animal life. Exposure to DDT impairs the nervous and immune systems in animals and is highly toxic, particularly for fish. It also causes eggshell thinning in birds, the primary reason why bald eagles became endangered in the United States.

Impaired aquatic life and low levels of dissolved oxygen were present in three subwatersheds. NJDEP Coastal Assessment testing of the Delaware Bay along Greenwich's border found that it was impaired or threatened due to seven pollutants, including DDX, mercury, and Dieldrin. Dieldrin was an insecticide developed as an alternative to DDT; however, it was later found to be toxic to animals, including humans.

As shown in ***Table 10*** above, an assessment unit may be listed on one or more sublists depending on the results of the assessment (i.e., on Sublist 2 for drinking water, Sublist 3 for aquatic life, etc.). The assessment unit can only be placed on Sublist 1 if all uses for an individual HUC-14 are assessed and attained. In order to determine whether or not an assessment unit supports a designated use, NJDEP identified a suite of parameters that serve as the minimum data set associated with each designated use.

Photo by Mike Ivanick

Many grasses thrive in wetland areas.

If one or more designated uses are assessed as "nonattainment" (Sublist 5), the pollutant(s) causing the nonattainment status is identified on the "303(d) List of Impaired Waters with Priority Ranking." When the pollutant causing nonattainment is not known, 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. The priority ranking is determined by NJDEP and takes into account the severity of the pollution and the uses of the waters, as well as any additional relevant factors. ***Table 11: New Jersey's 303(d) List of Impaired Waters with Priority Ranking (2008)***, lists the nonattaining assessment units and their pollutants in Greenwich Township. All have a priority ranking of medium. The Pine Mount Creek subwatershed had insufficient data, so it is not listed.

Table 11: New Jersey's 303(d) List of Impaired Waters with Priority Ranking (2008)

Assessment Unit ID	Assessment Unit Name	Parameters	Ranking
02040206090080	Cohansey R (Greenwich to 75d17m50s)	Chlordane	Medium
		DDX	Medium
		Mercury	Medium
		PCBs	Medium
02040206090100	Cohansey R (below Greenwich)	Chlordane	Medium
		DDX	Medium
		Mercury	Medium
		PCBs	Medium
02040206070070	Raccoon Ditch (Stow Creek)	PCBs	Medium
02040206070080	Stow Creek (below Canton Rd)	PCBs	Medium
02040206070090	Phillips Creek/Jacobs Creek	Dioxin	Medium
		PCBs	Medium
02040204910040	Delaware Bay (Cohansey R to FishingCk)	Chlordane	Medium
		DDX	Medium
		Dieldrin	Medium
		Dissolved Oxygen	Medium
		Mercury	Medium
		PCBs	Medium
		Total coliform	Medium

Source: NJDEP, 2009

Water-Quality Monitoring Networks

The determination of whether or not water quality is sufficient to meet an assessment unit's designated use(s) is based on testing results from various water-quality monitoring networks. Across the state, NJDEP primarily relies on two water-quality monitoring networks: the *Ambient Stream Monitoring Network (ASMN)* and the *Ambient Biomonitoring Network (AMNET).* NJDEP runs the ASMN network in cooperation with the U.S. Geological Survey (USGS). This network contains 115 stations that monitor for nutrients (i.e., phosphorous and nitrogen), bacteria, dissolved oxygen, metals, sediments, chemicals, and other parameters. There are no ASMN stations in Greenwich. AMNET, which is administered solely by NJDEP, evaluates the health of aquatic life as a biological indicator of water quality. This network includes 820 monitoring stations located throughout the state. Each station is sampled once every five years. The first round of sampling for all stations took place between 1992 and 1996, and a second round occurred between 1997 and 2001. A third round of sampling took place between 2002 and 2006.

Ambient Biomonitoring Network

There are two AMNET sites that assess aquatic life within Greenwich Township and which are sampled every five years. NJDEP sampled each of these AMNET sites in January 1995, and again in January 2001 (data for the third most recent round of sampling from 2006 was not available yet from NJDEP when the most recent Integrated Report was issued). Each AMNET site was tested for only one water-quality parameter–the diversity of the aquatic communities at the site; specifically, benthic (bottom-dwelling) macroinvertebrates (insects, worms, mollusks, and crustaceans that are large enough to be seen by the naked eye). Sites can be classified as either nonimpaired, moderately impaired, or severely impaired for aquatic-life support.

In the 1995 (first round) sampling, the Pine Mount Creek and Raccoon Ditch sites in Greenwich Township were both tested. In this sampling, both sites had impairment scores of 12, which means that they were ranked "moderately impaired" for aquatic-life support. In the 2000 (second round) sampling, the Raccoon Ditch site received an impairment score of 3, or "severely impaired." The Pine Mount Creek site, however, increased slightly in quality and scored a 15, remaining at "moderately impaired."

Greenwich's AMNET stations are listed in ***Table 12: New Jersey AMNET Sampling Locations for Greenwich Township Waterways*** and are depicted on **Map 11: Water Quality** on page 60.

Table 12: New Jersey AMNET Sampling Locations Greenwich Township Waterways

Site ID	Station Name/Water Body	Parameters Measured	1995 NJ Impairment Score*	2000 NJ Impairment Score
AN0708	Raccoon Ditch at Davis Mill Rd in Greenwich	Benthic Macroinvertebrates	12	3
AN0717	Pine Mt Creek at Rt 623 in Greenwich	Benthic Macroinvertebrates	12	15

Source: NJDEP, 1995, 2000

NJ Impairment Score	Biological Assessment
0-6	Severely Impaired
9-21	Moderately Impaired
24-30	Non-impaired

Other Monitoring

Certain fish may contain toxic chemicals, such as PCBs, dioxins, or mercury, which accumulate in water and aquatic life. Chemical contaminants, such as dioxin and PCBs, are classified by the USEPA as probable cancer-causing substances in humans. Elevated levels of mercury can pose health risks to the human nervous system. Infants, children, pregnant women, nursing mothers, and women of childbearing age are considered to be at a higher risk from contaminants in fish than other members of the general public. Since 1982, NJDEP has been catching fish at numerous sampling stations throughout the state and testing for contaminant levels of PCB, dioxin, and mercury, adopting advisories to guide residents on safe consumption practices.

Within Cumberland County, NJDEP has issued fish advisories for four species of fish on four bodies of water, as shown below in ***Table 13: Fish Consumption Advisories for Cumberland County***.

Concerning marine fish, the NJDEP advises that the general population eat no more than one meal per month of American eel from the Delaware Bay and its tributaries, and that high-risk individuals eat no more than four meals per year of American eel.

Table 13: Fish Consumption Advisories for Cumberland County

Water Body	Municipality	Species	General Population	High Risk Individuals
Cedar Lake	Lawrence	Chain Pickerel	One meal per week	Do not eat
		Largemouth Bass		
Sunset Lake	Hopewell	Largemouth Bass	One meal per week	One meal per month
Union Lake	Millville	White Perch	One meal per week	Do not eat
Willow Grove Lake	Vineland	Brown Bullhead	No restrictions	One meal per month

Source: NJDEP, 2008

Additionally, the EPA conducts the National Coastal Assessment (NCA), a comprehensive monitoring program that surveys the condition of the nation's coastal resources. This integrated assessment collects water column data, sediment contaminants and toxicity data, and benthic macroinvertebrate and fish community and contaminant data. The most recent NCA data from a station in Greenwich at the mouth of the Cohansey River Estuary (station ID: NJ00-0091) was sampled in 2000 and measured temperature, salinity, dissolved oxygen, and mean number of benthic species. Measurements from this station were within the NJDEP standards for temperature and dissolved oxygen. The bottom salinity, for which there is no standard, was 12.33 parts per thousand (ppt) at the Cohansey station. In comparison, the salinity of saltwater in the open sea is 35 ppt, whereas that of freshwater is between zero and five ppt. The mean number of benthic species was 61. Benthic species abundance, along with benthic diversity and other factors, is used by biologists to determine a benthic-quality index for a water body.

Knowing the actual condition of streams and stream banks, and planning for their improvement, requires fuller surveys and more frequent monitoring than the state can provide. The state primarily monitors main channels in nontidal areas and only does biological assessments on a five-year cycle. Stream surveys by local organizations are much needed, along with regular monitoring of water quality on all of a community's waterways.

Total Maximum Daily Loads

For each impaired waterway (waters on Sublist 5), the state is required by the US EPA to establish a Total Maximum Daily Load (TMDL). A TMDL quantifies the amount of a pollutant that a water body can assimilate (its loading capacity) without violating water-quality standards. A TMDL's purpose is to initiate a management approach or restoration plan based on identifying the sources of a pollutant and determining the percentage reductions of the pollutant that must be achieved by each source. These sources can be point sources, such as sewage treatment plants, or nonpoint sources, such as runoff from various types of residential, commercial, or agricultural lands. A TMDL goes through four stages: it is "proposed" in a report by NJDEP, "established" when NJDEP finalizes its report, "approved" by EPA Region 2, and "adopted" when NJDEP adopts it as an amendment to a water-quality management plan.

In general, implementation of a TMDL relies on actions mandated by the Municipal Stormwater Management program, including the ordinances that municipalities are required to adopt under that permit. It also depends on voluntary improvements in land and runoff management of agricultural areas. A list of U.S. Department of Agriculture and New Jersey Department of Agriculture programs that provide funding and technical assistance on relevant projects for farm landowners is included in **Appendix B: Federal and State Conservation Programs for Farmers**.

A TMDL determines the percentage of reduction needed in order for a stream segment to meet the water-quality standard. Nonpoint and stormwater point sources are the largest contributors, as runoff from various land uses transport fecal coliform from sources such as geese, farms, and domestic pets during rain events into water bodies. Nonpoint sources also include inputs from "illicit" sources, such as failing sewage conveyance systems, sanitary sewer overflows, and failing or inappropriately located septic systems.

There has only been one TDML proposed for a watershed or water body within Greenwich Township. A TDML for total coliform for the Cohansey River Estuary to address shellfish impairment was approved in September 2006 (NJPDES ID#: NJG0154083). This 64,860-acre water body requires a 72% reduction in total coliform. Implementation of the TMDL will involve substantial reduction in the amount of total coliform from each known source, such as farms, faulty septic systems, or sewage treatment plants.

Causes of Water-Quality Impairments

Saltwater Intrusion

One cause of water-quality impairment in Greenwich Township is saltwater intrusion, which can contaminate drinking water and impact the area's overall ecology. One cause of saltwater intrusion into previously fresh water bodies is groundwater depletion. Particularly in the Delaware Bay area, pumping of groundwater can lead to saltwater intrusion into the aquifers. Another cause of saltwater intrusion is the loss of traditional dikes built in the 19th century for agricultural purposes. These dikes served as a buffer and prevented saltwater from penetrating farther inland and upstream in rivers, bays, wetlands, and aquifers. As the dikes erode due to lack of maintenance, saltwater is reintroduced to inland waters. The effect of saltwater intrusion on drinking water supply is discussed in **Water Supply Wells** on page 65.

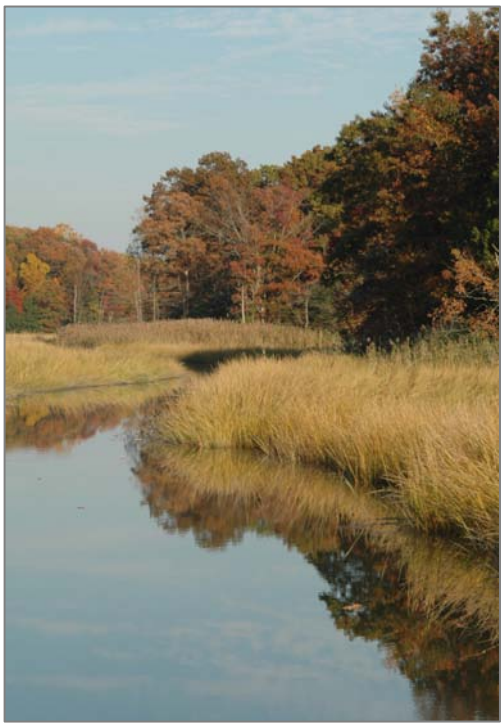


Photo by Mike Ivanick

Saline intrusion contaminates groundwater.

Assessment of one of the designated uses addressed in the New Jersey Integrated Water Quality Monitoring and Assessment Report–agricultural water supply–specifically uses total dissolved solids (TDS) and salinity as test parameters. However, data on water salinity was unavailable for the 2006 report, and so the assessment was based solely on TDS. TDS, composed of minerals and other substances

dissolved in water, is approximately equal to the amount of salinity. An assessment of drinking water supply also uses TDS as a test parameter, in addition to numerous other pollutants. It is recommended that drinking water contain no more than 500 milligrams per liter of TDS. Of the seven HUC-14 subwatersheds in Greenwich Township, six list both drinking and agricultural water supply as not applicable. The remaining subwatershed, Raccoon Ditch (Stow Creek), is placed on Sublist 2 for both designated uses, which indicates full attainment, although other designated uses are unassessed, assessed as not in attainment, or have an approved TMDL. See ***Table 10: New Jersey Integrated Water-Quality Monitoring and Assessment Report (2008)*** on page 50 for a summary of assessment by designated use.

Stormwater Runoff

Stormwater runoff and other nonpoint source pollution (pollution coming from a wide variety of sources rather than from a single point, such as a discharge pipe) have the largest effect on the water quality and channel health of streams in Cumberland County. These sources are also the most difficult to identify and remediate because they are diffuse, widespread, and cumulative in their effect. Most nonpoint source pollution in the Cohansey River watershed or Stow Creek watershed is known to derive from stormwater drainage from paved surfaces, such as streets, commercial or industrial areas, and residential sites (with and without detention basins), as well as from agricultural fields that lack adequate vegetative buffers. Some of this runoff comes to the waterways from similar inland sources in upstream townships.

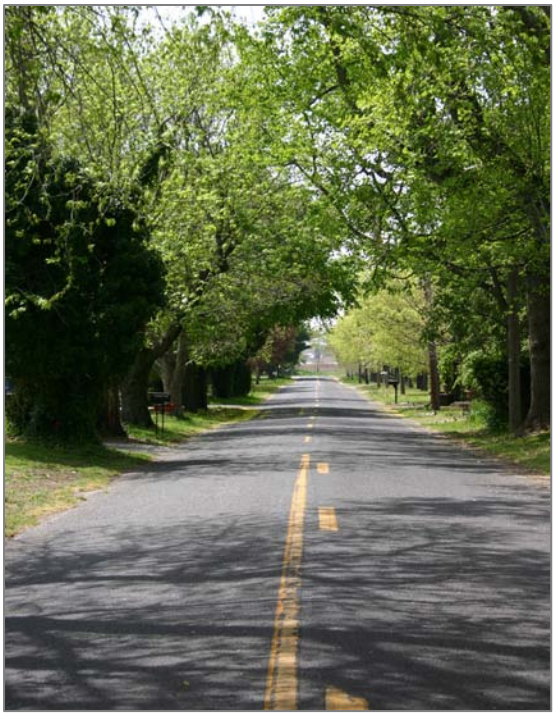


Photo by DVRPC

Impervious surfaces increase runoff.

In March 2003, NJDEP issued a new Stormwater Management Rule, as required by the U.S. Environmental Protection Agency's Phase II Stormwater Management Program for Municipal Separate Stormwater Sewer Systems (MS4). The rule lays out guidance and requirements for management of and education about stormwater at the local level. It applies to all towns in New Jersey, all county road departments, and all public institutional facilities on large sites (such as hospitals and colleges). Beginning in 2004, every municipality was required to obtain a New Jersey Pollution Discharge Elimination System (NJPDES) general permit for the stormwater system and its discharges within municipal borders, and to comply with permit requirements over a five-year period.

The volume of runoff that is carried to a stream also impacts stream channel condition. Increased volume usually results from increased impervious surface within a subwatershed. Although impervious surface coverage in Greenwich is currently minimal, future development would cause an increased level of impervious surfaces. As an area becomes developed, more stormwater is directed to the streams from neighborhood storm drains, residential and commercial stormwater facilities, and road drainage. In general, scientists have found that levels of impervious cover of 10% or more within a subwatershed 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% to 30% within a watershed or subwatershed, streams can become severely degraded.

Stormwater Management Statewide Basic Requirements: Tier B Municipalities

Tier B municipalities are communities with lower population levels and densities. They have fewer stormwater requirements imposed on them. See the NJDEP Stormwater website www.njstormwater.org for more information. Tier B requirements are:

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% of preconstruction recharge and use of low-impact design in stormwater facilities, among other features.
- Ensuring compliance with Residential Site Improvement Standards (RSIS) for stormwater management. The RSIS is currently being 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.
- 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, as well as proper identification, handling, and disposal of wastes, including pet waste and litter.
- Adopt specific ordinances to control waste disposal and other nonpoint sources.

Impervious Coverage

The volume of runoff that is carried to a stream impacts stream channel condition. Increased volume usually results from increased impervious surface within a subwatershed. As an area becomes developed, more stormwater is directed to the streams from neighborhood storm drains, residential and commercial stormwater facilities, and road drainage. An increase in impervious coverage can decrease groundwater recharge potential, which can lead to a decrease in stream base flow during the dry summer months.

All HUC 14 subwatersheds in Greenwich Township contain less than two percent impervious surface, reflecting the area's preserved natural environment. However, runoff from communities upstream that have more impervious coverage most likely affects the township's streams and water quality. See **Map 8: Watersheds** on page 41 for a depiction of these subwatersheds. See ***Table 14: Impervious Coverage by HUC 14 Watersheds*** for information regarding impervious cover.

Table 14: Impervious Coverage by HUC 14 Watersheds

HUC 14	Subwatershed Name	Percent of Subwatershed Covered by Impervious Surface
02040206070070	Raccoon Ditch (Stow Creek)	0.95%
02040206070080	Stow Creek (below Canton Rd)	0.42%
02040206070090	Phillips Creek/Jacobs Creek	0.18%
02040206090080	Cohansey R (Greenwich to 75d17m50s)	1.56%
02040206090090	Pine Mount Creek	1.40%
02040206090100	Cohansey R (below Greenwich)	0.54%

Source: NJDEP, 2006

Inadequate Stream Buffers

The stream buffer is the region immediately beyond the banks of a stream that serves to limit the entrance of sediment, pollutants, and nutrients into the stream itself. Stream buffers are quite effective at filtering substances that wash off the land. The vegetation of the buffer traps sediment and can actually utilize (uptake) a percentage of the nutrients flowing from lawns and farm fields. When forested, a stream buffer promotes bank stability and serves as a major control of water temperature. The buffer region also serves as a green corridor, a greenway for wildlife to move between larger forested habitat areas. Residents can utilize these greenways for recreation with the addition of trails, bikeways, and access points to water for fishing and canoe/kayak launching.

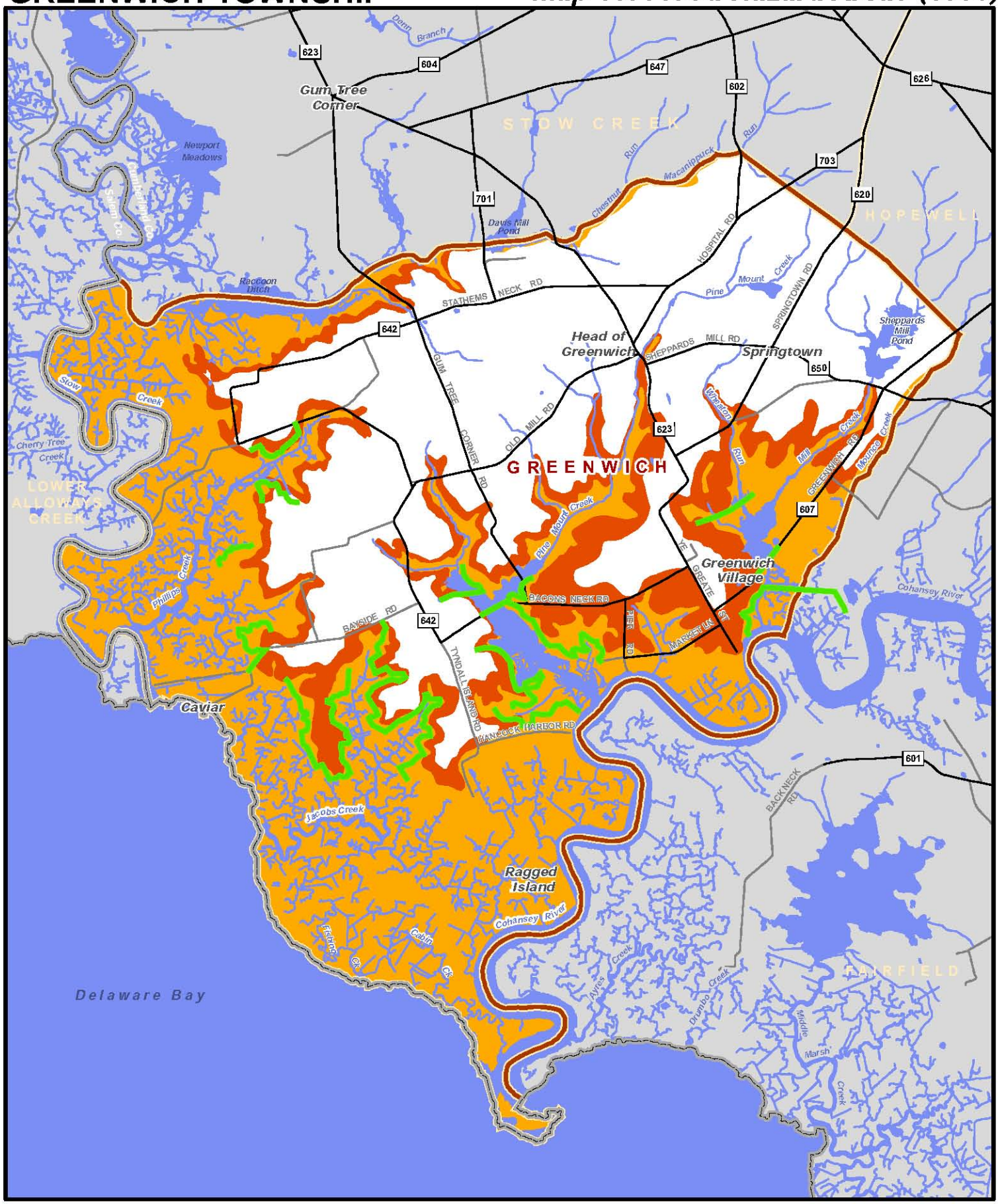
Photo by Mike Ivanick

Forested stream buffers help protect water quality.

The importance of a healthy, intact buffer zone (also referred to as a "riparian corridor") 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 literature on this issue, a recommended minimum buffer width of 100 feet is most common, with differing activities permitted in each of three zones within the buffer. Buffers of up to 300 feet are recommended for wildlife corridors and potential passive recreational use, such as walking trails.

GREENWICH TOWNSHIP

Map 10: Flood Hazard Areas (1996)



Sources : NJDEP, NJDOT, DVRPC, FEMA, Cumberland County Department of Planning. 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.

Dike (Approximate Location)

ZONE

100-Year Floodplain

500-Year Floodplain

N

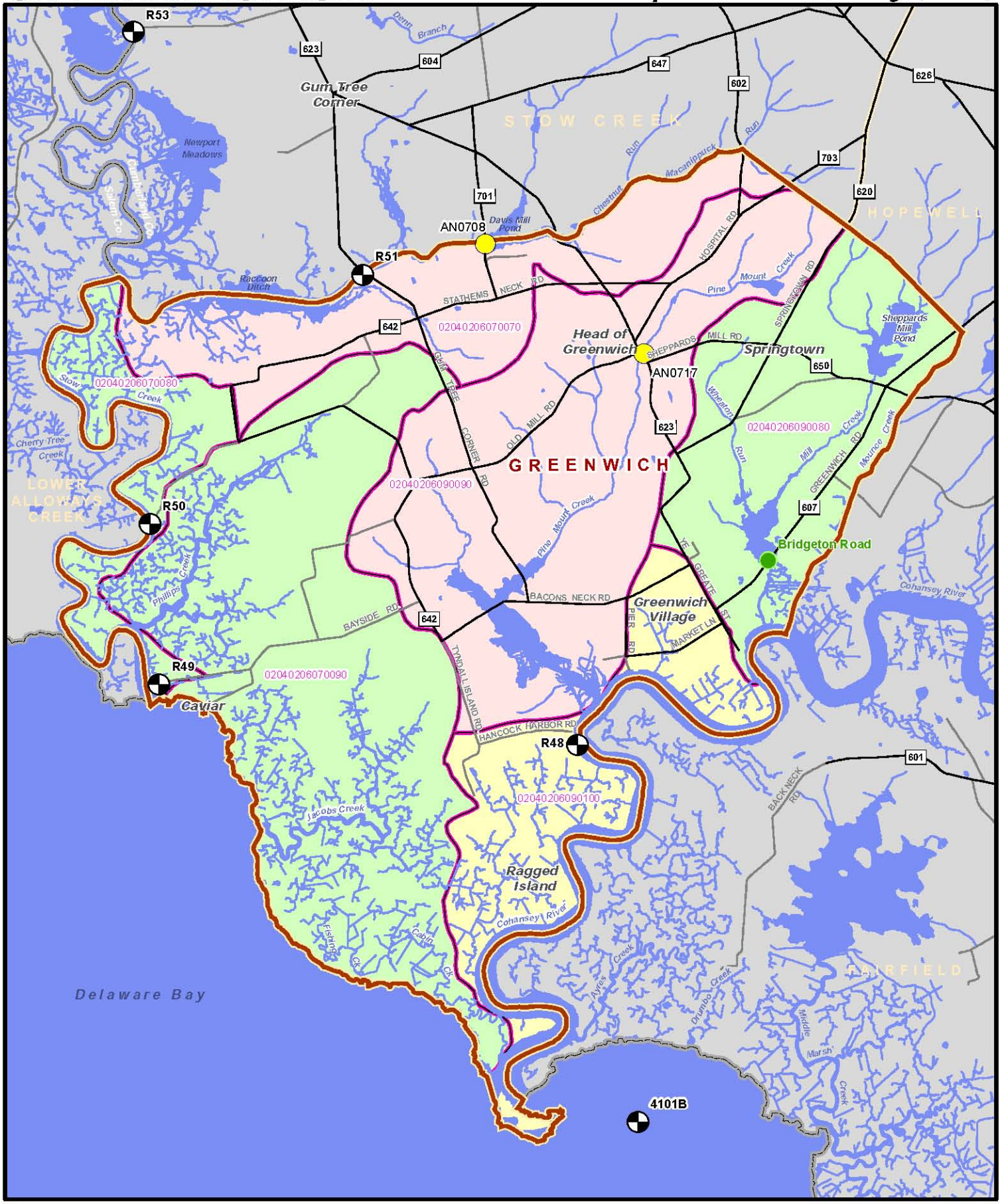
0 0.25 0.5 1

Miles

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

GREENWICH TOWNSHIP

Map 11: Water Quality (2008)



Sources : NJDEP, NJDOT, DVRPC.
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.

