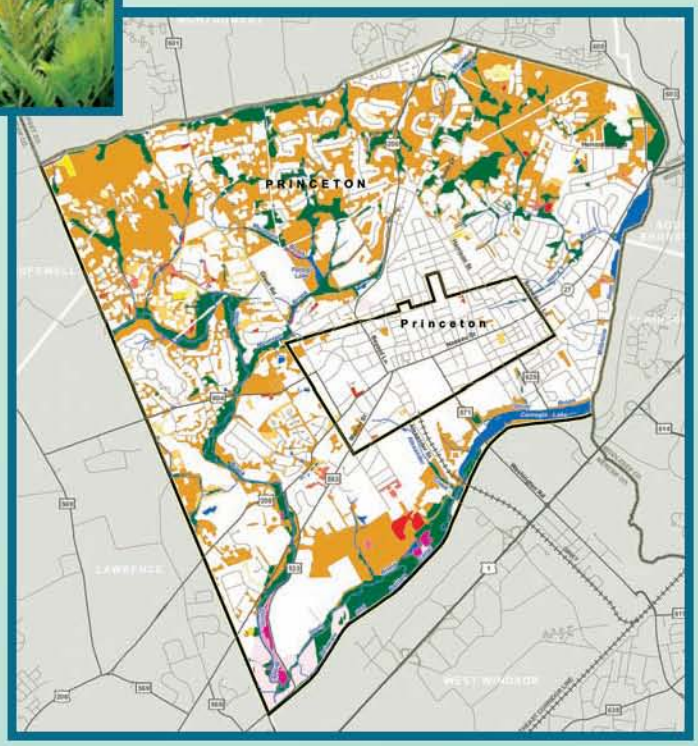
ENVIRONMENTAL RESOURCE INVENTORY

for the TOWNSHIP and BOROUGH of

PRINCETON

MERCER COUNTY, NEW JERSEY



prepared by:

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

with:

The Joint Princeton Environmental Commission

JANUARY 2010

The Delaware Valley Regional Planning Commission is dedicated to uniting the region's elected officials, planning professionals, and the public with the 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.

The symbol in our logo is adapted from the official DVRPC seal and is designed as a stylized image of the Delaware Valley. The outer ring symbolizes the region as a whole, while the diagonal bar signifies the Delaware River. The two adjoining crescents represent the Commonwealth of Pennsylvania and the State of New Jersey.

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

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ACKNOWLEDGEMENTS

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- The Borough of Princeton
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The impetus for the creation of this document, and its guidance and review, came from the Joint Princeton Environmental Commission.

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The following individuals, who formerly served on the Princeton Environmental Commission, were instrumental in conceiving this project in 2006, obtaining grant funding from ANJEC, and providing valuable input into the initial stages of the ERI, which officially began in June 2007.

David Breithaupt (chair) – Township
Rosemary Blair – Township
Lexi Gelperin – Township
Casey Lambert – Township
Victoria Bergman – Township Committee
Philip Feig – Planning Board
Grace Sinden – Princeton Health Commission

Special thanks is extended to Stephen Hiltner of the Princeton Environmental Commission for his countless contributions to this ERI. Without Mr. Hiltner's commitment, patience, and good humor, this project would have been far less successful. Mr. Hiltner served as primary editor for multiple drafts of the ERI and orchestrated efforts to obtain feedback from resource experts and professionals within the community. In addition, Mr. Hiltner conducted independent research and gathered data, without which this ERI would have been woefully incomplete. Mr. Hiltner's breadth and depth of knowledge on a wide range of environmental topics have added great value and quality to this document.

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INTRODUCTION

The purpose of this Environmental Resource Inventory is to identify and describe the natural resources of Princeton Township and Princeton Borough. A community's natural resources—its soil, water, air, forests, fields, and waterways—are fundamental to its character. They are the foundation for its economic success and its quality of life. The protection and wise use of those resources are 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.

Though separate and distinct municipalities, Princeton Borough and Princeton Township have a strong cooperative relationship, share a similar sense of place, and possess the same ecological framework. As a result, this Environmental Resource Inventory is being prepared for both Princeton Borough and Township simultaneously. In this report, the term "Princeton" will be used to denote both communities collectively where a single identity is warranted.

Princeton's natural resources have long shaped the lives of its inhabitants. The Lenape Indians, who inhabited the lands of Princeton for thousands of years before the arrival of Europeans, relied upon fish, game, and plants from the area's streams and upland forests. They also made good use of the region's rich agricultural soils. These soils also played a major role in the settlement of the Princeton area by Europeans. Almost immediately after their arrival, Quaker settlers began to clear the forest and work the land, cultivating grain, fruits, and vegetables.

In recent decades, significant areas of the township have experienced suburban growth, while the borough's traditional downtown has become a vibrant, mixed-use hub. According to NJDEP's most recent (2002) land use/land cover survey, approximately one-half of Princeton Township, and nearly all of Princeton Borough, are classified as "developed land," with the remaining half being classified as "undeveloped." It should be noted, however, that if naturally vegetated portions of privately owned improved parcels of two to 20 acres in size are considered "developed," as opposed to "forests" or "wetlands," Princeton Township planners estimate that up to 80 percent of the township is in fact "developed." Since much of the remaining 20 percent of the township is permanently protected open space, little open land is available for future development within Princeton.

Despite past growth and continuing development pressure, the township has been very successful in preserving open space. The Princeton Master Plan set a goal of preserving 25 percent of Princeton's land as open space. To assist in achieving this goal, the Princeton municipalities passed a dedicated tax to fund open space preservation. As of 2007, some 2,990 acres (25 percent of Princeton Township and Borough) have been permanently preserved through purchases and easements. Fourteen percent of Princeton's land is publicly owned and is used for parks, arboretums, and wildlife refuges. The remaining preserved land consists of preserved farms, privately owned lands protected with conservation easements, and homeowner association lands. Documentation of Princeton's environmental resources is a necessity if Princeton is to maintain its remaining rural areas, the integrity of its natural resources, its environmental quality, and its high standard of living.

Princeton's surface and ground water resources, and the terrestrial resources that sustain the area's hydrology, have become increasingly important to its population and to that of neighboring communities, as continuing development places increasing pressure on diminishing natural resources in Princeton. The area's wetlands, upland forests, and grasslands, which provide significant habitat for a wide range of plants and animals, will be vital to the continued health of the community and the enjoyment of its citizenry. Knowledge of the environmental resources of Princeton will allow its officials and its citizens to make informed decisions as they strive to maintain Princeton's identity and create a sustainable landscape.

Preparing an Environmental Resource Inventory requires gathering all the existing information that can be found about a community's resources, and presenting it in a form that is useful to a broad audience. This inventory reflects a particular moment in time, and it is anticipated that it will be updated as new data becomes available.

Several documents and reports were utilized in preparing the *Environmental Resource Inventory for Princeton Township and Princeton Borough*, including Princeton Township's *Master Plan (1996, revised 2006/2007)* and the Open Space and Trails Strategic Work Plan (2004), as well as a number of reference works. These are listed at the end of this document. The maps and data relating to natural resources in Princeton Township and Borough are principally derived from the New Jersey Department of Environmental Protection (NJDEP's) Geographic Information System mapping, from *The Landscape Project* produced by the Endangered and Nongame Species Program of the New Jersey Fish and Wildlife Division, and from the U.S. Geological Survey, the NJ Geological Survey and the Natural Resources Conservation Services (NRCS). This information is invaluable and can be easily accessed.

Photo by Stephen Hiltner

Winant-Coventry Farm, part of Princeton's preserved open space

BRIEF TOWNSHIP AND BOROUGH HISTORY

Colonial settlement in the Princeton area began during the late 17th century, but the human history of the region dates back thousands of years. The earliest inhabitants of the area today known as Princeton Township and Princeton Borough were the Lenape Indians (called "the Delawares" by the English). These migratory people ranged throughout New Jersey and along the banks of the Delaware River and its tributaries, from the lower reaches of the Hudson River to the mouth of the Delaware River. Early Native American communities thrived on the area's rich natural resources. The region's bountiful creeks and forested uplands provided rich natural resources for hunting, fishing, pottery-making, and simple farming.

Toward the end of the 17th century, the first settlers of European descent began to move into the area from the Raritan Valley and the nearby counties of Bucks and Burlington by way of numerous routes, including the King's Highway, one of the most heavily trafficked roads in colonial New Jersey. The area that would later be called "Princeton" was then, as it is now, gently rolling with fertile soils and moderate climate, and the earliest settlers came to farm these rich soils. Numerous streams and rivers also provided plentiful opportunities for grist mills and water transportation.

The first European to establish residence within the eventual Princeton boundaries is believed to be Henry Greenland, who opened his "house of accommodation" on what is now called Kingston Road in 1683. Greenland's tavern was to become a prominent gathering spot and meeting house during the early days of settlement due to its location on the border between the original colonial provinces of East and West New Jersey, a convenient stopping point halfway between New York and Philadelphia. As more settlers moved to the area, increasing tracts of land were cleared for farming, lumber, and fuel. The area was commonly referred to as "Stony Brook" in the deeds and correspondence of these earliest settlers. Around 1725, records from early colonists, such as Nathaniel Fitz Randolph, a native of the area, began to use the name Princeton. The origins of the name are not directly recorded, and several accounts exist. The name is thought to originate either out of homage to William Prince of Orange, who was the nominal head of the New Jersey Colony, or, perhaps more likely, as a complementary name to nearby Kingston, New Jersey.

During the colonial period, Princeton rose in prominence with the construction of Nassau Hall in 1756. Nassau Hall housed the College of New Jersey, which was relocated from its first home in Elizabeth Town to Newark and then to Princeton. The College would not become "Princeton University" until 1896, but it exerted strong influence on the area from its earliest days. The College of New Jersey was unique among colonial colleges in that its original charter allowed entrance to "*any person of any religious denomination whatsoever*." In the upcoming years of the Revolutionary War, Nassau Hall would temporarily serve as the home for the Continental Congress in 1783 and nine College of New Jersey alumni would attend the Constitutional Convention in 1787.

During the Revolutionary War, dozens of battles were fought on New Jersey soil, a number of them in the Princeton area, including the first and second Battles of Trenton and the Battle of Princeton. The period during which these battles were fought is known as the "Ten Crucial

Days" because the victories won during this period greatly bolstered the morale of the colonists. The Ten Crucial Days began when General Washington and 2,400 troops of the Continental Army crossed the ice-filled Delaware River by boat on Christmas Night in 1776. Beset by freezing rain, the army then marched nine miles to Trenton, and early the next morning delivered a stunning surprise attack on the Hessian garrison stationed there.

After ferrying their Hessian prisoners across the Delaware to Pennsylvania on December 26, Washington's troops recrossed the Delaware into New Jersey to engage the British at Trenton once again on January 2, 1777. Fighting along the Assunpink Creek ended at dusk. During the night, Washington led his troops along a back route toward Princeton, where he attacked General Cornwallis' rear guard on the morning of January 3, 1777, in the vicinity of Clarke Farms, just south of Princeton Borough. While the second Battle of Trenton (also known as the Battle of the Assunpink) had no military outcome, it enabled another American victory, at Princeton. In the 10 days succeeding Christmas, Washington had engaged the enemy in three battles, and by winning two had restored belief in the possibility of ultimate victory.

Princeton Borough was incorporated in 1813 along boundaries similar to the current ones in an effort to consolidate into a single municipality. Until its incorporation, Princeton Borough straddled the border of Somerset and Middlesex counties, with Nassau Street as the dividing line. In 1838, Mercer County and Princeton Township were established by an act of the New Jersey legislature from parts of Middlesex, Burlington, and Hunterdon counties in an effort to modernize and balance state politics in New Jersey. Although the boundaries of Princeton Borough and Township were substantially as they are today, some of the present lands were still held by West Windsor Township. It was not until 1853 that West Windsor Township completed the gradual ceding of the remaining land between the Delaware and Raritan Canal and Nassau Street, creating the modern municipal boundaries.

The construction of new roads such as the Princeton-Kingston Branch Turnpike in 1807 helped bring activity and commerce to the Princeton area. This growth in traffic coincided with the establishment of the Princeton Theological Seminary in 1811 and the construction of Alexander Hall in 1815. The development of Princeton as a commercial location began in earnest with the construction of the Delaware and Raritan Canal, as well as the Camden and Amboy Railroad in the 1830s. Two basins were constructed for turning barges (one of which still exists), and the coal and construction industries began to flourish in the area. Whig and Clio Halls at The College of New Jersey were constructed, along with a new First Presbyterian Church. The first stages of the Drumthwacket House, which would eventually house the governor of New Jersey, went up at the same time. Numerous other major buildings were designed and built in Princeton Borough and Princeton Township during the first half of the 19th century, including villas for the descendants of revolutionary leader Richard Stockton and renovations and modernization of Nassau Hall.

Following the Civil War, the College of New Jersey emerged as a dominant force in building the townscape of Princeton. By 1896, when the college was officially renamed Princeton University, the Collegiate Gothic style was firmly in place as the dominant architectural style

and would remain so for the next 50 years. In the following years, the university continued to expand along Nassau Street, University Place, and along both sides of Washington Road.

By the turn of the 19th century, most of Princeton Township's arable land was in cultivation or reserved in woodlots for fuel and timber, leaving much of the township cleared. While agriculture was Princeton Township's primary industry during its first 50 years, by the late 19th century, it began a slow but steady decline. In 1890, the owner of Worth's Mill, on the Stony Brook, closed down his operation, an indication of the declining importance of grain farming in the area. Agriculture's decline was hastened by real estate development as the northwestern portion of the township began to suburbanize in the 1920s and 1930s.

Following World War II, Princeton Township experienced rapid suburban growth. Advances in rail and automobile transportation put Princeton within an easy drive or train ride from two of the Northeast's major metropolitan centers: Philadelphia to the southwest and New York to the northeast. Princeton Borough gained statewide prominence by being selected in 1945 as the location for the state's first Governor's Mansion at Morven. The township then received that honor in 1982 when the residence was located at Drumthwacket.

Though many portions of Princeton Township have transitioned from an agrarian to a suburban character over the past six decades, the area has been able to maintain much of it historic charm, as well as significant areas of open space. The township is home to numerous natural areas, parks, and historic resources, as well as the prestigious Institute for Advanced Study. Princeton's historic town center, Princeton Borough, has become a vibrant hub, with a lively "main street" that is home to numerous businesses, institutions, and well-used public spaces. Together, the borough and township also host Princeton University, one of the nation's premier centers of advanced education.

Population in the township and borough grew steadily throughout the first half of the 20th century, with the majority of Princetonians residing in the borough. In 1930, Princeton Borough housed 6,992 residents, while the township held an additional 2,738. The population growth in the area would maintain this relationship for the next 20 years. The 1950 census shows 12,230 residents in Princeton Borough, compared to 5,407 in the township. By 1960, this trend had reversed; Princeton Borough had approached its maximum population capacity, while readily available land in the surrounding township promoted growth there.

The 1970 census shows the effects of suburbanization, with the township's population (13,651) eclipsing that of the borough (12,311) for the first time since its incorporation in 1813. Population growth has been relatively gradual since 1970. Princeton's desirability as a place to live and work has resulted in a nearly "built-out" condition in which most of the available land has been either developed or preserved. The 2000 census counts 14,203 residents in the borough and 16,027 in the township. The borough's population includes the majority of Princeton University's 7,000-member student body.

Today, Princeton Township and Princeton Borough are renowned for their history, natural beauty, and cultural richness. Princeton boasts Revolutionary War-era homes, as well as modern

residential, educational, and commercial communities. The township and borough offices are characterized by their close cooperation in planning and the provision of services, as well as their collaborative relationship with Princeton University. Although mostly built-out, Princeton is still experiencing some limited residential and commercial development and redevelopment. Such growth poses both challenges and opportunities for the two municipalities, as they strive to preserve the quality and character of their historic past, protect their natural resources, and forge a path to a prosperous and sustainable future.

Photo by DVRPC

Nassau Hall on the Princeton University Campus

PRINCETON LOCATION, SIZE, AND LAND USE

Princeton Borough and the surrounding township are incorporated municipalities located in Mercer County, north of the City of Trenton, which is the county seat and capital of New Jersey. The township is bounded by seven townships in three counties: Lawrence, Hopewell, and West Windsor in Mercer County, Plainsboro and South Brunswick in Middlesex County, and Franklin and Montgomery in Somerset County. See **Map 1: Base Map**

Princeton Township occupies 10,569 acres, or 16.25 square miles, and is situated in the Piedmont Plateau Province of New Jersey. Princeton Borough occupies 1,169 acres, or nearly two square miles, and is surrounded on all sides by Princeton Township. Princeton's growth can be attributed to a combination of its proximity to the Philadelphia and New York City metropolitan areas, easy access to major highways and the Northeast Corridor rail systems, and the strong influence of Princeton University. Princeton has had a long and prosperous relationship with its namesake university, which currently has a student body of nearly 7,000 and over 1,000 full and part-time faculty, as well as 4,400 staff and support personnel. The university facilities occupy 500 acres and its total land holdings include 214 acres within the borough and 759 in the township, making it the largest single landowner in the area.

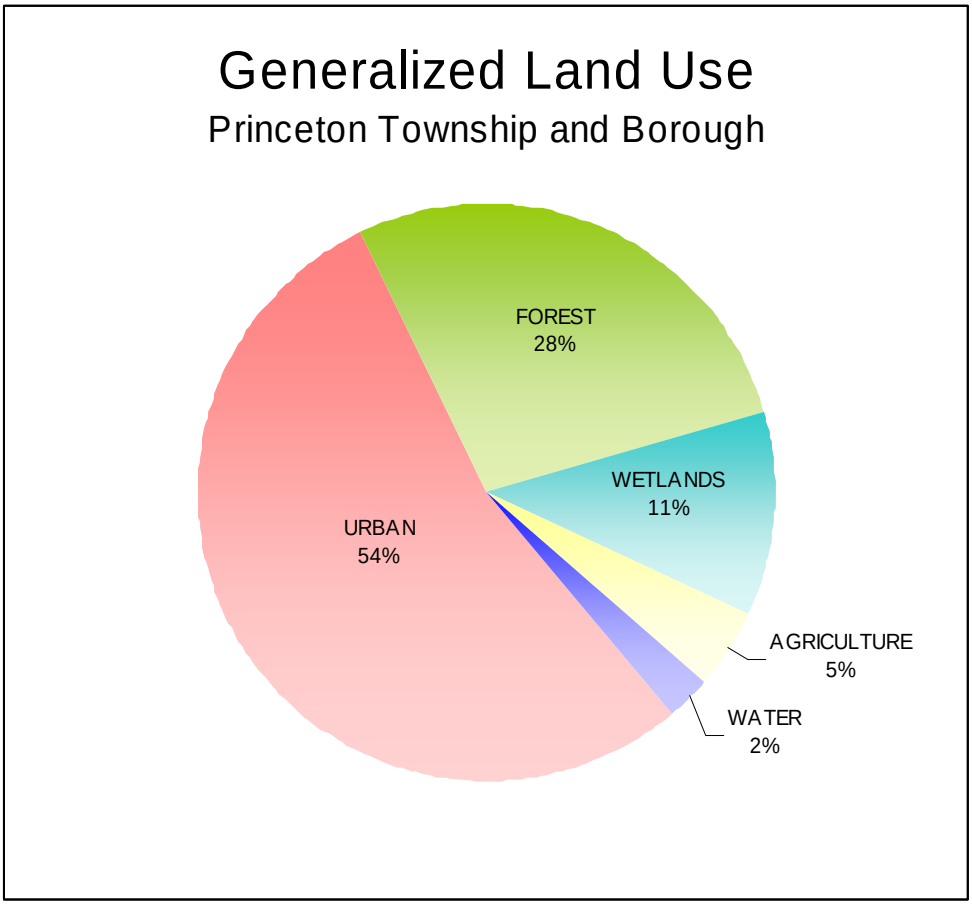
Princeton's land use reflects its natural setting, its agricultural past, and the large influence of Princeton University and its associated facilities and divisions. Land use is divided rather evenly between urban and rural land uses, with 54 percent of the land classified as urban, and the remaining 46 percent divided between forest, fields and pastures, wetlands, and waterbodies. Much of the urbanized land is within the boundaries of Princeton Borough, although development stretches through the township along several of the major arterials. Princeton's land cover is depicted on **Map 2: NJDEP Land Cover (2002).**

Approximately 25 percent of the township and borough are permanently protected open space. These protected open spaces consist of state-, county-, and township-owned parklands, preserved farmland, and privately owned protected open space, including homeowner association lands. Naturally vegetated yard areas are not included in this total unless they are protected by a conservation easement.

Figure 1 shows Princeton Township and Borough land cover grouped into general categories based on the New Jersey Department of Environmental Protection's (NJDEP) 2002 color infrared digital imagery.

Before European settlement, as much as 90 percent of Princeton was likely covered with a mixed deciduous hardwood forest consisting of maple, oak, beech, walnut, chestnut, and ash trees. While most of Princeton was cleared for farmland and timber in past centuries, a large portion of the land has returned to forest. Currently, within the township, 31 percent of the land area is forested. Only five percent of the township's land is classified as agricultural today. In the case of Princeton Township, the agricultural classification primarily refers to pastures, fields, meadows, and "gentleman's farms." The township's remaining land area is accounted for by urban uses (49 percent) and wetlands and open water (15 percent).

Figure 1: Generalized Land Use (2002)--Combined Figures for Township and Borough



Source: NJDEP, 2002 data, released 2006

Table 1-A shows Princeton Township land cover grouped into general categories based on the New Jersey Department of Environmental Protection's NJDEP's 2002 color infrared digital imagery. **Table 1-B** breaks down the 2002 general land cover categories for Princeton Township into detailed land cover categories. These categories are also depicted on **Map 2: NJDEP Land Cover (2002).**

Table 1-A: Princeton Township General Land Cover (2002)

Land Use Categories	Acres	Percent
Urban	5,204.7	49.25%
Forest	3,231.4	30.57%
Wetlands	1,314.4	12.44%
Agriculture	537.4	5.08%
Water	281.1	2.66%
Total	10,569.0	100.00%

Source: NJDEP, Bureau of Geographic Information Systems, 2002 data, released 2006

Table 1-B: Princeton Township Detailed Land Cover (2002)

Land Use Category	Acres	Percent
Deciduous forest (>50% crown closure)	2,705.8	25.6%
Residential, rural, single unit	1,664.7	15.8%
Residential, single unit, low density	1,375.6	13.0%
Deciduous wooded wetlands	1,087.7	10.3%
Cropland and pastureland	506.9	4.8%
Recreational land	451.7	4.3%
Residential, single unit, medium density	425.6	4.0%
Other urban or built-up land	355.9	3.4%
Commercial/services	341.3	3.2%
Residential, high density, or multiple dwelling	251.2	2.4%
Artificial lakes	173.9	1.6%
Deciduous forest (10-50% crown closure)	156.0	1.5%
Athletic fields (schools)	148.7	1.4%
Agricultural wetlands (modified)	104.0	1.0%
Streams and canals	99.2	0.9%
Mixed forest (> 50% deciduous with >50% crown closure)	99.0	0.9%
Transportation/communication	51.8	0.5%
Plantation	50.2	0.5%
Herbaceous wetlands	46.6	0.4%
Coniferous forest (>50% crown closure)	45.2	0.4%
Stormwater basin	40.6	0.4%
Mixed deciduous/coniferous brush/scrubland	40.4	0.4%
Upland rights-of-way, undeveloped	35.3	0.3%
Mixed Forest(>50% deciduous with 10-50% crown closure)	32.3	0.3%
Mixed Forest(>50% deciduous with 10-50% crown closure)	29.9	0.3%
Other Agriculture	27.9	0.3%
Old field(<25% brush covered)	25.4	0.2%
Managed wetland in built up maintained rec area	25.1	0.2%
Transitional areas	20.7	0.2%
Coniferous brush/scrubland	20.7	0.2%
Upland rights-of-way, developed	17.1	0.2%
Mixed scrub/shrub wetlands (coniferous dominated)	14.8	0.1%
Managed wetland in maintained lawn greenspace	14.0	0.1%
Deciduous brush/scrubland	12.2	0.1%
Stadium, theaters, cultural centers, and zoos	11.4	0.1%
Mixed forest (>50% coniferous with 10-50% crown closure)	10.9	0.1%
Wetland rights-of-way	10.2	0.1%
Deciduous scrub/shrub wetlands	7.2	0.1%
Natural lakes	6.4	0.1%
Industrial	6.1	0.1%

Land Use Category	Acres	Percent
Military installations	4.8	0.0%
Disturbed wetlands (modified)	3.7	0.0%
Coniferous forest (10-50% Crown Closure)	3.5	0.0%
Orchards/vineyards/nurseries/horticultural areas	2.5	0.0%
Cemetery	2.2	0.0%
Bridge over water	1.6	0.0%
Mixed scrub/shrub wetlands (deciduous dominated)	1.0	0.0%
Total Acreage	**10,569.0**	**100.0%**

Source: NJDEP, Bureau of Geographic Information Systems, 2002 data, released 2006

Land in Princeton Borough is primarily developed, with less than four percent of the area devoted to nonurban uses. Approximately 57 percent of the borough is residential. Commercial land use is the second largest land category, occupying 34 percent of the borough's land area. Approximately six percent of Princeton Borough is made up of athletic and recreation facilities, and the remaining three percent of the land is covered by urban forest.

Table 2-A shows Princeton Borough land cover grouped into general categories based on the NJDEP's 2002 color infrared digital imagery. **Table 2-B** breaks down the 2002 general land cover categories for Princeton Borough into detailed land cover categories.

Table 2-A: Princeton Borough General Land Cover (2002)

Land Use Category	Acres	Percent
Forest	38.8	3.3%
Urban	1,128.3	96.2%
Water	0.1	0.0%
Wetlands	1.7	0.1%
Total	1,168.9	100.0%

Source: NJDEP, Bureau of Geographic Information Systems, 2002 data, released 2006

Table 2-B: Princeton Borough Detailed Land Cover (2002)

Land Use Category	Acres	Percent
Commercial/services	336.9	28.8%
Residential, single unit, medium density	269.4	23.0%
Residential, single unit, low density	171.3	14.7%
Residential, high density or multiple unit	126.7	10.8%
Residential, rural, single unit	99.3	8.5%
Other urban or built-up land	54.2	4.6%
Deciduous forest, 50% crown closure	25.3	2.2%
Recreational land	24.7	2.1%
Cemetery	23.0	2.0%
Athletic fields (schools)	17.5	1.5%
Mixed forest (>50% deciduous with >50% crown closure)	5.6	0.5%
Transitional areas	3.3	0.3%
Coniferous forest, (10-50% crown closure)	3.1	0.3%
Stadiums, theaters, cultural centers and zoos	2.0	0.2%
Mixed forest (>50% coniferous with >50% crown closure)	1.9	0.2%
Mixed forest (>50% deciduous with 10-50% crown closure)	1.6	0.1%
Deciduous wooded wetlands	1.6	0.1%
Coniferous forest, (>50% crown closure)	1.3	0.1%
Herbaceous wetlands	0.1	0.0%
Natural lakes	0.1	0.0%
Artificial lakes	0.0	0.0%
Total Acreage	**1,168.9**	**100.0%**

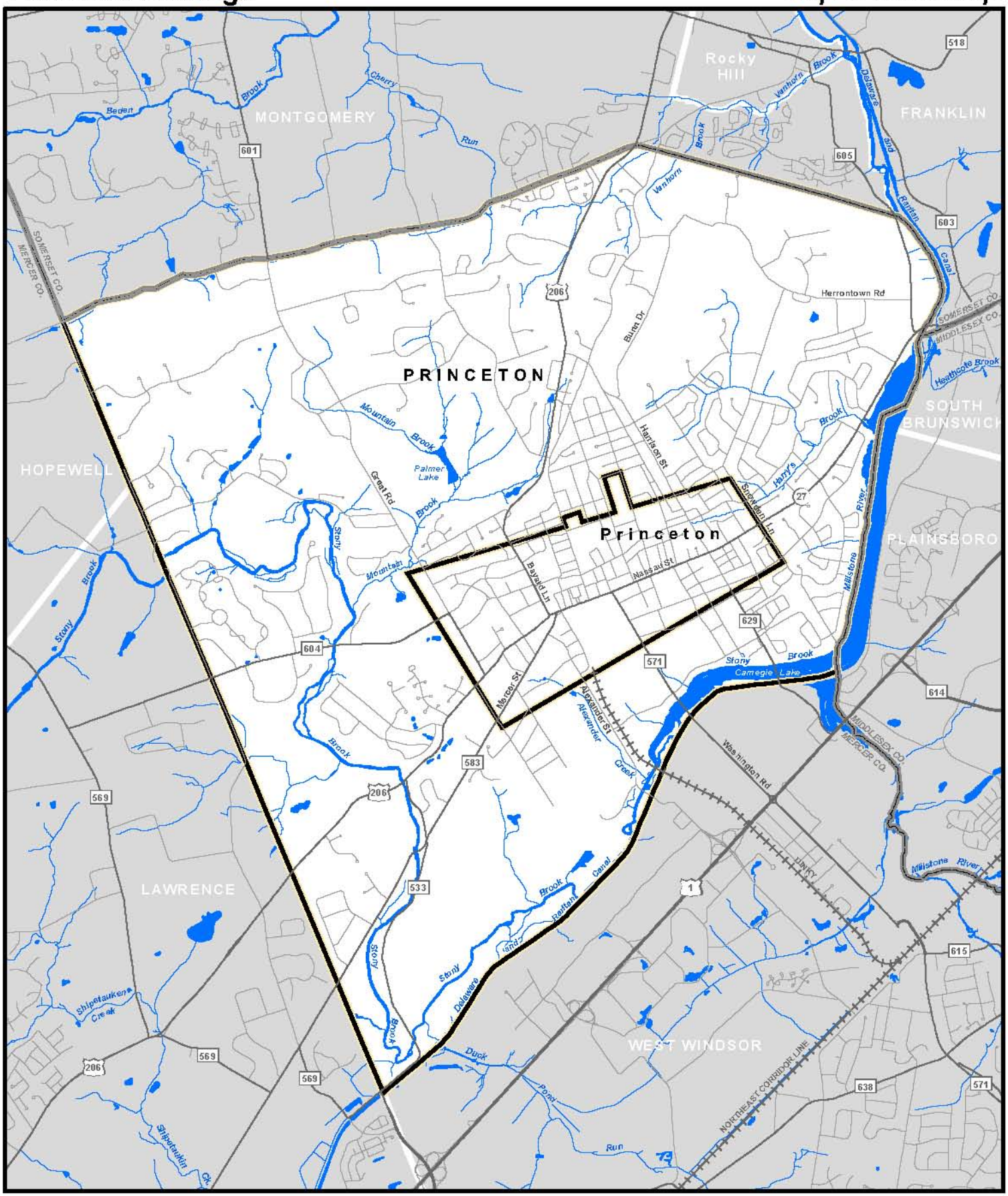
Source: NJDEP, Bureau of Geographic Information Systems, 2002 data, released 2006

Photo by Stephen Hiltner

Wetlands, such as those at Rogers Refuge, comprise over 12 percent of Princeton's land use

Princeton Township & Princeton Borough

Map 1: 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.

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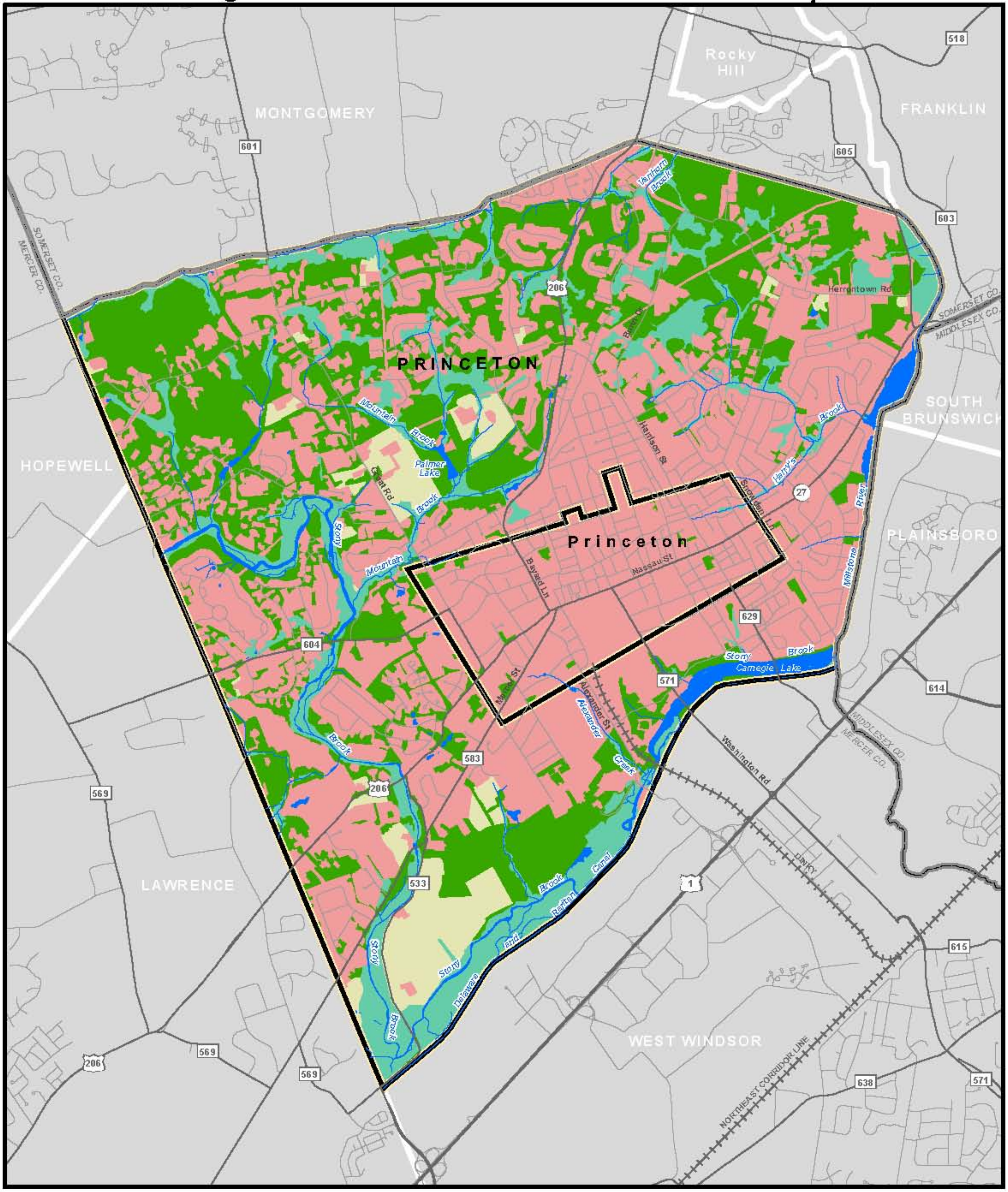
Map 2: 2002 NJDEP Land Cover - Updated to 2005



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.

Agriculture
Forest
Developed
Wetlands
Water

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Miles

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Princeton Township & Princeton Borough

Map 3: Aerial Photograph (2005)

Sources : NJDEP,NJDOT,DVRPC.
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NATURAL RESOURCES

PHYSIOGRAPHY

Physiography refers to the study of a location's underlying geology. New Jersey is characterized by four physiographic provinces. These provinces include the Ridge and Valley Province, the Highlands Province, the Piedmont Plateau Province, and the Coastal Plain Province. The Coastal Plain Province is further subdivided into the Inner Coastal Plain and the Outer Coastal Plain. The terrain of the four provinces is very diverse, with the rocky terrain of the Northern provinces at one extreme and the sands of the coast at the other.

Figure 2: Physiographic Regions of New Jersey

Princeton lies in the Piedmont Plateau, between the Highlands and the Inner Coastal Plain. Princeton is just north of the Fall Line, which is the dividing line between the Inner Coastal Plain and the Piedmont Plateau. The Fall Line is the name given to a drop in land level that separates the Piedmont Plateau from the Inner Coastal Plain. This line separates areas with considerable differences in geology, topography, and hydrology.

The fall line runs nearly parallel with U.S. Route 1 from Trenton to New York City and has numerous waterfalls marking its course. It is a boundary between older consolidated rock in Princeton and areas to the north, and younger, less consolidated rock—mostly gravels and sands—in the south. U.S. Route 1 runs just south and east of Princeton, marking the boundary between the Piedmont Plateau and the Inner Coastal Plain.

The Piedmont Plateau

The Piedmont Plateau extends from Massachusetts to Georgia and accounts for nearly 1,500 square miles, or one-fifth of New Jersey's land area. In New Jersey, the Piedmont is primarily composed of sandstone, shale and argillite. Generally, the rocks in this area are more susceptible to erosion than the rocks in the Highlands physiographic province to the north. The soils of the Piedmont Plateau are rich and well watered and the topography is gently rolling, with hills and valleys lying at elevations between 100 and 400 feet. Princeton Township lies at the southern edge of this region, and its physiography exhibits many of the general attributes listed above.

TOPOGRAPHY AND SURFACE LANDSCAPES

Princeton Township and Princeton Borough are situated in the northeast corner of Mercer County, occupying 10,569 and 1,169 acres, respectively. The topography of the area is relatively mild, with gentle slopes, flat areas, and occasional steep slopes. Princeton contains a number of

wetlands, most of which are located along the Delaware and Raritan Canal, Stony Brook, Mountain Brook, Harry's Brook, and the low-lying areas of the Princeton Ridge. Upland forest is found scattered throughout the township, with the largest sections found to the north, along the Princeton Ridge, and along Stony Brook. Smaller areas classified as farmland exist in the southwest corner of the township along Stony Brook and to the north of Princeton Borough, in the fertile soil between Mountain and Stony brooks. Princeton Borough is almost entirely urbanized land, devoted to residential, commercial, and institutional uses, along with their requisite infrastructure. The highest elevation in the Princeton communities is found near Leonard Court in Princeton Township and is 406 feet above sea level. The lowest elevations, which are around 40 feet, are found along the Delaware and Raritan Canal.

Upland areas in the Piedmont Plateau are characterized by rich soils that once supported deciduous forests of oak, maple, beech, hickory, walnut, and ash trees. In colonial days, most of these forests were cleared and converted to agricultural uses. Since that time much of the land has either been developed with residential and commercial uses or has reverted to second-growth forest. This forest offers significant environmental benefits to Princeton, including water and air quality benefits, the creation of habitat, maintenance of biodiversity, and opportunities for nature study and passive recreation.

Photo by DVRPC

Gently rolling topography of the Piedmont Plateau

Steep Slopes

Only a small percentage of Princeton has slopes over 15 percent (the ratio of vertical rise to horizontal distance), which is defined as steep for non residential uses under Princeton Township ordinances. For residential uses, only slopes greater than 25 percent are defined as steep. A somewhat larger portion of Princeton has slopes between 10 and 15 percent, which are relatively steep, but which are not regulated under Princeton Township ordinances. The steepest slopes in Princeton are found primarily along Stony Brook and its tributaries, as well as along the Princeton Ridge in the north of the township.

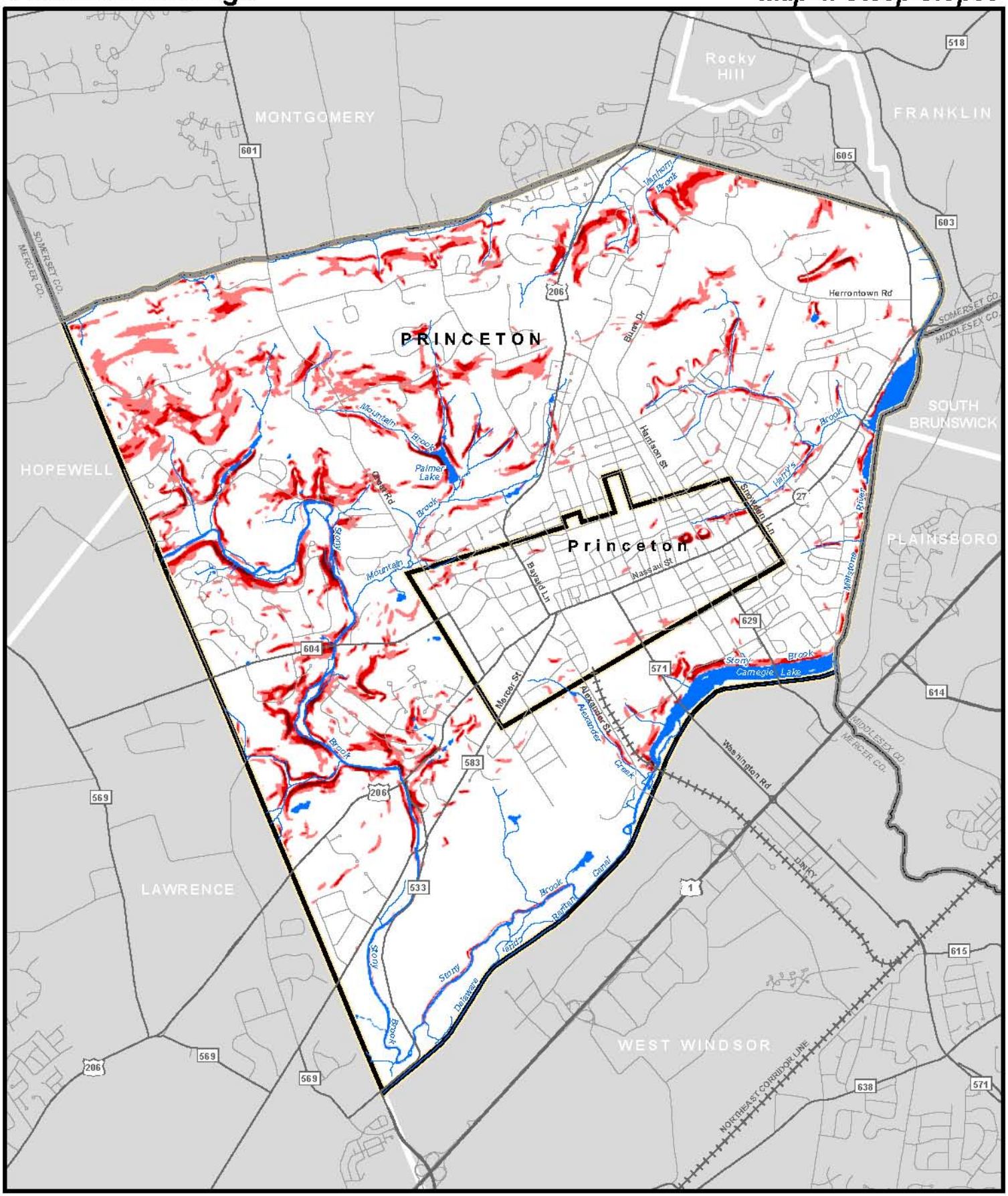
Most of the steep slopes in Princeton are well vegetated, although farm fields and residential properties may extend to the edge of slopes. In some locations, development has occurred on the edge of very steep slopes. In these instances, natural buffers and other storm water Best Management Practices should be used to separate the slope from development and to prevent runoff from eroding the slope. Such measures are now required, but past practices need to be remedied.

Development of steep slope areas can result in soil instability, erosion, increased stormwater runoff, flooding, and sedimentation of the stream below. These factors contribute to the degradation of water quality, habitat destruction, and potential damage to property. Erosion on steep slopes is especially prevalent where excessive tree removal has taken place.

Some of the oldest and most completely forested areas of Princeton exist along the steeper slopes of the Princeton Ridge. No detailed inventory of the trees in these naturally forested areas exists at present, although some of Princeton's endangered plants listed in the Natural Heritage Database (see **Table 20**) are found in these habitats. Some forested slopes have been negatively affected by runoff and recent flooding, both of which are exacerbated by development and impervious surfaces. However, they are at present some of Princeton's healthiest forested areas. Princeton's steep slopes are depicted on **Map 4: Steep Slopes**.

Princeton Township & Princeton Borough

Map 4: Steep Slopes



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.

Slope

- Slope < 10%
- Slope = 10% - 14.99%
- Slope = 15% - 24.99%
- Slope >= 25%

N

0 0.25 0.5 1
Miles

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CLIMATE

The Princeton area is favored with a mild and temperate climate that was held in high regard by a number of the original settlers to the area. According to the account of the Princeton area by Major E. M. Woodward and John F. Hageman in their 1883 publication, *History of Burlington and Mercer Counties*,

> *The Climate of Princeton is salubrious, and… [b]ecause of its healthfulness Princeton was called by Dr. Witherspoon the "Montpellier of America."… and the Rev. Samuel Miller, D.D., who resided here for about forty years while professor in the Theological Seminary, and who always watched the changes of the weather with interest, and kept a daily record of the thermometer, wrote near the close of his long life that "Princeton has one of the finest climates in the solar system."*

Due to its midlatitude location, New Jersey's climate is varied. The state's temperate, continental climate is influenced by airstreams that vary from hot and humid to dry and cold. Local weather can change rapidly. From May through September, New Jersey is dominated by moist, tropical air that originates in the Gulf of Mexico and is swept in by prevailing winds from the southwest. In winter, winds generally prevail from the northwest, bringing cold, polar air masses from subarctic Canada.

Climate also varies within the physiographic provinces of New Jersey. Princeton lies in the Piedmont Plateau Province and within New Jersey's central climate zone, which stretches from New York Harbor to the great bend of the Delaware River near Trenton. This region contains many urban areas, such as Trenton and New Brunswick, whose paved surfaces and buildings affect local temperatures by retaining more heat. Known as the "heat island effect," this causes nighttime temperatures to be generally warmer than surrounding rural areas.

The National Climate Data Center (NCDC) of the National Oceanic and Atmospheric Administration (NOAA) operates 13 cooperative stations in Mercer County. Data from seven of these stations is available online from the NCDC website: www.ncdc.noaa.gov. There are five weather stations located near Princeton. Three of these—one in Ewing Township, one in West Windsor, and one in Hamilton—are operated by the New Jersey Department of Environmental Protection. The Mercer County Airport in Trenton is operated by the Automated Surface Observing Systems (ASOS) network, a joint effort of the National Weather Service, the Federal Aviation Administration, and the Department of Defense. The fifth station is a state climatologist station in Hightstown.

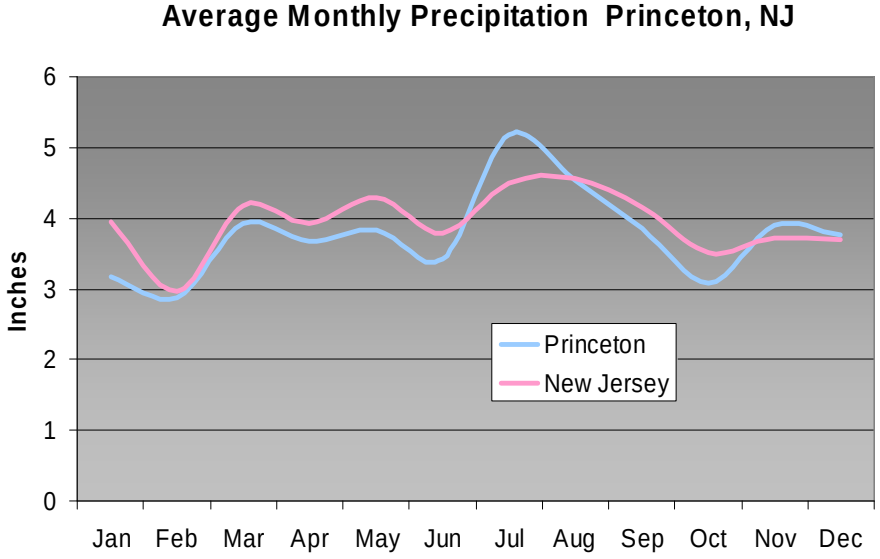
The region's annual mean temperature as recorded by the state climatologist station is 52.6°F, which is identical to the statewide mean temperature. This average accounts for the records of the past 110 years. The 10-year trend, however, shows a mean annual temperature of 53.5°F, which may reflect the rise in average global temperatures due to anthropogenic greenhouse gas emissions. Average temperatures are 74.1°F in July and 30.1°F in January. In the summer, temperatures in Princeton rarely exceed 100°F. In winter, the temperature rarely falls below 10°F for extended periods. Record temperatures for the region are a high of 102°F and a low of minus12°F.

Photo by Stephen Hiltner

Carnegie Lake frozen during a winter cold snap

Precipitation and Storm Events

Figure 3: Average Monthly Precipitation, Princeton, NJ



Source: Office of the New Jersey State Climatologist

According to data obtained from the National Oceanic and Atmospheric Administration, average annual precipitation for the township is 45.6 inches, which is based on a 50-year trend. This figure is somewhat less than the statewide annual average of 47.9 inches. Actual annual precipitation can vary considerably, from as little as 30 inches in dry years to 60 inches in wet ones.[1] Monthly averages for the area show that precipitation is generally well distributed throughout the year. However, rainfall tends to be a bit heavier in the summer months. On average the area receives the most precipitation in July, 5.18 inches, and the least precipitation in February, 2.87 inches. Severe thunderstorms can cause flash flooding along waterways in Princeton. In Mercer County, there are approximately 33 thunderstorms per year. While the effects of global warming are unclear, some international data suggests that it could skew local storm patterns toward less frequent, but more intense, storm events, thereby increasing flooding hazards. Vegetated stream buffers and stream corridor protection are valuable strategies for protecting against the detrimental environmental and physical effects of flooding.

Snowfall typically occurs in New Jersey when moist air from the south converges with cold air from the north. Average annual snowfall in Mercer County is 22.6 inches. In Princeton, snowfall may occur from mid-November to early April, but is most likely to occur from mid-December to mid-March.

