Environmental Resource Inventory

Update – 2013

for

Borough of Kinnelon

County of Morris

Compiled by

The Land Conservancy of New Jersey
an accredited land trust

with

Borough of Kinnelon Environmental Commission

March 2013

ENVIRONMENTAL RESOURCE INVENTORY UPDATE- 2013

for

Borough of Kinnelon
County of Morris

Prepared for:

Borough of Kinnelon Environmental Commission

Prepared March 12, 2013 by:

The Land Conservancy of New Jersey
an accredited land trust
19 Boonton Avenue
Boonton, NJ 07005

Barbara Heskins Davis

Barbara Heskins Davis, PP, AICP
NJ Professional Planner (License No.: 5926)

The original document was appropriately signed and sealed in accordance with Chapter 41, Title 13 of the State Board of Professional Planners.

Adopted by the Borough of Kinnelon Planning Board on April 4, 2013

ENVIRONMENTAL RESOURCE INVENTORY UPDATE - 2013

for

Borough of Kinnelon
County of Morris

Produced by:

The Land Conservancy of New Jersey's Partners for Greener Communities Team:
"Partnering with Communities to Preserve Natural Treasures"

David Epstein, President
Barbara Heskins Davis, P.P./AICP, Vice President, Programs
Kenneth Fung, GIS Manager
Albert Macaulay, Planning Intern

Kathleen Caccavale, Project Consultant

For further information please contact:

The Land Conservancy of New Jersey
an accredited land trust
19 Boonton Avenue
Boonton, NJ 07005
(973) 541-1010
Fax: (973) 541-1131
www.tlc-nj.org

Borough of Kinnelon
Environmental Commission
130 Kinnelon Road
Kinnelon, NJ 07405
(973) 838-5401
Fax: (973) 838-1862
http://www.kinnelonboro.org

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Environmental Commission:
Cheryl Canale, Chairperson
Carol Vreeland, Vice Chairperson
Norman Dotti
Nina Mickey
Gene Orcutt
Gary Moleta, 2012 Council Liaison
Carol Sventy, 2013 Council Liaison
Karen Iuele, Secretary

Mayor and Borough Council:

2012 Borough Council:
Robert Collins, Mayor
Stephen Cobell
Gary Moleta
Andrew SanFilippo
James Freda
Ronald Mondello
Dan O'Dougherty

2013 Borough Council:
Robert Collins, Mayor
Stephen Cobell
Gary Moleta
Carol Sventy
James Freda
Ronald Mondello
Dan O'Dougherty

Planning Board:
William Powell, Chairman
Richard Larson, Vice Chairman
Robert Collins, Mayor
Andrew SanFilippo, 2012 Council Liaison
Stephen Cobell, 2013 Council Liaison
Jennifer Highers, Secretary
William Yago
Gene Orcutt
Tamara Roselius
Paul Mudd
Mehul Gadhaui
Norman Dotti
Stephen Savino

Borough Staff:
Elizabeth M. Sebrowski, Borough Clerk (2012), Karen Iuele, Acting Borough Clerk
Jennifer Highers, Secretary, Planning Board

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IN APPRECIATION

The Borough of Kinnelon 2013 Environmental Commission and Council wish to recognize Lucy Meyer, citizen, historian, and environmentalist for her dedication and lifelong contributions to the Borough of Kinnelon.

In 1973-1974 she led the effort, in partnership with Carole Crossman, to complete *A Natural Resource Inventory for the Borough of Kinnelon.* Lucy was the Project Director for the Natural Resource Study Group and Carole Crossman was the Coordinator and also served as Chairwoman of the Kinnelon Environmental Commission at the time of the *NRI's* publication. As written in the *Acknowledgements* of the 1973-1974 *Natural Resource Inventory*, "Special mention is made of Lucy Meyer and Carole Crossman for their enthusiasm and dedication in the conception of this project and without whose perseverance the project would not have been completed." Lucy Meyer served the Borough for 38 years, as a volunteer on the Borough's Environmental Commission and as Historian. In 1976 Lucy authored *Kinnelon: A History Where the Future is Enriched by the Past*, and in the 1980s her efforts were instrumental in preserving Pyramid Mountain Natural Historic Area. For her inventory and documentation of the natural resources of Pyramid Mountain she, and the members of the Committee to Preserve Pyramid Mountain, received the "Pride in America Award" from President Ronald Reagan. Their work was the forerunner of environmental resource inventories throughout the State of New Jersey.

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Photobar Photographs:

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Horsechestnut at Silas Condict County Park
Mountain Laurels at Silas Condict County Park
Pinxter Azalea at the Weber Tract
Pileated Woodpecker at Bald Hill

Horsechestnut, Mountain Laurels and Pinxter Azalea photographs taken by Carol Vreeland, Borough of Kinnelon

Pileated Woodpecker photograph taken by Nina Mickey, Borough of Kinnelon

Photographs

EXECUTIVE SUMMARY

"Kinnelon … is an area of moderately high ridges with large outcrops of granites and gneisses and scattered remnants from its glacial past. Its bedrock consists of some of the oldest rock on earth and its mineral resources are varied…." (*1973-1974 Natural Resource Inventory of Kinnelon)* The Borough's stunning topography is characterized by extensively wooded, rough, rocky hills. Flowing through the valleys are streams leading to and emanating from its many lakes, reservoirs, and marshes. Because of these expansive water resources the New Jersey Highlands, specifically the Farny Highlands and Pequannock watershed lands located in and nearby Kinnelon, have been identified as a "critical treasure" for preservation. Kinnelon has been recognized as having enormous biological value and as home to significant drinking water supply areas.

The *2013 Environmental Resource Inventory (ERI) Update* is based on available data from federal and state resources, as well as municipal resources, including the *1973-1974 Environmental Resource Inventory for Kinnelon, NJ.* Ensuring the high quality of life for the residents of Kinnelon Borough is a driving force behind this *Environmental Resource Inventory Update*. Documentation of the natural resource base – the geology, hydrology, ecology, and wildlife – will convey the scope and condition of the resources upon which the Borough relies. This document, in combination with the *2012 Open Space and Recreation Plan Update* is a guide for the Borough's future growth and preservation. Extensive mapping and tables detailing the Borough's environmental resource base are included within the *ERI Update*. Sections include information on geology, topography, slopes, hydrology and water resources, soils, flooding, wetlands, wildlife habitat, historic resources, public infrastructure, air, and climate change. The *ERI Update* will assist the community as it makes decisions regarding future planning and development.

In 2011, Kinnelon began to work towards certification through the Sustainable Jersey program. New Jersey is the first state in the nation to have a comprehensive sustainability program for communities that links certification with strong state and private financial incentives, and a fully resourced program of technical support and training. The Borough's Sustainable Jersey Advisory Committee is spearheading the effort toward certification. The Committee's first completed action was the Stonybrook School Garden Project, which received an Environmental Achievement Awards "Honorable Mention" from the Association of New Jersey Environmental Commissions in October 2012. Other completed actions are the Kinnelon Recycling Program, Kinnelon Conserve's Earth Day Fair, K-FEST (Kinnelon Day), the Environmentally Conscious Grounds and Maintenance Policy, the *Open Space and Recreation Plan Update*, and numerous others. The Sustainable Land Use Pledge was passed by the Mayor and Council on March 21, 2013 (see *Appendices* of this report).

The submittal of an updated *Environmental Resource Inventory* will help meet the Borough's goal of being certified as a sustainable community. The Environmental Commission will add new material to the *ERI* as it becomes available and will complete an update to the *ERI* within the prescribed time period (which is currently every ten years).

GEOLOGY

Physiographic Provinces

New Jersey's landscape is divided into four distinctive regions, each characterized by unique geologic processes and landforms, known as physiographic provinces. Physiographic provinces classify landscapes based on terrain texture, rock type, and geologic structure and history. These attributes play an important role in determining the natural resources of an area. In New Jersey, beginning in the northwest and proceeding to the southeast, these provinces are identified as the Valley and Ridge, Highlands, Piedmont, and Coastal Plain Provinces. Kinnelon is located predominantly in the Highlands Province, with a small portion in the southeast corner, below the Ramapo Fault, in the Piedmont Province, generally east of Interstate 287 in the Borough.

The Highlands Province occupies an area of approximately 980 square miles to the east of the Valley and Ridge Province and comprises approximately one-eighth of the state. It is generally characterized as a mountainous belt ranging between 10 to 25 miles wide. The rugged topography of the Highlands consists of a series of discontinuous rounded ridges separated by deep, narrow valleys. The Highlands is mainly composed of highly metamorphosed igneous and sedimentary rocks dating from more than a billion years ago. These rocks are relatively resistant to erosion and result in the steep slopes and mountains common in the Highlands. Also found in the Highlands are small areas of slightly younger (about 540 to 900 million years old) metasedimentary rocks and diabase dikes. (*NJGS Information Circular, Physiographic Provinces of New Jersey)*

The Piedmont Province covers 1,600 square miles, which is roughly 20% of the state. This province is mostly underlain with "slightly folded and faulted sedimentary rocks of Triassic and Jurassic age (240 to 140 million years old) and igneous rocks of Jurassic age." (*New Jersey Geological Survey, Information Circular – Geologic Mapping in New Jersey)* The Piedmont Province's surface is generally low rolling hills marked with sudden, steep ridges, which extend across the state and includes the palisades area in the east.

The *Highlands Region Map (Map 1 in the Maps section)* shows the extent of the Highlands in New Jersey and surrounding states and the demarcation line between the two provinces.

Two of the most notable geological occurrences in Kinnelon are located in Morris County Park Commission's Pyramid Mountain Natural Historic Area. Tripod Rock and Bear Rock are two glacial erratics located within Pyramid Mountain. Glacial erratics are

typically boulders that have been carried great distances by glacial ice and differ from the bedrock or soils of their new home. Tripod Rock can found on the white trail near Big Cat Swamp. Bear Rock can be found on the blue trail near Bear Swamp.

Bedrock Geology

The geology of Kinnelon can be classified into two layers: bedrock geology, which is the consolidated, underlying rock that extends deep into the earth's crust, and surficial geology, which is the unconsolidated sedimentary materials overlaying bedrock formations, and which is the parent material for soils. The properties of these layers "determine the physical extent of aquifers and the chemical quality of the water they yield. They also control how groundwater recharges and moves through the aquifers, how contaminants seep into and move through soil and groundwater, and where natural hazards like radon, sinkholes, and seismic instability may occur. Finally, these properties establish where geologic resources such as sand, gravel, peat, clay, quarry rock, and mineral ores are located. Geologic properties also determine the suitability of an area for the use of septic systems, the management of stormwater and surface runoff, and the stability of foundations for buildings, bridges, tunnels, and other structures". *(New Jersey Geological Survey, Information Circular – Geologic Mapping in New Jersey)*

The underlying bedrock geology of Kinnelon changes significantly between the Highlands and Piedmont Provinces. The *Bedrock Geology Map (Map 2 in the Maps section)* depicts the distribution of bedrock types within Kinnelon and *Table 1* shows the frequency of occurrence. The predominant bedrock types are the Diorite formation (Yd) (3,976 acres or 32% of the Borough), the Quartz-Oligoclase Gneiss (Ylo) formation (3,123 acres, 25% of Kinnelon), and the Hornblende Granite (Ybh) formation (2,138 acres, 17% of the Borough). Of the formations found in Kinnelon Borough, the Quartz-Pebble Conglomerate (Jbcq) and the Hook Mt. Basalt (Jh) are part of the Piedmont Physiographic Province (totaling 64 acres or 0.5% of the Borough).[1]

Surficial Geology

Surficial geology is the unconsolidated materials overlaying bedrock formations. *Table 2. Surficial Geology in Kinnelon Borough* details the surficial geology, and the majority of the Borough (87%, or 10,231 acres) is covered in Netcong Till (Qwtn). The *Surface Geology Map (Map 3 in the Maps section)* depicts the surficial geology features in Kinnelon Borough.

[1] The ArcGIS mapping software calculates the acreages for the municipality based upon the specific dataset being utilized and this can vary slightly for each individual analysis.

Table 1. Bedrock Geology in Kinnelon Borough				
Abbreviation	*Formation*	*Description*	*Acres*	*Percent*
Ya	Amphibolite	amphibolite, fine- to medium-grained	48.73	0.40%
Yb	Biotite-Quartz-Feldspar Gneiss	gneiss, fine- to coarse-grained	814.23	6.61%
Ylb	Biotite-Quartz-Oligoclase Gneiss	gneiss, fine- to coarse-grained	440.28	3.58%
Yd	Diorite	diorite	3,975.77	32.30%
Jh	Hook Mt. Basalt	basalt, fine- to coarse-grained	37.90	0.31%
Ybh	Hornblende Granite	granite, medium- to coarse-grained	2,138.27	17.37%
Yba	Microperthite Alaskite	granite, medium- to coarse-grained	822.92	6.69%
Yk	Potassic Feldspar Gneiss	gneiss, fine- to medium-grained	656.75	5.34%
Yp	Pyroxene Gneiss	gneiss, fine- to medium-grained	94.02	0.76%
Ypg	Pyroxene Granite	granite, medium- to coarse-grained	131.04	1.06%
Ylo	Quartz-Oligoclase Gneiss	gneiss, medium- to coarse-grained	3,122.71	25.37%
Jbcq	Quartz-pebble Conglomerate	sandstone, siltstone, and mudstone, fine-grained; quartz-pebble conglomerate	26.53	0.22%
		Total:	**12,309.15**	**100.00%**
Source: NJDEP				

Table 2. Surficial Geology in Kinnelon Borough						
Abbreviation	*Formation*	*Lithology*	*Age*	*Note*	*Acres*	*Percent*
Qal	Alluvium	Sand, gravel, silt, minor clay and peat; reddish brown, yellowish brown, brown, gray. As much as 20 feet thick.	Holocene and late Pleistocene	Contains variable amounts of organic matter. Deposited in modern floodplains and channels.	2.60	0.02%
Qs	Swamp And Marsh Deposits	Peat and organic clay, silt, and minor sand; gray, brown, black. As much as 40 feet thick.	late Pleistocene and Holocene	Deposited in modern freshwater wetlands.	209.69	1.78%

Table 2. Surficial Geology in Kinnelon Borough						
Abbreviation	*Formation*	*Lithology*	*Age*	*Note*	*Acres*	*Percent*
Qwde	Late Wisconsinan Glacial Delta Deposits	Sand, pebble-to-cobble gravel, minor silt; yellowish brown, reddish brown, light gray. As much as 150 feet thick.	late Pleistocene, late Wisconsinan	Deposited in deltas and other ice-contact landforms in glacial lakes during the late Wisconsinan glaciation.	1,244.91	10.57%
Qwft	Late Wisconsinan Glaciofluvial Terrace Deposits	Sand, pebble-to-cobble gravel, minor silt; yellowish brown to reddish brown. As much as 40 feet thick.	late Pleistocene, late Wisconsinan	Form terraces deposited by glacial streams during the late Wisconsinan glaciation.	30.22	0.26%
Qwic	Ice-Contact Deposits	Sand, pebble-to-cobble gravel, few to some boulders, minor silt; yellowish brown to reddish brown. As much as 150 feet thick.	late Pleistocene, late Wisconsinan	Form knolls and ridges higher than adjacent glacial-lake levels or glaciofluvial plains. Deposited in ice-walled basins during the late Wisconsinan glaciation.	25.64	0.22%
Qwtn	Netcong Till	Silty sand to sandy silt with some to many pebbles and cobbles and some to many boulders; pale brown, yellowish brown, light gray. As much as 200 feet thick, generally less than 30 feet thick.	late Pleistocene, late Wisconsinan	Deposited directly from glacial ice during the late Wisconsinan glaciation.	10,231.06	86.85%
Qwtr	Rahway Till	Clayey silt to sandy silt with some to many pebbles and cobbles and few boulders; reddish brown, reddish yellow, yellowish brown, brown. As much as 100 feet thick, generally less than 40 feet thick.	late Pleistocene, late Wisconsinan	Deposited directly from glacial ice during the late Wisconsinan glaciation.	36.02	0.31%
				Total:	11,780.14	100.00%

GEOGRAPHY AND TOPOGRAPHY

The lowest point in Kinnelon is south of the Ramapo Fault in the Piedmont Valley at 200 feet. Conversely, the high point is Kitty Ann Mountain at 1,120 feet in the Smoke Rise section of town. Kitty Ann Mountain is where the historic Smoke Rise Tower can be seen. Other mountains in the Borough include Bear Mountain, Kakeout Mountain, Buck Mountain, Rock Pear Mountain, Stony Brook Mountain, Pyramid Mountain, Bald Hill, Boulder Hill, and Waughaw Mountain. (*Natural Resource Inventory of Kinnelon, NJ 1973-1974*) This varying topography has greatly affected the ability to develop within the Borough as well as the rate and expanse of soil erosion, due to the large amount of steep slopes in the area. *(See Topography Map, Map 4 in the Maps section)*

Limiting the disturbance of steep slopes is important in preventing soil loss, erosion, excessive stormwater runoff, and the degradation of surface water; as well as maintaining the natural topography and drainage patterns of the land. Disturbing the natural vegetation, topography and drainage patterns of steep slopes often increases the amount and speed of runoff, and can cause erosion, soil creep, slumping (sections of soil shifting down and outward on the slope), and landslides. The combination of unstable slopes and greater runoff means that more water and sediment (silt) enter streams during precipitation events. Increases in water volume entering streams can lead to, or exacerbate, flooding downstream. In addition, an increase in the volume entering streams through runoff means less water is percolating through the soil and back into the groundwater to replenish drinking water supplies or provide base flow for streams during drier periods. The increased water runoff also carries larger loads of sediment compared to predevelopment conditions. Excess sediments in streams can harm aquatic life, accelerate the filling of ponds and wetlands, and decrease a stream's aesthetic appearance.

A large portion of the Borough is identified as either moderately or severely constrained slopes, as per the *Severe and Moderately Constrained Slopes Map (Map 5 in the Maps section).* Because Kinnelon Borough is located predominantly within the Highlands Preservation Area (as identified by the *2004 Highlands Water Protection and Planning Act* and *2008 Highlands Regional Master Plan*) and is conforming to the Plan in the small portion (325 acres) that is identified as Highlands Planning Area, development has been restricted in areas of extreme steep slope throughout the Borough. This will prevent soil erosion and stormwater runoff that could result from such development.

CLIMATE

Prevailing Air Currents in New Jersey

According to the Office of the New Jersey State Climatologist (ONJSC) at Rutgers University, a "broad, undulating flow from west to east" dominates atmospheric circulation in the middle latitudes of North America, including New Jersey. "These 'prevailing westerlies' shift north and south and vary in strength during the course of the year, exerting a major influence on the weather throughout the State."

Climate Zone

New Jersey is divided into five climate zones, with Kinnelon lying in the Northern Zone. According to the ONJSC publication "*The Climate of New Jersey,*" the Northern Climate Zone usually has the shortest growing season, 155 days. The average date for the last killing spring frost is May 4, and the first frost in the fall occurs around October 7. These dates vary from year to year and from place to place within the region. Valley locations may have killing frost in mid-September and as late as mid-June. The average number of freeze free days in the northern Highlands is 163. Snow may fall from about October 15 to April 30, and annual snowfall averages 40 to 50 inches. The ONJSC reports a historic median annual snowfall of 35 inches at the Charlotteburg Reservoir weather station near Kinnelon, based on readings taken during the years 1893 to 2005. In addition, "The highlands and mountains in this area play a role in making the climate of the Northern Zone different from the rest of the state. For instance, following a cold frontal passage, air forced to rise over the mountains, produces clouds, and even precipitation, while the rest of the state observes clear skies." (*ONJSC)* During the warm season, thunderstorms, many of them "spawned" in Pennsylvania and New York, are responsible for most of the rainfall. They average 25 to 30 a year and often reach maximum development in the evening. Tropical cyclones are less frequent in Kinnelon and other inland areas than along the coast. Tornadoes are infrequent and generally weak. (*ONJSC)*

Temperature and Precipitation

The ONJSC maintains temperature and precipitation data from monitoring stations around the state. Some of these records go back to the 1890s. The ONJSC has compiled a northern New Jersey regional report, with values calculated from an average of monthly temperatures. *Figure 1, Figure 2, Figure 3,* and *Figure 4* show an overall upward trend in mean temperature between 1895 and 2011 and this region is both warmer and wetter than in the preceding periods. The long-term mean temperature average is 50.9^{o}F and the long-term mean total precipitation is 46.51 inches for the period 1895-2010.

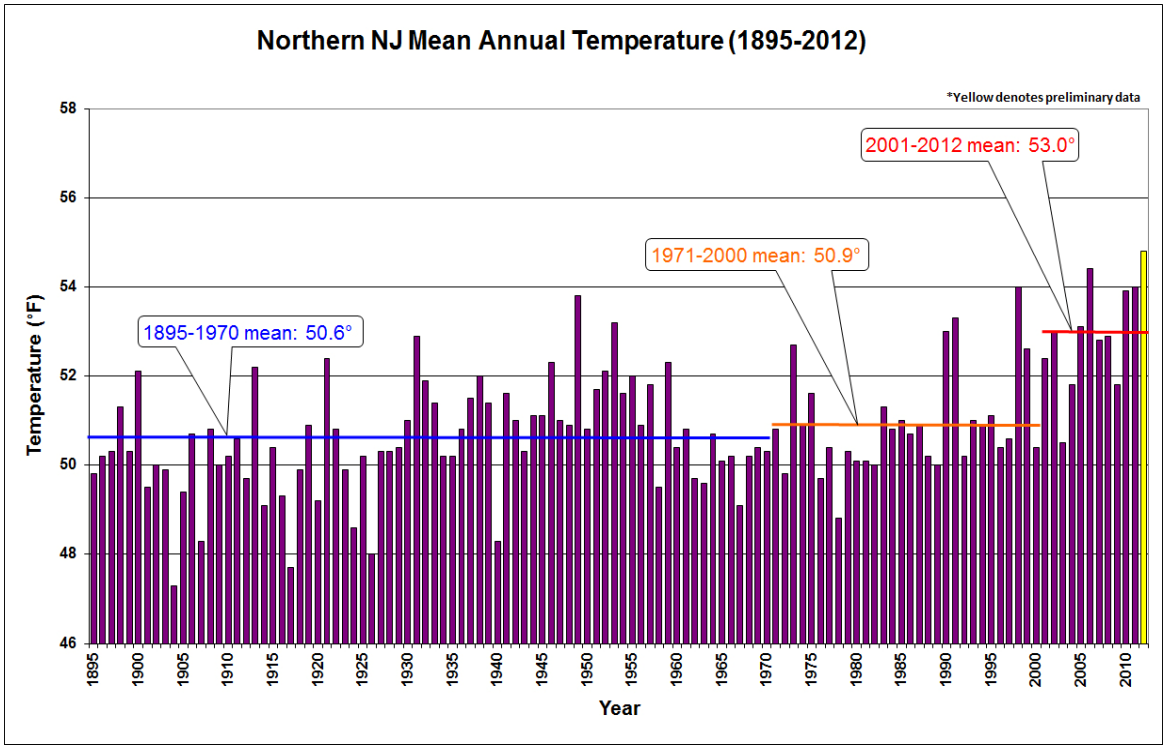


Figure 1. Northern NJ Mean Annual Temperature (1895-2011)

Source: ONJSC

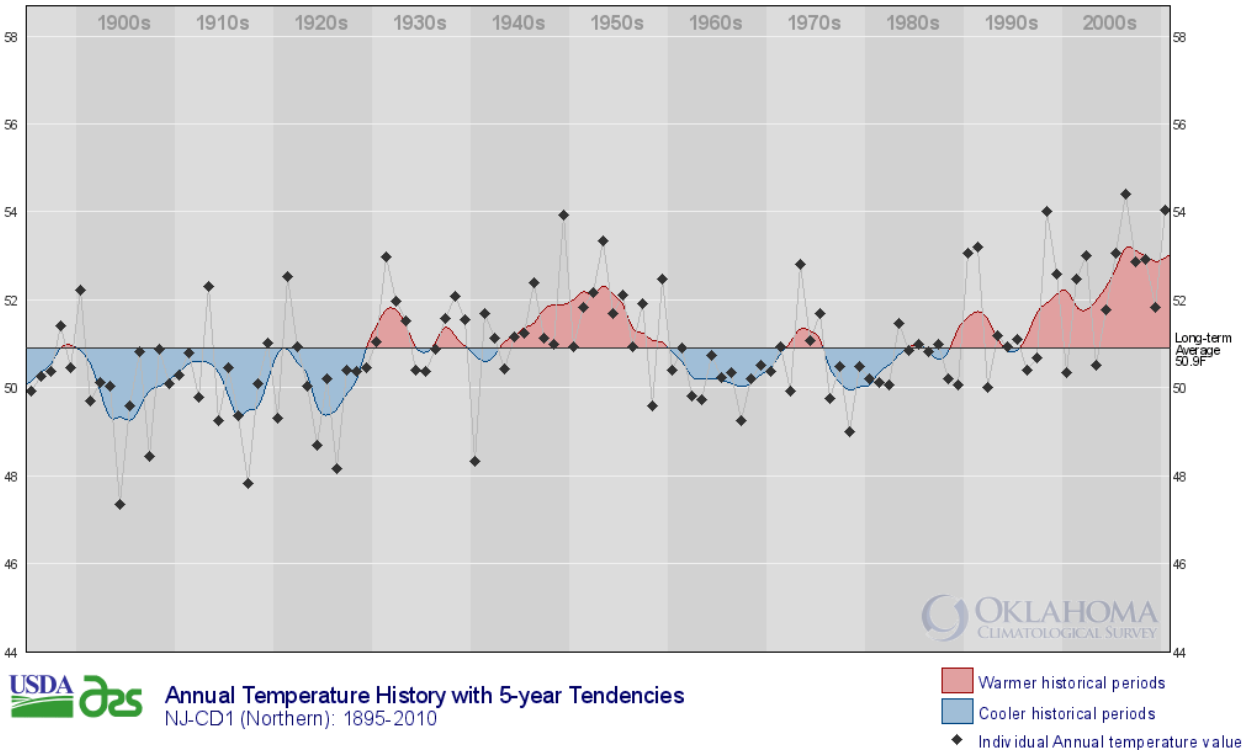


Figure 2. Northern NJ Annual Temperature History 1895-2010

Source: ONJSC/Courtesy of Oklahoma Climatological Survey

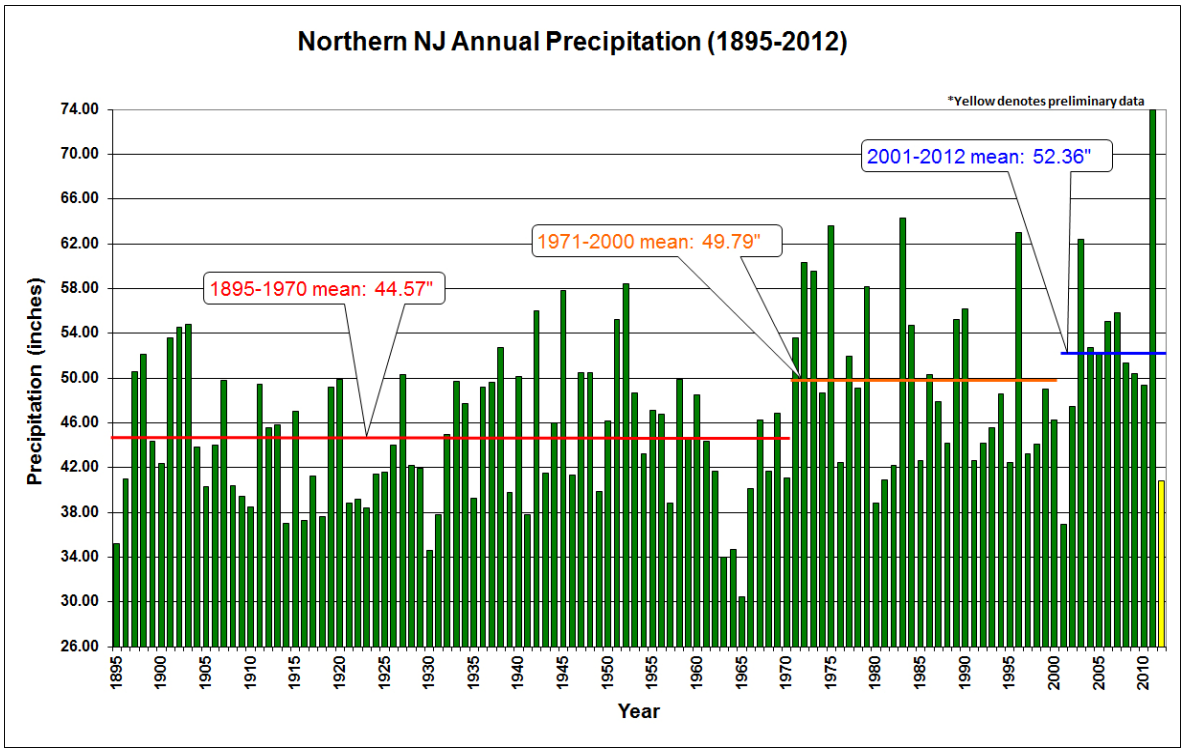


Figure 3. Northern NJ Mean Annual Precipitation (1895-2011)

Source: ONJSC

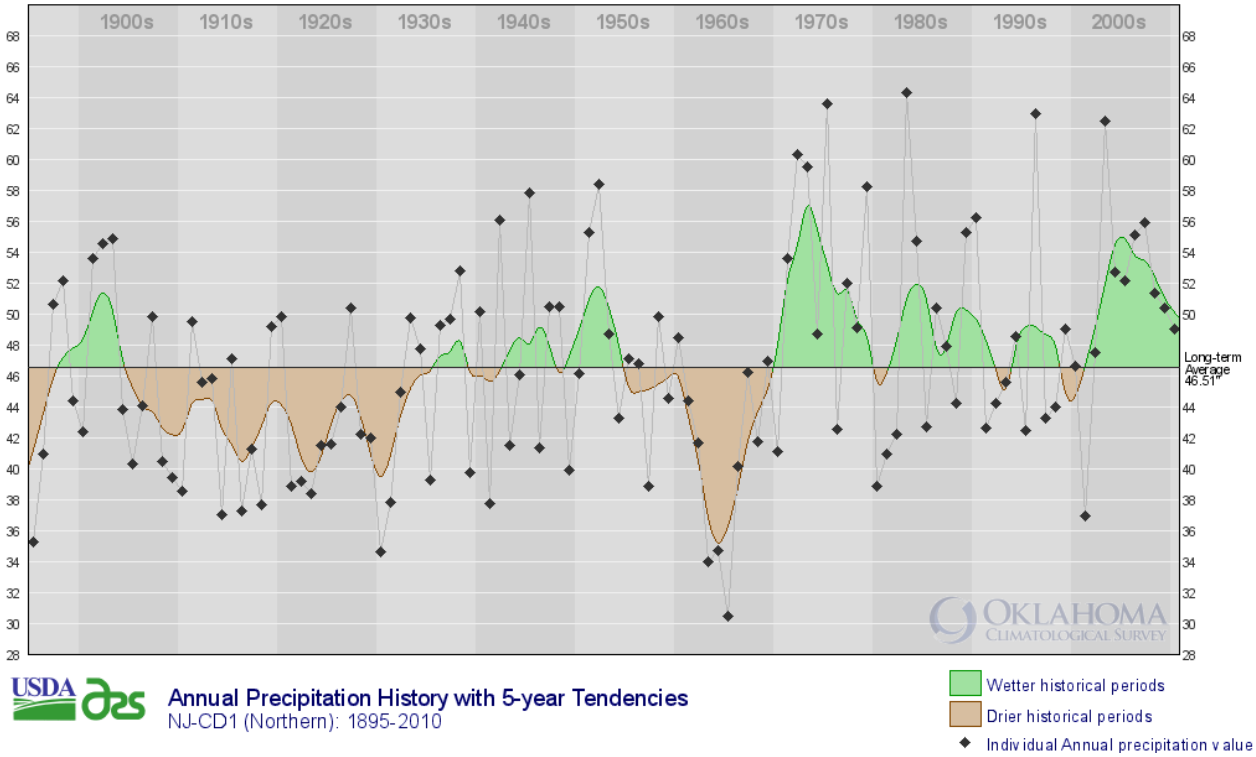


Figure 4. Northern NJ Annual Precipitation History

Source: ONJSC/Courtesy of the Oklahoma Climatological Survey

Local Historic Averages

Two of the ONJSC reporting stations are located close to Kinnelon, in Boonton and at Charlotteburg Reservoir. *Table 3* shows the monthly and annual historic averages for maximum, minimum and mean temperatures for these two stations, as computed over a more than 100-year period. The historic average of annual mean temperatures for Boonton is 50.3 and for Charlotteburg is 48.9, both cooler than the 50.9 computed for all of northern New Jersey for a similar period (1895-2010).

Table 3. Monthly and Annual Temperatures – Historic Averages for Boonton and Charlotteburg Reservoir

	Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Annual*
Boonton 1894-1998													
Max	36.7	38.1	47.4	59.5	70.7	79.2	83.9	82.2	75.6	64.7	52.3	40.3	60.9
Min	18.5	19.1	27.7	37.8	47.2	56.2	61.3	59.4	51.7	40.5	32.4	22.8	39.6
Mean	27.6	28.6	37.6	48.6	58.9	67.7	72.6	70.7	63.7	52.6	42.4	31.6	50.3
Charlotteburg Reservoir 1893-2011													
Max	36.4	37.7	47.1	59.1	70.3	78.3	82.9	81.1	74.7	64.0	51.6	39.7	60.3
Min	17.4	17.3	25.8	35.3	44.9	53.3	58.2	56.3	49.4	38.9	31.1	21.5	37.4
Mean	27.0	27.5	36.4	47.2	57.6	65.8	70.5	68.7	62.1	51.4	41.4	30.7	48.9

Source: NJ State Climatologist, Rutgers University. Accessed October 3, 2012.

Mean temperatures by year are plotted in *Figure 5*, along with the historic mean averages for each station as stated in *Table 3*. The date range for the Boonton station extends to 1998 and for Charlotteburg to 2011. Extreme spikes and drops can be the result of incomplete data for the monitoring period.

Table 4 details monthly and annual historic averages for all precipitation. Historic annual mean precipitation for Boonton is 46.66 inches and for Charlotteburg Reservoir is 50.3 inches, both higher than the long-term average of 46.51 inches for all of northern New Jersey.

Snowfall amounts were reported at the Charlotteburg Reservoir station, but not the Boonton station, and only until 2005. See *Table 5*.

Annual precipitation and snowfall by year for the Charlotteburg Reservoir station is shown in *Figure 6*, for the period 1926–2005, along with the historic average for each category. Extreme spikes and drops can be the result of incomplete data for the monitoring period.