2008 Integrated Water Quality Report
General Aquatic

- Sublist 2 - Attains designated use
- Sublist 4 - Does not attain designated use but measures are being implemented to improve water quality
- Sublist 5 - Does not attain designated use and a TMDL is necessary

- Monitoring Station in Coastal Waters
- NJDEP Ambient Biomonitoring Network (AMNET) Sampling Site
- Subwatershed Boundary (HUC 14)
- Known Contaminated Site

N

0 0.25 0.5 1
Miles

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

The New Jersey Freshwater Wetlands Protection Act incorporates buffer requirements into its wetland protection regulations. The width of the "transition zone" extending beyond a wetland is determined by the value of the wetland based on its current use and on the documented presence/absence of threatened or endangered species. Municipalities may not establish buffers on wetlands that exceed those required by the state statute. However, the municipality can make certain that those limits are accurate through its review of the wetlands delineation process, and it can also monitor use of the land within the transition area and take action against encroachments.

There are no buffer requirements on lands in agricultural use, unless and until that use is changed. However, voluntary restoration of stream buffers on agricultural lands is supported by various programs of the U.S. Department of Agriculture (USDA) and the New Jersey Department of Agriculture, such as the Conservation Reserve Program (CRP), administered by the USDA's Farm Service Agency (FSA), and the New Jersey version of this program, which is known as CREP. This program is designed to help farmers reduce impairments from agricultural water runoff sources in an effort to improve water quality. The program compensates farming landowners for the loss of land being converted to a buffer or other habitat. It also funds or directly creates new buffers where they are absent. Programs such as the Environmental Quality Incentive Program (EQIP), administered by the Natural Resources Conservation Service (NRCS) of USDA, encourage the "due care" management of agricultural lands, involving the proper levels of fertilizer and pesticide applications to farmland. It funds up to 75% of the costs of eligible conservation practices. These are all programs in which individual landowners volunteer to take part. See **Appendix B: Federal and State Conservation Programs for Farmers** for a listing of these programs.

Point Sources of Pollution

Point sources of pollution, 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 water bodies. The Act classified all water pollution into one of two categories: "point source" pollution and "nonpoint source" pollution (coming from many diffuse sources, such as through stormwater), but, until recently, only required states to regulate point sources.

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 (over 2000 gallons per day 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 conduct water-quality, biological, and toxicological analyses, and thermal impact and cooling water assessments periodically.

Under the Open Public Records Act (OPRA) of 2002, a list of active NJPDES permits is available. As of February 2008, five NJPDES permits were issued to three individual facilities in Greenwich. These are shown in ***Table 15: Greenwich NJPDES Permits***.

Since the adoption of the federal Clean Water Act in 1972 and the implementation of NJPDES in subsequent years, water pollution from point sources has decreased drastically. However, as

development has continued to spread throughout New Jersey, nonpoint source pollution has increased substantially in recent decades. NJDEP's new Stormwater Management Rules, described previously, focus on reducing and controlling nonpoint sources of water pollution. NJDEP utilizes an NJPDES stormwater general permit as the means to do this.

Table 15: Greenwich NJPDES Permits

NJPDES Permit Number	Facility Name	Effective Start Date	Expiration Date	Discharge Category Description	Street Address
NJG0137995	Greenwich Boatworks Inc	6/1/2007	5/31/2012	Basic Industrial Stormwater GP - NJ0088315 (5G2)	Pier 1
NJG0154083	Greenwich Twp	9/1/2005	2/28/2009	Tier B Municipal Stormwater General Permit	1000 Ye Greate St
NJG0141313	Hancock Harbor Marina	9/1/2003	5/31/2008	Sanitary Subsurface Disposal GP	30 Hancock Harbor Rd
NJG0111759	Hancock Harbor Marina	6/1/2007	5/31/2012	Basic Industrial Stormwater GP - NJ0088315 (5G2)	30 Hancock Harbor Rd
NJG0111759	Hancock Harbor Marina	6/1/2007	5/31/2012	Basic Industrial Stormwater GP - NJ0088315 (5G2)	30 Hancock Harbor Rd

Source: NJDEP, 2008

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.

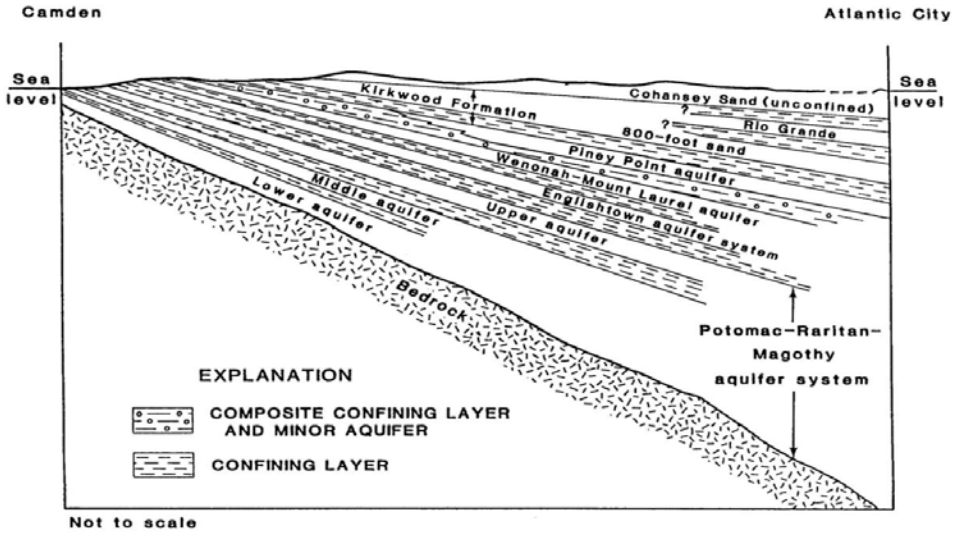
A cross section across southern New Jersey from west to east would show that the layers are not horizontal, but tilt downward toward the southeast, getting deeper as they cross the state toward the Atlantic Ocean. Because of this tilting, each layer formation emerges on the land surface in a sequential manner. The deepest formations emerge on the surface near the Delaware River. Where a formation emerges is its "outcrop" area. The Potomac-Raritan-Magothy (PRM) formation, the deepest and most abundant aquifer in the state, is a major water source for southern New Jersey communities. Other smaller aquifers on top of the PRM are the Englishtown, the Wenonah-Mount Laurel, and the Kirkwood-Cohansey. The Kirkwood-Cohansey is a formation composed of two thick layers, the Kirkwood (lower) and the Cohansey (upper), which overlie the older formations. It begins east of the inner/outer coastal plain divide.

Because Greenwich Township is situated entirely within the Outer Coastal Plain, the Kirkwood-Cohansey aquifer outcrops across the entire township. This aquifer is only about 50 feet thick in Greenwich. The underlying bed is composed of Shiloh Marl which outcrops in the wetlands areas along the western and southern borders.

Beneath the Kirkwood-Cohansey aquifer system is the Piney Point aquifer unit, with a depth of 125 to 175 feet and a thickness of 100 to 140 feet. Some wells in Greenwich may in fact be tapping the Piney Point aquifer, and this could become an important source of water in lieu of the more vulnerable Kirkwood-Cohansey. The Piney Point unit lies within the Navesink-Hornerstown confining unit, which has a depth of 100 to 150 feet and a thickness of 400 to 500 feet. The Navesink-Hornerstown confining unit is composed

of sands with a high silt and clay content. Beneath the Piney Point aquifer and its confining layers is the Wenonah-Mount Laurel aquifer, found at a depth of 500 to 650 feet and with a thickness of 90 feet. The confining unit below that aquifer is the Merchantville-Woodbury unit, located 600 to 800 feet below land surface. The Merchantville-Woodbury confining unit is less than 150 feet thick and has a high clay content. The deepest aquifer is the PRM aquifer system, which is 700 to 800 feet below the surface of Greenwich and is about 2,000 feet thick. Although the PRM is overly used in other parts of New Jersey, such as in the Camden area, it is too far beneath the surface in Cumberland County to be tapped. The underlying bedrock is about 2,500 to 3,000 feet beneath the township.

Figure 6 Aquifers of Southern New Jersey along a Line from Camden to Atlantic City



Source: USGS

Aquifers

Several aquifers underlie Greenwich Township, although only one–the Kirkwood-Cohansey Formation–outcrops and provides most, if not all, public and private drinking water for township residents.

Kirkwood-Cohansey Aquifer System

The Kirkwood-Cohansey aquifer is a major aquifer system underlying about 3,000 square miles of southern New Jersey on the Coastal Plain. It is an unconfined aquifer, which means that it is located on the surface and is not confined between two impenetrable layers. This aquifer is composed of the Kirkwood Formation and Cohansey Sand, both dating from the Miocene age. The Kirkwood Formation, along coastal areas, appears as thick clay beds, with interbedded zones of variable types of sand, clay, and gravel. The Cohansey Sand is made from coarser grained materials, predominantly light-colored quartz sand. It contains minor amounts of pebbly sand and interbedded clay. Some local clay beds within the Cohansey Sand are relatively thick.

The Kirkwood-Cohansey aquifer underlies the entirety of Greenwich Township. The Cohansey Formation outcrops in most upland areas of the township. Along the Delaware Bay coast and bordering the Cohansey River and Stow Creek, the Shiloh Marl Member outcrops. The surficial nature of the Kirkwood-

Cohansey makes it vulnerable to contamination from various land uses. Where possible, care must be taken to prevent contamination on the land surface because it can so easily enter the groundwater of this unconfined aquifer. In addition, it is important to site wells tapping the Kirkwood-Cohansey away from deleterious land use and contamination.

See **Map 12: Geologic Outcrops** on page 67 for a depiction of these land areas.

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 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 and rank land areas throughout the state by their groundwater recharge potential. Recharge is measured as the amount of precipitation that will reach the water table in one year.

Lands with groundwater recharge between 11 and 13 inches per acre per year, the highest rate in the township, cover about 7% (847 acres) of land in Greenwich Township. These lands are found mainly in the northeast corner around Sheppards Mill Pond as well as an area of steep slopes around Davis Mill Pond along Greenwich's northern border with Stow Creek Township. Another high recharge area is located around Ye Greate Streete near the Cohansey River. About 18% (2,024 acres) of Greenwich has a recharge rate of between 7 and 10 inches per year. These moderate recharge areas are found in the northeast part of the township. Another 22% (2,593 acres) of Greenwich has groundwater recharge of 2 to 6 inches per year, located mostly in the center of the township. More than half of the township, 53% (6,086 acres) has groundwater recharge of only zero to one inch per year. These areas are almost entirely covered by wetlands. See **Map 14: Groundwater Recharge** on page 69. Wetlands have a low recharge rate because they are a land area where the groundwater meets the land surface and therefore are already saturated.

Private Drinking Wells
Private wells, supplying potable water, are not routinely monitored like public community water systems (public water) and public noncommunity wells. Beginning in 2002, the State of New Jersey, under the Private Well Testing Act, required that well water be tested for contaminants when properties are sold or leased. Prior to 2002, each county health department mandated what parameters were to be tested for real estate transactions.

See **Appendix A: Private Well Testing Act** for more information about private wells and drinking water in Cumberland County.

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. Conversely, these are also regions where the dilution of substances like nitrates from septic systems 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 10 or more inches per year of groundwater recharge.

Water Supply Wells

Wells that provide drinking water are categorized as being either private or public water supply wells. Private water supply wells are those that serve less than 25 people and are not regulated by the EPA or DEP. Residents of Greenwich Township primarily obtain drinking water from private wells. On the other hand, public water supply wells, which may be publically 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% of the people in the United States with drinking water. Public water supply wells are further defined as being either community or noncommunity. A public community water supply well serves 15 or more service connections used by year-round residents or at least 25 year-round residents. Examples include municipalities, subdivisions, and nursing homes. There are no public community water supply wells in Greenwich Township, although there are four public noncommunity wells.

There are two types of public noncommunity water systems: transient and nontransient, which refers to their frequency of use. A transient noncommunity water system serves at least 25 people each day, but the population changes each day. These systems are at places such as rest stops, gas stations, and restaurants. A nontransient water system serves at least 25 of the same people daily at a minimum of six months per year, at places like schools, factories, and office parks. See ***Table 16: Public Non-Community Water Supply Wells*** below. All public wells in the area are shown on **Map 13: Public Water Supply Wells (2004)**.

Table 16: Public Non-Community Water Supply Wells

Public Water Supply ID	System Name	Municipality	Well Depth	Well Type
0606300	Morris Goodwin Greenwich	Greenwich	33	Non-transient
0606301	Bait Box Restaurant	Greenwich	55	Transient
0606303	Ship John Inn LLC	Greenwich	Unknown	Transient
0606304	Greenwich Country Store	Greenwich	Unknown	Transient

Source: NJDEP, 2004

Public water supply wells (both community and noncommunity) in the state are monitored by NJDEP on a regular basis. The following table outlines the monitoring schedule for the public water supply wells in Greenwich, which again are all public noncommunity wells. Levels of total coliform bacteria and nitrate are measured in all four wells; the well at the Morris Goodwin School is also measured for lead/copper, inorganics, and volatile organic compounds (VOCs).

Saline intrusion is known to be a significant problem in Greenwich Township and well drillers usually have trouble obtaining drinking water lacking saltwater. Due to this issue, wells in Greenwich Township tend to be very shallow and are usually between 40 and 55 feet, although older wells have been found to be as shallow as 17 feet. To avoid tapping such shallow groundwater, wells would have to be drilled as deep as 200 feet to access nonsaline water.[6]

[6] Personal communication with Danielle McKelvey, Environmental Specialist, Cumberland County Health Department, on March 6, 2009.

Table 17: 2009 Monitoring Schedule of Public Water Supply Wells

Water Facility	Contaminant	SDWIS Code	Monitoring Frequency	Population
Morris Goodwin Greenwich				
Distribution System (DS)	Total Coliform Bacteria	3100	quarter	Nontransient: 99 Transient: 4 From 1/1 to 12/31
	Lead/Copper		semiannual	
Treatment Plant (TP001001)	Inorganics		triennial	
	Nitrate	1040	annual	
	Volatile organic compounds		triennial	
Bait Box Restaurant				
Distribution System (DS)	Total Coliform Bacteria	3100	quarter	Nontransient: 2 Transient: 100 From 4/1 to 9/30
Well 1 (WL001001)	Nitrate	1040	quarter	
Ship John Inn LLC				
Distribution System (DS)	Total Coliform Bacteria	3100	quarter	Nontransient: 6 Transient: 100 From 1/1 to 12/31
Well 1 (WL001001)	Nitrate	1040	annual	
Greenwich Country Store				
Distribution System (DS)	Total Coliform Bacteria	3100	quarter	Nontransient: 2 Transient: 50 From 1/1 to 12/31
Treatment Plant (TP001001)	Nitrate	1040	quarter	

Source: NJDEP, 2009

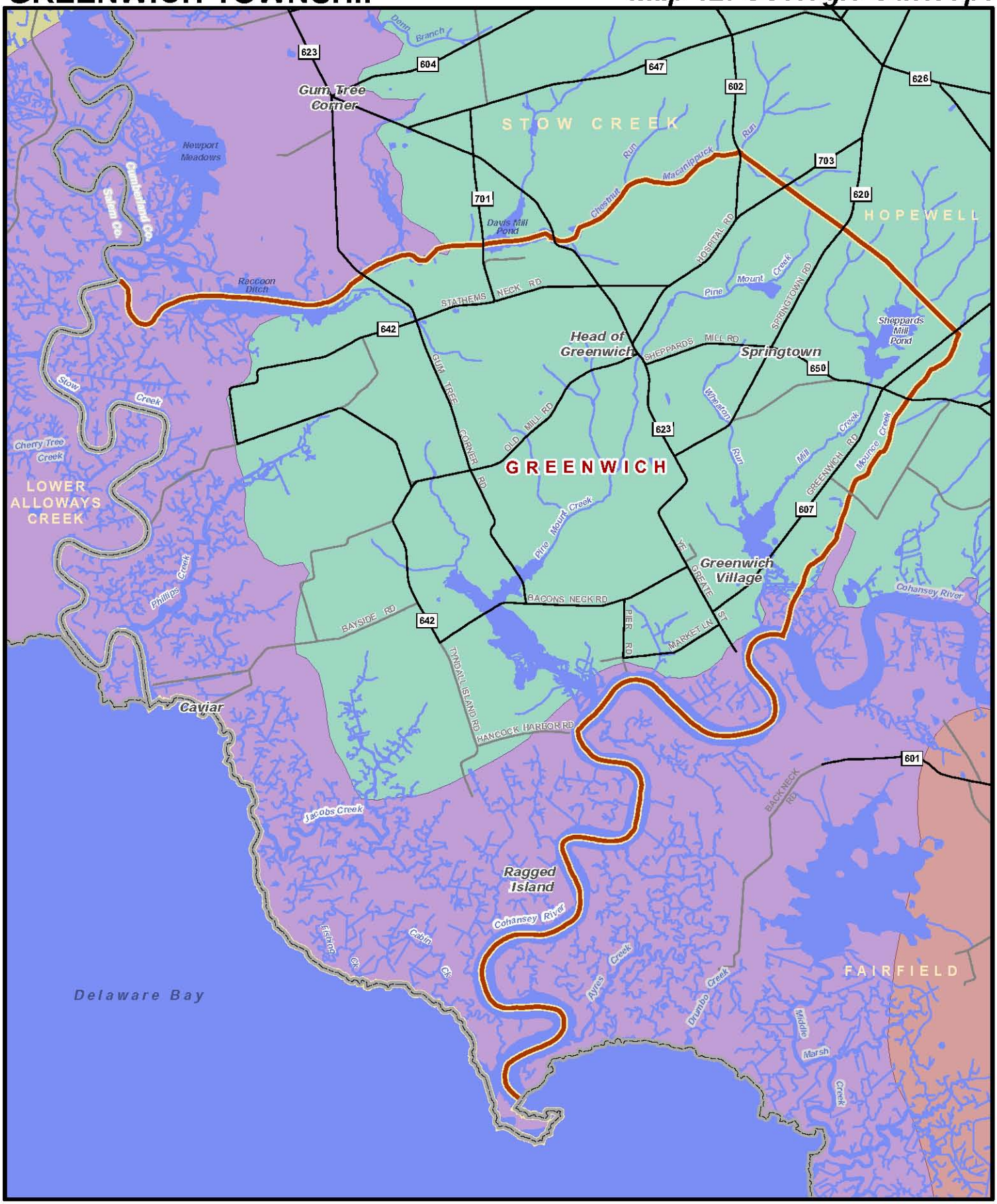
Wellhead Protection Areas

As part of its 1991 Well Head Protection Program Plan, the New Jersey Department of Environmental Protection has delineated Wellhead Protection Areas (WHPAs) around all community wells. A WHPA is the area from which a well draws its water within a specified time frame (tiers). Pollutants spilled directly on or near the wellhead will enter the water source within that time frame. Once delineated, these areas become a priority for efforts to prevent and clean up groundwater contamination. Other components of the Well Head Protection Plan include implementing best management practices to protect groundwater, land use planning, and education to promote public awareness of groundwater resources.

Once WHPAs are delineated, potential pollution sources may be managed by landowners or municipalities, in relation to the tier locations. Protection of land and restrictions on activities within wellhead zones, relating to uses that generate contaminants and to the storage, disposal, or handling of hazardous materials, are important for maintaining the quality of water within those zones.

GREENWICH TOWNSHIP

Map 12: Geologic Outcrops



Sources : NJDEP, NJDOT, DVRPC.
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.

Outcrop Formations

- Cohansey Formation
- Lower Member
- Shiloh Marl Member
- Wildwood Member

N

0 0.25 0.5 1
Miles

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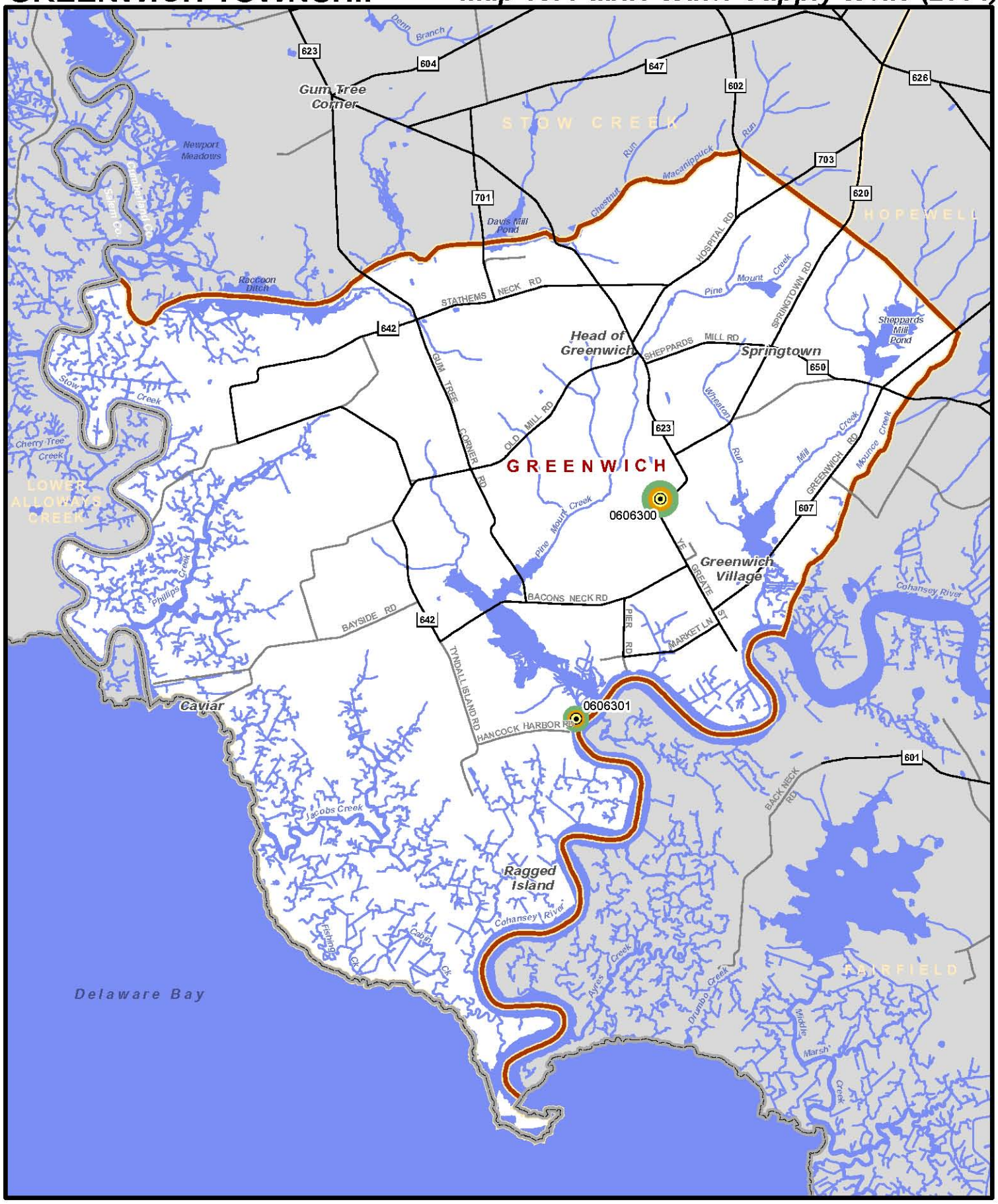
GREENWICH TOWNSHIP

Map 13: Public Water Supply Wells (2004)



Sources : NJDEP, NJDOT, DVRPC.
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.

Wellhead Protection Area

- 2-year time of travel
- 12-year time of travel
- 5-year time of travel
- Public Non-Community Well

**The following Greenwich public non-community wells are not located on the map: 0606303, 0606304*

N

0 0.25 0.5 1
Miles

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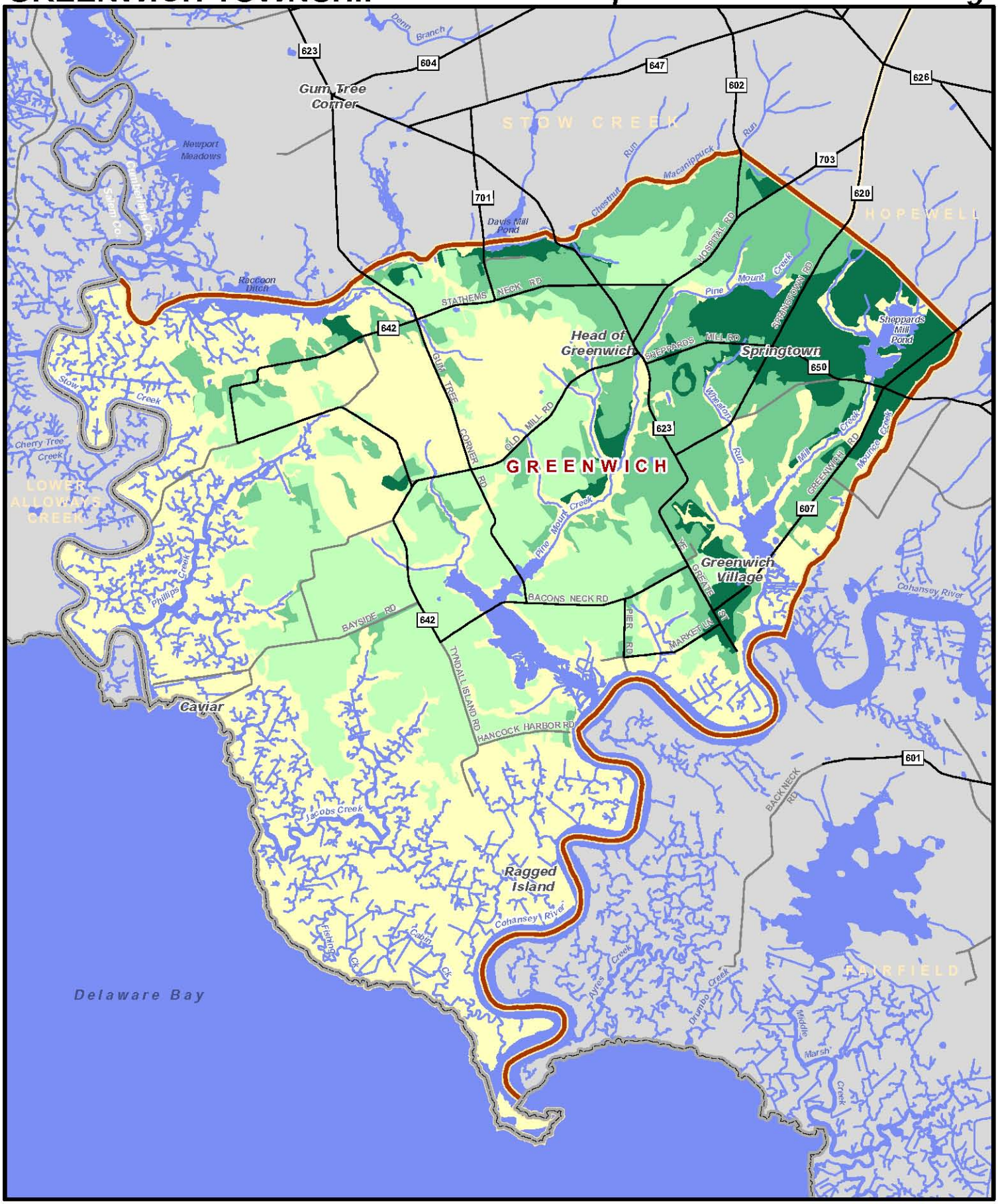
GREENWICH TOWNSHIP

Map 14: Groundwater Recharge



Sources : NJDEP, NJDOT, DVRPC.
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.