Severe storm events, including thunderstorms, tropical storms, hurricanes, blizzards, ice storms, hail storms, and tornadoes, all occur in Mercer County. Severe storms often result in flooding. During the past several decades, Princeton has experienced numerous severe flooding events, such as those of August 1971, June 1996, September 1999, September 2004, April 2005 and April 2007. On August 28, 1971, Hurricane Doria dumped over seven inches of rain on Princeton, resulting in severe flooding along major creeks. On September 17, 1999, the

[1] Office of the New Jersey State Climatologist. http://climate.rutgers.edu/stateclim/

remnants of Hurricane Floyd caused torrential rains, high winds, flooding, and widespread devastation across New Jersey. Princeton received nearly eight inches of rainfall on that date. The most recent flooding event occurred from the 15th to the 17th of April 2007, when nearly seven inches of rain fell on some parts of the Stony Brook Watershed. As development continues in Princeton and its neighboring communities, such extreme flooding events are expected to become more frequent.

Photo by Joan McGee

Flooding on Stony Brook at the King's Highway Stony Brook Bridge (a National Historic Landmark) in April 2007

Growing Seasons

According to the U.S. Department of Agriculture (USDA), Princeton lies within Plant Hardiness Zone 6b. Zone 6b encompasses areas where annual minimum temperatures are typically between -5°F and 0°F. The USDA continues to use the 1990 plant hardiness zones, although several other groups, including the Arbor Day Foundation, have reclassified areas based on the most recent 10-year trend in weather. The 2006 Arbor Day Foundation Plant Hardiness Zone Map shows Princeton within Zone 7a. Zone 7a is somewhat warmer, with average annual minimum temperatures ranging between 0°F and 5°F. The average growing season in Princeton is about 173 days. The first frost usually occurs in mid-October and the last frost occurs at the end of April. Temperatures in the winter are usually not low enough to keep the soils frozen for the entire winter season. Princeton's growing season is well suited for agriculture, if open land can be maintained for such purposes.

SOILS

Knowledge of local soils is fundamental to understanding a place's environment. A region's soil defines what vegetation is possible, thereby influencing agricultural uses. It also determines how land can be developed for other purposes. High-quality soils are a valuable environmental resource, not only because of their high agricultural productivity, but also because they are a nonrenewable resource. If the soil is lost to erosion, it cannot be replenished on a human time scale. Soils most suitable for agricultural purposes are also among the most desirable for development.

Princeton's soil types are predominantly those characteristic of the Piedmont Plateau Province. The township's soils consist of 25 series types and 76 variations within those series, as identified by the USDA's Natural Resource Conservation Service. These are listed in **Table 4-A: Princeton Township Soils** and shown on **Map 5: Soils**.

Photo by Stephen Hiltner

A field of tickseed along Quaker Road—an area of Princeton with high-quality agricutural soils

The vast majority (93 percent) of Princeton Borough soils are classified as manmade or disturbed soils (Udorthents) and are listed in **Table 4-B: Princeton Borough Soils**. Princeton Borough soils are also featured in **Map 5: Soils**, but are not included in the farmland suitability table due to the general absence of farming in the borough.

Soils of the Piedmont Plateau are predominantly silty, shaley, or stony soils, formed from underlying rock formations of shale, sandstone, mudstone, and metamorphic and igneous rocks. These types of soil are generally slow to absorb precipitation, and therefore the Piedmont Plateau experiences large amounts of surface drainage, flooding, and siltation. Piedmont soils are underlain by bedrock at depths ranging from two to 20 feet. The shallow bedrock depth limits the potential for aquifer formation, which makes surface water quality important for municipal uses, as well as natural wildlife habitat.

Soil Quality Classification

State and national agricultural agencies classify farmland soils into several categories. Princeton Township contains Prime Farmland soils, Soils of Statewide Importance, Soils of Local Importance, and Other Soils (soils not suitable for agricultural use), although only a very small percentage of the township's land is used for agriculture. Each category of farmland is explained below. See **Table 3: Agricultural Values for Princeton Township Soils** for the percentage and acreage of soil in each category. Locations of soil categories are shown on **Map 6: Agricultural Quality of Soils.**

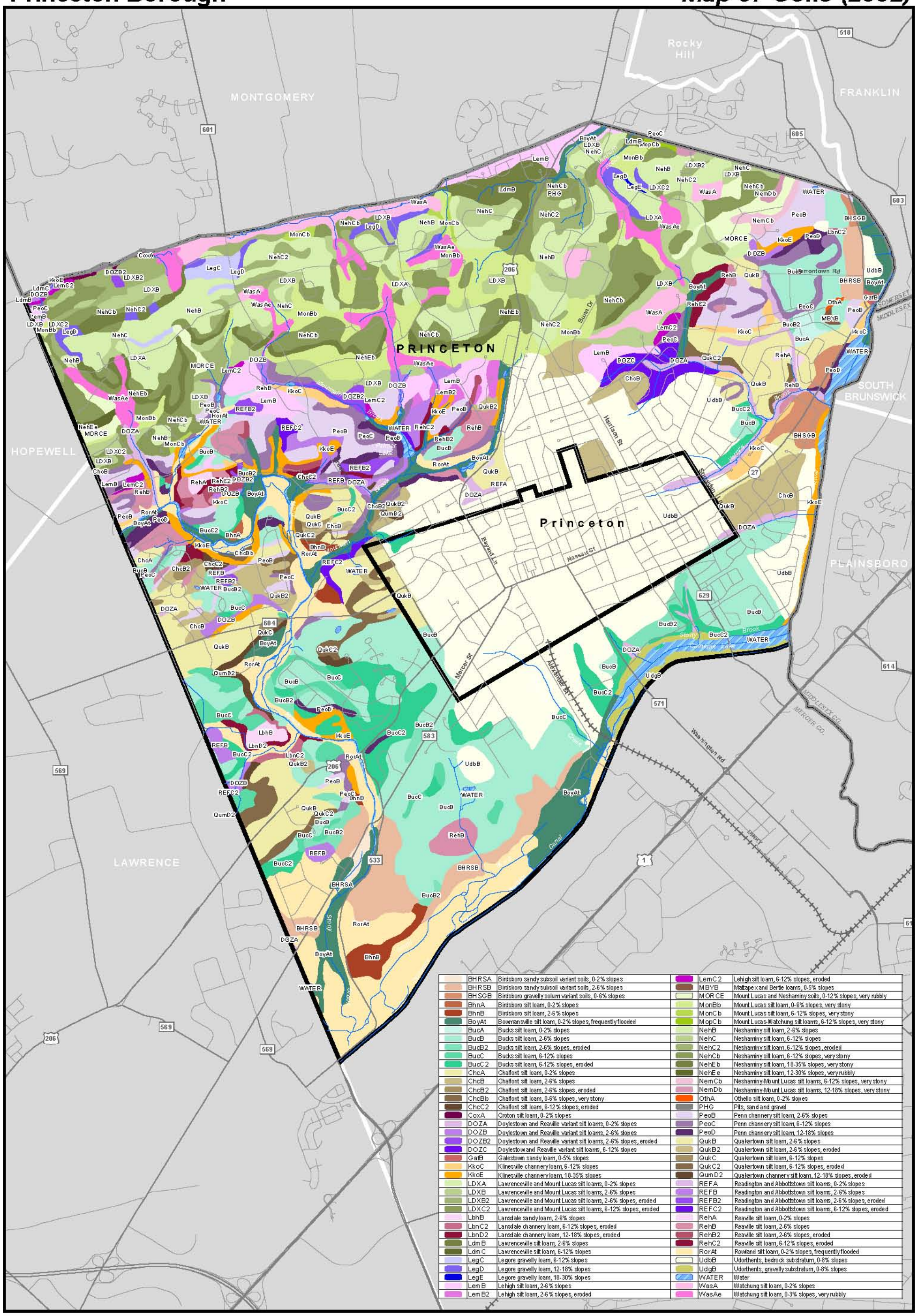
Table 3: Agricultural Values for Princeton Township Soils

Designation	Type	Area (acres)	Percent
P-1	Prime Farmland	3,857.4	36.5%
S-1	Farmland of Statewide Importance	2,999.0	28.4%
L-1	Farmland of Local Importance	258.6	2.4%
Other Soil	Urbanized Land, Wet Soils, Steep Slopes, etc.	3,443.3	32.6%
Totals		**10,558.3**	**100.0%**

Source: NJ Farmlands Inventory, NJ Natural Resources Conservation Service

Princeton Township & Princeton Borough

Map 5: Soils (2002)



	BHRSA	Birdsboro sandy subsoil variant soils, 0-2% slopes		LemC2	Lehigh silt loam, 6-12% slopes, eroded
	BHRSB	Birdsboro sandy subsoil variant soils, 2-6% slopes		MBYB	Mattapex and Bertie loams, 0-5% slopes
	BHSGB	Birdsboro gravelly solum variant soils, 0-6% slopes		MORCE	Mount Lucas and Neshaminy soils, 0-12% slopes, very rubbly
	BhnA	Birdsboro silt loam, 0-2% slopes		MonBb	Mount Lucas silt loam, 0-6% slopes, very stony
	BhnB	Birdsboro silt loam, 2-6% slopes		MonCb	Mount Lucas silt loam, 6-12% slopes, very stony
	BoyAt	Bowmansville silt loam, 0-2% slopes, frequently flooded		MopCb	Mount Lucas-Watchung silt loams, 6-12% slopes, very stony
	BucA	Bucks silt loam, 0-2% slopes		NehB	Neshaminy silt loam, 2-6% slopes
	BucB	Bucks silt loam, 2-6% slopes		NehC	Neshaminy silt loam, 6-12% slopes
	BucB2	Bucks silt loam, 2-6% slopes, eroded		NehC2	Neshaminy silt loam, 6-12% slopes, eroded
	BucC	Bucks silt loam, 6-12% slopes		NehCb	Neshaminy silt loam, 6-12% slopes, very stony
	BucC2	Bucks silt loam, 6-12% slopes, eroded		NehEb	Neshaminy silt loam, 18-35% slopes, very stony
	ChcA	Chalfont silt loam, 0-2% slopes		NehEe	Neshaminy silt loam, 12-30% slopes, very rubbly
	ChcB	Chalfont silt loam, 2-6% slopes		NemCb	Neshaminy-Mount Lucas silt loams, 6-12% slopes, very stony
	ChcB2	Chalfont silt loam, 2-6% slopes, eroded		NemDb	Neshaminy-Mount Lucas silt loams, 12-18% slopes, very stony
	ChcBb	Chalfont silt loam, 0-6% slopes, very stony		OthA	Othello silt loam, 0-2% slopes
	ChcC2	Chalfont silt loam, 6-12% slopes, eroded		PHG	Pits, sand and gravel
	CoxA	Croton silt loam, 0-2% slopes		PeoB	Penn channery silt loam, 2-6% slopes
	DOZA	Doylestown and Reaville variant silt loams, 0-2% slopes		PeoC	Penn channery silt loam, 6-12% slopes
	DOZB	Doylestown and Reaville variant silt loams, 2-6% slopes		PeoD	Penn channery silt loam, 12-18% slopes
	DOZB2	Doylestown and Reaville variant silt loams, 2-6% slopes, eroded		QukB	Quakertown silt loam, 2-6% slopes
	DOZC	Doylestown and Reaville variant silt loams, 6-12% slopes		QukB2	Quakertown silt loam, 2-6% slopes, eroded
	GafB	Galestown sandy loam, 0-5% slopes		QukC	Quakertown silt loam, 6-12% slopes
	KkoC	Klinesville channery loam, 6-12% slopes		QukC2	Quakertown silt loam, 6-12% slopes, eroded
	KkoE	Klinesville channery loam, 18-35% slopes		QumD2	Quakertown channery silt loam, 12-18% slopes, eroded
	LDXA	Lawrenceville and Mount Lucas silt loams, 0-2% slopes		REFA	Readington and Abbottstown silt loams, 0-2% slopes
	LDXB	Lawrenceville and Mount Lucas silt loams, 2-6% slopes		REFB	Readington and Abbottstown silt loams, 2-6% slopes
	LDXB2	Lawrenceville and Mount Lucas silt loams, 2-6% slopes, eroded		REFB2	Readington and Abbottstown silt loams, 2-6% slopes, eroded
	LDXC2	Lawrenceville and Mount Lucas silt loams, 6-12% slopes, eroded		REFC2	Readington and Abbottstown silt loams, 6-12% slopes, eroded
	LbhB	Lansdale sandy loam, 2-6% slopes		RehA	Reaville silt loam, 0-2% slopes
	LbnC2	Lansdale channery loam, 6-12% slopes, eroded		RehB	Reaville silt loam, 2-6% slopes
	LbnD2	Lansdale channery loam, 12-18% slopes, eroded		RehB2	Reaville silt loam, 2-6% slopes, eroded
	LdmB	Lawrenceville silt loam, 2-6% slopes		RehC2	Reaville silt loam, 6-12% slopes, eroded
	LdmC	Lawrenceville silt loam, 6-12% slopes		RorAt	Rowland silt loam, 0-2% slopes, frequently flooded
	LegC	Legore gravelly loam, 6-12% slopes		UdbB	Udorthents, bedrock substratum, 0-8% slopes
	LegD	Legore gravelly loam, 12-18% slopes		UdgB	Udorthents, gravelly substratum, 0-8% slopes
	LegE	Legore gravelly loam, 18-30% slopes		WATER	Water
	LemB	Lehigh silt loam, 2-6% slopes		WasA	Watchung silt loam, 0-2% slopes
	LemB2	Lehigh silt loam, 2-6% slopes, eroded		WasAe	Watchung silt loam, 0-3% slopes, very rubbly

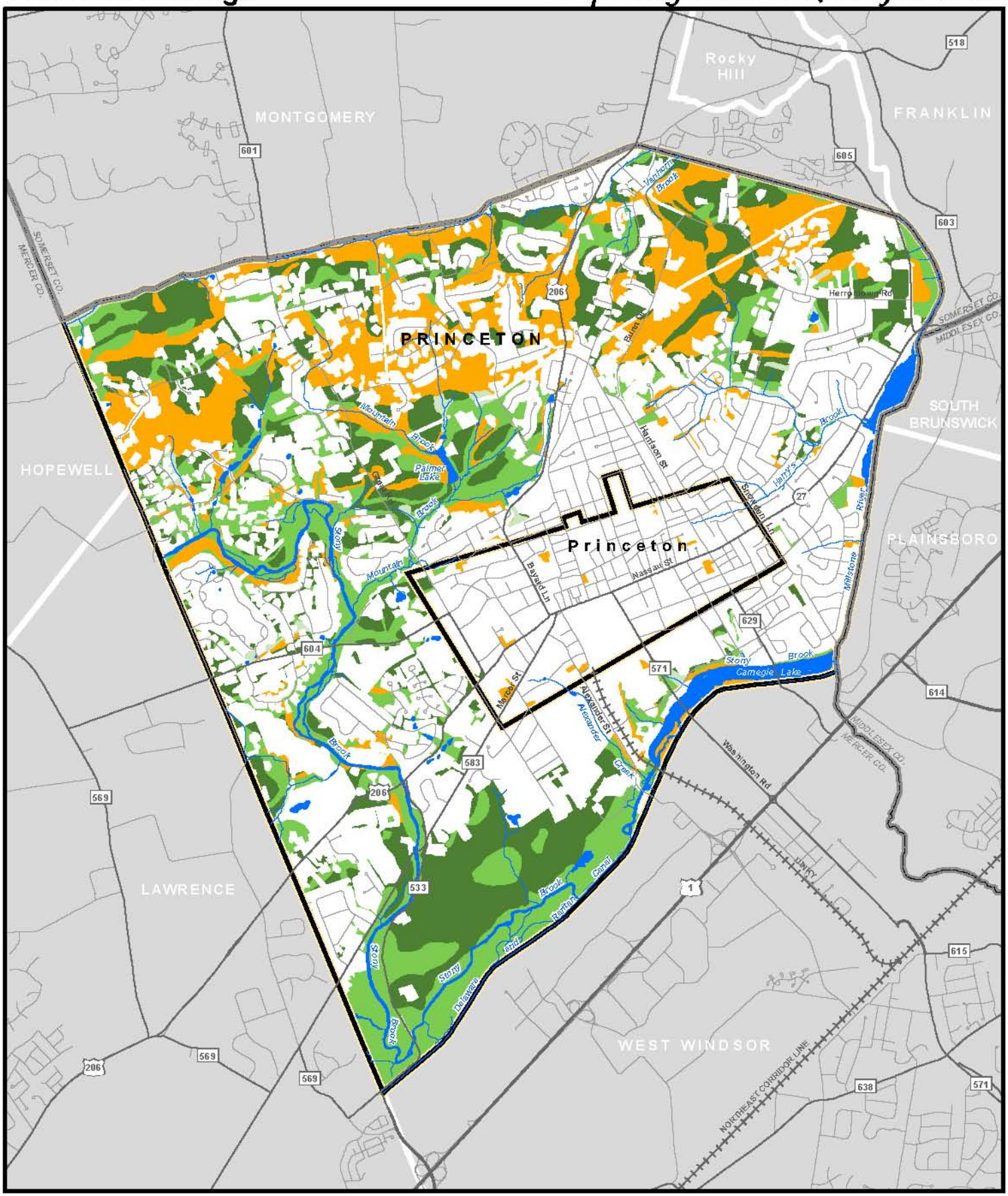
Sources : NJDEP,NJDOT,DVRPC,NRCS.
This map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state-authorized.

0 0.25 0.5 1
Miles

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

Princeton Township & Princeton Borough

Map 6: Agricultural Quality of Soils



Sources: NRCS, 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.

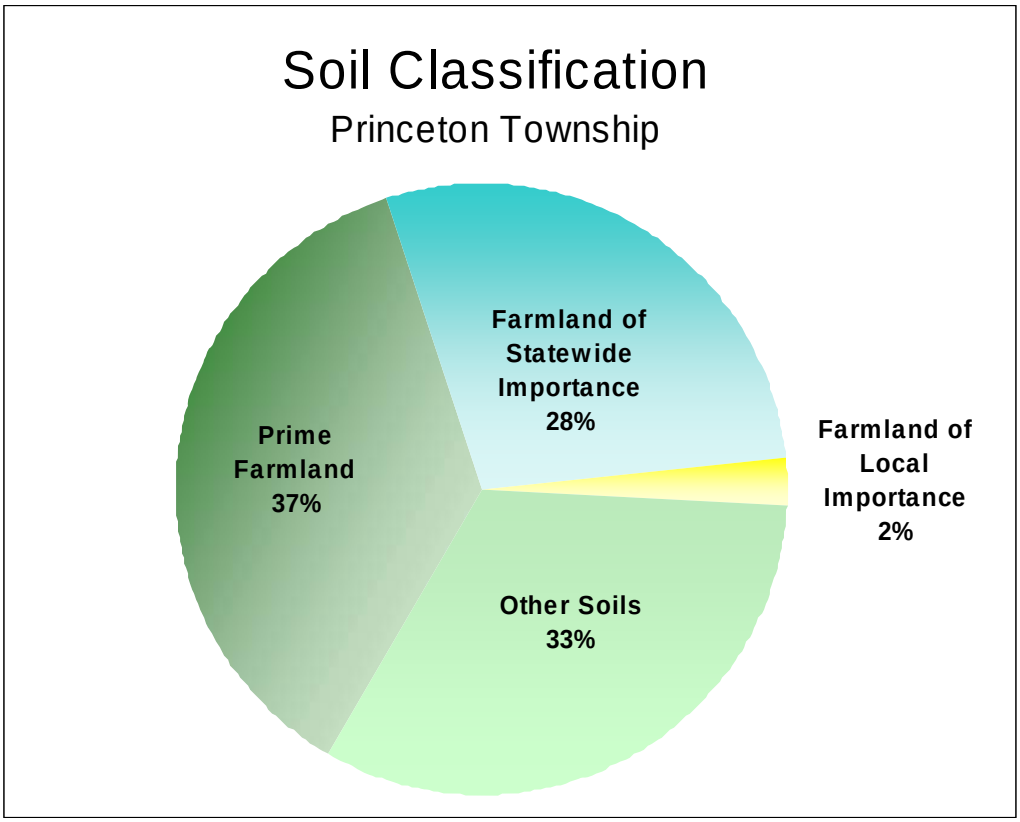
SOIL DESIGNATION

- P1 - Prime Farmland
- S1 - Farmland of Statewide Importance
- 2002 Developed Land
- L1 - Farmland of Local Importance
- NA - Not Rated for Agricultural Use

0 0.25 0.5 1 Miles

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

Figure 4: Agricultural Value Distribution of Soils for Princeton Township



Source: New Jersey Natural Resources Conservation Service

Prime Farmland Soils

Thirty-seven percent of the soils in the township are considered Prime Farmlands (P-1). Prime Farmlands include all those soils in Land Capability Class I and selected soils from Land Capability Class II. Prime Farmlands are lands that have the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops. They 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.

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

Soils of Statewide Importance

Almost 28 percent of Princeton Township'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 with 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 with a Land Capability Class of II or III that do not meet Prime Farmland criteria are rated as Soils of Statewide Importance.

Soils of Local Importance

An additional two percent of the township's soils are classified as Soils of Local Importance (L-1). Soils of Local Importance include those soils that are not of prime or statewide importance, but can support the production of high-value food, fiber, and horticultural crops (fruits and vegetables), such as tomatoes, sweet corn, blueberries, strawberries, cranberries, peaches, and nursery crops.

Other Soils

An additional 33 percent of Princeton Township's soils are classified as Other Soils. These soils are not considered suitable for farming due to a number of different constraints, including water saturation, soil composition, or slope. The largest subset of these soils in Princeton is Udorthents. Udorthents are heavily manipulated by development, compaction, or other human interaction and are therefore unsuitable for agriculture.

Hydric Soils

Almost 12 percent of the 33 percent listed as Other Soils are considered hydric soils. Hydric soils, as defined by the National Technical Committee of Hydric Soils, are soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in their subsurface. They support the development of hydrophytic vegetation. Hydric soils have unique soil properties that distinguish them from nonhydric soils. They are an important element of wetland areas and naturally support wetland vegetation. If a soil is classified as "hydric," land use may be restricted due to the relationship of hydric soils to wetlands and wetland preservation. More detailed descriptions of Princeton's wetland areas are found in the *Natural Resources* section, under "Wetlands" and "Agricultural Wetlands" beginning on *page 50*, and the *Biological Resources* section, under "Wetlands" on *page 92*. Wetland areas are strictly regulated under state law. All landowners must be cognizant of wetland areas because the New Jersey Department of Environmental Protection rules allow for penalties in the event of intrusion into any wetlands without proper authority.

Soil Series

Several soil series appear more frequently in Princeton than in other areas and are briefly described as follows.[2] The soil types are listed in alphabetical order in the following text and tables. Consult **Table 4a: Princeton Township Soils** and **Table 4b: Princeton Borough Soils** for detailed information.

Birdsboro

Birdsboro soils are very deep and well to moderately well drained. These soils make up about four percent of the township. They are commonly found on sloping stream terraces, with slopes ranging from zero to 15 percent. These soils, formed from alluvium and derived from weathered shale and sandstone, were laid down when streams were higher and their flow was greater, generally during the glacial/interglacial transitions that have occurred repeatedly during the past 130,000 years.[3] Their permeability is rapid to moderately rapid and their runoff is slow to rapid.[4] Historically, a large percentage of this type of soil was used for agriculture, and almost all areas of these soils were cleared to grow corn, small grains, and soybeans. Today, the soils support both agriculture and mixed hardwood forests. Birdsboro soils generally present few or no constraints to development and are classified as either Farmland of Statewide Importance or Prime Farmland depending on slope and other variables.

Bowmansville

About three and a half percent of Princeton Township is covered by Bowmansville silt loam. This hydric soil is found along the reaches of the Stony Brook Watershed. The soil is frequently flooded, and depths to bedrock of over six feet are not unusual. Bowmansville soils are often saturated and present numerous problems to development related to flooding and ponding. This soil presents large constraints to development and is classified as a Soil of Statewide Importance. Natural land cover for Bowmansville soils includes wetland shrubs and trees.

Bucks

Over 16 percent of Princeton Township's soils and about three percent of Princeton Borough are in the Bucks series. Bucks soils are deep, well-drained soils, located on upland divides and rolling slopes. They are underlain by silt and gravel that is over bedrock. Their surface runoff and permeability are moderate. Bucks soils have slight to moderate limitations for disposal of sewage from septic tanks. Much of the soil has been cleared of mixed oaks, maples, yellow

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[2] Soil Conservation Service. *Soil Survey of Mercer County New Jersey*, USDA and New Jersey Agricultural Experiment Station, January 1972.
[3] "A quick background to the last ice age." www.esd.ornl.gov/projects/qen/nerc130k.html.
[4] Permeability refers to the ability of water to flow through the soil from the ground surface to the underlying layers of unconsolidated materials and bedrock. Draining refers to the ability of water to dissipate after it permeates through the soil to the underlying layers of unconsolidated materials and bedrock. Water can dissipate by flowing into cracks and fissures in the bedrock, by draining into unconsolidated gravel layers beneath the soil, or by flowing out into streams and lakes. A soil may have any combination of permeability and draining characteristics.

poplar, hickory, and ash. Agriculturally, it is used mostly for growing corn, small grains, soybeans, hay, pasture, and, to a small extent, vegetables, fruits, and nursery plants. Several of the subtypes found in the township are considered prime farmland.

Lawrenceville

The Lawrenceville series accounts for 5.7 percent of Princeton's soils. This very deep type of soil consists of a fine silt loam surface layer and a silty clay loam subsurface formed from transported materials. They generally occur in uplands and terraces. Permeability is slow and water holding capacity is high. Lawrenceville soils are generally quite fertile; most subtypes in the series are classified as prime agricultural soils. The natural vegetation of the Lawrenceville soil series is upland deciduous forests, many containing oak, tulip poplar, beech, and hickory.

Mount Lucas

Mount Lucas soils occur on slopes from zero to 12 percent and consist of loamy residuals from the base rock. They make up five percent of Princeton's soil cover. The soils are deep, from 48 to 99 inches, and are moderately well drained. These soils are rarely flooded or ponded and are classified as prime farmland throughout their range. Mount Lucas soils are found in the northern third of the township and were once largely cleared for cultivation, though most have returned to a forested state as agriculture has declined in the township. Mount Lucas soils pose severe restrictions on the location of septic systems due to their high water table and seepage risks.

Neshaminy

Fifteen percent of Princeton's soil belongs to the Neshaminy series. Neshaminy soils consist of deep, well drained soils formed from weathered diabase and other dark colored basic rocks. This soil type is at most only moderately permeable. This soil is formed in areas with mean precipitation around 42 inches and an annual temperature near 50 degrees Fahrenheit. Neshaminy soils are found primarily in the northern portion of the township, along the Princeton Ridge, a large diabase dike that rises above the rest of the local topography. Where the grade is shallow, between 0 and 10 percent, this soil is classified as prime farmland or farmland of statewide importance. Steeper areas are unsuitable for farming. The low overall permeability of the soil places restrictions on the placement of septic systems. The Neshaminy soils of Princeton Township are predominantly wooded today, though most of the lands were logged out and/or cleared for farmland in the past.

Penn

Penn soils are shallow to moderately shallow, well-drained soils occurring on slopes ranging from zero to 18 percent. They formed from weathered siltstone and red shale. Permeability is moderate to moderately slow. While some crops may be grown on Penn series soils, they cannot hold large amounts of plant nutrients, making fertilization a common practice in agriculture on this soil type. The depth to bedrock is less than 40 inches. In Princeton, Penn soils occupy about six percent of the land and pose moderate to severe constraints to development depending on slope and depth to bedrock.

Quakertown

Quakertown series soils account for seven percent of Princeton Township's land area and about three percent of Princeton Borough's land area. These soils are moderately deep, well drained, and located on uplands. They have an undulating topography, with slopes ranging from two to 18 percent. Their surface runoff is moderate and their permeability is moderately rapid. Vegetation native to this soil includes oak, hickory, yellow poplar, and ash. Most of this type of soil has been cleared for growing corn, small grain, and grasses. Subseries with steeper slopes present severe limitations to development and are classified as either Farmland of Statewide Importance or Prime Farmland, depending on slope and other variables.

Rowland

This series consists of very deep, moderately well-drained soils. These soils make up nearly seven percent of the township. They are formed on floodplains from alluvial sediments weathered from sandstone, conglomerate, and red and brown shale, which washes from nearby uplands. These soils occur on slopes ranging from zero to three percent. The permeability of the soil is moderate to moderately slow in the upper 40 inches of the soil and moderately rapid in the soil's underlying stratified sand and gravel. This soil series is classified as Farmland of Statewide Importance, but presents severe limitations for septic systems and buildings because of a high water table and frequent flooding.

Udorthents

Largely concentrated throughout Princeton Borough, Udorthents also make up over 92 percent of the borough's soils and nearly 11 percent of the township's soils. Typically, this series consists of somewhat poorly drained to very poorly drained soils that have been altered mainly by filling and compaction. However, due to the degree of human influence on this classification of soil, large variance occurs within the category and on-site investigation is needed to determine the suitability of this soil for any use.

Despite the classification of nearly all of the borough's, and over 10 percent of the township's, soils as Udorthents, the character of these soils varies widely according to many variables, including land management, land use, vegetation types, and presence of impervious surfaces. When best management practices (BMPs), such as rain gardens, bioswales, and tree trenches, are employed, and natural vegetation is maintained, areas classified as Udorthents have considerable potential to infiltrate stormwater, improve water quality, reduce flooding, and prevent excessive runoff.

Table 4-A: Princeton Township Soils

Soil Code	Soil Description	Acres	Farmland Designation	% All acres
BhnA	Birdsboro silt loam, 0 to 2 percent slopes	3.86	P-1	0.04%
BhnB	Birdsboro silt loam, 2 to 6 percent slopes	58.95	P-1	0.56%
BHRSA	Birdsboro sandy subsoil variant soils, 0 to 2 percent slopes	13.16	P-1	0.12%
BHRSB	Birdsboro sandy subsoil variant soils, 2 to 6 percent slopes	246.69	P-1	2.34%
BHSGB	Bucks silt loam, 0 to 2 percent slopes	18.58	P-1	0.18%
BoyAt	Bucks silt loam, 2 to 6 percent slopes	1,157.61	P-1	10.96%
BucA	Bucks silt loam, 2 to 6 percent slopes, eroded	105.25	P-1	1.00%
BucB	Galestown sandy loam, 0 to 5 percent slopes	3.68	P-1	0.03%
BucB2	Lansdale sandy loam, 2 to 6 percent slopes	16.41	P-1	0.16%
BucC	Lawrenceville silt loam, 2 to 6 percent slopes	71.53	P-1	0.68%
BucC2	Lawrenceville and Mount Lucas silt loams, 0 to 2 percent slopes	15.72	P-1	0.15%
ChcA	Lawrenceville and Mount Lucas silt loams, 2 to 6 percent slopes	348.45	P-1	3.30%
ChcB	Lawrenceville and Mount Lucas silt loams, 2 to 6 percent slopes, eroded	88.30	P-1	0.84%
ChcB2	Neshaminy silt loam, 2 to 6 percent slopes	660.88	P-1	6.26%
ChcBb	Penn Channery silt loam, 2 to 6 percent slopes	319.65	P-1	3.03%
ChcC2	Quakertown silt loam, 2 to 6 percent slopes	549.38	P-1	5.20%
CoxA	Quakertown silt loam, 2 to 6 percent slopes, eroded	64.91	P-1	0.61%
DOZA	Readington and Abbottstown silt loams, 0 to 2 percent slopes	4.69	P-1	0.04%
DOZB	Readington and Abbottstown silt loams, 2 to 6 percent slopes	79.80	P-1	0.76%
DOZB2	Readington and Abbottstown silt loams, 2 to 6 percent slopes, eroded	29.87	P-1	0.28%
DOZC	Birdsboro gravelly solum variant soils, 0 to 6 percent slopes	71.44	L-1	0.68%
GafB	Doylestown and Reaville variant silt loams, 0 to 2 percent slopes	124.43	L-1	1.18%
KkoC	Doylestown and Reaville variant silt loams, 2 to 6 percent slopes	62.74	L-1	0.59%
KkoE	Bowmansville silt loam, 0 to 2 percent slopes, frequently flooded	374.36	S-1	3.55%
LbhB	Bucks silt loam, 6 to 12 percent slopes	125.36	S-1	1.19%
LbnC2	Bucks silt loam, 6 to 12 percent slopes, eroded	303.69	S-1	2.88%
LbnD2	Chalfont silt loam, 0 to 2 percent slopes	7.81	S-1	0.07%
LdmB	Chalfont silt loam, 2 to 6 percent slopes	228.50	S-1	2.16%
LdmC	Chalfont silt loam, 2 to 6 percent slopes, eroded	17.53	S-1	0.17%
LDXA	Chalfont silt loam, 6 to 12 percent slopes, eroded	8.98	S-1	0.09%
LDXB	Croton silt loam, 0 to 2 percent slopes	8.63	S-1	0.08%
LDXB2	Lansdale channery loam, 6 to 12 percent slopes, eroded	17.60	S-1	0.17%
LDXC2	Lawrenceville silt loam, 6 to 12 percent slopes	3.24	S-1	0.03%
LegC	Lawrenceville and Mount Lucas silt loams, 6 to 12 percent slopes, eroded	76.37	S-1	0.72%
LegD	Legore gravelly loam, 6 to 12 percent slopes	34.14	S-1	0.32%

Soil Code	Soil Description	Acres	Farmland Designation	% All acres
LegE	Lehigh silt loam, 2 to 6 percent slopes	204.81	S-1	1.94%
LemB	Lehigh silt loam, 2 to 6 percent slopes, eroded	24.71	S-1	0.23%
LemB2	Lehigh silt loam, 6 to 12 percent slopes, eroded	23.96	S-1	0.23%
LemC2	Mattapex and Bertie loams, 0 to 5 percent slopes	3.31	S-1	0.03%
MBYB	Neshaminy silt loam, 6 to 12 percent slopes	78.48	S-1	0.74%
MonBb	Neshaminy silt loam, 6 to 12 percent slopes, eroded	127.55	S-1	1.21%
MonCb	Othello silt loam, 0 to 2 percent slopes	1.91	S-1	0.02%
MopCb	Penn channery silt loam, 6 to 12 percent slopes	220.19	S-1	2.09%
MORCE	Quakertown silt loam, 6 to 12 percent slopes	9.36	S-1	0.09%
NehB	Quakertown silt loam, 6 to 12 percent slopes, eroded	114.02	S-1	1.08%
NehC	Readington and Abbottstown silt loams, 6 to 12 percent slopes, eroded	28.40	S-1	0.27%
NehC2	Reaville silt loam, 0 to 2 percent slopes	15.77	S-1	0.15%
NehCb	Reaville silt loam, 2 to 6 percent slopes	150.01	S-1	1.42%
NehEb	Reaville silt loam, 2 to 6 percent slopes, eroded	32.35	S-1	0.31%
NehEe	Reaville silt loam, 6 to 12 percent slopes, eroded	55.54	S-1	0.53%
NemCb	Rowland silt loam, 0 to 2 percent slopes, frequently flooded	702.43	S-1	6.65%
NemDb	Chalfont silt loam, 0 to 6 percent slopes, very stony	5.11	N/A	0.05%
OthA	Doylestown and Reaville variant silt loams, 2 to 6 percent slopes, eroded	25.46	N/A	0.24%
PeoB	Doylestow and Reaville variant silt loams, 6 to 12 percent slopes	61.22	N/A	0.58%
PeoC	Klinesville channery loam, 6 to 12 percent slopes	65.40	N/A	0.62%
PeoD	Klinesville channery loam, 18 to 35 percent slopes	169.08	N/A	1.60%
PHG	Lansdale channery loam, 12 to 18 percent slopes, eroded	14.33	N/A	0.14%
QukB	Legore gravelly loam, 12 to 18 percent slopes	59.79	N/A	0.57%
QukB2	Legore gravelly loam, 18 to 30 percent slopes	1.68	N/A	0.02%
QukC	Mount Lucas silt loam, 0 to 6 percent slopes, very stony	403.36	N/A	3.82%
QukC2	Mount Lucas silt loam, 6 to 12 percent slopes, very stony	18.32	N/A	0.17%
QumD2	Mount Lucas-Watchung silt loams, 6 to 12 percent slopes, very stony	7.16	N/A	0.07%
REFA	Mount Lucas and Neshaminy soils, 0 to 12 percent slopes, very rubbly	91.97	N/A	0.87%
REFB	Neshaminy silt loam, 6 to 12 percent slopes, very stony	514.43	N/A	4.87%
REFB2	Neshaminy silt loam, 18 to 35 percent slopes, very stony	143.88	N/A	1.36%
REFC2	Neshaminy silt loam, 12 to 30 percent slopes, very rubbly	8.77	N/A	0.08%
RehA	Neshaminy-Mount Lucas silt loams, 6 to 12 percent slopes, very stony	27.52	N/A	0.26%
RehB	Neshaminy-Mount Lucas silt loams, 12 to 18 percent slopes, very stony	11.85	N/A	0.11%
RehB2	Penn channery silt loam, 12 to 18 percent slopes	85.27	N/A	0.81%
RehC2	Pits, sand and gravel	0.62	N/A	0.01%
RorAt	Quakertown channery silt loam, 12 to 18 percent slopes, eroded	36.52	N/A	0.35%

Soil Code	Soil Description	Acres	Farmland Designation	% All acres
UdbB	Udorthents, bedrock substratum, 0 to 8 percent slopes	1,071.72	N/A	10.15%
UdgB	Udorthents, gravelly substratum, 0 to 8 percent slopes	55.44	N/A	0.53%
WasA	Watchung silt loam, 0 to 2 percent slopes	161.36	N/A	1.53%
WasAe	Watchung silt loam, 0 to 3 percent slopes, very rubbly	199.61	N/A	1.89%
WATER	Water	203.40	N/A	1.93%
	Totals	**10,558.25**		**100.00%**

Source: NJDEP (based on Soil Survey of Mercer County)

Table 4-B: Princeton Borough Soils

Soil Code	Soil Description	Designation	Acres	Percentage
BucB	Bucks silt loam, 2 to 6 percent slopes	P-1	24.6	2.1%
QukB	Quakertown silt loam, 2 to 6 percent slopes	P-1	31.3	2.7%
DOZA	Doylestown and Reaville variant silt loams, 0 to 2 percent slopes	L-1	12.0	1.0%
BucC2	Bucks silt loam, 6 to 12 percent slopes, eroded	S-1	6.6	0.6%
ChcB	Chalfont silt loam, 2 to 6 percent slopes	S-1	4.3	0.4%
QukC2	Quakertown silt loam, 6 to 12 percent slopes, eroded	S-1	4.4	0.4%
UdbB	Udorthents, bedrock substratum, 0 to 8 percent slopes	Other Soil	1,085.7	92.9%
Totals			**1,168.9**	**100.0%**

Source: NJDEP (based on Soil Survey of Mercer County)

Explanation of Farmland Designations	
P-1	Prime Farmland
S-1	Farmland of statewide importance
L-1	Farmland of local importance
N/A	Other soils, i.e., urbanized lands, steep slopes, permanently wet soils etc.

Soil characteristics can severely restrict the use of sites for construction and development. **Table 5: Soil Limitations for Development** 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 on-site septic systems. Septic systems require soils that have a low water table, below five feet, and slow permeability to allow for proper drainage of wastewater. **Map 7** shows the areas within Princeton that have been approved for sewer service. Areas not approved for sewer service (and areas *approved*, but not yet *served* by sewers) must be served by septic systems. High water tables, five feet or less from the surface, also create a potential for erosion, wet basements, alteration of plant life, and early frost for agricultural crops.

Key to Land Use Limitations in Table 5	
A=Slight	Little or no limitation or easily corrected by use of common equipment and techniques.
B=Moderate	Presence of some limitation, which normally can be overcome by careful design and management at somewhat greater cost.
C=Severe	Limitations that under normal circumstances cannot be overcome without exceptional, complex, or costly measures.

Table 5: Soil Limitations for Development

Soil Code	Soil Description	Acres	Sewage Lagoon	Septic Field	Dwelling w/o Basement	Dwelling w/ basement	Small Commercial
BhnA	Birdsboro silt loam, 0 to 2 percent slopes	3.86	C	C	A	A	A
BhnB	Birdsboro silt loam, 2 to 6 percent slopes	58.95	C	C	A	A	A
BHRSA	Birdsboro sandy subsoil variant soils, 0 to 2 percent slopes	13.16	C	C	A	B	A
BHRSB	Birdsboro sandy subsoil variant soils, 2 to 6 percent slopes	246.69	C	C	A	B	A
BHSGB	Bucks silt loam, 0 to 2 percent slopes	18.58	C	C	A	A	A
BoyAt	Bucks silt loam, 2 to 6 percent slopes	1,157.61	C	C	C	C	C
BucA	Bucks silt loam, 2 to 6 percent slopes, eroded	105.25	B	B	A	A	A
BucB	Galestown sandy loam, 0 to 5 percent slopes	3.68	B	B	A	A	A

Soil Code	Soil Description	Acres	Sewage Lagoon	Septic Field	Dwelling w/o Basement	Dwelling w/ basement	Small Commercial
BucB2	Lansdale sandy loam, 2 to 6 percent slopes	16.41	B	B	A	A	A
BucC	Lawrenceville silt loam, 2 to 6 percent slopes	71.53	C	B	B	B	C
BucC2	Lawrenceville and Mount Lucas silt loams, 0 to 2 percent slopes	15.72	C	B	B	B	C
ChcA	Lawrenceville and Mount Lucas silt loams, 2 to 6 percent slopes	348.45	C	C	C	C	C
ChcB	Lawrenceville and Mount Lucas silt loams, 2 to 6 percent slopes, eroded	88.30	C	C	C	C	C
ChcB2	Neshaminy silt loam, 2 to 6 percent slopes	660.88	C	C	C	C	C
ChcBb	Penn channery silt loam, 2 to 6 percent slopes	319.65	C	C	C	C	C
ChcC2	Quakertown silt loam, 2 to 6 percent slopes	549.38	C	C	C	C	C
CoxA	Quakertown silt loam, 2 to 6 percent slopes, eroded	64.91	C	C	C	C	C
DOZA	Readington and Abbottstown silt loams, 0 to 2 percent slopes	4.69	C	C	C	C	C
DOZB	Readington and Abbottstown silt loams, 2 to 6 percent slopes	79.80	C	C	C	C	C
DOZB2	Readington and Abbottstown silt loams, 2 to 6 percent slopes, eroded	29.87	C	C	C	C	C
DOZC	Birdsboro gravelly solum variant soils, 0 to 6 percent slopes	71.44	C	C	C	C	C
GafB	Doylestown and Reaville variant silt loams, 0 to 2 percent slopes	124.43	C	C	A	A	A
KkoC	Doylestown and Reaville variant silt loams, 2 to 6 percent slopes	62.74	C	C	B	C	C
KkoE	Bowmansville silt loam, 0 to 2 percent slopes, frequently flooded	374.36	C	C	C	C	C
LbhB	Bucks silt loam, 6 to 12 percent slopes	125.36	C	C	A	A	A
LbnC2	Bucks silt loam, 6 to 12 percent slopes, eroded	303.69	C	C	B	B	C
LbnD2	Chalfont silt loam, 0 to 2 percent slopes	7.81	C	C	C	C	C
LdmB	Chalfont silt loam, 2 to 6 percent slopes	228.50	B	C	B	C	B

Soil Code	Soil Description	Acres	Sewage Lagoon	Septic Field	Dwelling w/o Basement	Dwelling w/ basement	Small Commercial
LdmC	Chalfont silt loam, 2 to 6 percent slopes, eroded	17.53	C	C	B	C	C
LDXA	Chalfont silt loam, 6 to 12 percent slopes, eroded	8.98	C	C	B	C	B
LDXB	Croton silt loam, 0 to 2 percent slopes	8.63	C	C	B	C	B
LDXB2	Lansdale channery loam, 6 to 12 percent slopes, eroded	17.60	C	C	B	C	B
LDXC2	Lawrenceville silt loam, 6 to 12 percent slopes	3.24	C	C	B	C	C
LegC	Lawrenceville and Mount Lucas silt loams, 6 to 12 percent slopes, eroded	76.37	C	C	B	B	C
LegD	Legore gravelly loam, 6 to 12 percent slopes	34.14	C	C	C	C	C
LegE	Lehigh silt loam, 2 to 6 percent slopes	204.81	C	C	C	C	C
LemB	Lehigh silt loam, 2 to 6 percent slopes, eroded	24.71	C	C	C	C	C
LemB2	Lehigh silt loam, 6 to 12 percent slopes, eroded	23.96	C	C	C	C	C
LemC2	Mattapex and Bertie loams, 0 to 5 percent slopes	3.31	C	C	C	C	C
MBYB	Neshaminy silt loam, 6 to 12 percent slopes	78.48	C	C	B	C	B
MonBb	Neshaminy silt loam, 6 to 12 percent slopes, eroded	127.55	C	C	B	C	C
MonCb	Othello silt loam, 0 to 2 percent slopes	1.91	C	C	B	C	C
MopCb	Penn channery silt loam, 6 to 12 percent slopes	220.19	C	C	B	C	B
MORCE	Quakertown silt loam, 6 to 12 percent slopes	9.36	C	C	B	C	B
NehB	Quakertown silt loam, 6 to 12 percent slopes, eroded	114.02	B	C	A	A	A
NehC	Readington and Abbottstown silt loams, 6 to 12 percent slopes, eroded	28.40	C	C	B	B	C
NehC2	Reaville silt loam, 0 to 2 percent slopes	15.77	C	B	B	B	C
NehCb	Reaville silt loam, 2 to 6 percent slopes	150.01	B	C	A	A	B

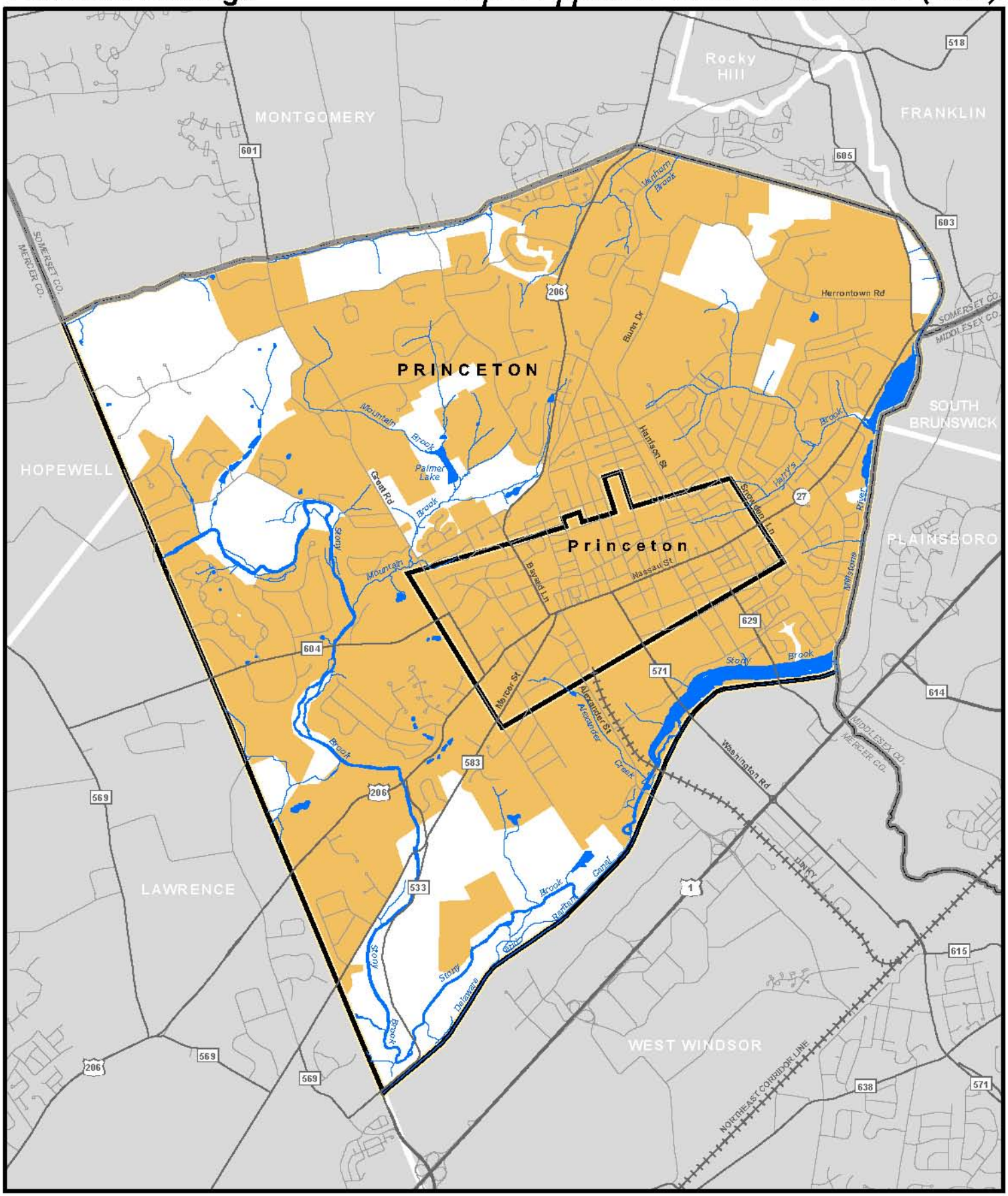
Soil Code	Soil Description	Acres	Sewage Lagoon	Septic Field	Dwelling w/o Basement	Dwelling w/ basement	Small Commercial
NehEb	Reaville silt loam, 2 to 6 percent slopes, eroded	32.35	C	C	C	C	C
NehEe	Reaville silt loam, 6 to 12 percent slopes, eroded	55.54	C	C	C	C	C
NemCb	Rowland silt loam, 0 to 2 percent slopes, frequently flooded	702.43	C	C	A	A	B
NemDb	Chalfont silt loam, 0 to 6 percent slopes, very stony	5.11	C	C	C	C	C
OthA	Doylestown and Reaville variant silt loams, 2 to 6 percent slopes, eroded	25.46	C	C	C	C	C
PeoB	Doylestow and Reaville variant silt loams, 6 to 12 percent slopes	61.22	C	C	A	B	A
PeoC	Klinesville channery loam, 6 to 12 percent slopes	65.40	C	C	B	B	C
PeoD	Klinesville channery loam, 18 to 35 percent slopes	169.08	C	C	C	C	C
PHG	Lansdale channery loam, 12 to 18 percent slopes, eroded	14.33	Not rated	Not rated	Not rated	Not rated	Not rated
QukB	Legore gravelly loam, 12 to 18 percent slopes	59.79	B	C	A	A	A
QukB2	Legore gravelly loam, 18 to 30 percent slopes	1.68	B	C	A	A	A
QukC	Mount Lucas silt loam, 0 to 6 percent slopes, very stony	403.36	C	C	B	B	C
QukC2	Mount Lucas silt loam, 6 to 12 percent slopes, very stony	18.32	C	C	B	B	C
QumD2	Mount Lucas-Watchung silt loams, 6 to 12 percent slopes, very stony	7.16	C	C	C	C	C
REFA	Mount Lucas and Neshaminy soils, 0 to 12 percent slopes, very rubbly	91.97	B	C	B	C	B
REFB	Neshaminy silt loam, 6 to 12 percent slopes, very stony	514.43	B	C	B	C	B
REFB2	Neshaminy silt loam, 18 to 35 percent slopes, very stony	143.88	B	C	B	C	B
REFC2	Neshaminy silt loam, 12 to 30 percent slopes, very rubbly	8.77	C	C	B	C	C
RehA	Neshaminy-Mount Lucas silt loams, 6 to 12 percent slopes, very stony	27.52	C	C	B	C	B
RehB	Neshaminy-Mount Lucas silt loams, 12 to 18 percent slopes, very stony	11.85	C	C	B	C	B

Soil Code	Soil Description	Acres	Sewage Lagoon	Septic Field	Dwelling w/o Basement	Dwelling w/ basement	Small Commercial
RehB2	Penn channery silt loam, 12 to 18 percent slopes	85.27	C	C	B	C	B
RehC2	Pits, sand, and gravel	0.62	C	C	B	C	C
RorAt	Quakertown channery silt loam, 12 to 18 percent slopes, eroded	36.52	C	C	C	C	C
UdbB	Udorthents, bedrock substratum, 0 to 8 percent slopes	1,071.72	C	C	A	C	A
UdgB	Udorthents, gravelly substratum, 0 to 8 percent slopes	55.44	C	C	A	A	A
WasA	Watchung silt loam, 0 to 2 percent slopes	161.36	C	C	C	C	C
WasAe	Watchung silt loam, 0 to 3 percent slopes, very rubbly	199.61	C	C	C	C	C

Sources: Soil Survey of Mercer County, NJ NRCS

Princeton Township & Princeton Borough

Map 7: Approved Sewer Service Area (2006)



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.