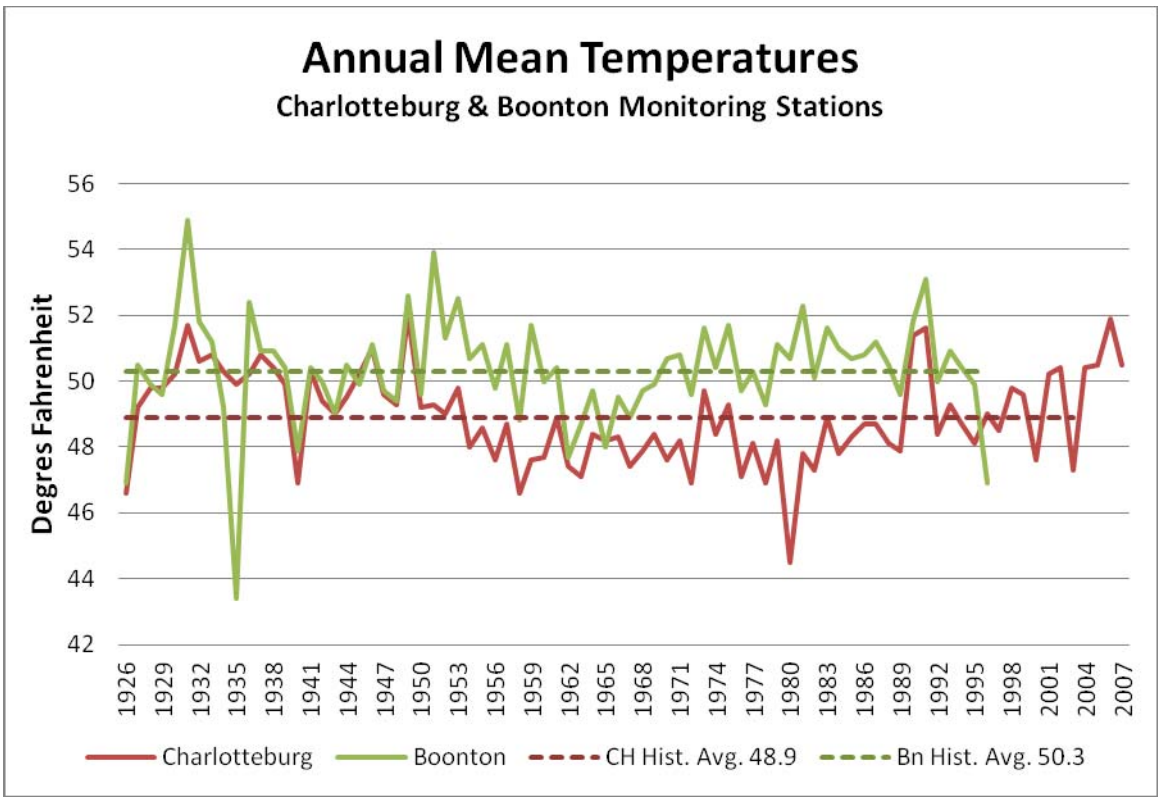


Figure 5. Annual Mean Temperatures for the Charlotteburg and Boonton Monitoring Stations

Source: ONJSC, Rutgers University. Accessed October 3,2012

Table 4. Precipitation for the Charlotteburg and Boonton Monitoring Stations
All Precipitation* (inches) Historic Averages

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Boonton 1893-1998													
Mean	3.40	3.03	3.73	3.96	4.21	3.91	4.32	4.45	4.19	3.65	3.92	3.54	46.66
Median	3.17	2.80	3.52	3.75	4.09	3.48	3.88	3.99	3.45	3.28	3.66	3.38	46.26
Max	11.62	8.35	8.48	10.75	11.21	13.87	11.63	11.36	12.95	10.91	10.01	9.24	68.53
Min	0.41	0.57	0.80	0.97	0.74	0.46	0.87	0.47	0.26	0.26	0.30	0.21	32.51
Charlotteburg Reservoir 1893-2011													
Mean	3.71	3.34	4.31	4.18	4.27	4.34	4.57	4.65	4.56	4.11	4.19	4.16	50.30
Median	3.41	2.95	3.98	3.77	3.95	4.05	4.38	4.04	3.87	3.69	3.93	4.00	49.74
Max	11.97	10.06	12.47	10.86	12.41	12.57	13.34	16.94	12.58	14.06	11.47	10.02	73.26
Min	0.51	0.79	0.76	0.69	0.74	0.56	0.67	0.84	0.33	0.12	0.55	0.45	33.95

**All precipitation includes the liquid equivalent of snowfall.*

Source: NJ State Climatologist, Rutgers University. Accessed October 3, 2012

Table 5. Snowfall (Historic Averages) for the Charlotteburg Reservoir Snowfall (inches) Historic Averages													
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Season
Charlotteburg Reservoir 1893-2005													
Mean	0.0	0.0	0.0	0.1	1.7	7.2	10.0	10.8	7.4	2.0	0.0	0.0	38.8
Median	0.0	0.0	0.0	0.0	0.5	5.0	8.0	9.8	5.5	0.0	0.0	0.0	35.0
Max	0.0	0.0	0.0	2.5	17.0	32.0	37.0	34.5	34.3	15.0	0.0	0.0	96.0
Min	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.0
Source: NJ State Climatologist, Rutgers University. Accessed October 3, 2012													

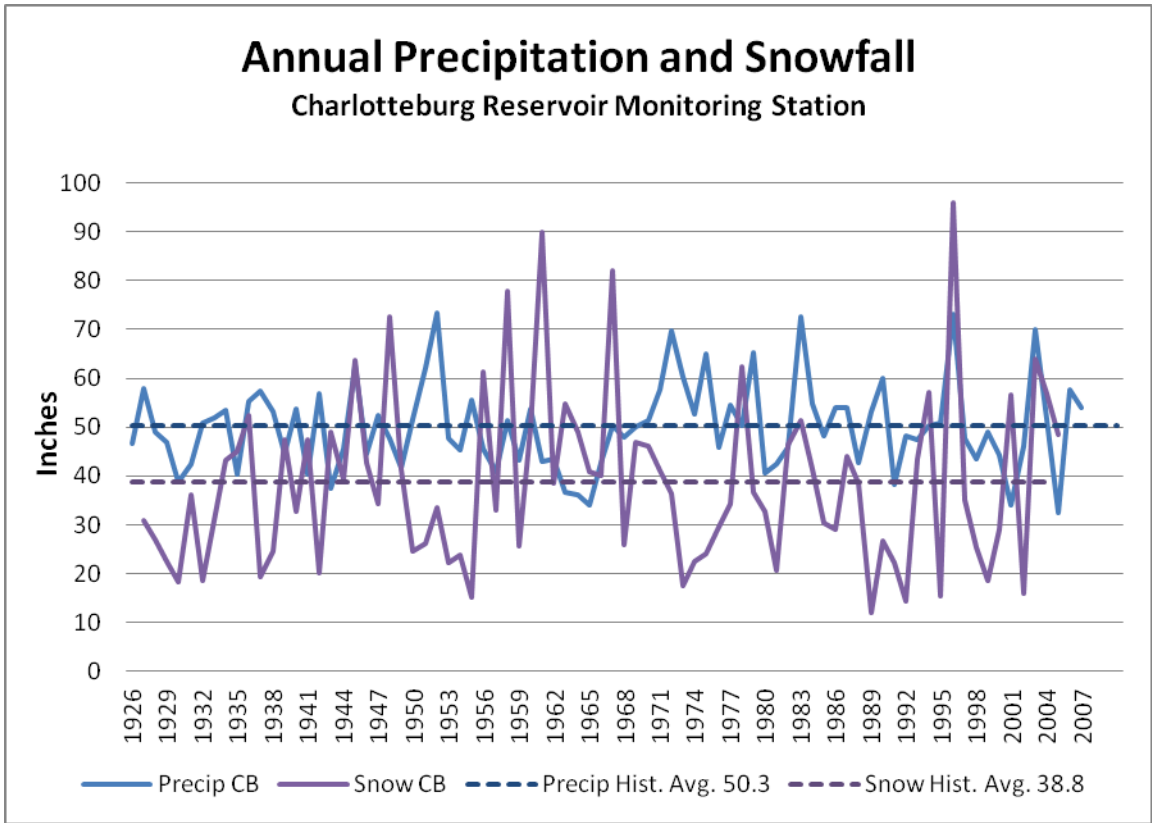


Figure 6. Annual Precipitation and Snowfall for the Charlotteburg Reservoir Monitoring Station

Source: ONJSC, Rutgers University. Accessed October 3,2012

Current Normals

Table 6 shows the maximum, minimum and mean temperatures; precipitation; and heating and cooling degrees day normals, or averages, for the 30-year period from 1981-2010. Heating degree days are the number of degrees the average daily temperature is below 65°F. Cooling degree days are the number of degrees the average daily temperature is above 65°F.

Table 6. Monthly Station Normals* 1981-2010 Charlotteburg Reservoir Station													
	Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Ann*
Temperature Normals (Deg F) 1981-2010													
Mean	27.2	29.8	37.8	48.8	58.7	67.6	72.1	70.5	63.2	52.0	42.7	32.6	50.3
Maximum	36.5	39.6	48.1	60.0	70.4	78.7	83.3	81.8	74.9	63.7	52.6	41.1	60.9
Minimum	18.0	20.0	27.5	37.7	47.0	56.4	60.8	59.2	51.5	40.2	32.9	24.1	39.6
Precipitation Normals (inches) 1981-2010													
Precipitation	3.85	3.27	4.55	4.41	4.36	4.50	4.56	4.38	4.94	4.72	4.30	4.36	52.20
Heating Degree Days (the number of degrees the average daily temperature is below 65°F_													
Heating	1170	985	843	489	226	50	7	14	117	410	668	1004	5983
Cooling Degree Days (the number of degrees the average daily temperature is above 65°F; values of ~0 represent a non-zero degree day that would round to zero.)													
Cooling	0	0	~0	5	31	127	225	185	63	6	~0	0	642
**Normal = 30-year average 1981-2010* *Source: ONJSC*													

Comparison of Current Normals with Historic Averages

Table 7 compares the annual historic averages for the Charlotteburg Reservoir station against the current normals (i.e., the averages for the 30-year period 1981-2010) for temperature and precipitation. In all categories, the current normals exceed the historic averages.

Table 7. Historic Averages versus Station Normals Annual Historic Averages 1893-2011 vs Annual Station Normals 1981-2010 Charlotteburg Reservoir			
	Historic Avg.	*Current Normals**	*Difference*
Temperature (°F)			
Max	60.3	60.9	+0.6
Min	37.4	39.6	+2.2
Mean	48.9	50.3	+1.4
Precipitation (Inches)	50.3	52.2	+1.9
**Current normals = 30- year average for period 1981-2010* *Source: ONJSC*			

Figure 7 shows annual heating (HDD) and cooling degree days (CDD) by five-year intervals for Charlotteburg Reservoir. The general trend is toward fewer heating degree days and more cooling degree days, indicating that temperatures are generally trending warmer. The 1981 statistics show HDD of 6570, or 587 DD above the 30-year average of 5983, and CDD of 417, or 225 DD below the 30-year average of 642. By comparison, the 2010 statistics show HDD of 5281, or 702 DD below the 30-year average, and CDD of 787, or 145 DD above the 30-year average.

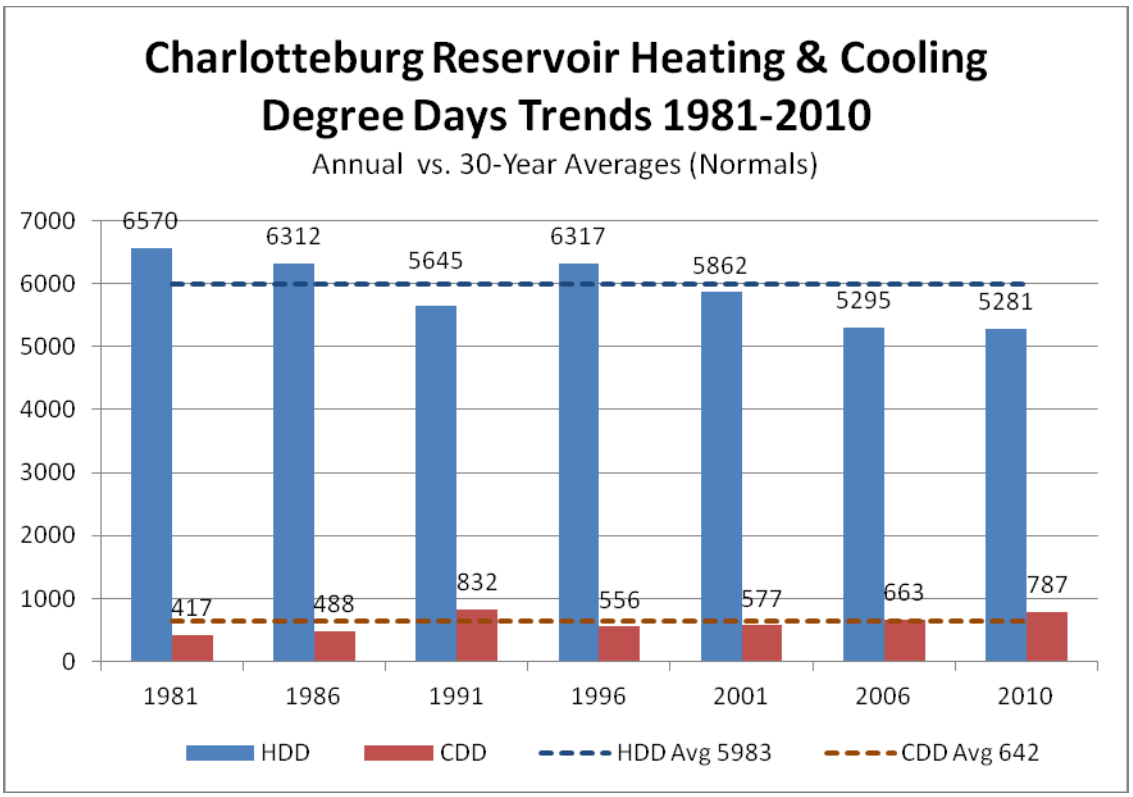


Figure 7. Heating and Cooling Degree Day Trends for the Charlotteburg Reservoir Monitoring Station

Sources: ONJSC & NOAA National Climatic Data Center

Topographic Protection (Wind)

According to the Natural Resource Conservation Service (NRCS), the soils of Kinnelon are not subject to erosion by wind. In part, this is because much of the soil is covered by vegetation, particularly forest cover. Wind erosion most often affects soils on bare lands, where the shear force of wind detaches particles protruding from the soil surface. Conservation measures to minimize wind erosion include maintaining a surface cover. *(Natural Resource Conservation Service)*

Extreme Phenomena

Tropical Cyclones

According to the National Oceanic and Atmospheric Administration (NOAA), tropical cyclones are rotating, organized systems of clouds and thunderstorms that originate over tropical or subtropical waters. Tropical cyclones have four major levels, increasing in severity: tropical depression, tropical storm, hurricane and major hurricane. Storms may start out as major hurricanes and weaken in strength as they travel and hit landfall. The season generally runs from spring through fall, with most activity for the mid-Atlantic states occurring in August and September.

Tropical cyclones tend to bypass New Jersey due to its protective location slightly west of coastal outcrops to the south and north. When they do affect New Jersey, they are more apt to affect coastal areas, although a few have traveled inland.

Notable recent tropical cyclones are Hurricane Floyd in September 1999, Hurricane Irene in August 2011 and Hurricane Sandy in October 2012. In the Kinnelon area, hurricane Irene's heavy rains caused local damage that affected roads and bridges, as well as structures and trees, as rivers overflowed their banks. Hurricane Sandy's high winds resulted in many downed trees. Both storms, as well as the snowstorm of October 2011, resulted in widespread power outages.

Other recent tropical cyclones affecting New Jersey:

- 2010 Tropical Storm Hanna took an inland track
- 2004 A number of tropical storm and depressions affected the East Coast but missed inland northern Jersey
- 2000 A tropical depression from hurricane Gordon affected coastal NJ
- 1999 Hurricane Bret clipped Jersey coast in September at tropical storm level
- 1996 Hurricane Josephine downgraded to tropical storm hit inland NJ in Oct
- 1994 A tropical depression traveled west and north of Jersey
- 1992 Tropical storm Earl traveled south and west of Jersey
- 1988 Tropical storm Chris traveled west to east through northern NJ
- 1985 Hurricane Gloria skirted the coast of NJ

Trend Comparison: For 2012, both the frequency and the accumulated energy (duration and strength) of tropical cyclones in the Atlantic Basin exceeded 1981-2010 averages. In October, there were five reported storms (two reaching hurricane status) against an historic average of two. For the year, the accumulated cyclone energy exceeded the average by 30%. (*NOAA)*

Landslides

Landslides in New Jersey have generally occurred in the northern and central parts of the state and include slumps, debris flows, rockfalls and rockslides. They are not as common in New Jersey as in other parts of the country.

There are 233 reported landslides in the New Jersey Department of Environmental Protection (NJDEP) database, only one of which was reported as occurring in Kinnelon. It was a debris flow caused by weathering in July 1995. Several surrounding municipalities have also experienced occasional landslides. These were mostly debris flow caused most frequently by heavy rain and sometimes by weathering. Of the 233 landslides recorded in New Jersey from 1887 to May 2012, nearly 10% (21) occurred

during the heavy rains of hurricane Irene in August 2011. Neighboring Boonton experienced two slides during this storm. No fatalities or injuries have occurred in Morris County landslides. (*NJDEP)*

Earthquakes

The NJDEP maintains a database of recorded earthquakes in New Jersey totaling 177 as of November 2012. They occur more frequently along the fault lines in north central New Jersey than in other parts of the state. These earthquakes are generally minor in nature, often registering in the category of micro quakes. The strongest earthquake *epicentered* in New Jersey, with a magnitude of 5.3, occurred in 1783, just north of present-day Picatinny Arsenal in neighboring Rockaway Township. The strongest earthquakes *felt* in New Jersey had a magnitude of 8.0-8.8 and were epicentered in New Madrid, Missouri. An earthquake epicentered in Virgina, was felt in New Jersey in August 2011. Four microearthquakes occurred in northern New Jersey, north and west of Kinnelon, between July 16 and November 5, 2012 *(NJDEP, LCSN)*

In New Jersey damage from earthquakes is rare or minor. According to the United States Geological Survey (USGS), on a scale of 0-100%, the section of northern New Jersey where Kinnelon is located has a relatively low seismic hazard ranking of between 8-16%. The baseline for the hazard ranking is the levels of horizontal shaking that have a 2-in-100 chance of being exceeded in a 50-year period. Shaking is expressed as a percentage of the acceleration of a falling object due to gravity. Maps available from the USGS can "form the basis for seismic design provisions of building codes, insurance rate structures, earthquake loss studies, retrofit priorities, and land-use planning." *(USGS Earthquakes Hazard Program)*

Earthquakes are measure by magnitude, intensity (level of shaking) and depth to hypocenter. Magnitude measures the relative size and the energy released (when one block or rock, e.g., along a fault line, slips over another, causing the ground to vibrate). *(USGS)* The magnitude scale begins at 0 and the highest magnitude ever recorded was 9.5. Of the 177 earthquakes recorded in the NJDEP database, 60% had a magnitude of 2 or under and only 2 occurrences had magnitudes greater than 4. Anything at a magnitude of 2 or below is considered a "microearthquake." *Table 8* shows the magnitude summary for New Jersey.

Generally, the intensity of an earthquake tracks with its magnitude, with a higher level intensity occurring at or near the epicenter of a higher magnitude earthquake. The intensity scale ranges from I to VIII or higher. Intensities of VI (felt by all, frightening but damage slight) or VII (damage negligible in buildings of good design and construction) are generally associated with a magnitude in the 5 range. Intensities of IV (felt by nearly everyone; some shaking, cracking of walls, standing cars rocked) or V (felt by everyone) are generally associated with magnitudes in the 4 range.

Table 8. Magnitude Summary for Earthquakes in New Jersey		
Range	*Count*	*% of Total*
2 & under	107	60%
2.1-3.0	57	32%
3.1-4.0	11	6%
4.1-5.0	1	1%
>5.0	1	1%
Total	177	100%
Source: NJDEP		

Another earthquake measurement is the depth below the surface at which the hypocenter occurs. The hypocenter is the point in the earth where the rupture starts, and the epicenter is the point at the earth's surface directly above the hypocenter. Depth levels are grouped as shallow, 0 - 70 km deep; intermediate, 70 - 300 km deep; and deep, 300 - 700 km deep. All earthquakes in New Jersey have a shallow depth to hypocenter, with the deepest recorded hypocenter at 25 km below surface for an earthquake occurrence near Sussex in northwestern New Jersey in 1969. *Figure 8* shows the frequency of earthquakes in New Jersey from 1982-2012. The highest annual count was 13 in 1984, and no earthquakes were reported in either 1985 or 2000.

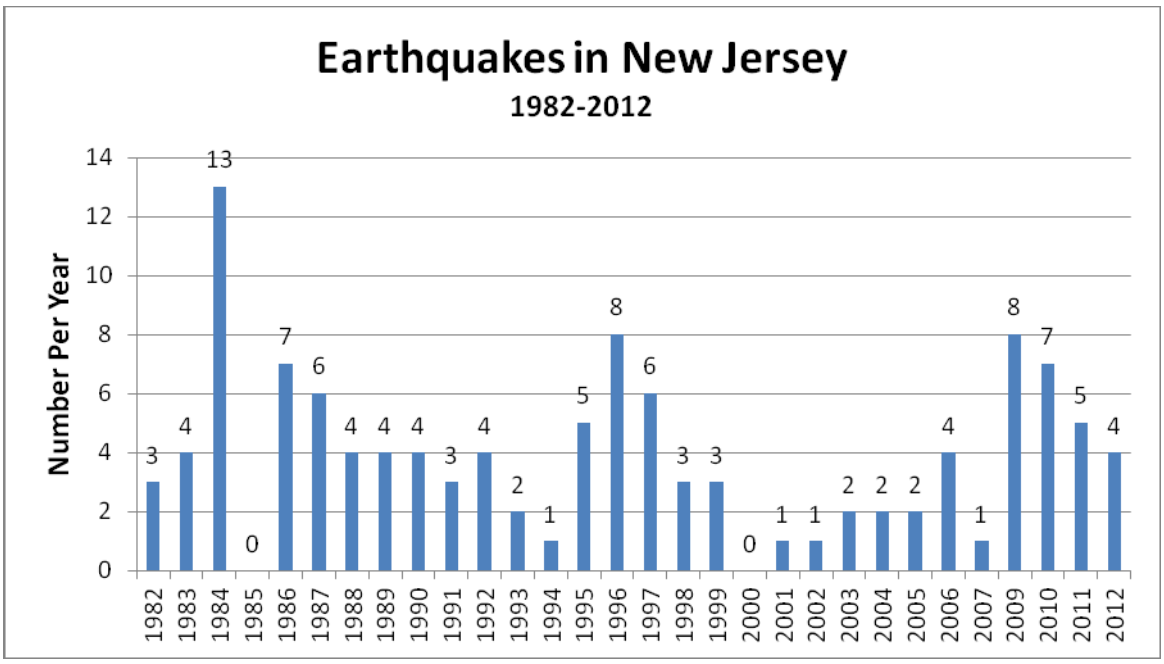


Figure 8. Earthquakes in New Jersey
Source: NJDEP

Earthquakes epicentered in or around Kinnelon are listed in *Table 9*. The strongest earthquake recorded in New Jersey occurred in 1783 a few miles west of Kinnelon in an area just north of the present-day Picatinny Arsenal and along the Longwood Valley

Fault. It had a magnitude of 5.3. The second strongest magnitude was 3.0, in 2009, along the Rockaway Valley Fault. Most of the other earthquakes in the vicinity of Kinnelon had magnitudes less than 2.0 (see *Figure 9 Magnitude of Earthquakes in Kinnelon & Vicinity*). Many occurred in the vicinity of the Mount Hope, Rockaway Valley and Ramapo Faults. NJDEP mapping shows 10 earthquakes within or along Kinnelon boundaries and another 24 close by in neighboring municipalities. *(Source: NJDEP Earthquakes Epicenter in New Jersey Map)*

Table 9. Earthquakes Epicentered in and Around Kinnelon 1783-2012

ID	*Date*	*Time*	*Lat-N*	*Long-W*	*Depth (km)*	*Magnitude*	*Location*
1	11/30/1783	3:50	41.000	74.500	0.00	5.3	West of New York City (N of Picatinny Arsenal)
21	4/1/1947	13:25	41.020	74.300	0.00	2.7	Pompton Lakes
27	10/13/1962	0:00	41.000	74.300	0.00	2.2	Pompton Lakes
33	**3/11/1976**	**21:07**	**41.000**	**74.400**	**1.00**	**2.8**	**Pompton Lakes (Kinnelon)**
43	2/15/1978	5:28	40.900	74.400	6.00	1.6	Boonton
45	5/18/1978	1:29	41.000	74.300	6.00	1.5	Bloomingdale
56	3/19/1981	8:51	40.940	74.360	9.60	2.0	Boonton (Montville)
63	6/1/1983	9:50	40.870	74.530	5.10	1.5	Dover
67	5/13/1984	3:18	40.920	74.540	5.60	2.1	Mount Hope
68	**6/3/1984**	**7:04**	**41.010**	**74.410**	**0.20**	**1.3**	**Kinnelon**
81	**6/29/1986**	**6:32**	**40.960**	**74.400**	**4.10**	**1.5**	**Kinnelon**
94	12/22/1988	7:44	41.060	74.300	2.70	1.0	Wanaque
100	1/26/1990	4:27	40.990	74.510	11.90	1.0	Franklin
104	5/12/1991	9:36	41.029	74.304	5.70	1.3	Wanaque
105	7/5/1991	16:26	40.931	74.353	8.80	1.3	Pompton Plains (Montville)
108	**3/4/1992**	**10:31**	**40.964**	**74.376**	**10.00**	**1.4**	**Kinnelon**
109	6/7/1992	23:51	40.964	74.564	6.00	0.4	Jefferson Township
110	10/13/1992	16:11	41.100	74.417	7.00	1.0	West Milford
113	5/23/1994	0:45	40.956	74.516	4.00	1.6	Butler
114	1/27/1995	2:37	40.958	74.501	3.00	2.3	Rockaway
115	4/1/1995	5:50	40.950	74.510	5.00	1.5	Rockaway
116	**5/26/1995**	**5:24**	**40.992**	**74.357**	**1.00**	**1.5**	**Kinnelon (Butler)**
129	6/27/1997	20:58	40.942	74.510	2.00	1.6	4.6 km N of Rockaway
134	**6/20/1998**	**12:54**	**40.989**	**74.359**	**6.00**	**1.2**	**2 km SE Kinnelon**
135	**6/30/1998**	**6:18**	**40.978**	**74.340**	**7.00**	**1.9**	**3 km S Butler (Kinnelon)**
139	**7/14/2001**	**20:08**	**40.960**	**74.370**	**7.00**	**1.9**	**7.1 km NE of Boonton**

Table 9. Earthquakes Epicentered in and Around Kinnelon 1783-2012							
ID	*Date*	*Time*	*Lat-N*	*Long-W*	*Depth (km)*	*Magnitude*	*Location*
146	**12/09/2005**	**3:35**	**40.790**	**74.379**	**4.70**	**2.1**	**16 km W of Franklin Lakes (Kinnelon)**
154	2/3/2009	03:34:19	40.870	74.522	5.00	3.0	3.5km SSW of Rockaway
155	02/14/2009	22:22:22	40.948	74.392	2.00	2.4	5 km NNE of Boonton
156	**2/18/2009**	**18:17:55**	**40.963**	**74.389**	**2.00**	**1.1**	**3 km SSW of Kinnelon**
164	02/10/2010	01:17:30	41.038	74.305	4.00	2.2	1 km W of Wanaque
174	07/17/2012	2:25:45	40.892	74.570	2.00	1.1	16 km NW of Morristown
175	07/18/2012	8:04:10	40.899	74.588	2.00	1.1	18 km NW of Morristown
177	11/05/2012	06:19:11	41.075	74.222	5.00	2.0	3 km SW of Mahwah, NJ
Source: NJDEP Division of Water Supply and Geoscience. New Jersey Geological and Water Survey. Digital Geodata Series. DGS04-1 Earthquakes Epicentered In New Jersey. Updated 11-5-2012. http://liberty.state.nj.us/dep/njgs/geodata/dgs04-1.htm							

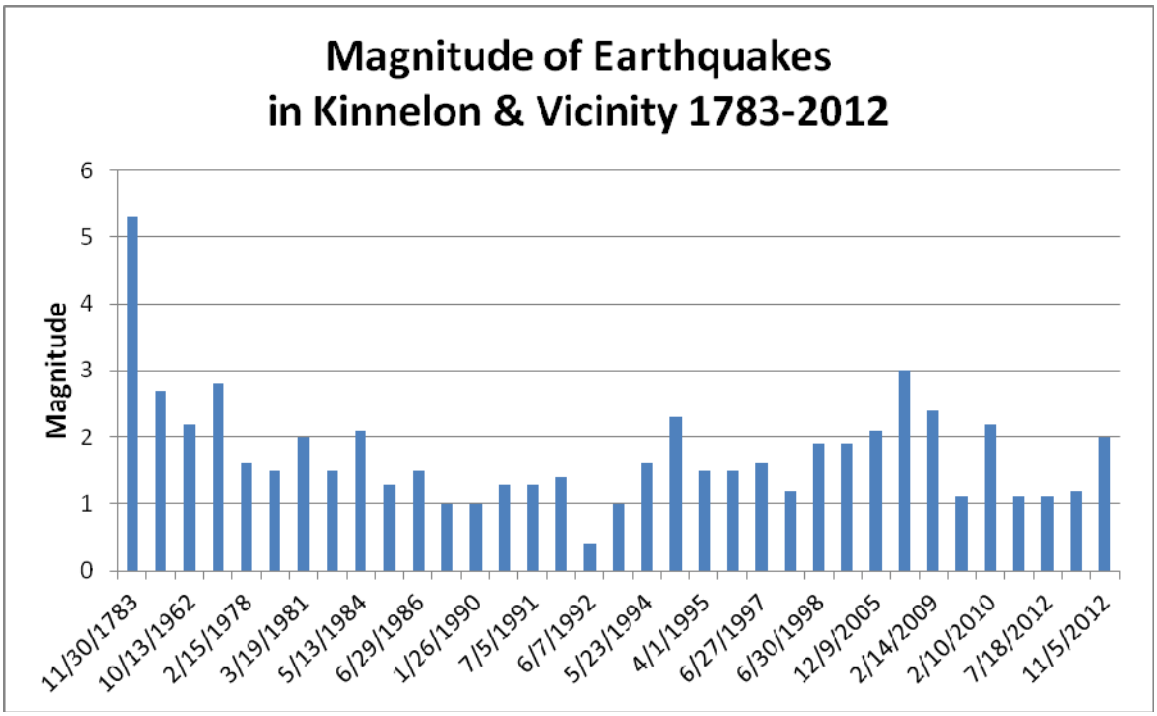


Figure 9. Magnitude of Earthquakes in Kinnelon and Vicinity

Source: NJDEP

Climate Change

In 2007, the International Panel on Climate Change (IPCC) reported that increasing carbon dioxide (CO_2) emissions into the atmosphere, as a result of human activity, has warmed the Earth's surface by more than 1.3°F during the past century. The Union of Concerned Scientists has indicated that temperatures in the Northeast are likely to rise in winter and summer over the next several decades. Without a reduction in CO_2 and other greenhouse gas emissions (GHGs), average temperatures may rise by up to 14°F. Studies have predicted that by the end of this century the New York City region and cities such as Trenton could experience more than 20 days per summer with temperatures above 100°F.

This warming trend can have impacts on the health of humans and the environment. The predicted effects on humans include heat stress, increased particulates in the air we breathe and increased occurrences of insect-spread diseases such as West Nile virus in the winter season of northern climates. Ecosystem repercussions include changes to the water cycle, with the following potential consequences: loss of critical habitat, further stressing some already threatened and endangered species; impacts on water supply and agriculture; more intense rain events; more frequent periods of extended dryness; and continued increases in fires, pests, disease pathogens, and invasive weed species. *(NJDEP)*

A greenhouse gas (GHG) is defined by the NJDEP as:

> "an atmospheric gas that slows the rate at which heat radiates into space, thus having a warming effect on the atmosphere. GHGs include water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide, chlorofluorocarbons (CFCs), hydrofluoroccarbons (HFCs) and some other halogenated gases."

To address the effects of GHGs, New Jersey enacted the Global Warming Response Act in 2007. This law requires:

- stabilization of statewide GHGs to 1990 levels by 2020, and
- a further reduction to 80% below 2006 levels by 2050.

According to the NJDEP, New Jersey must meet these limits in order to avoid the most damaging impacts of climate change. In 2009, the latest year for which major sector estimates are available, total estimated emissions were 112.1 million metric tons of CO_2 equivalent (MMTCOe), below the 1990 baseline and 2020 target of 125.6 MMTCOe. The 2050 goal is much more ambitious: to be 80% below the 2006 level, or approximately 25.5 MMTCOe.

In December 2011, the state revised its Energy Master Plan, which is the strategic vision for the use, management, and development of energy in New Jersey over the next decade. Because fossil fuels like coal, oil and natural gas are the largest sources of GHGs in the state, the Energy Master Plan serves as the platform for discussions about how New Jersey can meet the Global Warming Response Act's 2050 greenhouse gas limit. *(NJDEP)*

The transportation sector continues to be the major contributor to GHGs (47.3% in 2009) and vehicle miles traveled continue to increase while fuel efficiencies have leveled off. In 2009, electricity generation was the second largest contributor, at 23.5%, followed by residential at 15.2, industrial at 10.6, commercial at 10.8. Highly warming gases, waste management and land clearing contributed another approximately 23%, while terrestrial carbon sequestration (forests absorbing carbon) provided an offset of -7.6%.

The NJDEP predicts that major new initiatives and technologies will be required. Of most import for Kinnelon, which is largely residential in nature and which has minimal intrusion from high traffic roadways, a 2008 report states:

> "For the residential sector, emissions from direct fossil fuel use in 1990 were about 15.7 MMtCO2eq, and are estimated to decrease to about 11.5 MMtCO2e by 2020. Emissions associated with natural gas consumption accounted for about 60% of total residential emissions in 1990, and are estimated to increase to 98% of total residential emissions by 2020" while petroleum (39.5 to 2%), coal and wood decrease. *(NJDEP)*

On a county level, Morris County is using an Energy Efficiency and Conservation Block Grant (EECBG) to audit and retrofit existing county buildings with energy efficient components, promote greenhouse gas emissions inventories for public buildings and develop a smart vehicle routing system for its recycling vehicles to reduce transportation demands. One effect of these initiatives will be to avoid 75,290 metric tons of CO_2e emissions. *(EECBG)*

The Sustainable Jersey program is a certification program that acknowledges communities that complete qualifying actions toward sustainability. Kinnelon is a participating community working toward certification. Among the qualifying actions are a number of Greenhouse Gas initiatives that can be undertaken by a municipality.

On an individual level, rebates on energy efficient alternatives for household appliances, heating, cooling and alternative energy systems are available through New Jersey's Clean Energy Program (NJCEP), administered by the New Jersey Board of Public Utilities. Commercial, industrial and local government programs are also available. *(NJCEP)*

Municipal Clean Energy Initiatives

On July 19, 2012, Kinnelon Borough adopted Ordinance 13-12, amending Chapter 207, Zoning, of the municipal code to include a new section "Alternative Energy." This section:

- prohibits wind generators or wind turbines, except on Borough-owned property, and
- sets forth the requirements for installation of solar panels. In general, solar panel installation is limited to rooftop installations on roofs not facing the street. Ground-mounted solar systems or arrays are permitted only on Borough-owned property. Several other permitting and installation requirements must be met.

In 1982, Ordinance 13-82, addressed consideration of renewable energy, amending the municipal code as of 9/16/1982 as follows:

- § 176-20. Streets.
    - M. All new streets shall be so oriented as to permit, within the limits of practicability and feasibility, the buildings constructed thereon to maximize solar gain.
- § 173-10. Map profiles to conform with state and local requirements, requirements and specifications enumerated.
    - (25) All new roads shall be so oriented as to permit, within the limits of practicability and feasibility, the buildings constructed thereon to maximize solar gain.
- § 176-31. Criteria for review by Planning Board.
    - L. All buildings and structures shall use renewable energy sources within the limits of practicability and feasibility.

The municipal code can be accessed from the Borough website at *http://www.kinnelonboro.org*.

AIR

Air Quality: National Clean Air Standards

In 1970, the federal government passed the Clean Air Act, setting standards to be met throughout the country. The Act was amended in 1990, with focus on four areas of pollution: acid rain, urban air pollution, toxic air emissions, and stratospheric ozone depletion. The amendment also introduced a permits program and strengthened enforcement.

Under the Act, it is the responsibility of the US Environmental Protection Agency (USEPA) to set National Ambient Air Quality Standards (NAAQS) for six common pollutants (ozone, carbon monoxide, sulfur dioxide, lead, nitrogen dioxide and fine particulates) and the responsibility of each state to develop State Implementation Plans (SIPs) to attain and maintain these standards. In New Jersey, that role is assigned to the NJ Department of Environmental Protection (NJDEP) Division of Air Quality (DAQ) and its Bureau of Air Monitoring (BAM), which monitors the State's ambient air monitoring network.