Inches per Year

0 - 1	7 - 10
2 - 6	11 - 13

N

0 0.25 0.5 1
Miles

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Delineating a Wellhead Protection Area (WHPA)

A WHPA consists of three tiers, each based on time of travel to the well:

Tier 1 = two years
Tier 2 = five years
Tier 3 = 12 years

Calculation of the tier boundaries is based on findings of how long specific contaminants can survive in groundwater, how much time would be required to undertake specific remedies, and the likelihood of natural dilution over distance. The tiers are shown as rings around a well, with the groundwater direction of travel factored in to create plume-like shapes.

There are two public noncommunity wells with wellhead protection areas in Greenwich, both of which draw from the Kirkwood-Cohansey aquifer system. See **Map 13: Public Water Supply Wells (2004)** on page 68. The radius of the WHPA depends on a number of factors related to the well and the underlying hydrogeology. The thicker and more porous the aquifer and the slower the pumping rate of the well, the smaller the radius is of the WHPA. Additionally, wellhead protection areas are determined by how many people are served by the well. In Greenwich, the unconsolidated coastal plain aquifers consisting of sand and gravel are very porous, and the wells serve a small population fewer than 100 people each, so the WHPAs are smaller than they would be in an area with bedrock aquifers, serving a denser population.

Air Quality

Air quality is one of the most difficult environmental resources to measure because its sources are diffuse and regional in nature. Sources of air pollution include industry, cars, trucks, and buses, fires, and dust. Air pollutants can travel extremely far from their sources. For example, the burning of coal to generate electricity in Ohio, Michigan, and Western Pennsylvania sends pollutants like sulfur, nitrogen, and particulate matter all the way to the East Coast. Locally produced sources of air pollution are caused daily by traffic and industrial complexes in New Jersey and Delaware.

CRITERIA POLLUTANTS

Ground-level ozone is formed when volatile organic compounds (VOC) and **nitrogen oxides** react with sunlight and heat. It is produced more in the summer months and is the primary constituent of smog. Ground-level ozone is a pulmonary irritant that, even in low levels, can be dangerous to sensitive populations, such as people with asthma or emphysema, and the elderly. It can also affect plant growth and is responsible for hundreds of millions of dollars in lost crop production.

Particulate matter (PM), or particle pollution, is made up of dust, ash, smoke, and other small particles formed from the burning or crushing of materials, such as wood, rocks, or oil. When ingested, particulate matter can lodge deep in the lungs and can contribute to serious respiratory illnesses, such as asthma or lung disease. Particulate matter also creates haze, reduces visibility, and covers buildings in dirty soot.

Increasing public awareness regarding air pollution led to the passage of a number of state and federal laws, including the original Clean Air Act of 1963 and a much stronger Clean Air Act of 1970 (CAA). In 1990, the CAA was amended and expanded by Congress to include a market approach to reducing air pollution by allowing certain companies to buy and sell emission “allowances,” or “credits.” The 1990 CAA also required transportation projects receiving federal funding to be in conformity with state air-quality goals. The 1990 CAA also revised the way that air toxins are regulated, increasing the number of regulated toxic air pollutants from seven to 187.

In 1970, the US EPA was formed to enforce the CAA. In New Jersey, the US EPA allowed NJDEP to enforce the CAA because the state agency developed more stringent air standards and created a State Implementation Plan (see NJAC 7:27). The CAA identified six *criteria* pollutants–ozone, particulate matter, sulfur dioxide, nitrogen oxides, carbon monoxide, and lead–that are destructive to human health and to the built and natural environment. The EPA sets National Ambient Air Quality Standards (NAAQS) for these pollutants.

Between 1970 and 2007, total emissions of the six criteria air pollutants decreased by more than 50%. The industrial sector reduced its toxic air emissions by 70% during this time period. Stricter emissions standards in the auto industry have made cars 90% "cleaner" since 1970. Cars also pollute less because refineries are required to produce cleaner fuels; leaded gasoline was completely banned in 1996.

Under the CAA, the EPA limits the amount of other air pollutants and toxins that are emitted by point sources, such as chemical plants, industrial factories, power plants, and steel mills. The NJDEP Air Quality Permitting Program issues permits for stationary sources of air pollution, such as power plants, oil refineries, dry cleaners, food processing centers, and manufacturing plants, and regulates and monitors their emissions. There is only one active air-quality permit in Greenwich Township, the Hancock Harbor Marina (PI# 75565).

NJDEP enacted the Emission Statement Rule in 1992, requiring certain sites that have an air-quality permit to report specific air contaminants, including carbon monoxide (CO), sulfur dioxide (SO_2), ammonia (NH_3), total suspended particulate matter (TSP), respirable particulate matter (PM_{10} and $PM_{2.5}$), lead (Pb), volatile organic compounds (VOC), nitrogen oxides, and 38 other toxic air pollutants. Greenwich does not have any facilities that are required to submit emission statements.

NJDEP's Bureau of Air Monitoring maintains a network of 43 continuous monitoring stations across the state, most of which are clustered in the New York metropolitan area. These stations continually monitor some or all of seven parameters–carbon monoxide, nitrogen oxides, ozone, sulfur dioxide, smoke shade, particulate matter, and meteorological data. EPA and, when enabled, NJDEP have set NAAQS for the six criteria pollutants. There are two kinds of NAAQS: the primary standard is based on human health effects, while the secondary standard is based on environmental and property damage. The continuous monitoring station closest to Greenwich

CRITERIA POLLUTANTS continued

Carbon monoxide (CO) is a colorless, odorless gas that is formed when carbon in fuel is not burned completely. It is a component of motor vehicle exhaust; therefore, higher levels of CO generally occur in areas with heavy traffic congestion. The highest levels of CO typically occur during the colder months, when air pollution becomes trapped near the ground beneath a layer of rising warm air.

Nitrogen oxides are a group of highly reactive gases that contain nitrogen and oxygen in varying amounts. Motor vehicles, electric utilities, and homes and businesses that burn fuels emit nitrogen oxides; they can also be found naturally. Nitrogen oxides are primary components in ground-level ozone (smog), acid precipitation, and other toxic chemicals. Acid precipitation can cause lung ailments in humans, property damage, harm to aquatic life, and other environmental and human health problems.

Sulfur dioxide (SO_2) is released into the atmosphere when fuel containing sulfur, such as coal and oil, is burned, and when gasoline refined from oil is combusted. SO_2 dissolves in water vapor to form acid precipitation.

Lead (Pb) is a pollutant that was historically released by cars and trucks burning leaded fuel, but metal-processing plants and trash incinerators are the major source of emissions today. Lead tends to be a localized air pollutant, found in urban or high-traffic areas, and is deposited in soil and water, harming fish and wildlife.

Township is located in Millville, and it measures nitrogen oxides, ozone, and sulfur dioxide. The most recent data from this station is described below.

Nitrogen Dioxide and Nitrogen Oxides

The primary and secondary NAAQS for nitrogen dioxide are both an annual average of 0.053 ppm. The New Jersey standards are the same, although they are measured on any 12-month period, not just the calendar year. According to the 2005 Air Quality Report, the Millville station recorded an annual average of 0.013 ppm of nitrogen dioxide and 0.011 ppm of nitrogen oxides, well within the standard of 0.053 ppm.

Ground-level Ozone

The amount of ozone has decreased greatly in New Jersey since the 1980s, and one-hour concentrations have not exceeded 0.200 ppm since 1988. For ground-level ozone (O_3), there are two NAAQ standards: (1) a one-hour concentration of 0.12 ppm, and (2) an eight-hour average concentration of 0.08 ppm. For the national standards, these are the same for both primary and secondary effects. New Jersey, however, has tightened the one-hour concentration standard for secondary effects to 0.08 ppm. In 2005, the Millville station exceeded the one-hour maximum concentration of 0.12 ppm on one day, when its ground-level ozone measured 0.127 ppm, exceeding both the primary and secondary standards for New Jersey. Five of the 14 sites in New Jersey that measure ground-level ozone also exceeded the one-hour standard in 2005. Millville had four days in 2005 that exceeded the eight-hour standard of 0.08 ppm. The four highest eight-hour averages were 0.110, 0.092, 0.088, and 0.085 ppm. In 2005, all 14 sites in the state had at least three days that exceeded the eight-hour standard.

Photo by Mike Ivanick

Air quality in Greenwich is within most standards.

Sulfur Dioxide

There are three NAAQS for sulfur dioxide: (1) a yearly average of 0.030 ppm for primary effects; (2) a 24-hour average of 0.140 ppm, which cannot be exceeded more than once a calendar year, also for primary effects; and (3) a three-hour average of 0.5 ppm, which also cannot be exceeded more than once a calendar year for secondary effects. New Jersey's standards are slightly different in that they use a rolling year unit instead of a calendar year. The yearly average level of sulfur dioxide at the Millville station in 2005 was 0.004 ppm, the maximum 24-hour average was 0.015 ppm, and the maximum three-hour average was 0.025 ppm. All of these levels for Millville were well below the state and national standards and were also below state averages.

Particulate Matter

For Fine Particulates ($PM_{2.5}$), there are two NAAQS for primary and secondary effects: (1) an annual average of 15 micrograms per cubic meter ($\mu g/m^3$) and (2) a 24-hour maximum of 65 $\mu g/m^3$. Particulate matter was added as a parameter at the Millville station in 2005, although testing was not conducted for the entire year. The Millville site in 2005 had an annual average of 13 $\mu g/m^3$ and a 24-hour maximum of 47 $\mu g/m^3$. However, this site operates at the neighborhood scale, which is representative of one to 10 kilometers from the site and does not encompass Greenwich.

Air-Quality Index

The EPA created the Air-Quality Index (AQI) to indicate a region's air quality by measuring levels of five of the six criteria pollutants (excluding lead). The AQI is focused on the potential human health hazards experienced by breathing unhealthy air. Scores for the AQI range from 0 to 500 and are divided into six color-coded categories:

Figure 7: Air-Quality Index (AQI)

Numerical Air Quality Index (AQI) Rating	Descriptive Rating	AQI Color Code
0 to 50	Good	Green
51 to 100	Moderate	Yellow
101 to 150	Unhealthy for Sensitive Groups	Orange
151 to 200	Unhealthy	Red
201 to 300	Very Unhealthy	Purple
301 to 500	Hazardous	Maroon

Source: NJDEP 2005

The daily score is based on the highest individual pollutant score that is reported. For example, if ozone scored 150 and particulate matter scored 100, the daily AQI would be 150 – Unhealthy for Sensitive Groups. The index is used to measure overall air quality by counting the number of days per year when the AQI of each region exceeds 100.

New Jersey is subdivided into nine regions, which report their respective AQI. Greenwich Township is located in Region 9, which covers Salem and Cumberland counties. The monitoring station for this region is located in Millville. The AQI for Region 9 is based on three pollutants: nitrogen dioxide, ozone, and sulfur dioxide. In 2005, Region 9 reported 278 good days, 82 moderate days, four days that were unhealthy for sensitive groups, one unhealthy day, and no very unhealthy or hazardous days.

Other Monitoring

In addition to the continuous monitoring network, the NJDEP Bureau of Air Monitoring operates a manual monitoring network that measures a greater number of parameters. At these stations, samples are taken that are then analyzed in a laboratory for different sizes of particulate matter, lead, total suspended particulates, atmospheric deposition, ozone precursors, and a number of toxic pollutants. These stations are located across the state, but are generally concentrated in the New York metropolitan region. The two closest stations to Greenwich are located approximately 64 kilometers (40 miles) away, in Hammonton (Winslow Township, Camden County) and Gibbstown (Greenwich Township, Gloucester County). The Gibbstown site measures particulate matter on a neighborhood scale (one to 10 kilometers), which is not relevant to Greenwich. The Ancora State Hospital site in Hammonton measures wet acid deposition on an urban scale (10 to 100 kilometers), which encompasses Greenwich. In 2005, the average pH value measured at this site was 4.57, which is more acidic than normal precipitation, which has an average pH of 5.6.

CHAPTER 4

BIOLOGICAL RESOURCES

When a community protects wildlife and habitat, it is also protecting biodiversity, which enables many species, including humans, to thrive and live healthy lives. Biodiversity refers to the variety of genetic material within a species population, the variety of species (plants, animals, microorganisms) within a habitat, and the variety of ecosystems within a given region. Biodiversity facilitates adaptation and evolution, improving a species' chance of survival as the environment changes. A diversity of plant and animal species is also necessary to maintain healthy human environments, working landscapes, and productive ecosystems. Lower organisms, many 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 difficult for an ecosystem to recover or replace species.

Photo by Carey Hedlund

There are many hawks found in Greenwich.

Greenwich contains numerous types of natural habitats, all of which are important for maintaining biodiversity. Wetlands, which support plants that require constantly saturated soils, are the most abundant type of natural habitat in Greenwich. Most of these wetlands are saline marshes bordering the Delaware Bay, Stow Creek, and the Cohansey River. Grasslands cover a significant portion of the center of the township. Upland forests cover a smaller area of land and are located mostly in the northeast corner and northern border of Greenwich. Within and around Greenwich's water bodies are submerged communities, such as oyster beds, which require persistent standing water. The following sections will identify and describe in more detail the plant and animal communities that inhabit these ecosystems within Greenwich.

Natural Vegetation

An area's vegetation is dependent on many factors, the most important of which are climate and soils. The region has a cool, temperate climate, with rainfall averaging 46 inches per year. See the **Climate** section on page 34 for a detailed description of Greenwich's variable climate. About half of Greenwich's soils are at least moderately well-drained soils, supporting a diversity of trees and crops. The area also has a substantial amount of poorly drained soils that exhibit ponding and sustain aquatic plants in both

freshwater and saltwater wetlands. See the **Soils** section beginning on page 22 for a detailed description of Greenwich's soils.

Greenwich's natural vegetation types, along with human-influenced types of land cover, have been tabulated and mapped by NJDEP's 2002 land cover analysis. This data, based on infrared aerial photography, is the most recent available. The designation of a particular land cover as a vegetation type is based on definitions provided by the Anderson Land Use Classification System, created by the U.S. Geologic Survey. See ***Table 18: Greenwich Natural Vegetation*** below and **Map 15: Natural Vegetation (NJDEP 2002)** on page 83.

Table 18: Greenwich Natural Vegetation

Type of Vegetation	Acres	Percentage of Total Land
Beach	14.1	0.1%
Brush/Shrubland	200.5	1.7%
Brush/Shrubland - Oldfield	42.4	0.4%
Upland Forest - Coniferous	97.2	0.8%
Upland Forest - Deciduous	948.0	7.9%
Upland Forest - Mixed (Coniferous Dominated)	87.7	0.7%
Upland Forest - Mixed (Deciduous Dominated)	55.0	0.5%
Wetlands - Coastal (Phragmites Dominated)	194.3	1.6%
Wetlands - Herbaceous	27.8	0.2%
Wetlands - Modified	279.5	2.3%
Wetlands - Phragmites Dominated	62.2	0.5%
Wetlands - Saline Marshes (High Vegetation)	39.3	0.3%
Wetlands - Saline Marshes (Low Vegetation)	3,255.0	27.3%
Wetlands - Scrub/Shrub	209.0	1.8%
Wetlands - Wooded - Coniferous	7.0	0.1%
Wetlands - Wooded - Deciduous	835.9	7.0%
Wetlands - Wooded Mixed (Coniferous Dominated)	112.6	0.9%
Wetlands - Wooded Mixed (Deciduous Dominated)	120.8	1.0%
Tidal Waters	901.0	7.5%
Total	**7,489.6**	**62.7%**

Source: NJDEP, 2002

Wetlands

Wetlands are a critical ecological resource, supporting avian, terrestrial, and aquatic wildlife, and boasting biological productivities far greater than those found on dry land. Wetlands play a vital role in maintaining water quality by cleaning surface and ground waters. The ecological importance of wetlands, however, has not always been appreciated. For over three centuries, people drained, dredged, filled, and leveled wetlands to make room for development and agriculture. Although the pace of wetland destruction has slowed markedly in the past three decades, human activities have destroyed approximately 115 million of the original 221 million acres of wetlands in the United States since the beginning of European settlement. However, Greenwich is distinctive for having a minimal loss of wetlands.

Wetlands are the most common land use classification in Greenwich Township, covering 43% of the township's total land, or 5,144 acres. Most wetlands in Greenwich are found in association with waterways, including the Cohansey River, the Delaware Bay, Stow Creek, Pine Mount Creek, and Mounce Creek. Saline wetlands are dominant in the west and southwest, and there is a large area of freshwater wooded wetlands in the north-center of the township. Wetlands provide high-quality animal and plant habitat, purify surface and groundwater, and create picturesque landscapes that add immeasurably to the quality of life for area residents. Many of the wetlands in Greenwich Township are protected and maintained through PSE&G's Estuary Enhancement Program, which is discussed in the **History** section on page 11.

As defined by the Anderson Land Use Classification System, Greenwich has 10 types of unmodified wetlands. By far, the most dominant type of these is saline marshes with low vegetation, which cover 27% of Greenwich's total land. These saltwater tidal marshes support vegetation, such as salt hay, cordgrass, giant foxtail, coast flatsedge, and cylindrical-headed bulrush, as well as invasive species, such as *Phragmites.*

In addition to these saline tidal marshes, Greenwich contains a good deal of inland freshwater wetlands. The second most common type of unmodified wetlands is freshwater deciduous wooded wetlands, which cover 7% of the total land in the township. All other types of unmodified wetlands each cover less than 2% of the land in Greenwich. Freshwater wetlands along stream corridors contain vegetation such as smartweed, wild rice, wild millet, cordgrass, duckweed, and cattail. See ***Table 18: Greenwich Natural Vegetation*** for a detailed list of unmodified wetlands in the township.

Greenwich's deciduous wooded wetlands are concentrated roughly between Stathems Neck Road (Route 642) and Old Mill Road (Route 703) in the northern part of the township, but are also found in low-lying areas along freshwater stream corridors. Deciduous wooded wetlands occupy 836 acres of Greenwich and support mixed hardwoods that flourish in low elevations. Some common trees in the area's deciduous wooded wetlands are red maple, black tupelo, ash, black willow, American beech, swamp white oak, willow oak, southern red oak, and sweetgum.

Photo by Matt Blake

Most wetlands in Greenwich are saline marshes.

Closely associated with freshwater deciduous wooded wetlands are deciduous or deciduous-dominated mixed scrub/shrub wetlands, occupying 209 acres (2%) of the township. These areas are generally composed of young, medium-height woody plants. In these wetlands, vegetation is composed of over 75% deciduous species. Associated with scrub/shrub wetlands are tree species such as red maple, dogwood, sweetgum, sassafras, persimmon, and red cedar. Like scrub/shrub wetlands habitat, deciduous wooded wetlands are also characterized by shrub species like silky dogwood, red-osier dogwood, gray dogwood, mimosa,

southern arrowhead, hazel alder, buttonbush, clethra, spicebush, sumac, amelanchier, and high bush blueberry.

Freshwater herbaceous wetlands cover only 284 acres, or 2% of the total land. Two types of herbaceous wetlands exist. By far the largest are *Phragmites*-dominated wetlands, covering 257 acres. This plant, also called the common reed, is considered an invasive species and colonizes easily. It pushes into wetland areas from adjoining dryer land, growing through underground shoots that make it difficult to eradicate. As it spreads, it tends to trap silt and gradually to raise the land level, converting the habitat to one that is dryer. This conversion, plus its manner of growth, enables *Phragmites* to push out other wetland species of plants. *Phragmites* are found throughout the township around Wheaton Run, Mill Creek, Mounce Creek, Pine Mount Creek, the Cohansey River, and small tributaries, as well as throughout the Bayside tract.

The second type of freshwater herbaceous wetland includes plants such as Jack-in-the-pulpit, jewelweed, ferns, rice cutgrass, reed canary grass, pond lily, tearthumb, cordgrass, and cattail. In Greenwich, herbaceous wetlands are rare, occupying only 28 acres of the combined land area. Herbaceous wetlands are scattered in very small areas around the edges of saline marshes and in the northeast part of the township in and around upland forest areas near streams.

Modified wetlands are areas that have been altered by human activities and do not support natural wetland vegetation, but do show signs of soil saturation on aerial infrared surveys. Agricultural wetlands, described in some detail on page 44, occupy 216 acres (2%) of the land that is now under cultivation. This figure may be larger because not all modified agricultural wetlands show well on aerial infrared photos. Other modified wetlands encompass former agricultural wetlands, disturbed wetlands, and wetlands that occur in maintained greenspaces, such as open lawns, golf courses, and storm water swales. Disturbed land is particularly prone to invasive species such as *Phragmites,* Japanese honeysuckle, multiflora rose, and Japanese knotweed. In total, modified wetlands occupy 280 acres, or 2.3% of Greenwich's land area.

Upland forests cover 10% of the land in Greenwich.

Upland Forests

Upland areas are those locations without water at or near the soil surface. About 10% (1,188 acres) of Greenwich is composed of upland forests, most of which are located in the northeast portion of the township and the northern border with Stow Creek. There are some smaller areas of upland forest around Pine Mount Creek in the center of the township.

Upland forests are the third most abundant land cover type in Greenwich after wetlands and agriculture. The vast majority of upland forest in Greenwich is composed of deciduous forest. The composition of Greenwich's upland deciduous forests is largely one of mixed oaks, such as black, red, chestnut, blackjack, scarlet, pots, white, scrub, and willow oaks. Other hardwoods include American beech, hickory, and sweetgum. Along stream corridors, the Atlantic white cedar and holly tree can also be found. The understory is dominated by flowering dogwood, American holly,

greenbriar, and sassafras. Vines, such as Virginia creeper, wild grapes, Japanese honeysuckle, and poison ivy, are common. Spicebush, arrowwood, high bush blueberry, amelanchier, and black haw are common shrubs in moister locations.

About 97 acres of Greenwich are covered in coniferous upland forests. Some are a distinct reflection of the Pinelands ecosystem, particularly in the areas around Sheppards Mill Pond. These forests are mostly made up of successional, or pioneer, plants–like Virginia pine, scrub pine, and pitch pine–that will eventually be overgrown by dominant deciduous trees, such as ash, oak, and hickory.

Grasslands and Agricultural Lands

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 three to 20 years. Later, woody plants take over. This habitat is visible along wood edges, roadsides, and in landscapes where mowing is infrequent and where woody plants are not yet the dominant vegetation. Grasslands are also highly susceptible to invasive species.

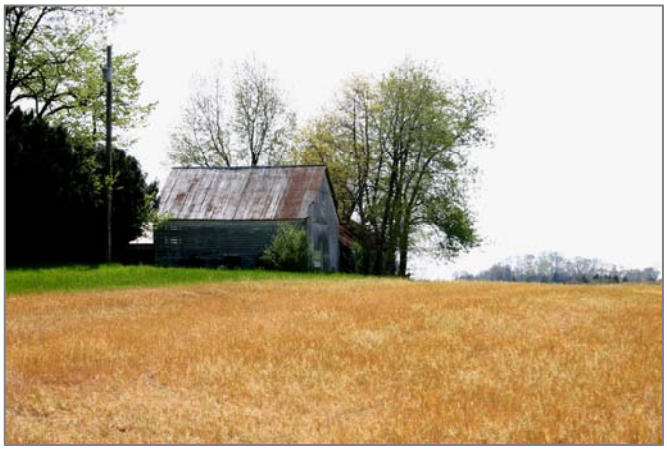


Photo by DVRPC

Thirty-two percent of land in Greenwich is agricultural.

According to 2002 NJDEP land cover data, about 2% of Greenwich's land cover consists of brushland, shrubland, or old fields. Old fields are sections of Greenwich's farmland that have become idle and have transitioned to land suitable for grassland and brushland species habitat. Brushland and shrubland are scattered in small patches throughout the township.

In addition to brushland and old fields, active agricultural cropland and pastureland is suitable "grassland" habitat for wildlife. Agricultural cropland and pastureland is the second most abundant type of vegetative land cover in Greenwich Township, covering about 32% (3,837 acres) of the township's total land area in 2002.

Landscape Project Priority Habitats

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 (five being the highest). Categories three through five are "critical" habitats throughout the state, which 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." Category two habitats have one or

Photo by DVRPC

The majority of land in Greenwich is habitat for rare species.

more occurrences of at least one nonlisted state priority species, and category one area habitat is deemed suitable for species that are included 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 Greenwich. It is important to preserve both levels of habitat in order to maintain the diversity of species that still exists in the area. The rankings in Greenwich are primarily the result of habitat being either “critical” or “suitable” for rare bird species, such as the bald eagle, osprey, northern harrier, or red-shouldered hawk, or for endangered reptiles and amphibians. See ***Table 19: Landscape Project Habitat - Acreage in Greenwich*** and **Map 16: Landscape Project Priority Habitats (2007)**.

Landscape Project Data on Wetland Habitat

The Landscape Project divides wetland habitats into two types–emergent and forested wetlands. Emergent wetlands are marshy areas characterized by low-growing shrubs and herbaceous (nonwoody) plants in standing water. About 32% (3,816 acres) of all land in Greenwich is identified as emergent wetlands habitat, of which 3,205 acres are ranked at the “critical” level, and 611 acres are ranked at the “suitable” level. Emergent wetland habitat is found mainly in a swath extending from around Raccoon Ditch on the northern border with Stow Creek Township, along Stow Creek, and continuing along the Delaware Bay and the Cohansey River. Animal species that can be found in these wetland habitats include endangered turtles, rare fish, mollusks, crustaceans, and insects. Emergent wetlands are also important habitats for migratory and resident waterfowl, as well as passerines, or smaller perching birds. Common waterfowl species include the Great Blue Heron, the Green Heron, egrets, rails, and shorebirds, such as terns, gulls, and willets. Passerine species found in Greenwich include migrating flycatchers and thrushes, and resident species, like sparrows, warblers, marsh wrens, and red-winged

Photo by Mike Ivanick

Egrets are commonly found in Greenwich.

blackbirds. Threatened and endangered birds found in Greenwich's wetlands include the bald eagle, the Northern harrier, the red-shouldered hawk, and the Osprey.

The Landscape Project designates Greenwich's forested wetlands as occupying 11% (1,265 acres) of the total land in the township, of which 968 acres are ranked as critical. Forested wetland critical habitat is located primarily between Stathems Neck Road (Route 642) and Old Mill Road (Route 703) in the northern part of the township, as well as on the edges of Pine Mount Creek. A large area of forested wetland suitable habitat is located to the west of Tindall Island Road, between Old Mill Road and Wheaton Island Road. Forested wetlands support many migratory and resident species and provide hunting grounds for various owls, hawks, and eagles.