TYPE OF SEWER SERVICE AREA

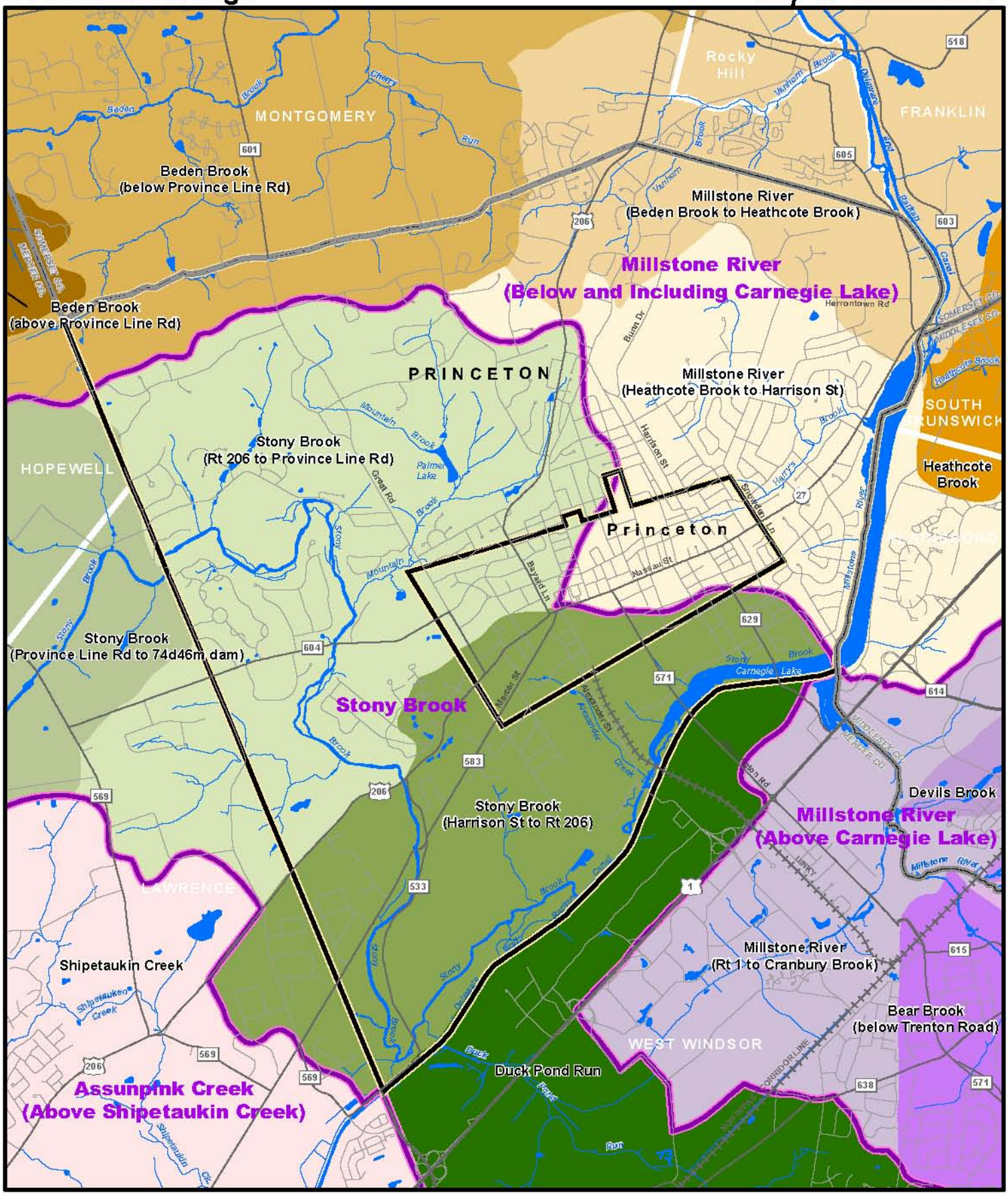
Area Approved for Sewer

0 0.25 0.5 1
Miles

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

Princeton Township & Princeton Borough

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.

Watershed (HUC 11) Containing Sub-Watershed (HUC 14)

0 0.25 0.5 1
Miles

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

SURFACE WATER RESOURCES

Most of Princeton's land drains to the Raritan River by way of two waterways—the Millstone River and its main tributary, the Stony Brook. Another significant waterbody is the Delaware and Raritan Canal, which, along with the Millstone River, makes up the southern border of the township.

WATERSHEDS

A watershed is all the land that drains to a particular waterway, such as a river, stream, lake, or wetland. The boundaries of a watershed are defined by the high points in the terrain, such as hills or ridges. A watershed includes not only the waterbody or waterway itself, but also the entire land area that drains to it. Large watersheds are made up of smaller ones, down to the catchment level of a local site. So, for example, the Raritan River Watershed is made up of many smaller watersheds, such as the Stony Brook Watershed. The Stony Brook Watershed, in turn, is formed of several subwatersheds, consisting of the land that drains to a major tributary or branch of the Stony Brook, such as Mountain Brook. These subwatersheds can be further subdivided into smaller ones. Mountain Brook itself has various branches, each fed by its surrounding land, with smaller and smaller subdivisions possible, down to the catchment level. Watersheds are natural ecological units, where soil, water, air, plants, and animals interact in a complex relationship.

The Hydrologic Unit Code (HUC) is a numerical identification code given to every drainage system in the United States by the U.S. Geological Survey. HUCs begin with a number representing the largest drainage area. For example, the first level divides the entire country into 21 major drainage areas. From there, numbers are added as the defined area becomes smaller. The numbers to the right represent the most local watershed. HUC-11 codes are 11-digit numbers applied to a drainage area that is approximately 40 square miles in size. Because HUC-11 watersheds need to be nearly uniform in size, the watersheds of some streams and rivers will be divided into multiple watersheds for classification purposes. Princeton falls into two HUC-11 watersheds—the Millstone River (below and including Carnegie Lake) and Stony Brook. HUC-11 watersheds are further subdivided into HUC-14 subwatersheds, with the identification number for each one having 14 digits. There are nine HUC-14 watersheds in Princeton, listed in **Table 6: Watersheds** and shown on **Map 8: Watersheds.**

Millstone River Watershed

The Millstone River is the major watershed in Princeton Township. In practice, all of Princeton is in the Millstone Watershed, since the Stony Brook drains into the Millstone River, although for the purposes of this discussion, the Stony Brook Watershed is considered in its own right. The Millstone River is 38 miles long and originates in Millstone Township in Monmouth County. The Millstone River is joined by Stony Brook at Carnegie Lake, where it forms the southeastern border of Princeton Township. The Millstone then travels north until it joins the Raritan River and empties into the Raritan Bay and the Atlantic Ocean. The eastern third of

Princeton, including the eastern half of the borough, is part of the Millstone River Watershed. The watershed of Harry's Brook, a subwatershed of the Millstone River Watershed, occupies most of this area.

Table 6: Watersheds

Watershed	USGS Watershed Code (HUC 11 Number)	Stream Classification	Acreage within Princeton Twp/Borough	% of land	Sub-watersheds (HUC 14 Numbers within Princeton)
Princeton Township					
Millstone River (below and including Carnegie Lake)	02030105110	FW2-NT	3,941	37.29%	02030105110050 02030105110030 02030105110020
Stony Brook	2030105090	FW2-NT	6,628	62.71%	02030105090060 02030105090050 02030105090070
Princeton Borough					
Millstone River (below and including Carnegie Lake)	02030105110	FW2-NT	505	43.22%	02030105110020
Stony Brook	02030105090	FW2-NT	664	56.78%	02030105090060 02030105090070

Source: NJDEP

Stony Brook Watershed

The Stony Brook Watershed covers 55.37 square miles, 11.4 of which are within Princeton. The Stony Brook Watershed drains the western two-thirds of the township and the western half of the borough. The watershed is drained by the Stony Brook, which is 21 miles long and flows eastward from East Amwell Township. It joins the Millstone River at Carnegie Lake. Tributaries to the Stony Brook River located within Princeton include Alexander Creek and Mountain Brook. Tributaries outside of Princeton include Baldwin's Creek, Cleveland Brook, Duck Pond Run, Honey Branch, Lewis Brook, Peters Brook, and Woodsville Brook.

STREAMS

In Princeton, there are a total of 48.30 stream miles flowing across the land, 12.73 of which are first or second order, or "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.

Photo by Stephen Hiltner

Stony Brook downstream from the Rosedale Bridge (2008)

Headwaters are of particular importance because they tend to contain a high diversity of aquatic species and their condition affects the water quality found downstream. They drain only a small area of land, usually no larger than one square mile (640 acres). Because of their small size, they are highly susceptible to impairment by human activities on the land. First- and second-order streams are narrow and often shallow, and they are characterized by relatively small base flows. Base flow is the portion of stream flow that comes from groundwater seepage, not surface water

runoff. This makes them subject to greater temperature fluctuations, especially when forested buffers on their banks are removed. They are also easily silted over 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.

Princeton's named streams include Stony Brook, Mountain Brook, Harry's Brook, and Alexander Creek, along with stretches of Beden Brook, Vanhorn Brook, and Cherry Run. Of these, Mountain Brook, Harry's Brook, and Alexander Creek are contained entirely within Princeton, and all have branches that originate within the borough boundary. The largest of Princeton's streams, Stony Book, flows from west to east along a sinuous path in the western and southern portions of the township. Mountain Brook forms in the north of the township and empties into Stony Brook. It has several branches that converge at Mountain Lakes (also called Palmer Lake), approximately one mile north of Princeton Borough. Harry's Brook lies in the eastern portion of the township; it empties into Carnegie Lake. One branch of Harry's Brook, now underground, flows eastward from Palmer Square in the borough. Alexander Creek forms on the Princeton University Campus and enters Carnegie Lake near the stadium. Beden Brook, Cherry Run, and Van Horn Brook begin in the northern portion of the township and flow north to eventually join up with the Millstone River outside of Mercer County.

Table 7: Princeton Township Streams*

Stream Order	Feet	Miles
1	48,851	9.25
2	18,366	3.48
3	81,969	15.52
5	7,722	1.46
Not Ranked	98,141	18.59
Total	**255,048**	**48.30**

Source: NJDEP

**Princeton Borough has less than 1 mile of ranked and unranked streams*

DELAWARE AND RARITAN CANAL

The Delaware and Raritan Canal does not fall into the category of streams or rivers, but has long been an important waterway in the area. Built in 1834, the waterway was once the most heavily trafficked canal in the country. Spanning 44 miles from Trenton to New Brunswick, the canal is some 75 feet wide and seven feet deep for most of its length. Commercial use of the canal peaked in the 1860s and then gradually declined with the advance of railroads in the region. The canal closed to commercial traffic in 1936 and was taken over by the State of New Jersey as a source of drinking water and recreation space. The canal and some of the remaining structures on the waterway were listed on the National Register of Historic Places in 1974, and since that

LAKES AND PONDS

There are two named waterbodies and numerous other small unnamed ponds and water impoundments in Princeton. The township's named waterbodies include Carnegie Lake and Mountain Lakes (which consist of two adjacent lakes). These open bodies of water are permanent waters and were created by impoundments on the Millstone River and Mountain Brook, respectively. Carnegie Lake covers nearly 300 acres, and the two lakes that make up Mountain Lakes cover approximately seven acres. Mountain Lakes is listed on the National Register of Historic Places as "the Princeton Ice Company." Carnegie Lake is a publicly accessible lake owned by Princeton University, and it is used for recreational activities, such as fishing and rowing. Carnegie Lake is also on the State and National Register of Historic Places. See **Map 9: Surface Water, Wetlands, and Vernal Ponds.**

Photo by Stephen Hiltner

Mountain Lakes (Fall 2008)

WETLANDS

Wetlands support unique communities that serve as natural filters and as incubators for many beneficial species. The term "wetland" is applied to areas where the soil is inundated or saturated at a frequency and duration great enough to support vegetation suited for life in saturated soils.[5] The source of water for a wetland can be surface water, such as an estuary,

[5] NJDEP. "Anderson Land Use Classification System." Originally derived from "A Land Use and Land Cover Classification System for Use with Remote Sensor Data" U.S. Geological Survey Professional Paper 964, 1976.

river, stream, or lake edge, or groundwater that intersects with a depression in land surface. Under normal conditions, 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, which are also known as *hydric* soils, are areas where the land is saturated for at least seven consecutive days during the growing season. While wetlands almost always require the presence of hydric soils, hydric soils are not always necessarily wetlands. By definition, wetlands require the presence of both wetlands vegetation and hydric soils. 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 do not support naturally occurring wetlands vegetation. This is typically due to human activities, such as agriculture.

Photo by Stephen Hiltner

Wetlands along Mountain Brook

New Jersey protects freshwater (interior) wetlands under the New Jersey Freshwater Wetlands Protection Act Rules: *N.J.A.C. A 7:7A.* This law also protects transitional 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 NJDEP, 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. Violations of the wetland regulations will result in penalties determined by NJDEP.

Once it is determined that wetlands are present, the NJDEP determines the value of the wetlands—ordinary, intermediate, or exceptional. Different "buffer" areas (i.e., distance to development) are required based on the value of the wetlands. The possible presence of any threatened or endangered species in or near a wetlands area is also an important consideration in determining the buffer width to be applied for development. Additional information on wetlands rules and permits is available through NJDEP and on its website under "land use." See *Sources of Information, page 155.*

Princeton contains only freshwater wetlands. The location of these wetlands is based on NJDEP's land use/land cover mapping (see **Map 2: NJDEP Land Cover (2005)**). New Jersey's land cover maps provide guidance on where wetlands are found in New Jersey, but only an LOI can officially verify the existence and location of freshwater wetlands on a site.

Total wetland acreage in the township, based on NJDEP's land use/land cover data, is 1,314 acres, of which 1,157 are naturally occurring wetlands and 157 are former natural wetlands that have been modified by human activities. The borough contains only two acres of wetlands. Accordingly, this discussion will focus on the township's wetlands. Of Princeton Township's naturally occurring wetlands, 1,087 acres are classified as forested wetlands, 46 acres are herbaceous wetlands, and 23 acres are scrub/shrub wetlands. See **Map 9: Surface Water, Wetlands, and Vernal Pools**.

Princeton Township contains 157 acres of pre-existing, or "former," wetlands that have been subsequently altered by human activities. These areas will collectively be referred to as *modified* wetlands in this document.[6] (Newly "created" features, such as retention ponds, are classified as "artificial lakes.") Although they do not typically support natural wetlands vegetation, modified wetlands do show obvious signs of soil saturation and exist in areas shown to have hydric soils on U.S. Soil Conservation Service soil surveys. Princeton's modified wetlands fall into the following categories as defined by the *Anderson Land Use Classification* system: 104 acres of agricultural wetlands, 10 acres of wetland rights-of-way, and 43 acres of wetlands found in maintained greenspace, recreational areas, or lawns. A more detailed description of all of Princeton's wetland areas is found in the *Biological Resources* section, under "Wetlands," *on page 92*.

The NJDEP Landscape Project maps wetlands habitat for threatened and endangered species. The presence of such habitats results in the determination of exceptional-value wetlands, which increases the buffer zone for development from 50 to 150 feet. Princeton has established habitats for threatened and endangered species in the forested area known as the Princeton Ridge and in several other isolated locations.

Agricultural Wetlands

Agricultural wetlands occupy 104 acres of Princeton Township. These "quasi-wetlands" are found scattered as small sites, primarily along the fertile but frequently flooded Stony Brook. Agricultural wetlands are lands under cultivation that are modified former wetland areas. These areas still exhibit evidence of soil saturation in aerial infrared photos, but they no longer support natural wetlands vegetation. See **Map 9: Surface Water, Wetlands, and Vernal Pools.**

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

[6] Like interior wetlands, Princeton Township's modified wetlands are also nontidal.

time a number of recreation trails and facilities have been completed. The canal currently serves as a major water source for a number of municipalities throughout central New Jersey.

Princeton is entirely within the "review zone" of the Delaware and Raritan Canal Commission–a state agency that reviews and regulates development affecting the Canal State Park. All water courses that enter the park are subject to the commission's regulations on stream corridors, impervious cover, stormwater management, and other influences on the environment. Rules adopted by the Delaware and Raritan Canal Commission in June 2009 require a vegetated 300-foot buffer for the D & R Canal, and all water courses flowing into the canal.

The Canal Commission's review is mandatory. It has specific definitions for "major" and "minor" development projects and definitions for "disturbance," "impervious surface," "compaction," and other terms related to stormwater management. Some of these definitions are different from, and sometimes more environmentally restrictive than, those contained in Princeton's ordinances. As state regulations, they take precedence over less-restrictive local ordinances. All developers must submit applications to the Canal Commission in order to determine the extent of applicability and effect of the regulations on potential development. Because the canal is a major source of drinking water, compliance with these regulations through the application process must be assured.

Photo by Stephen Hiltner

Carnegie Lake

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.

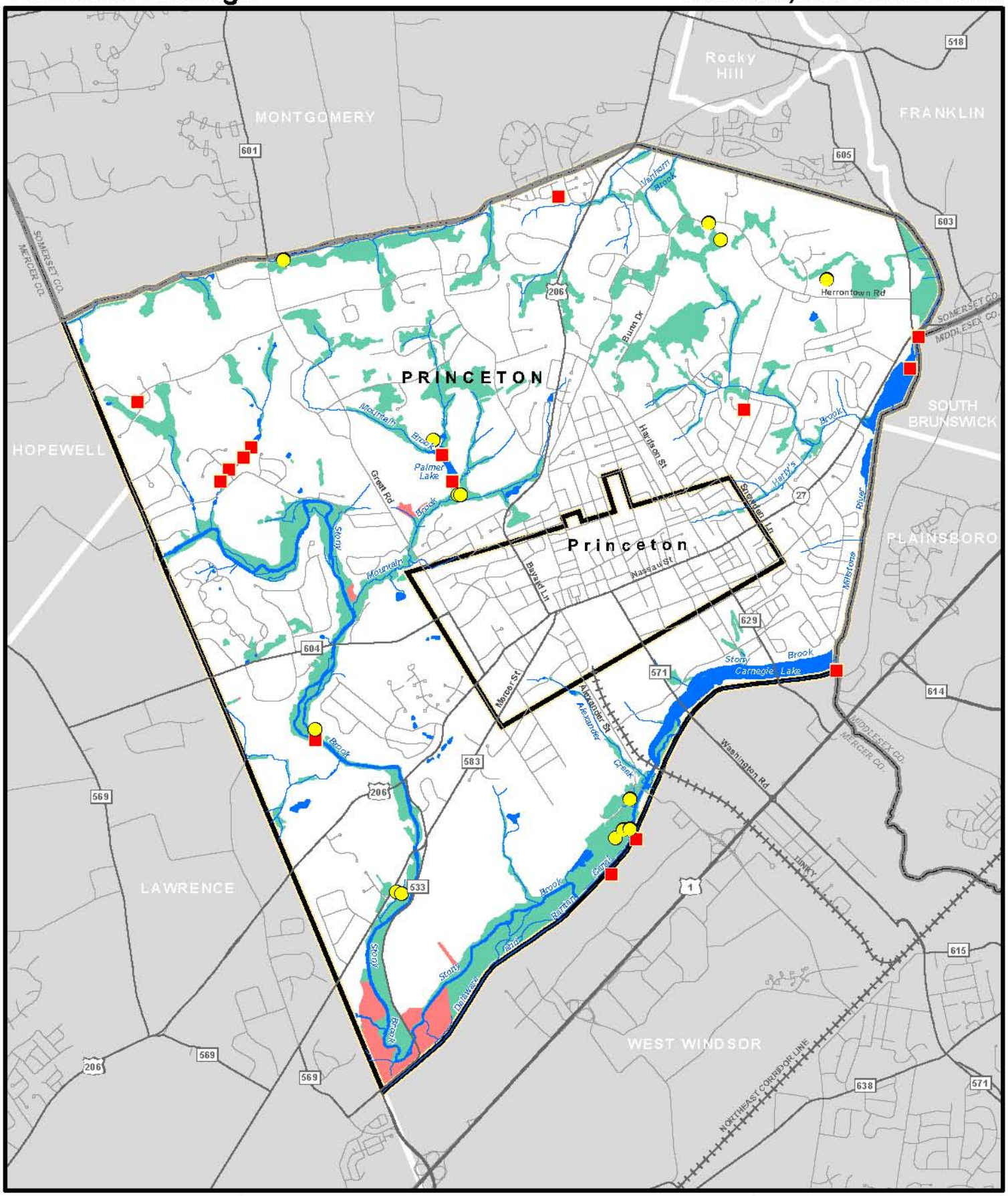
The Natural Resource Conservation Service sponsors the Wetlands Reserve Program, a voluntary program that offers landowners an opportunity to receive payments for restoring and protecting wetlands on their property, including agricultural wetlands. Restoring agricultural wetlands requires removing them from agricultural use and restoring them to their natural state. This program provides technical and financial assistance to eligible landowners, who can enroll eligible lands through permanent easements, 30-year easements, or restoration cost-share agreements. (See **Appendix B)**

Photo by Stephen Hiltner

A marshy area just south of the lower Mountain Lakes Dam

Princeton Township & Princeton Borough

Map 9: Surface Water, Wetlands, and 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.

- Possible Vernal Pool Location
- Dam
- Wetlands
- Agricultural Wetlands

0 0.25 0.5 1 Miles

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

Vernal Pools

Vernal pools are confined depressions, either natural or man-made, that hold water for at least two consecutive months out of the year and are devoid of breeding fish populations. Vernal pools come in an array of forms: isolated depressions within upland forests, seasonally flooded meadows, floodplain swamps, abandoned gravel pits or quarries, and even derelict swimming pools. However, no matter the structure or genesis of the pool, all vernal pools either dry out completely or draw down to very shallow levels unsuitable for sustaining fish. Vernal pools are critical sites for certain rare species of frogs and salamanders, called obligate breeders. The term "obligate breeder" refers to species that can only reproduce in vernal pools because the pools' impermanence prevents residence by predators, such as fish, that would consume the eggs and young. Vernal pools also provide habitat for amphibians and reptiles that may breed in them but not exclusively (facultative breeders), or may use the pools at some point in their life cycles.

Vernal pools are so intermittent, and often so small, 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 obligate amphibian species.[7]

In an effort to boost the effectiveness of the 1987 wetlands protection regulations, which allowed the filling of isolated wetlands up to one acre in size (including vernal pools), the New Jersey Division of Fish and Wildlife began the Vernal Pool Survey project in 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. To be certified, vernal pools must: (1) occur in a confined basin depression without a permanently flowing outlet; (2) provide documented habitat for obligate or facultative vernal pool herptile species; (3) maintain ponded water for at least two continuous months between March and September of a normal rainfall year; and (4) be free of fish populations throughout the year, or dry up at some time during a normal rainfall year.

The state has identified 14 *possible* vernal pools in Princeton (see **Map 9: Surface Water, Wetlands, and Vernal Pools**). This does not mean that 14 pools are actually present in Princeton. This information is recorded in NJDEP's current geographic data set. The actual number of pools could be much larger or smaller. In addition, as of 2008, *no pools in Princeton have been certified*. Determining the actual number of pools, as well as certifying pools, requires investigation in the field. Citizens, local governments, and nonprofit groups can survey pools and submit documentation to NJDEP to have pools certified. NJDEP's Division of Fish and Wildlife provides detailed guidance on what documentation is needed to certify a vernal pool at: www.state.nj.us/dep/fgw/ensp/vernalpool.htm.

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[7] Calhoun, A. J. K. and M. W. Klemens. *Conserving Pool-Breeding Amphibians in Residential and Commercial Developments in the Northeastern United States*. MCA Technical Paper Series: No. 5, Metropolitan Conservation Alliance, Wildlife Conservation Society. Bronx, New York, 2002. pp. 2-5.

Municipalities can provide additional protection for vernal pools by instituting restrictive zoning or negotiating conservation easements on the land surrounding vernal pools.

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 (see **Figure 5**) 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. The term "100-year flood" is a shorthand reference to a flood event that has a one in 100 chance of occurring in a given year. Due to variances in local rainfall and climate, it is possible that floods with a one in 100 chance of occurring can happen within a few years, or even a few months, of each other. Although this has not happened recently in Princeton, "100-year floods" did occur on the Millstone River in both 1971 and 2007. It is also important to note that 100-year storms may not produce 100-year floods, but the two are often related. Flooding severity is dictated by the intensity of the rainfall, current stream flow, and prior ground saturation, among other factors.

The probability of flooding is computed based on historical river flows and flood events. At least 10 years of data is required to calculate flood probabilities. The probability associated with a flood of a given size occurring can be periodically recalculated to account for changes in flood trends in an area. The 100-year flood in Princeton was defined by the 1984 Flood Insurance Study for Princeton Township. This study was produced by the Federal Emergency Management Agency (FEMA), which has done such studies throughout the United States. The Princeton Township Flood Insurance Study has not been updated since 1984.[8] A flood insurance study was never prepared for Princeton Borough. Flooding events can be characterized discharge rates–measured in cubic feet per second (cfs)–which are calculated at various points along Princeton streams, including the Millstone River, Stony Brook, Mountain Brook, Van Horn Brook, Harry's Brook, and Cherry Run.

The Princeton area has experienced three floods at or near the 100-year level in the past 38 years. The most recent 100-year flood on Stony Brook in Princeton occurred in August 1971. On that date, a peak flow of 8,860 cubic feet per second (cfs) was recorded by the USGS on the Stony Brook near its intersection with Route 206. The peak discharge on the Stony Brook from Hurricane Floyd in September 1999 was 8,780 cfs, slightly smaller than the August 1971 flood (i.e., approximately a "95-year" flood). On the Millstone River, 100-year floods occurred in both August 1971 and April 2007. As was the case with Stony Brook flooding, Hurricane Floyd was slightly smaller than a 100-year flood on the Millstone River. These findings are based on

[8] More up-to-date information on flooding in Princeton can be obtained by accessing the *Township of Princeton Flood Mitigation Plan (January 2005)* at www.princetontwp.org/floodmitigationplan012005.pdf

[10] Site plan and subdivision applications require detailed engineering studies that depict the boundaries of the flood hazard area, as defined by New Jersey, at a large scale.

historical streamflow data compiled by the USGS, and from the 1984 Flood Insurance Study for Princeton Township.
Although the term “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 percent. This type of flood is called the “flood hazard area design flood,” and it is the flood regulated by NJDEP.

Photo by Joan McGee

Flooding on the Millstone River at Carnegie Lake, December 2005

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 floodplain vegetation of excess chemical loads in the water and by the filtering of sediments generally. Efforts to keep

development out of floodplains will help to preserve the flood-carrying capacity of streams and maintain their water quality.

Figure 5: Parts of a Flood Hazard Area (From N.J.A.C. 7:13)

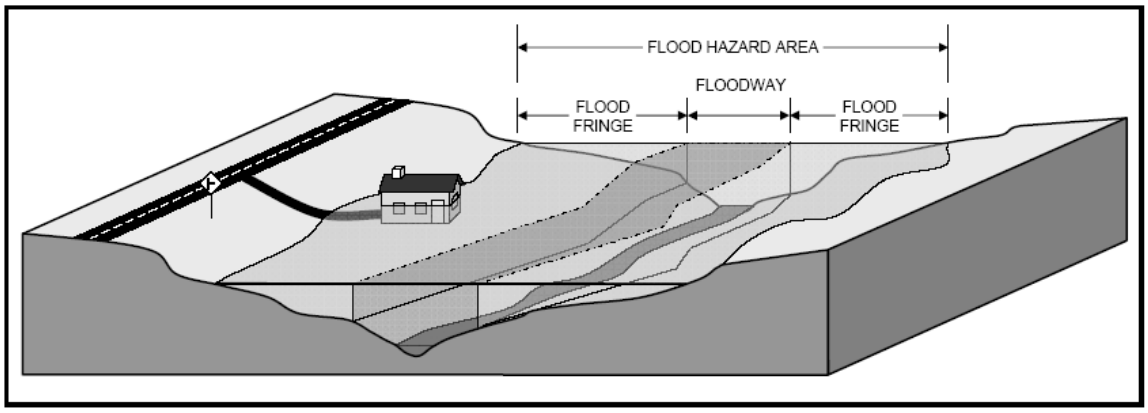


FIGURE A: THE FLOOD HAZARD AREA IS COMPRISED OF THE FLOODWAY AND FLOOD FRINGE

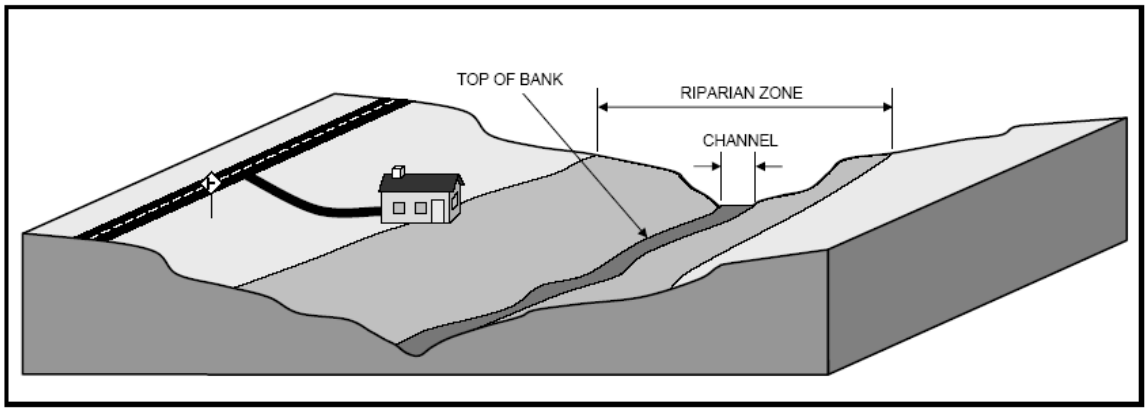


FIGURE B: THE RIPARIAN ZONE IS COMPRISED OF THE CHANNEL AND LAND WITHIN 50, 150 OR 300 FEET OF THE CHANNEL

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*. NJDEP adopted new Flood Hazard Area Control Act rules on November 5, 2007. In an effort to streamline the existing regulations and further improve water quality in New Jersey's waters, the redrafted Flood Hazard Control Act imposes additional requirements on property owners in the flood management area. Some of the changes to previous regulations are outlined below:

Changes to Flood Hazard Area Control Act 2007

- Provides greater flexibility in flood hazard area analysis; allows for the use of a greater variety of FEMA maps and calculation techniques than previous regulation.

- Introduces the concept of "riparian zone" which includes the stream, its banks and the land and vegetation within a certain distance of all regulated waters. These areas will require flood management permits for a wider variety of uses than the previous regulation.

    - *Riparian zone extends 300 feet from all Category One waters and their upstream tributaries within the same HUC-14 watershed*
    - *Zone extends 150 feet from all trout producing and maintaining streams and their headwaters as well as from areas that support endangered or threatened species*
    - *All other waters will maintain a 50 foot buffer*

- Improves overall flood mitigation by instituting a "zero net loss" criteria for flood storage area statewide.

    - *No more than 20 percent of the flood storage area onsite may be removed and there must not be any net loss in flood storage area in on- and off-site locations combined.*
    - *Flood storage compensation must be made within the same contiguous flood hazard area.*

- Streamlines the permitting process for activities identified to have minimal impacts.

    - *Introduces Permits by Rule*
    - *Introduces General Permits*
    - *Allows for permit transferrable with property sale*

Full text of the revised Flood Hazard Area Control rules and other additional information on floodplain activities is available from NJDEP and from its website under "Land Use." See *Sources of Information, page 155*.

New Jersey's flood hazard area maps are not available in digital form. Princeton's floodplains are depicted in this study (see **Map 10**) using digitized coverages of the Federal Emergency Management Agency's (FEMA's) Flood Insurance Rate Maps (FIRMs). These maps were initially produced in paper form as part of the 1984 Flood Insurance Study for Princeton Township. The boundaries of the 100-year and 500-year floodplains shown on the FIRMs were digitized by NJDEP in 1996. These files indicate that 1,254 acres or 12 percent of the township's land area falls within the 100-year floodplain. Only 16 acres of the borough fall within the 100-year floodplain. Presumably, the flood hazard area would be slightly larger than the floodplain.[10] See **Table 8: Flood Hazard Area Acreage.**

As of spring 2008, NJDEP and FEMA were in the process of creating updated Digital Flood Insurance Rate Maps (DFIRMs). This effort entails a complete remapping of the floodplain using Light Detection and Ranging (LIDAR) technology. While the project is complete in parts of the state, Mercer County was still under production as of summer 2008. However, there are no plans to redelineate floodplains in Princeton Township or Borough. Most of the efforts in Mercer County have focused on the Delaware River, which has experienced severe flooding during the last few years. While there are no plans to update the maps for Princeton, municipalities may request a review from FEMA. Information on the floodplain mapping update project is available from FEMA at: www.fema.gov/business/nfip/hillsbo_official.shtm, and from the NJDEP website at: www.state.nj.us/dep/landuse/se.html.

Most of Princeton Township's floodplain areas are located in the southwestern quadrant of the township, along Stony Brook and between Stony Brook and the Delaware and Raritan Canal. This area is also extensively occupied by wetlands. The majority of the township's remaining floodplain areas are found along Harry's Brook and Mountain Brook, and on either side of Carnegie Lake. The borough's small portion of floodplain lies mostly along the upper reaches of Alexander Creek and Harry's Brook, both of which extend into the borough. See **Map 10: Flood Hazard Areas (1996)**.

Table 8: Flood Hazard Area Acreage

FEMA Designation	Acres
Princeton Township	
A	73.0
AE	1,181.5
X500	114.5
Princeton Borough	
A	15.6
AE	0.2
X500	0.03

Source: Federal Emergency Management Agency

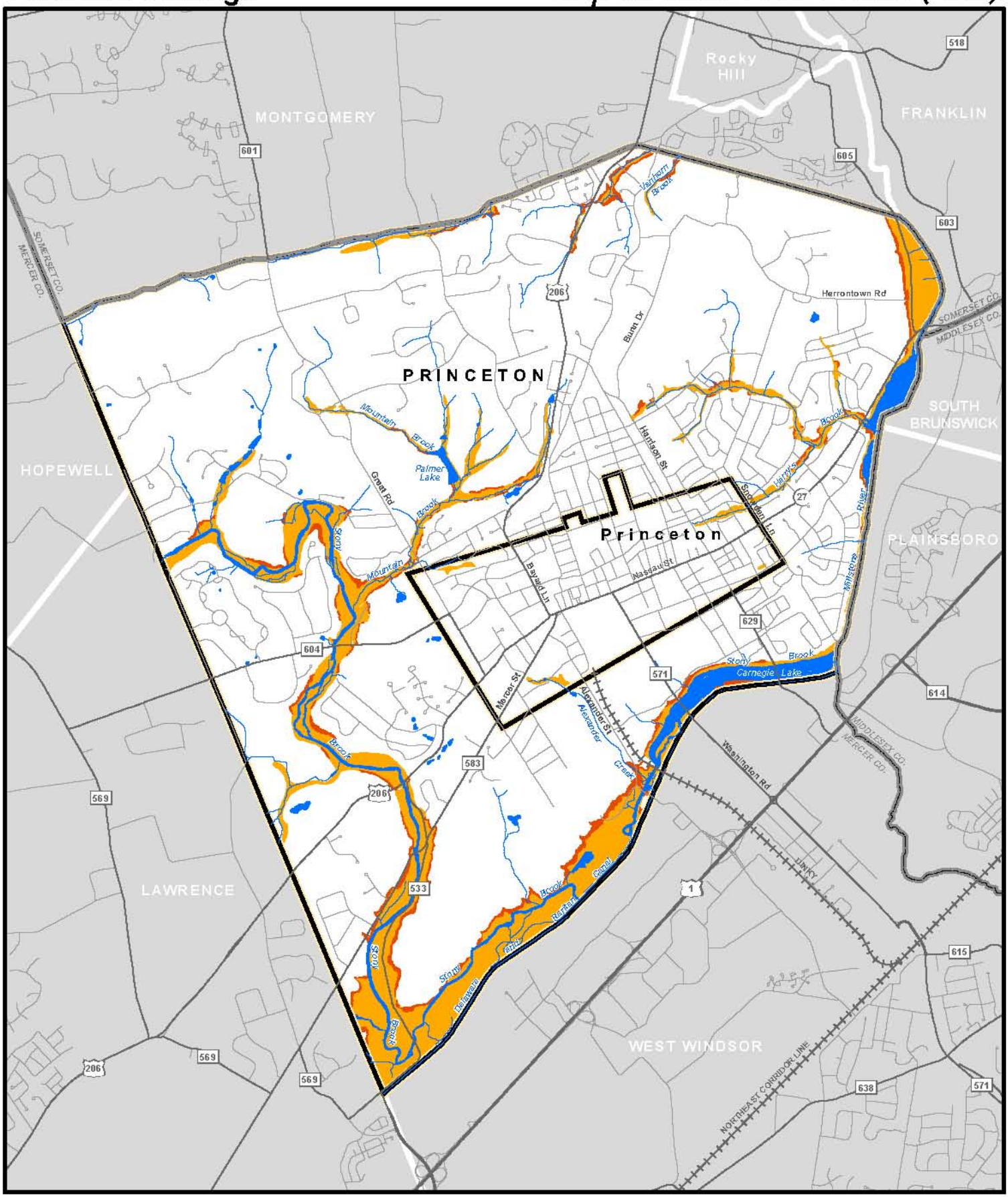
FEMA Flood Hazard Zone Designations

Flood Frequency	Designation
100-year floodplain (>1% annual chance of flooding)	A, AE
500-year floodplain (Between 0.2% and 1% annual chance of flooding)	X500

Source: Federal Emergency Management Agency

Princeton Township & Princeton Borough

Map 10: Flood Hazard Areas (1996)



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.

FLOOD ZONE

- 100-Year Floodplain
- 500-Year Floodplain

0 0.25 0.5 1
Miles

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

SURFACE WATER QUALITY

Surface 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 waterbodies 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). Freshwater,bodies (FW1 and FW2) are further broken down into 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 waterbody classification (see *Surface Water Quality Standards N.J.A.C 7:9B-1.12*).

The determination of whether or not water quality is sufficient to meet a waterbody's designated use(s) is based on numerous surface water quality parameters. Some examples of surface water quality parameters include fecal coliform, dissolved oxygen, pH, phosphorous, and toxic substances (see *N.J.A.C. 7:9B-1.14*). NJDEP also evaluates water quality by examining the health of aquatic life in a stream.

In addition to the waterbody classifications above, NJDEP has three tiers of "antidegradation designations" for all waters within the state. The most protective tier of antidegradation designation is Outstanding National Resource Waters (ONRW), which include all surface waters classified as FW1 and PL. NJDEP cannot approve any activity that might alter existing water quality in these waters. Princeton does not contain any ONRW (i.e., FW1 or PL) streams.

The second tier of protection is Category One (C1). C1 waters are designated through rulemaking for protection from measurable changes in water quality because of their exceptional ecological significance, exceptional water supply significance, exceptional recreational value, and/or exceptional fisheries. The water quality, aesthetic value, and ecological integrity of C1 waters should be protected and maintained. FW2, SE, or SC waters can also be assigned C1 status.

All waters not designated as ONRW or C1 are designated as Category 2 (C2) waters. Similar to C1, existing water quality should be maintained in C2 waters. However, lowering of water quality is authorized to accommodate necessary and important social and economic activities.

PRINCETON'S STREAM DESIGNATIONS AND CATEGORY ONE BUFFERS

Within Princeton, both the Stony Brook and the Millstone River are classified as FW2–NT, which means that they are both freshwater, non-trout-producing, non-trout-maintaining waters. According to NJDEP rules, all FW2 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); (3) industrial and agricultural water supply; (4) public potable water supply after conventional filtration and disinfection; and (5) any other reasonable uses.

Stony Brook, from the Lawrence border up to its intersection with Quaker Road, is also designated as a Category One (C1) stream. This designation was recently assigned by NJDEP in May 2008 (see **Table 9: Water Quality Classifications of Streams in Princeton Township)**. Princeton's remaining streams are not specifically listed in New Jersey's Surface Water Quality Standards (*N.J.A.C. 7:9B*). By regulation, these streams are assigned the same classification as the downstream waterbody into which they flow. So, for example, Mountain Brook is an FW2-NT (C1) stream since it flows into Stony Brook (itself an FW2-NT(C1) stream). Princeton's C1 streams are shown on **Map 11: Water Quality Sampling Locations**.

Special land use requirements apply to Category One (C1) waters through regulations administered by NJDEP. A 300-foot, or "Category One," buffer is required by the Stormwater Management (*N.J.A.C. 7:8*) and the Flood Hazard Area Control Act (*N.J.A.C. 7:13*) rules. The Stormwater Management rules state that a 300-foot buffer, or Special Water Resource Protection Area (SWRPA), is required for all development that results in a one-fourth acre increase in impervious surface or one acre of total disturbance when that development is adjacent to a C1 waterway. These rules are available at: www.state.nj.us/dep/rules.

The Flood Hazard Area Control Act rules require a 300-foot buffer, or "Riparian Zone" (RZ), adjacent to C1 waters. Limited disturbance may be permitted in an RZ under an individual permit or hardship exception. In most cases, the SWRPA and RZ will overlap. The standards protecting vegetation in the RZ and SWRPA do not apply where vegetation did not exist at the time of the establishment of the RZ and SWRPA rules or designation of a stream as C1. For more information on riparian buffers, see *Inadequate Stream Buffers* beginning on *page 76*.

In addition to the designations above, rules adopted by the Delaware and Raritan Canal Commission in June 2009 require a 300-foot buffer for the D & R Canal, and all water courses flowing into the canal.

Table 9: Water Quality Classifications of Streams in Princeton Township

Streams	Classification
Millstone River (below and including Carnegie Lake)	FW2-NT
Stony Brook	FW2-NT(C1)

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

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 (USEPA) 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 waterbodies that are not attaining water quality standards, or "303(d) List." States must also prioritize 303(d)-listed waterbodies for Total Maximum Daily Load (TMDL) analyses and identify those high-priority waterbodies for which they anticipate establishing TMDLs in the next two years. See *page 73* for a description of TMDLs.

In 2002, 2004, and again in 2006, NJDEP integrated the 303(d) List and the 305(b) Report into a single report according to USEPA's guidance. The 2006 *New Jersey Integrated Water Quality Monitoring and Assessment Report* (www.state.nj.us/dep/wmm/sgwqt), released in early 2007, 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.

In the 2002 and 2004 Integrated Reports, NJDEP placed each of the state's water quality monitoring stations on a sublist. Stations that tested for more than one water quality parameter, (i.e., pH, phosphorous, fecal coliform, dissolved oxygen, temperature, etc.), could be placed on different sublists for different parameters. For example, a station could be on Sublist 5 (nonattaining) for phosphorous and on Sublist 1 (attaining) for temperature. Individual stream segments (also referred to as waterbodies) were then associated with water quality sampling stations using a methodology established by NJDEP. However, the ability of a waterbody to meet its designated uses was not explicitly stated in the 2002 and 2004 Integrated Reports.

In 2006, NJDEP revised its methodology to report the attainment of water quality standards required for achieving designated uses on a subwatershed basis. Rather than placing water quality monitoring stations and their associated stream segments on a sublist for an individual parameter, NJDEP identified the designated uses applicable to each HUC-14 watershed (assessment unit) and assessed the status of use attainment for each applicable designated use.

Designated uses include:

- Aquatic life (general)
- Aquatic life (trout)
- Primary contact recreation
- Secondary contact recreation
- Drinking water supply
- Industrial water supply
- Agricultural water supply
- Shellfish harvesting
- Fish consumption

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

NJDEP based the assessment of entire HUC-14 watersheds 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 were 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 waterbody (stream, river, etc.) in a given HUC-14 watershed will result in that entire watershed being listed as impaired for that use/parameter. In addition, where a HUC-14 watershed contains waters of different classification, the more stringent classification was used to assess impairment, and that impairment was then applied to the entire watershed. Because of the extent of extrapolation required for this approach, NJDEP will perform more detailed testing to determine the actual cause, source, and extent of impairment in the HUC-14 watershed before developing a TMDL or taking other regulatory action to address the impairment.

See **Table 10: New Jersey Integrated Water Quality Monitoring and Assessment Report (2006)** for the status of each of Princeton's HUC-14 watersheds.

As shown in **Table 10**, an assessment unit may be listed on one or more sublists (i.e., on Sublist 2 for drinking water, Sublist 3 for aquatic life, etc.). Only if all uses for an individual HUC-14 are assessed and attained can the assessment unit be placed on Sublist 1. In order to determine whether 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.

If a waterbody does not "attain"one or more designated uses, 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 refers to the priority given to a specific assessment unit when determining the schedule for a TMDL. **Table 11: New Jersey's 303(d) List of Impaired Waterbodies with Priority Ranking (2006)** lists the nonattaining assessment units and their pollutants in Princeton Township and Borough.

Table 10: New Jersey Integrated Water Quality Monitoring and Assessment Report (2006)

Unit ID	Watershed Name	Aquatic Life	Primary Contact	Secondary Contact	Drinking Water Supply	Ag Water Supply	Industrial Water Supply	Fish Consumption
02030105090060-01	Stony Bk (Rt 206 to Province Line Rd)	Sublist 5	Sublist 4A	Sublist 3	Sublist 5	Sublist 2	Sublist 5	Sublist 3
02030105090070-01	Stony Bk (Harrison St to Rt 206)	Sublist 5	Sublist 4A	Sublist 3	Sublist 5	Sublist 2	Sublist 5	Sublist 3
02030105090080-01	Duck Pond Run	Sublist 2	Sublist 4A	Sublist 4A	Sublist 2	Sublist 2	Sublist 2	Sublist 3
02030105100130-01	Bear Brook (Below Trenton Rd)	Sublist 5	Sublist 3	Sublist 3	Sublist 2	Sublist 3	Sublist 2	Sublist 3
02030105100140-01	Millstone River (Rt 1 to Cranbury Brook)	Sublist 3	Sublist 3	Sublist 3	Sublist 5	Sublist 3	Sublist 3	Sublist 3
02030105110010-01	Heathcote Brook	Sublist 5	Sublist 4A	Sublist 4A	Sublist 2	Sublist 2	Sublist 2	Sublist 3
02030105110020-01	Millstone R (Heathcote Bk to Harrison St)	Sublist 5	Sublist 3	Sublist 3	Sublist 3	Sublist 3	Sublist 3	Sublist 3
02030105110030-01	Millstone R (Beden Brook to Heathcote Brook)	Sublist 5	Sublist 5	Sublist 3	Sublist 5	Sublist 3	Sublist 3	Sublist 3
02030105110050-01	Beden Brook (below Province Line Rd)	Sublist 5	Sublist 4A	Sublist 3	Sublist 5	Sublist 2	Sublist 2	Sublist 3

Source: NJDEP, Water Monitoring and Standards, 2006

Note: The designated uses "Aquatic Life (trout)" and "Shellfish Harvesting" are not applicable for any of the HUC-14 watersheds/assessment units in Princeton and are therefore not included in the above table.