Regional / Local Statistics

The State uses the air quality data from its air monitoring network to determine which areas are in compliance with NAAQS as well as overall trends in air pollution levels. The NJDEP produces yearly reports but also provides real-time reporting through its Air Quality Index website (www.njaqinow.net). Although there are monitoring sites throughout the state, each site measures a limited set of pollutants; no one site tracks them all.

The six pollutants for which standards have been set by the EPA – ozone, sulfur dioxide, carbon monoxide, nitrogen dioxide, particulate matter, and lead – are known as *criteria pollutants*. Over the period 1990-2010, total emissions of these air pollutants have decreased by more than 41 percent nationally. *(USEPA)*

In New Jersey, according to the NJDEP DAQ website, air quality has improved significantly over the last 40 years since the first Earth Day, in 1970, but exceeds the current NAAQS standards for ozone throughout the state and for fine particulates in urban areas (13 counties). New Jersey has attained sulfur dioxide (except for a portion of Warren County), lead, carbon monoxide and nitrogen dioxide standards.

Additional air pollutants that may cause adverse health effects but are not criteria pollutants are referred to as Hazardous Air Pollutants (HAPs) or air toxics. The NJDEP

DAQ also regulates the emissions of these HAPs. For many toxins the State has set its own standards, with stricter requirements than the EPA.

Criteria Pollutants

Each of the six criteria pollutants is discussed below. Information on national and state standards and localized air monitoring results (using those monitoring stations closest to Kinnelon) are provided based on 2010 NJDEP reports, the latest available data at time of publication. In the discussions of the individual criteria pollutants, primary standards are those associated with health effects and secondary standards are based on "welfare" effects (e.g., damage to trees, crops and materials).

Ozone

Ozone (O_3) is defined by the NJDEP *2010 Ozone Summary* as a gas that consists of three oxygen atoms. In the upper atmosphere, where it occurs naturally, it offers protection from harmful ultraviolet rays. But at ground level it can have adverse health effects. Ground-level ozone is monitored from April through October because its formation, from nitrous oxide (NOx) and volatile organic compounds (VOCs), requires the presence of sunlight and heat. Hot, dry summers result in more ozone than cool, wet ones.

The EPA revised National Ambient Air Quality Standards (NAAQS) for ozone in 2008, having determined that the previous standard of 0.08 parts per million (ppm) maximum daily eight-hour average did not sufficiently protect public health. The revised standard of 0.075 ppm maximum daily 8-hour average went into effect on May 27, 2008. Attainment of the NAAQS is determined by taking the average of the fourth highest daily maximum 8-hour average concentration that is recorded each year for three years.

New Jersey standards are based on 1-hour averaging, with primary standards set at 0.12 ppm and secondary standards set at 0.08 ppm. They are not as stringent as the revised NAAQS.

To date, the effort to lower ozone concentrations has focused on reducing emissions of VOCs. However, improvements have leveled off in recent years, especially with respect to maximum 8-hour average concentrations. According to the NJDEP report, significant further improvements will require reductions in both VOCs and NOx. Levels of NOx in New Jersey are affected by emissions from upwind sources outside New Jersey.

Statewide, New Jersey is classified as a "moderate" ozone non-attainment area for NAAQS for the 2008-2010 period, with an overall score of 0.092 ppm. This score falls at the lowest end of the moderate category. The ozone monitoring stations closest to Kinnelon reported levels close to NAAQS for the period 2008-2010, with Leonia, in Bergen County, slightly exceeding the standard, Chester, in Morris County, meeting the standard and Ramapo, in Passaic County, slightly below it. Chester and Leonia reported 5 days above .075 ppm and Ramapo reported 4, as shown in *Table 10*.

Table 10. Ozone - 2010						
8-Hour Averages in Parts Per Million (ppm) Standard: .075 ppm						
Station	*Highest*	*2nd*	*3rd*	*4th*	*Avg. of 4th Highest 8-Hr Avgs 2008-2010*	*# Days with 8-Hr Avg Above .075ppm*
Ramapo (c.11 mi)	.094	.083	.077	.077	.074	4
Leonia (c.22 mi)	.085	.083	.077	.076	.076	5
Chester (c.23 mi)	.094	.086	.078	.078	.075	5
State	.111	.083	.080	080	.092	35
Source: NJDEP 2010 Ozone Summary						

Sulfur Dioxide

NJDEP's *2010 Sulfur Dioxide Summary* defines SO_2 as "a heavy, colorless gas with a suffocating odor that easily dissolves in water to form sulfuric acid. SO_2 gases can be formed when fuels containing sulfur are burned, or when gasoline is extracted from oil." Most of the sulfur dioxide released into the air comes from electric utilities, followed by fossil fuel combustion, industrial processes, non-road equipment and on-road vehicles.

Sulfur dioxide reacts with other gases and particles in the air to form sulfates that can be harmful to people (particularly children, the elderly and asthmatics) and the environment. Sulfur dioxide reacting with other substances in the atmosphere forms acid rain, which damages forest, crops and aquatic environments and decays building materials.

There are several standards for monitoring SO_2, ranging from 1-hour to annual averaging. New Jersey's standards differ slightly from national standards, as shown in *Table 11*.

Table 11. National and New Jersey Ambient Air Quality Standards for Sulfur Dioxide ppm = parts per million; ppb = parts per billion; ug/m3 = micrograms per cubic meter			
Averaging Period	*Type*	*New Jersey*	*National*[a]
12 – month average	Primary	80 µg/m^3 (0.03 ppm)	0.03 ppm
12 – month average	Secondary	60 µg/m^3 (0.02 ppm)	---
24 – hour average	Primary	365 µg/m^3 (0.14 ppm)	0.14 ppm
24 – hour average	Secondary	260 µg/m^3 (0.10 ppm)	---
3 – hour average	Secondary	1300 µg/m^3 (0.5 ppm)	0.5 ppm
1 – hour average[b]	Primary	---	75 ppb
a – National standards are block averages rather than moving averages. b – Final rule signed June 2, 2010 and effective on August 23, 2010. To attain this standard, the 3-year average of the 99th percentile of the daily maximum 1-hr average at each monitor within an area must not exceed 75 ppb. *Source: NJDEP 2010 Sulfur Dioxide Summary*			

Regulations requiring the use of low sulfur fuels in New Jersey have been effective in lowering SO_2 concentrations. No monitoring sites recorded exceedances of the primary or secondary SO_2 NAAQ standards during 2010. The last year an exceedance of the national

SO_2 standards was recorded in the state was 1980. *Table 12* shows data for the three monitoring sites closest to Kinnelon that capture SO_2 data. Data from all three sites show levels well below the NAAQS.

Table 12. Sulfur Dioxide - 2010				
National Standards in Parts per Billion (ppb) and Parts per Million (ppm)				
	75 ppb	0.50 ppm	0.14 ppm	0.03 ppm
Monitoring Site Data				
Monitoring Site	*3-Year Avg. 99th %-ile of Daily Max 1-Hour Avg (ppb)*	*3-Hour Avg Max (ppm)*	*24-Hour Avg Max (ppm)*	*12-Month Avg Max (ppm)*
Hackensack (c.19 mi)	14	0.009	0.002	0.000
Newark Firehouse (c.21 mi)	---*	0.018	0.0108	0.0018
Chester (c.23 mi)	27	0.032	0.013	0.001
** Three-year data unavailable.* *Source: NJDEP 2010 Sulfur Dioxide Summary*				

Carbon Monoxide

According to the NJDEP *2010 Carbon Monoxide Summary,* vehicles, construction equipment, boats and other engines are the predominant contributors of carbon monoxide (CO) emissions nationwide. Boilers, incinerators and forest fires also contribute. This colorless, odorless and poisonous gas is formed when carbon in fuels is not burned completely. Exposure most often causes headaches and nausea; the threat to health is most serious in people with cardiovascular disease.

Although there are no national secondary standards, New Jersey has set its secondary standards at the same level as primary standards and uses a different measuring metric than national standards (see *Table 13*). In addition, New Jersey standards are not to be exceeded more than once in any 12-month period.

Table 13. National and New Jersey Ambient Air Quality Standards for Carbon Monoxide mg/m^3 = milligrams per cubic meter; ppm = parts per million			
Averaging Period	*Type*	*New Jersey*	*National*
1-Hour	Primary	40 mg/m^3 (35 ppm)	35 ppm
1-Hour	Secondary	40 mg/m^3 (35 ppm)	----
8-Hour	Primary	10 mg/m^3 (9 ppm)	9 ppm
8-Hour	Secondary	10 mg/m^3 (9 ppm)	----
Source: NJDEP 2010 Carbon Monoxide Summary			

According to the NJDEP report, "carbon monoxide levels have improved dramatically over the past 20 years. The last time the CO standard was exceeded in New Jersey was in

January of 1995, and the entire state was officially declared as having attained the CO standard on August 23, 2002." Because on-road vehicle emissions form the major contributor to CO levels, there is a variation throughout the day, with the highest peaks around 7 to 8 am, and another, lower but more extended, rise between 4 and 8 pm.

In 2010, of the CO monitoring stations closest to Kinnelon, the highest concentrations were reported in East Orange (see *Table 14*). The East Orange station also had the highest 8-hour average concentration of any reporting station in the state. Most CO monitoring stations are located in high traffic areas in northeastern New Jersey. All statistics are well below the national and state standards.

Table 14. Carbon Monoxide - 2010

1-Hour and 8-Hour Averages in Parts Per Million (ppm)
1-hour standard = 35 ppm; 8-hour standard = 9 ppm

Monitoring Sites	*Maximum 1-Hr Avg*	*2nd Highest 1-Hr Avg*	*Maximum 8-Hr Avg*	*2nd Highest 8-Hr Avg*
East Orange (c.18 mi)	3.7	3.4	3.1	2.1
Hackensack (c.19 mi)	2.7	2.3	1.9	1.6
Morristown (c.15 mi)	1.7	1.4	1.0	1.0

Source: NJDEP Carbon Monoxide Summary 2010

Nitrogen Dioxide

According to the NJDEP *2010 Nitrogen Dioxide Summary*, nitrogen dioxide (NO_2) is a reddish-brown, highly reactive gas that is formed in the air through the oxidation of nitric oxide (NO). When it reacts with other chemicals, it can form ozone, particulate matter and other contributors to acid rain and haze. Oxides of nitrogen (NO_x) are combinations of gases comprising mostly NO_2 and NO. They are emitted from fuel-related sources, which include vehicle exhaust, the burning of coal, natural gas and oil, industrial processes such as welding, and household gas stoves and heaters. NO is released into the atmosphere as NO_x but easily converts to NO_2.

NO_2 can aggravate or cause respiratory illness and prolonged exposure can permanently damage the lungs. Along with NO, it can irritate the eyes, nose, throat and lungs and cause nausea and tiredness. Both are found in tobacco smoke. The environmental effects of nitrogen oxides can include potential changes in the composition of some plants in wetland and terrestrial ecosystems, acidification of freshwater bodies, eutrophication of estuarine and coastal waters, increases in levels of toxins harmful to fish and other aquatic life, and visibility impairment.

The levels for the national and state standards are the same; however, national standards are based on calendar year averages, while state standards apply to any 12-month period. Because the bulk of NO_x emissions comes from vehicle exhaust, levels are highest during morning and afternoon rush hours. Levels are also higher in winter than in summer. (see *Table 15*)

Table 15. National and New Jersey Ambient Air Quality Standards for Nitrogen Dioxide (NO_2) Parts Per Million (ppm) and Micrograms Per Cubic Meter ($\mu g/m^3$)			
Averaging Period	*Type*	*New Jersey*	*National*
12-month average	Primary	100 $\mu g/m^3$ (0.053 ppm)	
Annual average	Primary		0.053 ppm (100 $\mu g/m^3$)
12-month average	Secondary	100 $\mu g/m^3$ (0.053 ppm)	
Annual average	Secondary		0.053 ppm (100 $\mu g/m^3$)
1-hour average	Primary		0.100 ppm (190 $\mu g/m^3$)
Source: NJDEP 2010 Nitrogen Dioxide Summary			

NO_2 concentrations in New Jersey have fallen steadily from an average of 0.040 ppm in 1975 to 0.012 ppm in 2010. Neither the statewide nor the individual station averages have exceeded the health standard of 0.053 ppm, although the highest reporting stations in 1975 came close. Of the eight reporting stations for 2010, East Orange and Chester are two of the closest to Kinnelon. Chester reported the lowest levels of all reporting stations, while East Orange's results were toward the higher end. Elizabeth Lab, which reported the highest levels, is included for comparison in *Table 16*.

Table 16. Nitrogen Dioxide (NO_2) and Nitric Oxide (NO) - 2010 Parts Per Million (ppm) National Standards: 1-Hour - 0.100 ppm; 12-Month - 0.053 ppm				
	Nitrogen Dioxide			*Nitric Oxide*
Monitoring Sites	*1-Hr Avg 2010 98th %-ile*	*1-Hr Avg 2008-2010 98th %-ile*	*12-Mo Avg*	*12-Mo Avg*
East Orange (c.18 mi)	0.064	0.062	0.018	0.012
Chester (c.23 mi)	0.035	0.038	0.004	0.000
Elizabeth Lab (c.25 mi)	0.071	0.073	0.022	0.021
Source: NJDEP 2010 Nitrogen Dioxide Summary				

Although NO_2 concentrations score well within the NAAQS, oxides of nitrogen continue to be of concern because of their role in the formation of other pollutants – particularly ozone and fine particles.

Particulate Matter

Particulate matter can be any manmade or natural particles found in the air, such as dust, dirt, smoke, sea salt and liquid droplets. At any size, these particles can affect the environment. The total of all particles, of whatever size, is referred to as "Total Suspended Particulates" (TSPs). Particles less than 10 micrometers in diameter (PM_{10}) are called "Inhalable Particulates" because they can be inhaled into and accumulate in the respiratory system. Particles less than 2.5 micrometers ($PM_{2.5}$), called "Fine Particulates," are believed to pose the greatest health risk. At greatest risk are children, the elderly, and individuals with heart and lung diseases, such as asthma.

NAAQs for both Inhalable Particulates (PM_{10}) and Fine Particulates ($PM_{2.5}$) are set at the same level for both primary (health) and secondary (environmental welfare) standards. Although the EPA abandoned standards for TSPs in favor of the smaller PM_{10} and $PM_{2.5}$ particulates, New Jersey still maintains TSP standards, as shown in *Table 17*.

Table 17. Particulate Matter – 2010 National and New Jersey AAQs
Micrograms Per Cubic Meter ($\mu g/m^3$)

	Averaging Period	*National*	*New Jersey*
Total Suspended Particulates (TSP)	12-Month Primary 12-Month Secondary 24-Month Primary 24-Month Secondary	--	75 $\mu g/m^3$ 60 $\mu g/m^3$ 260 $\mu g/m^3$ 150 $\mu g/m^3$
Inhalable Particulates (PM_{10})	Annual	50 $\mu g/m^3$	---
	24-Hr Avg	150 $\mu g/m^3$	---
Fine Particulates ($PM_{2.5}$)	Annual	15.0 $\mu g/m^3$	---
	24-Hr Avg	35 $\mu g/m^3$	---

Source: NJDEP 2010 Particulate Summary

In 2010, four New Jersey air monitoring stations measured PM_{10}, 24 measured $PM_{2.5}$ and seven monitored what is known as smoke shade or the coefficient of haze (COH), for which no standard is set. Several stations use the EPA sanctioned Federal Reference Method (FRM) sampling, based on a 24-hour period, but New Jersey also has additional monitors that continuously measure particulate concentrations (TEOMs), providing the real-time data that the FRM cannot. TEOM data is made available to the public via the Air Quality Index (www.njaqinow.net).

In 2010, all areas of the state were in attainment for Inhalable Particulates, PM_{10}. The closest of the four PM_{10} monitoring stations to Kinnelon was in Jersey City, where the highest daily concentration was 109 $\mu g/m^3$, versus the national standard of 150, and the annual mean was 29, versus the national standard of 50.

All sites met the annual standard for Fine Particulates, $PM_{2.5}$., but 10 sites, mostly in northern New Jersey, including Morristown, Paterson and Elizabeth Lab, exceeded the 24-hour standard of 35 $\mu g/m^3$. In addition, 10 northern New Jersey counties, including Morris County, were designated as non-attainment not for their local results but "due to their potential $PM_{2.5}$ contribution to the Elizabeth Lab monitor and additional sites in New York City that recorded violations."

Further breaking down the fine particulate contribution to air pollution, four stations, including Chester and Elizabeth Lab, measure 39 components. The five highest contributors are organic carbon, sulfate, nitrate, elemental carbon and sulfur. Elizabeth Lab reported the highest concentrations of each of these five particulates. Both organic and elemental carbon are sourced primarily from motor vehicles, and Elizabeth Lab is located in a high traffic area. Chester scored lowest for elemental carbon and nitrate but was close to Elizabeth Lab for both sulfate and sulfur levels.

"Smoke shade" is an indirect measurement of particles in the atmosphere and is used for daily reporting in the Air Quality Index. Smoke shade is measured as a Coefficient of Haze (COH), with a benchmark set at 2.0. Readings above this level are deemed "Unhealthy for Sensitive Groups." The two closest stations, Morristown and Hackensack stations, reported levels below the benchmark. The highest reporting stations were Jersey City and Elizabeth Lab, also below the benchmark (see *Table 18*).

Table 18. Smoke Shade – 2010

Benchmark 2.0			
Station	*Max Daily Avg.*	*2nd Highest Daily Avg.*	*Annual Mean*
Morristown* (c.15 mi)	0.58	0.54	0.17
Hackensack (c.19 mi)	0.56	0.50	0.15
Jersey City (c.24 mi)	1.15	1.10	0.35
Elizabeth Lab (c.25 mi)	1.12	0.99	0.32

**Morristown shut down at the end of 2010.*
Source: NJDEP

Lead

Lead is a hazard to the health of humans and the environment, whether the source is lead in the air, in paint on walls, in our water, or in our soils. When taken into the body, lead circulates via the blood and accumulates in the bones. It affects the oxygen carrying capacity of the blood and can negatively affect the nervous system, kidneys, immune system, reproductive, developmental and cardiovascular systems. It most commonly causes neurological effects in children and cardiovascular effects in adults. On a secondary level, lead from the air or water bodies may accumulate in soils and sediments, adversely affecting biodiversity.

According to the EPA, taking lead out of on-road motor vehicle gasoline has been the primary reason for a decline in lead in the air. Between 1980 and 2010 the EPA reported a 89% decrease in national average. Contributors to lead in the air today include ore and metals processing and leaded aviation fuel. As of 2012, only two non-attainment areas are listed for lead in the country: one in Montana and one in Missouri. *(EPA)*

The NJDEP has data for New Jersey stations monitoring lead in the air from 1990 to 1995-96. Although some stations exceeded NAAQS levels in the early 1990s, all were below the standards by 1996. Although no stations reporting to the NJDEP BAM were monitoring lead in recent years, a monitoring site is proposed for Paterson. (NJDEP)

Data available from the EPA includes information for a monitoring site in New Brunswick (see *Figure 10*) that includes statistics through 2008, indicating that levels were close to or above the national standards in several years during the 1999-2006 period. The primary and secondary NAAQS for lead are presently set at 0.15 micrograms per cubic meter of air ($\mu g/m^3$) measured on a rolling three month average. *(EPA)*

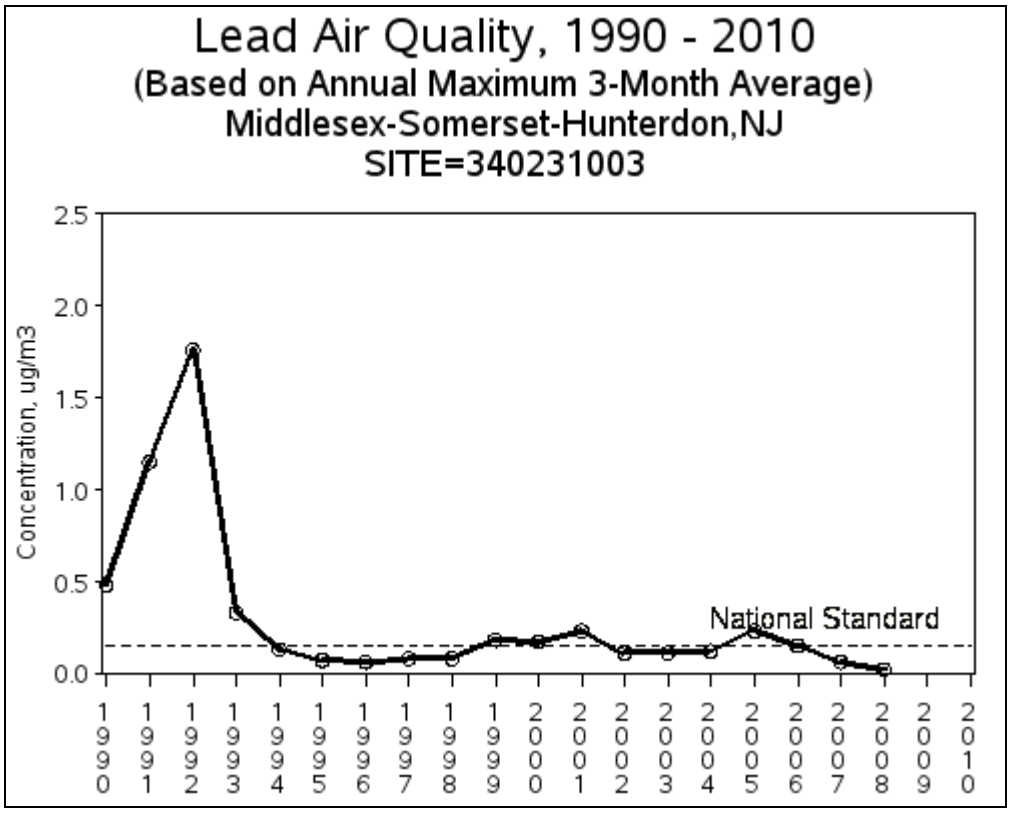


Figure 10. Lead Air Quality (1990-2010)
Source: USEPA

Air Toxics

Almost 200 air toxics have been identified on the list of Hazardous Air Pollutants (HAPs) maintained by the EPA. The EPA issues a National-Scale Air Toxics Assessment (NATA), which the NJDEP adapts to evaluate the types and amounts of air toxics people are exposed to in New Jersey. NJDEP compares the estimated NATA air concentrations to their chemical-specific health benchmarks and divides the modeled air concentration by the health benchmark to get a risk ratio. If the risk ratio for a specific chemical is greater than one, it may be of concern, increasing the risk for cancer or other negative health effects.

In 2005, NJDEP produced a county by county report on 22 air toxins, 21 of which are carcinogens and one of which, acrolein, is not. These toxins were considered to be of the greatest concern because their levels were predicted to exceed the health benchmarks in one or more counties. The list for Morris County, comparing air concentrations to health benchmarks, is shown in see *Table 19*.

Table 19. Morris County Average 2005 NATA Modeled Air Concentrations Compared to Health Benchmarks								
				% Contribution from				
Pollutant	*Modeled Air Concentration ($\mu g/m^3$)*	*Health Benchmark ($\mu g/m^3$)*	*Risk Ratio*	*Point Sources*	*Nonpoint Sources*	*On-road Mobile Sources*	*Nonroad Mobile Sources*	*Background & Secondary*
Acetaldehyde*	1.7	0.45	3.7	0%	3%	5%	2%	90%*
Acrolein*	0.041	0.020	2	<1%	16%	13%	11%	60%*
Arsenic Compounds	0.00049	0.00023	2.1	3%	7%	4%	3%	83%
Benzene	0.91	0.13	**7**	<1%	8%	29%	14%	49%
1,3-Butadiene	0.073	0.033	**2.2**	0%	0%	30%	15%	55%
Cadmium Compounds	0.000087	0.00024	0.4	6%	32%	0%	<1%	62%
Carbon Tetrachloride	0.61	0.067	**9.1**	0%	<1%	0%	0%	100%
Chloroform	0.096	0.043	**2.2**	<1%	38%	0%	0%	62%
Chromium (hexavalent form)	0.00025	0.000083	**3**	10%	4%	3%	<1%	83%
Cobalt Compounds	0.00014	0.00011	**1.3**	99%	1%	0%	0%	0%
1,4-Dichlorobenzene	0.082	0.091	0.9	<1%	44%	0%	0%	56%
1,3-Dichloropropene	0.069	0.25	0.3	0%	100%	0%	0%	0%
Diesel Particulate Matter	0.53	0.0033	**161**	0%	0%	56%	44%	0%
Ethylbenzene	0.19	0.4	0.5	<1%	15%	51%	34%	0%
Ethylene Oxide	0.0088	0.011	0.8	1%	11%	0%	0%	88%
Formaldehyde*	1.8	0.077	**24**	<1%	3%	7%	4%	86%*
Methyl Chloride	1.2	0.56	**2.1**	<1%	<1%	0%	0%	100%
Naphthalene	0.086	0.029	**3**	<1%	33%	27%	5%	35%
Nickel Compounds	0.0010	0.0021	0.5	39%	13%	2%	1%	45%
PAH/POM**	0.0078	0.0072**	**1.1**	<1%	79%	8%	13%	0%
Perchloroethylene	0.16	0.17	0.9	<1%	39%	0%	0%	61%
1,1,2-Trichloroethane	9.3E-7	0.063	2.0E-5	53%	47%	0%	0%	0%

- Chemicals with risk ratios greater than or equal to 1 are in **bold**. The four highest risks for Morris County are highlighted in gray.
- Risk Ratios based on noncarcinogenic effects are in *italics*.
- The symbol ug/m3 is micrograms per cubic meter, the amount (in micrograms) of a chemical in a cubic meter of air. This is also known as a concentration.

Table 19. Morris County Average 2005 NATA Modeled Air Concentrations Compared to Health Benchmarks

Pollutant	Modeled Air Concentration ($\mu g/m^3$)	Health Benchmark ($\mu g/m^3$)	Risk Ratio	% Contribution from				
				Point Sources	Nonpoint Sources	On-road Mobile Sources	Nonroad Mobile Sources	Background & Secondary

- For diesel particulate matter, on-road and non-road concentrations include a model-estimated background concentration.
- *Acetaldehyde, acrolein and formaldehyde concentration estimates include secondary formation, which is the process by which chemicals in the air are transformed into other chemicals.
- **PAH/POM is "polycyclic aromatic hydrocarbons/polycyclic organic matter." These define a broad class of compounds. The chemicals making up this class were broken up into 8 groups based on toxicity, and each group was assigned a cancer-weighted toxicity estimate. 0.0072 ug/m3 is the health benchmark average across the 8 groups.

Source: NJDEP

The four chemicals with the highest risk ratios in Morris County are diesel particulate matter (161), formaldehyde (24), carbon tetrachloride (9.1) and benzene (7).

Diesel particulate matter, according to table above, poses the highest risk factor for Morris County, with an overall ratio of 161 times the benchmark. The risk ratio is higher in the eastern and central part of the County and along the I-80 corridor; the risk factor in Kinnelon is lower, 50-100 times the benchmark. Sussex County has the lowest cancer risk ratio (40) from diesel particulate matter and Hudson County the highest (925). In Morris County, 56% of diesel particular matter comes from on-road mobile sources and 44% from non-road sources.

Formaldehyde. Formaldehyde is mostly formed in the atmosphere from chemicals released from mobile and other sources and does not degrade quickly. In Morris County, background and secondary formations account for 86% of sources. Kinnelon risk ratios range from 10 to 30 times benchmark, with lower ratios in the western part of the Borough. The Countywide score is 24.

Carbon tetrachloride (CT). The entire state is at a risk ratio of 5-10 times benchmark, with Morris County assessed at 9.1. While no longer used in New Jersey, CT has a long half-life and thus residual levels remain in the air. CT contributes significantly to ozone depletion and thus is being phased out nationally under the Clean Air Act Amendments.

Benzene. Benzene is a component of gasoline and oil and is used industrially to make other chemicals, plastics and synthetic fibers. It is ranked in the top 20 chemicals for production volume in the U.S. Eastern Morris County, including Kinnelon, has a benzene risk ratio of 5-10 times benchmark, with Morris County as a whole scoring 7. Primary sources are on-road mobile (29%) and background concentrations (49%).

On-road mobile sources of air toxics emissions are vehicles; nonroad mobile sources may includes aircraft, trains, lawnmowers and leaf blowers, boats, dirt bikes and construction vehicles. Nonpoint sources of emission include heating, fuel and pesticide use, dry cleaners and consumer products, such as adhesives, sealants, paint, personal care and other household products. Point sources are identified by the NJDEP as "large facilities

that emit a significant amount of air pollution during manufacturing, power generation, heating, incineration, or other such activity" as well as "smaller facilities including those that are required to report their emissions under the federal Toxic Release Inventory program and the state's Community Right-To-Know program" (see *Contaminated Sites* chapter).

Morris County's emissions come mostly from on-road and non-point sources, followed by non-road mobile sources, with a very low contribution by point sources (see *Figure 11*).

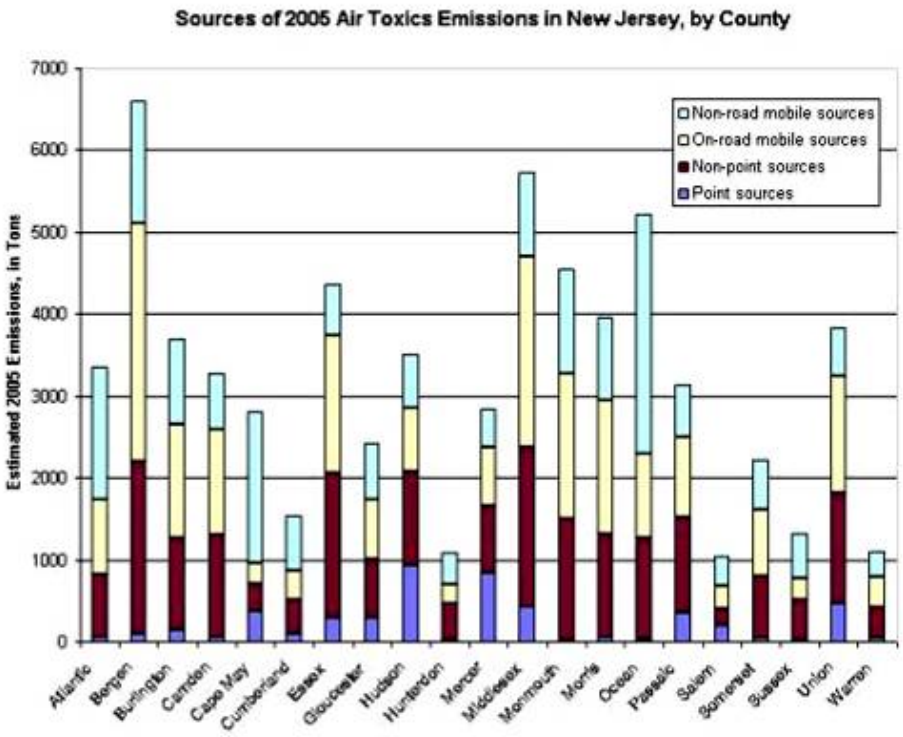


Figure 11. Sources of 2005 Air Toxics Emissions in New Jersey, by County
Source: NJDEP

The final category of contributions to emissions is background and secondary sources. Background concentrations generally cannot be sourced to current, local emissions. The six air toxics that are of concern in this category for New Jersey are:

- Arsenic compounds
- Benzene
- 1,3-Butadiene
- Carbon tetrachloride
- Chloroform
- Methyl chloride

Secondary formation, or atmospheric transformation, refers to chemicals that have been transformed in the air from an air pollutant into another chemical, which may have a different level of toxicity. Four air toxics of concern in this category are the primary

toxics acetaldehyde, formaldehyde, and acrolein and the decay of 1,3-butadiene to acrolein.

Radon

Radon is a naturally occurring radioactive gas. It is a byproduct of the decay of uranium and is found in soil at varying concentrations. Radon is a known health risk, causing lung cancer in smokers and non-smokers alike. Because it can accumulate in closed places such as houses, homeowners in high risk areas are encouraged to have their properties tested. Radon can also work its way into the water supply. The greatest risk of radon from drinking water is that it may escape into indoor air. Testing of drinking water supplies for uranium has been a recent development. If levels exceed the maximum set by the EPA for extended periods of time, kidney damage can occur.

The Reading Prong, which stretches from Pennsylvania to southern New York State, is particularly uranium rich. The New Jersey section of the Reading Prong is known as the New Jersey Highlands and encompasses much of Morris County and Kinnelon. Because of this uranium rich belt, Morris County is considered a high risk county for radon presence. Municipalities in the County rank as either Tier 1 (high radon potential) or Tier 2 (moderate radon potential). Kinnelon Borough is ranked Tier 2.

For more information on radon, visit *http://www.nj.gov/dep/rpp/radon/index.htm*

Noise and Odors

Noise

The NJDEP, authorized by the Noise Control Act of 1971, N.J.A.C. 7:29, oversees noise control and abatement in New Jersey. The Office of Local Environmental Management (OLEM) works with County Health Departments and municipalities to monitor noise complaints and compliance. The NJDEP does not have a Noise Control Program, but the Noise Information website provides a list of contacts depending on the type of noise: aircraft, highway, commercial or industrial, or residential noise and nuisances. (*NJDEP http://www.state.nj.us/dep/enforcement/contact-noise.html*).

While noise can be a factor in many areas of New Jersey, it does not appear to be a major issue for Morris County or Kinnelon Borough. Only one noise investigation was reported in Morris County for 2008. The NJDEP encourages municipalities to follow the Model Noise Ordinance available on the NJDEP website and maintains a list of municipal ordinances submitted to the NJDEP for review and approval. According to the NJDEP website, Kinnelon Borough has not submitted a noise ordinance to the State; however, Kinnelon Municipal Code restricts unnecessary noise as follows, per Ordinance 1-63:

- Chapter 146-1 Unnecessary noise restricted: No person, firm, corporation or association shall make, continue, suffer or cause to be made or continued any unnecessary or unusual sound or noise which either annoys, injures or endangers the comfort, repose, health or safety of others unless the making and continuing of the same is necessary for the protection or preservation of property or of the health, safety, life or limb of any person or persons.

- Operation of bulldozers, shovels and other types of construction equipment, including the loading or unloading of trucks carrying sand, clay, gravel or stone, is prohibited, other than between the hours of 7:00 a.m. and 7:00 p.m. prevailing time.

Noise restrictions exist in other chapters of the Borough municipal code including Chapters 176-31, 207-16 and 207-17. Chapter 207-16 (Limited industrial zone) states that noisemaking devices cannot be unreasonably audible beyond the boundaries of the site. General noise restrictions apply as well to peddlers and solicitors, firearms and hunting, dogs and other animals. *(Kinnelon Municipal Code)*

Odors

According to the NJDEP, "odor is an air contaminant and therefore may be considered air pollution if it is present in a way that unreasonably interferes with the enjoyment of life or property." Guidelines for odor control are set forth in The Air Pollution Control Act: N.J.S.A. 26:2C-1 et seq. and N.J.A.C. 7:27-1.1 et seq.

Odor complaints can be reported to the Northeast regional field office at 973-656-4444 or the NJDEP 24 hour toll-free environmental hotline at 877-927-6337.

In the Kinnelon Borough municipal code, restrictions against odors include:

- 176-31 Criteria for Review by Planning Board: No smoke, fumes or objectionable odors or noises shall be emitted from any building or use.
- 207-16 Limited Industrial Zone: Prohibits emission of smoke, fumes, gas, dust, obnoxious odors or any other atmospheric pollutant which is capable of dissemination ... substances in solution or suspension which are capable of creating odors or discoloration or of poisoning or polluting the stream in any way.
- 207-17 Commercial Zone: Prohibits any trade or use that is noxious or offensive by reason of the emission of odor, dust, smoke, gas or noise.