Table 19: Landscape Project Habitat Rankings – Acreage in Greenwich

Category	Rank	Area (Acres)	% of Total Habitat	% of All Land
Emergent Wetlands	Critical Habitat (4)	3,140.62	30.35%	26.31%
	Critical Habitat (3)	64.23	0.62%	0.54%
	Suitable Habitat (2)	610.66	5.90%	5.12%
		3,815.50	***36.87%***	***31.97%***
Forested Wetlands	Critical Habitat (4)	968.17	9.36%	8.11%
	Suitable Habitat (2)	296.36	2.86%	2.48%
		1,264.53	***12.22%***	***10.59%***
Upland Forest	Critical Habitat (4)	1,200.28	11.60%	10.06%
	Suitable Habitat (2)	243.26	2.35%	2.04%
		1,443.54	***13.95%***	***12.09%***
Grasslands	Critical Habitat (4)	3,605.94	34.85%	30.21%
	Suitable Habitat (2)	204.08	1.97%	1.71%
		3,810.02	***36.82%***	***31.92%***
Beach	Critical Habitat (3)	3.98	0.04%	0.03%
	Suitable Habitat (1)	10.15	0.10%	0.09%
		14.13	***0.14%***	***0.12%***
Total Priority Habitats		**10,347.73**	**100.00%**	**86.70%**
Total Greenwich Land		**11,935.69**		**100.00%**

Source: NJDEP, 2008

Table 20: Explanation of Landscape Project Habitat Rankings

Rank	Description
5	■ Area contains one or more occurrences of at least one wildlife species listed as endangered or threatened on the federal list of endangered and threatened species.
4	■ Area contains one or more occurrences of at least one state endangered species.
3	■ Area contains one or more occurrences of at least one state threatened species.
2	■ Area contains one or more occurrences of species considered to be species of special concern.
1	■ Area meets habitat-specific suitability requirements, such as minimum size criteria for endangered, threatened, or priority wildlife species, but does not intersect with any confirmed occurrences of such species.

Source: NJDEP, 2008

Landscape Project Data on Upland Forest Habitat

The Landscape Project ranks more than 12% (1,444 acres) of Greenwich's total land cover as upland forest habitat. Of this, 1,200 acres are ranked as "critical" upland forest habitat. Upland forest habitat can be found mostly in the northeast portion of the township, as well as along Chestnut and Macanippuck runs on the northern border with Stow Creek Township. There are also some upland forest areas around Pine Mount Creek and interspersed among the forested wetlands area. Upland forest in Greenwich is home to the endangered bald eagle and red-shouldered hawk, as well as other bird species of regional priority, such as the Brown Thrasher and the Wood Thrush.

Photo by Matt Blake

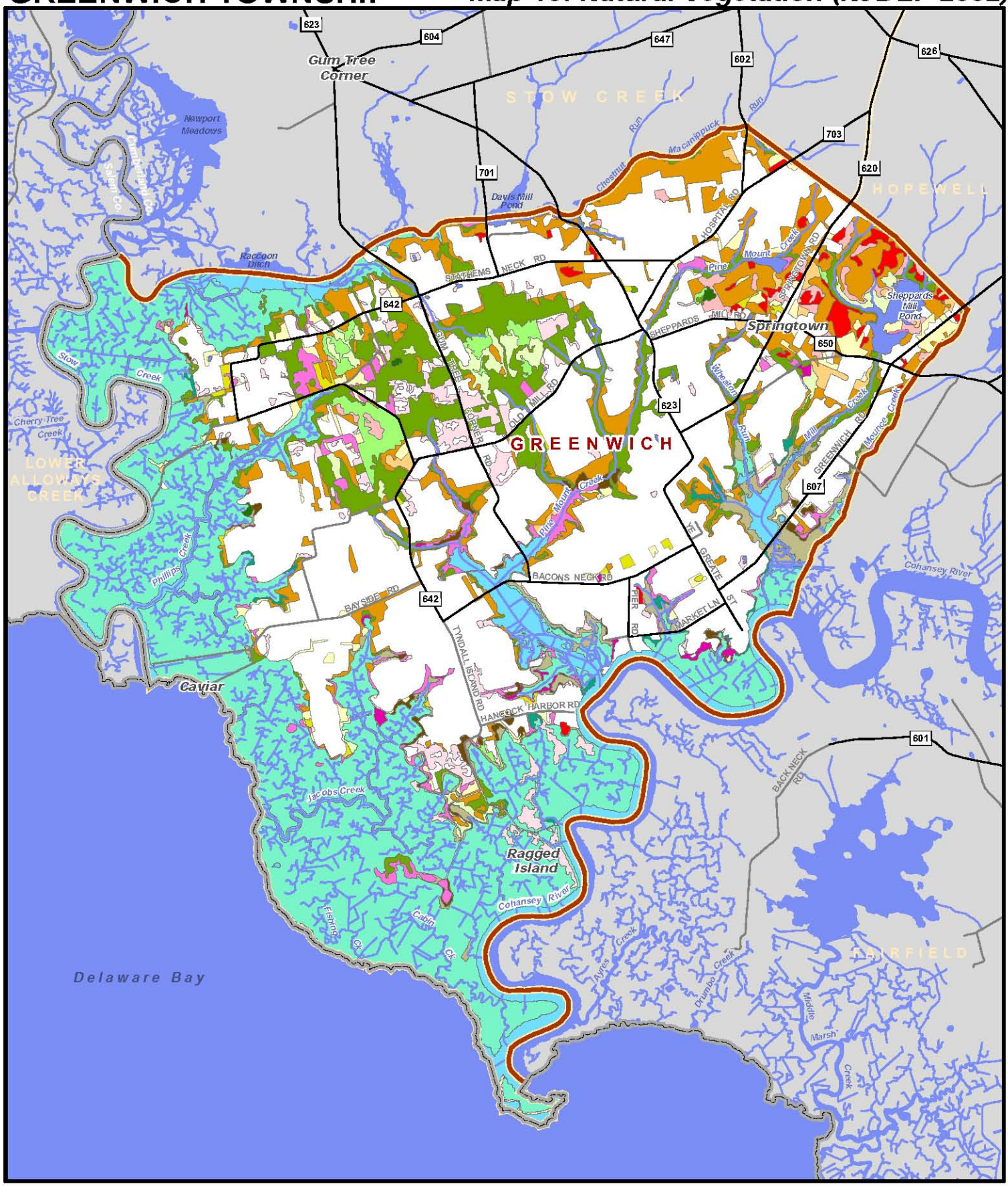
Grassland provides critical habitat for many rare birds.

Landscape Project Data on Grassland-Species Habitat

Another 3,810 acres (32%) of Greenwich is classified as "suitable" or "critical" grassland-species habitat. Most of this is ranked at the critical level (3,606 acres). Grassland-dependent species (mostly birds) are the most threatened group of species in New Jersey, primarily because the most common form of habitat used by these species–agricultural fields–is the most threatened habitat in the state due to development pressure, rising land values, and changing agricultural practices. "Critical" habitat is located throughout the center of the township, while "suitable" habitat is mainly located to the east around Wheaton Run and Mill Creek, where land is more developed.

GREENWICH TOWNSHIP

Map 15: Natural Vegetation (NJDEP 2002)



Vegetation

- Brush/Shrubland
- Brush/Shrubland - Oldfield
- Upland Forest - Coniferous
- Upland Forest - Mixed (Conif. Dom.)
- Upland Forest - Deciduous
- Upland Forest - Mixed (Decid. Dom.)
- Water
- Beach
- Tidal Waters
- Wetlands - Saline Marshes (High Vegetation)
- Wetlands - Saline Marshes (Low Vegetation)
- Wetlands - Coastal (Phragmites Dominated)
- Wetlands - Phragmites Dominated
- Wetlands - Modified
- Wetlands - Scrub/Shrub
- Wetlands - Herbaceous
- Wetlands - Wooded - Coniferous
- Wetlands - Wooded Mixed (Conif. Dom.)
- Wetlands - Wooded - Deciduous
- Wetlands - Wooded Mixed (Decid. Dom.)
- All Other Land Cover

Sources : NJDEP, NJDOT, DVRPC.
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.

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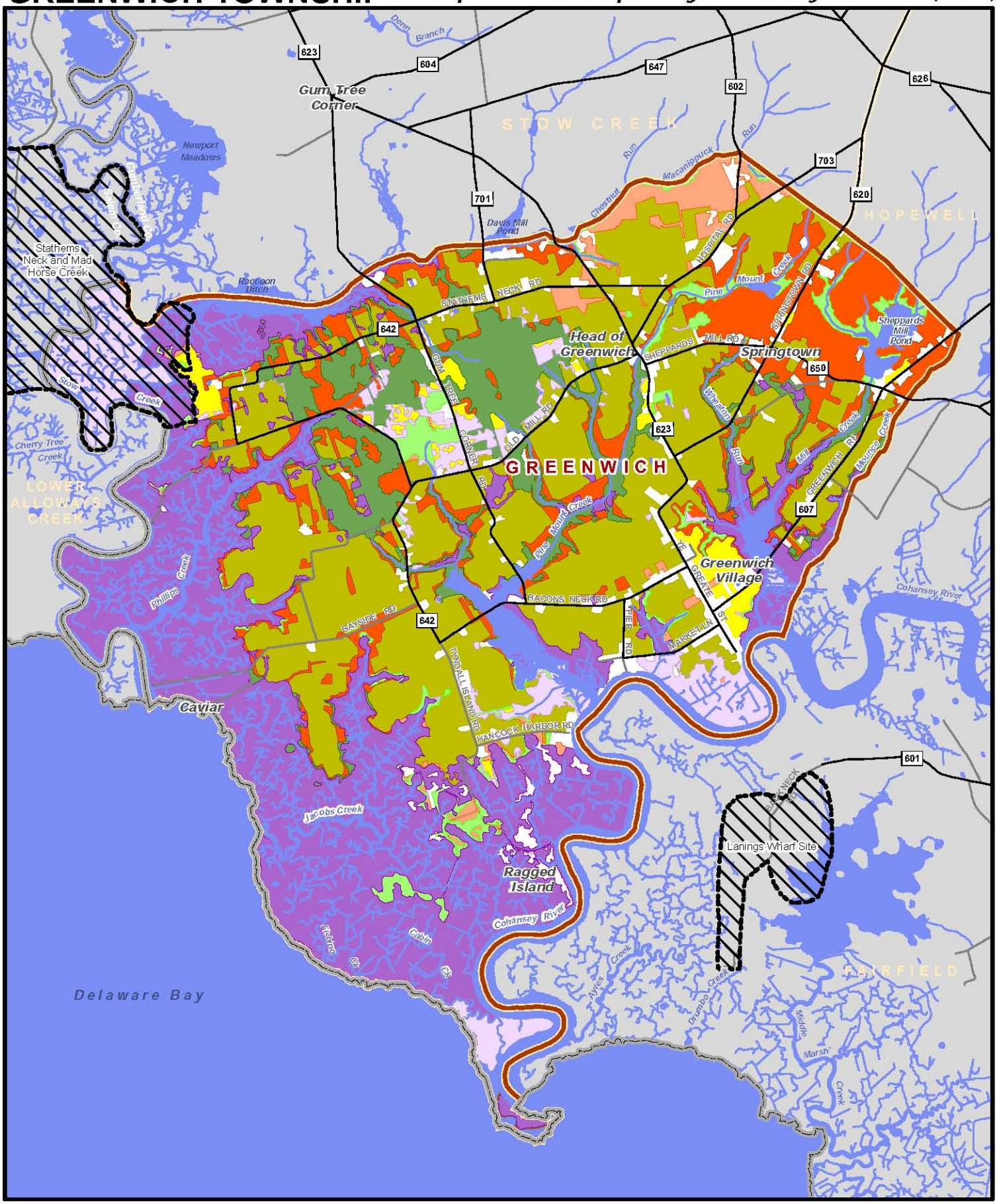
Miles

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

GREENWICH TOWNSHIP

Map 16: Landscape Project Priority Habitats (2007)



Sources : NJDEP, NJDOT, DVRPC.
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.

Conservation Priority Type

Emergent Wetlands	Forested Wetlands	Upland Forest	Grasslands
Critical Habitat	Critical Habitat	Critical Habitat	Critical Habitat
Suitable Habitat	Suitable Habitat	Suitable Habitat	Suitable Habitat

Natural Heritage Site

Beach

Critical Habitat

Suitable Habitat

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0 0.25 0.5 1

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DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

Nearly all of Greenwich's agricultural land is designated as "critical" or "suitable" grassland-species habitat, whether under cultivation or not, for some of the following reasons: (1) migrating birds cannot visually distinguish cropland from grassland; (2) cropland turns into grassland when it is fallow for one year or more; (3) some crops, like alfalfa and soybeans, provide suitable nesting habitat for some birds, especially for sparrows; and (4) all or most of the birds on the endangered and threatened lists are area sensitive, requiring large ranges that include agricultural lands. The Landscape Project includes this land in its assessment because agricultural lands provide important disturbance buffers for rare wildlife species, protecting them from both human activity and predation by domestic animals.

Examples of rare grassland-dependent species that use grassland habitat for nesting or feeding include the vesper sparrow and some species of butterflies and moths. Greenwich's designated grasslands provide habitat for these species and others, such as the grasshopper sparrow and savannah sparrow, which rely on agricultural lands, as well as reptiles and amphibians, which breed in wet areas found in agricultural fields.

Animal Communities

Although no comprehensive inventory of the different animal species within New Jersey, Cumberland County, or Greenwich exists, there are records of sightings, biological studies of range, environmental impact assessments, and evaluations of endangered and threatened status. Using federal, state, scientific, and nonprofit sources, it is possible to identify and describe the known and possible animals of Greenwich. See ***Sources of Information*** for specific sources that may provide more details about the township's animal communities.

Invertebrates

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

Macroinvertebrates are invertebrates that are visible to the naked eye but smaller than 50 millimeters. Benthic (bottom dwelling) macroinvertebrate communities provide a basis for ecological monitoring and are relatively simple to collect from shallow freshwater stream bottoms. 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 Ambient Biomonitoring Network (AMNET) surveys streams for macroinvertebrate communities, which indicate certain levels of water quality, as was discussed in the **Surface Water Quality** section of this document beginning on page 47.

There are nine endangered invertebrate species (two beetle species, four butterfly species, and three mussel species) and eight threatened invertebrate species (three butterfly species and five mussel species) in the State of New Jersey. Additionally, although not classified as endangered, the Eastern

Oyster has a particular significance in Greenwich, and it is important that its habitat be preserved. The entire coast of Greenwich along the Delaware Bay is a shellfish growing area, and the area near the mouth of Stow Creek is in fact called Oyster Cove due to its history as a center of the world's oyster industry. Although oyster recruitment, or the amount of young oysters entering the population, was consistently well below average in recent years, efforts by the Delaware Bay Oyster Restoration Project have been successful in stabilizing the area's oyster population. This project, a partnership of 10 organizations, has worked since 2005 to strategically plant millions of oyster shells in the Delaware Bay. These oyster shells provide clean surfaces to which juvenile oysters can attach and grow.

The Delaware Bay also has the largest population of horseshoe crabs (*Linulus polyphemus*) in the world, although their numbers are declining due primarily to overharvesting of the species for use as bait for eel and conch (NJDEP, 2005). Shorebirds like the endangered Red Knot rely upon the superabundance of horseshoe crabs when they stopover at the Delaware Bay to forage on the crab eggs on their epic migration from South America to the Arctic. There is a current moratorium in New Jersey on the harvesting of horseshoe crabs, for this reason. Other shellfish found in the Delaware Bay include blue crabs, hard clams, soft clams, mussels, and bay scallops.

Vertebrates

Vertebrates are less numerous than invertebrates, but their larger size makes them much more visible, and they are thus better studied and recorded. Fish species are fairly well documented, as are mammals. Birds that nest in Greenwich are known, and some migrants that depend on marshes in the township as stopover sites in which to rest and feed have been inventoried.

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 80 mammal species in New Jersey, nine of which are listed by the state as endangered or threatened. Some of the common mammals found in open fields in Greenwich include rabbits, Eastern Moles, Meadow Voles, house mice, Long-tailed Shrews, and woodchucks. Wetlands areas may contain small mammals, such as muskrats and otters. Wildlife found in upland forests include opossums, skunks, bats, chipmunks, raccoons, red and grey squirrels, grey and red foxes, and white-tailed deer. Some animals may live in a range of habitats.

Photo by DVRPC

White-tailed deer are abundant in New Jersey.

Management of white-tailed deer is an issue in New Jersey. While many residents prize the presence of mammalian life, deer often come into conflict with humans in suburban and farm areas. According to the U.S. Department of

Agriculture, deer cause more damage to agricultural crops than any other vertebrate wildlife species. Farmers in densely human-populated areas appear to be the most affected. Additionally, deer can devastate the understory of forests through overgrazing, destroying the growth of seedlings and young trees. Finally, as most motorists are aware, collisions between deer and automobiles frequently result in serious damage.

Controlling deer numbers has become increasingly difficult in New Jersey, primarily because suburban landscaping provides year-round food, which supports population growth, and because the principal method of culling the population–hunting–is not feasible in suburban environments.

To minimize human-deer conflicts, the New Jersey Agricultural Experiment Station recommends both lethal and nonlethal deer management options for community-based deer management programs. For example, under a state-approved management plan, municipalities can extend the hunting season, issue depredation permits to private landowners, engage in sharpshooting, and employ traps and euthanasia to reduce deer numbers. Alternatively, communities and private landowners can choose to apply nonlethal, although more costly, deer management strategies, such as installing reflectors and reducing speed limits on rural roads to decrease deer-vehicle collisions, modifying habitat by planting bad tasting plants on commercial and residential properties, using taste-based and odor-based repellents, and employing traps and translocation techniques.

Birds

There are between 350 and 500 species of birds in New Jersey, which is an exceptional number given the state's small size. 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 (established migratory air route) in North America.

Types of birds found in the grassland and agricultural land of Greenwich include quail, pheasants, pipits, red winged blackbirds, red-tailed hawks, northern harriers, sparrows, killdeer, kestrels, crows, and a large population of wild turkeys. In the upland forests, the American woodcock, bobwhites, owls, the red-shouldered hawk, woodpeckers, and many songbirds, such as flycatchers, warblers, thrushes, and vireos can be found.

Photo by Mike Ivanick

The Delaware Bay is a crucial stop on the Eastern Flyway.

The coastal wetlands of the Delaware Bay are renowned for their abundance and variety of birds, including protected species, such as the bald eagle, the Osprey, the Northern harrier, the red knot,

and several rails, including the Sora rail. Other bird species found in the wetlands of Greenwich at various times during the year include wood ducks, black ducks, snow geese, horned larks, willets, egrets, gulls and terns, red-throated loons, scoters, and swans.

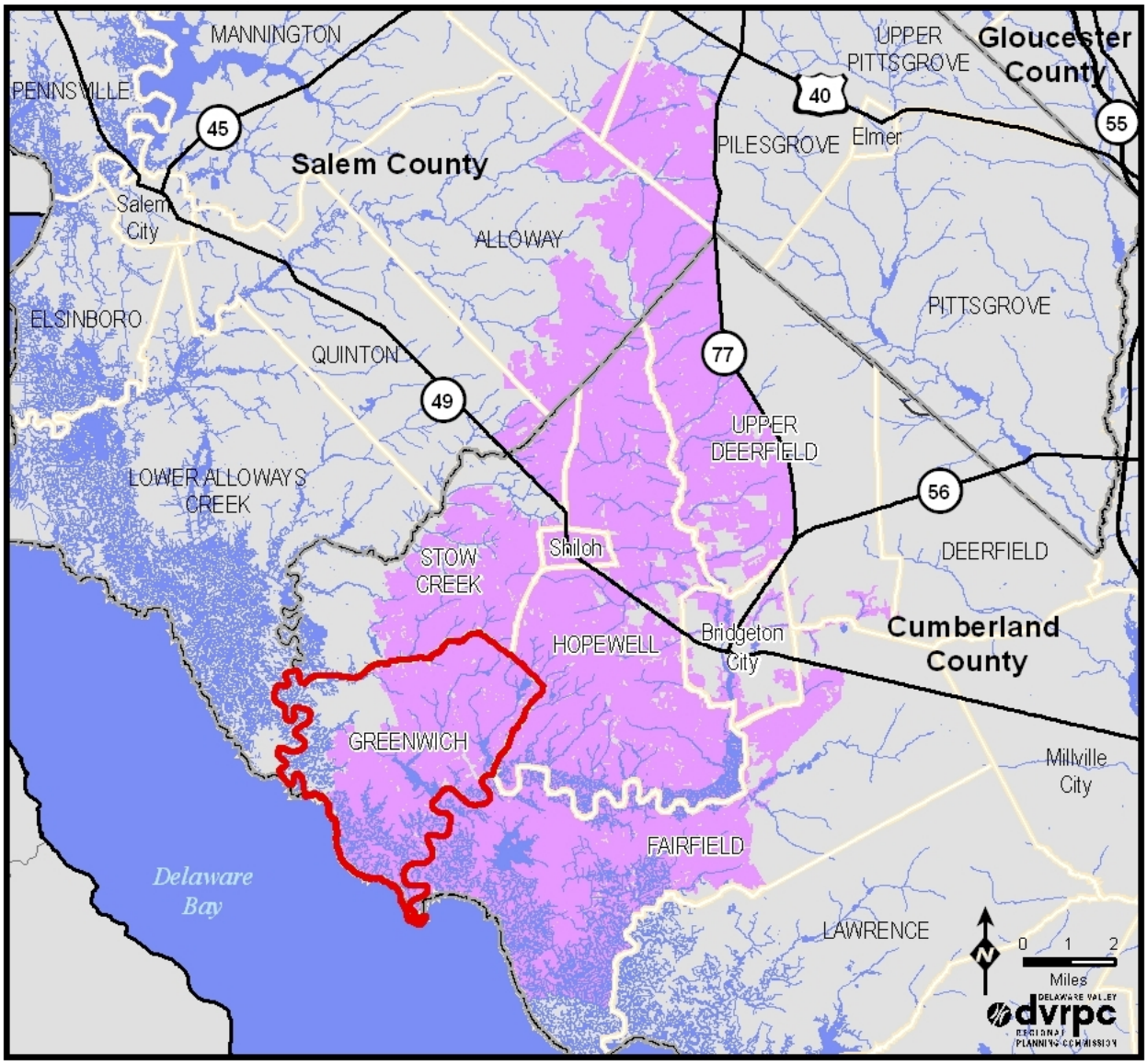
Important Bird and Birding Area

The Important Bird Area (IBA) is a global effort by the Audubon Society to identify and conserve areas that are vital to birds and other species. The New Jersey Audubon Society has an expanded initiative called the Important Bird and Birding Area (IBBA) Program, which identifies areas that provide essential habitat for sustaining bird populations (Bird Areas), as well as areas that provide exceptional opportunities for bird watching (Birding Areas). The New Jersey IBBA program has identified 122 sites within the state. Eight of these are within Cumberland County and one, the Cohansey River Corridor, is an IBA located partially in Greenwich Township.

The Cohansey River Corridor IBA includes areas of the Bayside Tract in Greenwich, the Dix and Clarks Pond WMAs (both in Fairfield Township), and the Bridgeton City Park. This area is significant for providing habitat for several breeding pairs of state-endangered bald eagles, state-threatened Ospreys, and state-special concern Cooper's Hawks. During the winter, the Cohansey River Corridor provides habitat for bald eagles, as well as state-endangered Northern harriers. Large numbers of waterfowl congregate here during the winter as well, including American Black Ducks, Mallards, and approximately 30,000 Snow Geese. Breeding Black Rails, a state-threatened species, have also been observed in the area.

Threats to the area include agricultural intensification and expansion, especially from numerous nursery operations, which threaten water and habitat quality. The Upper Cohansey River Watershed Restoration Plan is a coordinated effort by NJDEP, Rutgers University, and the Natural Resource Conservation Service (NRCS) to improve water quality in the area through conservation and management practices, such as water recovery systems and riparian buffers. PSEG's Estuary Enhancement Program is another effort to restore wetlands in the Delaware Estuary, including large areas of the Cohansey River Corridor. Additionally, the New Jersey Audubon Society and the American Littoral Society are conducting outreach efforts to communities and landowners in the Cohansey River Corridor to protect and conserve this essential habitat for rare birds and other species.

Figure 8: Important Birding Area



Source: New Jersey Audubon Society, 2009 and DVRPC, 2010.

Common Reptiles and Amphibians

Reptiles can be quite elusive when surveys attempt to find and record them. Snakes, such as the Water, Southern Ringneck, Black Racer, and Black Rat snakes, have been observed in Greenwich. A number of turtle species have also been observed, such as the snapping, box, mud, diamondback, red-bellied, and painted turtles. Frogs and toads common in the township include the leopard frog, the gray treefrog, the bullfrog, the spring peeper frog, and Fowlers toad. The red-backed salamander has also been observed. Amphibians of some types are abundant, such as bullfrogs. Other species are rare because they depend on vernal ponds, as was discussed in the **Vernal Pools** section of this document on page 45.

Fishes

When European settlers arrived in present-day Cumberland County, they encountered American Indians, who regularly fished along the inland streams and gathered shellfish in the Delaware River. Due to the unintended consequences of urban development, industrial advancement, and mechanized agriculture, the amount and diversity of aquatic life has decreased dramatically throughout most of New Jersey. As discussed in the **Agriculture and Industry** section on page 9, the sturgeon population of the Delaware Bayshore produced more caviar than anywhere else in the world in the late 19th century, until overfishing decimated the population.

The New Jersey Division of Fish and Wildlife, under the Bureau of Freshwater Fisheries, monitors and actively aids the propagation, protection, and management of the state's freshwater fisheries. The bureau raises several million fish for stocking in suitable water bodies and conducts research and management surveys. Greenwich's freshwater streams may contain sunfish, blue gill, shiner, pumpkinseed, eastern mudminnow, common carp, largemouth bass, perch, darter, catfish, pickerel, and the American eel. See **Appendix C: Vertebrate Fauna of Greenwich Township**.

Photo by Mike Ivanick

Greenwich is home to a number of bald eagles.

Endangered Vertebrates

According to the Natural Heritage Database and the Landscape Project, a number of rare wildlife species have been sighted in Greenwich. Brief descriptions, provided by the New Jersey Fish and Wildlife Service, of endangered and threatened bird species found in Greenwich Township and their preferred habitat follow. In fact, Greenwich is home to more than half of all endangered bird species in the state.

A **bald eagle** nest buffer is located in the township. The bald eagle (*Haliaeetus luecocephalus*) is an endangered species in New Jersey and a threatened species in the United States. Bald eagles mostly consume fish, and thus often choose to build nests in forested areas near water bodies. Population decline caused by shooting, poisoning, and egg collecting accelerated after the introduction of DDT into the New Jersey environment. DDT was shown to cause thinning of the eggshells of bald eagles and other birds, which would crack under the weight of the incubating adult. The bald eagle was listed as an endangered species in New Jersey in 1974, and as endangered in the lower 48 states in 1978. It was removed from the federal endangered list in 2008, but remains on the New Jersey endangered list. Bald eagle populations in New Jersey have since increased from a single nesting pair in 1970 to 69 nesting pairs in 2008. The Delaware Bayshore is the stronghold for the bald eagle population in New Jersey, with nearly half of all nesting pairs located in Cumberland and Salem counties. Greenwich Township in particular had a significant concentration of bald eagle nest sites found in 2008.

The **black skimmer** (*Rynchops niger*) is an endangered bird species in New Jersey that is named for its distinctive ability to fly horizontally over water, skimming the top with its beak. The black skimmer is black above and white below, with a white forehead and neck, and its long, narrow beak is a striking reddish-orange with a black tip. The preferred habitat of this shorebird is coastal and estuarine areas, such as beaches with shell fragments and limited vegetation. Although once a common species, the population of the black skimmer decreased in the early 1800s due to egg collection and hunting. Protection and monitoring has allowed the population of the black skimmer to stabilize, although it is still threatened by coastal development, tidal flooding, predation, and other activities.

Photo by Clifton Jones

A volunteer with the Endangered and Nongame Species Program of the N.J. Division of Fish & Wildlife helps band and monitor the health of a local eaglet.