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 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: A. A TMDL has been completed for the pollutant causing nonattainment B. 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 C. 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.

Table 11: Princeton 303(d) List of Impaired Waterbodies with Priority Ranking (2006)

Unit ID	Unit Name	Parameter	Ranking
02030105090060-01	Stony Bk (Rt 206 to Province Line Rd)	Total suspended solids	High
		Arsenic	Medium
		Phosphorus	High
02030105090070-01	Stony Bk (Harrison St to Rt 206)	Phosphorus	High
		Total suspended solids	High
		Arsenic	Medium
02030105100130-01	Bear Brook (below Trenton Road)	Unknown Toxic	Low
02030105100140-01	Millstone R (Rt 1 to Cranbury Bk)	Arsenic	Medium
02030105110010-01	Heathcote Brook	Pollutant Unknown	Low
02030105110030-01	Millstone R (Beden Bk to Heathcote Bk)	Pathogens	High
		Temperature	High
		Phosphorus	High
		pH	High
		Mercury	Medium
		Arsenic	Medium
02030105110050-01	Beden Brook (below Province Line Rd)	Arsenic	Medium
		Phosphorus	High

Source: NJDEP, Water Monitoring and Standards, 2006

WATER QUALITY MONITORING NETWORKS

The determination of whether 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. 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. The location of ASMN and AMNET stations are depicted on **Map 11: Water Quality Sampling Locations**.

Ambient Stream Monitoring Network

There are two sites in Princeton Township that are part of the USGS/NJDEP ASMN, formerly known as the Ambient Surface Water Monitoring network. The first of these stations is located on Stony Brook, near the crossing of U.S. Highway 206, and the second is located on the

Delaware and Raritan Canal. These sites are tested for dissolved oxygen, pH, ammonia, nitrogen, phosphorous, metals, and a wide range of organic and inorganic chemicals.

Ambient Biomonitoring Network

There are five AMNET sites that assess aquatic life within Princeton's streams (note: three of these five sampling locations are located beyond Princeton's boundaries). NJDEP sampled each of the five AMNET sites in three rounds. Sampling for Round 1 occurred between July 1990 and April 1994, Round 2 took place from April 1998 and April 1999, and Round 3 occurred in August and September 2004. Each AMNET site was tested for only one water quality parameter–the diversity of aquatic life. In testing this water quality parameter, NJDEP samples streams for benthic (bottom-dwelling) macroinvertebrates (insects, clams, mussels, snails, worms, and crustaceans that are large enough to be seen by the naked eye). Macroinvertebrates are studied because they are good indicator species; if pollution impacts a stream, their populations are adversely affected and require a significant amount of time to recover. While chemical tests measure water quality on a given day, the presence or absence of macroinvertebrates is affected by water quality over a long period preceding the testing day. NJDEP determines the number and diversity of aquatic organisms present. Waterbodies are rated on the number of different species of organisms present, as well as the number of individuals within those populations.

In Round 1 sampling:

Site AN0394 on Duck Run and AN0396 on Heathcote Brook were rated "severely impaired," while sites AN0384 (Bear Brook), AN0393 (Stony Brook), and AN0397 (Millstone River) were rated "moderately impaired" for aquatic life support. Moderate impairment means that stream habitat has been degraded and fewer than normal numbers of macroinvertebrate fauna are present. Severely impaired waters are those that are unable to sustain even a moderate level of biodiversity. These sites generally have a relative abundance of pollution-tolerant species and a lack of more sensitive types of invertebrates.

In the Round 2 sampling:

All of the sites attained at least a "moderately impaired" level, while two of the five sites, Heathcote Brook (AN0396) and Bear Brook (AN0384), were rated "unimpaired" during the testing period. Remarkably, the Heathcote Brook Site had been rated "severely impaired" during the Round One sampling. Both the Stony Brook (AN0393) and Millstone River (AN0397) testing sites declined in biodiversity between the first and second rounds of testing, though not enough to warrant a "severely impaired" ranking.

In Round 3 sampling:

All testing sites were ranked "moderately impaired." Bear Brook (AN0384), Duck Pond Run (AN0394), and Heathcote Brook (AN0396) all declined in biodiversity between the second and third sampling periods. Possible explanations for this decrease in biodiversity include the timing

of the samples, late summer during low water periods, and increased development along the Route 1 corridor through West Windsor and Plainsboro townships.

Princeton's AMNET stations are listed in **Table 12: AMNET Survey Results** and are depicted on **Map 11: Water Quality Sampling Locations**.

Table 12: AMNET Survey Results

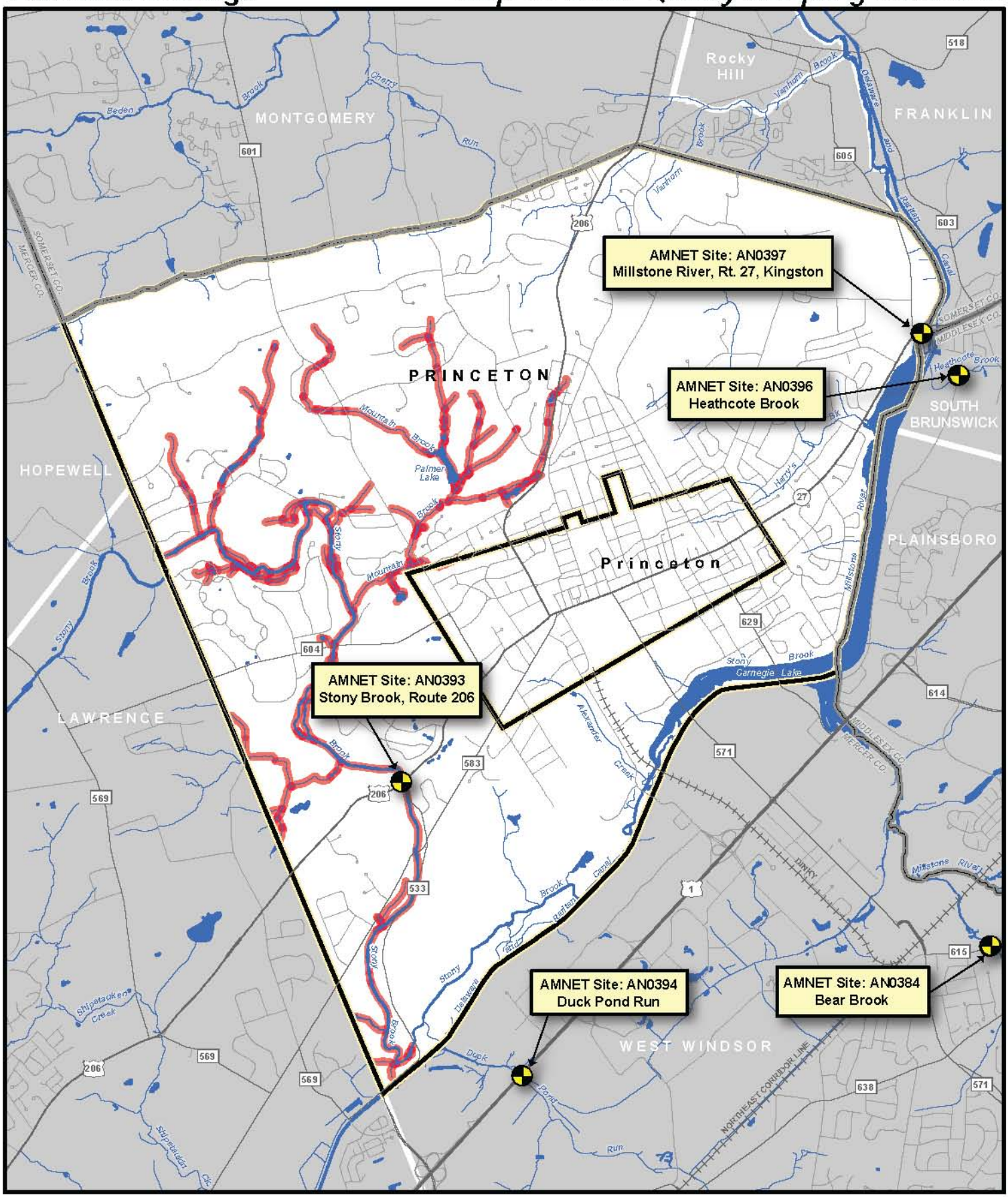
HUC 14	Station Name	AMNET Station	NJIS Round 1	NJIS Round 2	NJIS Round 3
02030105100130-01	Bear Brook	AN0384	21	24	12
02030105090060-01	Stony Brook, Route 206	AN0393	15	12	21
02030105090070-01	Duck Pond Run	AN0394	6	18	9
02030105110030-01	Millstone River, Rt 27, Kingston	AN0397	12	9	18
02030105110030-01	Heathcote Brook	AN0396	3	24	18

Source: NJDEP, Bureau of Freshwater and Biological Monitoring

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

Princeton Township & Princeton Borough

Map 11: Water Quality Sampling Locations



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.

Monitoring Site

Category 1 Stream

0 0.25 0.5 1
Miles

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

Other Water Quality Monitoring Networks

In addition to the various networks used by NJDEP, local groups often assess, monitor, and document water quality. Since 1992, volunteers of the Stony Brook Millstone Watershed Association have been performing this task throughout the Millstone Watershed through the *StreamWatch* program. StreamWatch focuses on measuring the health of local water quality through visual, biological, and chemical observations. StreamWatch data better enables the association to assess the impacts of pollution on local streams and determine actions necessary to protect and improve water quality for everyone. However, StreamWatch data is not utilized by NJDEP for the state's Water Quality Monitoring and Assessment Report.

Approximately four years ago, NJDEP reevaluated its standards for accepting volunteer water quality monitoring data. Organizations conducting volunteer water quality monitoring, such as the Stony Brook Millstone Watershed Association, may contact NJDEP's Bureau of Water Quality Standards and Assessment and complete a "Quality Assurance Project Plan" to have their data accepted by NJDEP for official use.

The Stony Brook Millstone Watershed Association's (SBMWA) StreamWatch program maintains six sites in Princeton on the Millstone River (Site CL1), Stony Brook (Sites CL3, SB1 and SB3), Mountain Brook (Site MB1), and Harry's Brook (site HA1). Three additional sites lie just beyond Princeton's borders. These sites test for and provide data on chemical and physical parameters such as temperature, dissolved oxygen (DO), turbidity, pH, nitrates, and phosphates. SBMWA shares the data it collects with Princeton on a regular basis.

Data shows that all six stations in Princeton met or exceeded the minimum state guidelines (i.e., were not polluted or impaired) for temperature, DO, turbidity, nitrates, and pH for the years 1992 to 2006. (SBMWA reports an "annual average" pollutant level over the course of a calendar year.) It should be noted, however, that the Stony Brook and Millstone River experience low dissolved oxygen levels during the summer months, which can stress fish and other aquatic organisms. Likewise, pH levels are sometimes outside of the optimal range on Carnegie Lake, though they do fall within NJDEP's proposed new standard for pH of 4.5 to 7.5. In addition, SBMWA reports that while nitrates "meet minimum state standards," the nitrate levels found in Princeton streams are often higher than what is necessary to ensure ecological health. The technical limit for nitrate is 10 ppm, but healthy streams often have levels less than 1.0 ppm. Nitrate levels on the Millstone River frequently exceed 1.0 ppm

The only parameter for which Princeton's streams have not met state minimum standards during the testing period is phosphates. Phosphate levels should not be higher than 0.1 parts per million (ppm), but annual averages as high as 0.29 ppm (CL1, 2003) have been recorded.

Biological data maintained by SBMWA indicates that portions of the Stony Brook are moderately impaired for aquatic life. In moderately impaired streams, the biological community, including insects and crustaceans that live in the stream, are stressed because the water quality is not optimal for their health. Enactment of ordinance protections such as Stream Corridor Protection, Forest Protection, and Critical Areas Protection can maintain and improve water

quality. For more information, visit the Stony Brook Millstone Watershed Association website at www.thewatershed.org/watershed_home.php

TOTAL MAXIMUM DAILY LOADS

For each impaired waterway (waters on Sublist 5), the state is required by the U.S. Environmental Protection Agency to establish a Total Maximum Daily Load (TMDL). A TMDL quantifies the amount of a pollutant that a waterbody 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 percent 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 residential, commercial, industrial and agricultural lands, roads, and parking lots.

Eight of Princeton's nine HUC 14 watersheds are listed on Sublist 5. Seven of these are listed in **Table 11** above, which shows the offending pollutant(s) and the priority for TMDL preparation (note: the Millstone River (Heathcote Brook to Harrison Street) was not included in NJDEP's two-year TMDL schedule). Four of these watersheds are listed as a high priority to receive TMDL reports by the end of 2008. These watersheds are: Stony Brook from Route 206 to Province Line Road, Stony Brook from Harrison Street to Route 206, Millstone River from Beden Brook to Heathcote Brook, and Beden Brook below Province Line Road.

In general, implementation of a TMDL relies on actions mandated by the Municipal Stormwater Management program, including the ordinances required to be adopted by municipalities under that permit (see **Figure 6** on *page 75* for details on the Statewide Basic Requirements for this program). It also depends on voluntary improvements to land and runoff management in agricultural areas. A list of U.S. Department of Agriculture and New Jersey 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**.

CAUSES OF WATER QUALITY IMPAIRMENTS

Stormwater Runoff and Impervious Cover

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 most detrimental effect on the water quality and channel health of streams in Princeton. 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 Princeton is known to derive from stormwater drainage off paved surfaces, such as streets and parking lots, commercial/industrial areas, residential sites (with and without detention basins), and lawns, and from agricultural fields that lack adequate vegetative buffers. Some of this runoff comes to the waterways from similar sources in upstream townships, and some of it derives from Princeton land uses.

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

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, each municipality was required to obtain a New Jersey Pollution Discharge Elimination System (NJPDES) general permit for the stormwater system and its discharges, within its borders, which is considered to be owned and "operated" by the municipality.

Photo by Stephen Hiltner

Nonpoint Source Pollution – yard waste accumulating on streets

Under the 2004 NJPDES permit, a town must meet certain specific requirements in planning, ordinance adoption, education, and management of township facilities and investigation of parts of the stormwater system. Fulfillment of these Statewide Basic Requirements is scheduled to occur by 2009. The stormwater rules were set to expire in 2009, but have been extended another year while new rules are developed.

All municipalities, including Princeton, may adopt more restrictive stormwater requirements than those required by the State of New Jersey, which sets minimum requirements. For example, Princeton currently defines "major development" that triggers its stormwater ordinance as: *Any development that results in either the disturbance of one or more acres of land or an increase in the peak 100-year*

stormwater runoff rate from the development site of more than 0.5 cfs. Some municipalities restrict this definition even further by requiring that "major development" include any increase in impervious cover of one-eighth of an acre or more. Given the "built-out" nature of Princeton, such a standard could be useful to protect groundwater recharge and avoid the run-off of non point source pollutants.

Figure 6: Stormwater Management Basic Requirements

Stormwater Management Statewide Basic Requirements
Tier A Towns, Highway Agencies, and Institutions

1. Control postconstruction 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 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.
    - Distribute information annually regarding proper identification, handling, and disposal of wastes, including pet waste and litter.
3. Control improper disposal of waste through improved yard waste collection and through adoption of ordinances (pet waste, litter, improper dumping, and wildlife feeding).
4. Control solids and floatables through increased street sweeping, retrofitting storm drain inlets during road repairs, and instituting programs for stormwater facility management, for roadside erosion control, and for outfall pipe scouring/erosion.
5. Improve maintenance yard operations, specifically for deicing material storage, fueling operations, vehicle maintenance, and housekeeping operations.
6. Increase employee training about all of the above.

Source: NJDEP

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. 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 percent or more within a subwatershed are directly linked to increased stormwater runoff, enlargement of stream channels, increased stream bank erosion, lower dry weather flows, high stream temperatures, lower water quality, increased pollution, and declines in aquatic wildlife diversity. These factors are directly related to the proportion of a subwatershed covered in impervious surfaces. When man-made impervious cover reaches 25 to 30 percent, streams are invariably found to be severely degraded.

Table 13: Acreage of Impervious Surface in Princeton's Subwatersheds

HUC14	Sub-watershed Name	Acres In Sub-watershed	Acres Covered by Impervious Surfaces	% of Sub-watershed Covered by Impervious Surface
02030105090060	Stony Brook Rt 206 to Province Line Rd)	5,150.7	495.0	9.6%
02030105090070	Stony Brook (Harrison St to Rt 206)	3,309.1	432.0	13.1%
02030105110020	Millstone River (Heathcote Bk to Harrison St)	3,445.8	790.6	22.9%
02030105110030	Millstone River (Beden Bk to Heathcote Bk)	5,132.8	482.9	9.4%
02030105110050	Beden Brook (below Province Line Rd)	6,488.6	453.9	7.0%

Source: NJDEP, DVRPC

Inadequate Stream Buffers

A stream buffer is the region immediately adjacent to 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 washing 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 for wildlife to move between larger forested habitat areas. This greenway can be utilized for passive recreation by residents as well, through trails, bikeways, and access points to the water for fishing and canoe/kayak launching.

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. The 2007 revisions to the New Jersey Flood Plain Management Regulations, outlined in a previous section, directly affect stream buffer requirements. As previously mentioned, the new regulations require the establishment of a 300-foot riparian buffer on all Category One waters, a

150-foot buffer along trout-producing waters and other select high-value waterways, and a 50-foot buffer on all other nontidal waters. These buffers are intended to reduce the direct and indirect impacts of flooding, improve wildlife habitat, and offer opportunities for passive recreational use, such as walking trails. In addition, municipalities may adopt their own stream corridor buffer ordinances to provide enhanced protection to streams and stream banks.

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.

Point Sources of Pollution

Point sources of pollution, which come from a single source, or "point," such as an industrial pipe or sewage 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, but 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 or ground water must apply for and obtain a permit for discharging. Rather than creating individually tailored permits for each and every facility, the Division of Water Quality uses scientific standards to create and issue general permits for different categories of dischargers. Permits are available and required for surface water, ground water, storm water, combined sewer overflow, and residual discharges. NJDEP enforces the terms of NJPDES permits by visiting discharging facilities and conducting water quality, biological, and toxicological analyses and thermal impact and cooling water assessments. The Stony Brook Residential Sewerage Authority is regulated with an NJPDES permit, which must be kept up-to-date.

Under the Open Public Records Act (OPRA) of 2002, a list of active NJPDES permits is available. As of December 1, 2007, seven NJPDES permits were issued to individual facilities in Princeton. Any expansion of the use or location of these facilities would necessitate a new application to NJDEP. These seven are shown in **Table 14: Princeton Township and Borough 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 above, focus on reducing and controlling nonpoint sources of water pollution.

Table 14: Princeton Township and Borough NJPDES Permits

NJPDES	Name	Start Date	Expiration Date	Description	NJPDES Category	Address
NJ0031119	Stony Brook Regional Sewerage Authority-River Road Sewage Treatment Plant	2/1/2006	1/31/2011	Domestic Surface Water Discharge	A	290 River RD
NJ0057312	Princeton Solid Waste Landfill	9/1/2003	8/31/2008	Discharge to Ground Water	GW	PO BOX 390 - 1 Monument DR
NJG0146358	Princeton Borough Parking Garage	1/1/2004	11/30/2008	General Permit	B4B	PO BOX 390 - 1 Monument DR
NJG0152064	Princeton Township	9/1/2005	2/28/2009	Municipal Stormwater General Permit	R9	369 Witherspoon ST
NJG0153834	Princeton Borough	9/1/2005	2/28/2009	Municipal Stormwater General Permit	R9	PO BOX 390 - 1 Monument DR
NJG0154768	Stony Brook Regional Sewerage Authority-River Road Sewage Treatment Plant	6/1/2007	5/31/2012	Basic Industrial Stormwater	5G2	290 River RD
NJG0166359	Stony Brook Regional Sewerage Authority-River Road Sewage Treatment Plant	10/1/2006	5/31/2011	General Reclaimed Water	ABR	290 River RD

Source: NJDEP, NJPDES Active Permit List

WATER QUALITY SUMMARY

In summary, most of Princeton's streams are impaired for one or more uses. In Princeton, water quality impairments are primarily the result of nonpoint source pollution, such as runoff from streets, parking lots, and lawn areas containing fertilizers; oil, lubricants and gasoline; pet and animal wastes; and effluent from leaking septic systems or malfunctioning sewage treatment plants. For a specific water body, detailed investigation is needed to determine the exact source of an impairment. For waters that are impaired, the state will require the establishment of TMDLs. TMDLs will identify the sources of a pollutant and determine the percent reductions of each pollutant needed to meet water quality standards. Implementation of a TMDL relies largely on actions mandated by the Municipal Stormwater Management program, including the ordinances that are required to be adopted by municipalities under that permit. Strengthening these ordinances will lead to improved water quality throughout the area.

GROUNDWATER

AQUIFERS AND GEOLOGICAL FORMATIONS

Principal aquifers in New Jersey are classified into two groups, Coastal Plain aquifers south of the Fall Line, and non-Coastal Plain aquifers north of the Fall Line. Princeton Township lies to the northwest of the Fall Line, which is the boundary between the Piedmont Plateau and the Atlantic Coastal Plain physiographic provinces. The two provinces contain different types of geologic outcrops, which affect groundwater supplies and recharge. Permeability of Piedmont Plateau soils is generally slow or moderate and runoff is more rapid. Coastal Plain soils are generally sandy or gravelly and permeability is moderate to rapid.

About two-thirds of the township lies in the Newark Basin, a part of the Piedmont Plateau that extends from the Hudson River Valley to the divide between the Schuylkill and Susquehanna river basins in Pennsylvania. The geology of the Newark Basin is composed of four sedimentary rock formations, three igneous rock formations, and several diabase intrusions. The deposits form low ridges and valleys in the region that trend from northeast to southwest. The predominant aquifers within the basin are called, collectively, the Newark Group and consist of the Passaic Formation, the Stockton Formation, and the Lockatong Formation. Together, these three bedrock aquifers provide 95 percent of the Newark Basin's groundwater. Princeton is roughly divided into thirds by the three main formations, with the Passaic Formation itself split by a diabase intrusion that forms much of the Princeton Ridge.

Water from bedrock aquifers is drawn from joints and fractures, or networks of fractures, in the rock. The number and size of these joints and fractures decrease with increasing depth below the ground surface. Shallow parts of bedrock aquifers are generally unconfined, which means that they are not bounded by confining layers made of less permeable materials, while deeper sections may be semiconfined or fully confined. Confining beds help slow the entry of any surface contaminants into the groundwater.

Most water in the Newark Group is found within 200 to 300 feet of the land surface. Sixty-five percent of all water from these aquifers is drawn from within 200 feet of the land surface. Another 20 percent is drawn from between 200 and 300 feet of the land surface. Below 500 feet, there are fewer and smaller fractures in the rock, which dramatically decreases groundwater storage.

Though the water quality of the Newark Basin aquifers tends to be satisfactory, large portions of the aquifers are unconfined, or close to the surface of the land, making them susceptible to local contamination. The groundwater is generally hard, containing more minerals than are found in surface water.

The type of rock formation in a given area directly affects the amount of water supply that may be available for future development, as well as what is available for current use. An adequate supply of water for drinking and others uses is critical to Princeton's future.

Stockton Formation

The Stockton Formation extends as a thin belt from Mercer County northward to Rockland County, New York. In Princeton, it underlies 3,486 acres, including approximately the southern half of the borough, and runs across the width of the township in a diagonal band, primarily to the south of Route 206 and County Highway 27. It is composed of very old sediments that are highly erodible. The bottom half of the formation is composed of mostly fluvial deposits containing medium to coarse grained sandstones, siltstone, and conglomerates, while the upper half of the formation contains fine-grained sandstone and shale. Most water in the Stockton Formation is found within 500 feet of the land's surface, in weathered and interconnected fractures. The water is frequently located in unconfined places, although locally, it may be found in semiconfined areas, depending on the layers of shale. The Stockton Formation is one of the most productive aquifers in this region. It can yield as much as 1,500 gallons of water per minute. The soils associated with this formation also are the best in the township for agricultural uses, septic filter fields, and water retention.

Lockatong Formation

The Lockatong Formation lies between the Stockton and Passaic formations and is composed of less erodible rocks, such as gray and black shale and siltstone, as well as subordinate purple and red mudstone. The rock has both low permeability and porosity, and the fractures are widely spaced and tight, allowing little infiltration. Of the three formations, it is the poorest for storing water and is one of the lowest yielding aquifers in New Jersey. Soils associated with this formation are generally poorly drained and have a high water table. The Lockatong Formation underlies 2,654 acres in a band approximately one mile wide that runs roughly parallel to Nassau Street. It underlies the northern half of the borough.

Passaic Formation

The Passaic Formation underlies 2,760 acres of Princeton and is interspersed with its complementary Gray Passaic Bed Formation underlying an additional 551 acres. The Passaic Formation is the second-most productive water-bearing geologic formation in the township. The zone of water-storing joints and fractures in the Passaic Formation is estimated to be 200 to 600 feet thick. It has an extensive system of rock fractures, which enable it to store and move groundwater. The Passaic Formation is composed mostly of red mudstone, as well as subordinate gray, purple, and black mudstone. The formation also is composed of sandstone and conglomerate containing glauberite and gypsum.

Jurassic Diabase Formation

A diabase intrusion underlies 2,287 acres of Princeton Ridge in the north of the township. The formation was created as part of volcanic events associated with the Alleghenian Orogeny approximately 180 million years ago. The Princeton Ridge forms the highest elevations in the township, with many places reaching nearly 400 feet above sea level. Diabase formations such as this have varied water permeability depending on the type and

density of fractures within the bedrock. Where eroded diabase parent material has formed clays, soil permeability is greatly reduced. Because they are characterized by low permeability and scattered perched water tables, the Princeton Ridge areas have been recognized for many decades as being relatively less suitable for development than other parts of the township (see **Map 12: Aquifers and Bedrock Geology** and **Table 15: Aquifers and Bedrock Geology in Princeton Township and Borough**).

Table 15: Aquifers and Bedrock Geology in Princeton Township and Borough

Geologic Formation	Acres	Lithology
Jurassic Diabase	2,287	diabase, medium- to coarse-grained
Lockatong Formation	2,654	dolomitic or silty argillite, mudstone, sandstone, siltstone, and minor silty limestone
Stockton Formation	3,486	sandstone, mudstone, silty mudstone, argillaceous siltstone, and shale
Passaic Formation	2,760	siltstone and shale
Passaic Formation (Grey Bed)	551	sandstone, siltstone, and shale

Source: USGS

DRINKING WATER SUPPLY

Most of Princeton Borough and Princeton Township, including Princeton University, purchase their drinking water from the Elizabethtown Division of the New Jersey American Water Company. The Elizabethtown Division draws water from seven surface water intakes and 129 wells, nine of which are located in Princeton Township. All of the public water supply wells in Princeton draw their water from the Stockton formation.

Approximately 95 percent of Princeton's drinking water is drawn from surface water intakes on the Raritan River and treated at the Elizabethtown Division's Canal Road treatment plant in Somerset. The Millstone River is a tributary of the Raritan River, and is therefore also a source of Princeton's drinking water. Likewise, the Delaware and Raritan Canal, which draws water all the way from Stockton, New Jersey, is also a tributary of the Raritan River.

The remaining five percent of Princeton's drinking water comes from groundwater, most of which is drawn from wells near the Rogers Refuge. A small percentage of Princeton residents have private wells.

The Princeton area's public community water supply wells are listed in **Table 16: Public Water Supply Wells** and shown on **Map 13: Public Water Supply Wells**. A public

community water supply well is a well that has at least 15 service connections used by year-round residents, or regularly serves at least 25 year-round residents. An example of a public community water supply well is a municipal system that services multiple single-family, residential homes. As shown on **Map 13**, public community water supply wells are clustered in two areas: near the Stony Brook on Springdale Road and near the crossing of the Delaware and Raritan Canal and the Millstone River.

There are also 17 public *noncommunity* water supply wells near Princeton Township, as shown on **Map 13: Public Water Supply Wells**. A public noncommunity water supply well is a public water supply well used by institutions and businesses, as opposed to year-round residents, for at least 60 days of the year. These can include wells serving schools, factories, office buildings, rest stops, restaurants, and motels. The public noncommunity water supply wells surrounding Princeton tap into the Passaic and Stockton formations and may affect groundwater levels within the township.

Most private wells in Princeton also probably draw from the Stockton and Passaic formations, but since there is no comprehensive inventory of private wells available to municipalities, it is difficult to know for sure. Permits for private wells are held by the Mercer County Health Department, but there are many gaps in the records due to various factors, including well age. The 2002 Private Well Testing Act requires state-certified laboratory water testing in order to sell a residential property. Such testing will not identify what aquifers are being drawn upon by private wells, but will eventually provide better documentation of the quality of drinking water from private wells in an area. See **Appendix B** for information on the Private Well Testing Act.

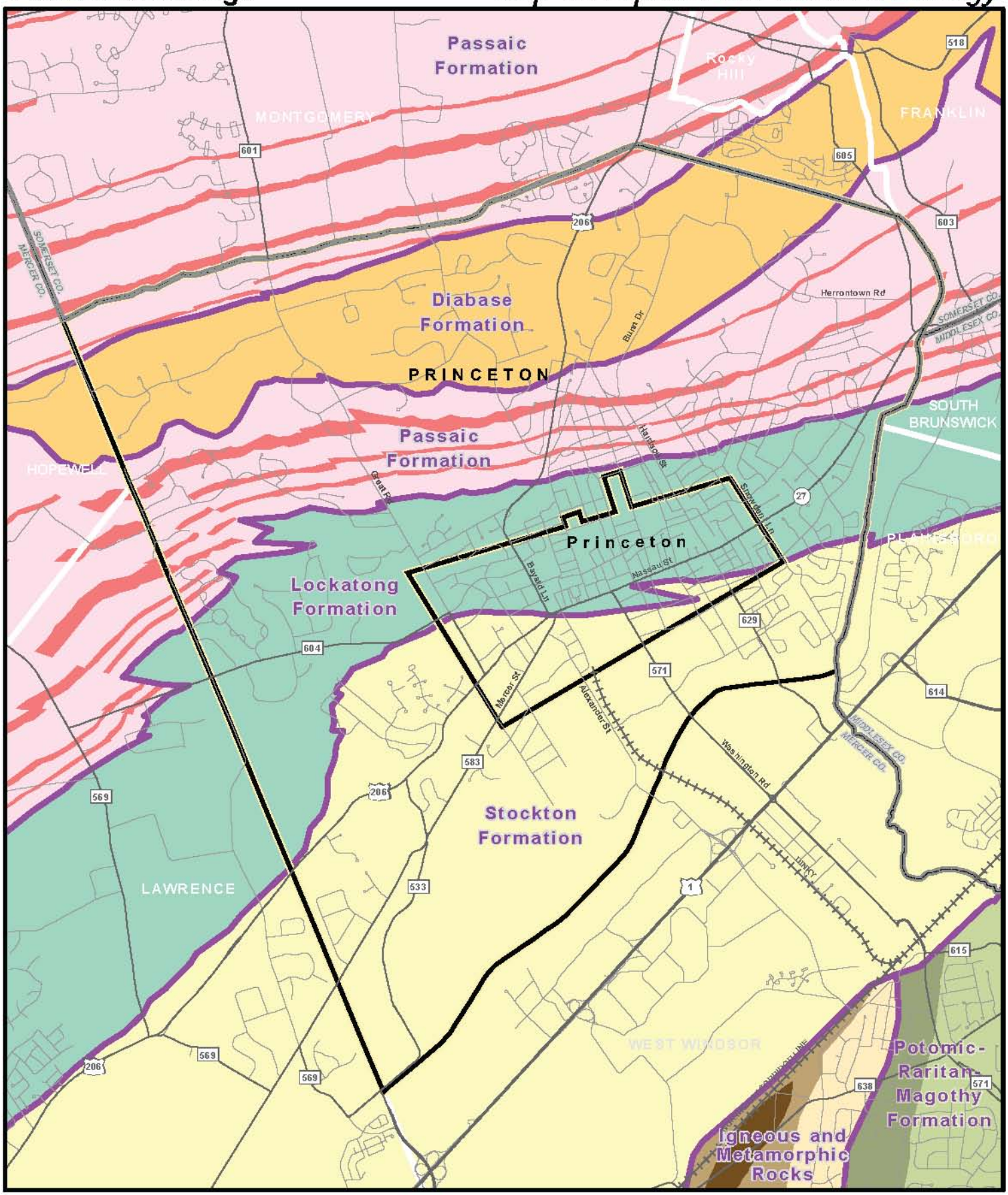
Table 16: Public Water Supply Wells

Well Permit #	Well Name	Municipality	Depth of Top of Well Screen	Depth to the Bottom of Well Screen	Primary Hydrologic Unit	Pump Rate (gal/min)
28-04999	Harrison St Well 7	Princeton Twp	30.0	300.0	Stockton Formation	200
28-05073	Harrison St Well 8	Princeton Twp	23.8	219.0	Stockton Formation	600
28-05003	Harrison St Well 9	Princeton Twp	27.0	300.0	Stockton Formation	100
48-00008	Stony Brook Well 2	Princeton Twp	0.0	0.0	Stockton Formation	600
48-00009	Stony Brook Well 3	Princeton Twp	20.0	353.0	Stockton Formation	300
48-00010	Stony Brook Well 4	Princeton Twp	-	-	Stockton Formation	250
48-00011	Stony Brook Well 6	Princeton Twp	-	-	Stockton Formation	600
28-20986	Stony Brook Well 7A	Princeton Twp	60.0	300.0	Stockton Formation	600
48-00013	Stony Brook Well 8	Princeton Twp	-	-	Stockton Formation	800
Relevant wellheads outside of Princeton Township						
48-00005	Harrison St Well 1	West Windsor Twp	35.0	503.0	Stockton Formation	150
28-04371	Harrison St Well 3	West Windsor Twp	95.0	301.0	Brunswick aquifer	100
48-00006	Harrison St Well 4	West Windsor Twp	-	-	Stockton Formation	450
48-00007	Harrison St Well 5	West Windsor Twp	-	-	Stockton Formation	250
28-01886	Harrison St Well 6	West Windsor Twp	38.6	335.0	Stockton Formation	700

Source: NJDEP, DVRPC

Princeton Township & Princeton Borough

Map 12: Aquifers and Bedrock Geology



Sources: NJGS, 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.

BEDROCK AQUIFERS
BED OUTCROP FORMATIONS

- Gneiss Granofels and Migmatite
- Jurassic Diabase
- Lockatong
- Magothy Formation
- Metabasalt
- Passaic - Gray Bed
- Passaic
- Potomac Formation
- Stockton
- Wissahickon Formation

N

0 0.25 0.5 1 Miles

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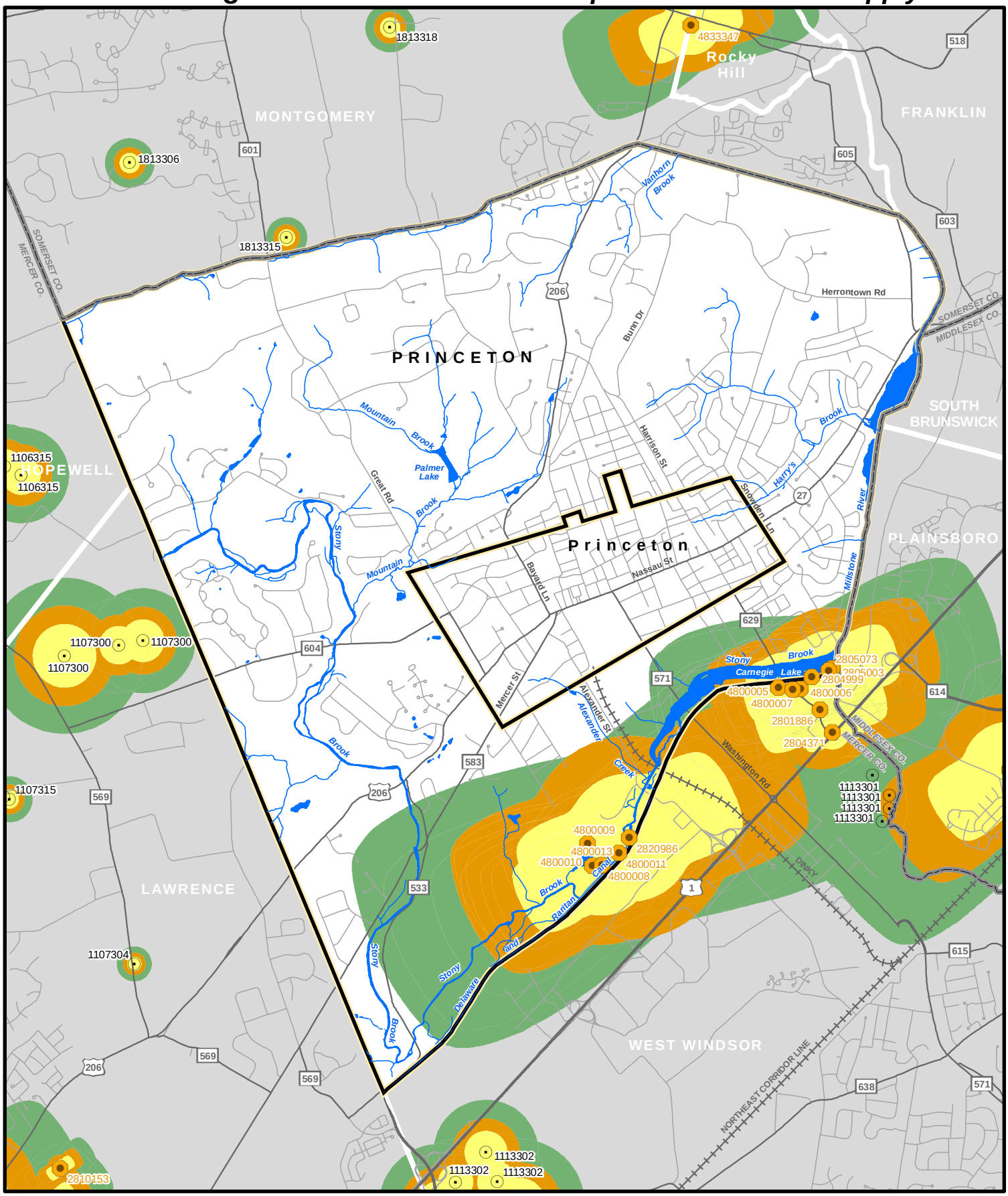
Princeton Township & Princeton Borough

Map 13: Public Water Supply Wells



Sources: NJGS, 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.

Public Non-Community Water Supply Well (2004)

Public Community Water Supply Well (2005)

Wellhead Protection Areas

(Public Community, 2006
Public Non-Community, 2004)

2-year 5-year 12-year

0 0.25 0.5 1

Miles

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WELLHEAD PROTECTION AREAS AND WATER SUPPLY WELLS

Preventing contamination in areas where aquifers (water-bearing formations of rock) intersect the land surface is extremely important in order to maintain a safe drinking water supply. To protect these aquifer outcrop areas, NJDEP established the Wellhead Protection Program Plan in 1991. The program delineates Wellhead Protection Areas (WHPAs) around public community water supply wells. A WHPA is the area from which a well draws its water within a specified time frame. Once delineated, these areas become a priority for efforts to prevent and clean up ground-water contamination. Other components of the Wellhead Protection Plan include implementing best management practices to protect groundwater, land use planning, and education to promote public awareness of groundwater resources.

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 ground water, how much time would be required for specific remedies to be undertaken, 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.

Once WHPAs are delineated, potential pollution sources may be managed by owners 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 in wellhead areas. Princeton could also require wellhead protection through municipal ordinances. Such action could further minimize the risk of drinking water contamination.

GROUNDWATER RECHARGE

Recharge of groundwater is an important issue because of the state's 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, and the nature of the soil, land use, and the vegetation of an area.

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

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

In Princeton Township, lands with highest *potential* recharge rates (between 13 and 16 inches per year) are found in scattered patches, with concentrations along the northern slope of the Princeton Ridge, where the Passaic Formation resumes after interruption by the diabase dike. Additional concentrations occur around the intersection of Stony Brook and Springdale Road, and near the Institute of Advanced Study Campus. See **Map 14: Groundwater Recharge**. Often, areas with high recharge rates are underlain by permeable, alluvial sediments, such as those found in the highly permeable Birdsboro and Neshaminy soil series. Paving and other impervious cover have the greatest detrimental impact on recharge, although, paradoxically, high-recharge lands are often the places most suitable for building because of their well-drained soils.

High-recharge areas are regions where the dilution of substances from septic systems, such as nitrates, may require a larger land area because the soils are more porous. Septic fields in these areas that are too closely spaced pose a threat of groundwater contamination because they do not provide adequate filters for pollutants. Large average lot sizes of approximately four acres or more are often needed for proper nitrate dilution from septic systems depending upon the amount of rainfall.

According to NJGS's groundwater recharge methodology, about 30 percent of Princeton's land experiences zero to one inch of groundwater recharge. Most of this land is located in and around Princeton Borough. However, this information is misleading. As stated previously, the NJGS model relies on soil survey data. The area in and around the borough is classified as "Udorthents" on NRCS soil surveys, which is essentially a "catch-all" category for complicated, disturbed, and altered soils, such as those found in built-up areas. In reality, Udorthents are composed of many different soil series. Because of the lack of specificity regarding Udorthents, they return a value of "0 inches per year" when plugged into the NJGS model. It would be more correct to say "no recharge rate calculated" for areas underlain by Udorthents. If a community has a map of local soils at a series level breakdown within the Udorthent family, NJGS's model can be "rerun" to more accurately calculate groundwater recharge potential.

Regardless of the limitations of the groundwater recharge model, impervious surfaces do impact groundwater recharge and stormwater infiltration in the borough. In total, 419 acres, or 36 percent, of the borough's area is covered by impervious surfaces, such as roads, sidewalks, parking lots, and buildings. Even so, it is a mistake to conclude that little can be done to infiltrate stormwater in developed communities. Best Management Practices (BMPs), such as green streets, tree trenches, bioswales, rain gardens, naturalized yard areas, rain barrel use, and porous pavement can be used with great success to capture, treat, and infiltrate precipitation in urban areas from all but the most significant storm events. Also

referred to as "urban green infrastructure," these techniques are utilized in more densely developed communities to cost-effectively manage stormwater and protect drinking water supplies. Urban green infrastructure not only improves water quality and reduces flooding, it improves the "spatial quality" of built-up areas, such as Princeton Borough, making them more desirable places to live, work, and play.[11]

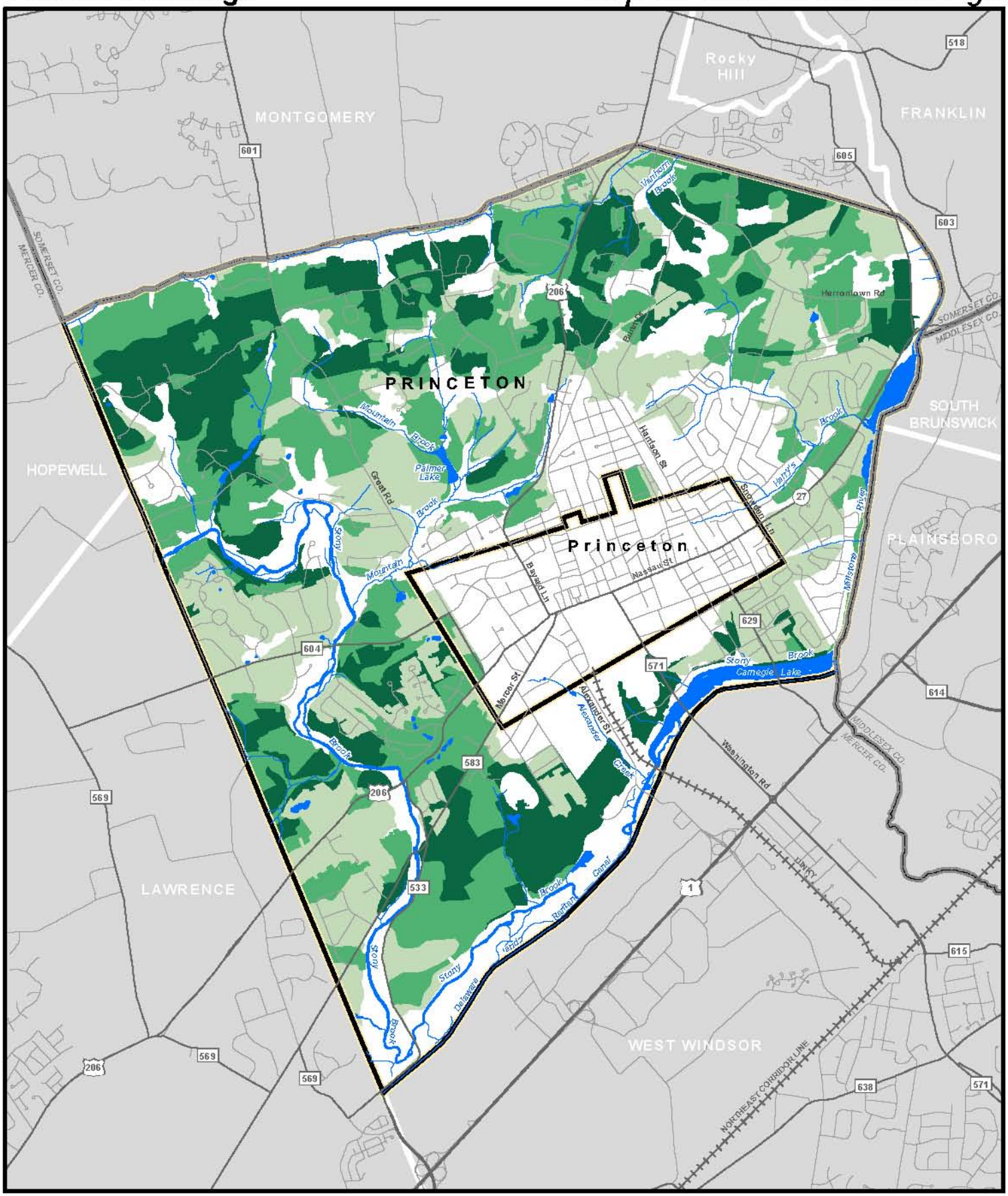
Photo by Stephen Hiltner

Princeton High School Ecolab–An example of urban green infrastructure

[11] Tarnay, Stella. "Green Neighborhoods." Urban Land May 2005: 63-68.

Princeton Township & Princeton Borough

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	11 - 12
2 - 10	13 - 16

N

0 0.25 0.5 1
Miles

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BIOLOGICAL RESOURCES

When a community protects wildlife and habitat, it is also protecting biodiversity, which is important for the health and productivity of the ecosystem and its inhabitants, including humans. Biodiversity refers to the variety of genetic material within a particular species population, the variety of species (plants, animals, and microorganisms) within a community, and the variety of natural communities within a given region. Biodiversity facilitates adaptation and evolution, improving the chances of survival for individual species, as well as the biological communities that they are a part of, as the environment changes. A diversity of plant and animal species is also necessary to maintain healthy human environments, agricultural productivity, and ecosystem health. Lower organisms, many of which are not well known, contribute to nutrient cycling, decomposition of organic matter, soil rehabilitation, pest and disease regulation, pollination, or water filtering. Once biodiversity declines, it is extremely hard for an ecosystem to recover or replace species.

Scientists have discovered and named somewhere between 1.5 and 1.8 million plant and animal species in the world. Far more species, possibly 10 to 20 times the number of known species, are unknown to science. Alarmingly, this great diversity of species is now diminishing at an unprecedented rate. Researchers generally agree that the extinction rate is now catastrophically high—somewhere between 1,000 and 10,000 times the rate before human beings began to exert significant pressure on the environment. Given these trends, and barring significant increases in conservation efforts, approximately one-half of the world's species will be gone by the end of this century.[12]

While the decline of biodiversity is indeed a global problem, conservation needs to occur on both global and local levels if it is to succeed. Princeton contains numerous types of natural habitats, all of which are important for maintaining biodiversity. Forested uplands are the most common ecosystem type in Princeton. Princeton also contains significant amounts of forested wetland. Suitable areas exist for the reestablishment of grassland and emergent wetland habitats. The following sections will identify and describe in more detail the plant and animal communities that inhabit these unique ecosystems within Princeton Township and Borough.

NATURAL VEGETATION

A region's vegetation is dependent on many factors, the most important of which are climate and soils. Princeton's climate is temperate and rainfall averages almost 46 inches per year. The majority of Princeton's soils are generally well drained, supporting a large diversity of trees and several agricultural crops. However, Princeton also contains a substantial amount of poorly drained soils that exhibit ponding and hydric characteristics, and that sustain wetland plants. For a detailed description of Princeton's soils, see *Soils* on *page 25.*

[12] Wilson, Edward O. *The Future of Life.* New York: Vintage Books, 2002. pp. 14 99-102.

Princeton'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 **Map 15: Natural Vegetation (2002)**.

Table 17: Natural Vegetation Princeton Township and Borough (2002)

Natural Vegetation Type	Acres	% of Land
Brush/Shrubland	73.2	0.6%
Brush/Shrubland - Oldfield	25.4	0.2%
Upland Forest - Coniferous	53.2	0.5%
Upland Forest - Deciduous	2,887.1	24.6%
Upland Forest - Mixed (Coniferous Dominated)	42.6	0.4%
Upland Forest - Mixed (Deciduous Dominated)	138.5	1.2%
Water	281.2	2.4%
Wetlands - Herbaceous	46.7	0.4%
Wetlands - Modified	157.1	1.3%
Wetlands - Scrub/Shrub	23.1	0.2%
Wetlands - Wooded - Deciduous	1,089.3	9.3%
Non-Natural Vegetation (Urban, farm fields, grass, etc)	*6,920.7*	*59.0%*
Total	**11,738.0**	**100.0%**

Source: NJDEP 2002 Aerial Photo

Wetlands

Wetlands are defined as areas that are inundated or saturated by surface or ground waters at a frequency to support vegetation suited for life in saturated soils (i.e., wetlands vegetation). New Jersey's wetlands are located primarily around interior stream systems and along coastal rivers and bays. NJDEP, which employs USGS guidelines, classifies wetlands with naturally occurring vegetation into two major categories: (1) *tidal wetlands*, which are wetlands associated with tidal portions of the Delaware River System and waterways draining into the Atlantic Ocean; and (2) *interior wetlands*, which are wetlands found in nontidal lowlands associated with waterways, and in isolated wetlands surrounded by uplands. All of Princeton's wetlands are interior wetlands. NJDEP also identifies *modified wetlands*, which are former wetland areas that have been altered by human activities and no longer support typical natural wetlands vegetation, but which do show signs of soil saturation on aerial infrared surveys.