Meteorology and Pollution

Meteorology plays an important role in the distribution of pollution throughout the troposphere, the layer of the atmosphere closest to the earth's surface. Atmospheric processes such as wind speed and wind direction affect the transport and dispersion of air pollution. Weather phenomena, such as precipitation and solar radiation, influence chemical reactions and transformations in the atmosphere that affect air pollutants. By studying meteorological and air pollution data together, scientists and mathematicians have developed reasonably accurate models for predicting the fate of pollutants as they go through the stages of transport, dispersion, transformation and removal. The Elizabeth Lab meteorological station monitors wind speed and wind direction. The East Orange meteorological station monitors temperature and relative humidity. The Chester meteorological station and Newark firehouse monitor solar radiation. *(NJDEP DAQ)*

HYDROLOGY

Kinnelon has developed around its lakes, which are a central part of life in the Borough. Tourism and recreation spurred residential development near many of the lakes, first as summer communities and now as year-round homes. (*Natural Resource Inventory of Kinnelon, NJ 1973-1974*)

The New Jersey Highlands region, including Kinnelon, provides drinking water to nearly two million residents statewide. Within Kinnelon Borough, the Kakeout (Butler) Reservoir west of Fayson Lakes provides water primarily to the Borough of Butler. Also partially within the Borough is the Taylortown Reservoir servicing Boonton Town and Township. Just over Kinnelon's western border is Jersey City's Split Rock Reservoir. Within the Pequannock River Basin, the Oak Ridge, Clinton, and Charlotteburg Reservoirs, and Echo Lake, are regulated surface water bodies utilized for water supply by the City of Newark. Charlotteburg Reservoir is partially located in Kinnelon Borough, near Smoke Rise.

Watersheds

"A watershed is a topographic area within which apparent surface water runoff drains into a specific point on a stream or to a waterbody such as a lake." *(EPA, Ecoregions and Watersheds, 1997)* The NJDEP has divided the state into Watershed Management Areas (WMAs). A watershed-based approach to natural resource management is considered by state and national agencies to be the most appropriate unit for managing complex environmental problems.

The majority of Kinnelon is part of WMA 3, which comprises the basins of the Pompton, Pequannock, Wanaque, and Ramapo Rivers. The Pequannock River is the major river in Kinnelon, flowing from the Charlotteburg Reservoir forming the northern boundary of the Borough east to Butler and Riverdale, where it proceeds in a southerly direction until its confluence with the Pompton River in Pequannock. The northern half of the Borough drains directly into either the Pequannock or its tributary, Stone House Brook. Stone House Brook originates from New Pond and flows east through Lake Kinnelon in Smoke Rise to the Kakeout Reservoir then to the Pequannock River. Only the southeastern corner of the Borough drains to the Pompton River by way of East Ditch and West Ditch tributaries, while feeding the groundwater resources of the Towaco aquifer. The southern part of Kinnelon is part of WMA 6, the Upper Passaic, Whippany, and Rockaway Watershed. Most of WMA 6 in Kinnelon Borough drains south to the Rockaway River, through Stony Brook, Bear House Brook, and Beaver Brook in Kinnelon. A small part of WMA 6 in Kinnelon flows west to the Split Rock Reservoir and Beaver Brook in

Rockaway Township. The Pequannock, Pompton, and Rockaway Rivers eventually join with the Passaic River.

Every WMA is composed of multiple watersheds and subwatersheds. The United States Geological Survey (USGS) has mapped and identified watersheds using a hierarchal numbering system. This system identifies watersheds using a hydrological unit code (HUC) consisting of up to 14 digits for the smallest watersheds. The HUC14 watersheds for Kinnelon Borough are identified on *Watershed Map (Map 6 in the Maps section)* and listed in *Table 20*.

Table 20. HUC 14 Watersheds in Kinnelon Borough

WMA	*WMA Name*	*Sub-Watersheds*	*Acres*	*Percent*
3	Pompton, Pequannock, Wanaque, Ramapo	Pequannock River (Charlotteburg to OakRidge)	192.37	1.56%
3	Pompton, Pequannock, Wanaque, Ramapo	Pequannock River (Macopin Gage to Charlotteburg)	970.83	7.89%
3	Pompton, Pequannock, Wanaque, Ramapo	Pequannock River (Below Macopin Gage)	2,306.54	18.74%
3	Pompton, Pequannock, Wanaque, Ramapo	Pequannock River (Stone House Brook)	3,853.50	31.31%
3	Pompton, Pequannock, Wanaque, Ramapo	Pompton River (Lincoln Park Tributaries)	1,157.01	9.40%
6	Upper Passaic, Whippany, and Rockaway	Rockaway River (Beaver Brook)	315.34	2.56%
6	Upper Passaic, Whippany, and Rockaway	Rockway River (Montville Tributaries)	418.43	3.40%
6	Upper Passaic, Whippany, and Rockaway	Rockaway River (Stony Brook-Boonton)	3,095.14	25.14%
		Total:	**12,309.15**	**100.00%**

Source: NJDEP
Note: Due to rounding, numbers may differ from recorded totals

Surface Water

Surface water is water that collects on the ground or in a stream, river, lake, wetland, or ocean. Major waterbodies in Kinnelon include Lake Kinnelon (formerly Stickle Pond), Charlotteburg Reservoir, the Pequannock River, Maple Lake, Canty's Lake, New Pond[2], Kakeout (Butler) Reservoir, Fayson Lakes, Surprise Lake, Lake Reality, Lake Rickabear, Lake Juliet, Taylortown Reservoir, Sawmill Pond, and Untermeyer Lake.

[2] Locally, New Pond is known as "Mr. Kinney's New Pond," or "Stillwater Pond," as Mr. Kinney had informally named this dammed pond. (*Personal communication, Tom Kline, Borough of Kinnelon Historical Commission)* On the Borough's tax maps and in the 1973-1974 Borough of Kinnelon *Natural Resource Inventory* this waterbody is known as "New Pond."

New Jersey's Surface Water Quality Standards (SWQS) (N. J. A. C. 7:9) classify Fresh Water 1 (FW1) as the highest level of classification, which is defined as:

> "those fresh waters, as designated in N.J.A.C. 7:9B-1.15(j), that are to be maintained in their natural state of quality (set aside for posterity) and not subjected to any manmade wastewater discharges or increases in runoff from anthropogenic activities. These waters are set aside for posterity because of their clarity, color, scenic setting, other characteristic of aesthetic value, unique ecological significance, exceptional recreational significance, exceptional water supply significance or exceptional fisheries resource(s)."

The general classification for the other fresh waters in the State is Fresh Water 2 (FW2). Further classifying these water bodies, the presence of trout in a stream means that the waters are relatively free of chemical or biological contaminants. A stream can be classified as Trout Production (TP), Trout Maintenance (TM) or Non-Trout (NT). Trout production waters are waters designated "for use by trout for spawning or nursery purposes during their first summer." Trout maintenance waters support trout throughout the year. Waters classified as Non-Trout (NT) do not support trout, either because of their physical nature or due to biological or chemical characteristics.

The rivers and streams of Kinnelon Borough are among the most pristine in the state and several have been classified by the NJDEP as Category One (C1) waterways. These high quality waterways are protected from measurable changes in water quality characteristics as determined by their clarity, color, scenic setting, aesthetic value, exceptional ecological significance, exceptional recreational significance, exceptional water supply significance, or exceptional fisheries resource(s). The C1 classification signifies the highest level of protection for a stream in New Jersey; among other regulations, no new development can occur within 300 feet of category one waterways.

The majority of the Pequannock River in Kinnelon Borough has been designated a Category One waterway. See *Surface Water Quality Map (Map 7 in the Maps section)* and *Table 21* for the surface water quality designations.

Table 21. Surface Water Quality Standards in Kinnelon Borough

Non-Trout Waters	*Trout Production*	*Category One*
Stone House Brook UNT*	Pequannock River UNT*	**Non-Trout**
Stone House Brook		Lake Reality
Stickle Pond		Fayson Lakes
Uncoded Tributary		Beaver Brook
Butler Reservoir		Beaver Brook UNT*
East Ditch UNT*		West Lake
East Ditch		East Lake
Cronin Pond		Ricabear Lake
West Ditch		Stony Brook UNT*
West Ditch UNT*		Stony Brook
Hoot Owl Lake		Taylortown Reservoir
New Pond		**Trout Maintenance**
Macopin Reservoir		Charlotteburg Reservoir

Table 21. Surface Water Quality Standards in Kinnelon Borough		
Non-Trout Waters	*Trout Production*	*Category One*
Surprise Lake Brook Surprise Lake Crooked Brook		**Trout Production** Pequannock River Maple Lake Timber Brook UNT* Canty's Lake
**UNT – Unnamed Tributary* *Source: NJDEP*		

The quality of surface waters can be affected by point sources and non-point sources of pollution as well as from erosion and sedimentation. Point source means any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged (*Clean Water Act, 1972*). This includes discharges from sewage treatment plants and factories, stormwater runoff, illegal dumping, and malfunctioning underground storage tanks and septic systems. This term does not include agricultural stormwater discharges and return flows from irrigated agriculture.

As opposed to point source pollution, non-point source pollution comes from many different sources. As rainfall or snowmelt moves over and through the ground, it picks up and carries natural and human-made pollutants (such as fertilizers, herbicides and motor oil) and deposits them into surface and groundwater.

The effects of pollutants on specific waterways can vary, but are manifested in drinking water supplies, recreation, fisheries, and wildlife. One of these effects is eutrophication. Eutrophication in freshwater systems is the addition of substances, either human-made or natural, to a waterbody, affecting the primary productivity of that waterbody. Substances such as nitrates and phosphates promote excessive algae and phytoplankton growth. These “blooms” can have negative effects on the ecosystem. These negative impacts include a clouding of the water, which limits sunlight, stopping the growth of plants deeper in the water. Additionally, eutrophication can lead to anoxia, a condition where a waterbody has depleted levels of oxygen, which is the result of the decomposition of dead phytoplankton.

Water quality can also be negatively impacted by sedimentation. Sedimentation is the transportation and deposition of eroded materials. Development near streams and on steep slopes reduces vegetation cover in these areas. This ground cover can typically absorb the impact of raindrops, and when it is removed, the soil becomes more susceptible to erosion. The eroded soil is then transported and deposited by runoff into surface waters, where it can contaminate water and increase its turbidity, effectively blocking sunlight to plant species and negatively affecting the ecosystem.

Groundwater Recharge Areas

Groundwater is the primary drinking and agricultural water source for the residents of New Jersey, and is a major source of drinking water for residents of Kinnelon Borough, with reservoirs providing the balance. Groundwater recharge is the process in which surface water, from lakes, streams, or rainwater runoff, flows or seeps downwards beneath ground surface, saturating soil or rock. Groundwater is contained in porous rocks and sediments. Where such water-holding rocks or unconsolidated materials yield a usable quantity of water, it is called an aquifer, the source from which drinking water is drawn through wells. Protecting the land's capacity to recharge its aquifers, and limiting development to stay within the capacity of local water resources, is critical to maintaining our water supply.

Aquifer-recharge potential was calculated through the combination of a standardized statewide aquifer ranking system and the particular groundwater recharge coverage in the area of interest. Aquifer recharge or recharge to water-bearing geologic units is defined as the groundwater that reaches the water table in the uppermost geologic unit with a thickness of 50 feet or greater. Groundwater recharge potential is ranked by average annual infiltration. The composite aquifer/groundwater recharge potential rank highlights the multiple relationships between the groundwater-recharge area ranks (indicative of the infiltration rate) and the underlying water-table aquifer ranks (indicative of the aquifer's capacity to absorb, transmit and supply water) and provides a guide to how well the system in any given area allows groundwater to reach and recharge the aquifer. *Table 22* depicts the ranking system.

Table 22. Statewide Aquifer and Morris County Groundwater Rankings

Aquifer Rank	*Median Well Yield (Gallons/Minute)*	*Groundwater Rank*	*Avg. Annual Infiltration (In/Yr)*
A	>500	A	20-23
B	>250-500	B	15-19
C	>100-250	C	10-14
D	25-100	D	1-9
E	<25	0	0

There are also hydric soils (L/L), wetlands and open water (W/W) and instances where no recharge is calculated (X/X).

Source: NJDEP NJGS

The *Aquifer Recharge Potential Map* (*Map 8 in the Maps section*) shows the distribution of rankings for Kinnelon Borough. This map shows the potential for an aquifer to recharge in a given area. The area with the highest potential for recharge would be ranked A/A (>500 gpm/20-23 in/yr). In Kinnelon, there are 14 acres that are ranked A/A, representing 0.12% of the Borough. 27% ranks at D/B (25-100 gpm/15-19 in/yr) and another 53% ranks at level D/C (25-100 gpm/10-14 in/yr). The acres associated with each aquifer/groundwater recharge ranking in Kinnelon are shown in *Table 23.*

Table 23. Aquifer/Groundwater Recharge Rankings in Kinnelon Borough			
Alpha Rank	*Numeric Rank*	*Acres*	*% of Borough*
A/A	11	14.40	0.12%
A/B	12	193.28	1.57%
A/C	13	210.50	1.71%
A/D	14	3.13	0.03%
A/E	15	3.12	0.03%
D/A	41	91.28	0.74%
D/B	42	3,297.87	26.80%
D/C	43	6,482.52	52.69%
D/D	44	137.45	1.12%
D/E	45	84.91	0.69%
E/A	51	0.03	0.00%
E/B	52	1.33	0.01%
L/L	97	691.04	5.62%
W/W	98	1,092.57	8.88%
		12,303.43	100.00%
Source: NJDEP			

Aquifer Identification

An aquifer is an underground formation of permeable rock or unconsolidated materials that can yield significant quantities of water to wells or springs. The rate of recharge is not the same for all aquifers, and that must be considered when pumping water from a well. Pumping too much water too fast draws down the water in the aquifer and eventually causes a well to yield less and less water and even run dry.

Aquifers are typically equated to the type of geologic formation in which they exist. Aquifers in New Jersey are classified as either bedrock or surficial. Bedrock aquifers consist of rock formations while surficial aquifers are formed from unconsolidated materials such as sand or gravel or glacial sediment. Bedrock aquifers in the Highlands contain water in fractures within the rock while surficial aquifers contain water primarily in the spaces between sand and gravel particles. The majority of Kinnelon Borough is serviced by bedrock aquifers through igneous and metamorphic rocks (12,245 acres). Bedrock and surficial aquifers in Kinnelon Borough are shown on the *Bedrock and Surficial Aquifers Map (Map 9 in the Maps section)* and detailed in *Table 24* and *Table 25*.

Table 24. Surficial Aquifers in Kinnelon Borough			
Name	*Rank*	*Acres*	*Percent*
Lake-bottom Sediment	E	4.13	0.63%
Sand and Gravel	B	505.19	76.50%
Till	D	151.05	22.87%
	Total:	660.37	100.00%
Source: NJDEP			

Table 25. Bedrock Aquifers in Kinnelon Borough			
Name	*Rank*	*Acres*	*Percent*
Igneous and metamorphic rocks	D	12,245.13	99.48%
Brunswick aquifer conglomerate	C	26.30	0.21%
Basalt	D	37.73	0.31%
	Total:	12,309.15	100.00%
Source: NJDEP			

Public Water Supply and Wellhead Protection

The 1986 Federal Safe Drinking Water Act Amendments (*Section 1428, P.L. 93-523, 42 USC 300 et. Seq*) direct all states to develop a Well Head Protection Program (WHPP) Plan for both public community (CWS) and public non-community (NCWS) water-supply wells. A component of the WHPP is the delineating of Well Head Protection Areas. This delineation is the first step in defining the sources of water to a public water supply in order to prevent and clean up groundwater contamination.

Well Head Protection Areas (WPAs) are delineated for both public community and non-community wells. The delineations for these wells are the two, five, and twelve-year tiers. Each tier represents the horizontal extent of groundwater captured by a well pumping at a specific rate over those periods of time (NJDEP).

There are five public community wells in Kinnelon Borough owned by Fayson Lake Water Company and the WPA for these wells is shown on the *Public Wellhead Protection Map* (*Map 10 in the Maps section*).

Riparian Zones

In order to better protect the public from the hazards of flooding, preserve the quality of surface waters, and protect wildlife and vegetation, the NJDEP has adopted Flood Hazard Area Control Act rules (N.J.A.C. 7:13) in order to incorporate more stringent standards for development in flood hazard areas and riparian zones. A riparian zone is land and vegetation within and adjacent to surface waters. Riparian areas in the Highlands include all open waters, flood prone areas, and wildlife corridors (300-foot corridors along each stream bank).

Activity within the regulated area of the flood hazard area and the riparian zone may be restricted if it includes or results in one or more of the following:

1. The alteration of topography through excavation, grading and/or placement of fill;
2. The clearing, cutting and/or removal of vegetation in a riparian zone;
3. The creation of impervious surface;
4. The storage of unsecured material;
5. The construction, reconstruction and/or enlargement of a structure; and
6. The conversion of a building into a private residence or a public building.

In most areas of New Jersey, Category 1 waters require a 300-foot buffer, while other surface waters, such as those classified as FW2-NT are subject only to a regulated 50-foot riparian zone, measured from the top of the bank, along both sides of all waters. In the Highlands, the *Regional Master Plan* requires a 300-foot buffer around all open waters.

SOILS

Soils Overview

Soils play a critical role in the environment. They support an area's vegetation, absorb rainwater, and provide habitat. The physical and chemical properties of soils reflect a large number of variables, including the parent material (bedrock), climate, vegetative cover, animal activities, slopes and drainage patterns, and time. New Jersey's fairly complex bedrock geology, history of glaciations, abundant precipitation, and patterns of human use have led to complex patterns of soil distribution (*NJGS Information Circular, Geologic Mapping in New Jersey*).

Soil Classifications

The official Soil Survey for Morris County was updated in 2008 by the Natural Resources Conservation Service (NRCS), an agency of the United Sates Department of Agriculture (USDA). The soils maps and tables in this *Environmental Resource Inventory Update* are based on the data from that official survey.

The NRCS Soil Survey plots soils by map units. The Soil Survey names each map unit based on the characteristics of the dominant soils within that unit. These *map unit names* identify the soils by both their *soil series* classification(s), such as Rockaway, and by characteristics that differentiate them from other soil groupings in the same series. For example, the soils of Rockaway series have characteristics that range from gravelly sandy loam with slopes of 3 to 8% to rock outcrop with slopes of up to 45%.

Each map unit name has an associated abbreviation that offers a shorthand version of the naming/classification system. This abbreviation system identifies the soil types by steepness, stoniness and frequency of flooding as follows:

- Capital letters at the end of the abbreviation indicate the slope phase, with "A" being less steep and "E" being steeper. An example is the Rockaway-Rock outcrop Complex, which includes RomC, RomD and RomE.

- The small letters "a," "b" or "c" following these capital letters indicate the degree of stoniness: stony, very stony, and extremely stony, respectively. An example is the Hibernia series, which in Kinnelon includes HhmCa and HhmDb.

- The small letter "t" at the end of an abbreviation indicates "frequently flooded." An example is Carlisle muck, CarAt.

The Soil Survey also categorizes each map unit as one of four *map unit types*: Consociations, complexes, associations and undifferentiated groups. The soils in Kinnelon fall into the first three groups, which are defined as follows:

Consociations (Cn) are named for the *dominant soil.* In a consociation, delineated areas use a single name from the dominant component in the map unit. Dissimilar components are minor in extent. Consociations represent 55% of Kinnelon's total area. Examples are Hibernia loam and Rockaway sandy loam.

Complexes (Cx) and ***associations (An)*** consist of two or more *dissimilar* components that occur in a regularly repeating pattern. The total amount of other dissimilar components is minor in extent. The major components of an association can be separated at the scale of mapping, while the major components of a complex cannot. Complexes often make up one of the major components of an association. For example, Rockaway-Rockaway outcrop Complex is an association that contains a complex. Associations account for 25%, and complexes account for 20%, of Kinnelon's total area.

The *ERI Update* includes two maps relating to soils (see *Maps* section). The *Soils Types Map* (*Map 11 in the Maps section*) depicts the distribution of soils within Kinnelon by *map unit name*; these soils are briefly described in the *Soils* table below. The *Soil Series Map* (*Map 12 in the Maps section*) shows the disbursements of the four soil series that occur most predominantly within the Borough. *Table 26* identifies the soils in Kinnelon Borough. *Table 26* identifies the major soil series table and provides descriptions to give further information about these soils.

Table 26. Soils of Kinnelon Borough

Abbrv.	*Map Unit (MU) Name*	*MU Type*	*Acres*	*%*
AdrAt	Adrian muck, 0 to 3 % slopes, frequently flooded	Cn	85.36	0.69%
BhdAt	Biddeford silt loam, 0 to 2 % slopes, frequently flooded	Cn	24.57	0.20%
BohB	Boonton moderately well drained gravelly loam, 3 to 8 % slopes	Cn	0.97	0.01%
BohC	Boonton moderately well drained gravelly loam, 8 to 15 % slopes	Cn	16.81	0.14%
CarAt	Carlisle muck, 0 to 2 % slopes, frequently flooded	Cn	179.19	1.46%
FmhAt	Fluvaquents, loamy, 0 to 3 % slopes, frequently flooded	Cn	12.09	0.10%
FNAT	Fluvaquents and udifluvents, 0 to 3 % slopes, frequently flooded	Cn	16.39	0.13%
HhmCa	Hibernia loam, 3 to 15 % slopes, stony	Cn	1,469.25	11.95%
HhmDb	Hibernia loam, 15 to 25 % slopes, very stony	Cn	67.17	0.55%
NerB	Netcong gravelly sandy loam, 3 to 8 % slopes	Cn	29.66	0.24%
NerC	Netcong gravelly sandy loam, 8 to 15 % slopes	Cn	13.85	0.11%
OtsC	Otisville gravelly loamy sand, 3 to 15 % slopes	Cn	42.64	0.35%
OtsD	Otisville gravelly loamy sand, 15 to 25 % slopes	Cn	62.32	0.51%
PauCc	Parker-Gladstone Complex, 0 to 15 % slopes, extremely stony	Cx	4.60	0.04%
PbphAt	Parsippany silt loam, sandy loam substratum, 0 to 3 % slopes, frequently flooded	Cn	7.90	0.06%

Table 26. Soils of Kinnelon Borough				
Abbrv.	*Map Unit (MU) Name*	*MU Type*	*Acres*	*%*
PHG	Pits, sand and gravel	Cn	8.81	0.07%
PohA	Pompton sandy loam, 0 to 3 % slopes	Cn	7.62	0.06%
PohB	Pompton sandy loam, 3 to 8 % slopes	Cn	10.83	0.09%
PrkAt	Preakness sandy loam, 0 to 3 % slopes, frequently flooded	Cn	13.20	0.11%
PrsdAt	Preakness dark surface variant sandy loam, 0 to 3 % slopes, frequently flooded	Cn	15.79	0.13%
RkgBb	Ridgebury loam, 0 to 8 % slopes, very stony	Cn	457.12	3.72%
RkgBc	Ridgebury loam, 0 to 8 % slopes, extremely stony	Cn	601.70	4.89%
RksB	Riverhead gravelly sandy loam, 3 to 8 % slopes	Cn	35.76	0.29%
RksC	Riverhead gravelly sandy loam, 8 to 15 % slopes	Cn	10.53	0.09%
RNRE	Rock outcrop-Rockaway Complex, 15 to 35 % slopes	An	1,900.42	15.45%
RobCb	Rockaway sandy loam, 8 to 15 % slopes, very stony	Cn	1,876.17	15.26%
RobDc	Rockaway sandy loam, 15 to 25 % slopes, extremely stony	Cn	789.27	6.42%
RocB	Rockaway gravelly sandy loam, 3 to 8 % slopes	Cn	70.05	0.57%
RocC	Rockaway gravelly sandy loam, 8 to 15 % slopes	Cn	50.41	0.41%
RomC	Rockaway-Rock outcrop Complex, 8 to 15 % slopes	Cx	1,866.96	15.18%
RomD	Rockaway-Rock outcrop Complex, 15 to 25 % slopes	An	1,139.78	9.27%
RomE	Rockaway-Rock outcrop Complex, 25 to 45 % slopes	Cx	374.58	3.05%
UR	Urban land	Cn	99.54	0.81%
USRHVB	Urban land-Riverhead Complex, 3 to 8 % slopes	Cx	3.93	0.03%
USROCC	Urban land-Rockaway Complex, 3 to 15 % slopes	Cm	244.67	1.99%
WhvAb	Whitman loam, 0 to 3 % slopes, very stony	Cn	65.00	0.53%
WATER	Water	Cn	622.21	5.06%
	Grand Total		**12,297.13**	**100%**
Source: NRCS Soil Survey 2008				

Major Soil Series

The four most prevalent soil series cover more than 89% of the Borough. The remaining soil series each represent less than 1% of Kinnelon's total area. The fluvaquents, udifluvents and urban land listed in the *Soils* table above are not considered soil series.

- ***Rockaway*** is the dominant series**,** covering 8,068 acres, or 65.61% of the Borough;
- ***Hibernia*** is second, covering 1,536 acres, or 12.5%;
- ***Ridgebury*** is a close third, at 1,058.82, or 8.61%; and
- ***Carlisle*** is a distant fourth, at 179 acres, or approximately 1.5%.

The soils within each series vary in characteristics. For example, in Rockaway, the most diverse and prevalent series, the characteristics range from gravelly sandy loam to rock outcrop and from 3 to 45% slope. The major soil series (*Table 27)* summarizes the

individual soil types within each series as found in Kinnelon, and the *Soil Series Map* (*Map 12 in the Maps section)* plots their locations.

Table 27. Major Soil Series in Kinnelon Borough						
Abbrv.	*Map Unit Name*	*Type*	*Farmland Type*	*Erodibility*	*Acres*	*% of Boro*
Rockaway Series						
RNRE	Rock outcrop-Rockaway complex, 15 to 35 percent slopes	An	Not prime farmland	Highly erodible	1,900.42	15.45%
RobCb	Rockaway sandy loam, 8 to 15 percent slopes, very stony	Cn	Not prime farmland	Potentially highly erodible	1,876.17	15.26%
RomC	Rockaway-Rock outcrop complex, 8 to 15 percent slopes	Cx	Not prime farmland	Potentially highly erodible	1,866.96	15.18%
RomD	Rockaway-Rock outcrop complex, 15 to 25 percent slopes	An	Not prime farmland	Highly erodible	1,139.78	9.27%
RobDc	Rockaway sandy loam, 15 to 25 percent slopes, extremely stony	Cn	Not prime farmland	Highly erodible	789.27	6.42%
RomE	Rockaway-Rock outcrop Complex, 25 to 45 % slopes	Cx	Not prime farmland	Highly erodible	374.58	3.05%
RocB, RocC &	Rockaway gravelly sandy loam, 3 to 8 % & 8 5o 15% slopes	Cn	Prime farmland	Potentially & highly erodible	120.46	0.98 %
Total Rockaway					*8,067.64*	*65.61%*
Hibernia Series						
HhmCa	Hibernia loam, 3 to 15 percent slopes, stony	Cn	Not prime farmland	Potentially highly erodible	1,469.25	11.95%
HhmDb	Hibernia loam, 15 to 25 % slopes, very stony	Cn	Not prime farmland	Highly erodible	67.17	0.55%
Total Hibernia					*1,536.42*	*12.49%*
Ridgebury Series						
RkgBb	Ridgebury loam, 0 to 8 % slopes, very stony	Cn	Not prime farmland	Not highly erodible	457.12	3.72%
RkgBc	Ridgebury loam, 0 to 8 % slopes, extremely stony	Cn	Not prime farmland	Potentially highly erodible	601.70	4.89%
Total Ridgebury					*1,058.83*	*18.61%*
Carlisle						
CarAt	Carlisle muck, 0 to 2 % slopes, frequently flooded	Cn	Farmland of unique importance	Not highly erodible	179.19	1.46%
Total					***10,962.53***	***89.15%***
Source: NRCS Soil Survey						

The following are descriptions of the major soil series in Kinnelon Borough, abstracted from the NRCS Soil Survey:

Rockaway - The Rockaway series consists of very deep well or moderately well drained soils formed in till on complex hilly to mountainous glaciated topography. They are

moderately deep to a *fragipan*, or dense, hard subsoil. In Kinnelon, slope ranges from 3 to 45%, but commonly is 8 to 35%. *Permeability* – how well water can flow through – is moderately rapid to moderate above the fragipan and slow to very slow in the fragipan. Mean annual temperature ranges from 45 to 52 degrees F. and mean annual precipitation ranges from 44 to 54 inches. Frost-free period ranges from 140 to 160 days.

Rockaway soils developed in coarse or moderately coarse textured *till* (material deposited by glacial ice) composed primarily of granitic gneiss with smaller amounts of quartzite, sandstone, and shale, and in some instances, limestone. Most areas are wooded or in idle fields but some areas are used for residential or industrial development. Natural vegetation is largely woodland dominated by oak, ash, and hickory with some maple, birch, and hemlock.

Depth to bedrock is typically greater than 6 feet. Depth to the fragipan is 18 to 40 inches and the thickness ranges from 12 to 36 inches. Rock fragments range from 5% to 65%of the soil's makeup and from gravel to boulders in size. Mineralogy is dominated by quartz and feldspars with some mica and ferromagnesian minerals. Reaction is strongly acid or very strongly acid throughout, except where limed.

According to the NRCS:

> Precautions need to be taken to prevent erosion on steeper slopes. Stones and boulders are commonly found on the ground surface and can present limitations for using construction equipment. Rockaway soils are often associated with areas of rock outcrops and soils that are shallow or moderately deep to bedrock, which may create limitations for urban development. *(NRCS New Jersey Featured Soil http://www.nj.nrcs.usda.gov/technical/soils/featuredsoil.html*)

Rockaway soils encompass 108,000 acres in northern New Jersey and are named for the Morris County town. The Rockaway series predominates in Kinnelon, covering some 65.61% of the borough's total area. It is often combined with rock outcrop complex on the steeper slopes and can consist of very to extremely stony sandy loam or gravelly sandy loam on the more modest slopes.

Hibernia – The Hibernia series consists of very deep, somewhat poorly drained soils on nearly level to moderately steep *ground moraines* (extensive layers of till having uneven or undulating surfaces), at the base of steeper sloping uplands, and in shallow concave drainageways. In Kinnelon slopes range from 3 to 25%. The soils are shallow or moderately deep to a fragipan. They formed in till and *colluvial material* transported by gravitational action or runoff and deposited at the base of slopes and derived primarily from granitic gneiss with small amounts of quartzite, sandstone and shale. Permeability is moderate above the fragipan, slow in the fragipan, and moderate to rapid in the substratum. *Saturated hydraulic conductivity* (the soil's ability to conduct water when saturated) is moderately low to high above the fragipan, moderately low or moderately high in the fragipan, and moderately low to very high in the substratum. A *perched water table* (a water table that is higher than the normal water table and may be separated from it by an impermeable layer) commonly ranges within a foot of the surface in late winter

and early spring and following periods of extended rainfall. Lateral seepage to the surface is common, particularly at slope breaks.

The mean annual precipitation ranges from 40 to 50 inches. The mean annual temperature ranges from 45 to 52 degrees F. The frost-free days range from 140 to 160 days.

Most areas are wooded or in idle fields. Natural vegetation is largely woodland dominated by oak, ash and birch with some maple and hemlock. In urban areas much of this soil has been drained or overfilled and is used for housing or industrial development.

Hibernia series covers 12.5% of Kinnelon's land area and is found adjacent to Rockaway and Ridgebury loam series soils.

Ridgebury Loam – The Ridgebury series consists of very deep, somewhat poorly and poorly drained soils formed in loamy till derived mainly from granite, gneiss and schist. It often borders waterways (but not water bodies) and is adjacent to other hydric soils, including Hibernia loam (see *Hydric Soils* table below). The soils are nearly level to gently sloping and found in low slightly concave areas and shallow drainageways of till uplands. They are largely forested to gray birch, yellow birch, red maple, hemlock, elm, spruce and balsam fir.

In Kinnelon, slope ranges from 0 to 8%. Runoff is negligible to medium. Saturated hydraulic conductivity ranges from moderately low to high in the top layer and very low to moderately low in the sublayer. Saturated hydraulic conductivity ranges from moderately low to high in top layer and very low to moderately low in the sublayer. A perched, fluctuating water table above the dense till saturates the surface soil for 7 to 9 months of the year.

Mean annual air temperature ranges from 45 to 52 degrees F. and mean annual precipitation ranges from 40 to 50 inches. Mean growing season ranges from l00 to l95 days.

Ridgebury loam is extensive from New England through New York and New Jersey and is the third most prevalent series in Kinnelon, covering more than 1,000 acres, or 8.6%.

Carlisle – The Carlisle series consists of very deep, very poorly drained soils formed in woody and herbaceous organic materials in depressions within lake plains, outwash plains, ground moraines, flood plains and moraines. Slope ranges from 0 to 2%. Mean annual precipitation ranges from 30 to 47 inches. Mean annual temperature ranges from 45 to 55 degrees F. Frost-free period is 110 to 180 days.

There are 179 acres of Carlisle muck in Kinnelon, or about 1.4% of the Borough's total area. Carlisle is generally located in areas that are identified as deciduous wooded wetlands (*Wetlands Map, Map 13 in the Maps section).* A 72-acre patch of such land, located in the southeast corner of the Borough, is protected as Borough-owned public open space known as Lake Valhalla Watershed. It contains the headwaters of a stream that flows south through Pyramid Mountain Natural Historic Area, Valhalla Hemlock

Glen and Lake Valhalla in Montville Township, forming a tributary to the Rockaway River.

Complete soil series descriptions can be found on the NRCS site at: *http://soils.usda.gov/technical/classification/osd/index.html*.