Also found in Greenwich Township is the **least tern** (*Sterna antillarum*), an endangered species in New Jersey. The least tern is only nine inches long, and the female is slightly smaller than the male. It has a black cap, white forehead and under parts, and gray upper parts, wings, and tail. Although the least tern was commonly found along the New Jersey coast in the 19th century, its numbers were decimated in the early 20th century due to egg collection, as well as the popular use of its feathers in hats. Its numbers rebounded due to changing fashions and the Migratory Bird Treaty Act of 1918. However, since the 1940s, its numbers have been decreasing once again due to intense coastal development and recreation, predation losses, and coastal flooding.

The **Northern goshawk** (*Accipiter gentilis*) is a large forest hawk with an endangered status in New Jersey. It has short rounded wings and a long tail, and its call is a series of loud, piercing “cacks.” Because it consumed chickens and game birds, the Northern goshawk was historically shot in large numbers by farmers and hunters. The habitat of the Northern goshawk is large continuous old-growth forest, and the loss of this in New Jersey is another cause of the decline of the species. Due to the loss of its habitat, combined with its rarity as a breeder, the Northern goshawk was listed as a threatened species in New Jersey in 1987, a status that was reclassified as endangered in 1999.

The **Northern harrier** (*Circus cyaneus*) is a medium- to large-sized hawk with an endangered status in New Jersey. It was commonly called a “marsh hawk” because its preferred habitat is wet open areas, such as tidal marshes, emergent wetlands, fallow fields, grasslands, meadows, airports, and agricultural areas. Many Northern harrier nests are found in brackish or saline marshes along the Delaware Bay shore in locations such as Greenwich. Like the Northern goshawk and other raptors, the Northern harrier was commonly shot in the early 20th century because of its predatory nature. The destruction of its wetlands habitat through reforestation and the draining and filling of coastal marshes also contributed to the decline of the species. An additional threat to the Northern harrier was the widespread use of DDT,

which was found to cause reproductive failure in the species during the 1950s and 1960s. Since DDT was federally banned in 1972, the numbers of Northern harriers have gradually increased. The Northern harrier was listed as a threatened species in New Jersey in 1979, a status that was elevated to endangered in 1984.

The **Osprey** (*Pandion haliaetus*) is a threatened species in New Jersey. Ospreys live near coastal and inland bodies of water that support adequate fish populations. The birds build nests near fishing areas on structures such as trees, telephone poles, and channel markers. Occasionally, ospreys nest on the ground in coastal marshes. Habitat destruction, the loss of nesting trees, egg collecting, and shooting contributed to population declines evident by the end of the 19th century. Osprey numbers then dropped further after DDT was introduced into the New Jersey environment in the 1940s. As a result, the osprey was placed on the New Jersey Endangered Species list soon after the 1974 passage of the New Jersey Endangered Species Act. After DDT was banned, ospreys generally began to recover, and in 1985 the species was moved from the endangered to the threatened species list. However, populations along the Delaware Bay coast did not recover as well as populations in other areas of the state. Investigations revealed higher levels of chemicals such as DDE, DDD, and PCBs in the Delaware Bay birds. By the late 1990s, contamination levels in the birds had decreased and the Delaware Bay populations were increasing. Monitoring of nesting sites along the Atlantic Coast and Delaware Bay has shown that the osprey population has been steadily reproducing in New Jersey in recent years, with a statewide average of 1.54 young ospreys per nest.

The **peregrine falcon** (*Falco peregrinus*) is an endangered species in New Jersey that has been observed in Greenwich. The peregrine falcon is the world's fastest bird, able to reach diving speeds of up to 200 miles per hour. Peregrines traditionally nested on rocky cliffs, but because of human intrusion in these areas, they have taken to nesting in man-made structures, such as buildings and bridges. Peregrines also nest on artificial nesting platforms that have been constructed in the last 20 years in coastal marshes. The population of peregrine falcons decreased due to the looting of nests by egg collectors and falconers, as well as the shooting of the predatory birds by gunners, game wardens, and pigeon fanciers. Like a number of other birds, the peregrine falcon population was devastated by the introduction of DDT; by the 1960s, there were no known nesting peregrine falcons in the eastern United States. It was listed as an endangered species for the United States in 1970, and for New Jersey in 1974. Young Peregrines were released into the wild in the late 1970s to reestablish their nesting populations. By 1986 there were 10 breeding pairs in the state, which increased to 17 by 2001. Peregrine falcons were removed from the federal endangered species list in 1999, although they remain listed as endangered in the New Jersey due to the continued threat of environmental contamination and human disturbance.

The **red-shouldered hawk** (*Buteo lineatus*) is another endangered species in New Jersey that has been observed in Greenwich. Its typical habitat is mature wet woods, such as hardwood swamps and riparian forests. The red-shouldered hawk typically nests in deciduous trees and, to a lesser extent, coniferous trees in remote and extensive old-growth forests containing standing water. Since red-shouldered hawks require large continuous tracts of old-growth forests and their nests are located far from areas of human habitation, the species is threatened by new development that fragments their habitat. Although once a very common species in the state, the red-shouldered hawk population began declining in the early 1900s due to shooting, egg collection, and placement in captivity. The clearing of forests and the filling of wetlands to make way for development were causes of population decline as early as the 1920s, and this habitat fragmentation accelerated between the 1950s and 1970s. In 1979, the red-shouldered hawk was placed on New Jersey's list of threatened species, when an estimated 100 breeding pairs were present in

the state. However, continued habitat loss in the 1980s further diminished the species' population, and by 1991, when the species was reclassified as endangered, there were only an estimated 36 breeding pairs.

The breeding population of the **short-eared owl** (*Asio flammeus*) is endangered in New Jersey. This medium-sized owl inhabits coastal marshes, inland fields, pastures, and grasslands. The short-eared owl requires large continuous tracts of undisturbed open land. Although hunting and egg collection affected the population, the larger threat to the species has been habitat loss, including the filling of many coastal marshes in the 1940s and 1950s. Due to severe population decline, the species was listed as threatened in 1979. Only a handful of short-eared owls were sighted in the early 1980s, however, leading to the species being relisted as endangered in 1984.

The **upland sandpiper** (*Bartramia longicauda*), formerly known as the Upland Plover, is listed as endangered in New Jersey. This thin, brown shorebird inhabits open countryside, such as grasslands, fallow fields, and meadows. Airports, pastures, and small farms provide ideal habitat, with combinations of tall and short grasses, as well as places to perch. The upland sandpiper requires a large home range, and the average area for a breeding pair in New Jersey is about 216 acres. The population of the upland sandpiper began to decline in the late 1800s and early 1900s due to excessive hunting of the species, particularly in response to the decline and eventual extinction of the passenger pigeon. Habitat loss and continued shooting brought the upland sandpiper close to suffering the same fate as the Passenger Pigeon, although the Migratory Bird Conservation Act of 1916 offered the species some protection from hunting. In the 1950's, much of its habitat in the state was lost when many small farms were converted to suburban development or large monoculture farms. The upland sandpiper was listed as a threatened species in 1979, a status that was changed to endangered in 1984.

See **Appendix C** for a list of **Vertebrate Fauna of Greenwich Township** and **Appendix D** for a list of **Birds Observed in Greenwich Township**.

See **Appendix E** for a list of **Rare Plants Likely Occurring in Greenwich Township**.

See **Appendix F** for **State Endangered and Threatened Species**

Natural Heritage Database and Natural Heritage Priority Sites

Natural Heritage Priority (NHP) sites are areas designated by the New Jersey Division of Parks and Forestry's Office of Natural Lands Management as exemplary natural communities within the state that are critically important habitat for rare species. Preserving these areas is a top priority for efforts to conserve biological diversity in New Jersey.

Designation as a Natural Heritage Priority site does not carry any specific requirements or restrictions on the land. Rather, the designation is made because of a site's high biological diversity value. Owners of NHP sites are encouraged to become informed stewards of the property and to consider working with the local community, nonprofit groups, or the state to preserve the land permanently.

NHP designations are based on the records of the Natural Heritage Database, which lists documented sightings of endangered and threatened species. Information on particular sites may also be provided by the Nature Conservancy or by the NJDEP Endangered and Nongame Species Program, and especially through the latter agency's Landscape Project.

A portion of the **Stathems Neck and Mad Horse Creek NHP Site** is located within Greenwich Township, and the **Lanings Wharf NHP Site** is located in nearby Fairfield. See **Map 16: Landscape Project Priority Habitats (2007)** on page 84**,** which depicts the NHP sites.

The **Stathems Neck and Mad Horse Creek NHP Site** is located over open tidal marsh and woods at the edge of saline marshland in Lower Alloways Creek, Greenwich Township, and Stow Creek Township. About 407 acres are located in Greenwich over wetlands in the northwest corner of the township. This site has a biodiversity ranking of B4 for containing a state endangered raptor, as well as a rare plant species of special concern.

The **Lanings Wharf NHP Site** is located in Fairfield Township about a half mile from the border with Greenwich. This site is located in the Dix State Wildlife Management Area on both sides of Back Neck Road (Route 601), on coastal plain lowland forest adjoining saline marshland. It has a biodiversity ranking of B4 and provides habitat for a number of special concern plant species.

The Natural Heritage Database also lists for Greenwich several species of threatened and endangered plants and animals, or rare natural communities that have been found in other parts of the township. The location with the rarest plant or community records is in the eastern part of the township around Ye Greate Street and the convergence of Wheaton Run and Mill Creek. There are three rare plants present in Greenwich that have state endangered status: coast flat sedge, the Carolina petunia, and swamp-pink, which also has federal threatened status. The Natural Heritage Database's individual records of animals have been incorporated into the Landscape Project, but plant listings are not a basis for modeling.

Photo by Mike Ivanick

Greenwich contains a few state record trees.

It is important to note that the Natural Heritage Database lists primarily those sightings that have been submitted to it, along with some ecological community data. It incorporates both historically and recently documented sightings. Areas without sightings may never have been surveyed. Conversely, land use in areas with sightings may have changed considerably over recent years, and the species once found there may be gone. Local surveys to update the database and regular consultation of records before any development is approved are two measures that would help to increase the protection of threatened and endangered species.

See **Appendix E: Rare Plants Likely Occurring in Greenwich Township** and **Appendix F: State Endangered and Threatened Species.**

CHAPTER 5

THE BUILT ENVIRONMENT

Population

The 1990 U.S. Census listed a population of 911 residents for Greenwich Township. By the 2000 Census, Greenwich's population had decreased by 7% to 847 residents. This is nearly the same as 1810, the earliest year of census data for the township, when the population was 858. The township was most populated during the mid- to late-1800s, when its population was around 1,200. The population of Greenwich reached its peak in 1900, when 1,283 people resided in the township.

Greenwich had 361 housing units in 2000, only three more than in 1990. Thirty-five of these were vacant; the township's vacancy rate of about 10% is similar to the national average of 9%. Of the 326 occupied housing units, 86% (281) are owner-occupied, much higher than the national rate of 66%. The median value of a single-family home in Greenwich Township in 2000 was $112,000, a 24% increase from the 1990 median value of $90,000. The age of housing in Greenwich is exceptionally old, with 206 (57%) built before 1939 (the oldest bracket for housing age).

Photo by DVRPC

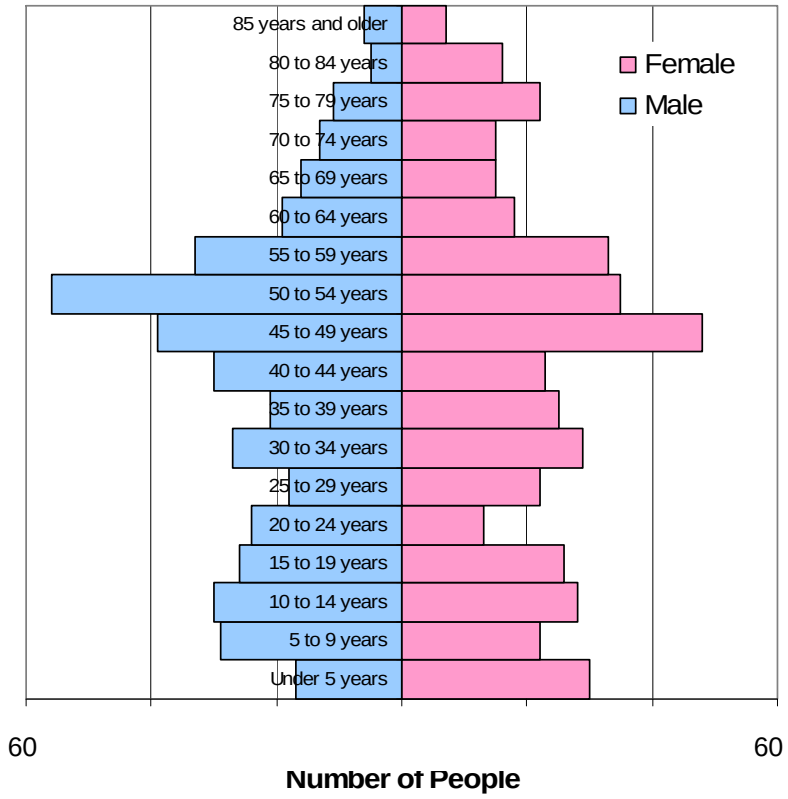
The Daniel Sheppard House on Ye Greate Street is an example of 19th century architecture in Greenwich.

In 2000, 460 individuals in Greenwich were within the work force, and 440 (96%) were currently employed. About 42% of jobs held by Greenwich residents were in management, professional, and related occupations. Another 22% were in sales and office occupations. Farming, fishing, and forestry constituted about 6% of industry jobs held by Greenwich residents in 2000, down from its 1990 share of 10%.

According to the 2000 Census, 20% (172 residents) of Greenwich's population are under the age of 18. Of those, 127 were between the ages of 5 and 18, representing the population most in need of recreational opportunities in the township. The township's median age is 43, significantly higher than the national average of 35. Comparing age cohorts in 1990 and 2000, Greenwich has been least successful in retaining those aged 15 to 29. The populations of all age groups under 24 have decreased between 1990 and 2000, as have those aged 35 to 44 and 65 to 74. The greatest increase in population has been

in the 50 to 54 age group of the “Baby Boomer” generation, which increased 63%. The changing demographic composition of Greenwich has implications for land use and civic needs. A demographic shift of more middle-aged and older people and fewer children implies greater disposable income of residents and less demand for schools and recreation.

Figure 9: Greenwich’s Population by Age and Sex (2000)



Source: US Census Bureau, 2000

The township’s population is ethnically homogenous, with 90% identifying themselves as white. The history and prevalence of American Indians in the Greenwich area, the Lenni-Lenape tribe in particular, is still present, as seen in the fact that about 4% of the population in the 2000 Census self-identified as American Indian, either alone or in combination with another race.

Transportation

There are no major roadways that cross through Greenwich, and it is nearly 20 miles to the nearest limited access highway, State Route 55. There are about 35 miles of roadways in the township. Of these, about 11 miles are owned by the township, and the other 24 miles are county roads. All roads in the township have two lanes and minimal traffic. County Route 607 (Greenwich Bridgeton Road) connects Greenwich with Bridgeton, while County Route 623 (Ye Greate Street) connects with Salem.

Although not within Greenwich, State Route 55, constructed between 1965 and 1989, increases accessibility to and from Cumberland County. Route 55 runs roughly parallel to the less-traveled Route

47 within Cumberland County. There are a number of exits in the Millville area, and the junction with Route 49 is particularly well used. It has dramatically increased the speed with which residents can access other parts of southern New Jersey.

There are no buses, trains, or airplanes that operate in the township, but there are New Jersey Transit bus stops in nearby Bridgeton, which connect to Vineland, Millville, Atlantic City, and Philadelphia. There is an abandoned freight rail line that crosses the length of Greenwich. Known as the New Jersey division of the Winchester and Western Short Line Railroad, this line begins at the coast by the Bayside area of Greenwich and continues towards the Sheppards Mill area. It then passes through Hopewell Township and continues to Bridgeton City, where the rail line is operational. According to the New Jersey Aviation Association, there are four secondary airports in Cumberland County, which are privately owned but available for public use: Li Calzi Airport in Bridgeton, Bucks Airport in Deerfield Township, Rudy's Airport, and Kroelinger Airport, both in Vineland. In addition, the Vineland-Downstown Airport is located just north of the Cumberland County border in Gloucester County and is also a privately owned public-use airport. The closest regional airport is the Millville Municipal Airport, an FAA Flight Service Station. In addition, the Philadelphia International Airport and the Atlantic City International Airport are located within an hour and a half drive from Greenwich Township.

Photo by Carey Hedlund

Hitch's Marina is one of two marinas in Greenwich.

Although the waterways of Greenwich that spurred its original development are not the primary forms of transportation that they once were, boat traffic through the Delaware Bay and on the Cohansey River is still active. Marinas on the Cohansey River are used primarily by recreational boaters and commercial watermen. The township's location on the Delaware Bay, part of the Intracoastal Waterway, makes it accessible from any port on the eastern seaboard.

Township Utilities and Services

Drinking Water

There are no public community wells within Greenwich. Residents of Greenwich Township rely solely on private wells for their drinking water supply. The Morris Goodwin School, the Bait Box Restaurant, the Greenwich Country Store, and the restaurant the Ship John Inn all have their own public noncommunity wells.

An explanation of noncommunity wells is found in the **Groundwater** section under **Water Supply Wells** and in ***Table 16: Public Non-Community Water Supply Wells***. **Map 13: Public Water Supply Wells (2004)** on page 68 shows the locations of the Morris Goodwin School and Bait Box wells; the other two wells are not mapped.

Sewer

There is no sewer service within Greenwich Township, so all residents rely on private septic systems.

Municipal Services

Trash and Recycling

There is no municipal trash or recycling service in Greenwich Township. Trash and recycling is managed through the Cumberland County Improvement Authority. The Cumberland County Solid Waste Complex in Millville contains a 75-acre landfill that handles over 550 tons of solid waste per day from the county. The pretreatment facility at the complex treats leachate from the landfill, which is then brought to the Sewerage Treatment Plant in Bridgeton. This makes the Cumberland County Solid Waste Complex one of only two “closed-loop” waste treatment plants in New Jersey.

Education

Photo by DVRPC

The Morris Goodwin School

The Morris Goodwin School in Greenwich Township educates approximately 100 children, from pre-kindergarten through eighth grade. Due to the school’s small size, the second and third grades are combined into one class, as are the seventh and eighth grades. The Morris Goodwin School shares a number of support services with other local elementary schools. These services include special education instruction and transportation, a child study team, speech services, and purchasing.

After eighth grade, students attend Cumberland Regional High School in Upper Deerfield Township. Students from seven municipalities in Cumberland County attend this school, drawing from an area of 162 square miles. High school students at any county school can also opt to attend the Cumberland County Technical Education Center. Students in this program attend the center for half a day and their regular high school for the rest of the day.

Open Space, Parks, and Recreation

Much of Greenwich Township is undeveloped, as it is wetlands. However, the township has developable land, which is actively farmed. Although it has not experienced widespread suburban development, 42% of the township’s farmland is preserved. These landowners have recognized the need to preserve agricultural lands for future generations of Greenwich Township farmers and the general public.

Greenwich's large areas of contiguous undeveloped wetlands provide a valuable source of passive recreation. The township is entirely within the Delsea Region of the New Jersey Coastal Heritage Trail, and the Greenwich Tea Burning Monument is a designated trail destination. The New Jersey Coastal Heritage Trail extends along the Atlantic Ocean coast, from Perth Amboy to Cape May, and continues along the Delaware Bay shore to the Delaware Memorial Bridge. Greenwich contains a very small area of the 9,345 acre Mad Horse Creek Wildlife Management Area, which is administered by the New Jersey Division of Fish and Wildlife Bureau of Land Management. This disconnected area is mostly located in Salem County and is composed of tidal saline marsh, impounded marsh, forest, and upland fields. In addition, the Bayside Tract, owned by PSEG, includes public access to the Delaware Bay for recreational activities like fishing and crabbing, as well as bird watching of a number of endangered species, such as the bald eagle, the peregrine falcon, the Northern harrier, and the red-shouldered hawk. Recreational boating is another popular activity on the waterways bordering Greenwich Township, and on the Cohansey River in particular.

Table 21: Protected Open Space

Description	Acres	% of Land Area
Federal Holdings	4.5	0.0%
State Holdings	19.3	0.2%
Municipal Holdings	118.2	1.0%
Permanently Preserved Farmland	1,606.1	13.5%
PSE&G Bayside Tract	4,393.4	36.8%
Other Open Space	104.8	0.9%
Total Protected Open Space	**6,246.3**	**52.3%**

Source: Greenwich Township, Cumberland County, 2009

See **Map 18: Existing Open Space (2009)** on page 110, which shows the amount of preserved land within the township.

According to 2002 USGS land use survey data, Greenwich Township contains 3.7 acres of school athletic fields and another 24 acres designated as recreational land. There is only one property in Greenwich–a tennis court located at the Morris Goodwin School–listed on the NJDEP's Recreation and Open Space Inventory (ROSI) as a Green Acres-funded property. Another source of recreation is the privately owned Camp Sheppards Mill, which is used year-round for a variety of recreational activities by a number of organizations, including the Girl Scouts and the Children of the Earth Foundation.

Photo by Carey Hedlund

Along the Cohansey River

Bicycling as a source of recreation and tourism has gained in popularity in recent years in Cumberland County. The Cumberland County Bike Trail Study, completed in 2000, points to the county's potential as a bicycling destination due to its flat terrain, wide and smooth shoulders on roadways, low traffic volume,

and expansive natural landscapes. In particular, County Road 642 in Greenwich (alternatively Stathems Neck Road, Wheaton Island Road, Tyndall Island Road, and Bacons Neck Road) was identified as one of the county's most scenic bicycle-compatible roads.

Historic Resources

Concerned citizens submitted an application for Greenwich's historic district centered on Ye Greate Street to be entered in the National Register of Historic Places, which was accepted in January 1972. Continued preservation efforts, both historic and environmental, combined with a shortage of new development, has maintained Greenwich's status as perhaps the least-changed colonial town of national significance on the eastern seaboard.

Photo by Clifton Jones

John Dubois Maritime Museum

The Greenwich Township Master Plan of 1995 outlined the following seven goals to guide future land use development, all of which emphasize preservation of the rural lifestyle, historic character, and natural resources of Greenwich:

- Preserve the existing historical character of Greenwich Village, Head of Greenwich, Springtown, and the surrounding countryside.
- Protect the environment and natural resource base.
- Maintain agriculture as a mainstay of the community.
- Designate and manage the cultural landscape as a special quality-of-life feature of the township.
- Allow for housing opportunities that are in keeping with the existing community character.
- Provide for limited, locally oriented development opportunities.
- Provide for sustainable economic and recreational opportunities adapted to the township's natural resources.[7]

[7] Greenwich Township Planning Board. *Greenwich Township Master Plan*. Greenwich Township, Cumberland County, New Jersey. December, 1995.

Greenwich has three sites–the Bethel AME Church, the Greenwich Historic District, and the Thomas Maskel House–on the New Jersey and National Registers of Historic Places.[8]

In addition to these historical sites, Greenwich contains a number of museums dedicated to local history, including the Prehistorical Museum, the Swedish Log Granary, the Red Barn Museum, the Cumberland County Historical Society, the William Lummis Genealogical and Historical Research Library, the Gibbon House, and the John DuBois Maritime Museum. Also of historic importance are the number of state record trees in the township, including an American Chestnut, a Cucumber Magnolia, and a Bitternut Hickory, shown on **Map 17: Historical Resources and Cultural Resources (2006)** on page 109.

See ***Table 22*** below for Greenwich's historical sites listed on the National and State Registers of Historic Places.

Table 22: Sites Listed on the National and State Registers of Historic Places

Name	Location	Year listed on National Register (NR) and State Register (SR)	State ID#
Bethel AME Church	Sheppards Mill Road, Springtown	NR: 1999 SR: 1999	1626
Greenwich Historic District	Main Street, from the Cohansey River north to Othello	NR: 1972 SR: 1971	1044
Thomas Maskel House	Old Mill Road	NR: 1975 SR: 1973	1045

Source: NJDEP Historic Preservation Office, 2008

Historic Homes in Greenwich

Greenwich is one of the most well-preserved colonial towns on the eastern seaboard; it largely retains the same character it had in the 18th and 19th centuries. The historic homes and public buildings of Greenwich are important elements of the historic record and culture of the area and, indeed, nation. Many facades display Flemish bond brickwork, some of which have patterns in red and black brick built by artisans who learned the trade in England. Bricks were made a black or dark blue color by burning them very close to a fire fueled by certain kinds of wood. These bricks were most likely made locally from sand and clay.

Photo by DVRPC

The Gibbon House

[8] Filing an Environmental Impact Statement (EIS) usually prompts the issuance of a State Historic Preservation Office Opinion. Private individuals, companies, organizations, or governments that use federal funding are often required to file an EIS, which may result in NJDEP recognizing possible threats to certain historic sites and identifying those sites as eligible for listing on the state Register of Historic Places.

Greenwich's historic homes and public buildings have long been recognized as an irreplaceable resource that should be preserved for future generations.

Based on deeds from the time, some of the earliest settlers included Francis Alexander, Samuel Bacon, William Bacon, Joshua Barkstead, Joseph Brown, John Budd, John Clark, Joseph Dennis, George Hazlewood, Obadiah Holme, Robert Hutchinson, Edward Hurlburt, Edmund Gibbon, Cornelius Mason, John Mason, Enoch Moore, Mark Reeve, Alexander Smith, Thomas Smith, James Wasse, and Thomas Watson.

The John Sheppard House is one of the oldest houses in Greenwich. The original 1686 structure was torn down, and the current structure dates from circa 1715, with an addition from 1900. The Thomas Maskel House (called Vauxhall Gardens during the 1800s) has one section built in 1698 and a second built in 1725, with additions constructed in the 1960s. Some well-preserved examples of 18th century architecture include the 1707 Ewing Homestead Resurrection Hall, the 1730 Gibbon House, the 1734 Daniels House (also known as the "Pirate House" due to local legend), the circa 1760 Phillip Vickers Fithian House (originally inhabited by Doctor Samuel Ward), the 1760 to 1770 Ewing House, the 1771 Orthodox Friends Meeting House, the 1795 Wood Mansion, and the circa 1796 Richard Wood III Store. A field stone tavern, now a private residence, was built in 1728 and acted as the county courthouse for a short period of time. Examples of buildings from the 19th century include the 1800 Charles Beatty Fithian house, the 1811 Old Stone Schoolhouse, the 1834 to 1835 Presbyterian Church, the 1834 Flanagan-Stathem-Landis House, the 1841 Bethel African Methodist Episcopal (AME) Church, and the 1848 Wheaton Homestead (also known as the Anchorage). The Wheaton Homestead was once the property of a son of Charles Willson Peale, the American painter renowned for his portraits of historic figures, such as George Washington, Thomas Jefferson, John Hancock, Alexander Hamilton, Meriwether Lewis, and William Clark (Pratt, 1956).

See **Appendix H: A Pictorial Guide to Historic Greenwich, NJ** for a reprinting of a guide, originally produced by the Cumberland County Historical Society in 1976, which depicts some of the historic buildings in the township.