Wetlands are a critical ecological resource, supporting both terrestrial and aquatic animals 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 have 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.

The location and type of vegetation are key features for classifying wetlands. Virtually all wetlands in Princeton are found in association with the major streams and their tributaries. Freshwater, deciduous wooded wetlands, particularly along Stony Brook, Mountain Brook, and the Delaware and Raritan Canal, are the dominant category of wetlands in the township. These wetlands are "palustrine" wetlands (stream-associated versus "lacustrine" or lake-associated) and are usually covered with deciduous trees or shrubs, although some evergreen trees or shrubs may be present. Shrubs are also the dominant plants where wetlands are recovering from past impacts. See **Map 9: Surface Water, Wetlands, and Vernal Ponds.**

Photo by Stephen Hiltner

Wetlands in Rogers Wildlife Refuge.

Interior wetlands provide high-quality animal and plant habitat, purify Princeton's surface and ground water, and create picturesque landscapes that add immeasurably to the quality of life for local residents. Princeton has three major types of interior wetlands: (1) wooded wetlands dominated by deciduous trees; (2) herbaceous wetlands; and (3) scrub/shrub wetlands. See **Map 15: Natural Vegetation (2002)**.

The vast majority of Princeton's wetlands are deciduous wooded wetlands, which occupy about 1,090 acres and support mixed hardwoods, such as green ash, box elder, pin oak, and swamp white oak, which flourish in lowlands and frequently saturated soils. All of the creeks in the township and their tributaries support some wooded wetlands. Closely associated with deciduous wooded wetlands are scrub/shrub wetlands, occupying about 23 acres. Scrub/shrub wetlands often make up transitional areas between deciduous wetlands and other land cover types. Typical native shrub species in lowlands are buttonbush, swamp rose, elderberry, arrowwood Viburnum, winterberry, and silky dogwood, with sweet pepperbush and swamp azalea making rare appearances. Multiflora rose is the most common invasive exotic shrub in floodplains. The largest pocket of scrub/shrub wetlands is found along Stony Brook near Route 533 in southwest Princeton Township.

Herbaceous wetlands (i.e., marshes) occupy approximately 47 acres. These wetlands generally occur along lake edges, in open floodplains, and in former agricultural fields. Herbaceous

wetlands are found in close proximity to scrub/shrub and wooded wetlands along Stony Brook and its tributaries. Herbaceous wetland plants include tussock sedge, arrow arum, yellow pond lily, tearthumb, wild rice, broadleaf cattail, and invasive species like reed canary grass, purple loosestrife, and the common reed (*Phragmites*).

Princeton's modified wetlands encompass agricultural wetlands, former agricultural wetlands, disturbed wetlands, and wetlands that occur in maintained greenspaces, such as lawns, golf courses, and stormwater swales. Modified wetlands differ from nonmodified wetlands in that they no longer support the typical natural wetlands vegetation found in analogous unaltered natural areas, although they do exhibit evidence of soil saturation. In total, modified wetlands occupy 157 acres.

Upland Forests

Upland areas are those locations without water at or near the soil surface. Most of Princeton's original upland forests have been cleared and converted to farms or residential or commercial development. Today's upland forests are second or third growth and tend to be located near stream corridors, on steep slopes, or on less agriculturally suitable soils. Approximately 3,120 acres, or 26 percent, of Princeton's land area is upland forest. See **Map 15: Natural Vegetation (2002)** and **Table 17: Natural Vegetation**.

The majority of Princeton's upland forest is deciduous forest (2,887 acres). Some of this upland forest has been preserved by the creation of parks, such as Institute Woods, Mountain Lakes, Herrontown Woods, and the Woodfield Reservation. The composition of Princeton's upland deciduous forests is largely one of mixed oaks—black, red, pin, and white oaks—joined by other hardwoods, such as ash, birch (primarily in the form of river birch, which is found along streambanks), maple, beech, hickory, locust, tulip poplar, and sweet gum. The understory contains species such as flowering dogwood, black cherry, ironwood, American holly, and sassafras. Vines, such as wild grapes, Virginia creeper, poison ivy, and greenbriar, as well as the exotic invasives Japanese honeysuckle and Asiatic bittersweet, are common. Exotic species like multiflora rose, Chinese privet, winged Euonymus, Asian photinia, and honeysuckle often dominate the shrub layer, although native spicebush and Viburnums are common in places.

Coniferous and coniferous/mixed forests cover about 95 acres of Princeton. These forests are mostly made up of successional, or pioneer, species like Eastern red cedar, Virginia pine, scrub pine, and pitch pine, which will eventually be overgrown by dominant deciduous trees, such as oak, ash, and hickory. A number of evergreen woods, such as those at the Institute Woods and Community Park North, consist of old fields that were planted with white pines and spruce. Because these areas were planted as "tree plantations," they are not considered "natural vegetation" and are not shown on **Map 15** or included in **Table 17**.

Grasslands and Agricultural Lands

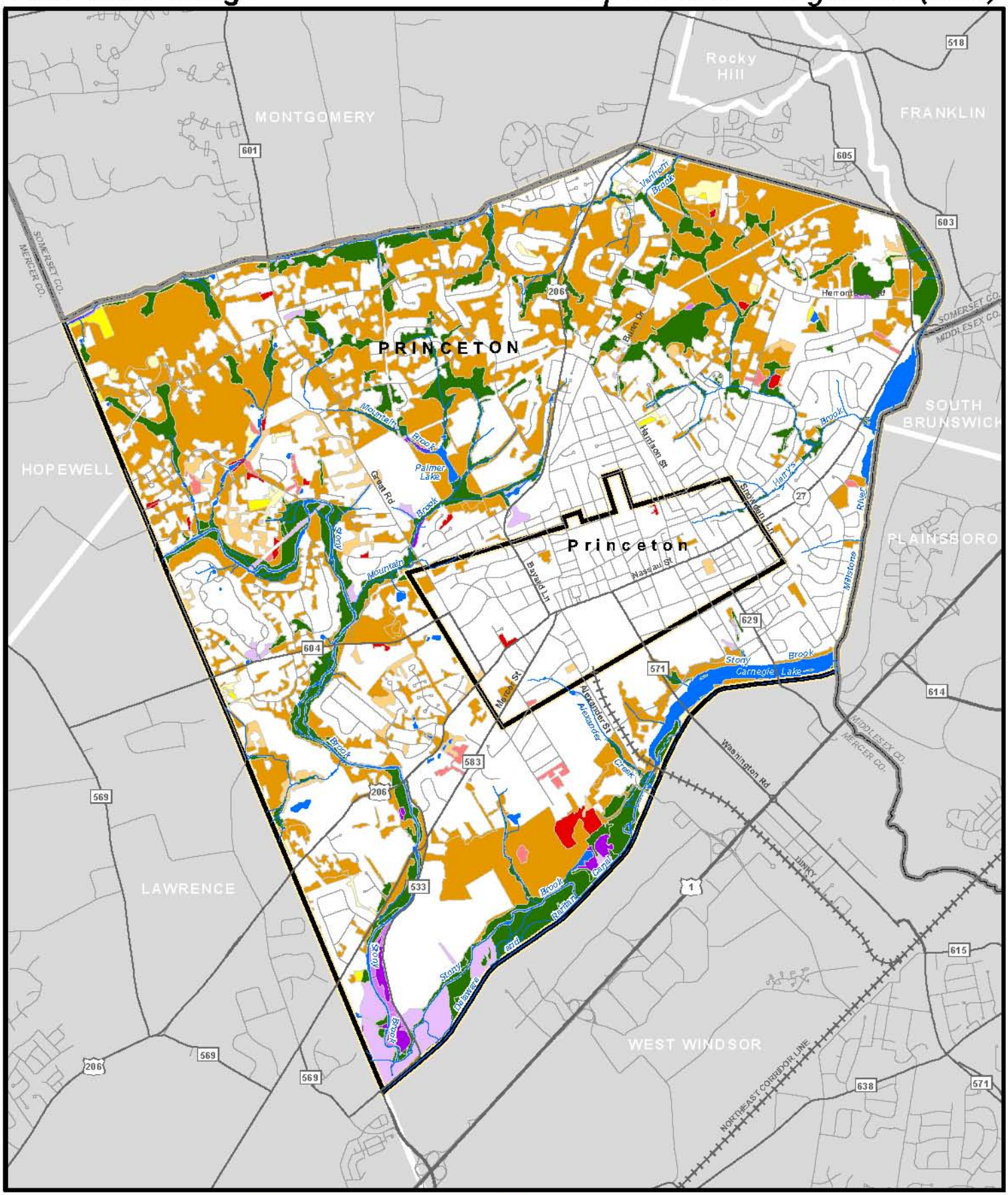
Grasslands are considered to be one of the most endangered ecosystems globally. They are threatened by human development, new agricultural technology, grazing, desertification, soil erosion, and invasive species. Grasslands are important because they provide habitat for specialized species, such as grassland birds and shade-intolerant herbaceous plants. Many species of increasingly rare grassland birds require large contiguous patches of grassland for successful breeding and roosting.

NJDEP defines brushland, shrubland, or old fields that were cleared or disturbed at one time and then abandoned as grassland habitat. Following abandonment, old fields are overgrown by perennial herbs and grasses. These pioneer plants remain the dominant species for three to 20 years, after which woody plants take over. This habitat is especially visible along wood edges, roadsides, and in landscapes where mowing is infrequent, but where woody plants are not yet the dominant vegetation. To be sustained, grasslands must be mowed every one or two years. In Princeton, just less than 100 acres is classified as brushland, shrubland, or old fields. Brushland and shrubland are generally found adjacent to residential, commercial, and industrial development, while old fields occur more often near agricultural areas. See **Map 15: Natural Vegetation (2002)**.

In addition to brushland, shrubland, and old fields, active agricultural cropland and pastureland is considered suitable "grassland" habitat for species that forage or nest on open land. Agricultural cropland and pastureland, which are located only within the township, cover slightly less than five percent of Princeton's land area.

Princeton Township & Princeton Borough

Map 15: Natural Vegetation (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.

- Brush/Shrubland
- Brush/Shrubland - Oldfield
- Upland Forest - Coniferous
- Upland Forest - Mixed (Coniferous dom.)
- Wetlands - Wooded - Deciduous
- Upland Forest - Deciduous
- Upland Forest - Mixed (Deciduous dom.)
- Wetlands - Herbaceous
- Wetlands - Scrub/Shrub
- Wetlands - Modified

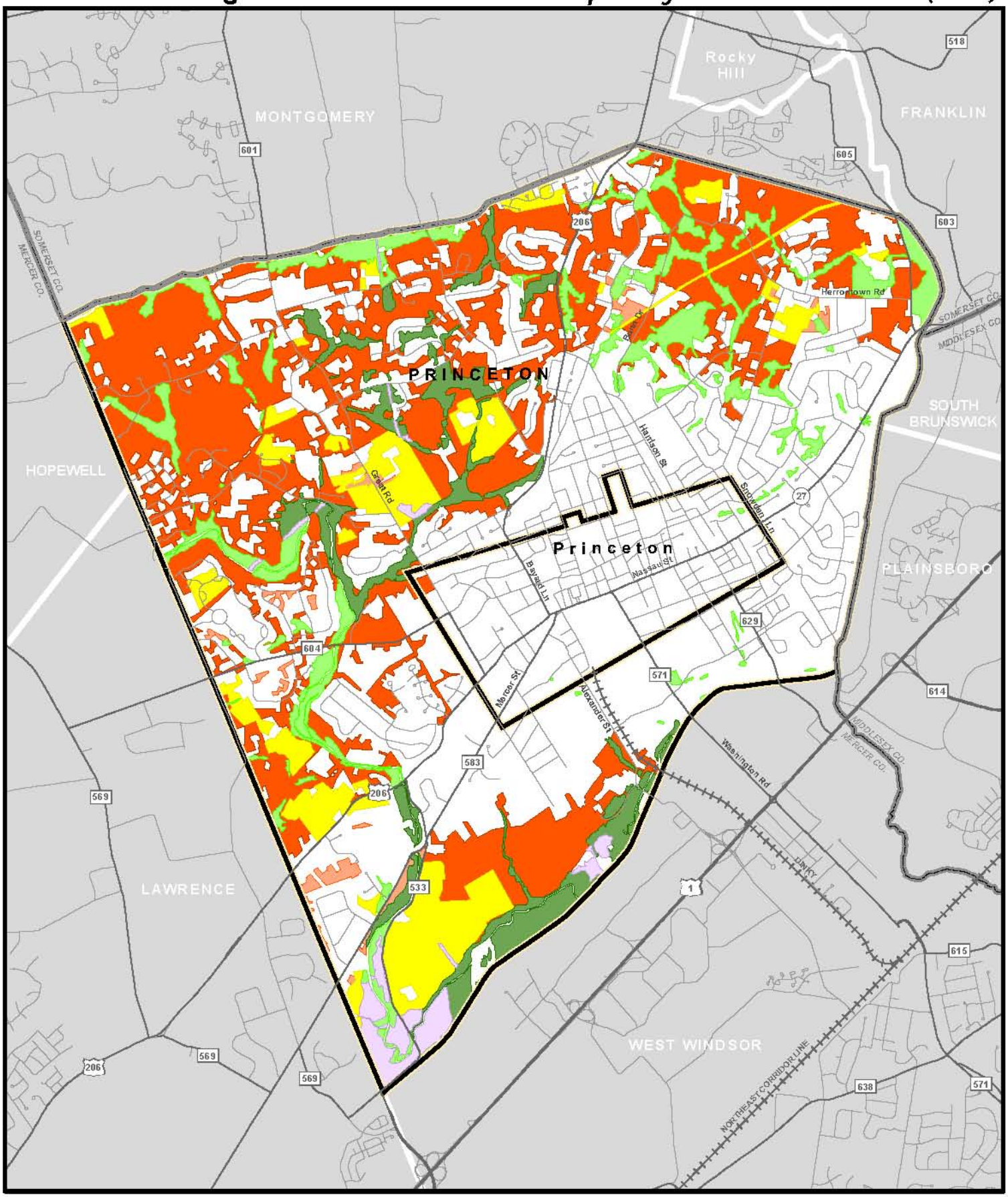
N

0 0.25 0.5 1
Miles

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

Princeton Township & Princeton Borough

Map 16: Landscape Project Habitat Priorities (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.

TYPE OF CONSERVATION PRIORITY

GRASSLANDS	FORESTED WETLANDS	UPLAND FOREST	EMERGENT WETLANDS
Suitable Habitat	Critical Habitat	Critical Habitat	Suitable Habitat
	Suitable Habitat	Suitable Habitat	

0 0.25 0.5 1
Miles

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

LANDSCAPE PROJECT PRIORITY HABITATS

The Landscape Project, developed by the Endangered and Nongame Species Program of the NJDEP Division of Fish and Wildlife, identifies and documents the value of wetland, grassland, and forest habitat within New Jersey. While the Landscape Project aims to identify, delineate, and ultimately protect critical habitat for all New Jersey wildlife, the project focuses on habitat that is or could be utilized by state- or federally designated threatened and endangered wildlife species. It is an informational tool and does not have its own regulatory program or rules. However, the information contained in the Landscape Project is referenced by other state statutes, which contain specific provisions for the protection of habitats determined to be critical to endangered and threatened wildlife. These regulatory programs—including the Freshwater Wetlands Protection Act Rules, the Coastal Zone Management Rules, the Flood Hazard Area Control Act Rules, the Water Quality Management Planning Rules, and the Highlands Water Protection and Planning Act, Special Adopted Rules—should be consulted directly to determine the ways in which they utilize Landscape Project data.

Mostly, the information contained in the Landscape Project should be used for planning purposes before any actions, such as proposed development, resource extraction, or conservation measures, occur. Proper planning with accurate, legally and scientifically sound information will result in less conflict. Landscape Project data can also inform the municipal land development approval process. For example, knowledge of critical habitat on a site could inform a planning board regarding whether to require a developer to perform a wildlife survey. At the same time, Landscape Project data provides a legal justification for requiring such a survey.

The Landscape Project categorizes habitats into one of five groups according to their importance (five being the highest). Categories three through five include habitats throughout the state that possess two exceptional conditions: (1) a documented occurrence of one or more species on either the federal or 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.” Categories one and two include habitats that either have a documented occurrence of a *species of special concern* in New Jersey or are habitat 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 Princeton Township and Princeton Borough. It is important to preserve both suitable and critical habitats in order to maintain the diversity of species that still exist in the township and to improve the likelihood of survival for endangered and threatened species in Princeton. It should be noted that almost all of Princeton’s critical and suitable habitat is located in the township, particularly throughout the Princeton Ridge and in the Institute Woods. A small patch of critical upland forest is located in the northwestern corner of the borough near Mountain Brook, and an even smaller patch of suitable forested wetland is located in the borough along Harry’s Brook. See **Map 16: Landscape Project Habitat Priorities** and **Table 18: Landscape Project Designations for Princeton Township and Borough.**

Although the borough has very little habitat that could serve the needs of species designated as threatened or endangered, even these more urbanized lands can be managed to provide habitat highly beneficial to wildlife in general.

Landscape Project Data on Wetland Habitat

The Landscape Project divides wetland habitats into two types—forested and emergent wetlands. Emergent wetlands are marshy areas characterized by low-growing shrubs and herbaceous plants in standing water. About 150 acres in Princeton are identified as priority emergent wetlands habitat. All of these lands are ranked as suitable. Animals that can be found in wetland habitats include rare fish, mollusks, crustaceans, and insects. Emergent wetlands are also important habitat for migratory waterfowl and passerines (small perching birds), such as migrating flycatchers and warblers.

Forested wetlands are Princeton's second-most common priority habitat type, occupying 1,108 acres, of which 507 are ranked as critical. Critical forested wetlands are located along Stony Brook and Mountain Brook, as well as in some areas of upper Cherry Creek. Forested wetlands support species such as migratory and nesting warblers, many of which are species of special concern. They can also be home to various rare amphibians (frogs and salamanders).

Table 18: Landscape Project Designations for Princeton Township and Borough

Category	Rank	Acres	% Total Habitat	% Princeton Land
Emergent Wetlands	Suitable Habitat (1)	10.4	0.2%	0.1%
	Suitable Habitat (2)	140.5	2.3%	1.3%
Forested Wetlands	Suitable Habitat (1)	384.4	6.3%	3.6%
	Suitable Habitat (2)	217.1	3.5%	2.1%
	Critical Habitat (3)	507	8.3%	4.8%
Upland Forest	Suitable Habitat (2)	127.6	2.1%	1.2%
	Critical Habitat (3)	1,398.4	22.8%	13.2%
	Critical Habitat (4)	2,625.7	42.8%	24.9%
Grassland	Suitable Habitat (1)	296.6	4.8%	2.8%
	Suitable Habitat (2)	433.3	7.1%	4.1%

Source: NJDEP

Landscape Project Data on Upland Forest Habitat

The most common habitat type in Princeton is upland forest. The Landscape Project ranked 128 acres as suitable habitat, and 4,024 acres as critical upland forest habitat. The majority of critical upland forest is located in the northern tier of the township along the Princeton Ridge and in the vicinity of Stony Brook at the Institute Woods. This habitat lies on both public and private lands.

Landscape Project Data on Grassland Species Habitat

The Landscape Project designates 730 acres of the township as suitable grassland habitat. Most of this habitat is found in scattered patches in or surrounding old farm fields. Large sections of suitable habitat are found in the southwest corner of the township adjacent to Institute Woods, immediately to the west and east of Mountain Lakes Park, and to the west of Stony Brook on the Jasna Polana Golf Course. Grassland-dependent species are the most threatened group of species in New Jersey, primarily because the most common form of grassland habitat—agricultural fields—is the most threatened habitat in the state due to development pressure and rising land values. Changes in agricultural practices have also had a profound impact on these species where such habitat does exist.

Photo by Stephen Hiltner

A Field of Black-eyed Susans at Tusculum – A type of grassland habitat

Most of the land designated as suitable grassland habitat within Princeton is agricultural land. The designation of agricultural land as grassland habitat occurs for 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 several bird species, such as sparrows; (4) all or most

endangered and threatened birds are area-sensitive, requiring large ranges that include agricultural "grasslands;" and (5) agricultural land provides important disturbance buffers, separating humans and domestic predatory animals like dogs and cats from rare and endangered bird species.

Examples of grassland-dependent species that use grassland habitat for nesting or feeding include the threatened grasshopper sparrow and bobolink, and some species of butterflies and moths. Princeton's designated grassland habitat also provides suitable habitat for migrating birds. Lands currently managed as grassland, though not specifically for the purpose of providing grassland habitat, include the township-owned meadows at Tusculum, Coventry Farm, and the natural gas pipeline right-of-way that slices through Princeton from east to west on the south side of the Princeton Ridge.

ANIMAL COMMUNITIES

Although no comprehensive inventory of the different animal species within New Jersey, Mercer County, or Princeton Township exists, there are records of sightings, biological studies of range, and assessments of endangered and threatened status that can be used to identify and describe known and possible animal communities in Princeton.

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. Though they are the most abundant and diverse animal life forms, they are not generally well recognized and their fundamental role in sustaining natural systems is often not fully appreciated.

Figure 7: The Dragonfly Nymph – a common macroinvertebrate found in southern New Jersey

Dragonflies

Nymph *Adult*

Invertebrates consist of insects (beetles, butterflies, moths, ants, dragonflies, termites, bees, flies, wasps, 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. Aquatic or otherwise water-dependent invertebrates often suffer first from environmental degradation due to the large impact that human activity has on waterbodies. Among aquatic macroinvertebrates, benthic (bottom-dwelling) macroinvertebrate communities provide a basis for ecological monitoring and are relatively simple to collect from shallow stream bottoms. Monitoring the presence of macroinvertebrates reveals the effect of pollutants over a long period of time. The Ambient Biomonitoring Network (AMNET) surveys streams for macroinvertebrate communities, which are an indicator of water quality, as discussed in the *Surface Water Quality* section of this document beginning on *page 63*.

Photo by Stephen Hiltner

Brown wasp on boneset

Threatened and Endangered Invertebrates

There are nine invertebrate species listed as endangered (two beetle species, four butterfly species, and three mussel species) and eight invertebrate species listed as threatened (three butterfly species and five mussel species) in the State of New Jersey. Four of these species can be or were once found in Princeton: the endangered brook floater (a mussel), the endangered green floater (a mussel), the threatened triangle floater (a mussel), and the threatened eastern pond mussel. At one time, freshwater mussels were abundant in the streams of Princeton, as well as in the rest of New Jersey, and served as a major food source for native peoples. Unfortunately, due to destruction of suitable aquatic habitats by dams and pollution, the native mussel population has sharply declined. Of those species on the New Jersey Endangered and Threatened List, one, the dwarf wedge-mussel, which has not been found in Princeton, is listed as endangered under the federal Endangered Species Act.

Vertebrates

Vertebrates are less numerous than invertebrates, but their larger size makes them much more visible and thus better studied and recorded. Fish species are fairly well documented, as are mammals. Birds that nest in Princeton are known, but migrants that depend on Princeton's wetlands and forests as stopover sites in which to rest and feed are not as thoroughly inventoried.

Mammals

Mammals appear to be abundant because they tend to be larger and live in habitats also ideal for human development. There are over 500 mammal species in New Jersey, of which only nine are listed as endangered and none are listed as threatened by the State of New Jersey. Six of these listed species are whales, and of the three land-based species, only one of these, the bobcat, is found in Princeton Township and occasionally seen in Princeton Borough. Some common mammals found in Princeton include cottontail rabbits, eastern gray squirrels, skunks, little brown bats, white-tailed deer, opossums, and raccoons. In addition, both red and gray foxes have been sighted in Princeton. In June 2008, several black bear sightings were reported in both the borough and township. The presence of black bears in Princeton is not a common occurrence.

Deer Management in New Jersey

Management of white-tailed deer is an issue throughout New Jersey. While many residents prize the presence of mammalian life, mammals often come into conflict with humans in suburban areas. The white-tailed deer presents a classic case of this conundrum. Indeed, the argument over whether New Jersey has too many, just enough, or not enough deer often causes controversy. On the one hand, there is inherent value in New Jersey's deer population: deer are a beloved symbol of wildlife; a visible subject for wildlife education and research; a part of human recreational activities like wildlife watching and hunting; and a food source for carnivores and humans. On the other hand, deer overpopulation has caused widespread destruction of habitat in New Jersey, and conflicts often arise when humans and deer compete for the same space. According to the U.S. Department of Agriculture, deer cause more damage to agricultural crops than any other vertebrate wildlife species, and farmers in densely human-populated areas appear to be the most affected. Additionally, the extirpation of predators that historically served to control the deer population has caused a severe ecological imbalance. An overabundance of deer can devastate the understory of forests through overgrazing, destroying the growth of seedlings and young trees, and eliminating many species of wildflowers. The preference of deer for native plant species has shifted the balance in forest understories toward a small number of invasive species that the deer tend not to eat, greatly reducing biodiversity and limiting the variety and seasonal availability of food for other wildlife. Deer also aid the spread of Lyme's Disease. Finally, as most motorists are well aware, collisions between deer and automobiles frequently cause serious damage, sometimes resulting in injury to humans and death to the deer.

Controlling deer numbers has become increasingly difficult in New Jersey for numerous reasons, including: (1) hunters have less access to land inhabited by deer; (2) some communities pass ordinances prohibiting hunting; (3) public and private groups establish deer refuges; (4) suburban housing patterns prevent hunting and provide year-round food for deer; (5) some public and private groups oppose deer hunting; and (6) hunters are leaving the state to hunt in nearby states. Predators that previously served to keep deer populations in balance were long ago extirpated from the state.

To minimize the negative impacts described, the New Jersey Agricultural Experiment Station recommends both lethal and nonlethal deer management options for community-based deer management programs. For example, municipalities can extend the hunting season, issue depredation permits to private landowners, engage in sharp shooting, and employ traps and euthanasia to reduce deer numbers. Alternatively, communities and private landowners can choose to apply not necessarily dependable nonlethal 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, employing traps, and using birth control and translocation techniques.

Princeton Township introduced its own deer population control measures in 2000 to address the growing number of auto-deer accidents and to reduce overgrazing and disease issues attributed to an estimated 1,600 deer in the township. In an initially very contentious move, Princeton

Township employed the professional deer management firm White Buffalo Inc., to reduce the township's deer population. This program has been successful in reducing deer numbers, and importantly, deer-related automobile accidents have declined by approximately 60 percent. Anecdotal evidence suggests additional benefits of reducing the deer population: a probable reduction in the number of cases of Lyme's Disease, which is spread by deer ticks, an incremental resurgence of native vegetation in natural areas, and reduced browsing of gardens and backyard plantings.

While current deer problems should be addressed, it is important to note that New Jersey's white-tailed deer population has remained relatively stable throughout the state over the past decade, and that a partial reason for the perceived upswing in conflicts between deer and humans is the result of suburban expansion.[13]

Fish

When European settlers arrived in present-day Mercer County, they encountered Native Americans who regularly fished along the inland streams and gathered mussels 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.

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 waterbodies and conducts research and management surveys. Based on survey data supplied by the bureau, as well as local observation, Princeton's freshwater streams may contain the following fish: red-breasted sunfish, blue gill sunfish, green sunfish, white sucker, chain pickerel, pumpkinseed, eastern mudminnow, common shiner, golden shiner, creek chub, small madtom catfish, largemouth bass, tessellated darter, white crappie, and the American eel. The Stony Brook is also stocked annually with brook trout.

Birds

Centrally located along the Atlantic flyway, where the Inner Coastal Plain meets the Piedmont, the Princeton area, especially the Institute Woods and the Charles H. Rogers Wildlife Refuge, is an important stopover and nesting place for a wide range of passerines and waterfowl. Based on a 1978 list, informally updated in 2007, over 200 species have been seen in the Institute Woods and the refuge over the past few decades (see **Appendix E: Birds of the C.H. Rogers Wildlife Refuge**). In 1995, a census compiled according to the standards of the Breeding Bird Atlas listed 53 species as breeding on these properties. Another 15 were categorized as probably breeding.

[13] See www.nj.gov/dep/dsr/trends2005/pdfs/wildlife-whitetail.pdf

Consistent with the well-documented declines in bird populations worldwide in the past 25 years, there has been a marked decline in the number of species and total bird count in the Princeton area in the same period. Despite this, it is still possible to see a dozen or more species of warblers on a good fall-out day in May at the Rogers Refuge and the adjacent woods. Northern Parula, redstart, ovenbird, common yellowthroat, yellow, Nashville, Canada, black-and-white, blackpoll, black-throated blue, black-throated green, pine, yellow-rumped, blue-winged, chestnut-sided, and magnolia warblers, along with red-eyed and yellow-throated vireos, are reliably seen. Louisiana and northern waterthrush, palm, worm-eating, Blackburnian, prairie, hooded, and Kentucky warblers are seen less often, but still regularly. In the marsh at the Rogers Refuge, wood ducks and green and great blue herons are almost always present. Green-winged teal, common snipe, and solitary sandpipers are seen in migration. Scarlet tanagers, rose-breasted grosbeaks, northern orioles, wood and hermit thrushes, six species of woodpeckers, and great-horned owls are common in the woods on the Princeton Ridge, particularly the Herrontown Woods preserve.

Other common birds in Princeton are geese, swallows, jays, robins, wrens, sparrows, and some hawks. The threatened barred owl, grasshopper sparrow, Bald Eagle, and bobolink have been sighted in the township, as has been the Cooper's hawk.

N.J. Department of Environmental Protection Freshwater Fish Advisories

Fishing provides enjoyable and relaxing recreation, and many people like to eat the fish they catch. Fish are an excellent source of protein, minerals, and vitamins, are low in fat and cholesterol, and play an important role in maintaining a healthy, well-balanced diet.

However, certain fish may contain toxic chemicals, such as polychlorinated biphenyls (PCBs), dioxins, or mercury, which accumulate in water and aquatic life. Chemical contaminants such as dioxin and PCBs are classified by the U.S. Environmental Protection Agency as probably 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 higher risk from contaminants in fish than other members of the general public. Since 1982, NJDEP catches fish at numerous sampling stations throughout the state and tests for contaminant levels, adopting advisories to guide residents on safe consumption practices.

NJDEP issued a fish advisory for the following species of fish in Mercer County: largemouth bass, smallmouth bass, striped bass, chain pickerel, yellow bullhead, sunfish, brown bullhead, American eel, striped bass, channel catfish, white catfish, and bluefish. Recreational fishermen and women should regularly check for local fish advisories on NJDEP's Division of Science, Research and Technology website: www.nj.gov/dep/dsr/njmainfish.htm

USEPA General Consumption Guidelines

- If possible, eat smaller amounts of several different types of fish rather than a large amount of one type that may be high in contaminants. Consume species of fish that have lower levels of contaminants, such as fluke or flounder.
- Smaller fish of a species will usually have lower chemical levels than larger fish in the same location because contaminants tend to buildup in the fish over time. It is advisable to eat smaller fish (of legal size) more often than larger fish.

Important Bird Areas

The Important Bird Area (IBA) Program began as an international initiative for saving bird and wildlife habitat. In North America, the IBA Program is carried out by chapters of the Audubon Society in 46 states. The state IBA programs have succeeded in protecting tens of thousands of acres of bird habitat and raised public awareness about habitat protection. While Princeton does not contain any officially listed IBAs, both the Pole Farm IBA and Brandon Farms IBA are located nearby in Lawrence and Hopewell townships.

In New Jersey, the New Jersey Audubon Society, in cooperation with the New Jersey Endangered and Nongame Species Program (ENSP) and the National Audubon Society, runs the Important Bird and Birding Area (IBBA) program. This program identifies not only Important Bird Areas, but also areas important for bird watching.

In New Jersey, for a site to qualify as an Important Bird Area, it must meet at least one of four primary criteria. These criteria include: the presence of species of conservation concern; the presence of "regional responsibility species;" the capacity to hold "significant congregations" of one or more bird species; and the presence of exceptionally high numbers of birds during migration relative to the surrounding areas. While no current IBA or IBBA sites exist in Princeton Township or Borough, the nomination process is ongoing, and likely sites should be identified by local birders and submitted to the state IBBA coordinator for evaluation.

Resident Canada Goose Populations

The State of New Jersey now has a "resident" Canada goose population of approximately 100,000 birds that no longer migrate to more southern locales, and this population may double in size in the next five to 10 years. While geese are a valuable component of the urban/suburban environment, providing enjoyable wildlife opportunities for the public, they can also cause property and environmental damage. Goose droppings that wash into lakes during storm events can elevate coliform bacteria to unhealthy levels, polluting surface waters and closing lakes to swimming. Goose droppings limit human use of grassy areas in parks, and because geese can be quite aggressive during the nesting season, they can potentially injure humans.

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

Common Reptiles and Amphibians

Reptiles can be quite elusive when surveys attempt to document them. Amphibians of some types are abundant, such as bullfrogs. Other species are rare because they depend on vernal pools, as was discussed in the *Surface Water Resources: Vernal Pools* section of this document on *page 55*. In Princeton Township, the eastern box turtle, wood turtle, spotted turtle, and Fowler's toad–all threatened or species of special concern–have been sighted in the last several years.

Threatened and Endangered Vertebrates

According to the Natural Heritage Database and the Landscape Project, eight threatened or endangered vertebrate species have been sighted in Princeton over the course of the past several years. Brief descriptions of several of these species and their preferred habitat, provided by the New Jersey Division of Fish and Wildlife, follow.

The Cooper's hawk (*Accipiter cooperii*) is a member of the Accipiter family–woodland hawks that prey on smaller birds–and is especially adapted to fly through dense cover chasing prey. In New Jersey, Cooper's hawks breed in remote wooded wetlands dominated by red maple or black gum. Adjacent upland pine or mixed oak/pine forests usually provide a buffer for nesting hawks. These hawks generally nest in forests composed of trees 30 years or older, which create a closed canopy. On average, a hawk will place his or her nest more than one-third of a mile away from the nearest human inhabitant. While other raptor species were threatened due to hunting practices and predator elimination, Cooper's hawk populations were not threatened until widespread suburbanization. Additionally, the pesticide DDT impaired many bird species' reproduction and contributed to declining populations from the 1950s to the 1970s. Populations began to recover due to the nationwide ban of DDT in 1972, coupled with the reforestation of old fields throughout New Jersey. The hawk was listed as endangered in 1974 and downgraded to threatened status in 1999 on the state list. The loss of large, contiguous forests remains a threat to this species and warrants the continued protection of Cooper's hawk nesting habitats.

The barred owl (*Strix varia*) inhabits remote, contiguous old-growth wetland forests. The owls use cavities in large trees for their nests. In northern New Jersey, barred owls live in mixed deciduous wetland or riparian forests. They avoid sites near residential, agricultural, industrial, or commercial areas. They prefer lowlands and avoid rocky hillsides. Barred owls were once abundant in the deep-wood swamps of New Jersey, but they diminished in numbers as they were shot by hunters, and as habitat was reduced beginning in the 1940s through the cutting of old-growth forests and filling of wetlands. In 1979, it was listed as a threatened species in New Jersey.

The bobcat (*Felix rufus*) is a member of the Felidae family. Bobcats can occupy a variety of habitats, ranging from forests to mixed agricultural areas to rural areas outside of cities. They generally occupy habitats with rocks or dense cover through vines, shrubs, or saplings, which provide protection from weather and predators, as well as resting places. In New Jersey, bobcats typically occupy areas of contiguous forest, or fragmented forests interspersed with agricultural areas. In the 1800s, many New Jersey forests were cleared, leading to a decline in the number of bobcats. By the 1970s, the animal was believed to have been extirpated from the state. In 1977, the New Jersey Division of Fish, Game, and Wildlife started a bobcat restoration project, releasing bobcats from Maine into northern New Jersey. While bobcat numbers today are steady, the animal is still listed as a state endangered species.

The bobolink (*Dolichonyx oryzivorus*) is a small-sized member of the blackbird family. These birds inhabit meadows or agricultural hayfields and pastures during the breeding season. It was an abundant species in New Jersey in the 1700s and 1800s. But by the 1900s, the species began

to decline in numbers because of changing agricultural practices. Through modern farming techniques, such as rotation of fields and mowing, agricultural fields became unsuitable for nesting bobolinks. In 1979, the species was listed as a threatened species in New Jersey.

The wood turtle (*Clemmys Insculpta*) occupies both aquatic and terrestrial environments. The aquatic habitats are used for feeding, mating, and hibernation, while the terrestrial habitats are used for foraging and egg laying. The turtle was fairly common in New Jersey until the 1970s, when declines in the species were noted due to stream degradation and loss of habitat. In 1979, the wood turtle was listed as a threatened species in New Jersey. In 1995, the species was proposed for inclusion on the federal endangered species list; however, populations throughout the country were considered stable enough to deny the listing.

See **Appendix C** for a list of *State Endangered and Threatened Species.*
See **Appendix F** for a list of *Plant Inventories for Princeton, New Jersey*.
See **Table 19** for a list of *Rare Animal Species and Natural Communities Presently Recorded in the NJ Natural Heritage Database for Princeton Township and Borough.*
See **Table 20** for a list of *Rare Plant Species and Natural Communities Presently Recorded in the NJ Natural Heritage Database for Princeton Township and Borough.*

Table 19: Rare Animal Species and Natural Communities Presently Recorded in the NJ Natural Heritage Database for Princeton Township and Borough

Common Name	Scientific Name	State Status	State Rank
Vertebrates			
barred owl	Strix varia	Threatened	S3B
bobcat	Lynx rufus	Endangered	S3
bobolink	Dolichonyx oryzivorus	Threatened	S2B
Cooper's hawk	Accipiter cooperii	Threatened	S3B, S4N
eastern box turtle	Terrapene carolina	Special Concern	S3
Fowler's toad	Bufo woodhousii fowleri	Special Concern	S3
spotted turtle	Clemmys guttata	Special Concern	S3
wood turtle	Clemmys insculpta	Threatened	S3
Invertebrates			
brook floater	Alasmidonta varicosa	Endangered	S1
eastern pond mussel	Ligumia nasuta	Threatened	S1
green floater	Lasmigona subfiridis	Endangered	S1
spine crowned clubtail	Gomphus abbreviatus	Special Concern	S2, S3
triangle floater	Alasmidonta undulata	Threatened	S3

Source: NJDEP, New Jersey Natural Heritage Program

Table 20: Rare Plant Species and Natural Communities Presently Recorded in the NJ Natural Heritage Database for Princeton Township and Borough

Common Name	Scientific Name	State Status	State Rank
wild comfrey	Cynoglossum virginaum	-	S2
winged monkey flower	Minimulus alatus	-	S3
Virginia pennywort	Obolaria virginica	-	S2
downy phlox	Phlox pilosa	Endangered	SH
veined skullcap	Scutellaria nervosa	-	S2

Source: NJDEP, New Jersey Natural Heritage Program

State Rank	
S1	Critically Imperiled in New Jersey (>5 occurrences)
S2	Imperiled in New Jersey (6-20 occurrences)
S3	Rare in state (21-100 occurrences)
S4	Apparently secure in state
SH	Elements of historical occurrence in New Jersey
B	Refers to in state breeding population
N	Refers to nonbreeding population

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 habitats for rare species. Preserving these areas is a top priority for efforts to conserve biological diversity in New Jersey. There are 410 NHP sites in the State of New Jersey, although none of these are located in Princeton.

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.

It is important to note that the Natural Heritage Database primarily lists 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 threatened and endangered species' protections (see "Cautions and Restrictions on Natural Heritage Data," located in **Appendix D)**.

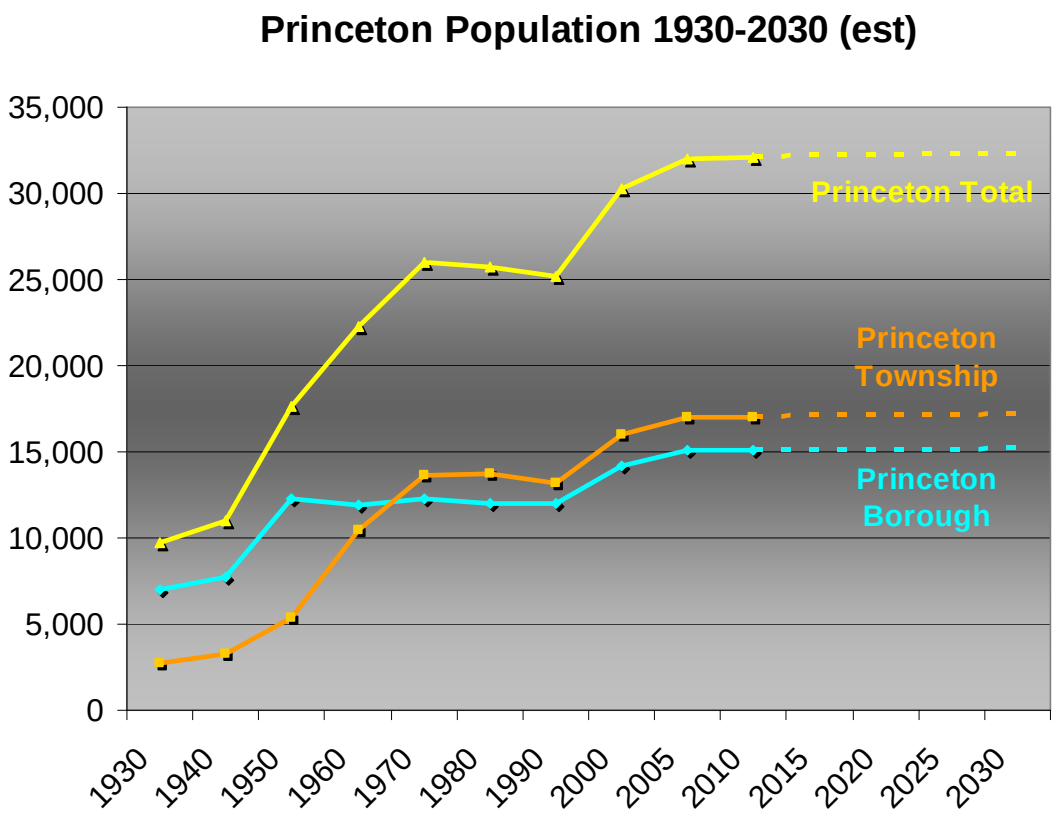
Designation as a NHP site does not carry any specific requirements or restrictions on the land. Rather, the designation is made because of a site's high biological diversity value. Owners of NHP sites are encouraged to become informed stewards of the property and to consider working with the local community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

THE BUILT ENVIRONMENT

DEMOGRAPHICS

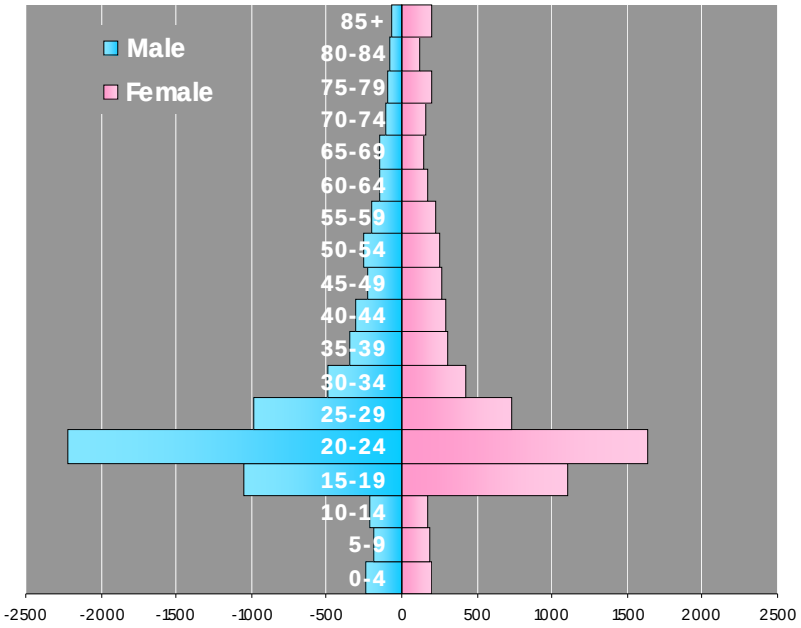
The 2000 census lists the population of Princeton Township and Borough as 30,230 people. Of this number, 14,203, or 47 percent, resided in the borough, and 16,027, or 53 percent, resided in the township. Included in this total for the borough is a significant portion (depending upon their residential status) of Princeton University's approximately 5,000 undergraduate and 2,400 graduate students. DVRPC's population projections show a modest growth of approximately 2,070 individuals in the township and borough by 2030, for a projected population of 32,301. Growth in general will proceed at a slower pace than the rest of the region, primarily due to a lack of available space for development in Princeton.

Figure 8: Princeton Population Growth, 1930 – 2030 (estimated)



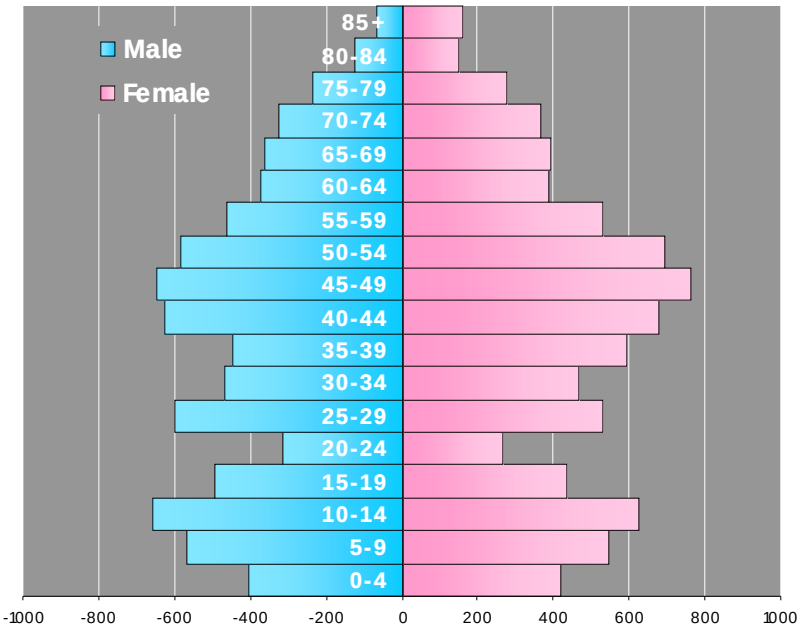
Source: U.S. Census and DVRPC Population Forecasts

Figure 9: Princeton Borough Population Pyramid



Source: 2000 U.S. Census

Figure 10: Princeton Township Population Pyramid



Source: 2000 U.S. Census

Population Pyramid

As might be suspected with its large student population, Princeton Borough's population profile is strongly skewed towards the 15 to 19, 20 to 24, and 25 to 29 age groups. These age groups most likely represent students associated with Princeton University and other educational institutions, such as Princeton Theological Seminary and Westminster Choir College. Although students are not likely to remain in Princeton past graduation, they will be replaced by incoming classes. This sizeable young population is among the most physically active of all age cohorts. For a graphic representation of Princeton Township and Princeton Borough's population, please refer to **Figures 9 and 10: Population Pyramids for Princeton Borough and Township.**

Single-family detached homes make up the bulk of Princeton's housing stock, accounting for 56 percent of the total housing stock. The next largest group of homes are single-family attached (row homes), accounting for an additional 17 percent of the housing stock. Multiunit structures make up the remaining 27 percent of the housing stock. All types of housing are represented in both the township and borough. For a more detailed breakdown of housing types, please refer to **Table 21: Housing Types in Princeton Township and Borough.**

Table 21: Housing Types in Princeton Township and Borough.

Housing Type	Princeton Twp	Twp %	Princeton Boro	Princeton Boro %	Total	Total %
1-unit, detached	3,991	64.1%	1,451	41.5%	5,442	56.0%
1-unit, attached	944	15.2%	750	21.5%	1,694	17.4%
2 units	179	2.9%	253	7.2%	432	4.4%
3 or 4 units	356	5.7%	321	9.2%	677	7.0%
5 to 9 units	175	2.8%	278	8.0%	453	4.7%
10 to 19 units	139	2.2%	207	5.9%	346	3.6%
20 or more units	440	7.1%	235	6.7%	675	6.9%
Mobile home	0	0.0%	0	0.0%	0	0.0%
Boat, RV, van, etc	0	0.0%	0	0.0%	0	0.0%
Totals	**6,224**	**100.0%**	**3,495**	**100.0%**	**9,719**	**100.0%**

Source: US Census 2000

TRANSPORTATION

Princeton has a strategic location in the Mid-Atlantic region. It is only 50 miles from New York City and 44 miles from Philadelphia. Commuters in Princeton benefit from the Amtrak and New Jersey Transit lines connecting New York City with Philadelphia. Princeton connects to these rail routes via the Princeton Junction Station. The Amtrak train line is part of the Northeast Corridor route that connects Washington D.C. to Boston, while the New Jersey Transit line serves local stations from Trenton to New York City with connections to other major transit networks, including SEPTA and the MTA.

Princeton is relatively accessible by vehicle, as it is bisected by several significant road corridors. The modern roadway transportation corridors that serve Princeton have contributed to much of its past and current growth. The township is accessible by three major roads: US Route 206, State Highway 27, and Princeton Pike (CR 583). Just outside of the township boundary, drivers can connect with US Route 1 and Interstate 95 outside of the Greater Trenton region.