Soil Characteristics

Agricultural Soils

There is little soil in Kinnelon that is deemed suitable for agricultural use, as defined by the Soil Survey. Areas of prime farmland in Kinnelon include sandy or gravelly loams with slopes of 8% or less, including Boonton, Netcong, Pompton, Riverhead, and Rockaway. Farmland of statewide importance includes Boonton, Netcong, Riverhead and Rockaway gravelly loams with slopes of 8 to 15%. Farmland of unique importance includes Adrian and Carlisle muck. Together, these agricultural soils represent 4% of Kinnelon's total area. (*Table 28*)

Table 28. Soils Rated for Agricultural Use

All areas are prime farmland	154.89	1.26%
Farmland of statewide importance	91.61	0.74%
Farmland of unique importance	264.55	2.15%
Not prime farmland	11,163.88	90.78%
Water	622.21	5.06%
Grand Total	12,297.13	100.00%

Source: NRCS Soil Survey 2008

Erodibilty

Soils can be categorized by their susceptibility to erosion, the natural process by which wind, moving water, ice and gravitational forces cause soil and particulate materials to be displaced. While erosion of exposed bedrock occurs over an extended time scale, soil erosion can occur more acutely with more immediate consequences. The consistency of the soil is one factor determining its erodibility potential, with dense, compact clayey soils being less susceptible and looser loamy soils, with varying ratios of clay and sand, being more susceptible. The *Erodibility Potential of Soils in Kinnelon Borough* table below shows the percentages of soils within Kinnelon characterized as highly erodible (38%), potentially highly erodible (52%) and not highly erodible (10%). Maintaining vegetative cover and limiting development on steep slopes are two ways to minimize the soil erosion that can lead to increased sediment loading of lakes and streams, with the concomitant negative effects on water quality. (*Table 29*)

Table 29. Erodibility Potential of Soils in Kinnelon Borough		
Erodibility of Rated Land	*Acres*	*% of Rated Land*
Highly erodible land	4,400.76	38.02%
Potentially highly erodible land	6,036.90	52.15%
Not highly erodible land	1,137.71	9.83%
Total Rated Land*	11,575.37	100.00%
**Rated land does not include water (622.21 acres) or urban land (99.54 acres), which together represent approximately 6% of Kinnelon's total area of 12,297.13 acres.*		
Source: NRCS Soil Survey		

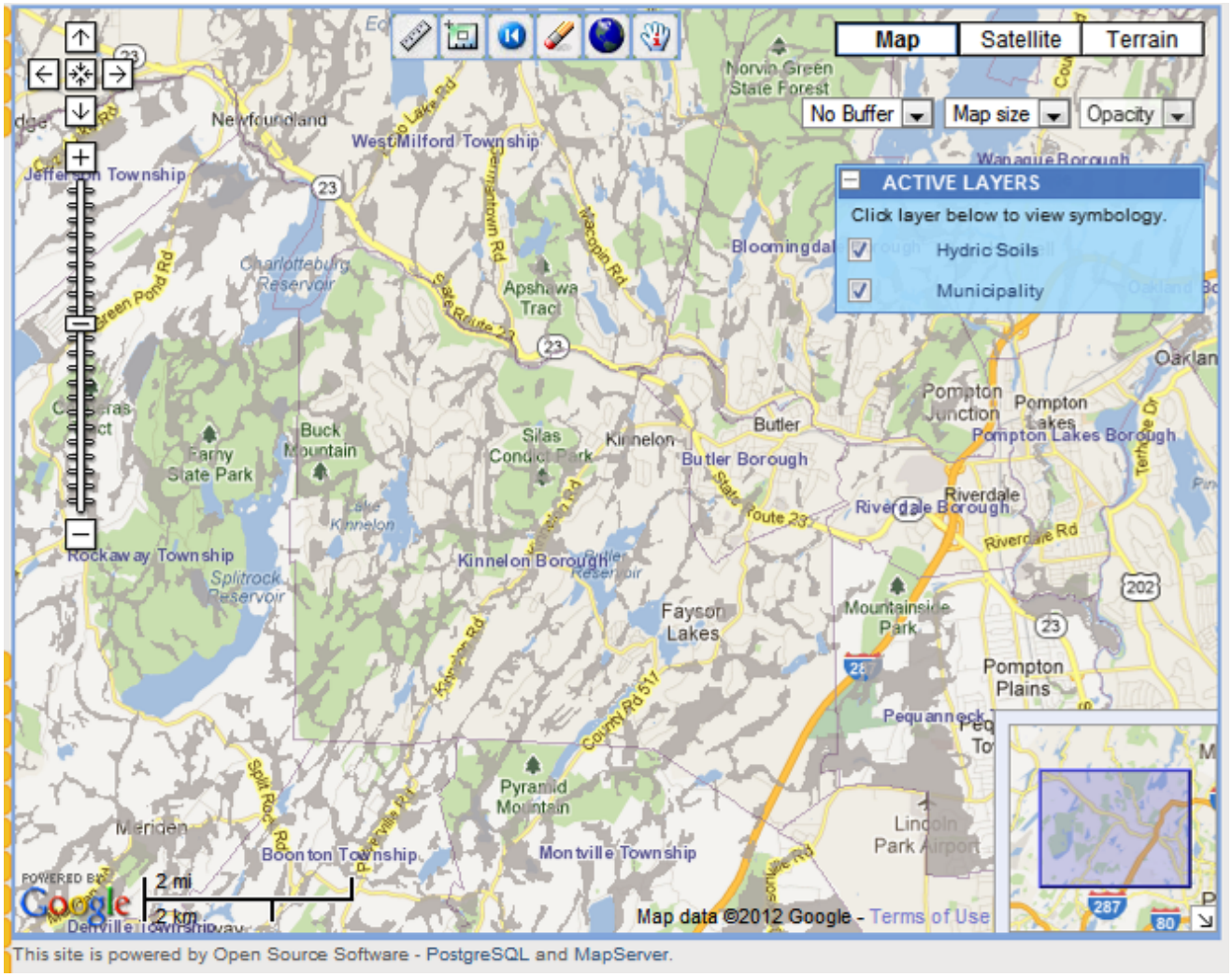
Hydric Soils

According to the NRCS, "A hydric soil is a soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part." *(NRCS, Hydric Soils - Introduction).* Hydric soils are an important element of wetland areas and naturally support wetland vegetation. If a soil is classified as "hydric," Federal/State Wetlands Law may restrict land use due to the relationship of hydric soils to wetlands and wetland preservation. The NRCS Soil Survey for Morris County reveals that 25% of Kinnelon's soils are hydric, and fully half of these hydric soils are Hibernia loam. The component in the Hibernia loam consociation that is considered hydric is Ridgebury, which represents only 5% of the makeup of Hibernia soils. The hydric soils, their acreages and typical locations are shown in *Table 30*.

Table 30. Hydric Soils in Kinnelon Borough					
Abbr.	*Component name, phase & % composition*	*Typical Landform*	*Acres*	*% of Hydric Soils*	*% of All Soils*
AdrAt	Adrian, frequently flooded, 85%	Flood plains	85.36	2.9%	0.7%
BhdAt	Biddeford, frequently flooded, 85%	River valleys	24.57	0.8%	0.2%
CarAt	Carlisle, frequently flooded, 85%	Flood plains	179.19	6.1%	1.5%
FmhAt	Fluvaquents, loamy, frequently flooded, 10%	Flood plains	12.09	0.4%	0.1%
FNAT	Fluvaquents, wet, frequently flooded, 55%	Flood plains	16.39	0.6%	0.1%
HhmCa	Hibernia loam, Ridgebury, very stony, 5%	Depressions	1,469.25	49.8%	12.6%
PbphAt	Parsippany, sandy loam substratum, frequently flooded, 85%	Flood plains	7.90	0.3%	0.1%
PrkAt	Preakness, poorly drained, 90%	Outwash plains	13.20	0.4%	0.1%
PrsdAt	Preakness variant, very poorly drained, frequently flooded, 90/10	Outwash plains, Outwash terraces	15.79	0.5%	0.1%
RkgBb	Ridgebury, very stony, 85%	Depressions	457.12	15.5%	3.9%
RkgBc	Ridgebury, extremely stony, 85%	Depressions	601.70	20.4%	5.2%
WhvAb	Whitman, very stony, 85%	Depressions	65.00	2.2%	0.6%
	Total Hydric Soils		**2,947.56**	**100.0%**	**25.2%**
	Total Soils (excludes water – 622.21 acres)		11,674.92		
Source: NRCS State Hydric Soils					

The Highlands Council has mapped hydric soils within the Highlands and a snapshot of the location of hydric soils within and surrounding Kinnelon is shown in *Figure 12*.

Figure 12. Hydric Soils within Kinnelon Borough



Source: NJ Highlands Council

Other Soil Characteristics and Limitations for Use

Other qualities and characteristics of soils determine land's suitability for development, including its capacity to support foundations without corrosion, limitations for septic and helping to identify areas whose water characteristics, such as ponding, flooding or a high water table, or potential for frost heaves contraindicate development. The NRCS Soil Survey states: "Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations."

The *Soil Limitations Table* (*Table 31)* explores the following characteristics:

Depth to restrictive layer is the vertical distance from the soil surface to the upper boundary of the restrictive layer. The restrictive layer is a nearly continuous layer that has one or more physical, chemical, or thermal properties that significantly impede the movement of water and air through the soil or that restrict roots or otherwise provide an unfavorable root environment. Examples are bedrock, cemented layers, dense layers, and frozen layers. Though not shown in this table, information on the hardness and thickness of the restrictive layer, both of which significantly affect the ease of excavation, can be obtained for specific soil types.

Drainage refers to the relative wetness of the soil under natural conditions as it pertains to wetness due to a water table. Drainage classes refer to the frequency and duration of wet periods under conditions similar to those under which the soil developed. Drainage classes range from excessively drained (water is removed very rapidly and the soils are commonly coarse-textured or shallow) to very poorly drained (water is removed from the soil so slowly that free water remains at or very near the ground surface during much of the growing season and unless artificially drained, most crops cannot be grown).

Capacity [of most limiting layer] to transmit water refers to the ease with which pores in a saturated soil transmit water. This capacity is considered in the design of soil drainage systems and septic tank absorption fields.

Depth to water table indicates a range of expected depth to a saturated zone in the soil, known as a "water table," that occurs during several months in most years. A saturated zone that lasts for less than a month is not considered a water table.

Flooding is the temporary inundation of an area caused by overflowing streams or by runoff from adjacent slopes. Water standing for short periods after rainfall or snowmelt is not considered flooding, and water standing in swamps and marshes is considered ponding rather than flooding. Frequency is expressed as none, very rare, rare, occasional, frequent, and very frequent.

- "None" means that flooding is not probable. The chance of flooding is nearly 0% in any year. Flooding occurs less than once in 500 years.
- "Very rare" means that flooding is very unlikely but possible under extremely unusual weather conditions. The chance of flooding is less than 1% in any year.
- "Rare" means that flooding is unlikely but possible under unusual weather conditions. The chance of flooding is 1-5% in any year.
- "Occasional" means that flooding occurs infrequently under normal weather conditions. The chance of flooding is 5-50% in any year.
- "Frequent" means that flooding is likely to occur often under normal weather conditions. The chance of flooding is more than 50% in any year but is less than 50% in all months in any year.
- "Very frequent" means that flooding is likely to occur often under normal weather conditions. The chance of flooding is more than 50% in all months of any year.

Ponding is standing water in a closed depression. Unless a drainage system is installed, the water is removed only by percolation, transpiration, or evaporation. Frequency is expressed as none, rare, occasional, and frequent.

- "None" means that ponding is not probable;
- "Rare" that it is unlikely but possible under unusual weather conditions (the chance of ponding is nearly 0 to 5% in any year);
- "Occasional" that it occurs, on the average, once or less in two years (the chance of ponding is 5-50% in any year); and
- "Frequent" that it occurs, on the average, more than once in two years (the chance of ponding is more than 50% in any year).

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each soil layer. The capacity varies, depending on soil properties that affect retention of water. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Potential for frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, saturated hydraulic conductivity (Ksat), content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured, clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that corrodes or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The steel or concrete in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than the steel or concrete in installations that are entirely within one kind of soil or within one soil layer.

Septic limitations: All of the rated soils in Kinnelon are classified by the NRCS as "very limited," which indicates that the soil has at least one feature that is unfavorable for such use, with the expectation of poor performance and high maintenance. The predominant limitations in Kinnelon soils are depth to saturated zone, slow water movement, the probability of seepage and/or excessive slope. Less prevalent limiting factors among Kinnelon soils include flooding, ponding, poor filtering capacity (due to sand or loose gravel), depth to bedrock, subsidence and large stones. Most soils have more than one limiting factor. *(USDA NRCS)*

Table 31. Soil Limitations in Kinnelon Borough									
Soil Abbr.	*Depth to Restrictive Feature (in)*	*Drainage*	*Capacity to Transmit Water (in/hr)*	*Depth to Water Table (in)*	*Available Water Capacity (in)*	*Ponding /Flooding*	*Frost Action Potential*	*Risk of Corrosion Steel/Concrete*	*Septic Limitations*
AdrAt	>80	Very poorly	H-VH 6.00-20.00	0	VH (17.9)	Frequent/Frequent	High	H-M	Very limited
BhdAt	>80	Very poorly	ML-MH 0.06-0.20	0	H (12.0)	Frequent/Frequent	High	H-M	Very limited
BohB	>80	Moderately well	ML-MH 0.06-0.20	18-36	L (5.1)	None/None	Mod	M-H	Very limited
BohC	>80	Moderately well	ML-MH 0.06-0.20	18-36	L (3.2)	None/None	Mod	M-H	Very limited
CarAt	>80	Very poorly	H 2.00-6.00	0		Frequent/Frequent	High	H-L	Very limited
FmhAt	>80	Somewhat poorly	MH-H 0.57-1.98	6-18	M (6.1)	Frequent/Frequent	High	H-M	Very limited
FNAT	>80	Poorly	MH-H 0.60-2.00	0-12	L (6.0)	None/Frequent	Low	L-H	Very limited
HhmCa HhmDb	>80	Somewhat poorly	ML-MH 0.06-0.20	6-18	VL (2.0)	None/None	High	M-H	Very limited
NerB NerC	>80	Well	H 2.00-6.00	>80	M (6.9)	None/None	Mod	L-M	Very limited
OtsC OtsD	>80	Excessively	H-VH 6.00-20.00	>80	VL (2.8)	None/None	Low	L-H	Very limited
PauCc Parker Gladstone	 48-99 to lithic BR 72-99 to lithic BR	 Somewhat excessively Well	 H 2.00-6.00 MH-H 0.60-2.00	 >80 >80	 L (5.3) M (7.8)	None/None	Mod	L-H	Very limited
PbphAt	>80	Poorly	ML-MH 0.06-0.20	0-12	H (10.4)	Frequent/Frequent	High	H-M	Very limited
PHG	--	--	--	--	--	None/None	--	L-H	Not rated

Table 31. Soil Limitations in Kinnelon Borough									
Soil Abbr.	*Depth to Restrictive Feature (in)*	*Drainage*	*Capacity to Transmit Water (in/hr)*	*Depth to Water Table (in)*	*Available Water Capacity (in)*	*Ponding /Flooding*	*Frost Action Potential*	*Risk of Corrosion Steel/Concrete*	*Septic Limitations*
PohA	>80	Somewhat poorly	MH-H 0.57-1.98	6-18	M (7.5)	None/None	High	M-H	Very limited
PohB	>80	Somewhat poorly	H 2.00-6.00	6-18	M (6.4)	None/None	High	M-H	Very limited
PrkAt	>80	Poorly	H 2.00-6.00	0-6	M (7.4)	Frequent/Frequent	High	H-H	Very limited
PrsdAt	>80	Very poorly	MH-H 0.57-1.98	0-6	H (10.8)	Rare/Frequent	High	H-H	Very limited
RkgBb	>80	Poorly	ML-MH 0.06-0.20	0-6	VL (1.8)	None/None	High	H-H	Very limited
RkgBc	>80; 72-99 to lithic BR	Porly	VL-MH 0.00-0.20	0-6	L (3.6)	None/None	High	H-H	Very limited
RksB RksC	>80	Well	H 2.00-6.00	>80	L (5.0)	None/None	Mod	L-H	Very limited
RNRE *	18-30 to fragipan; 72-99 to lithic BR	Moderately well	ML-MH 0.06-0.20	24-36	VL (2.6)	None/None	Mod	L-H	Not rated
RobCb	18-30 to fragipan	Well	ML-MH 0.06-0.20	24-36	VL (2.2)	None/None	Mod	L-H	Very limited
RobDc	18-30 to fragipan	Well	ML-MH 0.06-0.20	24-36	VL (2.0)	None/None	Mod	L-H	Very limited
RocB RocC	18-30 to fragipan	Well	ML-MH 0.06-0.20	24-36	VL (2.2)	None/None	Mod	L-H	Very limited
RomC *	18-30 to fragipan	Moderately well	ML-MH 0.06-0.20	24-36	VL (2.6)	None/None	Mod	L-H	Very limited
RomD*	18-30 to fragipan	Well	ML-MH 0.06-0.20	24-36	VL (2.2)	None/None	Mod	L-H	Very limited

Table 31. Soil Limitations in Kinnelon Borough									
Soil Abbr.	*Depth to Restrictive Feature (in)*	*Drainage*	*Capacity to Transmit Water (in/hr)*	*Depth to Water Table (in)*	*Available Water Capacity (in)*	*Ponding /Flooding*	*Frost Action Potential*	*Risk of Corrosion Steel/Concrete*	*Septic Limitations*
RomE *	18-30 to fragipan 48-72 to lithic BR	Moderately well	ML-MH 0.06-0.20	24-36	VL (1.9)	None/None	Mod	L-H	Very limited
UR	--	--	--	--	--	None/None	--	--	Not rated
USRHVB **	>80	Well	H 2.00-6.00	>80	L (5.8)	None/None	Mod	L-H	Not rated
USROCC **	18-30 to fragipan	Well	ML-MH 0.06-0.20	24-36	VL (2.0)	None/None	Mod	L-H	Very limited
WhvAb	>80	Very poorly	ML-MH 0.06-0.20	0	VL (3.0)	Frequent/ None	High	H-H	Very limited

**except rock outcrop component; **except urban land component*
BR=Bedrock; L=Low, ML = Moderately Low; VL = Very Low; H = High; MH = Moderately High; VH = Very High
Source: NRCS Web Soil Survey; accessed 9/29/2012

Soil Limitations for Building Site Development

Kinnelon has a number of soils that are rated by the NRCS Web Soil Survey as having no limits or some limits on their ability to support dwellings with or without basements and small commercial establishments.

For the purposes of these ratings, dwellings are defined as single-family houses of three stories or less and small commercial buildings are structures that are less than three stories high and do not have basements. For dwellings without basements and small commercial buildings, the foundation is "assumed to consist of spread footings of reinforced concrete built on undisturbed soil at a depth of 2 feet or at the depth of maximum frost penetration, whichever is deeper." For dwellings with basements, the foundation is "assumed to consist of spread footings of reinforced concrete built on undisturbed soil at a depth of about 7 feet. The ratings for dwellings are based on the soil properties that affect the capacity of the soil to support a load without movement and on the properties that affect excavation and construction costs. The properties that affect the load-supporting capacity include depth to a water table, ponding, flooding, subsidence, linear extensibility (shrink-swell potential), and compressibility….The properties that affect the ease and amount of excavation include depth to a water table, ponding, flooding, slope, depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, and the amount and size of rock fragments." *(NRCS Web Soil Survey)*

The ratings are described as follows:

- "Not limited" indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected.

- "Somewhat limited" indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected.

- "Very limited" indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected. *(NRCS Web Soil Survey)*

About one fifth of the Borough is covered by elements that are not rated for building development such as pits, sand and gravel, rock outcrops, water, or urban land ("surface covered by pavement, concrete, buildings, and other structures underlain by disturbed and natural soil material"). Soils with no limitations for development are minimal. About a third of the Borough soils are somewhat limited in their ability to support dwellings, while close to half are very limited. Almost three quarters of the soils offer very limited capacity to support small commercial buildings. All other soils in Kinnelon Borough are rated as very limited in their ability to support either dwellings or small commercial structures. The table below shows the breakdown of these ratings. (*Table 32*)

Table 32. Soil Limitations for Building Site Development in Kinnelon Borough			
Rating	*Dwellings Without Basements*	*Dwellings with Basements*	*Small Commercial Buildings*
Not Rated	PHG, RNRE, UR, USRHVB, Water Total Acres: 2,634.91; % of Boro: 21.43%		
Not Limited	NerB, RksB, RocB Total Acres: 135.47 % of Boro: 1.10%	NerB, RksB Total Acres: 65.42 % of Boro: 0.53%	RksB Total Acres: 35.76 % of Boro: 0.29%
Somewhat Limited	BohB, BohCm NerC, OtsC, PauCc, RksC, RobCb, RocC, RomC, USROCC Total Acres: 4,127.61 % of Boro: 33.57%	NerC, OtsC, PauC, RksC, RobCb, RocB, RocC, RomC, USROCC Total Acres: 4,179.88 % of Boro: 33.99%%	BohB, NerB, RocB Total Acres: 100.68 % of Boro: 0.82%
Very Limited	All other soils Total Acres: 5,399.14 % of Boro: 43.91%	All other soils Total Acres: 5,416.92 % of Boro: 44.05%	All other soils Total Acres: 9,525.78 % of Boro: 77.46%
Source: NRCS Web Soil Survey; accessed October 1, 2012			

Borough Initiatives

The Borough municipal code effective in October 2012 includes chapters that address soil-related concerns:

- Soil Erosion and Sediment Control (SESC) (167) – prohibits land disturbance without an approved and permitted SESC plan.
- Soil Disturbance (169) – sets standards and permit requirements when the disturbance involves 50 cubic yards' volume of soil or more on one site and prohibits the removal of the top layer of arable soil (up to 6 inches) from the site.
- Soil and Plant Fertilizers (170) – based on a finding that elevated levels of nutrients, particularly phosphorus in surface water bodies can be detrimental to aquatic life and inhibit (through excessive plant growth or eutrophication) recreational use, this chapter regulates the outdoor application of fertilizer "so as to reduce the overall amount of excess nutrients entering waterways, thereby helping to protect and improve surface water quality."

  Accordingly, no person may do any of the following:

  - Apply fertilizer when a runoff-producing rainfall is imminent or is occurring and/or when soils are saturated and a potential for fertilizer movement off site exists.

- Apply fertilizer to an impervious surface. Fertilizer inadvertently applied to an impervious surface must be swept or blown back into the target surface or returned to either its original or another appropriate container for reuse.

- Apply fertilizer within 25 feet of any water body unless a drop spreader is used. In no case shall fertilizer be applied within 10 feet of any water body.

- Apply fertilizer more than 15 days prior to the start of or at any time after the end of the recognized growing season, March 15 to October 31.

And specifically regarding Phosphorous Fertilizer Application:

- No person may apply phosphorus fertilizer in outdoor areas except as demonstrated to be needed for the specific soils and target vegetation on athletic playing fields in accordance with a soils test and the associated annual fertilizer recommendation issued by Rutgers Cooperative Research and Extension.

- Exceptions may include application for new vegetation, turf repair or reestablishment; container plantings, flowerbeds, vegetable gardens; subsurface applications direct to feeder roots.

WETLANDS

Wetlands are important natural resources that contribute significantly to an area's social, economic, and environmental health. Among the services they provide are filtration of chemicals, pollutants, and sediments from water; flood control; critical habitat for wildlife; recreation and tourism. The NJDEP defines a freshwater wetland as "an area that is inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions, commonly known as hydrophytic vegetation; provided, however, that the Department, in designating a wetland, shall use the three-parameter approach (that is, hydrology, soils and vegetation) enumerated in the 1989 Federal Manual." (*N.J.A.C. 7:7A)* NJDEP has adopted this manual as the technical basis for identifying and delineating wetlands.

The NJDEP regulates virtually all activities in a wetland, including removing vegetation, filling, and placing obstructions. Depending on the environmental value of a particular wetland, there may also be a transition area, or buffer, around the wetland that will require a waiver issued by the NJDEP for any activity within that zone. For example, a wetland containing endangered species habitat would require a 150-foot wide transition area, whereas a small wetland in a ditch might not require any transition area at all. Most freshwater wetlands require a 50-foot transition area.

Wetlands in New Jersey are classified into three different values; exceptional resource value, ordinary resource value, or intermediate resource value. The criteria for these classifications are described below.

Exceptional Resource Value Wetland

- Discharges into FW-1 water and FW-2 trout producing waters and their tributaries;
- Is a present habitat for threatened or endangered species; or
- Is a documented habitat for threatened or endangered species, and which remains suitable for breeding, resting, or feeding by these species during the normal period these species would use the habitat.

Ordinary Resource Value Wetland

- A freshwater wetland which does not exhibit any of the characteristics of a Exceptional Resource Value Wetland which is:
- An isolated wetland, as defined at *N.J.A.C. 7:7A-1.4*, which:
- Is smaller than 5,000 square feet; and

- Has the uses listed below covering more than 50% of the area within 50 feet of the wetland boundary. In calculating the area covered by a use, the Department will only consider a use that was legally existing in that location prior to July 1, 1988, or was permitted under this chapter since that date:

    - Lawns
    - Maintained landscaping
    - Impervious surfaces
    - Active railroad rights-of-way
    - Graveled or stoned parking/storage areas and roads
    - A drainage ditch
    - A swale or
    - A detention facility created by humans in an area that was upland at the time the facility was created regardless of the wetland resource classification of the wetland under these rules, or the classification of the body of water, as FW-1 or FW-2 trout production, to which it discharges.

Intermediate Resource Value Wetland

- A freshwater wetland of intermediate resource value is any wetland not defined as exceptional or ordinary.

According to the NJDEP 2007 Land Use/Land Cover data, there are 786 acres of wetlands within Kinnelon, occupying 5.4% of the Borough. The *Wetlands Map (Map 13 in the Maps section)* shows the locations of wetlands in Kinnelon. *Table 33* presents a summary of wetlands by type. The dominant type of wetland in Kinnelon is deciduous wooded wetlands, comprising 93% of the Borough's wetlands. Though this information is based on NJDEP mapped wetlands, unmapped wetlands, which are still subject to NJDEP regulation, may exist in Kinnelon. Wetlands would require a professional delineation before a regulated activity could occur in or around them. Wetlands are also considered open waters under the *Highlands Regional Master Plan,* and thus are subject to a 300-foot buffer to protect habitat and water quality.

Table 33. Wetlands in Kinnelon Borough

Type	*Acres*	*Percent*
Agricultural Wetlands (Modified)	2.21	0.28%
Deciduous Scrub/Shrub Wetlands	10.69	1.36%
Deciduous Wooded Wetlands	730.89	93.04%
Disturbed Wetlands (Modified)	0.84	0.11%
Herbaceous Wetlands	8.02	1.02%
Managed Wetland	8.82	1.12%
Mixed Wooded Wetlands (Coniferous Dom.)	16.81	2.14%
Phragmites Dominate Interior Wetlands	2.83	0.36%
Wetland Rights-of-Way	4.47	0.57%
Total:	785.60	100.00%

Source: NJDEP 2007 Land Use/Land Cover

VEGETATION

Since 1986, the NJDEP has mapped land use within the state through their Land Use/Land Cover (LU/LC) data sets. Areas are delineated using color infrared images. The latest update of this data occurred in 2007. The NJDEP also maps critical habitat for imperiled and priority species through the Landscape Project, which is a pro-active, ecosystem-level approach to the long-term protection of these habitats, and rare plant species and ecological communities through the Natural Heritage Database.

Land Cover

The NJDEP identifies six LU/LC categories: agriculture, barren land, forest, urban, water, and wetlands. Forested area represents 59% of Kinnelon's land cover, providing critical habitat for wildlife. Agricultural land is virtually nonexistent. Urban land, which has been developed for residential or commercial use, accounts for 29%, wetlands: 6%. Water, including several man-made lakes is about 5% of the land cover. Together, wetlands and streams provide riparian corridors providing a different type of habitat for wildlife species.

Table 34 shows the percentage of Kinnelon covered by each land cover type and the *Land Use/Land Cover Map* shows their distribution throughout the Borough. *(Map 14 in the Maps section)*

Table 34. Land Cover Type in Kinnelon Borough

Type	*Acres*	*Percent*
Agriculture	9.45	0.08%
Barren Land	78.36	0.64%
Forest	7,247.20	58.89%
Urban	3,524.33	28.64%
Water	662.13	5.38%
Wetlands	785.60	6.38%
Total:	12,307.06	100.00%

Source: NJDEP 2007 Land Use/Land Cover

Forest Types

According to the 2007 LU/LC data, 7,247 acres, or 59% of Kinnelon, is classified as forested, with 94% classified as deciduous forest with greater than 50% crown closure. The second most prevalent category is deciduous forest with 10-50% crown closure, followed by various types of mixed forest, 15 acres of coniferous forest and 22 acres of old field. See *Table 35* for the complete breakdown.

Table 35. Forest Types in Kinnelon Borough

Forest Type	*Acreage*	*Percent*
Coniferous Forest (>50% Crown Closure)	15.28	0.21%
Deciduous Brush/Shrubland	17.53	0.24%
Deciduous Forest (>50% Crown Closure)	6,798.97	93.79%
Deciduous Forest (10-50% Crown Closure)	288.26	3.98%
Mixed Deciduous/Coniferous Brush/Shrubland	1.64	0.02%
Mixed Forest (>50% Coniferous With >50% Crown Closure)	26.13	0.36%
Mixed Forest (>50% Coniferous With 10-50% Crown Closure)	6.75	0.09%
Mixed Forest (>50% Deciduous With >50% Crown Closure)	64.78	0.89%
Mixed Forest (>50% Deciduous With 10-50% Crown Closure)	7.62	0.11%
Old Field (< 25% Brush Covered)	22.34	0.31%
Total:	7,249.30	100.00%

Source: NJDEP 2007 Land Use/Land Cover

The following definitions set the classification parameters:

Deciduous – This category includes forested lands that contain deciduous tree species. Deciduous trees are those species which lose their leaves at the end of the growing season. These trees remain leafless throughout the winter and sprout new leaves the following spring. The average height of the stand is at least 20 feet. A forest stand must have at least 75% canopy coverage from deciduous tree species to be placed in this category.

Photograph 1. Blue Trail, Silas Condict County Park

Credit – Carol Vreeland

Deciduous > 50% Crown Closure

This category contains deciduous stands with crown closures greater than 50%. Crown closure is the percentage of a forest area occupied by the vertical projections of tree crowns. Crown closure percentages provide a reasonable estimate of stand density. The majority of the deciduous forests in New Jersey are in this category.

Deciduous, 10-50% Crown Closure
This category contains deciduous forest stands that have crown closure greater than 10%, but less than 50%.

Coniferous – This category includes forested lands that contain coniferous tree species. Coniferous species are those trees commonly known as evergreens. They do not lose their leaves (needles) at the end of the growing season but retain them through the year. Conifers can easily be distinguished from deciduous trees on wintertime color infrared photography because of their high infrared reflectance due to their leaf retention. The stand must be 20 feet high and must be stocked by at least 75% conifers to be labeled as a coniferous stand.

Coniferous, 10-50% Crown Closure
This category contains natural coniferous stands with crown closure > 10%, but less than 50%.

When neither coniferous or deciduous represents 75% or more of the forested area, it is classified as mixed forest. This category is further broken down according to which species is 50% or greater prevalent, coniferous or deciduous, and the extent of crown closure. Mixed forest of all types represents a very low percentage of Kinnelon's land area.

Brush/Shrubland - When the vegetation is less than 20 feet high, the area is categorized as brush/shrubland. The following types have been identified in Kinnelon:

Deciduous Brush/Shrubland
(>25% Brush Covered with Deciduous Species Predominant > 75%)
This category contains natural forested areas with deciduous species less than 20 feet in height. An area must have greater than 25% brush cover to be placed in this category. This category also contains inactive agricultural areas that have been grown over with brush.

There are photographic signature differences between brushland and the pole or saw-timber stage trees (Categories 4100, 4200, 4300). Besides the obvious height difference visible on stereo viewing, larger trees display much larger crown diameters than brushland areas.

Mixed Deciduous/Coniferous Brush/Shrubland
(>25% Brush Covered with Mixture of Deciduous Coniferous Species <75% of 1 Type)
This category contains natural forested areas less than 20 feet in height with a mixture of coniferous and deciduous trees.

Old Field (<25% Brush Covered)
This category includes open areas that have less than 25% brush cover. The predominant cover types are grasses, herbaceous species, tree seedlings and/or saplings. Old fields are distinguished from inactive farmland (2130) by the amount of brush cover. If a field contains few woody stems (<5%), it should be placed in the inactive farmland category. An area should be placed in the Old Field category if the amount of brush cover requires

extensive brush removal before plowing. In some cases, it may not be established that the previous use was agricultural.

Vegetation

The State of New Jersey is home to a wide range of different ecosystems, some large and dominating, others less pronounced and more vulnerable to development. The NJDEP indentifies and maps areas which are considered unique ecosystems, these are known as the Natural Heritage Priority Sites (NHP). At this time, Kinnelon Borough has been identified as containing no Natural Heritage Priority sites.

WILDLIFE

Critical Habitat

Much of Kinnelon Borough may provide habitat that is suitable for threatened or endangered species. The Landscape Project (*Version 3.1 2012*) ranks patches of habitat using a numeric system (0 through 5), for the purpose of identifying habitat which may be suitable for threatened and endangered species. Habitat identified as Ranks 3 through 5 are considered environmentally significant by the NJDEP. The following is a description of each rank.

Rank 5 is assigned to species-specific patches containing one or more occurrences of wildlife listed as endangered and threatened pursuant to the Federal Endangered Species Act of 1973.

Rank 4 is assigned to species-specific patches with one or more occurrences of State endangered species.

Rank 3 is assigned to species-specific patches containing one or more occurrences of State threatened species.

Rank 2 is assigned to species-specific patches containing one or more occurrences of species considered to be species of special concern (this rank represents "rare species" of wildlife as defined in the *Highlands Water Protection and Planning Act* rules).

Rank 1 is assigned to species-specific patches that meet habitat-specific suitability requirements such as minimum size criteria for endangered, threatened or priority wildlife species, but that do not intersect with any confirmed occurrences of such species.

Rank 0 is assigned to species-specific patches that do not contain any species occurrences and do not meet any habitat-specific suitability requirements.

According to the *NJDEP Landscape Project* Kinnelon contains habitat patches of all ranks. The majority of Kinnelon (45%) has been identified as Rank 5, federal endangered species habitat, covering a majority of the western half of the Borough. There is also a large concentration of Rank 4, state listed endangered species, at 31%, in the eastern half of the Borough. The Rank 3 patches, state threatened species, are clustered around the Kakeout Reservoir area, making up approximately 4% of Kinnelon. The Rank 2 patches, species of special concern, make up 17.14% of the Borough, located predominantly in the northwestern portion of the Borough.

Table 36 presents a summary of habitat patches within Kinnelon Borough and the *Patches with Endangered Species Habitats Map (Map 15 in the Maps section)* illustrates their distribution within the Borough.

Table 36. Critical Species Habitat in Kinnelon Borough		
Rank	*Acres*	*Percent*
5	4,717.44	45.18%
4	3,266.02	31.28%
3	387.13	3.71%
2	1,789.83	17.14%
1	281.09	2.69%
Total:	10,441.50	100.00%
Source: NJDEP Landscape Project (Version 3.1 2012)		

Threatened and Endangered Species

Kinnelon is home to a wide array of wildlife including endangered and threatened species listed on both state and federal registers. The Indiana Bat, a federally listed endangered species, occupies Kinnelon's forests, caves and mines during its hibernation season (October through April). There is also noted possible habitat for two additional federally endangered species, the Shortnose Sturgeon and the Small Whorled Pogonia. There are six state listed endangered species that inhabit Kinnelon, those being the Wood Turtle, Bobcat, Golden-winged Warbler, Northern Goshawk, Red-shouldered Hawk, and Timber Rattlesnake. Kinnelon is also home to three state threatened species, the Bald Eagle, Barred Owl, and Red-headed Woodpecker.

Kinnelon also serves as the home to 15 other species, considered by the NJDEP as species of special concern. A full list of all species listed by the NJDEP Landscape Project can be found in *Table 37*.

Table 37. Threatened and Endangered Species in Kinnelon Borough					
Common Name	*Scientific Name*	*Class*	*Landscape Project Rank*	*Federal Status*	*NJ Status*
Black-billed Cuckoo	Coccyzus erythropthalmus	Birds	2	NA	Special Concern
Broad-winged Hawk	Buteo platypterus	Birds	2	NA	Special Concern
Cooper's Hawk	Accipiter cooperii	Birds	2	NA	Special Concern
Eastern Box Turtle	Terrapene carolina carolina	Reptilia	2	NA	Special Concern
Fowler's Toad	Bufo fowleri	Amphibia	2	NA	Special Concern
Great Blue Heron	Ardea herodias	Birds	2	NA	Special Concern

Table 37. Threatened and Endangered Species in Kinnelon Borough					
Common Name	*Scientific Name*	*Class*	*Landscape Project Rank*	*Federal Status*	*NJ Status*
Harris' Checkerspot	Chlosyne harrisii	Insecta	2	NA	Special Concern
Hooded Warbler	Wilsonia citrina	Birds	2	NA	Special Concern
Kentucky Warbler	Oporornis formosus	Birds	2	NA	Special Concern
Northern Copperhead	Agkistrodon contortrix mokasen	Reptilia	2	NA	Special Concern
Spatterdock Darner	Rhionaeschna mutata	Insecta	2	NA	Special Concern
Tiger Spiketail	Cordulegaster erronea	Insecta	2	NA	Special Concern
Veery	Catharus fuscescens	Birds	2	NA	Special Concern
Wood Thrush	Hylocichla mustelina	Birds	2	NA	Special Concern
Worm-eating Warbler	Helmitheros vermivorum	Birds	2	NA	Special Concern
Bald Eagle	Haliaeetus leucocephalus	Birds	3	NA	State Threatened
Barred Owl	Strix varia	Birds	3	NA	State Threatened
Red-headed Woodpecker	Melanerpes erythrocephalus	Birds	3	NA	State Threatened
Wood Turtle	Glyptemys insculpta	Reptiles	3	NA	State Threatened
Bobcat	Lynx rufus	Mammals	4	NA	State Endangered
Golden-winged Warbler	Vermivora chrysoptera	Birds	4	NA	State Endangered
Northern Goshawk	Accipiter gentilis	Birds	4	NA	State Endangered
Red-shouldered Hawk	Buteo lineatus	Birds	4	NA	State Endangered
Timber Rattlesnake	Crotalus horridus horridus	Reptiles	4	NA	State Endangered
Indiana Bat	Myotis sodalis	Mammals	5	Endangered	State Endangered
Source: NJDEP Landscape Project (Version 3.1 2012)					

Vernal Habitat

Kinnelon has many beautiful vernal habitats, also referred to as vernal pools. These natural wetland depressions fill with water during the rainy season in fall and remain ponded until the dry weather in early summer causes them to dry out. The vernal pools provide habitat for a wide array of amphibians, reptiles, invertebrates and many species of wetland vegetation, but cannot support a fish population because of the pools' brief dry period. Certain wildlife species, referred to as "obligate" vernal pool breeders, have evolved with a reliance upon these fish-free breeding sites and cannot successfully reproduce elsewhere. Other wildlife species, referred to as "facultative" vernal pool species, also take advantage of vernal habitats for breeding and/or feeding purposes, but are not limited to performing these functions solely in vernal pools.