Municipal Protection of Historic Resources

The National Park Service and the New Jersey State Historic Preservation Office (SHPO) jointly administer the Certified Local Governments (CLG) program, which provides technical assistance and funding for community-based preservation efforts. No municipalities in Cumberland County or neighboring Salem County are CLGs. To participate, a municipality must maintain a historic preservation commission, survey local historic properties, provide opportunities for public participation in preservation activities, and develop and enforce local preservation laws. If a community were to become a CLG, it would be eligible to draw on an exclusive pool of matching federal and state funds for program implementation and rehabilitation work consistent with historic preservation standards.

There are also federal incentives to individuals, organizations, or firms that own historic properties and are interested in historic preservation. Interested parties can take advantage of the Rehabilitation Investment Tax Credit, a federal tax incentive to encourage the preservation and reuse of older income-producing properties, including offices, apartment buildings, and retail stores.

Residents of Greenwich organize a number of historical events each year, such as a Christmas house tour, a Saint Lucia ceremony, and a historic Farm Day. Investing in historic preservation efforts can provide municipalities with important and impressive returns. Private and public efforts to preserve and rehabilitate historic structures create attractive places to live, work, and play. Furthermore, historic preservation maintains a municipality's character, distinctly separating it from other rural and suburban communities, for both new and established residents.

Photo by Mike Ivanick

The old stone schoolhouse was built as a schoolhouse and town hall.

ENVIRONMENTAL ISSUES

Known Contaminated Sites

NJDEP's 2008 inventory of Known Contaminated Sites reported 223 active sites with confirmed contamination in Cumberland County. As of the May 2008 report, Greenwich Township contains one active known contaminated site, designated by its address on Bridgeton Road. Additionally, there are 17 pending sites with confirmed contamination in Cumberland County, none of which are located in Greenwich Township. Also, according to the May 2008 report, there are 277 closed sites with remediated contamination in Cumberland County, three of which are located in Greenwich Township. Although not categorized as known contaminated sites, there are two sites known to have been used as dumping grounds in the 1940s and 1950s; the sites on Randall Island and Tyndall Island are both located in salt marsh areas.

Table 23: Known Contaminated Sites in Greenwich Township

Site ID	PI Number	Name	Address	Status	Lead Agency	Remedial Level
218459	453540	Private Property	Bridgeton Road	Active	BFO-S	C1
188409	247587	Private Property	School Street	Closed	BFO-S	C2
72399	G000024664	Private Property	Delaware Avenue	Closed	BFO-S	C1
9468	020458	Woods Country Store	Ye Greate St	Closed	BUST	C2

Source: NJDEP Site Remediation Program, 2008

Lead Agencies and Contact Information

Acronym	Bureau	Telephone Number
BFO-S	Bureau of Field Operations - Southern	(609) 584-4150
BSCM	Bureau of Southern Case Management (formerly BUST)	(609) 292-8761

Explanation of Remedial Levels

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 ground-water contamination.

Remedial Level	Explanation of Site Complexity
C2	Remediation requires a formal design. The source of the contamination is known OR the release has caused ground-water contamination.
C3	A multiphased 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 multiphased remediation with multiple sources/releases to multiple media, including ground water.
S	Should have a Remedial Level, but this field was either blank or designated as "N/A" in Pre-NJEMS data.

The 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, these are eligible for federal cleanup funds. Other sites are handled by state or individual programs, or through private funds. There are three active Superfund sites in Cumberland County, none of which are within Greenwich. There are an additional two in the county–again, not located within Greenwich–that have been deleted from the National Priorities List.

Radon

Radon is a radioactive gas that comes from the natural decay of uranium found in nearly all soils. It is invisible, odorless, and tasteless. It moves up through the ground to the air above and into all types of homes through cracks and other holes in foundations. A build-up of radon-contaminated air (internal alpha particle exposure hazard) within a home can pose a long-term health hazard to residents, specifically for 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 DEP 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.

NJDEP classifies municipalities into three categories–high (Tier 1), moderate (Tier 2), or low (Tier 3)–as to the risk of having high radon levels. Greenwich is listed as a Tier 1 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, 25% or more have radon concentrations greater that or equal to four picocuries per liter in air. The level at which homeowners should take immediate action is 4.0 picocuries per liter in air. If radon levels are high in a home, NJDEP suggests that the homeowner take the following actions: (1) prevent radon from entering the house by repairing cracks and insulation and (2) dilute radon concentrations currently in the house by installing a radon extraction system and/or frequently ventilating indoor air. NJDEP maintains www.njradon.org as an information source for concerned citizens. Free information packets are available upon request. All companies conducting radon testing and mitigations are certified by NJDEP and listed on their website.

Other Environmental Concerns

PSE&G Salem Nuclear Generating Station

Greenwich is located less than 10 miles south of three Public Service Electric & Gas (PSE&G) nuclear reactors–Salem 1, Salem 2, and Hope Creek–located in Lower Alloways Creek Township. PSE&G has a 57% share in the Salem plants and owns 100% of the Hope Creek plant. Nuclear power from these plants produces about half of all electricity used in New Jersey. The western portion of Greenwich Township is within Emergency Planning Zone 7. This area is in the "Plume Zone," which extends out in a 10-mile radius of the facility. The Plume Zone is the area in which immediate evacuation and other protective actions would be taken in the event of a nuclear accident. In case of an evacuation, the nearest "reception center" is the Bridgeton High School.

Sea Level Rise

Sea level rise due to increasing greenhouse gas concentrations is expected to lead to threats such as permanent inundation, more frequent flooding, beach erosion, and saline intrusion in low-lying coastal areas like Greenwich. A 1999 study[9] evaluated the sensitivity of New Jersey's coast based on six variables: geomorphology, coastal slope, relative sea-level rise, shoreline erosion/accretion rate, mean tide range, and mean wave height. Coastal areas were then ranked as having a vulnerability level of low, moderate, high, or very high. About 80% of New Jersey's coast was found to be highly or very highly vulnerable to the effects of sea level rise, although the coast of Greenwich was found to be moderately vulnerable.

One response to rising sea levels is to defend the existing coastline through coastal stabilization structures, such as bulkheads, seawalls, or jetties. Although effective in the short-term, these structures can negatively impact sediment transport and beach profiles. Nonstructural approaches to protect the existing coastline, such as beach nourishment, have been favored in New Jersey in recent years, although they can be prohibitively expensive. Also, the continual erosion of beaches requires continual replenishment.

On the other hand, an alternate response to rising sea levels is to allow the coastline to naturally migrate inland. However, the ability of wetlands to migrate inland is inhibited by coastal stabilization structures, as well as development in the areas where wetlands would migrate to. Without adaptive action, the likely result is increased inundation and disappearance of wetlands. Future losses of wetlands from sea-level rise could be reduced by (1) slowing the rate of sea-level rise through reduction of greenhouse gas emissions, (2) enhancing wetlands' ability to keep pace with sea-level rise, (3) decreasing human interference with natural processes by which wetlands adapt to sea-level rise, or (4) holding back the sea while maintaining coastal wetlands artificially.

[9] Thieler and Hammer-Klose, 1999.

Pesticides

New Jersey is one of the first states in the nation to address issues relating to toxic pesticide residuals, such as dichloro-diphenyl-trichloroethane (better known as DDT), arsenic, and lead, which remain in the soil from past agricultural operations. In 1996, NJDEP convened a task force to study the extent of the historic pesticide problem in New Jersey and to develop strategies for protecting human health. The task force's findings were issued in an April 1999 report (see *Sources*). While the task force examined 18 agricultural sites throughout New Jersey (none in Cumberland County), it is estimated that five percent of the state's land area is impacted by residues from agricultural pesticides. The primary human health concern of residual contamination is the ingestion of contaminated soil. Therefore, small children who may ingest soil are at the greatest health risk. This issue may affect residents of homes and subdivisions built on former cropland and orchards. Homeowners can take precautions, such as maintaining grass coverage and washing hands and toys after playing in exposed soil. Some developers may be willing to address this problem by testing and removing the existing topsoil and bringing in clean topsoil before construction commences.

The current use of herbicides, pesticides, and fertilizers in both agricultural and residential areas, and their subsequent runoff, should remain an issue of concern.

Insects

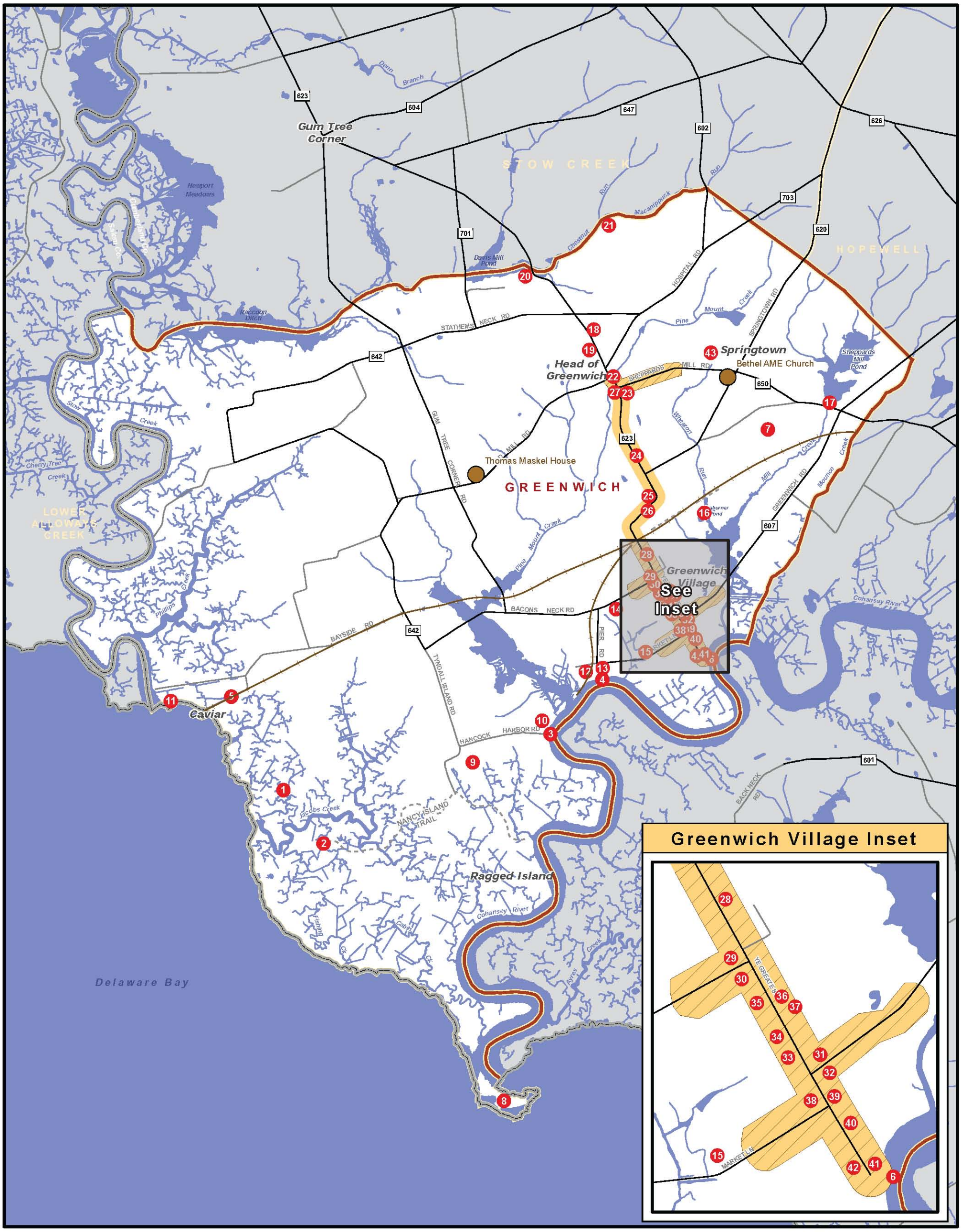
Due to Greenwich's location on the Delaware Bay and its vast areas of wetlands, insects like green-head flies, strawberry flies, gnats, and mosquitoes, including the Asian Tiger mosquito, are a major concern. The Cumberland County Mosquito Control Division uses an integrated pest management approach to controlling mosquito populations. In early March, the Mosquito Control Division conducts surveillance of known mosquito areas in the county. They also inspect areas of concern noted by residents. Inspectors identify and remediate areas of standing water, such as large containers or tires, where mosquitoes breed. Larvicide is a preferred treatment to kill mosquito larvae, which are easier to eliminate than adult mosquitoes. Targeted spraying of pesticides is also used in mosquito-prone areas. Mosquitofish (*Gambusia affinis*), which consume hundreds of mosquito larvae every day, are used as a natural biological control. A low ground pressure hydraulic excavator is used to clean ditches and streams as part of source reduction. Cleaning ditches that have become clogged by debris allows water to flow freely and discourages standing water. Other problematic insects found in Greenwich Township include deer ticks, which can spread Lyme disease.

Hurricanes

According to the USGS, Greenwich Township lies in a coastal area that is expected to experience 20 to 40 hurricanes over a 100-year period. In recent years, a number of hurricanes have struck the state and have caused damage in Greenwich. In 1996, Tropical Storm Bertha made landfall in Cumberland County, near Greenwich Township, and traveled through the center of the state. Hurricane Floyd made landfall in New Jersey in September 1999, but it was downgraded to a tropical storm by the time it reached the state. Floyd caused significant damage across the state, including flooding on the scale of a 500-year flood. Floyd traveled up the entire Atlantic coastline of New Jersey, and its impact was also felt on the Delaware Bay shore. Hurricanes that did not make landfall in New Jersey but caused damage in

GREENWICH TOWNSHIP

Map 17: Historical Resources and Cultural Resources (2006)



Site on NJ & National Registers of Historic Places

Historic Resource

Greenwich Historic District (NJ & National Registers of Historic Places)

Local Historic District

Historic Sites & Local Sites of Interest

1. Picnic Island
2. Nancy Island
3. Marina
4. Greenwich Piers
5. Former rail line
6. Historic Ferry Crossing
7. Tea Burner Farm
8. Cohansey Lighthouse Site
9. American Chestnut - State Record Tree
10. Shad Scowl (Floating Cabin)
11. Monument to Goose Goslin
12. "Mother's Darling" Plaque
13. Schooner Shipyard & Oyster Shucking House
14. Cucumber Magnolia - State Record Tree
15. Bitternut Hickory - State Record Tree
16. Native American Monument
17. Former mill site
18. Bethel AME Cemetary on Ambury Hill
19. Former schoolhouse
20. Former saw mill site
21. Former button mill site
22. Former flax mill site
23. Presbyterian Church
24. Upper Friends Meeting House
25. Old Stone Schoolhouse
26. Orthodox Friends Cemetery
27. Old Presbyterian Cemetery & Original Church Site
28. Baptist Church & Cemetery
29. Wood Mansion
30. Wood Store
31. Prehistorical Museum
32. Greenwich Post Office & Store
33. Tea Burners Monument
34. Lummis Geneological Library
35. Maritime Museum
36. Gibbon House
37. Swedish Granary
38. Firehouse
39. Site of St. Stephen's Episcopal Church
40. Lower Friends Meeting House
41. Reeve Sheppard House
42. Watson's Tavern
43. Former road

N

0 0.25 0.5 1

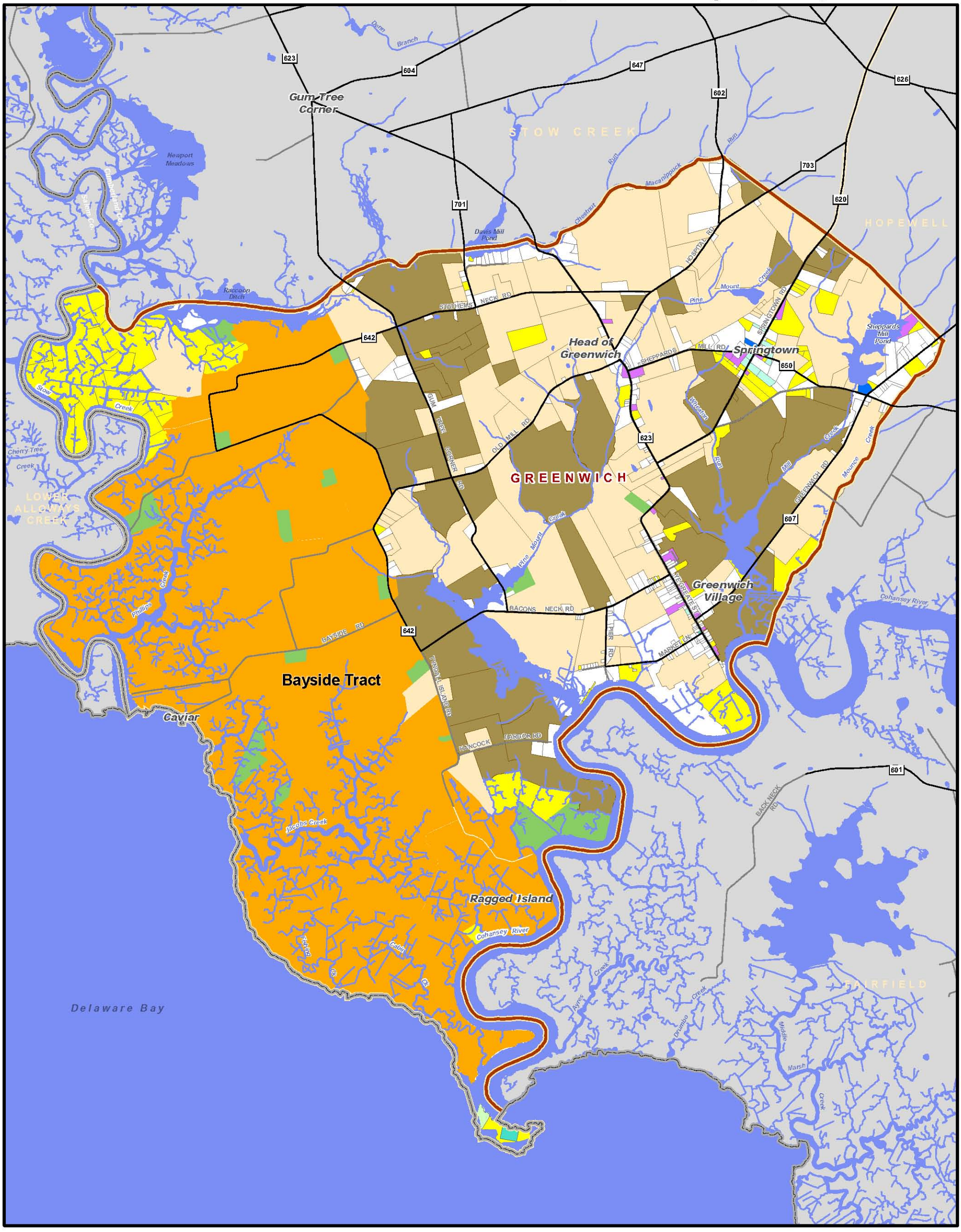
Miles

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

Sources : NJDEP, NJDOT, DVRPC, NJSHPO. Cumberland County Planning Department. 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.

GREENWICH TOWNSHIP

Map 18: Existing Open Space (2009)



- Federal Property
- Municipal Property
- State Property
- Tax Exempt
- Preserved Farmland
- Other Preserved Parcel
- Bayside Tract – PSEG
- Farm Assessed
- School & Church Property
- Vacant
- Developed Land

N

0 0.25 0.5 1

Miles

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

Sources : NJDEP, NJDOT, DVRPC, Cumberland County Planning Department
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.

Greenwich include Hurricane Gloria in 1985 and Hurricane Isabel in 2003. One victim of Hurricane Gloria was the historic “shoe tree” outside the Presbyterian Church. A number of pieces of church furniture were made from the downed tree, including a baptismal fount.

Greenwich Township is fortunate in having its coastline protected by large areas of intact wetlands, which act as a buffer between waves and upland development. In case of a hurricane, Greenwich Township must be evacuated through an evacuation route. The closest official evacuation route from Greenwich is County Route 607.

Photo by Clifton Jones

Boats in harbor along the Cohansey River.

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Table 24: Lead Agencies

Acronym	Bureau	Telephone No.
BCFM	Contract & Fund Management	(609) 777-0101
BCM	Case Management	(609) 633-1455
BDC	Design & Construction	(609) 984-2991
BER-I	Emergency Response Region I	(973) 631-6385
BER-II	Emergency Response Region II	(609) 584-4130
BFO-N	Field Operations - Northern Field Office	(973) 631-6401
BFO-S	Field Operations - Southern Field Office	(609) 584-4150
BLRM	Landfill Compliance & Recycling Management	(609) 984-6650
BNCM	Northern Case Management	(609) 777-0899
BOMM	Operation, Maintenance & Monitoring	(609) 984-2990
BSCM	Southern Case Management (formerly BUST)	(609) 292-8761
CAS	Case Assignment Section	(609) 292-2943
INS	Initial Notice Section	(609) 633-1464
OBR	Office of Brownfield Reuse	(609) 292-1251
OWR	Office of Wellfield Remediation	(609) 984-2990
SA	Site Assessment	(609) 584-4280
STAR	Cleanup Star Program	(609) 292-1251

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P.L. 96-510. *Federal Comprehensive, Environmental Response, Compensations and Liability Act of 1980*

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N.J.S.A. 13:19-1 et seq. *Coastal Area Facilities Review Act*

N.J.S.A. 13:19-19*. Tidal Wetlands Act*

N.J.S.A. 23:2A et seq. *New Jersey Endangered and Nongame Species Conservation Act of 1973.*

N.J.S.A. 26:2D et seq. *Radiation Protection Act.*

N.J.S.A. 58:10A-1 et seq. *New Jersey Water Pollution Control Act.*

N.J.S.A 58:12A-26 et seq. *The Private Well Testing Act.*

N.J.S.A 58:16A-50 et seq. *New Jersey Flood Hazard Area Control Act.*

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APPENDICES

Private Well Testing Act

The Private Well Testing Act (*N.J.S.A. 58:12A-26 et seq.*), passed in 2002 and administered by NJDEP, requires that well water be tested for contaminants when properties served by certain types of drinking water wells are sold or leased. The law does not prohibit the sale of property if the water fails one or more drinking water test standards. Rather, the fundamental goal of the PWTA is to ensure that purchasers and lessees of properties served by private potable wells are fully aware of the quality of the untreated drinking water sources prior to sale or lease. The state law allows the buyer and seller to determine which party will pay for the test, as well as what actions, if any, need to be taken if test results indicate a contaminant is present in the water above an applicable standard. However, individual county health rules may mandate that certain actions are required in order for a real estate transaction to be finalized.

Volatile Organic Compounds Regulated by NJDEP

- Benzene
- Carbon Tetrachloride
- meta-Dichlorobenzene
- ortho-Dichlorobenzene
- para-Dichlorobenzene
- 1, 1-Dichloroethane
- 1, 2-Dichloroethane
- 1, 1-Dichloroethylene
- *cis* – 1, 2-Dichloroethylene
- *trans* – 1, 2-Dichloroethylene
- 1, 2-Dichloropropane
- Ethylbenzene
- Methyl tertiary butyl ether
- Methylene Chloride
- Monochlorobenzene
- Naphthalene
- Styrene
- 1, 1, 2, 2-Tetrachloroethane
- Tetrachloroethylene
- Toluene
- 1, 2, 4-Trichlorobenzene
- 1, 1, 1-Trichloroethane
- 1, 2, 2-Trichloroethane
- Trichloroethylene
- Vinyl Chloride
- Xylenes (Total)

The PWTA program requires that water be tested for primary contaminants (health-based) and secondary parameters (aesthetic characteristics). Primary contaminants are contaminants that may cause a potential health risk if consumed on a regular basis above the established maximum contaminant level (MCL). New Jersey regulates 18 primary contaminants, five more than federal EPA requirements. Primary contaminants include bacteriological (fecal coliform and *E. coli*), Volatile Organic Compounds (VOCs), inorganics (arsenic, lead, mercury, and nitrates), and Radiological (radium decay) substances. A certified laboratory must collect a water sample at a point before the water goes through any treatment. This sample represents the condition of the ground water in the aquifer, which may be different from water out of a kitchen faucet. Property owners may choose to also have the tap water tested to assure that filters or treatments are working effectively.

The PWTA program requires tests for three naturally occurring secondary parameters: pH, iron, and manganese. Secondary drinking water standards address aesthetics, such as corrosivity, taste, and color, and testing for these parameters determines if water is suitable for laundering, plumbing, and

showering. For example, due to the nature of soils and geology in southern New Jersey, the ground waters tend to be acidic (pH below 7), while ground waters in the northern part are neutral (pH=7) to basic (pH above 7). If the pH is too low (less than 6.5), water has a bitter, metallic taste, and causes corrosion of pipes and fixtures. If the pH is too high (greater than 8.5), the water has a slippery feel, it tastes like soda, and deposits can form on plumbing fixtures.

Test results are reported by the lab to the person who requested the testing, to NJDEP, and to the local health authority. Suspicious or unexpected results are neither confirmed nor verified by NJDEP. Local health authorities will investigate suspect results, if necessary.

In February 2004, NJDEP released an online report summarizing the initial well test results reported to the agency during the PWTA program's first six months (September 2002 to March 2003). Results for 5,179 wells were included, which represent approximately one percent of private wells used as potable water supplies in New Jersey. The compilation of water test results was organized by county and municipality, but did not include the names of specific property owners, their addresses, or well locations, because releasing that information is prohibited by law. About 92% of the 5,179 wells passed all the required (health-based) standards, with the exception of lead. Of the 8% (417 wells) of wells sampled that exceeded the maximum contaminant level for primary contaminants, the most common reason for failure statewide was nitrate (inorganics), followed by fecal coliform (bacteriological), and Volatile Organic Compounds (VOCs). Nitrates are found in groundwater due to a number of factors, including natural deposits, runoff from fertilizer, leaching from septic tanks, and from sewage pipes.

More wells in northern New Jersey were found to have fecal coliform, or *E. coli* bacteria, than in southern New Jersey. The northern/southern difference is probably due to the different geology in these regions. Northern New Jersey is characterized by limestone subject to solution cavities, fractured bedrock, or gravel water-bearing zones, while the southern part of the state is composed mainly of coastal plain sand and gravel, which appears to provide better protection of groundwater from fecal contaminants.

For those wells in the counties where mercury testing is required, 14 wells failed for mercury. Nine southern counties, including Camden, Gloucester, Salem and Cumberland, are required to test for mercury, which has been linked to neurological problems.

The test results for Greenwich Township, Cumberland County, are summarized in the table below. NJDEP's initial report indicates the presence of several drinking water contaminants, including mercury, gross alpha (radium), 1,2,3 trichloropropane, and 1,2 dichloropropane, in the county's groundwater. None of these contaminants were present in the six wells tested in Greenwich Township.

Summary of PWTA Test Results for Greenwich and Cumberland County (September 2002 – March 2003)

Geographic Area	# Wells Sampled	# Wells over MCL	Fecal/E.coli	Nitrate	Arsenic	Mercury	Any VOC over the MCL
Greenwich Twp	6	0	0	0	NR*	0	0
Cumberland Co	161	28	2	15	NR*	4	8

Source: NJDEP, Division of Science, Research, and Technology (DSRT), 2003

*NR – Not required to sample
* MCL – Maximum Contaminant Level, set as the limit of a particular substance allowable to achieve a water quality standard
** VOC – Volatile Organic Compound.

APPENDIX B

Federal and State Conservation Programs for Farmers

There are several financial and economic incentive programs and technical assistance to help farmers plan and use conservation practices on their farms. The United States Department of Agriculture Natural Resources Conservation Service (NRCS) has a Farm Service Agency office in Vineland, Cumberland County, which serves the county. NRCS staff members are available to work with farmers to help identify their conservation goals and then craft appropriate conservation plans to meet those goals.