County roads within Princeton include Washington Road (CR 571), Great Road (CR 601), Rosedale Road (CR 604), River Road (CR 605), and Harrison Street (CR 629). These routes provide access and connections within Princeton and Mercer County and reflect the region's land use and distribution of historic centers of activity. Smaller roads in the township and borough are a mixture of old rural lanes, residential streets, and newer subdivision thoroughfares.

Princeton, along with much of Mercer County, experiences heavy congestion during rush hours. East-west traffic is the most affected in the county, causing bottlenecks on many major roads leading to and from the US Route 1 corridor. Recent collaboration with Montgomery Township in neighboring Somerset County has brought the first phase of proposed congestion easement measures along CR 206 by creating a separate turn lane and connector road at the intersection with Cherry Valley Road, which borders both townships. Future collaborative efforts are needed to fully integrate such regional roads into an effective system that minimizes driver delay and improves quality of life in the township.

New Jersey Transit is also working to alleviate traffic congestion on US Route 1 by preparing an alternatives analysis to study the feasibility of providing a Bus-Rapid Transit (BRT) system along the US Route 1 corridor. A BRT system is a public transportation system that uses infrastructure and scheduling improvements to provide a higher quality of bus service. The New Jersey Transit report will examine various methods of traffic reduction, as well as highway improvements, ridership, cost effectiveness, and locations for routes and stations. Princeton Township's master plan states a goal of increased pedestrian and bicycle transportation options, which would work to alleviate some of this congestion, although through-traffic would likely remain unaffected. Measures such as the BRT system along US Route 1 would likely improve connectivity in the region.

HISTORIC RESOURCES

The Princeton area is rich with historic structures, sites, and buildings. Many homes in the area date from the prerevolutionary era and belonged to some of the nation's early heroes. Other homes have been occupied by individuals of great renown, including Woodrow Wilson and Albert Einstein. According to the New Jersey Historic Preservation Office, the township and borough contain 24 places that are listed on the national and state registers of historic places. Nine of these places, including the Albert Einstein House, the Joseph Henry House, Morven, Nassau Hall, the President's House, Princeton Battlefield, Maybury Hill, Prospect (one of Woodrow Wilson's houses), and the Grover Cleveland House, are listed as National Historic Landmarks and are deemed to have nationwide significance.

Photo by DVRPC

Intersection of Witherspoon and Stockton streets in the Princeton Historic District

In addition to the national and state registers, the Princeton Township Historic Preservation Commission and the Princeton Borough Historic Preservation Review Committee administer historic districts that have been designated by either the Princeton Township Committee or the Princeton Borough Council. Within Princeton Township, there are 15 designated historic districts. Princeton Borough contains four locally designated districts: Jugtown, Bank Street,

Mercer Hill, and the Princeton Central District. Locally designated districts may partially overlap with national and state register districts, but often have different boundaries. Historic districts contain numerous structures that represent important periods in Princeton's past. Sites on the national and New Jersey state registers of historic places and locally designated historic districts are depicted on **Map 17a: Historic Resources (Princeton Borough) and Map 17b: Historic Resources (Princeton Township).**

There are various mechanisms to enhance historic preservation at the federal, state, and local levels. At the federal level, placing sites and districts on the National Register of Historic Places affords them added protection in the planning of federally assisted projects, and it makes properties eligible for certain tax benefits and grant programs. It does not, however, prevent properties from being altered or demolished. Local historic districts, on the other hand, can be created by municipalities to preserve significant historic sites by regulating the erection, alteration, restoration, and demolition of buildings and other historic attributes within the historic district. Properties within the township's and borough's historic districts are subject to review by the Princeton Township Historic Preservation Commission and the Princeton Borough Historic Preservation Review Committee, respectively. These two groups also aid homeowners in preserving the historical value of their properties. They are government bodies that oversee historic preservation planning and decision making in their communities. The establishment of these bodies by local government officials is typically the first step in implementing local preservation efforts.

The Historical Society of Princeton is a private, nonprofit organization that maintains information about significant historic properties and sites within the township and borough. The stated mission of the society is "to collect and preserve materials pertaining to the town and its environs, and to interpret the history of the area through exhibitions, educational programs, and publications," as well as to preserve historic resources. The society maintains two historic sites, the Bainbridge House and the Updike Farm, and gives annual preservation awards to owners who have made unusual efforts to restore or maintain their properties. The society also holds recorded preservation covenants for three Princeton buildings. See www.princetonhistory.org.

Table 22: Sites Listed on the National & State Registers of Historic Places and Locally Designated Historic Districts lists sites on the national and state registers of historic places, as well as historic districts designated by the township and borough.

Historic location listings in Princeton Township and Princeton Borough were compiled from multiple sources, including the booklet *Historic Preservation in Princeton Township* published by the Princeton Township Historic Preservation Commission, the Princeton Borough Historic Preservation Review Committee, and from interviews with representatives of those organizations.

Table 22: Sites Listed on the National & State Registers of Historic Places and Locally Designated Historic Districts

ID #	Name	Address/Location	Location	Type	Historic Listing
1734	Albert Einstein House	112 Mercer Street	Borough	Building	NHL, NR, SR
1600	Delaware and Raritan Canal Historic District	Canal bed and 100 yds to either side	Township	District	NR, SR, PTC
1745	Donald Grant Herring Estate – Old Arreton Road Historic Distict	52, 72 and 75 Arreton Road (NR, SR) (11, 22, 45, and 115 Arreton Road are in the local historic district)	Township	District	NR, SR, PTC
1744	Drumthwacket	344 Stockton Road	Township	District	NR, SR, PTC
1731	Grover Cleveland House	15 Hodge Road	Borough	Building	NHL, NR, SR
1735	Joseph Henry House	Princeton University Campus	Borough	Building	NHL, NR, SR
1737	Jugtown Historic District	Nassau and Harrison Streets	Borough	District	NR, SR PBC
353	Kings Highway Historic District	US Route 206 and NJ Route 27	Borough/ Township	District	NR, SR
1746	Kingston Mill Historic District	Portions of River, Herrontown and Princeton-Kingston roads	Township	District	NR, SR, PTC
1747	Lake Carnegie Historic District	Lake Carnegie	Township	District	NR, SR
1748	Maybury Hill	346 Snowden Lane	Township	District	NHL, NR, SR, PTC
1750	Mountain Avenue Historic District	73-143 Mountain Ave	Township	District	NR, SR
1738	Morven	55 Stockton Street	Borough	Building	NHL, NR, SR
1739	Nassau Hall	Nassau Street	Borough	Building	NHL, NR, SR
1740	President's House (Maclean House)	Nassau Street	Borough	Building	NHL, NR, SR
1751	Princeton Battlefield/Stony Brook Village Historic District	Portions of: Mercer, Lawrenceville, Quaker and Stockton roads	Township	District	NR, SR, PTC
1752	Princeton Battlefield	Princeton Battlefield State Park	Township	Battlefield	NHL, NR, SR
1741	Princeton Historic District	Parts of Mercer, Nassau, Prospect, Williams, Stockton, Wiggins, and Olden Streets; Alexander, Springdale, and College Roads; Lovers Lane and Library Place	Borough/ Township	District	NR, SR
1749	Princeton Ice Company	North of Princeton Borough, West of Route 206	Township	Building	NR, SR
1742	Princeton Railroad Station	University Place	Borough	Building	NR, SR
1743	Prospect (Woodrow Wilson House)	Princeton University Campus	Borough	Building	NHL, NR, SR
1755	Tusculum	Cherry Hill Road	Township	District	NR, SR, PTC
175	University Cottage Club	51 Prospect Ave	Borough	Building	NR, SR
4390	Witherspoon Street School for Colored Children	35 Quarry Street	Borough	Building	NR, SR
	Bank Street Historic District	Bank Street North of Nassau	Borough	District	PBC
	Castle Howard	10 Castle Howard Court	Township	District	PTC

ID #	Name	Address/Location	Location	Type	Historic Listing
	Constitution Hill	1 Constitution Hill Road	Township	District	PTC
	Drumthwacket Outbuildings	Near Route 206	Township	District	PTC
	Edgerstoune	176 Edgerstoune Road	Township	District	PTC
	Joline-Gulick House	700 Princeton Kingston Road	Township	District	PTC
	Mansgrove	75 Terhune Road	Township	District	PTC
	Mercer Hill Historic District	Western Princeton Borough North and South of US Route 206 and CR 583; extending from University Place in the East to Springdale Road in the West	Borough	District	PBC
	Olden Manor	1 Einstein Drive	Township	District	PTC
	Princeton Basin Historic District	Basin Street	Township	District	PTC
	Princeton Central Historic District	Central Princeton between Moore and Bank Streets	Borough	District	PBC

Listing of Historic Designation Types

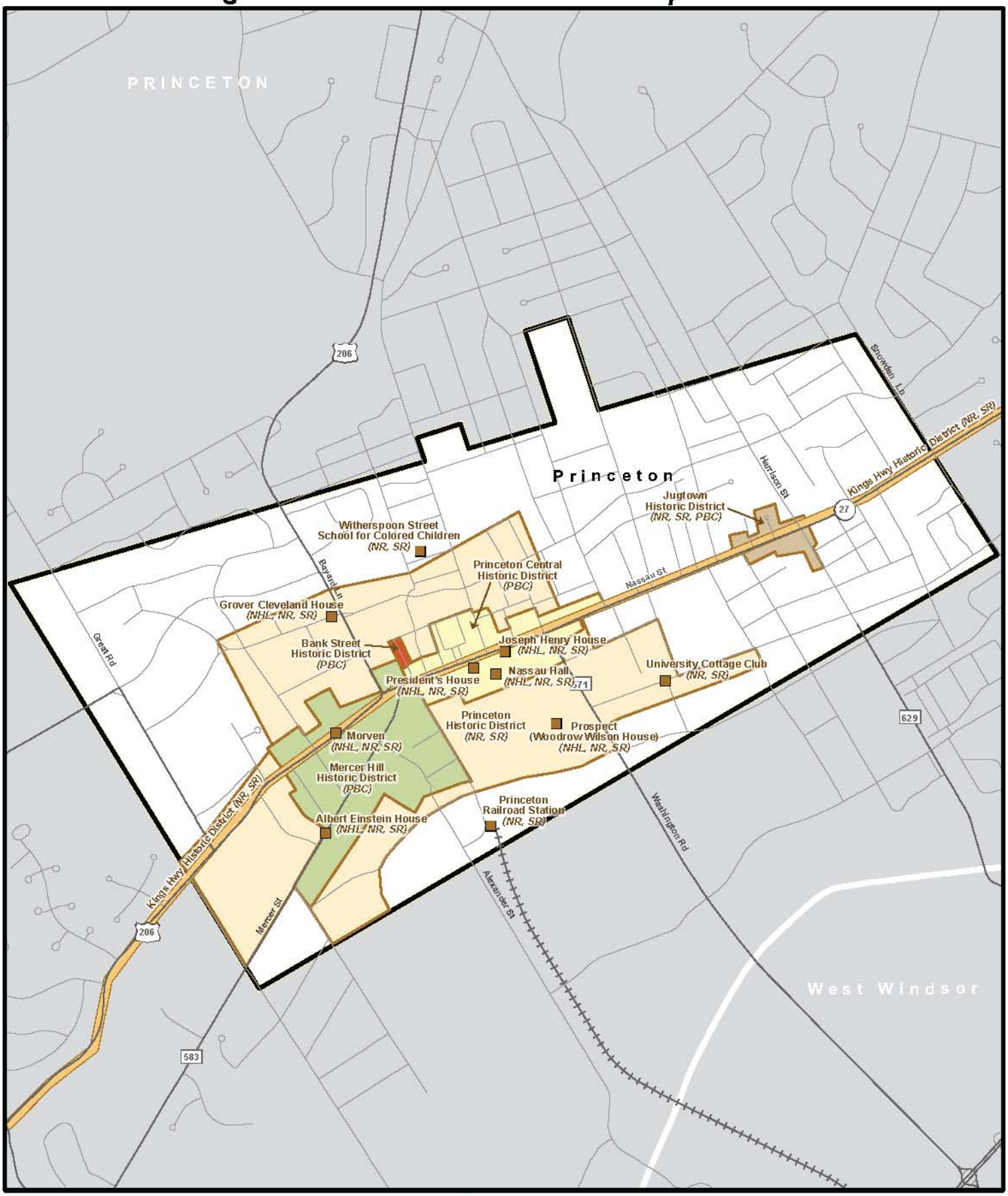
NHL	National Historic Landmark refers to a designation by the National Park Service that a property has national significance. Properties designated NHLs are automatically listed in the National Register.
NR	This abbreviation indicates that a property is listed on the National Register of Historic Places.
SR	This abbreviation indicates that a property is listed on the New Jersey Register of Historic Places (State Register).
PTC	Historic Districts designated by the Princeton Township Committee
PBC	Historic Districts designated by the Princeton Borough Council

Photo by DVRPC

A residence in the Princeton Historic District

Princeton Borough

Map 17a: Historic Resources



Sources: NJDEP,NJDOT,DVRPC, NJHPO, Princeton Borough
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.

Historic Site

Historic Districts

Princeton | Bank Street | Jugtown | Mercer Hill | Princeton Central | Kings Highway

NHL - National Historic Landmark *NR* - National Register
SR - State Register *PBC* - Princeton Borough Council

N

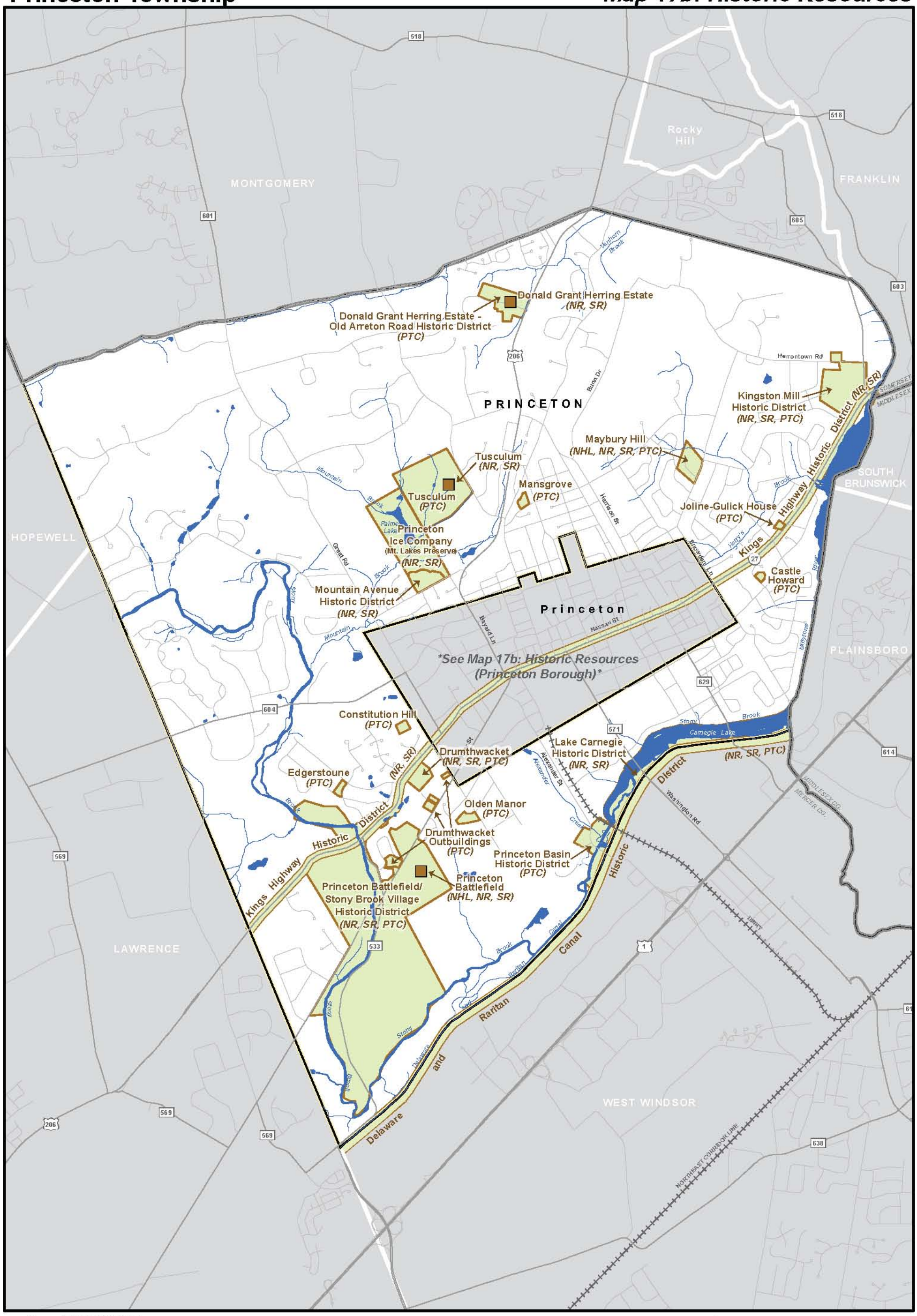
0 500 1,000 2,000

Feet

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

Princeton Township

Map 17b: Historic Resources



Sources : NJDEP,NJDOT,DVRPC, NJHPO, Princeton Township Committee
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.

Historic Site Historic District

NHL - National Historic Landmark *NR* - National Register *SR* - State Register *PTC* - Princeton Township Committee

0 0.25 0.5 1
Miles

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

PRINCETON AREA FACILITIES, UTILITIES, AND SERVICES

Drinking Water

Public drinking water in Princeton Township and Borough is supplied by the New Jersey American Water (NJAW) Corporation, formerly known as Elizabethtown Water. NJAW serves all of Princeton Borough and the majority of Princeton Township. Approximately 95 percent of the public drinking water supplied to Princeton residents comes from surface water. According to NJAW, 99 percent of this surface water is drawn from the Raritan River. The rest of Princeton's public water supply is drawn from groundwater wells near Rogers Refuge. Like the township and borough, Princeton University also purchases its drinking water from NJAW. For a more detailed discussion of surface waters, see *Surface Water Resources* and *Surface Water Quality*, beginning on *page 45*.

Private wells also provide drinking water to a small but unknown number of township residents. Many private wells predate modern testing and documentation requirements and, therefore, records on them are largely incomplete.

The public drinking water wells that serve Princeton Township and Borough are listed in **Table 16** on *page 83* and depicted on **Map 13: Public Water Supply Wells. Map 13** also shows wellhead protection areas surrounding public wells. Wellhead protection areas are those areas that are critical for the maintenance of groundwater quality. Groundwater can be contaminated by a number of chemical sources, including fuel storage tanks, salt from roads, overuse of fertilizers, or pesticides. Wellhead protection areas are established by NJDEP and represent the horizontal extent of groundwater captured at two-, five-, and 12-year periods of time for confined wells. These areas are subject to additional water quality assessment and protection by the local water purveyors and NJDEP. It is within Princeton's authority to create additional wellhead protection through the adoption of appropriate ordinances.

Water testing information is available from New Jersey American Water Corporation from its website at: *www.amwater.com/awpr1/njaw/pdf/NJ-Elizabethtown-web.pdf*

Sewer

Sewer service for Princeton residents is provided through the Stony Brook Regional Sewerage Authority (SBRSA). The SBRSA provides service to Princeton Township and Borough through its River Road facility, located at 209 River Road in Princeton Township. The River Road facility is rated for 13.06 million gallons per day. Peak flows of up to 18 million gallons per day can occur during periods of saturated soil and heavy rains due to infiltration of runoff into local sewer lines. Average daily flow is currently 10 million gallons per day, which represents a steady increase over past decades. Anecdotal evidence suggests that this increase in flow is a result of increased population in Princeton, along with changing water consumption habits in the township and borough.

Sewage from the township and borough is treated using a modified two-stage system. In the first combined phase (primary treatment), raw sewage is first subjected to rough separation to remove materials that could damage equipment, then it is sent to aeration tanks, where microbes are used to break down organic matter in the sewage. The second phase (secondary treatment) involves fine filtration to remove the precipitated sludge from the treated wastewater. At this point, wastewater is sent to nitrification chambers, where a second set of microbes and chemicals are used to convert toxic ammonia to nitrates and phosphorus. According to SBRSA, the resulting concentrations of nitrogen and phosphorus are so low that they do not warrant removal through further treatment, and the treated water can be discharged directly to surface water without creating unhealthful conditions or harmful algal blooms. A final "polishing" or chlorine sterilization phase (tertiary treatment) occurs before the treated water is released into the Millstone River at a point just downstream of Carnegie Lake.

SBRSA also dewaters and incinerates sewage both for Princeton municipal sewage and for other entities on a contract basis. Sludge dewatering and incineration reduces the final volume of waste by approximately 90 percent. Ash produced by the incineration process is then used as a covering layer by regional landfills. Extensions of the sewer service area within the township must be approved by the township council and be consistent with the utility element of the master plan, as well as the Mercer County Water Quality Management Plan and 201 Sewer Service Plan. Updated Wastewater Management Plans are required by NJDEP to be filed in 2009. Mercer County is the lead agency for filing this plan.

Trash/Recycling

Princeton Township residents contract individually with private haulers for their garbage collection. The township does not provide trash collection services. In Princeton Borough, the borough contracts with a private hauler on behalf of its residents, and trash collection has just been reduced from twice a week to once a week. In both the borough and township, recyclables are picked up curbside every other Monday. Recycling service is provided by the county through the Mercer County Improvement Authority. Both the borough and the township receive annual Clean Community grants from the NJDEP to fund recycling coordinator positions and initiatives to maintain and improve recycling. Materials recycled include glass, plastics, aluminum, tin, newspapers, cardboard, and mixed paper. The township also collects leaf, brush, and log waste. The borough performs mechanical leaf collection in the fall and picks up yard waste during other seasons as well. This yard waste is hauled out of town to composting facilities, primarily the Lawrenceville Ecological Center. NJDEP has set strict limitations on the placement of leaves on streets through its stormwater rules.

Education

Princeton has a longstanding reputation for higher learning. The community boasts a full complement of educational opportunities, including three universities, and a number of elementary, middle, and high schools. Princeton has long been a center of higher learning in the United States.

Public Schools

The Princeton Regional School District serves both Princeton Township and Princeton Borough. The Princeton public school system includes four elementary schools, John Witherspoon Middle School, and Princeton High School. The Princeton Charter School provides Princeton students in kindergarten through eighth grade with an additional option. The Princeton Regional School District serves over 3,000 children in Princeton Township and Borough and is well regarded among New Jersey school districts.

Private Schools

In addition to the public school offerings in Princeton, there are 13 private schools serving residents of Princeton and the surrounding communities. While many of the private school programs focus on the younger kindergarten through fifth grade ages, several schools offer full kindergarten to 12th grade levels, while others focus on middle and high school grades. Notable schools in this category include the Princeton Day School, the Hun School, Stuart Country Day School, Princeton Academy, and the Princeton Friends School.

Colleges and Universities

Princeton University is currently regarded as one of the top private universities in the United States and has consistently produced world-class scholars and academic work. Notable graduates of the university have included six heads of state, including James Madison and Woodrow Wilson, along with over 30 senators, congressmen, and holders of power in the past 250 years. Currently, the university hosts about 7,000 students and over 1,000 full- and part-time faculty, as well as 4,400 staff and support personnel.

Princeton Theological Seminary was founded in 1812 by the General Assembly of the Presbyterian Church. An elected board of directors chose Archibald Alexander as the institution's first professor. The seminary began with 12 students under the sole instruction of Professor Alexander and has grown to a community of nearly 700 students today. The Princeton Theological Seminary is a separate institution from Princeton University, but the two schools share some resources, including library materials, and some courses are cross-listed between the two institutions. The Princeton Theological Seminary is renowned for its theological library, which is the largest of its kind in the United States.

Westminster Choir College is a residential college associated with nearby Rider University in Lawrenceville. Westminster Choir College is dedicated to providing a unique musical field of study for choral and voice performers, as well as those interested in teaching in these areas. There are currently 330 undergraduate and 110 graduate students, along with over 100 full- and part-time instructors.

PARKS, OPEN SPACE, AND GREENWAYS

Borough and Township Parks

Princeton Borough and Township have a large number of parks available for various types of recreation throughout the area. The parks can roughly be divided between *active* and *passive* recreation types. Active recreation includes activities such as soccer, baseball, volleyball, and Frisbee. Facilities such as jungle gyms, swing sets, tennis courts, and sports fields are typically required for active recreation pursuits. Passive recreation encompasses most other park activities, including walking, fishing, bird watching, bike riding, and picnicking. Typically, these activities can take place in natural settings. In total, Princeton Township and Borough contain over 1,100 acres of park space for active and passive uses.

Princeton is fortunate in having a large amount of passive recreation available year-round for its citizens. Walking and hiking trails in the township's and borough's many parks are popular, well-used resources that provide an outlet for exercise, as well as interaction with the natural world and an escape from the hectic pace of life. Popular parks in Princeton include: Herrontown Woods, the Woodfield Reservation, Mountain Lakes Preserve, and Community Park North and South, as well as the Delaware and Raritan Canal and the Princeton Battlefield parks.

Three notable parks in Princeton include Community Park North and South and the abutting Mountain Lakes Preserve Park. Mountain Lakes Park, Community Park North, and Community Park South provide both active and passive recreation opportunities for residents. Due to their convenient, central location, these three parks are among the most heavily used in Princeton.

- Community Park South covers 26 acres and has facilities for various activities, including swimming, tennis, basketball, soccer, football, and baseball, as well as a paved walking path and large pavilion.
- Community Park North covers 71 acres and lies between Elm Road and Route 206, and it can be reached via a parking lot off of Mountain Avenue or from the footpath that connects the tract to Route 206 and Valley Road. The park features Pettoranello Pond, a small amphitheatre for outdoor performances, and several trails suitable for wheelchair use. The park's vegetation includes an indigenous second-growth forest, as well as a section of evergreen trees planted in the 1960s.
- Mountain Lakes Nature Preserve covers almost 77 acres. Combined with neighboring township-owned properties (Mountain Lakes North, Witherspoon Woods, Tusculum, and Community Park North, as well as the preserved, privately owned Coventry Farm), the park is part of a large contiguous block of nearly 400 acres of preserved land. This park, once a working farmstead, has now largely reverted to forest. The park features two popular fishing lakes, nature paths that include a long boardwalk, and a township-owned house that provides space for community meetings and environmental group offices. The house, called Mountain Lakes House, is also rented out for weddings, parties, and other events.

The Princeton community benefits greatly from its extensive park network, though active recreation facilities are often in high demand. Playing fields are often booked weeks and months ahead of time to account for the needs and schedules of various clubs and activities. Although competitive sports leagues begin in March, park fields are often not available until April due to field conditions. The Princeton Recreation Department has begun working to address these issues and is looking for opportunities to expand the number of playing fields available. The Recreation Department is also exploring different options for field surfaces, such as installing field turf in the most heavily used facilities. These projects are scheduled to begin in the 2008 and 2009 fiscal years, with potential funding coming from a number of sources, including state grants or municipal funds. A Princeton Parks and Recreation Master Plan was recently completed, which provides some of the results of a community-wide survey, along with proposals for addressing community parks and recreation needs. The survey results showed particularly strong public demand for passive recreation opportunities.

Open Space and Greenways

In addition to its parks, other open spaces and greenways are important to township and borough residents. Princeton's landscape is heavily developed, and the preservation of existing open space is a concern shared by many in the community. With the adoption of the 1996 Township and Borough Master Plan, Princeton set for itself the goal of preserving natural and visual amenities, including: "critical environmental features such as steep slopes, waterway corridors, floodplains, and wetlands; resources with exceptional community value, including both man-made and natural visual resources and scenic corridors; and special environmental areas, such as the Princeton Ridge, the Delaware and Raritan Canal, and Lake Carnegie."[14] For a depiction of protected open space, see **Map 18a** and **Map 18b**.

Visual amenities, such as unbroken vistas, scenic woods, and key open spaces providing context for historic landscapes are also part of Princeton's open space plan for the future. The citizens of both Princeton Borough and Princeton Township have backed up this commitment by voting for dedicated property tax increases to provide money for open space preservation, park facilities, and maintenance. As of 2007, Princeton Borough has a tax of one cent on every 100 dollars of assessed property value, while Princeton Township just raised its open space tax from one to two cents per 100 dollars of assessed value. These taxes are estimated to raise $100,000 and $500,000 per year, respectively. In addition, Mercer County has a three-cent tax, which raises about $9.3 million per year for countywide projects. Mercer County has contributed to several open space acquisition projects in Princeton. Despite the success of past preservation efforts, the Princeton community may need to leverage public-private partnerships (in addition to government funding) to maintain or increase the pace of preservation in the present economic climate.

Several local organizations have made significant contributions to open space preservation in Princeton. The Princeton Environmental Commission is charged with the protection and stewardship of Princeton's natural areas. The Environmental Commission meets monthly and

[14] *1996 Princeton Community Master Plan*, "Master Plan Overview." December 1996.

has been instrumental in forming environmental policy at the township and borough level for the past 30 years.

Friends of Princeton Open Space (FOPOS) is a nonprofit organization dedicated to preserving and protecting the community's natural areas and resources (www.fopos.org). FOPOS was incorporated in 1969 and has negotiated, raised funds for, and obtained grants to preserve open space in Princeton. FOPOS took the lead in acquiring/preserving Turning Basin Park and Woodfield Reservation and Mountain Lakes Preserve (its headquarters), and it played a role in preserving the Institute Lands, Greenway Meadows Park, Tusculum, Coventry Farm, and other parcels. FOPOS, with the township, went to court and succeeded in preventing high-density development on the Western Princeton Ridge. The township and FOPOS collaborated on construction of the J. Seward Johnson, Sr., boardwalk across the southern end of Coventry Farm. FOPOS also promotes open space trails, trail maintenance, habitat restoration, and outreach programs.

The D&R Greenway Land Trust (www.greenway.org) has been an active partner since 1989 in preserving open space lands in Princeton, which is just one part of its total operating region of over 1,500 square miles. It maintains its headquarters and educational center at Greenway Meadows Park, in Princeton Township, where it conducts educational and artistic programs and forums related to the environment. D&R Greenway is also increasingly involved in habitat restoration in the vicinity of its headquarters. Notable preservation projects in Princeton in which the D&R Greenway Land Trust has played a role include the Institute Woods, Greenway Meadows, Tusculum, and the Coventry Farm.

An important state program that has played a significant role in providing funding to acquire open space is the New Jersey Green Acres Program. The program, created in 1961, aims to partner with townships and counties to acquire and preserve open space in New Jersey. The program's goal is to create a system of interconnected open spaces to protect and enhance the natural environment of New Jersey for historic, scenic, and recreational purposes, and for public enjoyment. Since 1961, over $1.5 billion has been used to acquire land and develop parks. In 1998, the Garden State Preservation Trust Act was signed into law, with the intention of providing a stable source of funding for open space, farmland, and historic preservation, and recreation development efforts. As of March 2007, the funds allocated through the 1998 Act were exhausted. In November 2007, New Jersey's residents voted to approve a one-year extension of the fund. In fall 2008, voters approved a new $400 million bond reauthorization, which will maintain the program until these funds are exhausted . While the Garden State Preservation Trust Fund has remained a popular and important program in New Jersey, a dedicated revenue source that could provide long-term stability has yet to be created.

As of 2007, Princeton Township and Borough had preserved 2,990 acres of land, which accounts for approximately 25 percent of Princeton. See **Map 18a: Princeton Borough Protected Open Space** and **Map 18b: Princeton Township Protected Open Space**. Approximately 75 percent of this preserved land is open to Princeton residents, with the remainder preserved privately and not publicly accessible. For more information on preserved land and parks within the township, refer to the recently completed Princeton Parks and Recreation Master Plan.

Photo by Stephen Hiltner

The Delaware and Raritan Canal: A Key Open Space, Greenway, and Trail Corridor in Princeton

One of the most important greenways in Princeton is the Delaware and Raritan Canal, which makes up the southern border of the township. This canal was built between 1830 and 1834 and created the final link in the intercoastal waterway that extended from Massachusetts to Georgia. In 1871, the Pennsylvania Railroad leased the canal to use it for water supply. After the canal's closure in the 1930s, some portions were filled in to accommodate the state's expanding highway system. By the 1970's, the canal was being heavily used for recreation, and citizen activists rallied to save the canal from destruction. In 1973, the canal and its remaining structures were listed on the National Register of Historic Places, and by 1974, the state established the Delaware and Raritan Canal State Park. In 1992, the park's trail system was designated a National Recreation Trail.

Today, the Delaware and Raritan Canal State Park is 70 miles long, including the feeder canal portion, which parallels the Delaware River from above Frenchtown south to Bordentown, and the main canal portion, which runs from Trenton to New Brunswick. The canal and adjacent

towpath provides canoeing, jogging, hiking, biking, fishing, horseback riding, picnicking, and camping opportunities. A 2008 survey conducted by the Princeton Recreation Department listed the Delaware and Raritan Canal as the most popular park in the township. The path along the main canal portion is part of the East Coast Greenway—an urban equivalent to the Appalachian Trail—which is planned to extend from Maine to Florida. Bass, sunfish, catfish, pickerel, and perch occupy the canal's water year-round, and in the spring, the canal is stocked with trout. Fishing is allowed along the entire length of the canal. There are two canoe rental sites, one in Griggstown and one in Princeton, and numerous launch sites along the canal. The canal park is also an important wildlife corridor. Recent bird surveys revealed 160 species, with 90 thought to nest in the park. Furthermore, the Delaware and Raritan Canal is a source of public water for agriculture, industry, and homes, pumping out about 75 million gallons per day. Through a collaborative effort by staff of Delaware and Raritan Canal State Park, Friends of Princeton Open Space and New Jersey Water Watch, sections of the Delaware and Raritan Canal State Park in Princeton are now being managed for native wildflower species through annual mowing and invasive species control.

Trails

Princeton's trail system is strongest within the borders of its many regional parks. Walking and multiuse trails abound in these parks, providing exercise and accessibility through many areas of the township and borough. Parks with walking and multiuse trails include:

- Autumn Hill Reservation
- Community Park North
- Community Park South
- Herrontown Woods
- Institute Woods
- Mountain Lakes Preserve
- Van Dyke Wight Woods
- Woodfield Reservation

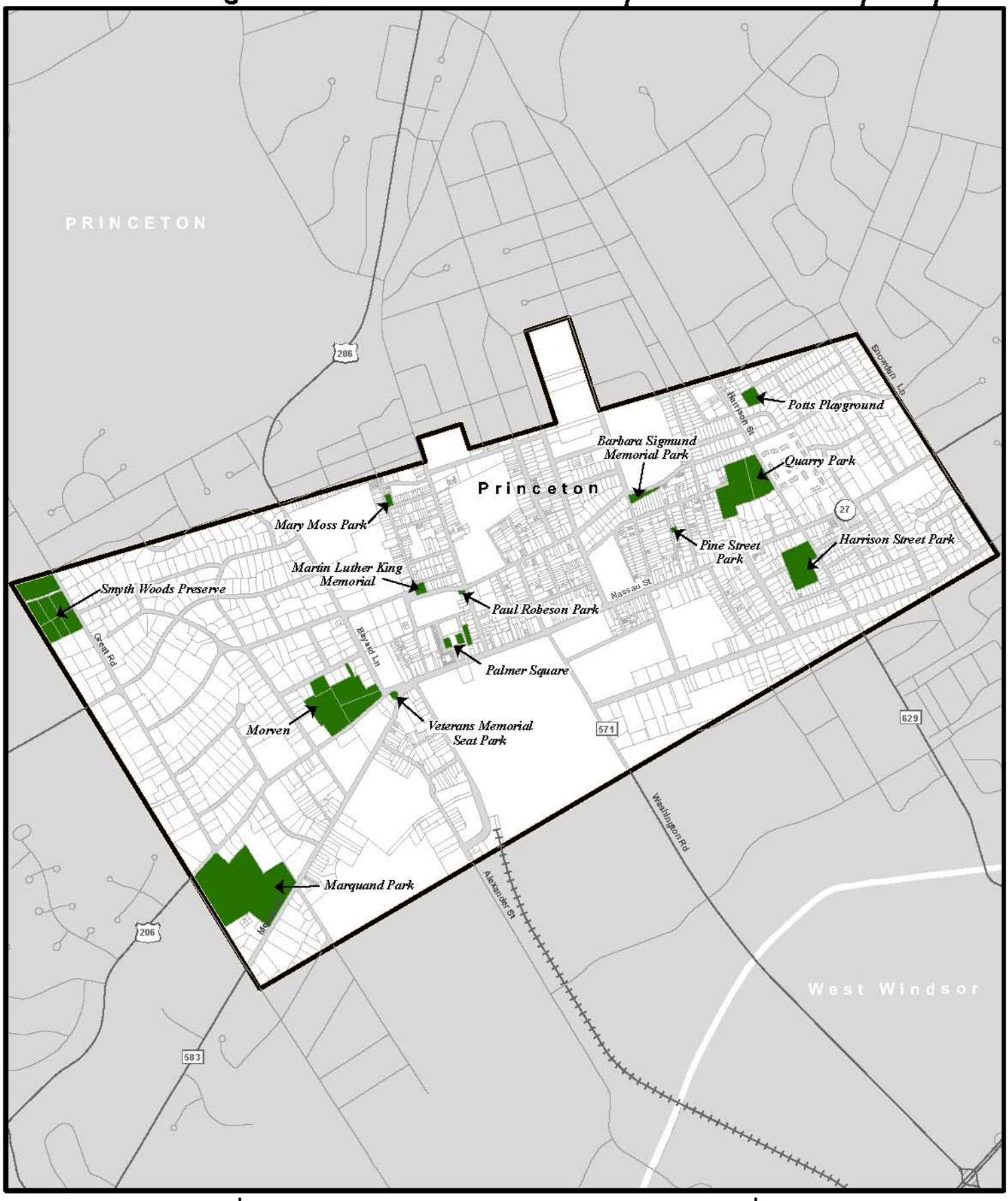
Princeton also benefits greatly from the Delaware and Raritan Canal Towpath, which follows the course of the canal through the township. This trail, maintained by the Delaware and Raritan State Park Commission, extends from Trenton to New Brunswick and provides over 70 miles of multiuse path for joggers, cyclists, and, in the winter, cross country skiers. For more information and detailed maps of Princeton's trails, see www.njtrails.org or www.fopos.org.

Photo by Stephen Hiltner

The Boardwalk: A Trail Connecting Great Road to Mountain Lakes Preserve

Princeton Borough

Map 18a: Protected Open Space



Sources : NJDEP,NJDOT,DVRPC, Mercer County Planning Division. 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.

Type of Protected Open Space

Public

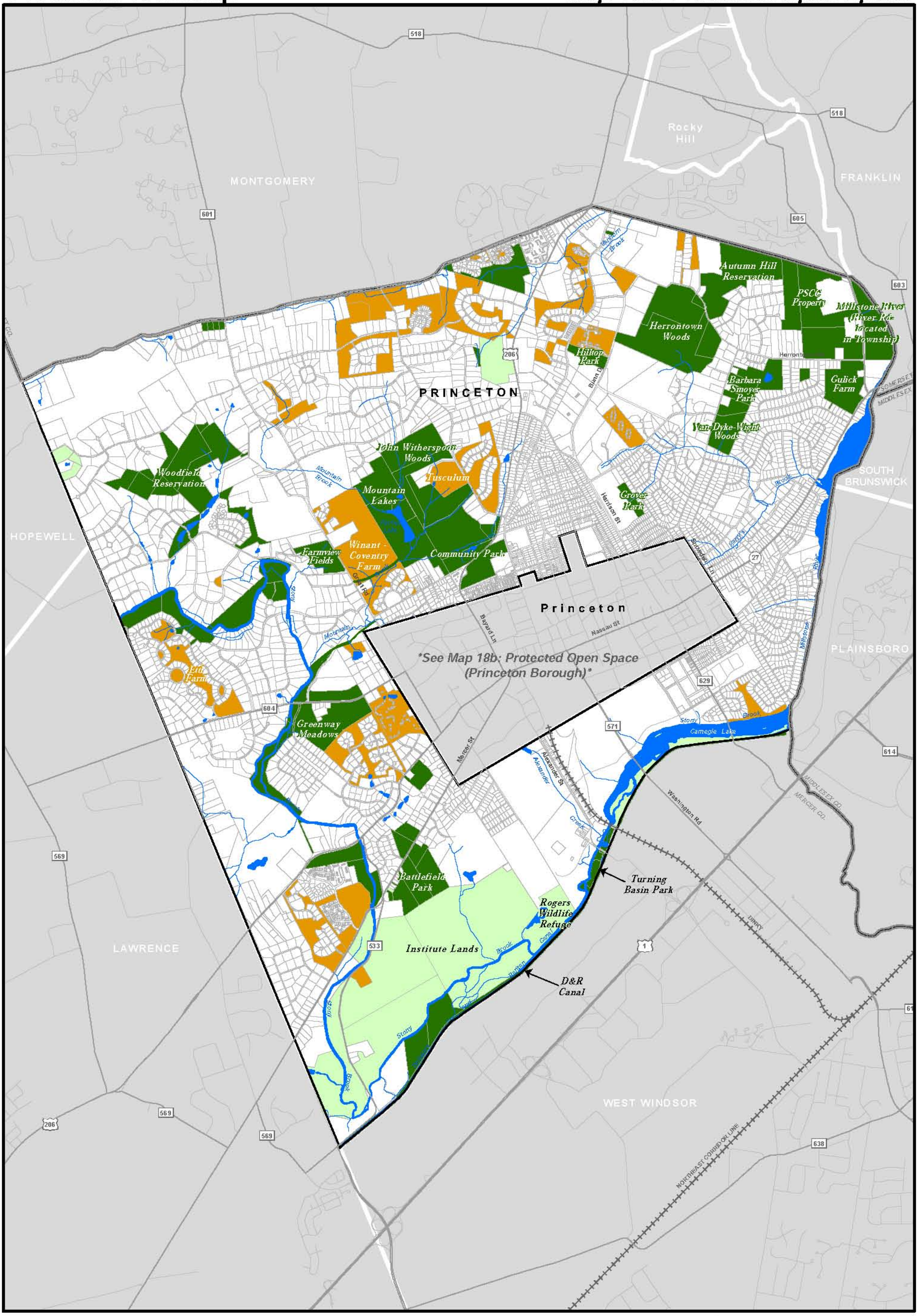
0 500 1,000 2,000

Feet

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

Princeton Township

Map 18b: Protected Open Space



Sources : NJDEP,NJDOT,DVRPC, Mercer County Planning Division. 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.

Type of Protected Open Space

- Public
- Private (Open to Public)
- Private (Not Open to Public)

0 0.25 0.5 1
Miles

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

Ongoing Threats to Open Space and Natural Areas

Useful Definitions

A **Native (indigenous)** species occurs in a particular region, ecosystem, and habitat without direct or indirect human actions (Kartesz and Morse, 1997). Species native to North America are generally recognized as those occurring on the continent prior to European settlement (www.dcnr.state.pa.us).

Nonnative (alien, exotic, foreign, introduced, and nonindigenous) organisms are those that occur artificially in locations beyond their known historical natural ranges. Non-native can refer to species brought in from other continents, regions, ecosystems, and even other habitats (www.dcnr.state.pa.us). Not all nonnative plant species become invasive.

An **Invasive plant** displays rapid growth and spread, allowing it to establish itself over large areas. Free from the vast and complex array of natural controls present in their native lands, including herbivores, parasites, and diseases, invasive plants may experience rapid and unrestricted growth in new environments. Their phenomenal growth allows them to overwhelm and displace existing vegetation and form dense one-species stands (PCA - APWG, Weeds Gone Wild). Not all nonnative plant species prove to be invasive. In addition, a small number of native species, such as cattails, can behave aggressively enough to be considered invasive in some circumstances.

The Ecological Role of Disturbance

In addition to development pressures, Princeton's natural areas face ongoing and emerging threats to their natural ecological balance. Although a substantial portion of Princeton's open space is now legally protected, most of these preserved lands still suffer from negative historic interventions.

Farming: Much of Princeton's preserved land was at one time farmed. Plowing and intense grazing eliminated native flora from large areas.

Nonnative Invasive Plants: Though most farmed land was later recolonized by native trees, the understory has in many areas become dominated by nonnative invasive plants, whose abundant seed production and lack of natural predators have given them a competitive advantage.

Deer's dietary preference for native species has given invasive nonnative plants an additional competitive advantage. In particular, many native spring ephemeral wildflower species have been browsed into rarity or oblivion, as have some native shrubs species and tree seedlings. Efforts by Princeton Township to reduce deer numbers have markedly reduced these negative impacts.

Hydrologic disruption: Water drives much of what we see in the landscape. Historically, water tables were closer to the surface and therefore more accessible to the flora. Topsoil erosion,

incised stream channels, and the dumping of fill have all altered hydrology in ways favoring nonnative invasive plants.

Lack of natural disturbance: Not all forms of disturbance are ecologically destructive. For instance, fire once played a role in the eastern forest, whether caused by lightning or by Indians, who used fire as a management tool. Many native species, such as oaks and warm-season grasses, are adapted to periodic fire and are diminished by its complete absence. The fires would not have been destructive wildfires, but instead low-level fires, burning through oak leaves and dried herbaceous vegetation, creating a more open canopy, and promoting seed germination by exposing mineral soil. The result would have been a rich herbaceous layer growing beneath a more open forest canopy. The important, beneficial role of fire in ecosystems has prompted some land managers to reintroduce periodic fire in highly controlled "prescribed burns." Annual mowing can also mimic natural fire, and it is used in Princeton to maintain meadows, for instance, along the canal and at Tusculum. In addition, America's megafauna—large mammalian species that went extinct 13,000 years ago—would also have played a role in creating disturbance and opening up the forest.

The Impact of Nonnative Species

In particular, nonnative invasive species pose a significant threat to Princeton's natural resources. Invasive species not only crowd out native species, they also tend to diminish biodiversity, thereby creating ripple effects throughout an ecosystem.

Nonnative species tend to be inedible for wildlife, or provide food that is lower in nutritional value than the native plant species that they have displaced. Domination of large expanses by nonnatives, therefore, represents a considerable shrinkage in quality habitat for wildlife, even though the land they occupy may be preserved in a legal sense.

Some nonnative invasives, such as Japanese stiltgrass and garlic mustard, may be altering the chemistry and porosity of the soil, with long-term consequences for forest health and water quality.

Photo by Stephen Hiltner

Honeysuckle Berry–an exotic, invasive species found in Princeton

The nonnative species, most of which grow very quickly, also increase the cost and effort involved in maintaining nature trails. Their dense growth reduces sightlines along trails, and in many areas has made the forest essentially impenetrable.

Preventing the establishment and spread of invasives and restoring native diversity to affected natural areas is an important part of natural resource protection. Education of residents about the

damage that nonnative species can cause and the methods that can be taken to reduce their spread plays a role in this effort.

Invasive Shrubs

Multiflora rose (*Rosa multiflora*) is the most prevalent nonnative invasive shrub, growing densely in floodplains and uplands. Other common invasives are privet, honeysuckle, barberry, and winged euonymus. A relatively new invasive shrub that has become established in Princeton but has yet to spread across New Jersey is Asian Photinia (*Photinia villosa*). It grows particularly densely in parts of Mountain Lakes Preserve. Both the Friends of Princeton Open Space and D&R Greenway have launched efforts to combat its spread and reduce its numbers.

Invasive Grasses

Japanese stiltgrass is by far the most prevalent invasive exotic species in Princeton. An annual grass, it dominates the forest floor and even displaces perennial lawn grasses in low-lying backyards. Phragmites and reed canary grass frequently invade marshy areas. Carpgrass is another increasingly common nonnative, similar in appearance to stiltgrass.

Invasive Vines

Oriental bittersweet and Japanese honeysuckle are common in wooded areas. Porcelain berry is very aggressive along forest edges, particularly along the canal. Asian wisteria grows in isolated patches. Unlike most native vines, nonnative vines are apt to strangle and overtop trees, causing them eventually to topple.

Invasive Herbaceous Species

Garlic mustard is the most widespread invasive wildflower. Lesser celandine carpets floodplains in the spring in many areas, growing so densely that other species are excluded. Japanese knotweed grows densely along streambanks. Purple loosestrife spreads along streambanks and in wet meadows.

Invasive Trees

Most trees in natural areas in Princeton are native. Tree of Heaven (*Ailanthus*) is the primary exception, being most common along the canal, with sporadic occurrences along streets and in nature preserves. Norway Maple is the other most frequently seen nonnative invasive tree, particularly in untended woodlots adjacent to homes.

Photo by Stephen Hiltner

Japanese Stiltgrass—a nonnative species

Asian Tiger Mosquito

The Asian Tiger Mosquito (*Aedes albopictus*) recently arrived in Princeton. It is believed to have spread to the Western Hemisphere as a result of the international trade in used tires. First found in the United States in Texas in 1985, it is now present in more than 30 states, its spread expedited by the trade of used tires within the U.S.

Unlike most native mosquito species, the Asian Tiger Mosquito is an aggressive day-biter and is most active from 10 a.m. to 3 p.m. It breeds in artificial containers such as tires, flower pots, cans, rain gutters, and many other artificial water-holding containers. It does not travel far from its breeding habitat. Because the tiger mosquito does best in residential areas where shade and water-holding containers are common, many urban and suburban communities that experienced very little mosquito annoyance in the past are now infested by tiger mosquitoes. It is found in all neighborhoods, from the poorest to the most affluent. Older residential areas with a good deal of shade are preferred sites. Areas near commercial establishments that store a large number of tire casings outside are often infested with the greatest number of tiger mosquitoes.

Since this mosquito is active in the daytime, not just after dawn and just before dusk as most indigenous mosquito species, it is a likely culprit if people or pets are being bitten in the daytime. Most mosquito spraying done at night will have little effect on tiger mosquitoes. (Daytime spraying may be a violation of label directions if foraging bees are present on blossoms in the application area.) In Asia, this species is a vector of dengue fever and Japanese encephalitis. Laboratory studies have found the tiger mosquito to be an efficient vector of many viral disease agents, including yellow fever, West Nile virus, St. Louis encephalitis, and LaCrosse encephalitis.