Photograph 2. Vernal Pool, Weber Tract

Credit: Carol Vreeland

The NJ Department of Environmental Protection defines a vernal habitat in the Freshwater Wetlands Protection Act Rules (see N.J.A.C. 7:7A-1.4) as a wetland that meets the following criteria:

1. The wetland must consist of or contain a confined basin or depression without a permanently flowing outlet;
2. The pool must feature evidence of breeding by at least one obligate or two facultative vernal habitat species (these species are identified in N.J.A.C. 7:7A, Appendix 1 and listed in Table X below);
3. The area must maintain ponded water for at least two continuous months between March and September of a normal rainfall year, and;
4. The area must remain free of fish populations throughout the year, or it must dry up at some time during a normal rainfall year.

Wetland areas featuring a confined basin depression exhibiting the hydrologic and biological criteria established above are said to meet "certification" requirements, and may be referred to as "certified vernal habitats," or simply "vernal habitat areas." The NJDEP maps both certified "vernal habitat areas" and "potential vernal habitat areas" using New Jersey's Landscape Project, which is available online on NJ-GeoWeb at *http://www.nj.gov/dep/gis/geowebsplash.htm*. The mapping depicts a 300 meter radii circle over the estimated center of both "certified" and "potential" vernal habitats. The 300 meter buffer is intended to account for the varying sizes of individual pools, the likely presence of adjacent wetland areas and – significantly- the adjacent dispersal habitats typically utilized by many resident amphibian species. The Landscape Project defines its mapping of vernal habitats as follows:

Potential vernal habitat area – These are areas identified as possibly containing a vernal pool that meets the criteria of a "vernal habitat" pursuant to N.J.A.C. 7:7A-1.4. These sites include sites that have been field inspected and have been found to meet the physical

characteristics of a vernal habitat, but for which biological criteria have not yet been measured, as well as sites that have not been checked by NJDEP staff.

Vernal habitat areas – These are areas that contain pools that have been field-verified by the NJDEP and have been determined to meet both the physical and biological characteristics of a vernal habitat in accordance with N.J.A.C. 7:7A-1.4.

Note that if the mapped location of a confirmed ("certified") vernal habitat area overlaps the mapped location of a "potential vernal habitat area," the combined area is mapped as "vernal habitat area," as it is likely that the species confirmed in the "certified" pool are also present in any nearby pools, though these adjacent pools may not have formally been inspected by the NJDEP.

In Kinnelon Borough the Landscape Project mapping identifies 29 separate vernal habitat polygons. 14 represent vernal pools that have been field inspected and confirmed to meet certification requirement. 5 additional pool areas overlap with these 14 "certified" pools and are therefore also mapped by the Landscape Project as "vernal habitat areas." This equates to 577 acres of vernal habitat and associated wetlands/dispersal areas. 10 additional areas totaling 460 acres are mapped as "potential" vernal habitats and associated wetlands/dispersal areas. Eight of the certified vernal pool areas occur on land once considered for development but which is now preserved as municipal open space. This land borders Maple Lake Road and is contiguous to Silas Condict County Park. Another area containing several patches of vernal habitat and potential vernal habitats is the southwestern corner Kinnelon.

The obligate and facultative species specified in Appendix 1 of N.J.A.C. 7:7A are listed below. Obligate species (those dependent on vernal pools for the completion of their lifecycle) observed in the Borough include wood frogs (*Lithobates sylvaticus*) and spotted salamander (*Ambystoma maculatum*); facultative species (those which may use vernal pool habitat but do not necessarily rely on it) include, but are not limited to: red spotted newt (*Notophthalmus v. viridescens*) northern spring peepers (*Pseudacris c. crucifer*) and green frog (*Lithobates c. melanotus*). The Landscape Project database confirms occurrences of two additional facultative species within the Borough: Fowler's Toad (special concern) and the wood turtle (state threatened). However, these have not been specifically associated with vernal pool certifications to date. *Table 38* lists obligate and facultative fauna species found in vernal habitats.

Table 38. Obligate and Facultative Fauna Species Found in Vernal Habitats

Obligate Species	*Facultative Species*
Marbled Salamander***	Snapping Turtle
Blue-spotted Salamander*	Eastern Mud Turtle
Jefferson Salamander***	Spotted Turtle***
Eastern Tiger Salamander*	Eastern Painted Turtle
Wood Frog	Red-spotted Newt
Eastern Spadefoot Toad	American Toad
Fairy shrimp (order Arnostraca)	Fowler's Toad***
	Pine Barrens Treefrog**
	Northern Gray Treefrog

Table 38. Obligate and Facultative Fauna Species Found in Vernal Habitats	
Obligate Species	*Facultative Species*
	Southern Gray Treefrog* Upland Chorus Frog Northern Cricket Frog New Jersey Chorus Frog Bull Frog Green Frog Southern Leopard Frog Four-toed Salamander Northern Spring Peeper Long-tailed Salamander** Wood Turtle**
** State Endangered; ** State threatened; *** special concern* *Source: NJDEP*	

Descriptions of the 71 species of reptiles and amphibians found in New Jersey, including the obligate and facultative vernal pool species listed above, can be found on the NJDEP Division of Fish and Wildlife website at *http://www.nj.gov/dep/fgw/ensp/fieldguide_herps.htm.*

The Freshwater Wetlands Protection Act Rules (N.J.A.C. 7:7A) protects vernal habitats as wetland areas requiring a 50 foot buffer, or a 150 foot buffer if the pool supports a State threatened or endangered species. In addition, within Highlands preservation areas, the New Jersey Highlands Council requires a 1,000 foot *vernal habitat area* buffer around each pool. Vernal habitat areas and potential vernal habitat areas in Kinnelon Borough are shown on the *Vernal Habitats Map (Map 16 in the Maps section).*

Wild Trout

Wild trout are another form of wildlife that is a valuable natural resource in New Jersey and in Kinnelon. According to the NJDEP:

> Trout that are able to complete their life cycle in a natural aquatic habitat, and maintain a population through natural reproduction, are termed wild trout. The survival of self-sustaining populations of wild trout is not dependent upon the stocking of hatchery-reared trout. Because of their high water quality and habitat requirements, trout are valuable indicators of healthy aquatic ecosystems. The importance of water quality, as related to the ability of a stream or lake to support wild (reproducing) trout populations is recognized in New Jersey through the state's surface water classification system. Waters that support reproducing trout populations are referred to as "trout production waters" and are classified as FW2-Trout Production Category 1 (FW2-TP(C1)). Through this classification trout production waters receive one of the highest levels of protection available from activities that could potentially impact coldwater quality and habitat, through a variety of NJDEP regulatory programs. (See *Table 21. Surface Water Quality Standards in Kinnelon Borough* on *page 40* for a list of trout production waters in Kinnelon.)

LAND USE

Kinnelon Borough is a forested, residential community with much of its land, approximately 46%, assessed as residential or commercial use. Water utilities own 8% of the land and 11% of the community is undeveloped, vacant land. *Table 39* presents a summary of land use in Kinnelon.

Table 39. Summary of Land Use in Kinnelon Borough

Preserved Land	**Acres**	**Percent**
State Parks	994.71	9%
County Parks	2,052.63	18%
Municipal Parks	460.19	4%
Sub-Total (Preserved Land):	3,507.52	30%
Private and Public Land:		
Water Utilities :	886.28	8%
Residential & Commercial Property:	5,288.69	46%
Vacant (Undeveloped) Land:	1,220.09	11%
Schools, Churches & Cemeteries:	166.78	1%
Public Land:	347.45	3%
Farm Assessed Property:	180.92	2%
Transportation:	21.89	0%
Sub-Total (Private and Public):	8,112.10	70%
Total:	11,619.62	100%

Source: 2012 Open Space and Recreation Plan

The Borough of Kinnelon contains over 3,500 acres of permanently protected open space, parks, recreation areas, and watershed land. This includes state land, municipal land, and county land making up 30% of the Borough's 11,620 acres. Preserved land in Kinnelon Borough is shown on the *Preserved Land Map* (*Map 17* in the *Maps Section*).

The *Trails and Greenway Map* included within the *2012 Open Space and Recreation Plan Update* focuses on the Borough's goals of connectivity (for both wildlife and people) and access by tying the various elements together in a system of open space. Five greenways are identified: North Kinnelon Greenway Loop, Pyramid Mountain/Buck Mountain Greenway, Lake Conservation Area, Waughaw Mountain Greenway, and Mountainside Greenway. The greenways in Kinnelon Borough are shown on the *Trail and Greenway Map* (*Map 18* in the *Maps Section*).

HISTORIC AND CULTURAL FEATURES

History

Kinnelon's history has been laid out in the following documents, which are available for review at the Morris County Library or the Kinnelon Library:

- "This Is Kinnelon" – League of Women Voters of Kinnelon, N.J.
- Natural Resource Inventory of Kinnelon, N.J. 1973-74, Prepared by the Kinnelon Environmental Commission (research and compiled by Lucy A. Meyer)
- Kinnelon: A History, 1976, Lucy A, Meyer, Published by the Kinnelon Bicentennial Committee

In summary, the area that is now known as Kinnelon was first occupied by Lenni Lenape Indians. European settlers first appeared in the late 18th century and included iron ore miners followed by farmers, service providers such as blacksmiths, large estate owners, seasonal lake communities, and, suburban homeowners. Kinnelon was part of Pequannock Township until 1922, when the Borough incorporated as a separate entity. Due to the hilly topography, the area was never a huge farming community, but the most prominent agriculturalists were the Mead family, known for their orchards, and the Kinney estate (now the private gated community of Smoke Rise), where livestock were raised. The Untermeyer estate on Sawmill road (no longer intact) was another notable estate in the Borough. Although many sites, such as schoolhouses and blacksmith shops, have been reconfigured to other uses, several buildings have been reviewed for their historic merits.

Historic/Cultural Features

The historic sites of Kinnelon were summarized in the *2012 Open Space and Recreation Plan Update* and that discussion is reproduced here.

As of March 3, 2012, the NJDEP Historic Preservation Office (SHPO) lists the following three existing sites on its New Jersey and National Registers of Historic Places:

- *Frederick's House,* a private residence on Duchess Drive, dates from circa 1716-1750 and was placed on both the National Register (NR) and State Register (SR) in 1979.
- *L'Ecole (Kinnelon Museum).* Constructed in 1873 to serve as a one-room schoolhouse, the building became the home and office of Dr. Helen Miller, an

early pioneer in female cancer detection and screening, and is now the Borough-owned Kinnelon Museum. L'Ecole received a Certificate of Eligibility (COE) for the State Register in January 2011. The COE qualifies the site to be eligible for funding from the New Jersey Historic Trust, as well as the Morris County Preservation Trust Fund (MCPTF). The Borough of Kinnelon Historical Commission (HC) has proposed a three-year plan to seek funding from the County with matching funding provided by the municipal Open Space Trust Fund (OSTF) for an Historic Preservation and Restoration Plan. The Borough has issued a resolution of support for this project. In 2011, L'Ecole received a $25,200 non-construction grant from the MCPTF to "assist with completion of a Preservation Plan including structural and mechanical / electrical / plumbing evaluation." Kinnelon's OSTF provided a 20% match and the Plan was completed in 2011. *Update:* In 2012, the Morris County Freeholders awarded Kinnelon a $12,480 MCPTF grant to "assist with preparation of Construction Documents for the partial exterior restoration of the building and repair to the asphalt shingle roof and drainage that need immediate attention."

- *Pennsylvania-New Jersey Interconnection Bushkill to Roseland Transmission Line* SHPO 9/9/2011. The right of way for this electric power transmission line runs through several Morris County communities, including Kinnelon. According to the Morris County Heritage Commission, expansion plans threaten historic resources and will drastically change the scenic and historic look of the County. The Heritage Commission lists this corridor as among the ten most endangered sites in Morris County.

In April 2007, Kise Straw & Kolodner Inc prepared an update to the *1986 Historic Sites Survey* for the Morris County Department of Planning, Development, and Technology that was prepared by Acterion. Resources for both these documents included Lucy Meyer's 1976 *Kinnelon: A History* and information provided by Tom Kline, Chair of the Kinnelon Historical Commission. The County's electronic database (MCPRIMA) includes information for 21 historic sites in Kinnelon. These are shown on *Table 40*.

Table 40. Historic Sites in Kinnelon Borough

Site Name	*Block-Lot*	*Address*
Carter Estate	57_69	275-A Kinnelon Rd.
Caretaker's House*	30_47	1 Robins Ln.
Decker House	30.01_27	198 Kinnelon Rd.
Canty Estate* (Silas Condict)	11_79.01	100 Wm Lewis Arthur Dr.
Our Lady Of The Magnificat Chapel	57_94.03	Miller Rd.
56 Ricker Rd	11_110.01	56 Ricker Rd.
Benjamin Miller House**	111_26	146 Kiel Ave.
110 Kiel Ave	111_36	110 Kiel Ave.
Kiel School*** (now known as The Glenn L. Sisco School)	134_133	109 Kiel Ave.
210 Boonton Ave	79_6.01	210 Boonton Ave.

Table 40. Historic Sites in Kinnelon Borough		
Site Name	*Block-Lot*	*Address*
60 Kiel Ave	211_170	60 Kiel Ave.
Frederick's House	34_234	6 Duchess Dr.
Kayhart House	89_51	241 Brook Valley Rd.
Meadtown School (L'Ecole Museum)	34_57	25 Kiel Ave.
61 Lakeside Trail	61_50	61 Lakeside Trail
Mead House	36_9	197 Kakeout Rd.
42 Tintle Rd	34_424	42 Tintle Rd.
H. Gormely House	88_18	1 Cutlass Rd.
Abraham or Henry Smith House	88_12	31 Cutlass Rd.
John Henry Millidge House	1421_24.1_1.3	24 Brook Valley Rd.
Butternut Tree	33.02_1	Butternut Mall or Kakeout and Kiel Ave.

**Eligible or potentially eligible for National Register of Historic Places;*
***Demolished in 2009*
****The currently named Kiel School is located at 115 Kiel Avenue and is not the historically designated structure identified in this table; this historic building houses the Board of Education.*
Sources: MCPRIMA, 2007 Historic Sites Survey, Kinnelon tax database, Tom Kline

Of the 37 sites identified in the print version of the *2007 Survey*, 16 were not included in the electronic MCPRIMA database. Some of the omitted sites have been demolished since 1986, including the Abraham Millidge and C.J. Van Ness houses. Others were not accessible for assessment at the time of the 2007 Survey, often at the request of the private owners of the property. Most historic sites in Kinnelon are privately owned; exceptions include the Butternut Tree, L'Ecole and the Canty Estate (now Silas Condict County Park).

Several of the most notable sites no longer included were part of the former Kinney Estate, now contained within the boundaries of the private, gated community of Smoke Rise. Among these are structures that are deemed eligible for the National Register of Historic Places. The Smoke Rise sites include the following landmarks from the former Kinney Estate.

Not Included in the MCPRIMA database:

- Lookout Tower (not eligible for NR)
- St. Hubert's Chapel (Louis Comfort Tiffany design – eligible for NR)
- Kinney Outbuildings A, now the clubhouse area (eligible for NR)
- Kinney Outbuildings B, located on the Talbot property (eligibility undetermined)
- Morris Kinney House, East Lake Road (potentially eligible for NR)

Included in the MCPRIMA database:

- Caretaker's House (eligible for NR)

A notable site in Kinnelon is the Butternut Tree located at Kinnelon Mall, the site of the former Mead farmstead. Although not eligible for State or National Register recognition, the tree is listed in historic surveys and on the MCPRIMA website. It is one of three sites honored by historical markers placed by the Morris County Heritage Commission:

- Butternut Tree, Kiel Avenue and Kinnelon Road (Kinnelon Mall/Butternut Plaza). The historical marker placed by the Morris County Heritage Commission in 1978 reads "Oldest and largest known tree of its species in New Jersey stands on site of 18th century Mead Farm. Hulls, nuts and bark traditionally used by Indians and colonists." Additional information about the roles butternut trees played in Native American and early colonial life in the Kinnelon area can be found in Lucy Meyer's 1976 Kinnelon: A History. According to the 2007 Historic Sites Survey, the tree is estimated to be between 150 and 200 years old. In 1973, it had a circumference of 144 inches, a height of 65 feet and a crown spread of 84 feet. By 2000, the circumference was 164 inches. The botanical name of the tree is *Juglans cinerea* and it is commonly known as either butternut or white walnut. The Kinnelon tree may have been replaced as the largest known example of its species in New Jersey, according to the NJDEP Register of Big Trees, which lists as the state champion a tree located in Dover that measures 217 in circumference, 75 feet high and 93 feet at the crown. The national champion, according to the American Forests website, measures 219 inches in circumference, with a height of 110 feet and a crown spread of 103 feet. The Butternut Tree is protected by a tree preservation and pedestrian access easement *(1999 Resolutions Granting Site Approval and Ordinance 4-01).*
- Fredericks House, 6 Duchess Drive. The marker placed by the Morris County Heritage Commission in 1994 reads: "A Dutch stone house, built circa 1720 by Fredericks family, one of the first families to settle in this region. Their descendants lived and farmed here through early twentieth century." This property, in private ownership, was placed on the National and State Registers of Historic Places in 1979 (see above).
- Charlotteburg Forge, Route 23 South near Smoke Rise North Gate. The historical marker placed by the Morris County Heritage Commission in 1978 reads: "Great Charlotteburg Furnace Tract. 1765. In this area, Peter Hasenclever built iron works for the American Company operation of furnace and three forges later managed by John Jacob Faesch and Robert Erskine." The forge is not included in the 2007 Historic Sites Survey. Lucy Meyer's 1976 *Kinnelon: A History* includes information on the Charlotteburg Furnace Tract, which totaled 6,583 acres in 1765-66. According to Meyer, the Charlotteburg Middle Forge was located about 200 yards southeast of the North Gate of Smoke Rise, along the Pequannock River.

Additionally, the following sites were preserved through open space acquisitions since the publication of the *2005 Open Space and Recreation Plan:*

- Stickle Forge Site, located at a waterfall along Stone House Brook and Robins Lane. This is part of the Silas Condict County Park Expansion Area east of Lake Kinnelon.
- Pikes Peak Iron Mines (aka Stony Brook Mine), located north of New Pond in the Silas Condict County Park expansion area west of Lake Kinnelon, and dating from the 1700s.

According to Tom Kline, Chair of the Kinnelon Historical Commission, "although neither site has much discernable structure remaining, they are none the less significant in our early history."

PUBLIC INFRASTRUCTURE

The public infrastructure of a municipality includes services such as local and regional roads and highways, mass transit opportunities and public sewer and water supply. Kinnelon is located entirely in the New Jersey Highlands, and thus is subject to the *Highlands Water Protection and Planning Act of 2004* and the *Highlands Regional Master Plan (RMP)* developed to implement the Act. Since the borough has chosen to conform to the *RMP* in its Planning Area as well as its Preservation Area, Kinnelon's future development potential is regulated by the NJDEP Highlands Rules, the *RMP* and several municipal documents developed and approved as part of the Plan conformance process. These documents include a Highlands Master Plan Element, a Municipal Build-Out Report, a Highlands Environmental Resource Inventory and a Highlands Area Land Use Ordinance. They help both to see where development and infrastructure expansion should be limited and to strategize on ways that public infrastructure improvements, such as to mass transit, stormwater management plans and water conservation, can help meet the goals of the Act and improve the quality of life for Kinnelon's residents and their environment.

Transportation

Roadways

Kinnelon's road network is defined to a large degree by its topography. Major roadways skirt its northern border (NJ 23) and bisect its southeastern corner (I-287). Two county roads serve as north/south corridors and a handful of east/west trending roads serve as arterials connecting these roads. The rest of the roads in Kinnelon primarily serve to access the residential areas of the borough. The hierarchy of roads, based on a functional classification system, is detailed below:

Interstate: I-287, cutting through the southeastern corner of the Borough, connects I-95 (New Jersey Turnpike) in central New Jersey to I-87 (New York Thruway) at the border with New York State to bypass the New York City area. Access to Kinnelon is via Exit 47 onto US 202 in Montville or Exit 52 onto NJ 23 west into Riverdale. I-287 increased public access to Kinnelon Borough and the surrounding communities, sparking additional development in this region.

Principal Arterial (carries large volumes of traffic at relative high speeds and may connect to the interstate highway network):

- NJ 23, skirting the northern border from the western boundary into Butler, including access to the north gate entrance into the private community of Smoke Rise, Kinnelon Rd. and Boonton Avenue.

Minor Arterial (interconnects with principal arterials, such as NJ 23):

- County Route (CR) 618, Kinnelon Road, running north/south from NJ 23 in Butler through Kinnelon continuing into Boonton Township.

Collectors (provide access and traffic circulation within residential neighborhoods, commercial and industrial areas and connect local roads with arterials):

- North/South: CR 511 (Boonton Avenue), enters Kinnelon at the border with Butler and exits into Montville; and Kiel Avenue, extends from Kinnelon Road, near Fayson Lakes Road, to Kakeout Road near NJ 23.
- East/West: Fayson Lakes and Kakeout Roads (both running between CR 618 and CR 511) and Cutlass Road (between CR 511 and NJ 23).

The remaining roads in Kinnelon are classified as local roads, serving mainly as access to residential neighborhoods.

Mass Transit

Access to mass transit for Kinnelon residents, in large part, requires driving to bus stops or train stations at the border of Kinnelon or in neighboring communities. There are no regularly scheduled mass transit service destinations within Kinnelon.

Train. Passenger rail service is available on the NJ Transit Montclair-Boonton line. The closest stations are in neighboring Boonton and Towaco (Montville Township). The line operates between New York Penn Station and Mount Olive, with opportunities to change at Newark Broad Street and Secaucus Junction to other NJ Transit lines for service to other destinations. *(NJ Transit)* There is also access to passenger rail through the Wayne Transit Center on Route 23 South.

Bus. NJ Transit provides service to New York City along both the NJ 23 and US 46/I-80 corridors; service between Morris, Essex, Passaic and Sussex counties; and eight weekday routes within Morris County, including one between Morristown and Wayne, via Boonton. The Wayne Transit Center on Route 23 South, the Mother's Park and Ride on Route 23 North and the Willowbrook Mall also provides access to bus lines.

A private carrier, Lakeland Bus Lines, Inc. also provides service to New York City and within Morris and Sussex counties.

According to the Morris County Division of Transportation (MCDOT), as of November 2012, five park and ride locations are located convenient to Kinnelon residents:

- Boonton Town - Kiwanis Ambulance Lot, Madison Street near Washington Street (US 202). Lakeland 46; NJ Transit 871
- Boonton Town - Main Street Lot, Main Street (CR 624) & Plane Street. Lakeland 46
- Butler - NJ 23 Lot, NJ 23 North & Cascade Way. NJ Transit 75, 194
- Butler/Kinnelon - Meadtown Lot NJ 23 & Kiel Avenue. NJ Transit 75, 194
- Wayne Township – NJ 23. NJ Transit 194, 748, 871

Specialty Bus Service:

- The ***Morris Area Paratransit System*** (MAPS) provides rides at a nominal fee for residents 60 or older, 18 or younger, or with a disability for purposes such as medical appointments and trips to work, school and adult day care. (*http://www.morrishumanservices.org/adv/maps.asp*)
- In the Kinnelon area, ***Five Town Regional Dial-A-Ride, Inc.*** offers similar services and regular routes weekdays within Butler, Kinnelon, Lincoln Park, Pequannock and Riverdale. (*http://www.morrishumanservices.org/adv/dialaride.asp*) *(MCDOT)*

Bicycle & Pedestrian

MCDOT has produced a *Bicycle & Pedestrian Map* that includes the Kinnelon roads designated as shared roadways for bicycle and motor vehicle traffic: Boonton Avenue, Kinnelon Road, and Fayson Lakes Road. The NJ Transit station in Boonton has a limited number of bike racks and most NJ Transit buses are equipped with bike racks. *(MCDOT)*

Water

Although most of Kinnelon is dependent upon private wells for water supply, there are three water companies serving limited areas of the Borough as documented in the *Highlands Environmental Resource Inventory* of April 2011 (see *Table 41*). There is a portion served by the Kinnelon Water Department, which contracts with Butler Borough for bulk purchase, a portion served directly by the Butler Water Department and a third portion served by the Fayson Lake Water Company.

Table 41. Water Companies Serving Kinnelon Borough

Purveyor	*Acres*
Fayson Lake Water Company	542.57
Kinnelon Water Department	129.15
Butler Water Department	175.80
Source: Highlands ERI for Kinnelon Borough	

Each system has monthly and yearly available water supply limits tied to a Water Allocation Permit. All three systems show surpluses in the reports available in October 2012. Information on usage is illustrated in *Table 42*.

Table 42. Public Water Supply Usage and Deficit/Surplus MGM – Million Gallons Per Month; MGY = Million Gallons Per Year			
	Limits	*Peak Demand*	*(Deficit)/Surplus*
Fayson Lake Water Company (2007/2008)	11.000 MGM 88.000 MGY	10.620 MGM 80.637 MGY	0.380 MGM 7.363 MGY
Kinnelon Water Department (2010)	23.25 MGM 273.75 MGY	10.639 MGM 66.645 MGY	12.611 MGM 207.105 MGY
Butler Water Department* (2010)	124.00 MGM 1488.00 MGM	71.852 MGM 623.171 MGM	52.148 MGM 864.829 MGY
**entire service area.* *Source: NJDEP Division of Water Supply and GeoScience. Public Water System Deficit/Surplus. Accessed 10/18/2012. http://www.state.nj.us/dep/watersupply/pws.html*			

The reports also include an analysis of Firm Capacity Deficit or Surplus, which is a measure of the system's ability to provide treated water at adequate pressure when the largest pumping unit is out of service. The Kinnelon Water Department report showed a firm capacity surplus of .407 million gallons per day (MGD). The Butler Water Department report showed a surplus of .460 MGD, and the Fayson Lake Water Company report showed a deficit of -0.189 MGD.

Wastewater

Most of Kinnelon is dependent on private septic systems for sewage disposal, but a small portion, totaling 435 acres, in the northeastern corner, abutting Butler Borough, is served by the Two Bridges Sewerage Authority.

The NJ Highlands Council *Highlands Implementation Plan* for Kinnelon calls for development of a *Municipal Wastewater Management Plan (WMP).* The Highlands Council will work with Kinnelon, as a conforming municipality, to determine a WMP that adheres to the intent of the Highlands *Act* and *Regional Master Plan.* According to the Morris County Planning Department, once this Plan is completed, it will be included in the Morris County Draft Wastewater Management Plan.

Future Expansion of Service Areas in Kinnelon

The NJ Highlands Council *Highlands Municipal Build-Out Report for Kinnelon Borough* determined that constraints on potentially developable land in the entire municipality would result in 0 residential dwellings and 0 square feet of non-residential development in the Borough's wastewater and water service areas, resulting in no increase in public water supply and wastewater demands as a result of new development. The build-out calculations allow for 0 additional septic systems in the Planning Area and 1 septic system in the Preservation Area.

These build-outs results are not constrained by either water supply utility capacity, wastewater utility capacity, or water availability. *(NJ Highlands Council Build-Out Report)*

FLOOD HAZARD/FLOOD PRONE AREAS

There are at least three levels of government oversight regarding areas prone to flooding. The intent is to minimize property damage and negative ecological effects by limiting development and protecting positive environmental influences in areas deemed subject to flooding.

At the federal level, the Federal Emergency Management Agency (FEMA) evaluates and maps Special Flood Hazard Areas (SFHAs). Communities can opt to participate in the National Flood Insurance Program (NFIP), which requires mandatory flood insurance in areas mapped as SFHAs. An SFHA is defined as "an area that would be inundated by the flood having a one percent chance of being equaled or exceeded in any given year," also known as the based flood or 100-year-flood zone. NFIP mapping also includes information on 500-year flood zones and various sublevels within the 100-year zone. *(FEMA)*

Currently, there is no FEMA mapping available for Kinnelon and Kinnelon is not a participating community in the NFIP. FEMA mapping is available for communities bordering Kinnelon, all of which participate in the NFIP.

At the state level, New Jersey regulates flood prone areas through the New Jersey Flood Hazard Area Control Act, N.J.S.A. 58:16A-50 et seq., and its rules, adopted November 5, 2007. The Act recognizes the importance not only of avoiding building in unsafe places but also of preserving the vegetation that "is essential for maintaining bank stability and water quality." The rules set standards for development in flood hazard areas and adjacent to surface waters "in order to mitigate the adverse impacts to flooding and the environment that can be caused by such development." *(NJDEP Division of Land Use Regulation)*

By NJDEP definition, "a flood hazard area and a riparian zone exist along every regulated water that has a drainage area of 50 acres or more." The flood prone or flood hazard area (FHA) mapped by the NJDEP is defined by the 100-year flood area plus an additional amount (25%) to allow for changes over time. The inner portion of the FHA is the floodway and the outer portion is the flood fringe. The state is attempting to coordinate with FEMA so that FEMA mapping for New Jersey will use the state standard, eliminating the need for double mapping. *(NJDEP DLUR)*

On a regional level, Kinnelon Borough is a conforming community under the *Highlands Water Protection and Planning Act* and its *Regional Master Plan.* The New Jersey Highlands Council (NJHC), which serves as the administrative body, released updated mapping of flood hazard/ flood prone areas in March 2012. This mapping combines data

from FEMA and from the NJDEP to include both the FEMA 100-year floodplains and the NJDEP documented and undocumented flood prone areas. The mapping for Kinnelon shows NJHC areas of concern around all the major water bodies in Kinnelon, along several of the feeder streams and in pockets of wetland areas such as in the vicinity of Buck Mountain.

On a local level, the Kinnelon Municipal Code addresses flood hazard areas in Chapter 172, Stormwater Control, which considers flood hazard areas as environmentally sensitive and thus subject to restrictions regarding development.

Specific regulations regarding flood hazard areas are included in Chapter 207, Zoning.

Section 207-79, Determination of affected areas, designates flood hazard areas as environmentally sensitive. It defines a flood hazard area as "The stream channel and the relatively flat area adjoining the channel of a natural stream which has been inundated or covered by floodwaters, from a one-hundred-year storm frequency flood, as defined by the New Jersey Department of Environmental Protection."

Section 207-81, Regulations, provides the following regulations for flood hazard areas.

> Notwithstanding any other provision of this chapter, development in flood hazard areas shall be regulated as follows:
>
> (1) In flood hazard areas having a drainage area of less than 50 acres, no building or structure shall be erected or constructed, either above or below ground level, within the flood hazard area or within a minimum of 50 feet from the center line of any stream.
>
> (2) In a flood hazard area having a drainage area of 50 acres or greater, no building or structure shall be erected or constructed, either above or below ground level, except in accordance with a stream encroachment permit issued pursuant to the Flood Hazard Areas Act, N.J.S.A. 58:16A-50 et seq., and a minimum of 50 feet from the top of the stream embankment.

KNOWN CONTAMINATED SITES

Soil and groundwater contamination by pollutants is tracked by the state and federal governments at varying degrees of contamination or potential contamination, including brownfields and other extensive or long-term remediation, point source facilities that require continuous monitoring (Community Right to Know) and point source occurrences that are specific and limited (Known Contaminated Sites).

Brownfields

A brownfield is "any former or current commercial or industrial site, currently vacant or underutilized and on which there has been, or there is suspected to have been, a discharge of a contaminant." (*Brownfield and Contaminated Site Remediation Act,* N.J.S.A. 58:10B-1 et seq.) The State of New Jersey encourages municipalities and counties to redevelop their brownfields as part of Smart Growth initiatives.

There are no brownfields in Kinnelon, although there are a number of sites in neighboring municipalities of Boonton, Butler, Lincoln Park, Montville, Pequannock, Riverdale and Rockaway in Morris County and Bloomingdale and West Milford in Passaic County.

Community Right to Know

The Community Right to Know (CRTK) program is responsible for collecting and disseminating data on hazardous substances produced, stored or used at companies in New Jersey. In 2012, there were no active or non-active CRTK facilities in Kinnelon Borough. *(NJDEP)*

Known Contaminated Sites

The Known Contaminated Sites List (KCSL) for New Jersey includes those sites and properties within the state where contamination of soil or groundwater has been confirmed at levels equal to or greater than applicable standards.

Known Contaminated Sites may include:

- Active sites with known contamination, these sites can have one or more active cases with any number of pending and closed cases,
- Pending sites with confirmed contamination which are those sites having one or more pending cases, no active cases, and any number of closed cases, and

- Closed sites with remediated contamination, which are those sites having only closed cases. Sites in this category have no active or pending cases.

These lists are produced by the NJDEP in response to the *Brownfield and Contaminated Site Remediation Act, N.J.S.A. 58:10-23.16-17*, which requires the preparation of a list of sites affected by hazardous substances. It also satisfies obligations under the New Jersey New Residential Construction Off-Site Conditions Disclosure Act (*N.J.S.A. 46:3C1 et seq.*). Sites included in the KCSL report can undergo a wide variety of remedial activities, ranging from relatively simple "cut and scrape" cleanups to highly complex cleanups. The sites with complex contamination issues can have several sources of contamination, which can affect both soil and groundwater at the same time.

The *Site Remediation Reform Act*, N.J.S.A. 58:10C-1 et seq. (SRRA), enacted in 2009, has helped to speed up the remediation process, "thus helping to decrease the threat of contamination to public health and safety and of the environment, and to quickly return underutilized properties to productive use." As of May 7, 2012, with limited exceptions, all remediations in the state of New Jersey, without regard to when remediation was initiated, proceed under the supervision of a Licensed Site Remediation Professional (LSRP), without New Jersey Department of Environmental Protection (Department) approval, following nine requirements set forth at N.J.S.A. 58:10B-1.3b(1) through (9).

Further information can be on the NJDEP website.