Numerous programs provide financial incentives to help farmers voluntarily engage in these practices. Financial incentives can include rental payments to farmers for reserved land, easement payments, and cost sharing, up to 100% for some programs, to develop and follow conservation plans.

The **Conservation Reserve Program (CRP)** is offered by NRCS and administered by the Farm Service Agency. It provides technical and financial aid and gives farmers assistance in complying with federal, state, and tribal environmental laws. The primary environmental goals of this program include reducing soil erosion, reducing sedimentation in streams and lakes, improving water quality, establishing wildlife habitat, and enhancing forest and wetland resources. Website: http://www.nrcs.usda.gov/programs/crp/.

The State of New Jersey partnered with the USDA to help farmers protect water quality by establishing a $100 million **Conservation Reserve Enhancement Program (CREP)**, which is the New Jersey version of the federal program**.** Under an agreement signed by Governor McGreevy in February 2004, the USDA provides $77 million and the state contributes $23 million for New Jersey farmers to install stream buffers in order to reduce the flow of nonpoint source pollution into the state's waterways. New Jersey's goal is to enroll 30,000 acres of agricultural land into this state-federal program over a 10-year period. Types of buffers to be installed include trees, shrubs, vegetative filter strips, contour grass strips, and grass waterways. Under the program, a landowner installs and maintains approved practices through a 10- or 15-year rental contract agreement. A landowner entering the state Farmland Preservation Program or Green Acres Program also may opt for a permanent easement under the Conservation Reserve Enhancement Program. This would provide additional payment for permanent maintenance of approved conservation practices. The program will pay landowners annual rental and incentive payments for participating in the program, as well as 100% of the cost to establish approved practices. Additional information can be found at www.fsa.usda.gov, or contact the local FSA office or Soil and Water Conservation District Office.

Another program targeted for wetlands preservation is called the **Wetlands Reserve Program (WRP)**. WRP is a voluntary resource conservation program that provides landowners the opportunity to receive financial incentive to restore, protect, and enhance wetlands in exchange for returning marginal land from

agriculture. WRP is made possible by a reauthorization in the Farm Security and Rural Investment Act of 2002, known as the Farm Bill. The program has three enrollment options: permanent easement, 30-year easement, or restoration cost-share agreement, which has a minimum 10-year commitment. Applications are accepted on a continuous basis and may be obtained and filed at any time. Please see the website for more details: www.nrcs.usda.gov/programs/farmbill/2002/

The **Grassland Reserve Program (GRP)** is another conservation program authorized by the Farm Bill of 2002. GRP is a voluntary program that protects grasslands, pasturelands, and rangelands without prohibiting grazing. Participants voluntarily put limitations on the future land use of their land, while retaining the ability and right to conduct grazing practices, hay production, mow or harvest for seed production, conduct fire rehabilitation, and construct firebreaks and fences. There are four enrollment options: permanent easement; 30-year easement; rental agreement, which is available in 10-, 15-, 20-, or 30-year contracts; and restoration agreement. Participants are compensated in different ways according to the enrollment option. For more information and application procedures, visit the GRP website: www.fsa.usda.gov/dafp/GRP/default1.htm

The **Wildlife Habitat Incentives Program (WHIP)** is similar to those above in that it is also a USDA voluntary program, but differs in that WHIP targets landowners who want to preserve and protect fish and wildlife habitat on nonfederal lands. The program provides technical and cost-sharing assistance to protect these environments. Enrollment consists of a cost-share agreement lasting from five to 10 years. In New Jersey, NRCS has received over $900,000 to implement WHIP since 1998, where the majority of funds have been used for cost-share payments to landowners. A state plan has been developed in New Jersey that targets several areas as priority wildlife habitat areas. NRCS has also targeted a priority species, the bog turtle, for protection. For more information, visit the NRCS New Jersey website: www.nj.nrcs.usda.gov.

The **Environmental Quality Incentives Program (EQIP)** is also a part of the reauthorized Farm Bill of 2002. EQIP is a voluntary program that focuses on conservation and promotes both agricultural production and environmental quality. The program itself offers technical and financial assistance with installation and implementation of structural and management practices on agricultural land. EQIP features a minimum contract term compared to other programs, lasting a maximum of 10 years. Landowners are eligible for incentive and cost-share payments of up to 75%, and sometimes up to 90%, while still engaging in livestock or agricultural production activities. For more information, please visit the website: www.nrcs.usda.gov/programs/eqip.

The **Conservation Security Program (CSP)** is a voluntary program administered by the NRCS and authorized by the Farm Bill of 2002. This program is intended to promote conservation and improvement of soil, water, air, energy, plant and animal life, etc., on tribal and private working lands. Working lands refer to a variety of land types, including cropland, grassland, prairie land, improved pasture, and rangeland. In some cases, forested lands would also be included in this category. CSP is available in 50 states, as well as the Caribbean and Pacific Basin areas, and provides equal access to funding. For more information, please visit the website: www.nrcs.usda.gov/programs/csp/.

The **Forestland Enhancement Program (FLEP)** is also authorized through the Farm Bill of 2002 and replaces the Stewardship Incentives Program (SIP) and the Forestry Incentives Program (FIP). FLEP is a voluntary program for landowners of nonindustrial private forest and provides technical, educational, and cost-sharing assistance in an effort to promote the conservation of these forested areas. Landowners

must have a forest management plan and are limited to 1,000 acres per year for the cost-share practices. For more information about this program, please visit the website: http://www.fs.fed.us/spf/coop/programs/loa/flep.shtml and the National Association of State Foresters website to find your local agency: www.stateforesters.org.

The **Farm and Ranch Lands Protection Program (FRPP)** is a voluntary land conservation program that assists farmers to keep their lands for agricultural purposes. FRPP provides matching funds to those provided by state, tribal, local government, or nongovernment organizations offering farm and ranch protection programs designed to purchase conservation easements. The FRPP is authorized by the Farm Bill of 2002 and is managed by the NRCS. Conservation easements are purchased by the state, tribal, or local entity. The participating landowner agrees not to convert his or her land to nonagricultural uses, as well as to develop a conservation plan for any highly erodable lands. Landowners do, however, maintain all of their rights to utilize their land for agricultural purposes. For more information about FRPP, please visit the website: www.nrcs.usda.gov/programs/farmbill/2002/ and search for the Farm and Ranch Lands Protection Program.

The **State Agricultural Development Committee (SADC) in New Jersey** has made soil and water conservation grants available as part of the Farmland Preservation Program. The grants give landowners up to 50% of costs associated with approved soil and water conservation projects. Farms are only eligible if they are already enrolled in a permanent or eight-year easement program. Soil projects can include measures to prevent or control erosion, control pollution on agricultural land, and improve water management for agricultural purposes. Projects must be completed within three years of SADC funding approval. However, under special circumstances, the grant may be renewed for an additional year. For more information, contact the local Soil Conservation District, or the State Agricultural Development Committee at (609) 984-2504, or visit the website: http://www.state.nj.us/agriculture/sadc/sadc.htm for additional details.

The **Landowner Incentive Program (LIP)** is a preservation program for private landowners who wish to protect and conserve rare wildlife habitat and species. LIP is funded by the U.S. Fish and Wildlife Service and is administered by the New Jersey Department of Environmental Protection’s Division of Fish and Wildlife Endangered Nongame Species Program. Participating landowners receive both technical and financial assistance through this competitive grant program. Last year, $1.12 million was awarded for a variety of preservation programs, including habitat improvements, habitat management, and habitat protection projects. Generally, a five-year minimum commitment is required, and longer terms are preferred. A 25% cost share is required of the landowner. While the LIP is seeking funding for additional habitat protection projects, it may be another year before grants are available. Interested landowners are encouraged to contact Kim Korth, ENSP assistant zoologist at (609) 984-1581 for additional details. To learn more about the program in general, visit the website: http://www.state.nj.us/dep/fgw/ensp/lip_prog.htm or http://www.state.nj.us/dep/fgw/ensp/pdf/lip_broch.pdf.

APPENDIX C

Vertebrate Fauna of Greenwich Township

Mammals

Common Name	Scientific Name	New Jersey Status
Big Brown Bat	*Eptesicus fuscus*	Stable
Chipmunk	*Tamias striatus*	Stable
Eastern Cottontail	*Sylvilagus floridanus*	Stable
Eastern Mole	*Scalopus aquaticus*	Stable
Gray Fox	*Urocyon cinereoargenteus*	Stable
Gray Squirrel	*Sciurus carolinensis*	Stable
House Mouse	*Mus musculus*	Introduced
Little Brown Bat	*Myotis lucifugus*	Stable
Long-tailed Shrew	*Sorex dispar*	Undetermined
Marsh Rice Rat	*Oryzomys palustris*	Stable
Meadow Vole	*Microtus pennsylvanicus*	Stable
Muskrat	*Ondatra zibethicus*	Stable
Norway Rat	*Rattus norvegicus*	Introduced
Opossum	*Didelphis marsupialis*	Stable
Raccoon	*Procyon lotor*	Stable
Red Fox	*Vulpes vulpes*	Stable
Red Squirrel	*Tamiasciurus hudsonicus*	Stable
River Otter	*Lutra canadensis*	Stable
Striped Skunk	*Mephitis mephitis*	Stable
White-tailed Deer	*Odocoileus virginianus*	Decreasing
Woodchuck	*Marmota monax*	Stable

Birds

Common Name	Scientific Name	New Jersey Status
American Black Duck	*Anas rubripes*	Regional Priority
American Crow	*Corvus brachyrhynchos*	Stable
American Kestrel	*Falco sparverius*	Special Concern
American pipit	*Anthus rubescens*	Undetermined
Bald eagle	*Haliaeetus leucocephalus*	Endangered
Barred Owl	*Strix varia*	Threatened
Black Rail	*Laterallus jamaicensis*	Threatened
Black skimmer	*Rynchops niger*	Endangered
Black Vulture	*Coragyps atratus*	Increasing
Broad-winged Hawk	*Buteo platypterus*	Special Concern

Common Name	Scientific Name	New Jersey Status
Canada Goose	*Branta canadensis*	Increasing
Cedar Waxwing	*Bombycilla cedrorum*	Stable
Chipping Sparrow	*Spizella passerina*	Stable
Common Barn Owl	*Tyto alba*	Special Concern
Common Quail	*Coturnix coturnix*	Stable
Cooper's Hawk	*Accipiter cooperii*	Threatened
Egret	*Egretta*	Regional Priority
Field Sparrow	*Spizella pusilla*	Regional Priority
Grasshopper Sparrow	*Ammodramus savannarum*	Threatened
Great Horned Owl	*Bubo virginianus*	Stable
Horned Lark	*Eremophila alpestris*	Special Concern
Killdeer	*Charadrius vociferus*	Stable
Least Tern	*Sterna antillarum*	Endangered
Merlin	*Falco columbarius*	Increasing
Mute Swan	*Cygnus olor*	Introduced
Northern Bobwhite	*Colinus virginianus*	Regional Priority
Branta canadensis	*Colaptes auratus*	Regional Priority
Northern Goshawk	*Accipiter gentilis*	Endangered
Northern harrier	*Circus cyaneus*	Endangered
Osprey	*Pandion haliaetus*	Threatened
Peregrine falcon	*Falco peregrinus*	Endangered
Red Knot	*Calidris canutus*	Threatened
Red-shouldered hawk	*Buteo lineatus*	Endangered
Red-tailed Hawk	*Buteo jamaicensis*	Increasing
Red-throated Loon	*Gavia stellata*	Regional Priority
Red-winged Blackbird	*Agelaius phoeniceus*	Stable
Ring-necked Pheasant	*Phasianus colchicus*	Decreasing
Rough-legged Hawk	*Buteo lagopus*	Decreasing
Ruffed Grouse	*Bonasa umbellus*	Decreasing
Sanderling	*Calidris alba*	Special Concern
Sharp-shinned Hawk	*Accipiter striatus*	Special Concern
Short-eared owl	*Asio flammeus*	Endangered
Snow Goose	*Chen caerulescens*	Increasing
Swainson's Hawk	*Catharus ustulatus*	Stable
Swallow	*Tachycineta bicolor*	Increasing
Turkey Vulture	*Cathartes aura*	Increasing
Upland sandpiper	*Bartramia longicauda*	Endangered
Vireo	*Vireo*	
Willet	*Catoptrophorus semipalmatus*	Regional Priority
Wood Duck	*Aix sponsa*	Regional Priority

Reptiles

Common Name	Scientific Name	New Jersey Status
Black Racer Snake	*Coluber c. constrictor*	Undetermined
Black Rat Snake	*Elaphe o. obsoleta*	Undetermined
Eastern Box Turtle	*Terrapene c. carolina*	Stable
Eastern Mud Turtle	*Kinosternon s. subrubrum*	Undetermined
Eastern Painted Turtle	*Chrysemys p. picta*	Stable
Northern Diamondback Terrapin	*Malaclemys t. terrapin*	Decreasing
Northern Water Snake	*Nerodia s. sipedon*	Stable
Red-bellied Turtle	*Pseudemys rubriventris*	Undetermined
Snapping Turtle	*Chelydra s. serpentina*	Stable
Southern Ringneck Snake	*Diadophis p. punctatus*	Stable

Amphibians

Common Name	Scientific Name	New Jersey Status
Bullfrog	*Rana catesbeiana*	Stable
Fowler's Toad	*Bufo woodhousii fowleri*	Special Concern
Green Frog	*Rana clamitans melanota*	Stable
Northern Gray Treefrog	*Hyla versicolor*	Stable
Northern Spring Peeper Frog	*Hyla c. crucifer*	Stable
Red-backed Salamander	*Plethodon c. cinereus*	Stable
Southern Leopard Frog	*Rana spenocephala*	Stable

Freshwater Fish

Common Name	Scientific Name	Historical Presence
American eel	*Anguilla rostrata*	Native
Common carp	*Cyprinus carpio*	Exotic
Golden shiner	*Notemigonus crysoleucas*	Native
White catfish	*Ameiurus catus*	Native
Brown bullhead	*Ameiurus nebulosus*	Native
Channel catfish	*Ictalurus punctatus*	Introduced
Chain pickerel	*Esox niger*	Native
Eastern mudminnow	*Umbra pygmaea*	Native
Mummichog	*Fundulus heteroclitus*	Native
White perch	*Morone americana*	Native
Striped bass	*Morone saxatilis*	Native
Pumpkinseed	*Lepomis gibbosus*	Native
Bluegill	*Lepomis macrochirus*	Introduced
Largemouth bass	*Micropterus salmoides*	Introduced
Black crappie	*Pomoxis nigromaculatus*	Introduced
Yellow perch	*Perca flavescens*	Native
Hogchoker	*Trinectes maculatus*	Native

Sources: NJDEP Dept of Fish and Wildlife, 2008; PSE&G Bayside Tract Management Plan, 1995; Greenwich Township Master Plan, 1995; Arndt, Rudolf G. "Annotated Checklist…," 2004.

Birds Observed in Greenwich Township

STATUS CODES

A – Abundant (May be seen on any given day in numbers) C – Common (May be seen more than once a week) U – Uncommon (May be seen a few times a year) R – Rare (may be seen once a year or less frequently) Ac – Accidental (May be seen only once over many years)	D – Decreasing I – Increasing S – Stable U – Undetermined	B – Breeding W - Winters Pb - Possibly breeding M - Migrant

COMMON NAME	SCIENTIFIC NAME	OBSERVED	STATUS		SEASON
Red-throated loon	*Gavia stellata*	Yes ☑	U	U	W
Common loon	*Gavia immer*	Yes ☑	U	U	W
Pied-billed grebe	*Podilymbus podiceps*	Yes ☑	U	U	W
Northern gannet	*Morus bassanus*	Yes ☑	R	U	W
Great cormorant	*Phalacrocorax carbo*	Yes ☑	R	U	W
Double-crested cormorant	*Phalacrocorax auritus*	Yes ☑	C	S	
American bittern	*Botaurus lentiginosos*	Yes ☑	U	U	Pb
Least bittern	*Ixobrychus exilis*	Yes ☑	U	U	Pb
Great blue heron	*Ardea herodias*	Yes ☑	C	S	
Great egret	*Casmerodius albus*	Yes ☑	C	S	Pb
Snowy egret	*Egretta thula*	Yes ☑	C	S	Pb
Little blue heron	*Egretta caerulea*	Yes ☑	U	U	Pb
Tricolored heron	*Egretta tricolor*	Yes ☑	U	U	Pb
Cattle egret	*Bubulcus ibis*	Yes ☑	U	D	
Green heron	*Butorides striatus*	Yes ☑	C	S	Pb

COMMON NAME	SCIENTIFIC NAME	OBSERVED	STATUS		SEASON
Black-crowned night heron	*Nycticorax nycticorax*	Yes ☑	U	U	
Yellow-crowned night heron	*Nyctanassa violaceus*	Yes ☑	U		Pb
Glossy ibis	*Plegadis falcinellus*	Yes ☑	C	S	
Tundra swan	*Cygnus columbianus*	Yes ☑	R	U	W
Mute swan	*Cygnus olor*	Yes ☑	C	S	
Snow goose	*Chen caerulescens*	Yes ☑	A	S	W
Brant	*Branta bernicla*	Yes ☑	R	U	
Canada goose	*Branta canadensis*	Yes ☑	A	I	W
Wood duck	*Aix sponsa*	Yes ☑	U	S	Pb
Green-winged Teal	*Anas crecca*	Yes ☑	C	S	
American black duck	*Anas rubripes*	Yes ☑	C	S	Pb W
Mallard	*Anas platyrhynchos*	Yes ☑	C	S	Pb W
Northern pintail	*Anas acuta*	Yes ☑	U	S	
Blue-winged teal	*Anas discors*	Yes ☑	U	S	
Northern shoveler	*Anas clypeata*	Yes ☑	R	U	
Gadwall	*Anas Strepera*	Yes ☑	U	U	
American wigeon	*Anas americana*	Yes ☑	U	U	
Canvasback	*Aythya valisineria*	Yes ☑	U	S	W
Redhead	*Aythya americana*	Yes ☑	R	U	
Greater scaup	*Aythya marila*	Yes ☑	U	U	W
Lesser scaup	*Aythya affinis*	Yes ☑	U	U	W
Black scoter	*Melanitta nigra*	Yes ☑	U	U	W
Surf scoter	*Melanitta perspicillata*	Yes ☑	U	U	W

COMMON NAME	SCIENTIFIC NAME	OBSERVED	STATUS		SEASON
White-winged scoter	*Melanitta fusca*	Yes ☑	R		W
Common goldeneye	*Bucephala clangula*	Yes ☑	U	U	W
Bufflehead	*Bucephala albeola*	Yes ☑	U	U	W
Hooded merganser	*Lophodytes cucullatus*	Yes ☑	U	U	W
Common merganser	*Mergus merganser*	Yes ☑	C	S	W
Red-breasted merganser	*Mergus serrator*	Yes ☑	R		
Ruddy duck	*Oxyura jamaicensis*	Yes ☑	U	S	W
Black vulture	*Coragyps atratus*	Yes ☑	C	S	
Turkey vulture	*Cathartes aura*	Yes ☑	A	S	Pb
Osprey	*Pandion haliaetus*	Yes ☑	C	S	Pb
Bald eagle	*Haliaeetus leucocephalus*	Yes ☑	C	I	Pb
Northern harrier	*Circus cyaneus*	Yes ☑	C	D	W
Sharp-shinned hawk	*Accipiter striatus*	Yes ☑	C	S	W
Cooper's hawk	*Accipiter Cooperii*	Yes ☑	C	S	W
Northern goshawk	*Accipiter gentilis*	Yes ☑	R		
Red-shouldered hawk	*Buteo lineatus*	Yes ☑	U		
Broad-winged hawk	*Buteo platypterus*	Yes ☑	U		
Red-tailed hawk	*Buteo jamaicensis*	Yes ☑	C	S	Pb
Rough-legged hawk	*Buteo lagopus*	Yes ☑	R		
Golden eagle	*Aquila chrysaetos*	Yes ☑	R		

COMMON NAME	SCIENTIFIC NAME	OBSERVED	STATUS		SEASON
American kestrel	*Falco sparverius*	Yes ☑	C	D	W
Merlin	*Falco columbarius*	Yes ☑	U		
Peregrine falcon	*Falco peregrinus*	Yes ☑	R		
Ring-necked pheasant	*Phasianus colchicus*	Yes ☑	U	D	W
Eastern wild turkey	*Meleagris gallopavo*	Yes ☑	A	I	W
Northern bobwhite	*Colinus virginianus*	Yes ☑	R	D	W
Black rail	*Laterallus jamaicensis*	Yes ☑	R		
Clapper rail	*Rallus longirostris*	Yes ☑	C	S	Pb
King rail	*Rallus elegans*	Yes ☑	U	U	Pb
Virginia rail	*Rallus limocola*	Yes ☑	U	U	Pb
Common moorhen	*Gallinula chloropus*	Yes ☑	R	U	
Purple gallinule	*Porphyrula martinica*	Yes ☑	R		
American coot	*Fulica americana*	Yes ☑	U	U	W
Black-bellied plover	*Pluvialis squatarola*	Yes ☑	U	U	
American golden pover	*Pluvialis dominica*	Yes ☑	R		
Semipalmated plover	*Charadrius semipalmatus*	Yes ☑	C	S	
Killdeer	*Charadrius vociferus*	Yes ☑	C	S	Pb
American oystercatcher	*Haematopus palliatus*	Yes ☑	R		
Greater yellowlegs	*tringa melanoleuca*	Yes ☑	C	S	W
Lesser yellowlegs	*tringa flavipes*	Yes ☑	C	S	W
Solitary sandpiper	*tringa solitaria*	Yes ☑	U		
Willet	*Catoptrophorus semipalmatus*	Yes ☑	C	S	Pb

COMMON NAME	SCIENTIFIC NAME	OBSERVED	STATUS		SEASON
Spotted sandpiper	*Actitis macularia*	Yes ☑	U	S	
Whimbrel	*Numenius phaeopus*	Yes ☑	C	S	Pb
Hudsonian godwit	*Limosa haemastica*	Yes ☑	Ac		
Ruddy turnstone	*Arenaria interpres*	Yes ☑	U	S	
Red knot	*Calidris canutus*	Yes ☑	U	D	
Sanderling	*Calidris alba*	Yes ☑	C	S	
Semipalmated sandpiper	*Calidris pusilla*	Yes ☑	A	S	
Western sandpiper	*Calidris mauri*	Yes ☑	U		
Least sandpiper	*Calidris minutilla*	Yes ☑	U		
White-rumped sandpiper	*Calidris fuscicollis*	Yes ☑	R		
Dunlin	*Calidris alpina*	Yes ☑	R		
Stilt sandpiper	*Calidris himantopus*	Yes ☑	R		
Ruff	*Philomachus pugnax*	Yes ☑	Ac		
Short-billed dowitcher	*Limnodromus griseus*	Yes ☑	U		
Long-billed dowitcher	*Limnodromus scolopaceus*	Yes ☑	R		
Common snipe	*Gallinago gallinago*	Yes ☑	U	D	
American woodcock	*Philohela minor*	Yes ☑	U	S	
Laughing gull	*Larus atricilla*	Yes ☑	A	S	
Ring-billed gull	*Larus delawarensis*	Yes ☑	A	S	
Herring gull	*Larus argentatus*	Yes ☑	C	S	
Lesser black-backed gull	*Larus fuscus*	Yes ☑	Ac		

COMMON NAME	SCIENTIFIC NAME	OBSERVED	STATUS		SEASON
Great black-backed gull	*Larus marinus*	Yes ☑	C	S	
Caspian tern	*Sterna caspia*	Yes ☑	U	S	
Common tern	*Sterna hirundo*	Yes ☑	R		
Forster's tern	*Sterna forsteri*	Yes ☑	A	S	
Rock dove	*Columba livia*	Yes ☑	C	S	Pb
Mourning dove	*Zenaida macroura*	Yes ☑	A	S	Pb
Black-billed cuckoo	*Coccyzus erythropthalmus*	Yes ☑	U	S	Pb
Yellow-billed cuckoo	*Coccyzus americanus*	Yes ☑	U	S	Pb
Common barn owl	*Tyto alba*	Yes ☑	U	D	Pb
Eastern screech owl	*Otus asio*	Yes ☑	C	S	Pb
Great horned owl	*Bubo virginianus*	Yes ☑	C	S	Pb
Snowy owl	*Nyctea scandiaca*	Yes ☑	Ac		
Barred owl	*Strix varia*	Yes ☑	U	U	Pb
Common nighthawk	*Chordeiles minor*	Yes ☑	R		
Chuck-will's-widow	*Caprimulgus carolinensis*	Yes ☑	R		
Whip-poor-will	*Caprimulgus vociferus*	Yes ☑	R		
Chimney swift	*Chaetura pelagica*	Yes ☑	C	S	Pb
Ruby-throated hummingbird	*Archilochus colubris*	Yes ☑	C	S	Pb
Belted kingfisher	*Ceryle alcyon*	Yes ☑	C	S	W
Red-bellied woodpecker	*Melanerpes carolinus*	Yes ☑	C	S	Pb

COMMON NAME	SCIENTIFIC NAME	OBSERVED	STATUS		SEASON
Yellow-bellied sapsucker	*Sphyrapicus varius*	Yes ☑	U		W
Downy woodpecker	*Picoides pubescens*	Yes ☑	C	S	Pb
Hairy woodpecker	*Picoides villosus*	Yes ☑	U	I	Pb
Northern flicker	*Colaptes auratus*	Yes ☑	C	S	Pb
Olive-sided flycatcher	*Contopus borealis*	Yes ☑	R		
Eastern wood pewee	*Contopus virens*	Yes ☑	U	S	
Yellow-bellied flycatcher	*Empidonax flaviventris*	Yes ☑	R		
Acadian flycatcher	*Empidonax virescens*	Yes ☑	R		
Alder flycatcher	*Empidonax alnorum*	Yes ☑	R		
Willow flycatcher	*Empidonax traillii*	Yes ☑	U		
Least flycatcher	*Empidonax minimus*	Yes ☑	U		
Eastern phoebe	*Sayornis phoebe*	Yes ☑	C	S	Pb
Great crested flycatcher	*Myiarchus crinitus*	Yes ☑	U	S	
Eastern kingbird	*Tyrannus Tyrannus*	Yes ☑	C	S	Pb
Horned lark	*Eremophila alpestris*	Yes ☑	U	U	W
Purple martin	*Progne subis*	Yes ☑	C	S	Pb
Tree swallow	*Tachycineta bicolor*	Yes ☑	C	S	Pb
Northern rough-winged swallow	*Stelgidopteryx serripennis*	Yes ☑	U		
Bank swallow	*Riparia riparia*	Yes ☑	U		
Cliff swallow	*Hirundo pyrrhonota*	Yes ☑	Ac		
Barn swallow	*Hirundo rustica*	Yes ☑	C	S	Pb