Control of tiger mosquitoes by conventional methods in the United States has proven to be difficult. The impact of several predators and parasites as biological control agents of larvae has been investigated. In general, these agents have been found to play a small role in regulating the number of mosquitoes, but they do not have a significant impact.

The most promising predators of tiger mosquito larvae are mosquito fish (*Gambusia spp.*) and cannibal mosquitoes (*Toxorhynchitus spp.*). Fish are very effective when stocked in cisterns, water barrels, and ornamental ponds, but many of the breeding sites of tiger mosquitoes are so small and cryptic as to make the use of fish of limited value.

The most effective method of controlling tiger mosquitoes is reducing or eliminating breeding spots, which are never far from where people are being bitten, since this is a weak flyer with only about a 200-yard lifetime flying radius. Draining or removal of water holding containers, even on a localized basis, will produce remarkable long-term reductions in mosquito annoyance.

See www.mda.state.md.us/plants-pests/mosquito_control/_asian_tiger_mosquito_md.php for more information.

Future Threats to Open Space and Natural Areas

Some of the more prominent emerging invasives that have yet to become established in Princeton but that could have an ecological, economic, and/or quality-of-life impact in coming years include plants like mile-a-minute, insects like the Emerald Ash Borer (EAB) and Asian Longhorned Beetle (ALB), and fish species such as the snakehead. To aid in monitoring and quick response, it is important that Princeton residents and municipalities be familiar with these species.

More information about these and other invasive species can be found at:

Mid-Atlantic Exotic Pest Plant Council (www.ma-eppc.org)–both new and established invasive plants; Central Jersey Invasive Species Strike Team (cjisst.org)–focuses on emerging invasive plant threats; and Animal and Plant Health Inspection Service (www.aphis.usda.gov), which is leading the effort to combat invasive insects like the ALB and EAB.

Mile-A-Minute Weed

Mile-a-minute weed is an annual or perennial vine native to eastern Asia. Mile-a-minute weed grows rapidly, outcompeting native species by blocking available light. It infests orchards, openings in forested areas, roadsides, power line cuts, drainage ditches, and recreational areas. Subsequently, wildlife species are affected by diminished food and habitat sources. Mile-a-minute weed is a particular threat to forest regeneration by outcompeting tree seedlings. It is extremely difficult to eradicate with a single herbicide application due to prolonged seed persistence in the soil. The seeds may survive in the soil for up to four years. Mile-a-minute weed also infests recreational and residential areas. Dense thickets of the sharp-spined plants can provide an unpleasant experience for those recreating in the outdoors.

Introduced into the United States in the 1930s at a plant nursery in York County, Pennsylvania, mile-a-minute has expanded in several directions for approximately 300 miles, reaching Princeton. Though the one occurrence of the plant in Princeton was quickly dealt with, monitoring and quick action will be required to prevent it from becoming established here.

Emerald Ash Borer

Ash trees are very common in Princeton's forests and residential areas. Emerald Ash Borer (EAB) is an exotic beetle that was discovered in southeastern Michigan near Detroit in the summer of 2002. The larvae of the beetles feed on the inner bark of ash trees, disrupting the tree's ability to transport water and nutrients. EABs probably arrived in the United States on solid wood packing material carried in cargo ships or airplanes originating in its native Asia. EAB has since spread eastward through Pennsylvania. Although it has yet to appear in New Jersey, it is possible that it will impact the state in the near future. In North America, native ash trees have little or no resistance to EAB, and natural enemies have so far had little effect when EAB populations are high. Since its discovery, EAB has killed more than 30 million ash trees in southeastern Michigan alone, costing municipalities, property owners, nursery operators, and forest products industries tens of millions of dollars.

The canopy of trees infested with EAB begins to thin above the infested portions of the trunk and major branches because the borer destroys the water- and nutrient-conducting tissues under the bark. Heavily infested trees exhibit canopy die-back, usually starting at the top of the tree. Most of the canopy will be dead within two years of when symptoms are first observed. Although difficult to see, the adult beetles leave a "D"-shaped exit hole in the bark, roughly one-eighth inch in diameter, when they emerge in June. Native ash borers leave a circular exit hole. The adult beetle is dark metallic green in color, one-half inch long and one-eighth inch wide.

EAB is primarily spread when people move infested ash nursery trees, logs, or firewood into uninfested areas. Shipments of ash nursery trees and ash logs with bark are now regulated, and transporting firewood outside to the quarantined areas is illegal, but transport of infested firewood remains a problem. Ash firewood or logs should never be moved outside a quarantined area.

If and when EAB reaches Princeton, it will severely damage Princeton's forests and suburban shade trees and greatly impact budgets. The citizens of Princeton can help by carefully monitoring their ash trees for sign and symptoms of EAB throughout the year. If signs of EAB infestations are spotted, state or county natural resource agencies should be contacted. The USDA also maintains an Emerald Ash Borer toll-free hotline at 1-866-322-4512. See www.emeraldashborer.info for additional information.

Asian Longhorned Beetle

A relatively new and potentially serious threat to some of North America's most beautiful and popular trees is the Asian Longhorned Beetle (ALB) (*Anoplophora glabripennis*). Native to parts of Asia, the beetle is believed to have arrived in North America in the wooden packing material used in cargo shipments from China. Isolated ALB infestations have been discovered in Brooklyn and Amityville, New York, and in Chicago, Illinois (also in Toronto and recently in Massachusetts). In all instances where ALBs have been found, authorities have reacted quickly to stop the infestation from spreading. However, two infestations of ALB were discovered in New Jersey.

Trees favored by the ALB are predominantly maples, but infestations have also been discovered in horse chestnuts, poplars, willows, elms, mulberries, and black locusts. If ALB were allowed to spread, it would devastate eastern American forests. Currently, there is no known chemical or biological defense against the ALB and, in North America, they have few natural predators. In all cases of infestation, the affected trees are cut down and the wood destroyed.

Mature ALBs are very large insects, with bodies ranging from one to one and a half inches (2.5 to 4 cm) in length, and antennae that can be as long as four inches (10 cm). They are shiny and black, with white spots and long antennae banded black and white. These beetles have wings and can fly, although only for short distances because of their size and weight.

The ALB is extremely destructive. The damage is caused by beetle larvae that burrow deep within a tree to feed on its food and water conducting vessels. Continued feeding causes structural defects and eventually kills the life-sustaining cambial layer by girdling. Mature beetles then burrow out of the tree, leaving holes the diameter of ball-point pens. Heavy ALB infestations can kill otherwise healthy adult trees.

Mature beetles emerge from trees beginning in late May and lasting through October, with a frequency peaking in July. Tree infestations can be detected by looking for tell-tail exit holes three-eighths to three-fourths of an inch in diameter (1.5-2 cm), often in the larger branches of the crowns of infested trees. Sometimes sap can be seen oozing from the exit holes, with coarse sawdust or 'frass' in evidence on the ground or lower branches.

If the presence of ALBs is detected, local forestry officials should be contacted immediately so that they can take steps to contain the outbreak. Unfortunately, the only way currently known to combat the ALB is to destroy the infested trees, and many healthy trees have also been destroyed

as part of the effort to prevent the beetle's spread. See www.asian-longhorned-beetle.com for more information.

Snakehead Fish

Snakehead fish are native to China but are imported into the U.S. as aquarium fish and food fish. Snakeheads can cause serious problems to native fish populations if they get established in U.S. waters. These predatory fishes are distinguished by a long dorsal fin, a small head with large head scales on top, a large mouth, and large teeth. They have a physiological need to breathe atmospheric air, which they do with a suprabranchial organ: a primitive form of a labyrinth organ. When the Snakehead eats, it is a thrust predator, which means that it will eat its prey all at once, striking and inhaling it whole.

It is illegal to possess live snakeheads in 13 states of the U.S., including New Jersey, as they have become an invasive species due to irresponsible owners releasing them into the wild when they could/would no longer take care of them. If in an enclosed area, they will try anything to escape. If in an aquarium, they will charge at full force and tend to knock over the aquarium or shatter the glass.

Snakeheads can cause ecological damage because they are top-level predators, which means that they have no natural enemies outside of their native environment and can outcompete native fish. Not only can they breathe atmospheric air, but they can also survive on land for up to four days, provided they are wet, and are known to migrate on wet land to other bodies of water by wriggling with their body and fins. Snakeheads became a national news topic in the U.S. because of the appearance of northern snakeheads spawning in a Maryland pond in 2002. Northern snakeheads became permanently established in the Potomac River around 2004, and are possibly established in Florida. Nonestablished specimens have been found in Flushing Meadows-Corona Park, New York, two ponds outside Philadelphia, Pennsylvania, a pond in Massachusetts, and reservoirs in California and North Carolina.

Humans have been introducing snakeheads to nonindigenous waters for over 100 years. In parts of Asia and Africa, the snakehead is considered a valuable food fish and is produced in aquacultures. As a result, it was introduced either on purpose (fisheries motivation) or by ignorance.

While not present in Princeton, snakeheads were first reported in Philadelphia's FDR Park in 2004, and soon thereafter were discovered in the Delaware River. Although snakeheads have not yet been reported in large numbers in the Delaware, experience has shown that snakeheads can spread rapidly. In the Potomac River, where snakeheads were also first reported in 2004, many hundreds are now caught each year by fishermen. While snakeheads may be exterminated in confined waterbodies by the use of herbicides, once they are present in open waters, officials are primarily left to study and monitor their spread. The USGS tracks confirmed snakehead sightings at nas.er.usgs.gov/taxgroup/fish/northernsnakeheaddistribution.asp.

ENVIRONMENTAL ISSUES

KNOWN CONTAMINATED SITES

A 2006 NJDEP inventory of Known Contaminated Sites reported 569 contaminated sites in Mercer County. Thirty-three of these sites are located in Princeton Township and 17 are within Princeton Borough. See **Table 23: Known Contaminated Sites in Princeton** and **Map 19a and Map 19b: Known Contaminated Sites**. Of the 50 contaminated sites in Princeton, 28 are residential properties. In all likelihood, these residential properties are on the Known Contaminated Sites List due to leaking underground storage tanks.

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, can be listed under the 1980 CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act) as superfund sites, which make them eligible for federal cleanup funds. Other sites are handled by state or individual programs, or through private funds.

According to the U.S. Environmental Protection Agency (EPA), a superfund site is any land in the United States that has been contaminated by hazardous waste and is identified by the EPA as a candidate for cleanup because it poses a risk to human health and/or the environment. There are 19 superfund or potential superfund sites in Mercer County, though none are located in Princeton Township or Borough. The superfund site with the largest potential impact on Princeton is the American Cyanamid Company (ACCo) Agricultural Research Division at the intersection of Quakerbridge and Clarksville roads in West Windsor Township. The ACCo site poses a concern due to its proximity to both Duck Run, which empties into the Stony Brook, and to aquifers used by the New Jersey American Water Company Elizabethtown Division, which supplies most of Princeton's drinking water. This site is currently being monitored under RCRA (Resource Conservation and Recovery Act) statutes and has been given a Conditional NFA (No Further Action) report upon completion of the recommended remediation measures in 1995. On-site monitoring continues at the ACCo site to ensure the attenuation of current volatile organic compounds and pesticides present in the soil near a former landfill on the property. Current testing indicates that the toxins from this site have been appropriately contained and pose no immediate threat. This information was retrieved using the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS).

Table 23: Known Contaminated Sites in Princeton

Site ID	Place Name	Address	Status	Status Date	Remediation Level	Muni	Lead Agency
186485	Residence	Boudinot St	Active	2/28/2005	C1	Boro	BFO-S
74637	Residence	Jefferson Rd	Active	9/16/1999	C1	Boro	BFO-S
122847	Residence	Chambers St	Active	8/1/2002	C2	Boro	BFO-S
170343	Residence	Hodge Rd	NFA-A (Restricted Use)	3/31/2004	C1	Boro	BFO-S
73969	Residence	Greenview Ave	Active	11/19/1998	C1	Boro	BFO-S
14626	Medical Center at Princeton	253 Witherspoon St	Active	1/29/2004	C1	Boro	BSCM
45532	Public Works Garage	27 N Harrison St	Active	12/30/1994	C2	Boro	BSCM
6336	Auto Repairs of Princeton, Inc.	271 Nassau St	Active	1/26/2001	C2	Boro	BSCM
183308	Residence	Witherspoon St	Active	11/9/2004	C1	Boro	BFO-S
74899	Residence	Greenholm St	Active	12/10/1999	C2	Boro	BFO-S
66973	Residence	RTE 27 (Nassau St)	NFA-A (Limited Restricted Use)	12/4/2002	C2	Boro	BOMM
75891	Residence	Prospect Ave	Active	3/14/2001	C1	Boro	BFO-S
45755	Princeton Theological Seminary	Mercer St	Active	5/20/2004	B	Boro	INS
51035	Princeton University - Stanworth	N & S Stanworth Dr off Bayarn Ln	Active	1/7/2003	C2	Boro	BFO-S
15395	Sunoco 0010-3259	Nassau St & Murray Pl	Active	6/26/1995	C2	Boro	BSCM
123976	Princeton Borough Spring St. Parking	Spring St & S Tulane St	Active	6/10/2004	C2	Boro	BFO-S
58056	Hoyt Laboratory	Washington Rd & William St	Active	5/11/2000	C1	Boro	BFO-S
21159	Princeton Gas Works	Witherspoon & Wiggins Streets	Active	11/23/1998	C3	Boro	BCM
85799	Residence	Brookstone Dr	Active	12/21/2000	C1	Twp	BFO-S
74267	Residence	Stuart Rd	Active	4/7/2003	C1	Twp	BFO-S
91561	Residence	Red Hill Rd	Active	11/7/2001	C1	Twp	BFO-S
23872	Residence	Edgerstoune Rd	Active	2/13/2003	C1	Twp	BSCM
91452	Residence	Maybury Hill	Active	8/7/2001	C1	Twp	BFO-S
93077	Residence	State Rd	Active	1/2/2002	C1	Twp	BFO-S
176572	Residence	Edgerstoune Rd	Active	6/23/2004	C1	Twp	BFO-S
178625	231 Brooks Bend	231 Brooks Bend	Active	9/13/2004	C2	Twp	BFO-S
118940	234 Birch Ave	234 Birch Ave	Active	4/30/2002	C2	Twp	BFO-S

Site ID	Place Name	Address	Status	Status Date	Remediation Level	Muni	Lead Agency
170332	249 Snowden Ln	249 Snowden Ln	Active	3/18/2004	C1	Twp	BFO-S
35646	Valley Road Admin. Building	25 Valley Rd	Active	5/11/2001	C2	Twp	BSCM
6332	Larini's Service Center	272 Alexander St	Active	10/30/1992	C2	Twp	BSCM
185893	288 Mount Lucas Rd	288 Mount Lucas Rd	Active	1/3/2005	C1	Twp	BFO-S
99216	Transcontinental Gas Pipeline Valve 200A27	29 Hilltop Dr	Active	1/2/2002	C3	Twp	BCM
6330	AMOCO Service Station 60762	300 N Harrison St	Active	8/15/1995	C2	Twp	BSCM
67844	309 Ewing St	309 Ewing St	Active	11/21/1994	C1	Twp	BFO-S
75664	Dry Cleaner at Clifton Center	45-61 State Rd & RT 206	Active	8/21/2000	C2	Twp	BFO-S
153615	54 Rollingmead St	54 Rollingmead St	Active	7/31/2003	C2	Twp	BFO-S
170615	599 Pretty Brook Rd	599 Pretty Brook Rd	Active	3/24/2004	C1	Twp	BFO-S
91455	6 Newlin Rd	6 Newlin Rd	Active	12/5/2001	C1	Twp	BFO-S
154373	Textiles Research Institute	601 Prospect Ave	Active	8/21/2003	C1	Twp	BFO-S
74740	658 Snowden Ln	658 Snowden Ln	Active	9/15/1999	C1	Twp	BFO-S
124736	76 Valley Road	76 Valley Rd	Active	9/26/2002	C1	Twp	BFO-S
148830	79 Wheatsheaf Lane	79 Wheatsheaf Ln	Active	6/18/2003	B	Twp	BFO-S
37844	Tournament Players Club at Jasna Polana	8 Lawrenceville Rd	Active	10/17/1994	C2	Twp	BFO-S
14625	Whale Oil Corp of New Jersey	800 State Rd	Active	5/16/2000	C2	Twp	BFO-S

A case manager is assigned to every Known Contaminated Site case and can provide further information on each site. The case manager can be reached by contacting the Site Remediation Program's lead agency, which is listed in the table for each site.

Go to www.state.nj.us/dep/srp/kcs-nj/Mercer/index.html for contact information, or call 1-800-253-5647.

Status

Code	Meaning
NFA-A	No further action for a partial area of a site

Lead Agencies

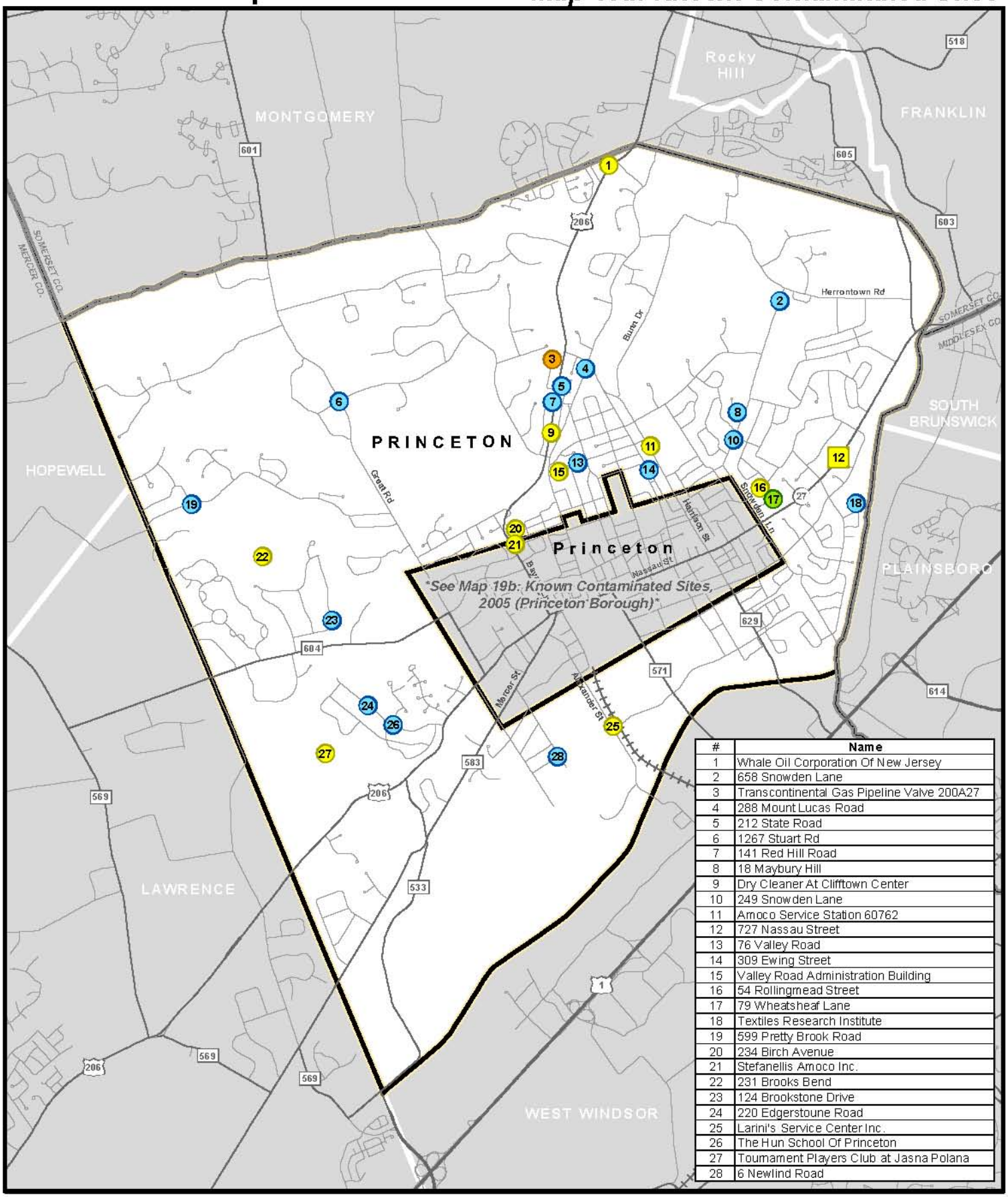
Initials	Full Name
BCM	Bureau of Case Management
BFO-S	Bureau of Field Operations-Southern
BNCM	Bureau of Northern Case Management
BOMM	Bureau of Operation, Maintenance and Management
BSCM	Bureau of Southern Case Management
CAS	Case Assignment Section
INS	Initial Notice Section
OWR	Office of Wellfield Remediation

Explanation of Remedial Levels

Remedial Level	Explanation of Site Complexity
B	A single phase remedial action with a single contaminant affecting only the soil.
C1	A remedial action with simple sites; one or two contaminants localized to soil and the immediate spill or discharge area.
C2	A remedial action with more complicated contaminant discharges; multiple site spills and discharges; more than one contaminant, with both soil and groundwater impacted or threatened.
C3	A multiphase remedial action with high complexity and threatening sites. Multiple contaminants some at high concentrations with unknown sources continuing to impact soils, groundwater, and possibly surface waters and potable water resources. Dangerous for direct contact with contaminated soils.
D	Same conditions as C3 except that D levels are also usually designated federal "Superfund Sites."

Princeton Township

Map 19a: Known Contaminated Sites



#	Name
1	Whale Oil Corporation Of New Jersey
2	658 Snowden Lane
3	Transcontinental Gas Pipeline Valve 200A27
4	288 Mount Lucas Road
5	212 State Road
6	1267 Stuart Rd
7	141 Red Hill Road
8	18 Maybury Hill
9	Dry Cleaner At Clifftown Center
10	249 Snowden Lane
11	Amoco Service Station 60762
12	727 Nassau Street
13	76 Valley Road
14	309 Ewing Street
15	Valley Road Administration Building
16	54 Rollingmead Street
17	79 Wheatsheaf Lane
18	Textiles Research Institute
19	599 Pretty Brook Road
20	234 Birch Avenue
21	Stefanellis Amoco Inc.
22	231 Brooks Bend
23	124 Brookstone Drive
24	220 Edgerstoune Road
25	Larini's Service Center Inc.
26	The Hun School Of Princeton
27	Tournament Players Club at Jasna Polana
28	6 Newlind Road

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.

STATUS, LEVEL OF SITE COMPLEXITY

Active - B | Active - C1 | Active - C2 | Active - C3

NFA-A, Limited Restricted Use - C2

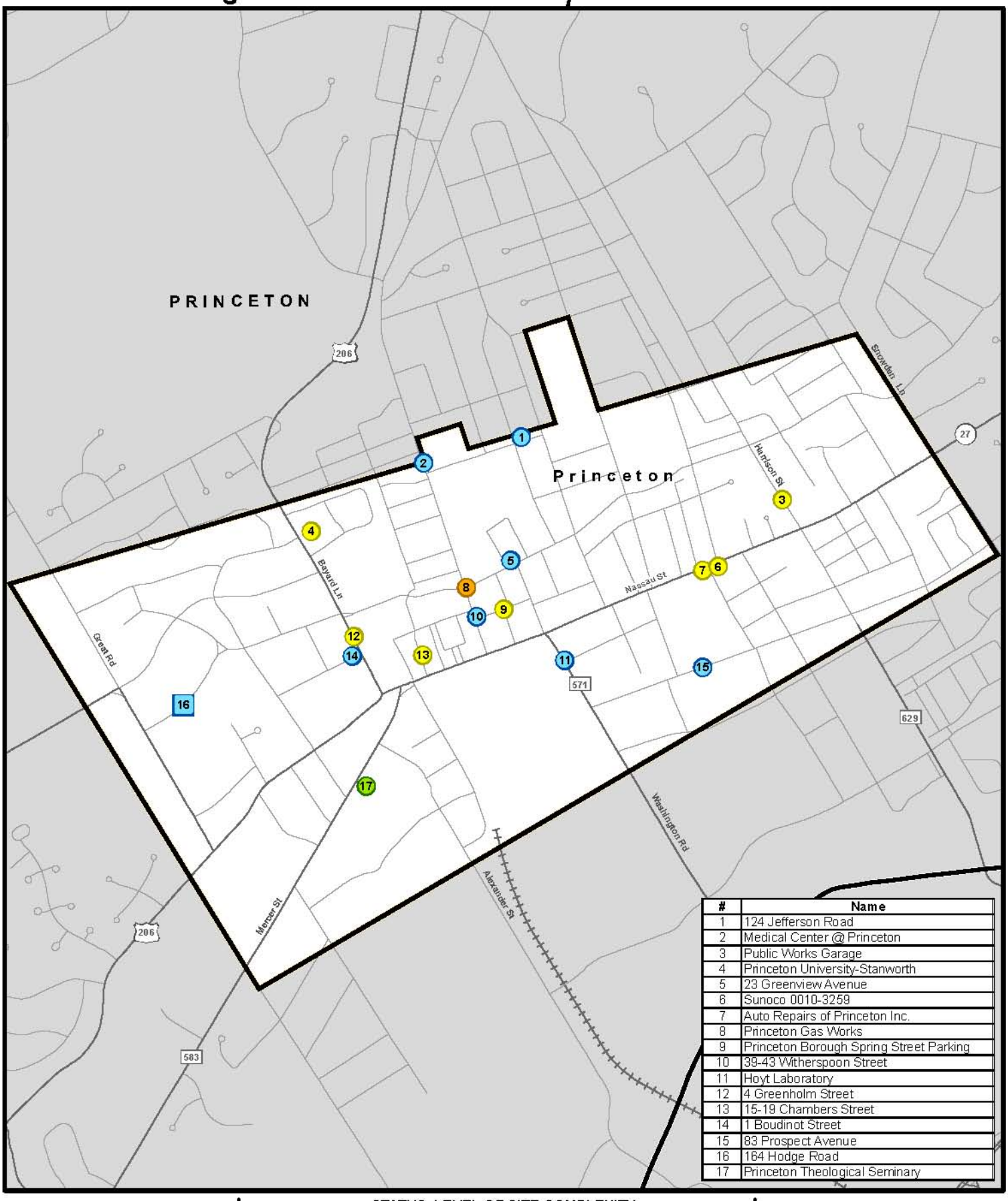
B: Single Phase Remedial Action - Single Contamination Affecting Only Soils
C1: No Formal Design - Source Known or Identified-Potential GW Contamination
C2: Formal Design - Known Source or Release with GW Contamination
C3: Multi-Phased RA - Unknown or Uncontrolled Discharge to Soil or GW

0 0.25 0.5 1
Miles

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

Princeton Borough

Map 19b: Known Contaminated Sites



#	Name
1	124 Jefferson Road
2	Medical Center @ Princeton
3	Public Works Garage
4	Princeton University-Stanworth
5	23 Greenview Avenue
6	Sunoco 0010-3259
7	Auto Repairs of Princeton Inc.
8	Princeton Gas Works
9	Princeton Borough Spring Street Parking
10	39-43 Witherspoon Street
11	Hoyt Laboratory
12	4 Greenholm Street
13	15-19 Chambers Street
14	1 Boudinot Street
15	83 Prospect Avenue
16	164 Hodge Road
17	Princeton Theological Seminary

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.

STATUS, LEVEL OF SITE COMPLEXITY

Active - B Active - C1 Active - C2 Active - C3

NFA-A, Restricted Use - C1

B: Single Phase Remedial Action - Single Contamination Affecting Only Soils
C1: No Formal Design - Source Known or Identified-Potential GW Contamination
C2: Formal Design - Known Source or Release with GW Contamination
C3: Multi-Phased RA - Unknown or Uncontrolled Discharge to Soil or GW

N

0 500 1,000 2,000

Feet

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

UNDERGROUND STORAGE TANKS

There are a number of businesses in Princeton that still have underground storage tanks (USTs). These tanks are commonly used to store fuel oil, or in the case of service stations, gasoline or diesel fuel. Storage tanks installed prior to 1998 may have outdated leak control and corrosion prevention measures and must be continually monitored for emissions. Corrosion and leakage of USTs can become a serious threat to the groundwater and soil surrounding them. These sites are monitored under a program called the Bureau of Underground Storage Tanks, or BUST. Sites are registered, receive permits, and are monitored for leaks at regular intervals. The sites on this list sometimes overlap with, and are cross-listed as, Known Contaminated Sites, but are often less contaminated and require a lower level of remediation. See **Table 24: Underground Storage Tanks in Princeton**.

Table 24: Underground Storage Tanks in Princeton

PI Number	PI Name	Street Address	Permit Status	Expiration Date
Princeton Township				
156	Larini's Service Center	272 Alexander ST	Effective	3/31/2010
15323	Macmillan Building	Elm Dr Maintenance Building	Effective	3/31/2010
4796	Princeton Amoco Inc	301 N Harrison St	Effective	3/31/2010
18538	Princeton Pumping Station	200 River Rd	Effective	3/31/2010
15484	River Road Treatment Plant	290 River Rd	Effective	3/31/2010
828	Rocky Hill BP	870 Rt 206	Effective	3/31/2010
17215	Tamasis' Automotive	171 Bayard Ln	Effective	3/31/2010
31296	Trustees of Princeton University	Princeton University Cogeneration Plant	Effective	3/31/2010
16820	Princeton Racquet Club	150 Raymond Rd	Expired	3/31/2001
33298	Samuel Bahadurian	883 State Rd	Expired	3/31/2001
22617	Vaccaro Farms Inc	4240 Quaker Bridge Rd	Expired	3/31/2001
5607	Whale Oil Corp of New Jersey	800 State Rd	Expired	3/31/2001
Princeton Borough				
7693	Auto Repairs of Princeton Inc	271 Nassau Street	Effective	3/31/2010
11700	Medical Center at Princeton	253 Witherspoon St	Effective	3/31/2010
134862	Medical Center at Princeton Merwick Unit	79 Bayard Ln	Effective	3/31/2010
4227	Princeton Theological Seminary	64 Mercer St	Effective	3/31/2010
16462	Sunoco 0010-3259	Nassau St and Murray Pl	Effective	3/31/2010
33610	The Princeton Institute for Integrated Genomics	Washington Rd	Effective	3/31/2010
24323	Alfred A Perna	830 St Road	Expired	3/31/2001
163810	Princeton Borough Street Parking Lot	Spring St and S. Tulane St	Pending	
2659	Verrbeyst Inc	Tulane Street S	Pending	

Source: NJDEP

Detailed information on each of the listed USTs above can be found on the NJDEP UST website: www.nj.gov/dep/srp/bust/bust.htm

GROUNDWATER CONTAMINATION

There are four sites within Princeton that have documented groundwater contamination from various sources. These sites are restricted by a *Classification Exception Area (CEA)* designation (see **Table 25:** Classification Exemption Areas in Princeton). A CEA can be established for a contaminated site's aquifer, if state drinking water quality standards are not or will not be met due to: (1) natural groundwater quality, (2) discharges from a NJPDES permitted site, or (3) pollution caused by human activity. A CEA designation suspends aquifer use in the affected areas until state drinking water standards are met. It is not a groundwater remedy; it is an institutional control established in conjunction with an approved remedy. NJDEP may revise or establish a CEA at any time using revised data to more accurately reflect the groundwater conditions. If possible, NJDEP or the entity responsible for the remediation or monitoring of the site (known as the responsible party) estimates the duration that the CEA will remain in effect. Often, a responsible party applying for a NJPDES permit or submitting a remediation plan for a contaminated site will also submit a CEA designation application, called a CEA Fact Sheet, detailing the aquifer contamination (see **Table 25: Classification Exemption Areas in Princeton).**

Table 25: Classification Exemption Areas in Princeton

CEA Number	Name	Address	Start Date	Duration
2423	Princeton Back and Neck Institute	727 State Road	Sep-98	To 2026
1427	Amoco Service Station	N Harrison St	Aug-95	Indeterminate
382	Princeton Public Works Garage	Valley Rd & Rt 206	Jan-98	Indeterminate
1628	Princeton Regional School Dist	25 Valley Rd	Mar-98	Indeterminate

Source: NJDEP

A *Currently Known Extent (CKE) Area* is a geographically defined area within which the local ground water resources are known to be contaminated because the water quality does not meet drinking water and ground water quality standards for specific contaminants. There are no designated CKE areas in Princeton.

Information about the dangers of different types of pollutants found in aquifers or wells can be found at the Environmental Defense Scorecard website: www.scorecard.org. New Jersey GIS data can be obtained from NJDEP at: www.state.nj.us/dep/gis/stateshp.html#GWCKE.

RADON

Radon is a radioactive gas that comes from the natural decay of uranium found in nearly all soils. It moves up through the ground to the air above and into all types of homes through cracks and other holes in foundations. A build-up of radon contamination within a home can pose a long-term health hazard to residents, specifically for lung cancer. It is invisible, odorless, and tasteless; the only method of detection is to conduct a radon test of the air within a home. Fortunately, radon testing is inexpensive. 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 through installing ventilation systems.

NJDEP classifies townships into three categories as to the risk of having high radon levels. Tier 1 is the highest level. Both Princeton Township and Borough are listed as a Tier 1 municipality with a high risk of having high radon levels in homes. The level at which homeowners should take immediate action is 4.0 picocuries per liter of air. While state law does not require radon testing before a real estate transaction, NJDEP recommends that a contingency clause be included in a sale contract allowing the buyer to have the home tested for radon and fixing the home if an elevated level of radon gas is discovered. State law (*N.J.A.C. 26:2D-73*) does require, at the time of a real estate transaction, that the seller provide the buyer with a copy of the results of any radon testing, if such testing was conducted during the homeowner's tenure in the house.

The Princeton Township Health Department has radon kits available for sale to measure the level of radon in residents' homes. The Health Department also has free literature available regarding radon testing and remediation.

FLOODING

Princeton sometimes experiences significant flooding from storm events. The most severe flooding in Princeton occurs along Stony Brook and the Millstone River. In flooding events that affect both waterbodies, some roadways, such as Quaker Road and River Road, may temporarily become impassable due to rising floodwaters. Flooding also has the potential to damage homes and structures, although only six homes have claimed minor damages as a result of flooding, according to township records.

Flooding proved to be a threat to Princeton in the spring of 2007, when consistent heavy rain fell between April 15 and 17, flooding many streams and rivers throughout New Jersey. This storm was unusual both in its intensity and longevity, dropping nearly six inches of water on parts of the township. This deluge created 100-year flood conditions in Princeton and surrounding areas, where floodwaters overtopped some local bridges and roads. At one point, only Washington Road Bridge was open across Carnegie Lake and access was restricted on several other roads in the township. Bridges across Stony Brook were also closed by the flooding and many area basements were flooded.

Other major recent flooding events include the heavy storms of June 12, 1996, Hurricane Floyd, which hit Princeton on September 17, 1999, the remnants of Tropical Storm Ivan, which moved through the area in September 2004, and the severe spring flooding of April 2005. Hurricane Floyd in September 1999 proved to be the worst flooding in recent history. Record rainfall amounts between seven and eight inches fell on the township, causing severe flooding throughout Mercer, Somerset, and Middlesex counties. The Stony Brook crested at four feet above flood level and 12 feet above its normal level, while the Millstone River crested a full two and a half feet above its previously measured high. Problems associated with flooding included blocked roads, downed power lines, and severely limited water supply caused by the partial destruction of the Elizabethtown Water Company facility. The flooding associated with Tropical Storm Floyd proved influential in informing the current stormwater and flooding regulations and in developing the 2006 Princeton Township Stormwater Management Plan.

Photo by Stephen Hiltner

Localized flooding at a house on Harrison Street

Even before the 2006 Stormwater Management Plan update, there were attempts to develop a solution to flooding problems. Several plans were developed, including the Natural Resources Conservation Service (NRCS) comprehensive plan of 1964. This plan suggested building reservoirs (the last of which was built in Hamilton Township in 1994) to contain excess water during storm events. The plan proposed a reservoir on the Shipetauken Creek in neighboring

Lawrence Township, but it was not constructed. After severe flooding events in 1975, the NRCS reexamined the area to determine the impact of the reservoirs. The agency reported, in a 1982 report, that the reservoirs produced only slight mitigation effects and that "there was nothing else that they, or the federal government, could do to resolve the problem."

A lasting solution to preventing an increase in the likelihood of future flooding problems in Princeton and neighboring communities will require preserving, maintaining, and restoring wetlands, woodlands, and naturally functioning floodplains, and maximizing infiltration through the use of stormwater best management practices (BMPs). Reforestation, the planting of vegetated riparian buffers, and the creation of greenways along waterbodies all help to restore the ability of floodplains to capture, store, and retain floodwaters and keep people and structures out of harm's way during flooding events.

Impervious surfaces, such as asphalt, increase flooding problems because they do not allow water to percolate into the ground. On an impervious surface, water is forced to travel downhill until it can find a place to sink into soil or enter a waterbody. This runoff is greatest during a storm or a major snow melt. As the amount of impervious surface increases in a watershed, runoff increases in quantity, velocity, temperature, and pollution levels. New developments create large amounts of impervious surface through the construction of roads, sidewalks, parking lots, driveways, rooftops, and compacted soil. A municipality can lessen these effects by instituting coverage requirements on new development and by implementing stormwater BMPs, which give guidance in preventing unnecessary runoff and flooding. Most importantly, development should be kept out of floodplains to the greatest degree possible so floods can occur (as they naturally do) with few impacts to people and property.

OTHER ENVIRONMENTAL CONCERNS

Toxic Releases

According to the U.S. EPA's annual Toxics Release Inventory (TRI), no toxic releases have been recorded in Princeton. However, the Bristol-Myers Squibb facility located on Province Line Road in Lawrenceville is listed in the EPA's TRI. The 2005 report listed this facility as releasing almost 2,000 pounds of ammonia into the environment.

Historic 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, all of 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. While the task force examined 18 agricultural sites throughout New Jersey (none in Mercer 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, toys, and tools after working or 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 landscaping occurs.

To reduce possible detrimental effects from pesticide use, Princeton could consider having all of its public properties become "Pesticide Free Zones" and require that Integrated Pest Management be used in as many locations as possible. All New Jersey schools are currently required to use Integrated Pest Management techniques, and this represents an important step in protecting human health and the environment.

CONCLUSION

Princeton is a wonderful place to live and work. It is a vibrant community with a high quality of life and a strong sense of identity. The resources documented in this environmental resource inventory—natural resources, water resources, and biological resources—as well as historic and cultural resources, are key contributors to the character and quality of the Princeton community. Documentation of these resources provides a foundation for their care, protection, and enhancement for the benefit of current and future Princeton residents. Accomplishing these latter tasks will also require further planning and policy making. Fortunately, local officials and community residents have a wide variety of tools at their disposal for this purpose, including municipal land use tools, natural resource protection ordinances, and land preservation techniques. Perhaps most importantly, Princeton is blessed with numerous organizations that continuously work to educate Princetonians on the need for, and benefits of, environmental resource protection.

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  - Natural Resources Conservation Service. Soil Series Name Search: http://ortho.ftw.nrcs.usda.gov/cgi-bin/osd/osdnamequery.cgi
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Surface Water Quality

- New Jersey Department of Environmental Protection (NJDEP):
  - Bureau of Freshwater and Biological Monitoring, Ambient Biomonitoring Network: www.state.nj.us/dep/wmm/bfbm/amnet.html
  - Bureau of Freshwater and Biological Monitoring, Ambient Lake Monitoring Network: www.state.nj.us/dep/wmm/bfbm/lakes.html
  - Division of Water Quality: www.state.nj.us/dep/dwq
  - Water Quality Monitoring and Standards, New Jersey Integrated Water Quality Monitoring and Assessment Report: www.state.nj.us/dep/wms/bwqsa/generalinfo.htm
  - Surface Water Quality Standards, N.J.A.C. 7:9B. www.nj.gov/dep/rules/rules/njac7_9b.pdf
- Stony Brook Millstone Watershed Association: www.thewatershed.org
- U.S. Environmental Protection Agency. Total Maximum Daily Loads: http://oaspub.epa.gov/tmdl/waters_list.control?state=NJ&wbtype=STREAM%2FCREEK%2FRIVER

Groundwater

- New Jersey Department of Environmental Protection (NJDEP):
  - NJPDES permits: www.nj.gov/dep/dwq/database
  - Division of Land Use Regulation, Wetlands and flood hazard area regulations and permits. www.state.nj.us/dep/landuse
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The Built Environment

Population

- DVRPC Data Navigator, Population Projections: www.dvrpc.org/asp/Test/DataNavigator
- U.S. Census Bureau: www.census.gov

Transportation

- New Jersey Department of Transportation Roadway Reports: www.state.nj.us/transportation/refdata/roadway/traffic.shtm

Historic Resources

- Historical Society of Princeton: www.princetonhistory.org

LIST OF LEGAL CITATIONS

P.L. 93-205. *Federal Endangered Species Act of 1973 (ESA).*

P.L. 95-217. *Federal Clean Water Act.*

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

P.L. 105-312. *Federal Migratory Bird Treaty Act of 1918.*

N.J.S.A. 13:1B-15.151 et seq. *New Jersey Endangered Plant Species Act.*

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

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

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

N.J.A.C. 7:7A et seq. *New Jersey Freshwater Wetlands Protection Act Rules.*

N.J.A.C 7:8 et seq. *Stormwater Management Rules.*

N.J.A.C. 7:9B-1.12. *New Jersey Surface Water Quality Standards.*

N.J.A.C. 7:9E. *Private Well Testing Act.*

N.J.A.C. 7:13 et seq. *New Jersey Flood Hazard Area Control.*

N.J.A.C. 7:14A-2 et seq. *New Jersey Pollution Discharge Elimination System – General Program Requirements.*

N.J.A.C 7:15 et seq. *Water Quality Management Planning Rule.*

N.J.A.C. 10:1B. *Open Public Records Act of 2002.*

APPENDICES

APPENDIX A

PRIVATE WELL TESTING ACT

The Private Well Testing Act (PWTA) (*N.J.S.A. 58:12A-26 et seq.*), enacted 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 in cases where 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 that 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.

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.

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 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 are included, which represent approximately one percent of private wells used as potable water supplies in New Jersey. The compilation of water test results is organized by county and municipality, but does not include the names of specific property owners, their addresses, or well locations because releasing that information is prohibited by law. About 92 percent of the 5,179 wells passed all the required (health-based) standards, with the exception of lead. Of the eight percent (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 VOCs. Nitrates are found in ground water due to a number of factors, including natural deposits, runoff from fertilizer, leaching from septic tanks, and leaking 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 ground water from fecal contaminants.

The test results for Mercer County and Princeton Borough and Princeton Township 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, but not necessarily in the township's groundwater.

Summary of PWTA Test Results for Mercer County (Sept. 2002 – March 2003)

Municipality	# Wells sampled	Total # Wells over the MCL*	Fecal coliform/ E. coli	Nitrate	Arsenic	Mercury	Any VOC** over the MCL
Princeton Borough	2	1	0	0	0	NR	1
Princeton Township	2	1	0	0	1	NR	0
Mercer County Totals	***131***	***16***	***2***	***1***	***8***	***NR***	***5***

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

* 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 AND LANDOWNERS

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's Natural Resources Conservation Service (NRCS) has a Farm Service Agency office in Freehold, Monmouth County, which serves Mercer 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 percent for some programs, to develop and follow conservation plans.

The **Conservation Reserve Program (CRP)** is offered by NRCS and is 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. The program's website address is: 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 former 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 percent of the cost to establish approved practices. Additional information can be found at www.fsa.usda.gov, or contact the local Farm Service Agency (FSA) Office or Soil and Water Conservation District Office.