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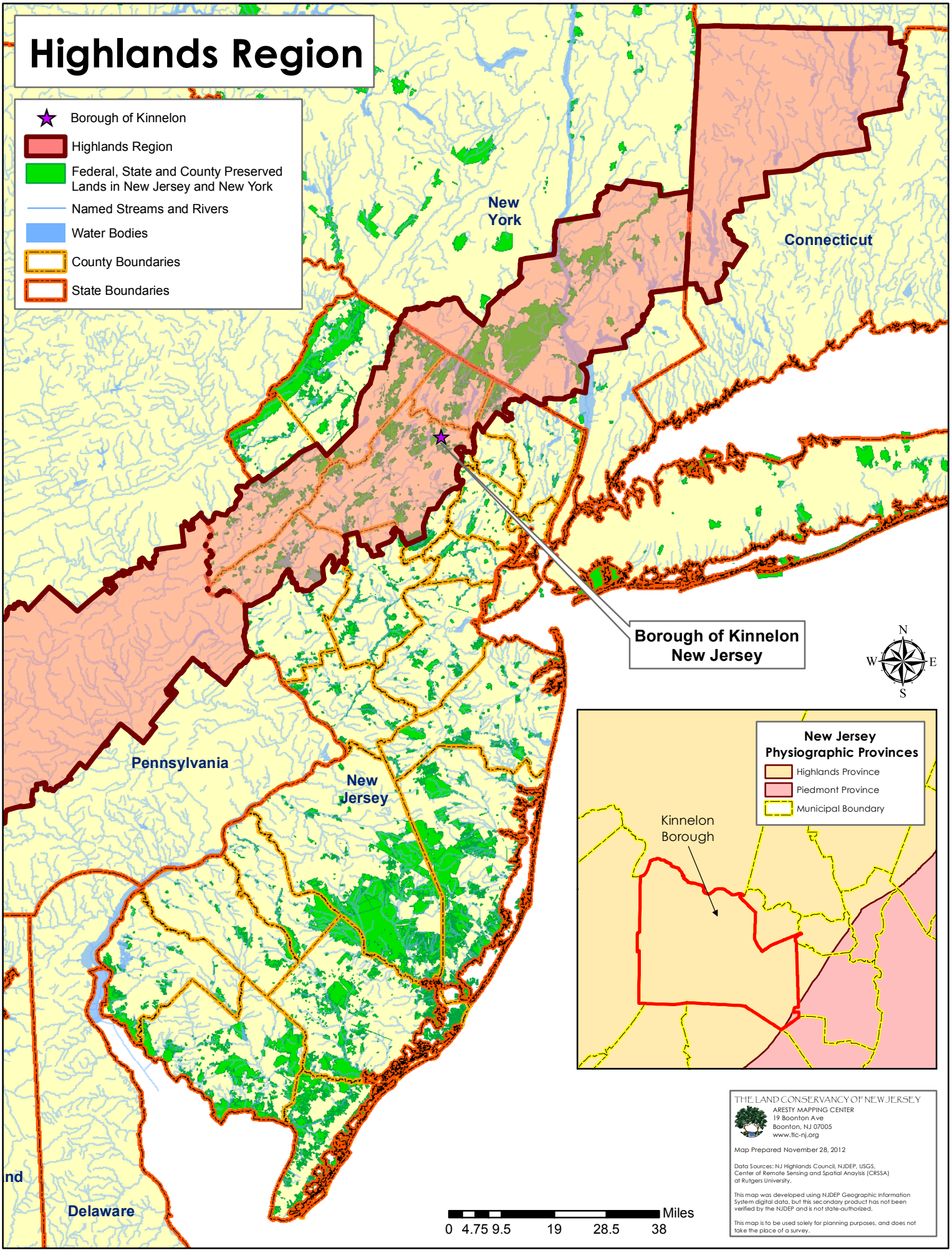
Personal communication

John Heilferty, NJDEP, Department of Land Use Regulation.

Tom Kline, Borough of Kinnelon, Historical Commission.

MAPS

1. **Highlands Region Map**
2. **Bedrock Geology Map**
3. **Surface Geology Map**
4. **Topography Map**
5. **Severe and Moderately Constrained Slopes Map**
6. **Watershed Map**
7. **Surface Water Quality Map**
8. **Aquifer Recharge Potential Map**
9. **Bedrock and Surficial Aquifers Map**
10. **Public Wellhead Protection Map**
11. **Soils Types Map and Legend**
12. **Soil Series Map**
13. **Wetlands Map**
14. **Land Use/Land Cover Map**
15. **Patches with Endangered Species Habitats Identified by the Landscape Project 2012**
16. **Vernal Habitats Map**
17. **Preserved Land Map**
18. **Trail and Greenway Map**



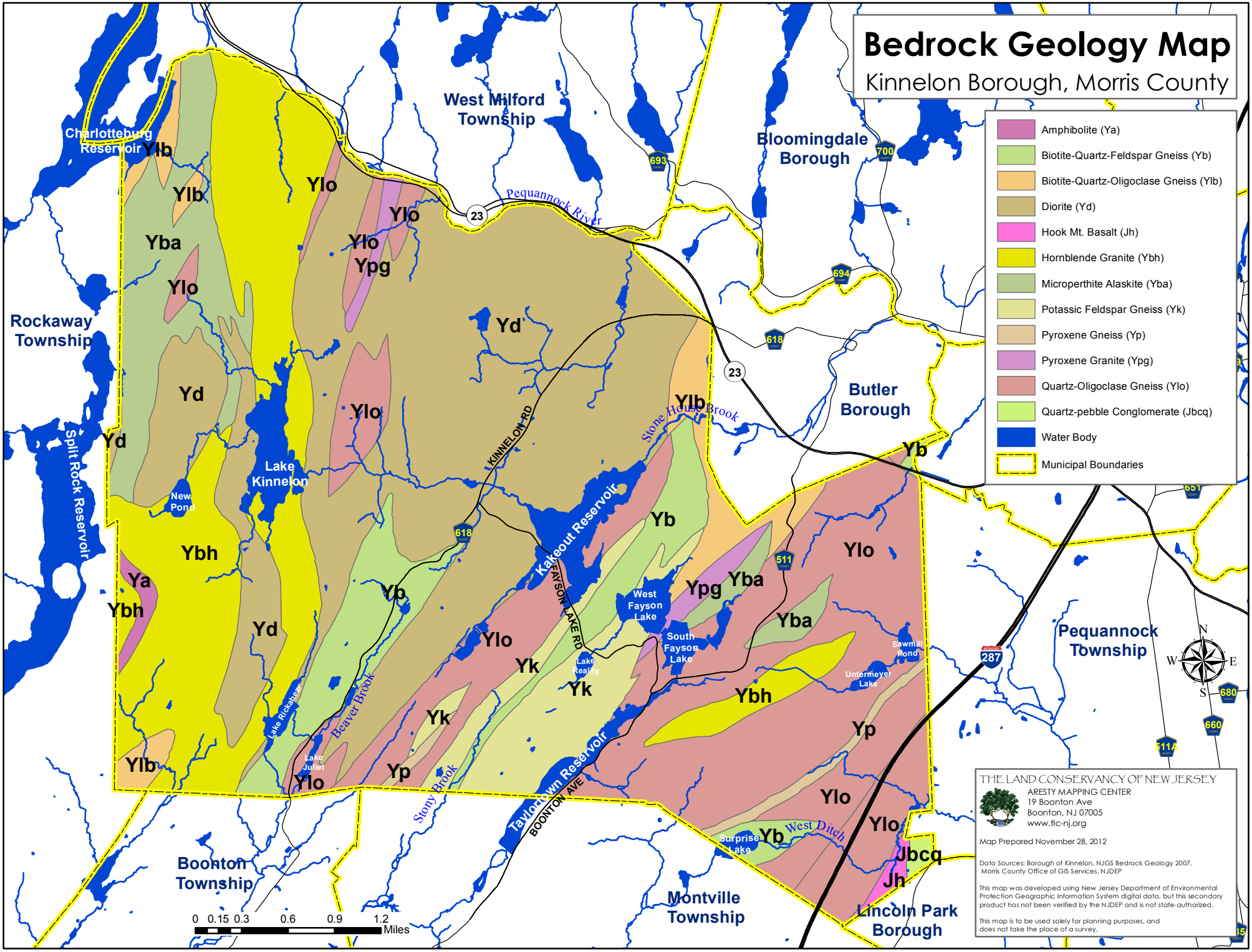
THE LAND CONSERVANCY OF NEW JERSEY
ARESTY MAPPING CENTER
19 Boonton Ave
Boonton, NJ 07005
www.tlc-nj.org

Map Prepared November 28, 2012

Data Sources: NJ Highlands Council, NJDEP, USGS, Center of Remote Sensing and Spatial Anaylsis (CRSSA) at Rutgers University.

This map was developed using NJDEP Geographic Information System digital data, but this secondary product has not been verified by the NJDEP and is not state-authorized.

This map is to be used solely for planning purposes, and does not take the place of a survey.


Bedrock Geology Map
Kinnelon Borough, Morris County
Amphibolite (Ya)
Biotite-Quartz-Feldspar Gneiss (Yb)
Biotite-Quartz-Oligoclase Gneiss (Ylb)
Diorite (Yd)
Hook Mt. Basalt (Jh)
Hornblende Granite (Ybh)
Microperthite Alaskite (Yba)
Potassic Feldspar Gneiss (Yk)
Pyroxene Gneiss (Yp)
Pyroxene Granite (Ypg)
Quartz-Oligoclase Gneiss (Ylo)
Quartz-pebble Conglomerate (Jbcq)
Water Body
Municipal Boundaries
West Milford Township
Bloomingdale Borough
Rockaway Township
Butler Borough
Pequannock Township
Boonton Township
Montville Township
Lincoln Park Borough
Charlotteburg Reservoir
Split Rock Reservoir
Lake Kinnelon
New Pond
Kakeout Reservoir
West Fayson Lake
South Fayson Lake
Lake Reality
Sawmill Pond
Untermeyer Lake
Surprise Lake
Lake Rickabee
Lake Juliet
Taylortown Reservoir
Pequannock River
Stone House Brook
Beaver Brook
Stony Brook
West Ditch
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THE LAND CONSERVANCY OF NEW JERSEY
ARESTY MAPPING CENTER
19 Boonton Ave
Boonton, NJ 07005
www.tlc-nj.org
Map Prepared November 28, 2012
Data Sources: Borough of Kinnelon, NJGS Bedrock Geology 2007, Morris County Office of GIS Services, NJDEP
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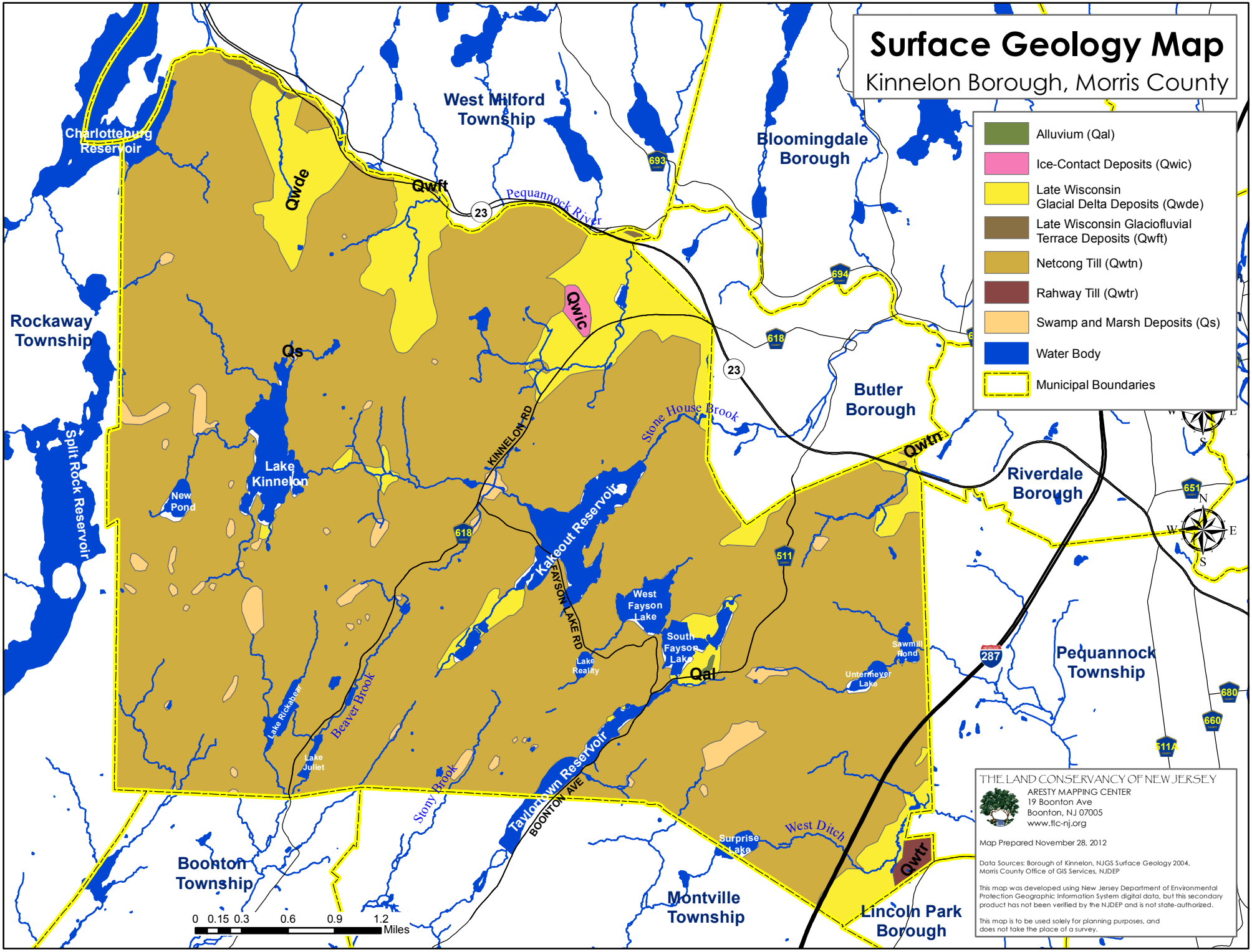
Surface Geology Map
Kinnelon Borough, Morris County
Alluvium (Qal)
Ice-Contact Deposits (Qwic)
Late Wisconsin Glacial Delta Deposits (Qwde)
Late Wisconsin Glaciofluvial Terrace Deposits (Qwft)
Netcong Till (Qwtn)
Rahway Till (Qwtr)
Swamp and Marsh Deposits (Qs)
Water Body
Municipal Boundaries
West Milford Township
Bloomingdale Borough
Rockaway Township
Butler Borough
Riverdale Borough
Pequannock Township
Boonton Township
Montville Township
Lincoln Park Borough
Charlotteburg Reservoir
Split Rock Reservoir
Lake Kinnelon
New Pond
Kakeout Reservoir
Taylortown Reservoir
West Fayson Lake
South Fayson Lake
Lake Reality
Sawmill Pond
Untermeyer Lake
Surprise Lake
Lake Rickabear
Lake Juliet
Pequannock River
Stone House Brook
Beaver Brook
Stony Brook
West Ditch
KINNELON RD
FAYSON LAKE RD
BOONTON AVE
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THE LAND CONSERVANCY OF NEW JERSEY
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Data Sources: Borough of Kinnelon, NJGS Surface Geology 2004, Morris County Office of GIS Services, NJDEP
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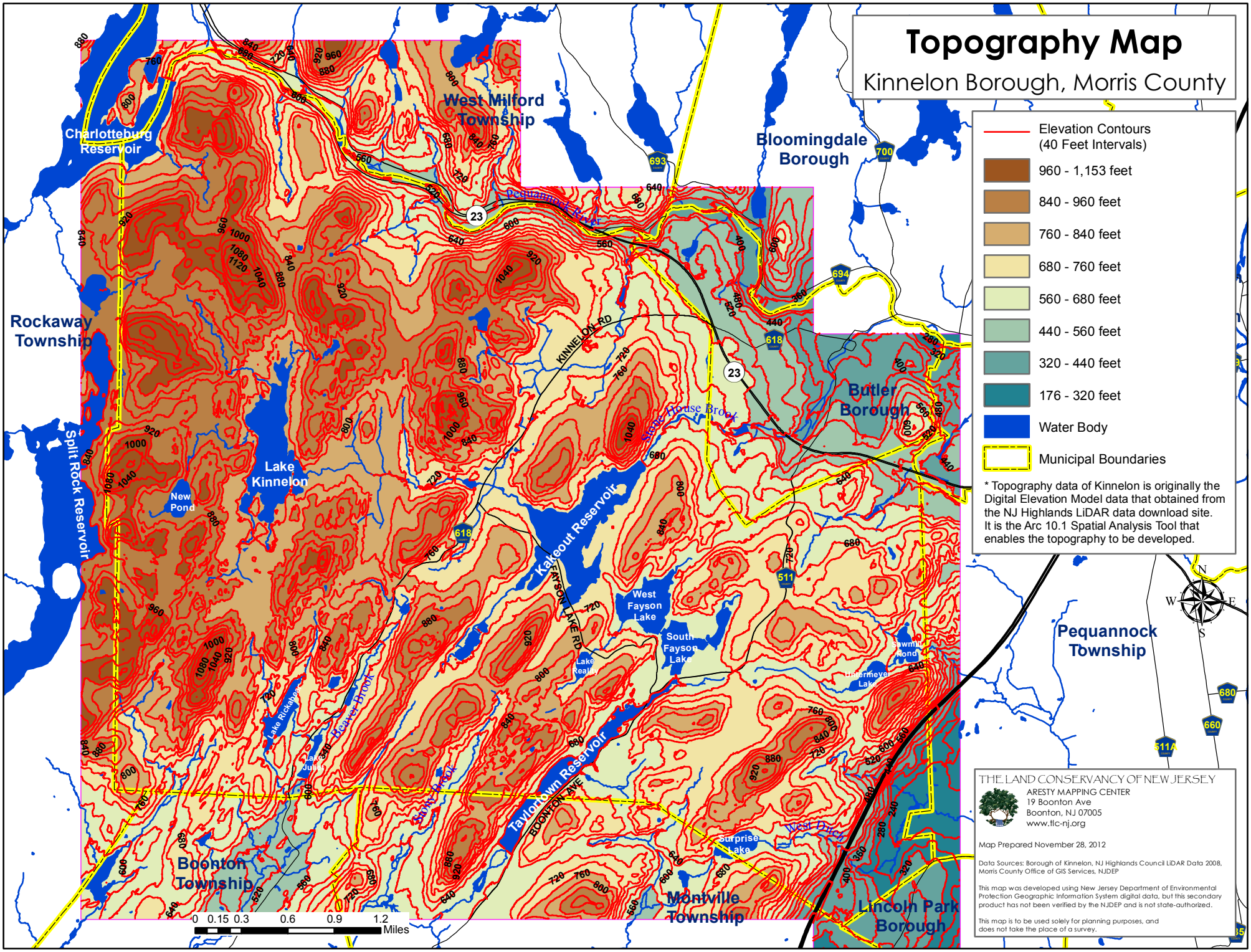
Topography Map
Kinnelon Borough, Morris County
Elevation Contours
(40 Feet Intervals)
960 - 1,153 feet
840 - 960 feet
760 - 840 feet
680 - 760 feet
560 - 680 feet
440 - 560 feet
320 - 440 feet
176 - 320 feet
Water Body
Municipal Boundaries
* Topography data of Kinnelon is originally the Digital Elevation Model data that obtained from the NJ Highlands LiDAR data download site. It is the Arc 10.1 Spatial Analysis Tool that enables the topography to be developed.
Charlottebug Reservoir
West Milford Township
Bloomingdale Borough
Rockaway Township
Split Rock Reservoir
Lake Kinnelon
New Pond
Butler Borough
Kakeout Reservoir
West Fayson Lake
South Fayson Lake
Pequannock Township
Boonton Township
Montville Township
Lincoln Park Borough
Taylortown Reservoir
Surprise Lake
KINNELON RD
FAYSON LAKE RD
BOONTON AVE
Beaver Brook
Stony Brook
Stone House Brook
Pequannock River
0 0.15 0.3 0.6 0.9 1.2 Miles
THE LAND CONSERVANCY OF NEW JERSEY
ARESTY MAPPING CENTER
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Map Prepared November 28, 2012
Data Sources: Borough of Kinnelon, NJ Highlands Council LiDAR Data 2008, Morris County Office of GIS Services, NJDEP
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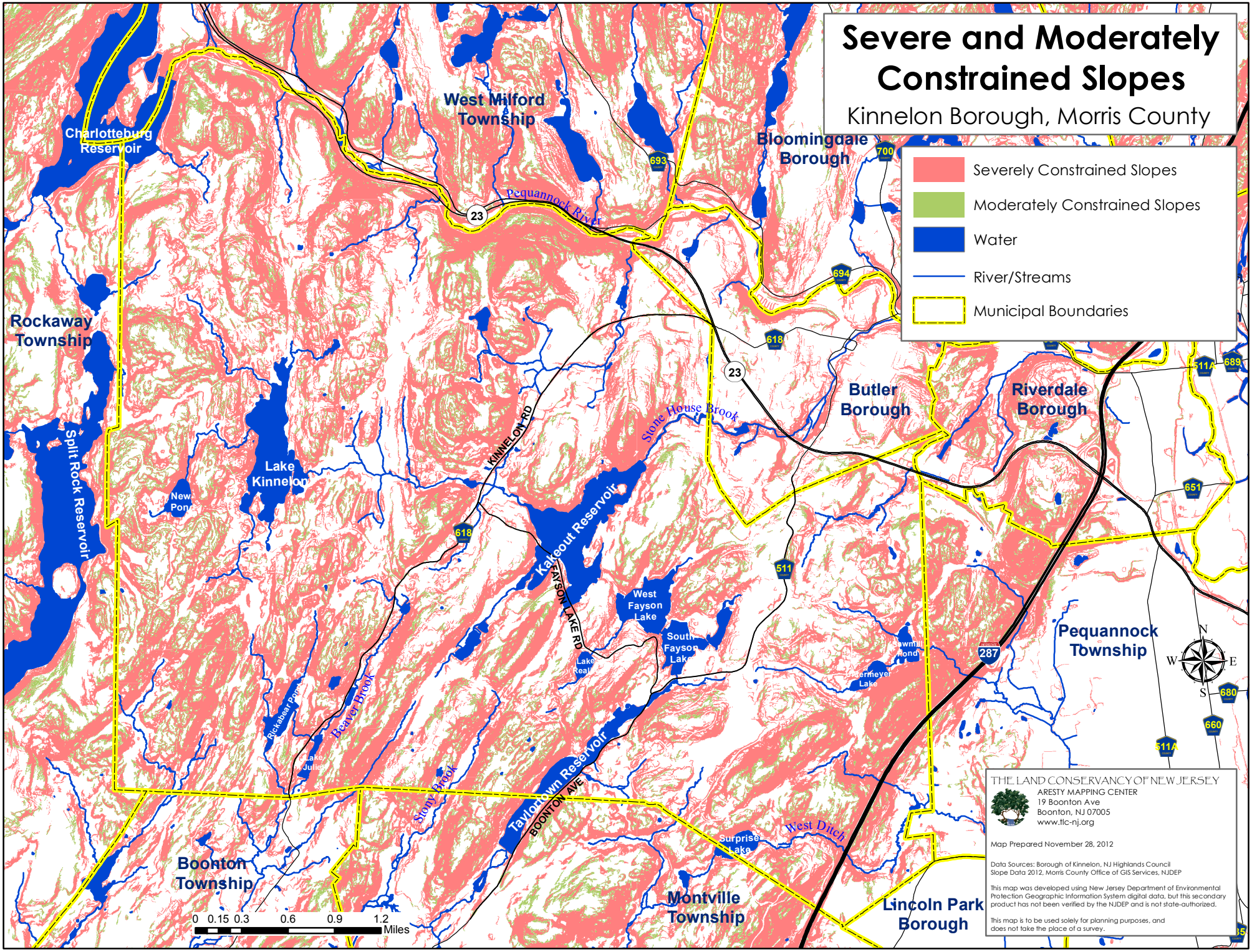
Severe and Moderately Constrained Slopes
Kinnelon Borough, Morris County
Severely Constrained Slopes
Moderately Constrained Slopes
Water
River/Streams
Municipal Boundaries
West Milford Township
Bloomingdale Borough
Charlotteburg Reservoir
Pequannock River
Rockaway Township
Split Rock Reservoir
Lake Kinnelon
KINNELON RD
Stone House Brook
Butler Borough
Riverdale Borough
Kakeout Reservoir
FAYSON LAKE RD
West Fayson Lake
South Fayson Lake
Pequannock Township
Beaver Brook
Stony Brook
Taylortown Reservoir
BOONTON AVE
West Ditch
Surprise Lake
Boonton Township
Montville Township
Lincoln Park Borough
0 0.15 0.3 0.6 0.9 1.2 Miles
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Map Prepared November 28, 2012
Data Sources: Borough of Kinnelon, NJ Highlands Council Slope Data 2012, Morris County Office of GIS Services, NJDEP
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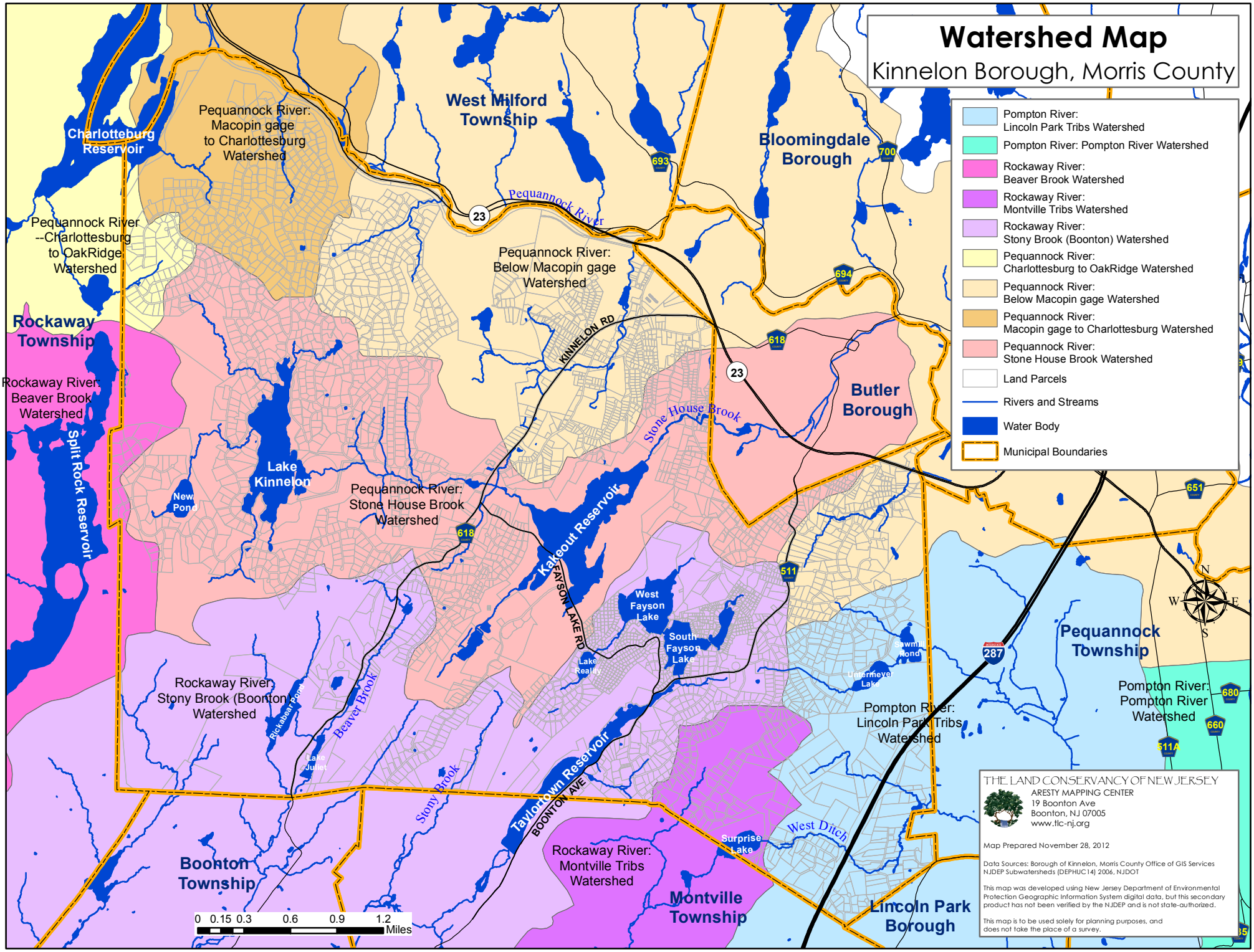
Watershed Map
Kinnelon Borough, Morris County
Pompton River: Lincoln Park Tribs Watershed
Pompton River: Pompton River Watershed
Rockaway River: Beaver Brook Watershed
Rockaway River: Montville Tribs Watershed
Rockaway River: Stony Brook (Boonton) Watershed
Pequannock River: Charlottesburg to OakRidge Watershed
Pequannock River: Below Macopin gage Watershed
Pequannock River: Macopin gage to Charlottesburg Watershed
Pequannock River: Stone House Brook Watershed
Land Parcels
Rivers and Streams
Water Body
Municipal Boundaries
West Milford Township
Bloomingdale Borough
Charlotteburg Reservoir
Pequannock River: Macopin gage to Charlottesburg Watershed
Pequannock River --Charlottesburg to OakRidge Watershed
Pequannock River: Below Macopin gage Watershed
Pequannock River
KINNELON RD
Rockaway Township
Rockaway River: Beaver Brook Watershed
Split Rock Reservoir
Lake Kinnelon
New Pond
Pequannock River: Stone House Brook Watershed
Stone House Brook
Butler Borough
Kakeout Reservoir
FAYSON LAKE RD
West Fayson Lake
South Fayson Lake
Lake Reality
Swim Pond
Lindermeyer Lake
Pequannock Township
Rockaway River: Stony Brook (Boonton) Watershed
Pickerbear Pond
Lake Juliet
Beaver Brook
Stony Brook
Taylortown Reservoir
BOONTON AVE
Pompton River: Lincoln Park Tribs Watershed
Pompton River: Pompton River Watershed
West Ditch
Surprise Lake
Rockaway River: Montville Tribs Watershed
Boonton Township
Montville Township
Lincoln Park Borough
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THE LAND CONSERVANCY OF NEW JERSEY
ARESTY MAPPING CENTER
19 Boonton Ave
Boonton, NJ 07005
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Map Prepared November 28, 2012
Data Sources: Borough of Kinnelon, Morris County Office of GIS Services NJDEP Subwatersheds (DEPHUC14) 2006, NJDOT
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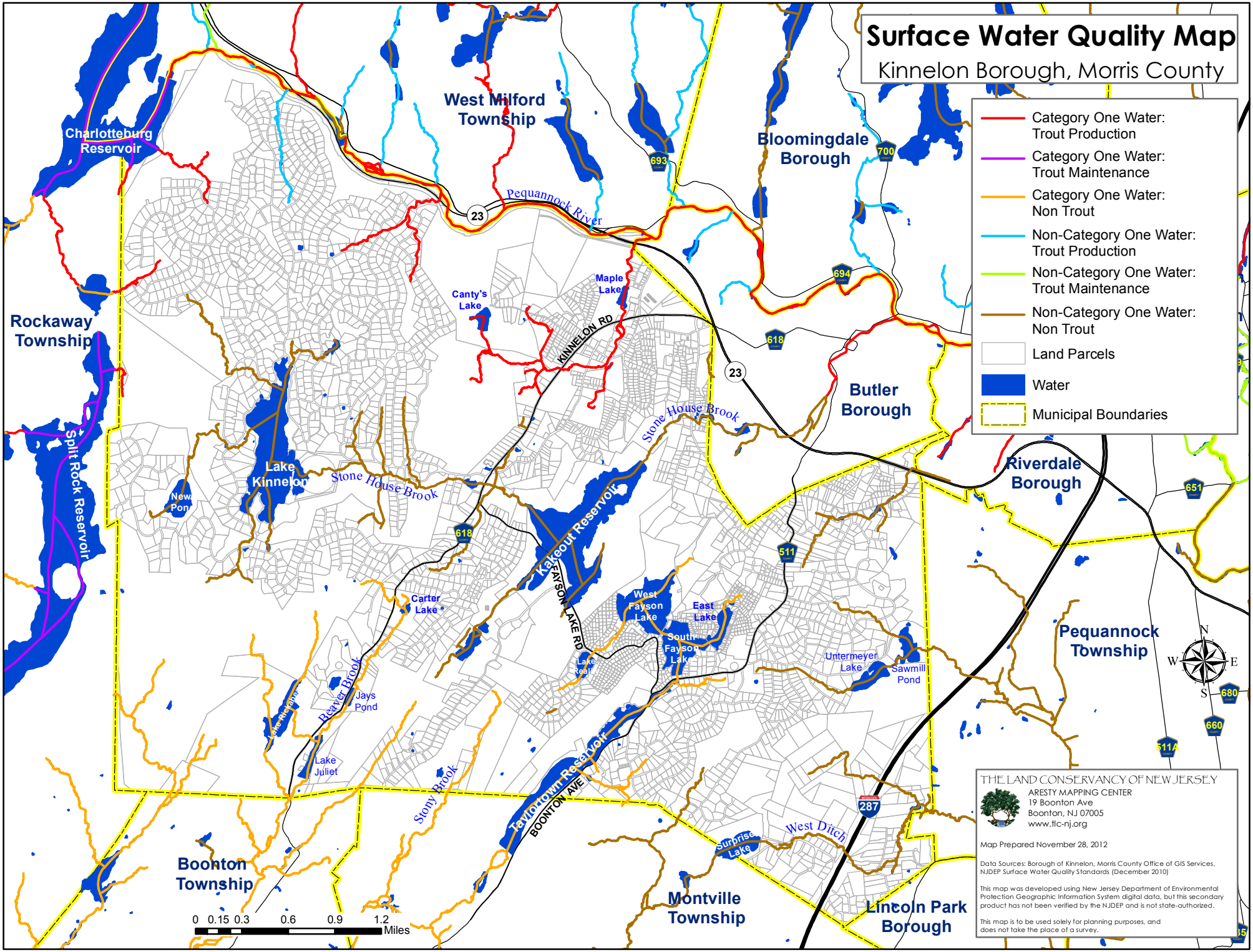
Surface Water Quality Map
Kinnelon Borough, Morris County
Category One Water: Trout Production
Category One Water: Trout Maintenance
Category One Water: Non Trout
Non-Category One Water: Trout Production
Non-Category One Water: Trout Maintenance
Non-Category One Water: Non Trout
Land Parcels
Water
Municipal Boundaries
West Milford Township
Bloomingdale Borough
Charlotteburg Reservoir
Rockaway Township
Butler Borough
Riverdale Borough
Pequannock Township
Boonton Township
Montville Township
Lincoln Park Borough
Pequannock River
Stone House Brook
Kakeout Reservoir
Lake Kinnelon
Canty's Lake
Maple Lake
New Pond
Carter Lake
West Fayson Lake
East Lake
South Fayson Lake
Lake Real
Untermeyer Lake
Sawmill Pond
Jays Pond
Lake Rediscovery
Lake Juliet
Beaver Brook
Stony Brook
Taylortown Reservoir
Surprise Lake
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Miles
THE LAND CONSERVANCY OF NEW JERSEY
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19 Boonton Ave
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Map Prepared November 28, 2012
Data Sources: Borough of Kinnelon, Morris County Office of GIS Services, NJDEP Surface Water Quality Standards (December 2010)
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 the NJDEP and is not state-authorized.
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Aquifer Recharge Potential

Kinnelon Borough, Morris County

The areas with the highest recharge potential are those with the lowest ranking number; thus, a ranking of 11 indicates a higher rate of potential recharge than a ranking of 98.