COMMON NAME	SCIENTIFIC NAME	OBSERVED	STATUS		SEASON
Blue Jay	*Cyanocitta cristata*	Yes ☑	C	S	Pb
American crow	*Corvus brachyrhynchos*	Yes ☑	C	S	Pb
Fish crow	*Corvus ossifragus*	Yes ☑	C	S	Pb
Carolina chickadee	*Parus carolinensis*	Yes ☑	C	S	Pb
Tufted titmouse	*Parus bicolor*	Yes ☑	C	S	Pb
Red-breasted nuthatch	*Sitta canadensis*	Yes ☑	U	U	W
White-breasted nuthatch	*Sitta carolinensis*	Yes ☑	C	S	Pb
Brown creeper	*Certhia americana*	Yes ☑	U	S	Pb
Carolina wren	*Thryothorus ludovicianus*	Yes ☑	C	S	Pb
House wren	*troglogytes aedon*	Yes ☑	C	S	Pb
Winter wren	*troglodytes troglodytes*	Yes ☑	R		
Sedge wren	*Cistothorus platensis*	Yes ☑	R		
Marsh wren	*Cistothorus palustris*	Yes ☑	C	S	Pb
Golden-crowned kinglet	*Regulus satrapa*	Yes ☑	U		W
Ruby-crowned kinglet	*Regulus calendula*	Yes ☑	U		
Blue-gray gnatcatcher	*Polioptila caerulea*	Yes ☑	C	S	Pb
Eastern bluebird	*Sialia sialis*	Yes ☑	C	S	Pb
Veery	*Catharus fuscescens*	Yes ☑	U		
Gray-cheeked thrush	*Catharus minimus*	Yes ☑	R		
Swainson’s thrush	*Catharus ustulatus*	Yes ☑	R		
Hermit thrush	*Catharus guttatus*	Yes ☑	U	S	W

COMMON NAME	SCIENTIFIC NAME	OBSERVED	STATUS		SEASON
Wood thrush	*Hylocichla mustelina*	Yes ☑	C	D	Pb
American robin	*Turdus migratorius*	Yes ☑	A	S	Pb
Gray catbird	*Dumetella carolinensis*	Yes ☑	C	S	Pb
Northern mockingbird	*Mimus polyglottos*	Yes ☑	C	S	Pb
Brown thrasher	*Toxostoma rufum*	Yes ☑	U	S	Pb
Water pipit	*Anthus rubescens*	Yes ☑	U	U	W
Cedar waxwing	*Bombycilla cedrorum*	Yes ☑	U	S	Pb
Loggerhead shrike	*Lanius ludovicianus*	Yes ☑	Ac		
European starling	*Sturnus vulgaris*	Yes ☑	A	S	Pb
White-eyed vireo	*Vireo griseus*	Yes ☑	U	S	Pb
Blue-headed vireo	*Vireo solitarius*	Yes ☑	R		
Yellow-throated vireo	*Vireo flavifrons*	Yes ☑	R		
Warbling vireo	*Vireo gilvus*	Yes ☑	R		
Philadelphia vireo	*Vireo philadelphicus*	Yes ☑	R		
Red-eyed vireo	*Vireo olivaceus*	Yes ☑	C	S	Pb
Blue-winged warbler	*Vermivora pinus*	Yes ☑	U		
Tennessee warbler	*Vermivora peregrina*	Yes ☑	R		
Orange-crowned warbler	*Vermivora celata*	Yes ☑	R		
Nashville warbler	*Vermivora reficapilla*	Yes ☑	R		
Northern parula	*Parula americana*	Yes ☑	R		
Yellow warbler	*Dendroica petechia*	Yes ☑	C	S	Pb
Chestnut-sided warbler	*Dendroica pensylvanica*	Yes ☑	U		

COMMON NAME	SCIENTIFIC NAME	OBSERVED	STATUS		SEASON
Magnolia warbler	*Dendroica magnolia*	Yes ☑	U		
Cape May warbler	*Dendroica tigrina*	Yes ☑	R		
Black-throated blue warbler	*Dendroica caerulescens*	Yes ☑	U		
Yellow-rumped warbler	*Dendroica coronata*	Yes ☑	C	S	W
Black-throated green warbler	*Dendroica virens*	Yes ☑	U		
Blackburnian warbler	*Dendroica fusca*	Yes ☑	R		
Yellow-throated warbler	*Dendroica dominica*	Yes ☑	U		
Pine warbler	*Dendroica pinus*	Yes ☑	U		
Prairie warbler	*Dendroica discolor*	Yes ☑	U		
Palm warbler	*Dendroica palmarum*	Yes ☑	R		
Bay-breasted warbler	*Dendroica castanea*	Yes ☑	R		
Blackpoll warbler	*Dendroica striata*	Yes ☑	R		
Cerulean warbler	*Dendroica cerulea*	Yes ☑	R		
Black-and-white warbler	*Miniotilta varia*	Yes ☑	U		
American redstart	*Setophaga ruticilla*	Yes ☑	U		
Ovenbird	*Seiurus aurocapillus*	Yes ☑	C	S	Pb
Northern waterthrush	*Seiurus noveboracensis*	Yes ☑	R		
Connecticut warbler	*Oporornis agilis*	Yes ☑	R		
Common yellowthroat	*Geothlypis trichas*	Yes ☑	C	S	Pb
Hooded warbler	*Wilsonia citrina*	Yes ☑	U	U	Pb

COMMON NAME	SCIENTIFIC NAME	OBSERVED	STATUS		SEASON
Wilson's warbler	*Wilsonia pusilla*	Yes ☑	R		
Canada warbler	*Wilsonia canadensis*	Yes ☑	R		
Yellow-breasted chat	*Icteria virens*	Yes ☑	U	U	Pb
Summer tanager	*Piranga rubra*	Yes ☑	R		
Scarlet tanager	*Piranga olivacea*	Yes ☑	U	U	
Northern cardinal	*Cardinalis cardinalis*	Yes ☑	C	S	Pb
Rose-breasted grosbeak	*Pheucticus ludovicianus*	Yes ☑	R		
Blue grosbeak	*Guiraca caerulea*	Yes ☑	U	I	Pb
Indigo bunting	*Passerina cyanea*	Yes ☑	C	S	Pb
Eastern towhee	*Pipilo erythrophthalmus*	Yes ☑	C	S	Pb
American tree sparrow	*Spizella arborea*	Yes ☑	R		
Chipping sparrow	*Spizella passerina*	Yes ☑	C	S	Pb
Field sparrow	*Spizella pusilla*	Yes ☑	C	S	Pb
Vesper sparrow	*Pooecetes gramineus*	Yes ☑	R		
Savannah sparrow	*Passerculus sandwichensis*	Yes ☑	U	U	
Saltmarsh sharp-tailed sparrow	*Ammodramus caudacutus*	Yes ☑	R		
Seaside sparrow	*Ammodramus maritima*	Yes ☑	C	S	Pb
Fox sparrow	*Passerella iliaca*	Yes ☑	U	U	W
Song sparrow	*Melospiza melodia*	Yes ☑	C	S	Pb
Lincoln's sparrow	*Melospiza lincolnii*	Yes ☑	R		
Swamp sparrow	*Melospiza georgiana*	Yes ☑	C	S	Pb
White-throated sparrow	*Zonotrichia albicollis*	Yes ☑	A	S	W

COMMON NAME	SCIENTIFIC NAME	OBSERVED	STATUS		SEASON
White-crowned sparrow	*Zonotrichia leucophrys*	Yes ☑	R		
Dark-eyed junco	*Junco hyemalis*	Yes ☑	A	S	W
Snow bunting	*Plectophenax nivalis*	Yes ☑	R		
Bobolink	*Dolichonyx oryzivorus*	Yes ☑	R		
Red-winged blackbird	*Agelaius phoeniceus*	Yes ☑	A	S	Pb
Eastern meadowlark	*Sturnella magna*	Yes ☑	U	D	Pb
Rusty blackbird	*Euphagus carolinus*	Yes ☑	R		
Boat-tailed grackle	*Quiscalus major*	Yes ☑	C	S	PB
Common grackle	*Quiscalus quiscula*	Yes ☑	A	S	Pb
Brown-headed cowbird	*Molothrus ater*	Yes ☑	C	S	Pb
Orchard oriole	*Icterus spurius*	Yes ☑	C	S	Pb
Baltimore oriole	*Icterus galbula*	Yes ☑	C	S	PB
Purple finch	*Carpodacus purpureus*	Yes ☑	U		W
House finch	*Carpodacus mexicanus*	Yes ☑	C	S	Pb
Common redpoll	*Carduelis flammea*	Yes ☑	Ac		
Hoary redpoll	*Carduelis hornemanni*	Yes ☑	Ac		
American goldfinch	*Carduelis tristis*	Yes ☑	C	S	Pb
European goldfinch	*Carduelis carduelis*	Yes ☑	A		
House sparrow	*Passer domesticus*	Yes ☑	C	I	Pb

Source: Greenwich Township Environmental Commission, 2008

Rare Plants Likely Occurring in Greenwich Township

Name	Common Name	Federal Status	State Status	Reg'l Status	Global Element Rank	State Element Rank	Habitat
Sesuvium Maritimum	Seabeach Purslane				G5	S2	Estuarine; Palustrine; Terrestrial
Cyperus Polystachyos	Coast Flat Sedge		E		G5T5	S1	Palustrine
Puccinellia Fasciculata	Saltmarsh Alkali Grass				G3G5	S2	Estuarine
Pinus Taeda	Loblolly Pine				G5	S2	Palustrine; Terrestrial
Rhynchospora Pallida	Pale Beaked-Rush				G3	S3	Palustrine
Helonias Bullata	Swamp-Pink	T	E	LP	G3	S3	Palustrine
Ruellia Caroliniensis	Carolina Petunia		E		G5	SH	Palustrine; Terrestrial
Desmodium Viridiflorum	Velvety Tick-Treefoil				G5?	S2	Terrestrial
Schoenoplectus Novae-Angliae	New England Bulrush				G5	S2	Estuarine

Source: NJDEP Natural Heritage Program, 2008

Key to Federal, State, and Regional Status Codes

T	Threatened species – may become endangered if conditions surrounding the species begin to or continue to deteriorate.
E	Endangered species – one whose prospects for survival within the state are in immediate danger due to one or many factors.
INC	Increasing species – population has exhibited a significant increase
S	Stable species
D	Declining species – species that exhibited a continued decline in population numbers over the years.
LP	Indicates taxa listed by the Pinelands Commission as endangered or threatened within their legal jurisdiction. Not all species currently tracked by the Pinelands Commission are tracked by the Natural Heritage Program. A complete list of endangered and threatened Pineland species is included in the New Jersey Pinelands Comprehensive Management Plan

Key to Global Element Rank

G1	Critically imperiled globally because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction
G2	Imperiled globally because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range
G3	Either very rare or local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g., a single western state, a physiographic region in the East) or because of other factors making it vulnerable to extinction throughout its range; with the number of occurrences in the range of 21 to 100.
G4	Apparently secure globally; although it may be quite rare in parts of its range, especially at the periphery
G5	Demonstrably secure globally; although it may be quite rare in parts of its range, especially at the periphery
T	Element ranks containing a “T” indicate that infraspecific taxon is being ranked differently than the full species.
Note: To express uncertainty, the most likely rank is assigned and a question mark added (e.g., G2?). A range is indicated by combining two ranks (e.g., G1G2, S1S3).	

Key to State Element Rank

S1	Critically imperiled in New Jersey because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres). Elements so ranked are often restricted to very specialized conditions or habitats and/or restricted to an extremely small geographic area of the state. Also, included are elements which were formerly more abundant, but because of habitat destruction or some other critical factor of its biology, they have been demonstrably reduced in abundance. In essence, these are elements for which, even with intensive searching, sizable additional occurrences are unlikely to be discovered.
S2	Imperiled in New Jersey because of rarity (6 to 20 occurrences). Historically many of these elements may have been more frequent but are now known from very few extant occurrences, primarily because of habitat destruction. Diligent searching may yield additionally occurrences.

S3	Rare in state with 21 to 100 occurrences (plant species and ecological communities in this category have only 21 to 50 occurrences). Includes elements which are widely distributed in the state but with small populations/acreage or elements with restricted distribution, but locally abundant. Not yet imperiled in state but may soon be if current trends continue. Searching often yields additional occurrences.
SH	Elements of historical occurrence in New Jersey. Despite some searching of historical occurrences and/or potential habitat, no extant occurrences are known. Since not all of the historical occurrences have been field surveyed, and unsearched potential habitat remains, historically ranked taxa are considered possibly extant, and remain a conservation priority for continued field work.

NATURAL HERITAGE PROGRAM DISCLAIMER

CAUTIONS AND RESTRICTIONS ON NATURAL HERITAGE DATA

The quantity and quality of data collected by the Natural Heritage Program is dependent on the research and observations of many individuals and organizations. Not all of this information is the result of comprehensive or site-specific field surveys. Some natural areas in New Jersey have never been thoroughly surveyed. As a result, new locations for plant and animal species are continuously added to the database. Since data acquisition is a dynamic, ongoing process, the Natural Heritage Program cannot provide a definitive statement on the presence, absence, or condition of biological elements in any part of New Jersey. Information supplied by the Natural Heritage Program summarizes existing data known to the program at the time of the request regarding the biological elements or locations in question. They should never be regarded as final statements on the elements or areas being considered, nor should they be substituted for on-site surveys required for environmental assessments. The attached data is provided as one source of information to assist others in the preservation of natural diversity.

This office cannot provide a letter of interpretation or a statement addressing the classification of wetlands as defined by the Freshwater Wetlands Act. Requests for such determination should be sent to the DEP Land Use Regulation Program, P.O. Box 401, Trenton, NJ 08625-0401.

The Landscape Project was developed by the Division of Fish & Wildlife, Endangered and Nongame Species Program to map critical habitat for rare animal species. Some of the rare species data in the Landscape Project is in the Natural Heritage Database, while other records were obtained from other sources. Natural Heritage Database response letters will list all species (if any) found during a search of the Landscape Project. However, any reports that are included with the response letter will only reference specific records if they are in the Natural Heritage Database. This office cannot answer any inquiries about the Landscape Project. All questions should be directed to the DEP Division of Fish and Wildlife, Endangered and Nongame Species Program, P.O. Box 400, Trenton, NJ 08625-0400.

This cautions and restrictions notice must be included whenever information provided by the Natural Heritage Database is published.

NJ Department of Environmental Protection
Division of Parks and Forestry
Natural Lands Management

State Endangered and Threatened Species

Birds

Endangered		Threatened	
American Bittern	*Botaurus lentiginosos BR*	Bobolink	*Dolichonyx oryzivorus*
Eagle, bald	*Haliaeetus leucocephalus BR*	Eagle, bald	*Haliaeetus leucocephalus NB*
Falcon, peregrine	*Falco peregrinus*	Hawk, Cooper's	*Accipiter cooperii*
Goshawk, northern	*Accipiter gentilis BR*	Hawk, red-shouldered	*Butuo lineatus NB*
Grebe, pied-billed	*Podilymbus podiceps*	Night-heron, black-crowned	*Nycticorax nycticorax BR*
Harrier, northern	*Circus cyaneus BR*	Night-heron, yellow-crowned	*Nyctanassa violaceus*
Hawk, red-shouldered	*Butuo lineatus BR*	Knot, red	*Calidris canutus BR*
Owl, short-eared	*Asio flammeus BR*	Osprey	*Pandion haliaetus BR*
Plover, piping	*Charadrius melodus***	Owl, barred	*Strix varia*
Sandpiper, upland	*Batramia longicauda*	Owl, long-eared	*Asio otus*
Shrike, loggerhead	*Lanius ludovicianus*	Rail, black	*Laterallus jamaicensis*
Skimmer, black	*Rynchops nige BRr*	Skimmer, black	*Rynchops nigher NB*
Sparrow, Henslow's	*Ammodramus henslowii*	Sparrow, grasshopper	*Ammodramus savannarum BR*
Sparrow, vesper	*Pooecetes gramineus BR*	Sparrow, Savannah	*Passerculus sandwichensis BR*
Tern, least	*Sterna antillarum*	Sparrow, vesper	*Pooecetes gramineus NB*
Tern, roseate	*Sterna dougallii***	Woodpecker, red-headed	*Melanerpes erythrocephalus*
Wren, sedge	*Cisothorus platensis*		

Reptiles

Endangered		Threatened	
Rattlesnake, timber	*Crotalus h. horridus*	Snake, northern pine	*Pituophis m. melanoleucus*
Snake, corn	*Elaphe g. guttata*	Turtle, Atlantic green	*Chelonia mydas***
Snake, queen	*Regina septemvittata*	Turtle, wood	*Clemmys insculpta*

Altantic hawksbill	*Eretmochelys imbricate***		
Atlantic leatherback	*Demrochelys coriacea***		
Atlantic loggerhead	*Caretta caretta***		
Atlantic Ridley	*Lepidochelys kempi***		

Amphibians

Endangered		Threatened	
Salamander, blue-spotted	*Ambystoma laterale*	Salamander, eastern mud	*Pseudotriton montanus*
Salamander, eastern tiger	*Ambystoma tigrinum*	Salmander, long-tailed	*Eurycea longicauda*
Treefrog, southern gray	*Hyla chrysocelis*	Treefrog, pine barrens	*Hyla andersonii*

Invertebrates

Endangered		Threatened	
Beetle, American burying	*Nicrophorus mericanus***	Elfin, frosted (butterfly)	*Callophrys irus*
Beetle, northeastern beach tiger	*Cincindela d. dorsalis***	Floater, triangle (mussel)	*Alasmidonta undulata*
Cooper, bronze	*Lycaena hyllus*	Fritillary, silver-bordered (butterfly)	*Bolaria selene myrina*
Floater, brook (mussel)	*Alasmidonta varicose*	Lampmussel, eastern (mussel)	*Lampsilis radiata*
Floater, green (mussel)	*Lasmigona subviridis*	Lampmussel, yellow (mussel)	*Lampsilis cariosa*
Satyr, Mitchell's (butterfly)	*Neonympha m. mitchellii***	Mucket, tidewater (mussel)	*Leptodea ochracea*
Skipper, arogos (butterfly)	*Atrytone arogos arogos*	Pondmussel, eastern (mussel)	*Ligumia nasuta*
Skipper, Appalachian grizzled (butterfly)	*Pyrgus wyandot*	White, checkered (butterfly)	*Pontia protodice*
Wedgemussel, dwarf	*Alasmidonta heterodon***		

Mammals

Endangered	
Bat, Indiana	*Myotis sodalis***
Bobcat	*Lynx rufus*
Whale, black right	*Balaenoptera glacialis***
Whale, blue	*Balaenoptera musculus***
Whale, fin	*Balaenoptera physalus***
Whale, humpback	*Megaptera novaeangliae***
Whale, sei	*Blaenoptera borealis***

Fish

Endangered	
Sturgeon, shortnose	*Acipenser brevirostrum***

Whale, sperm	*Physeter macrocephalus***		
Woodrat, Allegheny	*Neotoma floridana magister*		

Source: NJDEP, 2010

** Federally Endangered
BR – Breeding
NB – Non-Breeding

Possible Vernal Pools in Greenwich Township

	ID Number	Vernal	X__UTM	Y_UTM
1	2042ocp	Not Surveyed	465591	4362452
2	2043ocp	Not Surveyed	466565	4362112
3	2044ocp	Not Surveyed	466640	4362204
4	2045ocp	Not Surveyed	466684	4362422
5	2046ocp	Not Surveyed	466997	4362891
6	2047ocp	Not Surveyed	467582	4362884
7	2048ocp	Not Surveyed	467122	4362622
8	2049ocp	Not Surveyed	467017	4362490
9	2050ocp	Not Surveyed	467087	4362671
10	2051ocp	Not Surveyed	466566	4362346
11	2052ocp	Not Surveyed	466420	4362292
12	2053ocp	Not Surveyed	466487	4362333
13	2054ocp	Not Surveyed	466522	4362407
14	2055ocp	Not Surveyed	465299	4362635
15	2056ocp	Not Surveyed	467333	4361938
16	2594ocp	Not Surveyed	468100	4362963
17	2595ocp	Not Surveyed	470613	4363055
18	2598ocp	Not Surveyed	470359	4363253
19	2599ocp	Not Surveyed	469284	4362919
20	2600ocp	Not Surveyed	469345	4362875
21	2601ocp	Not Surveyed	469416	4362901
22	2602ocp	Not Surveyed	469311	4362829
23	2603ocp	Not Surveyed	468245	4362905
24	2604ocp	Not Surveyed	469450	4362811
25	2605ocp	Not Surveyed	470385	4362298
26	2606ocp	Not Surveyed	470362	4362360
27	2607ocp	Not Surveyed	470351	4362308
28	2608ocp	Not Surveyed	469032	4363005
29	2609ocp	Not Surveyed	468226	4362319
30	2610ocp	Not Surveyed	468460	4362058
31	2611ocp	Not Surveyed	468388	4362114
32	2612ocp	Not Surveyed	468425	4361951
33	2613ocp	Not Surveyed	468133	4357978

	ID Number	Vernal	X__UTM	Y_UTM
34	2614ocp	Not Surveyed	468282	4357856
35	2615ocp	Not Surveyed	468387	4357937

Source: Center for Remote Sensing and Spatial Analysis (CRSSA), 2008

APPENDIX H

A Pictorial Guide to Historic Greenwich, NJ

The pictorial guide is reproduced on behalf of the Greenwich Township Environmental Commission. The guide was originally created by the Cumberland County Planning Board in 1976. Bob Watson, an architect and member of the Greenwich Environmental Commission, created the illustrations.

A Pictorial Guide to Historic Greenwich, N. J.

Published by the
Cumberland County Planning Board
1976

Continued on Section 4


before 1862


circa 1855

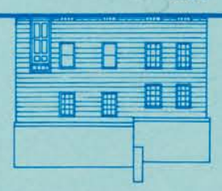

circa 1850
Captain James Mason House


1734
Mark Reeve House

Friends Cemetery

Cohansey River


circa 1950
Residence


1733
William Watson Tavern

The preparation of this map was financed in part through a Federal grant from the Department of Housing and Urban Development under the Comprehensive Planning Assistance Program authorized by Section 701 of the Housing Act of 1954, as amended.

circa 1860
W. M. Stewart Store

circa 1860
W. M. Stewart House

circa 1869

1847
Job Watson House

1730 and 1935 Levi Bond House
(Built as Rectory for
St. Stephens Church)

1870
James Stewart House

1729
Site of St. Stephens Episcopal
Church and Cemetery

circa 1900
Chris Kubler Bakery

Ye Greate Street

Charles Cotton House
1910

Dr. Thomas Ewing House
1742

Warren Butler House
1918

Tea Burning Monument
1908

Market Lane

Section 3

Section 4

before 1862
The Shiloh House

before 1862
Isaac Sheppard House

before 1774
Site of Dan Bowen House

1771
Greenwich Orthodox Friends Meeting House

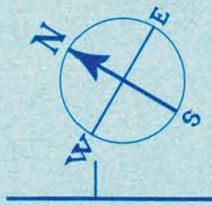
Ye Greate Street

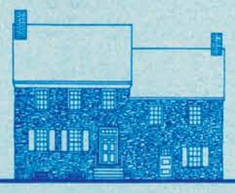
circa 1860

circa 1820
Margarita Miller House

1797
Mark Reeve, Jr. House

Dr. Helena Goodwin House
1913





Park Road

1728
Stone Tavern

Leaming House

Former Private School

circa 1875
Dr. Snyder House

circa 1890
Lippincott House

Head of Greenwich

Ye Greate Street

1795
Richard Wood Mansion

Bacon's Neck Road

1795
Richard Wood Store

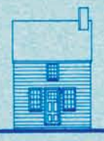
circa 1850
Providence Wheaton House

1852
Presbyterian Lecture Room

before 1862
E. Ogden House

Section 1

Section 2



1780
Jeremiah Harding House

late 1700's
Nancy Griffith House
(Owner in 1862)

1760
Doctor Holmes House
(Owner in mid-1800's)

circa 1860
Sam Mills Store
(Originally a residence)

1737
Benjamin Reeve House

circa 1850
E. M. Mulford House

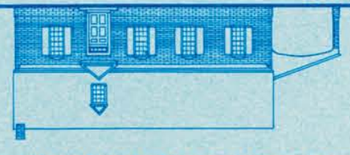
Ye Greate Street

after 1862
Richard Evans House

circa 1890
Allie Turner House

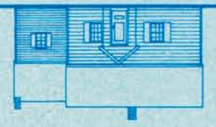
1734
Pirate House

1969
Farmers and Merchants National Bank



circa 1930
William Flanigan House

1734
Benjamin Harding House



This brochure is prepared as a guide to one of Cumberland County's significant historical areas on Ye Greate Street in Greenwich. The partially inverted arrangement of the brochure is made necessary so that the building locations are correctly oriented to those on the opposite side of the street. This scheme also helps to place the buildings in their proper perspective to the visitor walking or riding along the street.

Most of the buildings shown are private homes. Please do not invade the owner's privacy by walking on his grounds or seeking admission to his home. Some of the buildings are opened to the public for special events. Information concerning many of the buildings and the times at which some of them may be visited can be obtained at the Gibbon House, staffed by the Cumberland County Historical Society, located on Ye Greate Street.

circa 1880
Samuel Miller House

1730
Nicholas Gibbon House

Continued on Section 2

1811
George Bacon House

1874
Daniel Sheppard House

circa 1860
Captain Charles Miller House

circa 1760
Richard Wood House

after 1876
Fred Opdyke House

before 1871
Presbyterian Parsonage

1974
Residence

1785
John Harding House

circa 1875
Greenwich Elementary School

1949 & 1976
County Historical and Cultural
Commission Headquarters

Maple Street

Continued on Section 3

1834
James Josiah Ewing House

circa 1780
Isaac Harding House

1925
Firehouse

Resolution to Adopt the Environmental Resource Inventory

GREENWICH TOWNSHIP
CUMBERLAND COUNTY
STATE OF NEW JERSEY

RESOLUTION OF THE
GREENWICH TOWNSHIP PLANNING BOARD
TO
ADOPT GREENWICH TOWNSHIP
ENVIRONMENTAL RESOURCE INVENTORY

NOW, THEREFORE, BE IT RESOLVED, by the Planning Board of the Township of Greenwich, County of Cumberland, and State of New Jersey, as follows:

WHEREAS, the Greenwich Township Planning Board has reviewed and considered the Environmental Resource Inventory prepared by the Greenwich Township Environmental Commission and the Delaware Valley Regional Planning Commission: and

NOW, THEREFORE BE IT RESOLVED that the Environmental Resource Inventory for Greenwich Township, Cumberland County, of 2009, be adopted.

WILLIAM VAN PELT, Chairman

CERTIFICATION

I certify that the above Resolution was adopted by the Greenwich Township Planning Board on February 1, 2010.

Elaine C. Hancock, Secretary

Abstract Page

Publication Title:	Environmental Resource Inventory for the Township of Greenwich
Publication Number:	09079
Date Published:	June 2010
Geographic Area Covered:	Greenwich Township, Cumberland County, New Jersey

Key Words

Agriculture, air, aquifers, biodiversity, biological resources, built environment, climate, Cohansey River, conservation, Cumberland County, development, endangered species, environmental issues, environmental resource inventory, floodplains, forests, grasslands, Greenwich Township, groundwater, habitat, land preservation, Landscape Project, master planning, natural resources, New Jersey, open space, population, soils, steep slopes, topography, U.S. Census, vernal pools, water quality, watersheds, wetlands.

Abstract

This publication documents the natural and community resources of Greenwich Township, Cumberland 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; Natural Heritage Priority Sites; Landscape Project Priority Habitats and known contaminated sites. Community resources that are briefly described include population, transportation, township utilities and services, historic buildings, and protected open space. A short history of the community is also included.

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