Another program designed to conserve natural resources is called the **Wetlands Reserve Program (WRP)**. WRP is a voluntary resource conservation program that provides landowners with 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 they 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 use of their land, while retaining the ability and right to conduct grazing practices, produce hay, 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.nrcs.usda.gov/programs/grp/

The **Wildlife Habitat Incentives Program (WHIP)** is similar to those above in that it is also a USDA voluntary program, but it 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 provisions 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 and 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 that promotes both agricultural production and environmental quality. The program itself offers technical and financial assistance with the installation and implementation of structural and management practices on agricultural land. EQIP features a shorter 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 percent, and sometimes up to 90 percent, 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 it

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 non-industrial private forest and it 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. They are limited to 1,000 acres per year for the cost-share practices. For more information about this program, please visit the website: 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 in keeping 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 into nonagricultural uses and to develop a conservation plan for any highly erodible 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 percent of the funds required for 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: 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 NJDEP'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 percent 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: www.state.nj.us/dep/fgw/ensp/lip_prog.htm or www.state.nj.us/dep/fgw/ensp/pdf/lip_broch.pdf

APPENDIX C

STATE ENDANGERED AND THREATENED SPECIES

Birds			
Endangered		Threatened	
American Bittern	*Botaurus lentiginosos*	Bobolink	*Dolichonyx oryzivorus* BR
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	*Buteo 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	*Buteo 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 niger* BR	Skimmer, black	*Rynchops niger* 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	*Cistothorus 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*
Turtle, bog	*Clemmys muhlenbergii***		
Atlantic hawksbill	*Eretmochelys imbricata***		
Atlantic leatherback	*Dermochelys 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*	Salamander, 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*
Copper, bronze	*Lycaena hyllus*	Fritillary, silver-bordered (butterfly)	*Bolaria selene myrina*
Floater, brook (mussel)	*Alasmidonta varicosa*	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	*Balaena glacialis***
Whale, blue	*Balaenoptera musculus***
Whale, fin	*Balaenoptera physalus***
Whale, humpback	*Megaptera novaeangliae***
Whale, sei	*Balaenoptera borealis***
Whale, sperm	*Physeter macrocephalus***
Woodrat, Allegheny	*Neotoma floridana magister*

Fishes

Endangered	
Sturgeon, shortnose	*Acipenser brevirostrum***

Source: NJDEP, Division of Fish & Wildlife

**Also on the federal Endangered and Threatened list

APPENDIX D

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

APPENDIX E

BIRDS OF THE C. H. ROGERS WILDLIFE REFUGE

From July, 2005 correspondence

Based on the 1977 list by R. Blicharz

Updated by Laurie Larson and Tom Southerland

1	Canada Goose	Branta canadensis
2	Wood Duck	Aix sponsa
3	Gadwall	Anas strepera
4	American Wigeon	Anas americana
5	American Black Duck	Anas rubripes
6	Mallard	Anas platyrhynchos
7	Blue-winged Teal	Anas discors
8	Northern Pintail	Anas acuta
9	Green-winged Teal	Anas crecca
10	Ring-necked Duck	Aythya collaris
11	Hooded Merganser	Lophodytes cucullatus
12	Common Merganser	Mergus merganser
13	Ring-necked Pheasant	Phasianus colchicus
14	Wild Turkey	Meleagris gallopavo
15	Northern Bobwhite	Colinus virginianus
16	Common Loon	Gavia immer
17	Pied-billed Grebe	Podilymbus podiceps
18	Double-crested Cormorant	Phalacrocorax auritus
19	American Bittern	Botaurus lentiginosus
20	Least Bittern	Ixobrychus exilis
21	Great Blue Heron	Ardea herodias
22	Great Egret	Ardea alba
23	Snowy Egret	Egretta thula
24	Little Blue Heron	Egretta caerulea
25	Green Heron	Butorides virescens
26	Black-crowned Night-Heron	Nycticorax nycticorax
27	Yellow-crowned Night-Heron	Nyctanassa violacea
28	Glossy Ibis	Plegadis falcinellus

29	Black Vulture	Coragyps atratus
30	Turkey Vulture	Cathartes aura
31	Osprey	Pandion haliaetus
32	Bald Eagle	Haliaeetus leucocephalus
33	Northern Harrier	Circus cyaneus
34	Sharp-shinned Hawk	Accipiter striatus
35	Cooper's Hawk	Accipiter cooperii
36	Red-shouldered Hawk	Buteo lineatus
37	Broad-winged Hawk	Buteo platypterus
38	Red-tailed Hawk	Buteo jamaicensis
39	Rough-legged Hawk	Buteo lagopus
40	American Kestrel	Falco sparverius
41	Merlin	Falco columbarius
42	Peregrine Falcon	Falco peregrinus
43	King Rail	Rallus elegans
44	Virginia Rail	Rallus limicola
45	Sora	Porzana carolina
46	Common Moorhen	Gallinula chloropus
47	American Coot	Fulica americana
48	Killdeer	Charadrius vociferus
49	Greater Yellowlegs	Tringa melanoleuca
50	Lesser Yellowlegs	Tringa flavipes
51	Solitary Sandpiper	Tringa solitaria
52	Spotted Sandpiper	Actitis macularius
53	Least Sandpiper	Calidris minutilla
54	Wilson's Snipe	Gallinago delicata
55	American Woodcock	Scolopax minor
56	Laughing Gull	Larus atricilla
57	Ring-billed Gull	Larus delawarensis
58	Herring Gull	Larus argentatus
59	Great Black-backed Gull	Larus marinus
60	Rock Pigeon	Columba livia
61	Mourning Dove	Zenaida macroura
62	Black-billed Cuckoo	Coccyzus erythropthalmus
63	Yellow-billed Cuckoo	Coccyzus americanus
64	Barn Owl	Tyto alba

65	Eastern Screech-Owl	Megascops asio
66	Great Horned Owl	Bubo virginianus
67	Barred Owl	Strix varia
68	Long-eared Owl	Asio otus
69	Northern Saw-whet Owl	Aegolius acadicus
70	Common Nighthawk	Chordeiles minor
71	Whip-poor-will	Caprimulgus vociferus
72	Chimney Swift	Chaetura pelagica
73	Ruby-throated Hummingbird	Archilochus colubris
74	Belted Kingfisher	Ceryle alcyon
75	Red-headed Woodpecker	Melanerpes erythrocephalus
76	Red-bellied Woodpecker	Melanerpes carolinus
77	Yellow-bellied Sapsucker	Sphyrapicus varius
78	Downy Woodpecker	Picoides pubescens
79	Hairy Woodpecker	Picoides villosus
80	Northern Flicker	Colaptes auratus
81	Pileated Woodpecker	Dryocopus pileatus
82	Olive-sided Flycatcher	Contopus cooperi
83	Eastern Wood-Pewee	Contopus virens
84	Yellow-bellied Flycatcher	Empidonax flaviventris
85	Acadian Flycatcher	Empidonax virescens
86	Alder Flycatcher	Empidonax alnorum
87	Willow Flycatcher	Empidonax traillii
88	Least Flycatcher	Empidonax minimus
89	Eastern Phoebe	Sayornis phoebe
90	Great Crested Flycatcher	Myiarchus crinitus
91	Eastern Kingbird	Tyrannus tyrannus
92	White-eyed Vireo	Vireo griseus
93	Yellow-throated Vireo	Vireo flavifrons
94	Blue-headed Vireo	Vireo solitarius
95	Warbling Vireo	Vireo gilvus
96	Philadelphia Vireo	Vireo philadelphicus
97	Red-eyed Vireo	Vireo olivaceus
98	Blue Jay	Cyanocitta cristata
99	American Crow	Corvus brachyrhynchos
100	Fish Crow	Corvus ossifragus

101	Purple Martin	Progne subis
102	Tree Swallow	Tachycineta bicolor
103	Northern Rough-winged Swallow	Stelgidopteryx serripennis
104	Bank Swallow	Riparia riparia
105	Cliff Swallow	Petrochelidon pyrrhonota
106	Barn Swallow	Hirundo rustica
107	Carolina Chickadee	Poecile carolinensis
108	Black-capped Chickadee	Poecile atricapillus
109	Tufted Titmouse	Baeolophus bicolor
110	Red-breasted Nuthatch	Sitta canadensis
111	White-breasted Nuthatch	Sitta carolinensis
112	Brown Creeper	Certhia americana
113	Carolina Wren	Thryothorus ludovicianus
114	House Wren	Troglodytes aedon
115	Winter Wren	Troglodytes troglodytes
116	Marsh Wren	Cistothorus palustris
117	Golden-crowned Kinglet	Regulus satrapa
118	Ruby-crowned Kinglet	Regulus calendula
119	Blue-gray Gnatcatcher	Polioptila caerulea
120	Eastern Bluebird	Sialia sialis
121	Veery	Catharus fuscescens
122	Gray-cheeked Thrush	Catharus minimus
123	Bicknell's Thrush	Catharus bicknelli
124	Swainson's Thrush	Catharus ustulatus
125	Hermit Thrush	Catharus guttatus
126	Wood Thrush	Hylocichla mustelina
127	American Robin	Turdus migratorius
128	Gray Catbird	Dumetella carolinensis
129	Northern Mockingbird	Mimus polyglottos
130	Brown Thrasher	Toxostoma rufum
131	European Starling	Sturnus vulgaris
132	Cedar Waxwing	Bombycilla cedrorum
133	Blue-winged Warbler	Vermivora pinus
134	Golden-winged Warbler	Vermivora chrysoptera
135	Tennessee Warbler	Vermivora peregrina
136	Orange-crowned Warbler	Vermivora celata

137	Nashville Warbler	Vermivora ruficapilla
138	Northern Parula	Parula americana
139	Yellow Warbler	Dendroica petechia
140	Chestnut-sided Warbler	Dendroica pensylvanica
141	Magnolia Warbler	Dendroica magnolia
142	Cape May Warbler	Dendroica tigrina
143	Black-throated Blue Warbler	Dendroica caerulescens
144	Yellow-rumped Warbler	Dendroica coronata
145	Black-throated Gray Warbler	Dendroica nigrescens
146	Black-throated Green Warbler	Dendroica virens
147	Townsend's Warbler	Dendroica townsendi
148	Blackburnian Warbler	Dendroica fusca
149	Yellow-throated Warbler	Dendroica dominica
150	Pine Warbler	Dendroica pinus
151	Prairie Warbler	Dendroica discolor
152	Palm Warbler	Dendroica palmarum
153	Bay-breasted Warbler	Dendroica castanea
154	Blackpoll Warbler	Dendroica striata
155	Cerulean Warbler	Dendroica cerulea
156	Black-and-white Warbler	Mniotilta varia
157	American Redstart	Setophaga ruticilla
158	Prothonotary Warbler	Protonotaria citrea
159	Worm-eating Warbler	Helmitheros vermivorum
160	Ovenbird	Seiurus aurocapilla
161	Northern Waterthrush	Seiurus noveboracensis
162	Louisiana Waterthrush	Seiurus motacilla
163	Kentucky Warbler	Oporornis formosus
164	Connecticut Warbler	Oporornis agilis
165	Mourning Warbler	Oporornis philadelphia
166	Common Yellowthroat	Geothlypis trichas
167	Hooded Warbler	Wilsonia citrina
168	Wilson's Warbler	Wilsonia pusilla
169	Canada Warbler	Wilsonia canadensis
170	Yellow-breasted Chat	Icteria virens
171	Summer Tanager	Piranga rubra
172	Scarlet Tanager	Piranga olivacea

173	Eastern Towhee	Pipilo erythrophthalmus
174	American Tree Sparrow	Spizella arborea
175	Chipping Sparrow	Spizella passerina
176	Field Sparrow	Spizella pusilla
177	Savannah Sparrow	Passerculus sandwichensis
178	Fox Sparrow	Passerella iliaca
179	Song Sparrow	Melospiza melodia
180	Lincoln's Sparrow	Melospiza lincolnii
181	Swamp Sparrow	Melospiza georgiana
182	White-throated Sparrow	Zonotrichia albicollis
183	White-crowned Sparrow	Zonotrichia leucophrys
184	Dark-eyed Junco	Junco hyemalis
185	Snow Bunting	Plectrophenax nivalis
186	Northern Cardinal	Cardinalis cardinalis
187	Rose-breasted Grosbeak	Pheucticus ludovicianus
188	Blue Grosbeak	Guiraca caerulea
189	Indigo Bunting	Passerina cyanea
190	Bobolink	Dolichonyx oryzivorus
191	Red-winged Blackbird	Agelaius phoeniceus
192	Eastern Meadowlark	Sturnella magna
193	Yellow-headed Blackbird	Xanthocephalus xanthocephalus
194	Rusty Blackbird	Euphagus carolinus
195	Common Grackle	Quiscalus quiscula
196	Brown-headed Cowbird	Molothrus ater
197	Orchard Oriole	Icterus spurius
198	Baltimore Oriole	Icterus galbula
199	Pine Grosbeak	Pinicola enucleator
200	Purple Finch	Carpodacus purpureus
201	House Finch	Carpodacus mexicanus
202	Red Crossbill	Loxia curvirostra
203	Common Redpoll	Carduelis flammea
204	Pine Siskin	Carduelis pinus
205	American Goldfinch	Carduelis tristis
206	Evening Grosbeak	Coccothraustes vespertinus
207	House Sparrow	Passer domesticus

CONFIRMED BREEDERS IN 1995

From Laurie Larson, a list of the birds that were "confirmed" breeders (by the standards of the Breeding Bird Atlas) in 1995 in the Institute Woods and Rogers Refuge (53 total):

Green-backed Heron
Canada Goose
Wood Duck
Mallard
Killdeer
Rock Dove
Mourning Dove
Great Horned Owl
Belted Kingfisher
Red-bellied Woodpecker
Downy Woodpecker
Northern Flicker
Pileated Woodpecker
Eastern Wood-Pewee
Willow Flycatcher
Eastern Phoebe
Eastern Kingbird
Tree Swallow
Barn Swallow
Blue Jay
American Crow
Carolina Chickadee
Tufted Titmouse
White-breasted Nuthatch
Carolina Wren
House Wren
Blue-gray Gnatcatcher
Wood Thrush
American Robin
Gray Catbird
Northern Mockingbird

Cedar Waxwing
European Starling
Yellow-throated Vireo
Warbling Vireo
Blue-winged Warbler
Yellow Warbler
American Redstart
Ovenbird
Common Yellowthroat
Scarlet Tanager
Northern Cardinal
Rose-breasted Grosbeak
Chipping Sparrow
Song Sparrow
Swamp Sparrow
Red-winged Blackbird
Common Grackle
Brown-headed Cowbird
Orchard Oriole
Northern Oriole
House Finch
House Sparrow

In addition, these species were categorized as "probably breeding" (15 total):

Yellow-billed Cuckoo
Chimney Swift
Ruby-throated Hummingbird
Hairy Woodpecker
Acadian Flycatcher
Great Crested Flycatcher
Veery
White-eyed Vireo
Red-eyed Vireo
Black-and-White Warbler
Worm-eating Warbler

Kentucky Warbler

Indigo Bunting

Rufous-sided Towhee

American Goldfinch

APPENDIX F

PLANT INVENTORIES FOR PRINCETON, NEW JERSEY

Compiled and amended by Stephen Hiltner,
with the help of FOPOS intern Sarah Chambliss

Location Key	
ML/WW = Mountain Lakes/Witherspoon Woods	AH = Autumn Hill
TNC = Original TNC survey of ML	SP = Smoyer Park
T/WW = Tusculum/Witherspoon Woods	BF = Princeton Battlefield
T = Tusculum	IW = Institute Woods
PROW = Petroleum Right of Way	IW/RWR = Institute Woods/Rogers Wildlife Refuge
CPN = Community Park North	RWR = Rogers Wildlife Refuge
GM = Greenway Meadows	CWH = D&R Canal, from Washington Rd to Harrison St
14AP = 14 Acre Preserve	TBP = Turning Basin Park and canal east of Alexander Rd.
WF = Woodfield	WRSC = Washington Rd Stream Corridor
HW1 = Herrontown Woods, done in 70's	MP = Marquand Park
HW 2= Herrontown Woods, done in 2008	HSP = Harrison Street Park
PL – Planted *E – Exotic species* ** - Particularly invasive exotic species* *? – Possibly present, but not confirmed*	

PRINCETON ERI

The following are the sources for the inventories contained in this appendix:

- The HW1 inventory was done by Richard J. Kramer and published by Stony Brook-Millstone Watershed Association in a 1971 book entitled *Herrontown Woods: A Guide to a Natural Preserve.*
- The Nature Conservancy inventory of Mountain Lakes was compiled by botanists working for TNC in July 1987.
- The T/WW, IW/RWR, and SP inventories were conducted by Dr. Patrick L. Cooney in 2004.
- The RWR, HSP, and 14 AP inventories were done by Stephen Hiltner in 2005 to 2007.
- All other plant inventories were led by Stephen Hiltner in summer 2008, with help from Princeton University PICS intern Sarah Chambliss.

Some of these inventories, specifically, HW1, RWR, and HSP, were developed through repeated visits. The rest of the inventories are the result of a single visit along selected trails, and therefore represent only a portion of the existing plant diversity in those preserves.

More than 30 plant species are marked with an asterisk, indicating that they are highly invasive exotics in nature preserves, parks, and/or backyards of Princeton. Many other exotic species that are less invasive are also included in the inventories.

Scientific Name	English Name	ML/WW	TNC	T/WW	T	PROW	CPN	GM	14AP	WF	HW1	HW2	AH	SP	BF	IW	IW/RWR	RWR	CWH	TBP	WRSC	MP	HSP
Abutilon theophrastii	Velvetleaf																	X					
Acalypha sp.	Three-Seeded Mercury			X																			
Acer japonicum	Japanese Maple										X												
Acer negundo	Box Elder	X	X	X			X	X	X					X	X	X	X	X			X		
Acer palmatum	Japanese Maple											X											
*Acer platanoides**	Norway maple	X	X	X	X			X	X					X	X								X
Acer rubrum	Red maple	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X			X		X
Acer saccharinum	Silver Maple	X	X								X			X			X			X		X	X
Acer saccharum	Sugar Maple	X	X						X			X		X	X	X		X					X
Achillea millefolium	Common Yarrow	X	X	X	X	X		X							X				X				
Acorus calamus	Sweetflag	X	X		X																		

Scientific Name	English Name	ML/WW	TNC	T/WW	T	PROW	CPN	GM	14AP	WF	HW1	HW2	AH	SP	BF	IW	IW/RWR	RWR	CWH	TBP	WRSC	MP	HSP
Actaea pachypoda	Baneberry										X	X											
Adiantum pedatum	Maidenhair fern									X	X	X	X										
Ageratum sp.																X							
Agrimonia gryposepela	Tall, Hairy Agrimony										X												
Agrimonia parviflora	Small-Flowered Agrimony										X												
Agropyron repens	Witch Wheatgrass	X	X																				
Agrostis perennans	Upland Bentgrass										X												
Agrostis verticillata	Water Bentgrass										X												
Akebia quinata	Five-Leaf Akebia																	X					
*Ailanthus altissima**	Tree-of-Heaven			X	X						X				X				X	X			X
Alisma subcordatum	Water Plantain																X	X					
*Alliaria petiolata**	Garlic Mustard	X	X	X	X		X	X	X	X			X	X	X	X	X	X	X			X	X
Allium canadense	Wild Onion	X	X					X															
Allium tricoccum	Wild leek								X														
*Allium vineale**	Wild garlic				X	X			X	X	X			X	X								X
Alnus serrulata	Smooth Alder	X	X															X	X	X			
Ambrosia artemisiifolia	Common Ragweed			X										X				X	X	X			X
Ambrosia trifida	Giant Ragweed														X	X				X			
Amelanchier arborea	Shadbush										X												
Amorpha fruticosa	False Indigo	X	X																X		X		
*Ampelopsis brevipedunculata**	Porcelainberry														X	X		X	X	X		X	
Amphicarpa bracteata	Hog Peanut	X							X	X		X	X			X			X				
Anagallis arvensis	Scarlet Pimpernel	X	X																				
Anaphalis margaritacea	Pearly Everlasting																		X				
Andropogon gerardii	Big Bluestem																						
Andropogon virginicus	Broom Sedge Grass			X																			
Anemone nemorosa	Windflower											X											
Anemone quinquefolia	Wood Anemone/Windflower	X								X			X										
Anemonella thalictroides	Rue Anemone										X												

PRINCETON ERI

Scientific Name	English Name	ML/WW	TNC	T/WW	T	PROW	CPN	GM	14AP	WF	HW1	HW2	AH	SP	BF	IW	IW/RWR	RWR	CWH	TBP	WRSC	MP	HSP
Anthemis arvensis	Field or Corn Chamomile										X												
Anthoxanthum odoratum	Sweet Vernalgrass	X	X								X												
Apios americana	Groundnut																		X				
Apocynum cannabinum	Indian Hemp	X	X		X	X				X					X		X		X	X	X		
Arabis candensis	Sicklepod										X												
Aralia sp.	Devils' Club-like (exotic?)						X					X											
Aralia nudicaulis	Wild Sarsaparilla										X												
Arctium minus	Common Burdoch													X	X		X		X				
Arisaema triphyllum	Jack in the Pulpit	X		X					X	X	X	X	X		X	X	X				X		
Aronia arbutifolia	Red Chokeberry	X																					
*Artemisia vulgaris**	Mugwort	X						X	X					X	X		X	X	X	X			
*Arthraxon hispidus**	Small Carpgrass	X				X		X				X											
Arundinaria sp.	Cane																						E
Asclepias incarnata	Swamp Milkweed				X	X	X					X		X			X	X	X				
Asclepias syriaca	Common Milkweed	X	X	X	X	X		X						X	X			X	X	X			
Asclepias tuberosa	Butterfly Weed				X																		
Asclepias viridiflora	Green Comet Milkweed				X																		
Asimina triloba	Pawpaw									?													
Asplenium platyneuron	Ebony Spleenwort										X										X		
Aster divaricatus	White Wood Aster	X		X					X		X						X						
Aster lateriflorus	Calico Aster										X												
Aster pilosus	Frost Aster				X										X								
Aster simplex	Simple Aster										X												
Aster sp.	Aster													X									
Athyrium felix-femina	Lady Fern	X	X	X							X						X		X		X		
Athyrium thelypteroides	Silvery Spleenwort Fern										X												
*Berberis thunbergii**	Japanese Barberry	X	X	X						X	X	X	X	X		X							
Betula alleghaniensis	Yellow Birch								?														
Betula lenta	Black Birch			X							X	X											

Scientific Name	English Name	ML/WW	TNC	T/WW	T	PROW	CPN	GM	14AP	WF	HW1	HW2	AH	SP	BF	IW	IW/RWR	RWR	CWH	TBP	WRSC	MP	HSP
Betula lutea	Yellow Birch										X												
Betula nigra	River Birch								?					X		X	X			X	X		
Betula populifolia	Gray Birch	X	X								X												
Bidens cernua	Beggar Ticks													X									
Bidens coronata, var. trichosperma	Tickseed Sunflower										X												
Bidens sp.	Beggar Ticks			X										X									
Boehmeria cylindrica	False Nettle			X							X	X					X	X		X			X
Botrychium dissectum	Common Grape Fern										X												
Botrychium dissectum, forma oneidense	Blunt-Lobe Grape Fern										X												
Botrychium virginianum	Rattlesnake Fern									X	X	X											
Brassica sp.	Mustard	X	X																				
Bromus inermis	Smooth Brome Grass			X																			
Cardamine bulbosa	Spring Cress	X																					
Cardamine pratensis	Cuckoo Flower	X		X																			
Carex conoidea	Field Sedge	X	X																				
Carex crinita	Fringed Sedge	X	X														X	X					
Carex digitalis	Slender Woodland Sedge										X												
Carex frankii	Frank's Sedge	X	X																				
Carex intumescens	Bladder Sedge	X	X																				
Carex laxiflora type	Loose-Flowered Type Sedge			X																			
Carex lupulina	Hop Sedge										X												
Carex lurida	Sallow Sedge	X	X	X				X															
Carex pennsylvanica	Pennsylvania sedge	X							X														
Carex scoparia	Broom Sedge	X	X		X			X															
Carex squarrosa	Squarrose Sedge	X	X																				
Carex stipata	Awl-fruited Sedge	X	X																				
Carex stricta	Tussock Sedge	X							X														
Carex vulpinoidea	Fox Sedge							X							X								
Carpinus caroliniana	Ironwood	X	X	X					X	X	X	X	X			X	X	X		X			

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Scientific Name	English Name	ML/WW	TNC	T/WW	T	PROW	CPN	GM	14AP	WF	HW1	HW2	AH	SP	BF	IW	IW/RWR	RWR	CWH	TBP	WRSC	MP	HSP
Carya glabra	Pignut Hickory			X								X											
Carya illioinensis	Pecan														X								
Carya ovalis	Red Hickory	X	X								X												
Carya ovata	Shagbark Hickory	X	X	X					X		X	X	X		X	X		X			X		
Carya sp.	Hickory															X					X		
Carya sp.	Hickory																						
Carya tomentosa	Mockernut Hickory	X	X	X							X						X						
Castanea dentata	American Chestnut										X												
Castanea mollissima	Chinese Chestnut														X								
Catalpa speciosa	Northern Catalpa	X	X					X									X				X		X
*Celastrus orbiculatus**	Oriental bittersweet	X	X	X				X	X			X	X	X	X		X	X	X				X
Celtis occidentalis	Common Hackberry						X				X												X
Centaurea nigrescens	Tyrol knapweed																		X				
*Centaurea sp.**	Knapweed							X															
Cephalanthus occidentalis	Buttonbush																	X	X	X			
Chamaecrista nictitans	Wild Sensitive Plant																		X				
Chamaecrista sp.	Wild Senna																		X				
Chelone glabra	turtlehead	X		X					X		X							X					
Chimaphila maculata	Spotted Wintergreen	X	X								X	X											
Chrysanthemum leucanthemum	Ox-eye Daisy	X	X		X																		
Cichorium intybus	Chicory			X							X												
Cicuta maculata	Spotted Water Hemlock																	X					
Cimicifuga racemosa	Black Cohosh	X								X	X	X	X								X		
Cinna arundinacea	Sweet Wood Reed			X			X				X							X		X			
Circaea lutetiana	Enchanter's Nightshade				X							X	X		X	X		X				X	
Circaea quadrisulcata	Enchanter's Nightshade										X												
*Cirsium arvense**	Canada Thistle	X	X		X			X						X	X								
Cirsium discolor	Field Thistle			X																			
*Cirsium vulgare**	Bull Thistle	X	X			X								X									

Scientific Name	English Name	ML/WW	TNC	T/WW	T	PROW	CPN	GM	14AP	WF	HW1	HW2	AH	SP	BF	IW	IW/RWR	RWR	CWH	TBP	WRSC	MP	HSP
Claytonia virginica	Spring Beauty	X								X	X						X				X		
*Clematis ternifolia**	Sweet Autumn Clematis																						X
Clematis virginiana	Virgin's Bower												X						X				
Clethra alnifolia	Sweet Pepperbush																		X				
Collinsonia canadensis	Horse Balm										X										X		
Commelina sp.	Dayflower	X	X																				X
Convulvulus arvensis	Bindweed														X								
Conyza canadensis	Horseweed							X															
Cornus amomum	Silky Dogwood				X		X								X			X	X	X			
Cornus drummondii	Roughleaf Dogwood	X	X																				
Cornus florida	Flowering Dogwood	X	X	X	X		X	X		X	X	X	X	X	X		X						X
Cornus kousa	Kousa dogwood																						X
Cornus racemosa	Gray-Stemmed Dogwood										X												
*Coronilla varia**	Crown Vetch	X																	X				
Corylus americana	American Hazelnut										X												
Crataegus crus-galli	Cockspur Hawthorn																	X					
*Cynodon dactylon**	Bermuda Grass																		X				X
Cynoglossum virginianum	Wild Comfrey										X												
*Cyperus esculentus**	Yellow Nutsedge							X						X				X					
Dactylis glomerata	Orchard Grass				X						X			X									
Daucus carota	Queen Anne's Lace			X	X	X						X		X	X		X		X	X			
Decodon verticillatus	Water-willow																	X					
Dennstaedtia punctilobula	Hayscented Fern										X										X	X	
Dentaria laciniata	Cut-leaved Toothwort	X							X														
Desmodium canadense	Showy Tick-Trefoil				X										X				X				
Desmodium nudiflorum	Naked-flowered Tick Trefoil										X	X											
Desmodium paniculatum	Paniculate Tick Trefoil										X												
Deutsia sp.	Deutsia																						X
Dianthus armeria	Deptford Pink				X																		

PRINCETON ERI

Scientific Name	English Name	ML/WW	TNC	T/WW	T	PROW	CPN	GM	14AP	WF	HW1	HW2	AH	SP	BF	IW	IW/RWR	RWR	CWH	TBP	WRSC	MP	HSP
Dichanthelium boscii	Bosc's Panic-Grass										X												
Dichanthelium clandestinum	Deertongue Grass		X	X	X	X			X	X					X	X		X	X				
Dichanthelium dichotomum	Cypress Panic-Grass										X												
Dioscorea villosa	Wild Yam Root			X							X												
Diospyros virginiana	Persimmon					X				X	X												
Dryopteris erythrosora	Autumn Fern																				X		
Dryopteris marginalis	Wood Fern										X										X		
Dryopteris spinulosa	Spinulose Wood Fern	X									X					X							
*Duchesnea indica**	Indian Mock-Strawberry									X				X									X
Echinochloa crus-galli	Barnyard Grass					X		X						X									
*Eleagnus angustifolia**	Russian Olive				X						X				X								
*Eleagnus umbellata**	Autumn Olive							X						X				X					
Elymus hystrix	Bottlebrush Grass	X		X			X		X	X	X												
Elymus virginicus	Wild Rye	X		X						X								X		X			
Epifagus virginiana	Beech Drops			X							X							X					
Epilobium coloratum	Purpleleaf Willowherb			X										X				X			X		
Equisetum arvense	Field Horsetail			X																			
Equisetum sp.	Horsetail											X											
Erechtites hieraciifolia	Pilewort							X						X								X	
Erigeron annuus	Daisy Fleabane				X			X			X				X					X			
Erythronium americanum	Trout Lily	X		X						X	X						X						
*Euonymus alatus**	Winged Euonymus		X					X	X	X		X	X	X	X	X		X			X	X	
Euonymus americanus	Strawberry Bush										X	X											
Eupatorium dubium	Eastern Joe-Pye-Weed																	X					
Eupatorium fistulosum	Hollow Joe-Pye-Weed												X						X				
Eupatorium perfoliatum	Common Boneset										X						X	X					
Eupatorium purpureum	Joe-pye-weed										X	X											
Eupatorium rugosum	White Snakeroot			X					X		X							X					X
Eurybia divaricata	Woodland Aster							X		X		X											

Scientific Name	English Name	ML/WW	TNC	T/WW	T	PROW	CPN	GM	14AP	WF	HW1	HW2	AH	SP	BF	IW	IW/RWR	RWR	CWH	TBP	WRSC	MP	HSP
Euthamia graminifolia	Lance-leaved Goldenrod				X	X					X			X									
Fagus grandifolia	American Beech		X	X				X	X		X	X	X		X	X	X	X			X	X	
Festuca rubra	Red Fescue		X																				
Forsythia sp.	Forsythia																						X
Fragaria vesca	Woodland Strawberry		X								X												
Fragaria sp.	Wild Strawberry	X													X				X				
Fraxinus americana	White Ash		X	X	X				X		X	X	X	X		X	X				X		X
Fraxinus americana, var. biltmoreana	Biltmore Ash										X												
Fraxinus pennsylvanica	Green Ash		X				X		X								X	X			X		X
Fraxinus sp.	Ash														X								
Galium asprellum	Rough Bedstraw										X												
Galium circaezans	Licorice Bedstraw										X												
Galium sp.	Bedstraw											X	X										
Gaultheria procumbens	Wintergreen									X													
Gaylussacia frondosa	Huckleberry										X												
Geranium maculatum	Wild Geranium	X									X	X	X										
Gerardia laevigata	Entire-Leaved False Foxglove										X												
Gerardia virginica	Downy False Foxglove										X												
Geum aleppicum	Yellow Avens														X								
Geum canadense	White Avens			X																			
Geum laciniatum	Rough Avens							X															
Geum sp.	Avens				X					X		X	X										
Geum virginianum	Cream Avens										X												
Ginkgo biloba	Gingko																						X
*Glechoma hederacea**	Ground Ivy										X												X
Glyceria striata	Fowl Meadow Grass										X												
Goodyera pubescens	Downy Rattlesnake Plantain										X												
Hamamelis virginiana	Witch Hazel	X		X					X	X	X	X									X		X
*Hedera helix**	English Ivy			X																		X	X

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Scientific Name	English Name	ML/WW	TNC	T/WW	T	PROW	CPN	GM	14AP	WF	HW1	HW2	AH	SP	BF	IW	IW/RWR	RWR	CWH	TBP	WRSC	MP	HSP
Helenium autumnale	Common Sneezeweed																	X					
Helenium flexuosum	Purple-Headed Sneezeweed	PL																	X				
Helianthus sp.	Sunflower												X						X	X			
Hepatica americana, forma candida	White Hepatica										X												
Hesperis matronalis	Dame's Rocket	X																					
Heuchera americana	Alumroot										X												
Hibiscus moscheutos	Rose Mallow Hibiscus						PL											X	X	X			
Hibiscus syriacus	Rose of Sharon																						X
Hieracium aurantiacum	Devil's Paint-Brush										X												
Hieracium sp.	Hawkweed (non-native)	X												X									
Hypericum perforatum	St. John's Wort				X														X				
Hypericum spathulatum	Shrubby St. Johnswort	X																					
Hypoxis hirsute	Stargrass	X									X												
Ilex crenata	Japanese Holly										X												
Ilex laevigata	Smooth Winterberry										X												
Ilex opaca	American Holly			X						X	X	X										X	
Ilex verticillata	Common Winterberry	X									X												
Impatiens capensis	Jewelweed		X	X	X			X	X	X	X			X	X	X	X	X	X			X	
Impatiens palida	Pale Jewelweed	X																					
*Iris pseudacorus**	Yellow Flag Iris	X															X	X					
Iris versicolor	Blue Flag Iris	X																	X				
Juglans cinerea	Butternut										X												
Juglans nigra	Black Walnut		X		X		X				X				X			X					X
Juncas effusus	Soft Rush		X		X	X		X	X			X		X				X	X				
Juncas tenuis	Path Rush		X	X	X					X	X	X	X	X	X	X	X		X				
Juniperus virginiana	Eastern Redcedar		X	X	X			X		X	X		X	X									X
Kalmia latifolia	Mountain Laurel																					PL	
Koelreuteria paniculata	Goldenrain Tree																					PL	
Krigia biflora	Dwarf Dandelion										X												

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Leersia oryzoides	Rice cutgrass							X		X			X			X					X		
Leersia virginica	White Cutgrass										X												X
Lemna sp.	Duckweed													X			X						
Lepidium campestre	Field Peppergrass										X												
Lepidium virginicum	Wild Pepperweed		X																				
*Lespedeza cuneata**	Chinese Bush Clover			X		X		X				X											
Leucothoe sp.																						PL	
*Ligustrum sinense**	Chinese privet	X			X								X		X								X
Ligustrum sp.	Privet		X	X					X					X			X					X	
*Ligustrum vulgare**	Common Privet										X							X		X			
Lilium philadelphicum	Wood Lily										X												
Linaria vulgaris	Butter and Eggs			X	X	X					X												
Lindera benzoin	Spicebush		X	X	X		X		X	X	X		X		X	X	X	X			X		
Liquidambar styraciflua	Sweetgum			X							X	X		X		X	X	X					
Liriodendron tulipifera	Tuliptree/Tulip poplar	X	X	X	X				X	X	X	X	X	X	X	X	X	X			X	X	
Lobelia cardinalis	Cardinal Flower	X									X	X								X			
Lobelia inflata	Indian Tobacco			X																			
Lobelia sp.	Lobelia				X			X															
*Lonicera japonica**	Japanese Honeysuckle	X		X	X			X	X		X	X	X	X		X		X	X	X			X
*Lonicera sp.**	additional shrub species	X							X														
*Lonicera sp.**	Bush Honeysuckle		X		X		X	X	X						X		X						X
*Lonicera mackii**	Amur Honeysuckle			X										X									
*Lonicera morrowii**	Morrow's Honeysuckle			X										X									
Lotus corniculatus	Birdfoot Trefoil	X			X	X													X				
Ludwigia palustris	Marsh Purslane										X						X						
Lycopodium complanatum	Ground-Pine										X												
Lycopodium lucidulum	Shining Club Moss										X												
Lycopus sp.	Water Horehound			X										X									
Lycopus virginiana	Virginia Bugleweed					X											X						

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Scientific Name	English Name	ML/WW	TNC	T/WW	T	PROW	CPN	GM	14AP	WF	HW1	HW2	AH	SP	BF	IW	IW/RWR	RWR	CWH	TBP	WRSC	MP	HSP
Lyonia ligustrina	Maleberry										X												
Lysimachia ciliata	Fringed Loosestrife		X															X	X				
Lysimachia nummularia	Moneywort		X	X	X										X	X	X						
Lysimachia punctata	Yellow Loosestrife									X													
Lysimachia quadrifolia	Whorled Loosestrife										X												
*Lythrum salicaria**	Purple Loosestrife																X	X	X	X			
Maclura pomifera	Osage-orange		X																				
Magnolia tripetala	Umbrella Magnolia																				X		
Magnolia virginiana	Sweetbay Magnolia													PL									
Maianthemum racemosum	False Solomon's Seal										X	X				X							
Malus coronaria	Wild Crabapple		X																				
Malus pumila	Apple		X																				
Matteuccia struthopteris	Ostrich fern												X										
Medicago lupulina	Black Medic				X																		
Medeola virginiana	Indian Cucumber Root										X												
Menispermum canadensis	Canada Moonseed										X						X						
*Microstegium vimineum**	Japanese Stiltgrass	X		X	X			X	X	X		X	X	X	X		X	X	X			X	X
Mikania scandens	Climbing Boneset																	X	X	X			
Mimulus ringens	Allegheny Monkeyflower			X		X											X			X			
Mitchella repens	Partridge Berry			X							X	X											
Monotropa uniflora	Indian Pipes									X	X	X	X			X							
Morus alba	White Mulberry			X																			
Morus rubra	Red Mulberry				X																		X
Morus sp.	Mulberry														X								
Muhlenbergia schreberi	Nimblewill									X													
Myosotis laxa	Small Forget-Me-Not										X												
Nuphar variegata	Spatterdock																X	X		X			
Nyssa sylvatica	Blackgum	X?		X						X	X	X	X				X				X		
Oenothera biennis	Evening Primrose																		X	X			

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Oenothera fruticosa	Sundrops										X												
Onoclea sensibilis	Sensitive Fern		X		X	X			X	X	X	X	X		X	X	X	X			X	X	
	Orchid-like Flower																		X				
*Ornithogalum umbellatum**	Star of Bethlehem								X														
Orobanche uniflora	One-Flowered Broomrape										X												
Osmunda cinnamomea	Cinnamon Fern										X												
Osmunda claytoniana	Interrupted Fern										X												
Osmunda regalis	Royal Fern										X	X											
Ostrya virginiana	Hop Hornbeam		X?	X																			
Oxalis acetosella	Wood Sorrel		X	X				X														X	
Oxydendrum arboreum	Sourwood																						
Pachysandra terminalis	Pachysandra			X									X									PL	
Panicum virgatum	Switch Grass		X		X	X													X				
Paronychia canadensis	Slender Forked Chickweed		X																				
Parthenocissus quinquefolia	Virginia Creeper	X	X	X	X			X	X	X	X	X	X	X	X	X		X				X	X
Paspalum sp.	Paspalum							X															
Paulownia tomentosa	Princess Tree			X											X				X	X			
Pedicularis canadensis	Wood Betony										X												
Peltandra virginica	Arrow Arum																X	X					
Penstemon sp.	Penstemon				X																		
Penstemon digitalis	Foxglove Beardtongue	X		X																			
Penthorum sedoides	Ditch Stonecrop	X																					
*Phalaris arundinacea**	Reed Canary Grass			X													X	X					
Phegopteris hexagonoptera	Broad Beech Fern									X													
Philadelphus sp.	Mock Orange						X																
Phleum pratense	Timothy		X		X										X								
*Photinia villosa**	Asian Photinia			X	X		X	X		X		X			X	X						X	
*Phragmites australis**	Common Reed			X	X	X					X	X					X	X					
Physostegia virginiana	Obedient Plant						X																

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Phytolacca americana	Pokeweed		X					X			X			X	X	X	X	X	X	X	X	X	X
Picea abies	Norway Spruce			X			X	X						X		X							X
Picea sp.	Spruce				X																		
Pilea pumila	Clearweed		X	X				X			X	X				X	X	X			X	X	
Pinus griffithii (P. wallichiana?)	Himalayan White Pine																						X
Pinus strobus	White Pine		X	X			X		X		X			X		X	X						X
Pinus sylvestris	Scotch Pine		X								X												
Pistia stratiotes	Water Lettuce																		X				
*Plantago lanceolata**	English Plantain		X											X									X
*Plantago major**	Common Plantain		X											X		X						X	X
Plantanthera lacera	Ragged Fringed Orchis				X																		
Platanus occidentalis	Sycamore		X						X								X	X					X
Platanus sp.	Sycamore							X						PL								X	
Poa pratensis	Kentucky Blue Grass										X												
Podophyllum peltatum	Mayapple	X							X	X	X	X	X			X	X				X	X	
Polygonatum canaliculatum	Great Solomon's Seal																			X			
Polygonatum commutatum	Solomon's Seal									X													
Polygonatum pubescens	Hairy Soloman's Seal										X												
Polygonum arifolium	Halberdleaf Tearthumb																	X					
Polygonum caespitosum	Long-bristled Smartweed		X	X										X			X						
Polygonum coccineum	Water Smartweed										X												
*Polygonum cuspidatum**	Japanese Knotweed																	X		X		X	
Polygonum hydropiperoides	Swamp Smartweed		X	X										X		X							
*Polygonum persicaria**	Lady's Thumb							X		X		X	X		X	X		X	X	X		X	X
Polygonum sagittatum	Arrow-leaved Tear Thumb		X	X		X								X			X	X					
Polygonum scandens	Climbing False Buckwheat																	X					
Polygonum sp.	Smartweed					X		X															
Polygonum virginianum	Jumpseed Knotweed		X	X			X	X		X		X			X	X	X	X		X	X	X	X
Polypodium sp	Rockcap Fern			X																			

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Polypodium virginianum	Rock Polypody										X												
Polystichum acrostichoides	Christmas Fern	X		X					X	X	X	X									X	X	
Pontederia cordata	Pickerelweed																X	X					
Populus grandidentata	Large-Toothed Aspen										X												
Populus tremuloides	Quaking Aspen																X						
Potentilla canadensis	Dwarf Cinquefoil			X							X												
Potentilla recta	Rough-rooted Cinquefoil				X																		
Prenanthes sp.	Lion's Foot												X										
Prenanthes alba	White Lettuce	X							X														
Prenanthes altissima	Tall White Lettuce																X						
Prenanthes serpentaria	Cankerweed, Lion's Foot										X												
Prenanthes sp.										X													
Prunella vulgaris	Heal-all										X	X				X	X						
Prunus avium	Sweet Cherry										X												
Prunus serotina	Black Cherry	X		X				X	X	X	X		X	X		X	X	X			X	X	X
Prunus virginiana	Chokecherry																				X	X	
Prunus sp.	Cherry				X							X			X								
Pteridium aquilinum	Bracken Fern										X												
Pycnanthemum flexuosum	Appalachian Mountain Mint										X												
Pycnanthemum tenuifolium	Narrow-leaved Mountain Mint	X		X	X	X																	
Pyrus floribunda	Purple Chokeberry										X												
Pyrus malus	Apple			X																			
Quercus alba	White Oak		X	X			X		X	X	X	X	X		X	X		X			X	X	X
Quercus bicolor	Swamp White Oak						X				X		X								X		
Quercus coccinea	Scarlet Oak										X												
Quercus macrocarpa	Bur Oak	X																	X				
Quercus palustris	Pin Oak		X	X	X				X		X	X	X	X	X		X	X			X		X
Quercus rubra	Red Oak		X	X					X		X	X	X			X					X		X
Quercus sp.	Autumn Oak												X										

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Scientific Name	English Name	ML/WW	TNC	T/WW	T	PROW	CPN	GM	14AP	WF	HW1	HW2	AH	SP	BF	IW	IW/RWR	RWR	CWH	TBP	WRSC	MP	HSP
Quercus velutina	Black Oak		X	X					X	X	X	X	X			X					X		
Ranunculus allegheniensis	Common Buttercup										X												
Ranunculus bulbosus	Bulbous Buttercup										X												
*Ranunculus ficaria**	Lesser Celandine	X					X	X	X							X		X	X				
Rhododendron periclymenoides	Pink Azalea										X												
Rhus copallinum	Winged Sumac										X								X	X	X		
Rhus glabra	Smooth Sumac		X												X					X			
Rhus typhina	Staghorn Sumac										X									X			
Robinia pseudoacacia	Black Locust	X		X	X						X	X			X	X		X	X	X		X	X
Rosa carolina	Carolina Rose										X												
*Rosa multiflora**	Multiflora Rose		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X		X	X
Rosa palustris	Swamp Rose																	X	X				
Rubus allegheniensis	Common Blackberry		X		X						X	X	X	X	X	X		X	X				X
Rubus laciniatus	Cutleaf Blackberry							X															
Rubus occidentalis	Black Raspberry		X	X			X			X				X	X								
*Rubus phoenicolasius**	Wineberry	X	X	X			X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X
Rudbeckia hirta	Black-eyed Susan				X																		
Rudbeckia laciniata	Cutleaf Coneflower	PL					PL												X				
Rumex acetosella	Field Sorrel													X									
Rumex crispus	Curly Dock		X											X	X				X				X
Sagittaria latifolia	Broad-leaved Arrowhead		X											X			X		X				
Salix nigra	Black Willow		X	X										X			X						
Salix sp.	Willow Species										X									X			
Sambucus canadensis	Elderberry			X							X						X	X		X			
Sanicula trifoliata	Large-Fruit Blacksnakeroot										X												
Sanguinaria canadensis	Bloodroot									X			X										
Sassafras albidum	Sassafras		X	X	X				X	X	X	X	X	X	X	X	X	X		X			
Satureja vulgaris	Basil	X			X																		
Saururus cernuus	Lizard's Tail																	X	X				

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Schizachyrium scoparium	Little Bluestem				X			X															
Scirpus atrovirens	Dark-green Bulrush		X	X	X	X		X		X		X	X										
Scirpus cyperinus	Wool Grass		X			X						X						X					
Scutellaria elliptica	Hairy Skullcap										X												
Scutellaria lateriflora	Maddog Skullcap																X						
Setaria faberi	Nodding Foxtail Grass			X										X									
Setaria glauca	Yellow Foxtail Grass			X										X									
Sicyos angulatus	Oneseed Bur Cucumber																	X					
Silene dichotoma	Forked Catchfly																			X			
Sisyrinchium angustifolium	Northern Blue-eyed Grass		X							X			X										
Sisyrinchium sp.	Blue-eyed Grass				X																		
Smilacina racemosa	False Solomon's Seal										X		X								X	X	
Smilax glauca	Sawbrier			X																			
Smilax herbacea	Carrion Flower			X							X									X			
Smilax rotundifolia	Round-Leaved Greenbrier		X	X	X					X	X	X				X							
Smilax tamnoides var. hispida	Bristly Greenbrier										X												
Solanum carolinense	Horse Nettle		X	X	X																		
Solanum dulcamara	Climbing Nightshade										X												
Solanum nigrum	Black Nightshade																						X
Solidago caesia	Blue-Stem Goldenrod			X							X												
Solidago canadensis	Canada Goldenrod													X									
Solidago graminifolia (see Euthamia)	Grass-Leaved Goldenrod																						
Solidago rugosa	Rough-Stemmed Goldenrod			X																			
Solidago sp.	Goldenrod							X				X			X	X				X			
Sorghastrum nutans	Indian Grass			X	X			X							X								
Sparganium eurycarpum	Broadfruit Bur-Reed																	X					
Spiraea alba var latifolia	Meadow-Sweet																	X					
Staphylea trifolia	American Bladdernut															X		X					
Liquidambar styraciflua	Sweet Gum												X										

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Symplocarpus foetidus	Skunk-Cabbage		X		X					X	X	X				X	X	X			X		
*Taraxacum officinale**	Dandelion									X				X									X
Taxus canadensis	Yew Bush										X											PL	
Thalictrum pubescens	Tall Meadow Rue	X															X	X	X	X		X	
Thaspium trifoliatum	Meadow Parsnip										X												
Thelypteris hexagonoptera	Southern Beech Fern			X							X												
Thelypteris noveboracensis	New York Fern		X	X						X	X		X								X	X	
Thelypteris palustris	Marsh Fern	X	X								X												
Thuja occidentalis	Eastern White Cedar																						X
Tilia americana	Basswood		X	X						X	X				X					X			X
Tilia sp.	Linden																					X	
Toxicodendron radicans	Poison Ivy		X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X			X
Tradescantia virginiana	Virginia Spiderwort										X												
Tridens flavus	Purple Top Grass			X	X	X		X						X				X	X				
Trifolium agrarium	Yellow Clover		X																				
Trifolium pratense	Red Clover			X																			
*Trifolium repens**	White Clover		X											X									X
Tsuga canadensis	Eastern Hemlock		X	X				X							X								X
Typha latifolia	Broad-Leaved Cattail										X						X	X					
Ulmus americana	American elm		X	X					X		X					X	X				X		X
Ulmus rubra	Slippery Elm		X								X												X
Urtica dioica	Stinging Nettle																	X					
Urtica dioica spp. Gracilis	Great Nettle																	X					
Urtica sp.	Nettle								X	X													
Uvularia perfoliata	Perfoliate Bellwort										X												
Vaccinium atrococcum	Black Highbush Blueberry										X												
Vaccinium corymbosum	Highbush Blueberry									X	X										X		
Vaccinium stamineum	Deerberry									X	X												
Vaccinium vacillans	Lowbush Blueberry										X	X											

Scientific Name	English Name	ML/WW	TNC	T/WW	T	PROW	CPN	GM	14AP	WF	HW1	HW2	AH	SP	BF	IW	IW/RWR	RWR	CWH	TBP	WRSC	MP	HSP
Verbascum blattaria	Moth Mullein		X																				
Verbascum thapsus	Common Mullein		X		X										X				X				
Verbena hastata	Blue Vervain													X									
Verbena urticifolia	White Vervain	X		X										X		X			X	X			
Verbesina occidentalis	Stickweed									X													
Vernonia noveboracensis	Ironweed	PL									X	X					X	X	X				
Veronica officinalis	Common Speedwell										X												
Viburnum acerifolium	Maple-leaf viburnum									X	X	X	X			X					X		
Viburnum alnifolia	Hobblebush Viburnum			X																			
Viburnum dentatum	Southern Arrowwood		X							X	X	X						X		X	X		
*Viburnum dilitatum**	Linden Viburnum									X		X	X		X	X						X	
Viburnum lentago	Nannyberry																	X					
Viburnum prunifolium	Blackhaw Viburnum		X	X	X				X	X	X	X	X			X		X			X		
Viburnum rhytidophyllum	Leatherleaf Viburnum						X																
Viburnum setigerum	Tea Viburnum																				X		
Viburnum sieboldil	Siebold's Viburnum																				X		
Viburnum sp.	unidentified at M.L.	X																					
Viburnum trilobum	Highbush Cranberry																						X
Vinca minor	Dwarf Periwinkle/Myrtle																						X
Viola papilionacea	Common Blue Violet									X													
Viola pensylvanica	Smooth Yellow Violet									X													
Viola pubescens	Downy Yellow Violet										X												
Viola sororia	Wooly Blue Violet										X												
Viola spp.	Violets		X						X				X		X		X						
Vitis labrusca	Fox grapes														X								
Vitis palmata	Catbird Grape										X												
Vitis riparia	River-Bank Grape										X												
Vitis spp.	Grapes		X	X	X			X						X	X		X						X
Vitis vulpina	Frost Grape										X												

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Scientific Name	English Name	ML/WW	TNC	T/WW	T	PROW	CPN	GM	14AP	WF	HW1	HW2	AH	SP	BF	IW	IW/RWR	RWR	CWH	TBP	WRSC	MP	HSP
Wisteria sinensis	Chinese Wisteria												X		X			X					X
Wolffia sp.	Water Meal																X						
woodland grass																			X				
Xanthium strumarium	Common Clotbur													X									
Zizania aquatica var. aquatica	Wild-Rice																	X					
Zizia sp.									X														

Abstract Page

Publication Title:	Environmental Resources Inventory for the Township and Borough of Princeton
Publication Number:	09077
Date Published:	January 2010
Geographic Area Covered:	Princeton Township and Princeton Borough, Mercer County
Key Words:	Environment, water quality, watersheds, stormwater, floodplains, wetlands, drinking water, soils, upland forests, grasslands, landscape project, habitat, deer management, historic resources, parks, open space, trails, contaminated sites, conservation, endangered species, Princeton Township, Princeton Borough
Abstract:	This report documents the natural and environmental resources of Princeton Township and Princeton Borough, Mercer County, New Jersey. The natural resource information includes descriptions, tables and maps of land use, soils, physiography, geology, aquifers, surface waters, floodplains, wetlands, natural vegetation, forests, grasslands and animal communities. The report also documents community resources including open space, parks, trails, historic resources, and public utilities. The report also examines current policies regarding surface water protection, non point source pollution, floodplain management, habitat protection, open space preservation, historic resources and known contaminated sites.

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- NJDEP, Historic Preservation Office. *New Jersey and National Registers of Historic Places: Mercer County*. www.nj.gov/dep/hpo/1identify/lists/mercer.pdf
- Princeton Borough Historic Preservation Review Committee: www.princetonhistoricpreservation.org
- Princeton Township Historic Preservation Commission: www.princetontwp.org/histmain.html

Utilities and Services

- List of Public and Private Schools in Princeton: www.princetonol.com/local/priv_schools.shtml
- New Jersey American Water, Water Quality Reporting: www.amwater.com/awpr1/njaw/newsroom/reports_notifications
- Princeton Regional School District: www.prs.k12.nj.us
- Princeton Sewer Operating Committee: www.princetonboro.org/sewer.cfm
- Princeton Townwhip website. Trash and Recycling: www.princetontwp.org/new_resident_info.html
- Stony Brook Regional Sewerage Authority: www.sbrsa.com

Parks and Recreation

- Friends of Princeton Open Space: www.fopos.org
- New Jersey Trails Association. *Find a Place to Walk*. www.njtrails.org/index.php
- Princeton Township Parks and Open Space Guide: www.princetontwp.org/parks_main.html
- Princeton Recreation Department: www.leaguelineup.com/welcome.asp?cmenuid=1&url=princetonrecreation&sid=56437327

Environmental Issues

Known Contaminated Sites

- NJDEP BUST Program: www.nj.gov/dep/srp/bust/bust.htm
- NJDEP Classification Exception Areas: www.state.nj.us/dep/gis/stateshp.html#GWCKE
- NJDEP Known Contaminated Sites Listing: www.state.nj.us/dep/srp/kcsnj
- USEPA Superfund (CERCLIS) Site Finder: www.epa.gov/enviro/html/cerclis/cerclis_query.html

Radon

- NJ Health and Human Services: www.state.nj.us/dep/rpp/radon/ctytiera.htm#11

Air Quality

- NJDEP Air Quality Monitoring: www.state.nj.us/dep/airmon/
- NJDEP Air Toxics Data: www.state.nj.us/dep/airmon/airtoxics/
- USEPA Toxic Release Inventory: www.epa.gov/triexplorer/statefactsheet.htm

for the TOWNSHIP and BOROUGH of

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