A/A (11)	D/D (44)
A/B (12)	D/E (45)
A/C (13)	E/A (51)
A/D (14)	E/B (52)
A/E (15)	L/L (97)
D/A (41)	W/W (98)
D/B (42)	Water Body
D/C (43)	Municipal Boundaries

West Milford Township
Bloomingdale Borough
Rockaway Township
Butler Borough
Riverdale Borough
Pequannock Township
Boonton Township
Montville Township
Lincoln Park Borough
Charlotteburg Reservoir
Splitrock Reservoir
Lake Kinnelon
Kakeout Reservoir
West Fayson Lake
South Fayson Lake
Taylortown Reservoir

0 0.2 0.4 0.8 1.2 1.6 Miles

THE LAND CONSERVANCY OF NEW JERSEY
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Map Prepared March 6, 2013

Data Sources: USGS Aquifer Recharge Potential 2005, Borough of Kinnelon, Morris County Office of GIS Services, NJDEP

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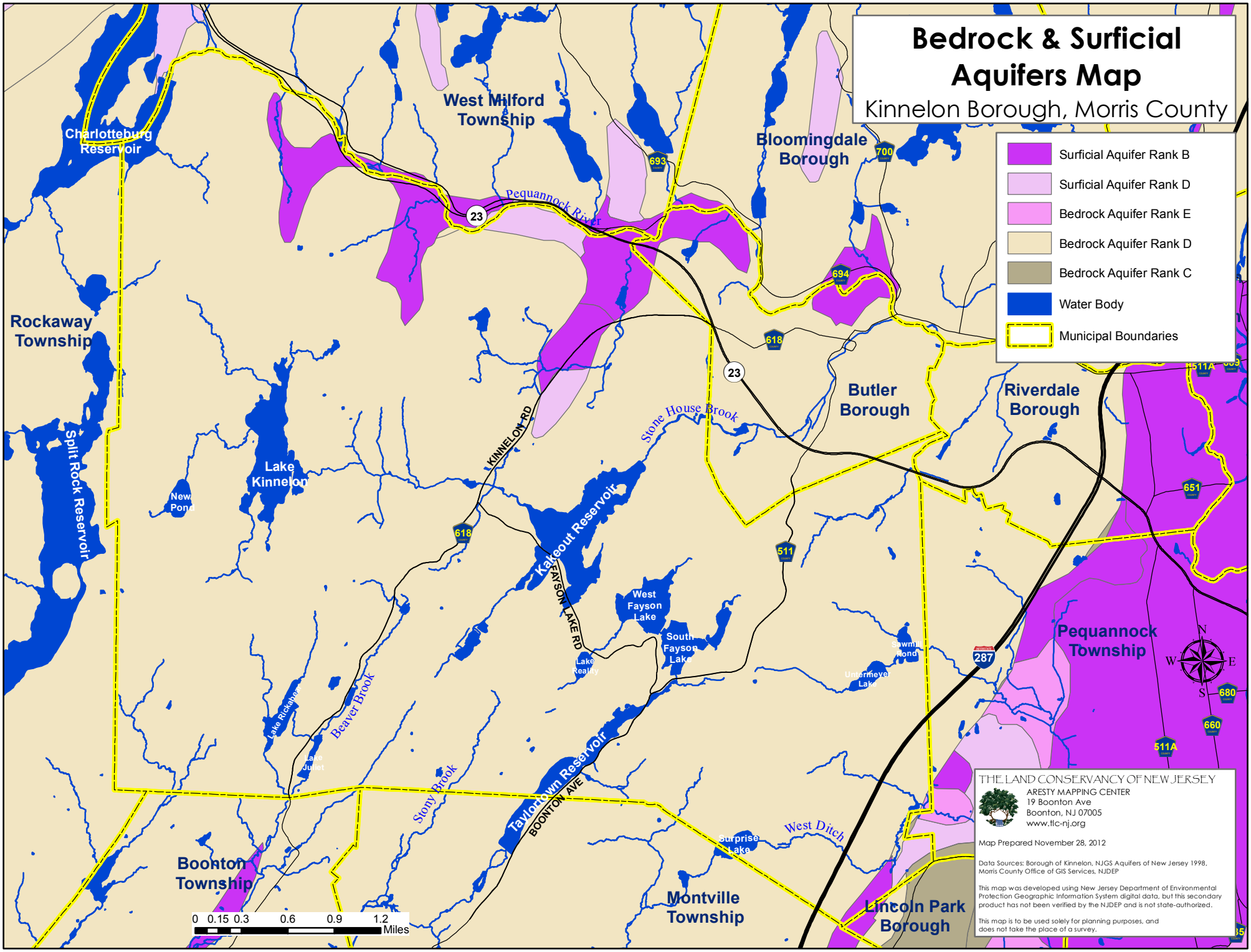
Bedrock & Surficial Aquifers Map
Kinnelon Borough, Morris County
Surficial Aquifer Rank B
Surficial Aquifer Rank D
Bedrock Aquifer Rank E
Bedrock Aquifer Rank D
Bedrock Aquifer Rank C
Water Body
Municipal Boundaries
West Milford Township
Bloomingdale Borough
Charlotteburg Reservoir
Pequannock River
Rockaway Township
Split Rock Reservoir
Lake Kinnelon
New Pond
KINNELON RD
Stone House Brook
Butler Borough
Riverdale Borough
Kakeout Reservoir
FAYSON LAKE RD
West Fayson Lake
South Fayson Lake
Lake Readly
Swim Pond
Unitermeyer Lake
Pequannock Township
Lake Rickenbach
Beaver Brook
Lake Juliet
Stony Brook
Taylortown Reservoir
BOONTON AVE
Surprise Lake
West Ditch
Boonton Township
Montville Township
Lincoln Park Borough
0 0.15 0.3 0.6 0.9 1.2 Miles
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THE LAND CONSERVANCY OF NEW JERSEY
ARESTY MAPPING CENTER
19 Boonton Ave
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Map Prepared November 28, 2012
Data Sources: Borough of Kinnelon, NJGS Aquifers of New Jersey 1998, Morris County Office of GIS Services, NJDEP
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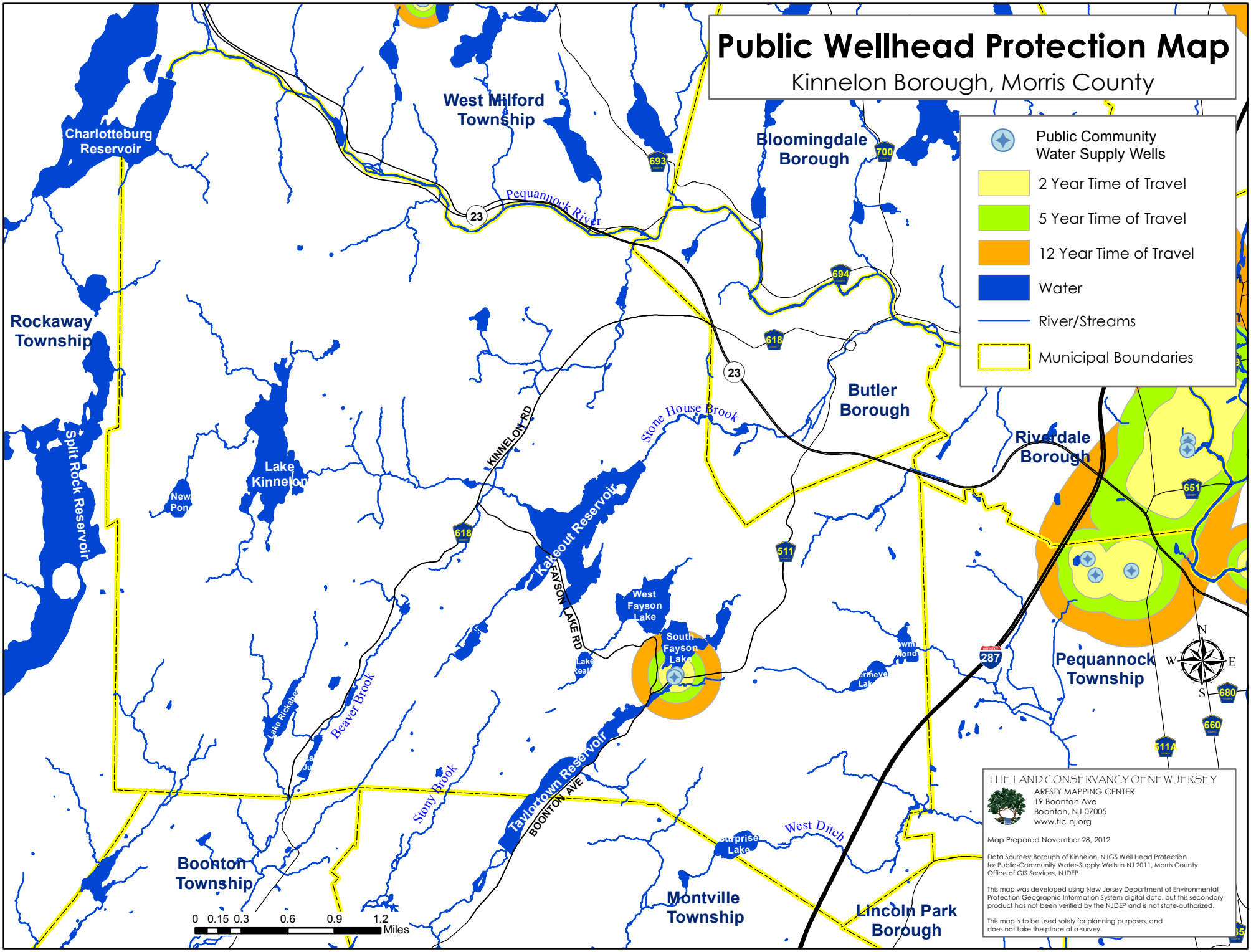
Public Wellhead Protection Map
Kinnelon Borough, Morris County
Public Community Water Supply Wells
2 Year Time of Travel
5 Year Time of Travel
12 Year Time of Travel
Water
River/Streams
Municipal Boundaries
Charlotteburg Reservoir
West Milford Township
Bloomingdale Borough
Pequannock River
Rockaway Township
Split Rock Reservoir
Lake Kinnelon
KINNELON RD
Stone House Brook
Butler Borough
Riverdale Borough
Kakeout Reservoir
FAYSON LAKE RD
West Fayson Lake
South Fayson Lake
Pequannock Township
Beaver Brook
Stony Brook
Taylortown Reservoir
BOONTON AVE
West Ditch
Boonton Township
Montville Township
Lincoln Park Borough
0 0.15 0.3 0.6 0.9 1.2 Miles
THE LAND CONSERVANCY OF NEW JERSEY
ARESTY MAPPING CENTER
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Map Prepared November 28, 2012
Data Sources: Borough of Kinnelon, NJGS Well Head Protection for Public-Community Water-Supply Wells in NJ 2011, Morris County Office of GIS Services, NJDEP
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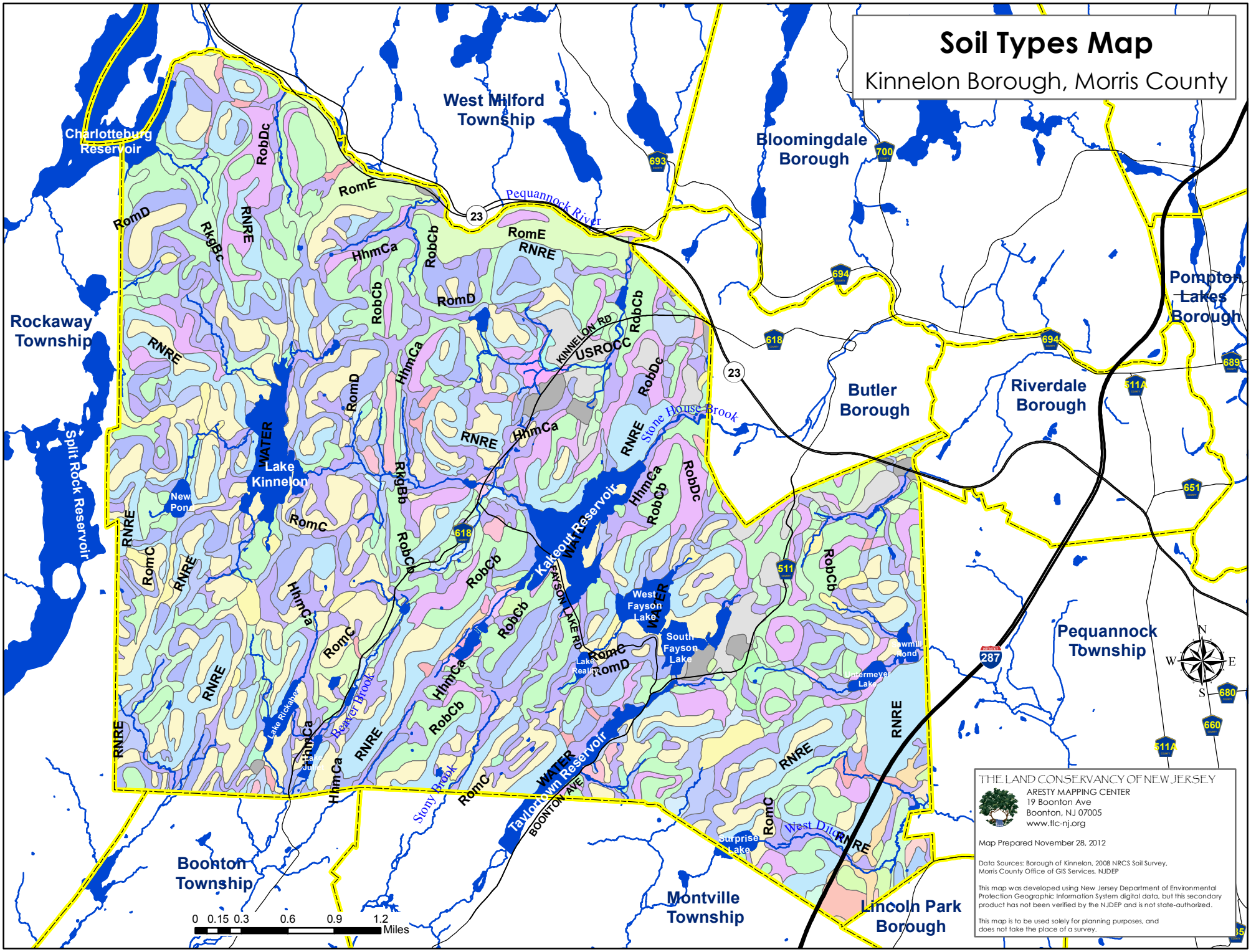
Soil Types Map
Kinnelon Borough, Morris County
West Milford Township
Bloomingdale Borough
Pompton Lakes Borough
Rockaway Township
Butler Borough
Riverdale Borough
Pequannock Township
Boonton Township
Montville Township
Lincoln Park Borough
Charlottetburg Reservoir
Split Rock Reservoir
Lake Kinnelon
Kakeout Reservoir
Taylortown Reservoir
West Fayson Lake
South Fayson Lake
Surprise Lake
Pequannock River
Stone House Brook
Beaver Brook
Stony Brook
West Ditch
KINNELON RD
FAYSON LAKE RD
BOONTON AVE
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WATER
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19 Boonton Ave
Boonton, NJ 07005
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Map Prepared November 28, 2012
Data Sources: Borough of Kinnelon, 2008 NRCS Soil Survey, Morris County Office of GIS Services, NJDEP
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Soil Types Map--Legends

Kinnelon Borough, Morris County

- AdrAt--Adrian muck, 0 to 3 percent slopes, frequently flooded
- BhdAt--Biddeford silt loam, 0 to 2 percent slopes, frequently flooded
- BohB--Boonton moderately well drained gravelly loam, 3 to 8 percent slopes
- BohC--Boonton moderately well drained gravelly loam, 8 to 15 percent slopes
- CarAt--Carlisle muck, 0 to 2 percent slopes, frequently flooded
- FNAT--Fluvaquents and udifluvents, 0 to 3 percent slopes, frequently flooded
- FmhAt--Fluvaquents, loamy, 0 to 3 percent slopes, frequently flooded
- HhmCa--Hibernia loam, 3 to 15 percent slopes, stony
- HhmDb--Hibernia loam, 15 to 25 percent slopes, very stony
- NerB--Netcong gravelly sandy loam, 3 to 8 percent slopes
- NerC--Netcong gravelly sandy loam, 8 to 15 percent slopes
- OtsC--Otisville gravelly loamy sand, 3 to 15 percent slopes
- OtsD--Otisville gravelly loamy sand, 15 to 25 percent slopes
- PHG--Pits, sand and gravel
- PauCc--Parker-Gladstone complex, 0 to 15 percent slopes, extremely stony
- PbphAt--Parsippany silt loam, sandy loam substratum, 0 to 3 percent slopes, frequently flooded
- PohA--Pompton sandy loam, 0 to 3 percent slopes
- PohB--Pompton sandy loam, 3 to 8 percent slopes
- PrkAt--Preakness sandy loam, 0 to 3 percent slopes, frequently flooded
- PrsdAt--Preakness dark surface variant sandy loam, 0 to 3 percent slopes, frequently flooded
- RNRE--Rock outcrop-Rockaway complex, 15 to 35 percent slopes
- RkgBb--Ridgebury loam, 0 to 8 percent slopes, very stony
- RkgBc--Ridgebury loam, 0 to 8 percent slopes, extremely stony
- RksB--Riverhead gravelly sandy loam, 3 to 8 percent slopes
- RksC--Riverhead gravelly sandy loam, 8 to 15 percent slopes
- RobCb--Rockaway sandy loam, 8 to 15 percent slopes, very stony
- RobDc--Rockaway sandy loam, 15 to 25 percent slopes, extremely stony
- RocB--Rockaway gravelly sandy loam, 3 to 8 percent slopes
- RocC--Rockaway gravelly sandy loam, 8 to 15 percent slopes
- RomC--Rockaway-Rock outcrop complex, 8 to 15 percent slopes
- RomD--Rockaway-Rock outcrop complex, 15 to 25 percent slopes
- RomE--Rockaway-Rock outcrop complex, 25 to 45 percent slopes
- UR--Urban land
- USRHVB--Urban land-Riverhead complex, 3 to 8 percent slopes
- USROCC--Urban land-Rockaway complex, 3 to 15 percent slopes
- WATER--Water
- WhvAb--Whitman loam, 0 to 3 percent slopes, very stony

THE LAND CONSERVANCY OF NEW JERSEY
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19 Boonton Ave
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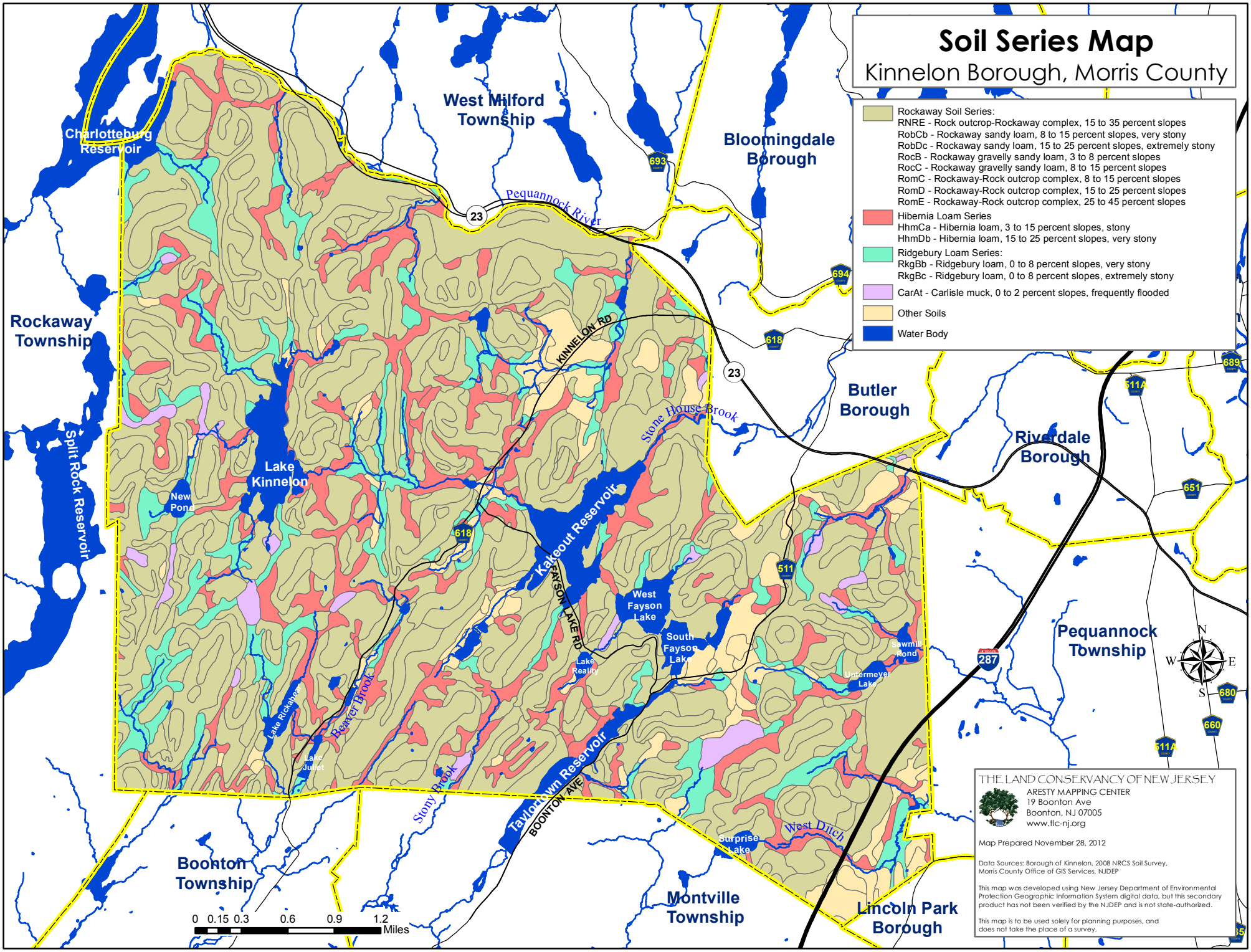
Map Prepared September 25, 2012

Data Sources: Borough of Kinnelon, 2008 NRCS Soil Survey,
Morris County Office of GIS Services, NJDEP


Soil Series Map
Kinnelon Borough, Morris County
Rockaway Soil Series:
RNRE - Rock outcrop-Rockaway complex, 15 to 35 percent slopes
RobCb - Rockaway sandy loam, 8 to 15 percent slopes, very stony
RobDc - Rockaway sandy loam, 15 to 25 percent slopes, extremely stony
RocB - Rockaway gravelly sandy loam, 3 to 8 percent slopes
RocC - Rockaway gravelly sandy loam, 8 to 15 percent slopes
RomC - Rockaway-Rock outcrop complex, 8 to 15 percent slopes
RomD - Rockaway-Rock outcrop complex, 15 to 25 percent slopes
RomE - Rockaway-Rock outcrop complex, 25 to 45 percent slopes
Hibernia Loam Series
HhmCa - Hibernia loam, 3 to 15 percent slopes, stony
HhmDb - Hibernia loam, 15 to 25 percent slopes, very stony
Ridgebury Loam Series:
RkgBb - Ridgebury loam, 0 to 8 percent slopes, very stony
RkgBc - Ridgebury loam, 0 to 8 percent slopes, extremely stony
CarAt - Carlisle muck, 0 to 2 percent slopes, frequently flooded
Other Soils
Water Body
West Milford Township
Bloomingdale Borough
Charlotteburg Reservoir
Pequannock River
Rockaway Township
Split Rock Reservoir
Lake Kinnelon
New Pond
KINNELON RD
Stone House Brook
Butler Borough
Riverdale Borough
Kakeout Reservoir
FAYSON LAKE RD
West Fayson Lake
South Fayson Lake
Lake Reality
Sawmill Pond
Untermeyer Lake
Pequannock Township
Lake Rickeybee
Lake Juliet
Beaver Brook
Stony Brook
Taylortown Reservoir
BOONTON AVE
West Ditch
Surprise Lake
Boonton Township
Montville Township
Lincoln Park Borough
0 0.15 0.3 0.6 0.9 1.2 Miles
N
W
E
S
THE LAND CONSERVANCY OF NEW JERSEY
ARESTY MAPPING CENTER
19 Boonton Ave
Boonton, NJ 07005
www.tlc-nj.org
Map Prepared November 28, 2012
Data Sources: Borough of Kinnelon, 2008 NRCS Soil Survey, Morris County Office of GIS Services, NJDEP
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 the NJDEP and is not state-authorized.
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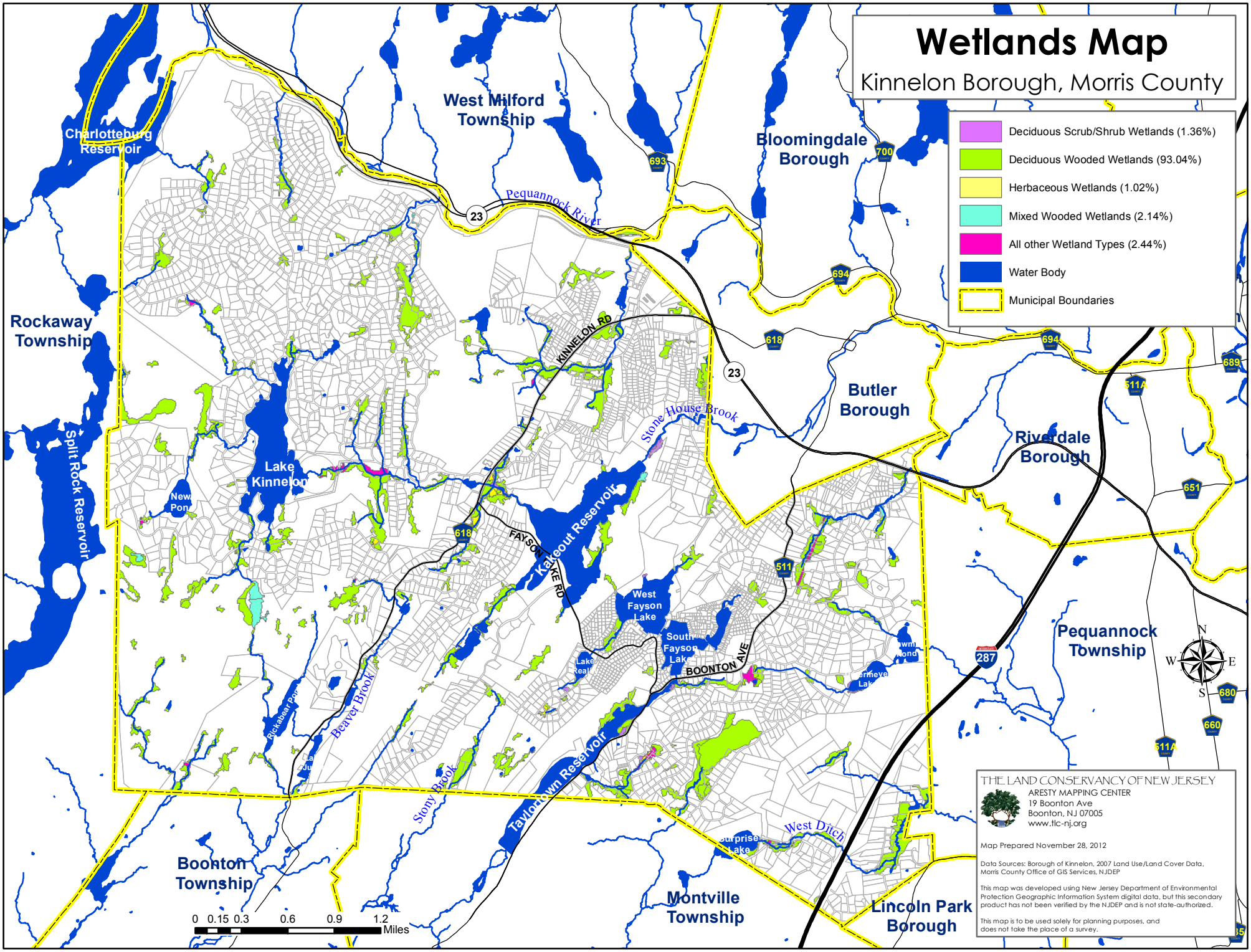
Wetlands Map
Kinnelon Borough, Morris County
Deciduous Scrub/Shrub Wetlands (1.36%)
Deciduous Wooded Wetlands (93.04%)
Herbaceous Wetlands (1.02%)
Mixed Wooded Wetlands (2.14%)
All other Wetland Types (2.44%)
Water Body
Municipal Boundaries
West Milford Township
Bloomingdale Borough
Charlotteburg Reservoir
Pequannock River
Rockaway Township
Split Rock Reservoir
Lake Kinnelon
KINNELON RD
Stone House Brook
Butler Borough
Riverdale Borough
Kakeout Reservoir
FAYSON LAKE RD
West Fayson Lake
South Fayson Lake
BOONTON AVE
Pequannock Township
Beaver Brook
Stony Brook
Taylortown Reservoir
West Ditch
Boonton Township
Montville Township
Lincoln Park Borough
0 0.15 0.3 0.6 0.9 1.2 Miles
N
S
E
W
THE LAND CONSERVANCY OF NEW JERSEY
ARESTY MAPPING CENTER
19 Boonton Ave
Boonton, NJ 07005
www.tlc-nj.org
Map Prepared November 28, 2012
Data Sources: Borough of Kinnelon, 2007 Land Use/Land Cover Data, Morris County Office of GIS Services, NJDEP
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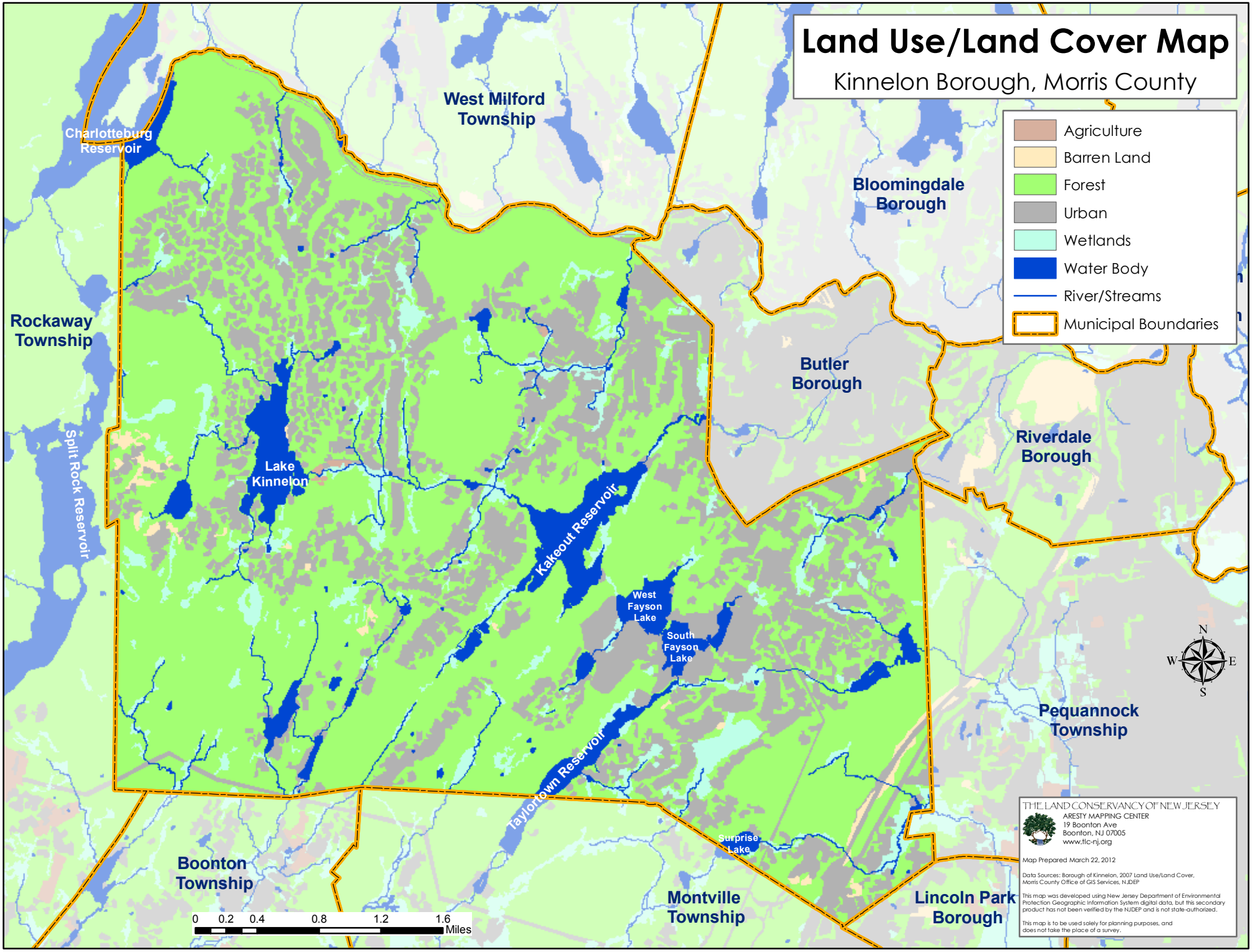
Land Use/Land Cover Map
Kinnelon Borough, Morris County
Agriculture
Barren Land
Forest
Urban
Wetlands
Water Body
River/Streams
Municipal Boundaries
West Milford Township
Charlotteburg Reservoir
Bloomingdale Borough
Rockaway Township
Butler Borough
Riverdale Borough
Split Rock Reservoir
Lake Kinnelon
Kakeout Reservoir
West Fayson Lake
South Fayson Lake
Pequannock Township
Taylortown Reservoir
Surprise Lake
Boonton Township
Montville Township
Lincoln Park Borough
N
W
E
S
0 0.2 0.4 0.8 1.2 1.6 Miles
THE LAND CONSERVANCY OF NEW JERSEY
ARESTY MAPPING CENTER
19 Boonton Ave
Boonton, NJ 07005
www.tlc-nj.org
Map Prepared March 22, 2012
Data Sources: Borough of Kinnelon, 2007 Land Use/Land Cover, Morris County Office of GIS Services, NJDEP
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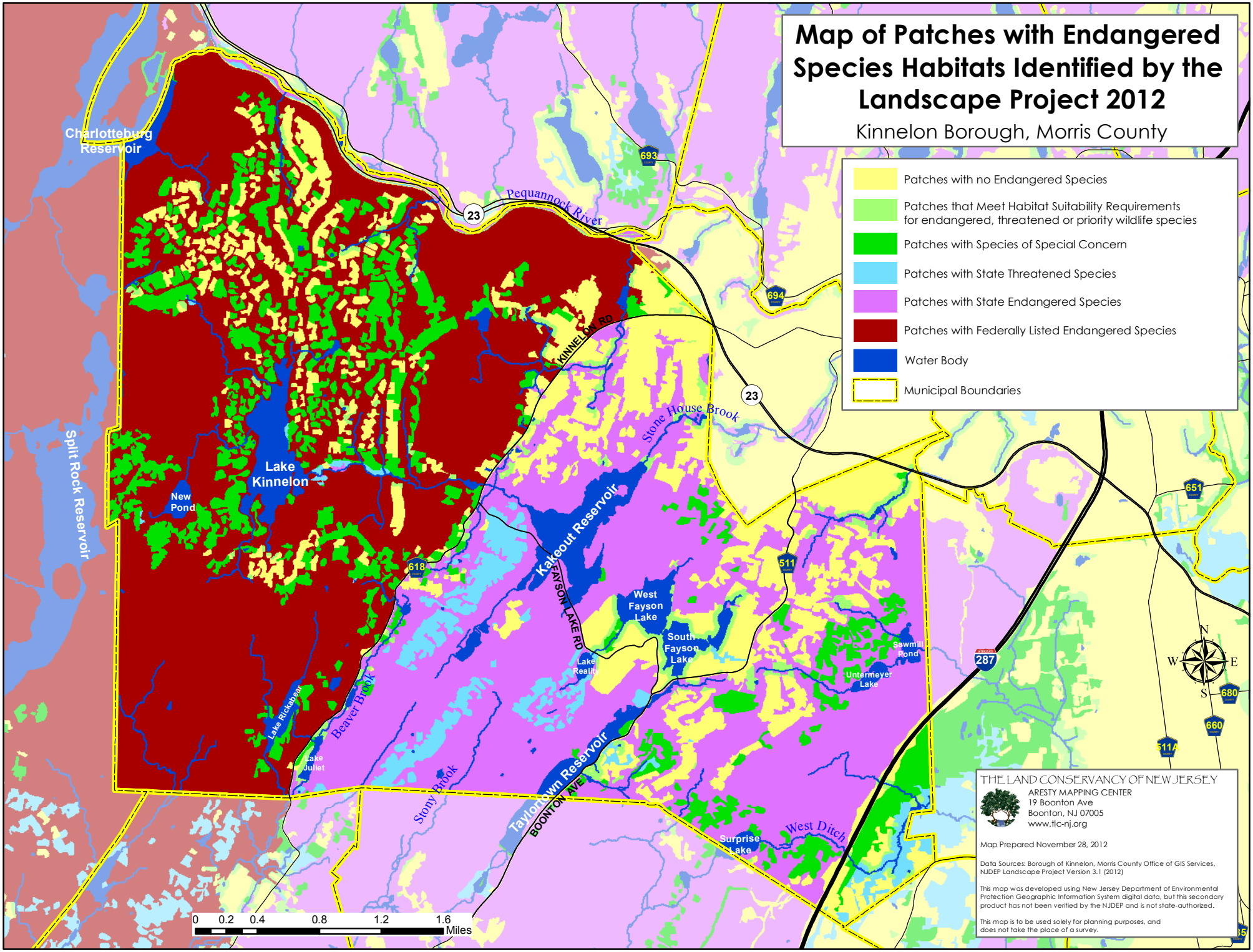
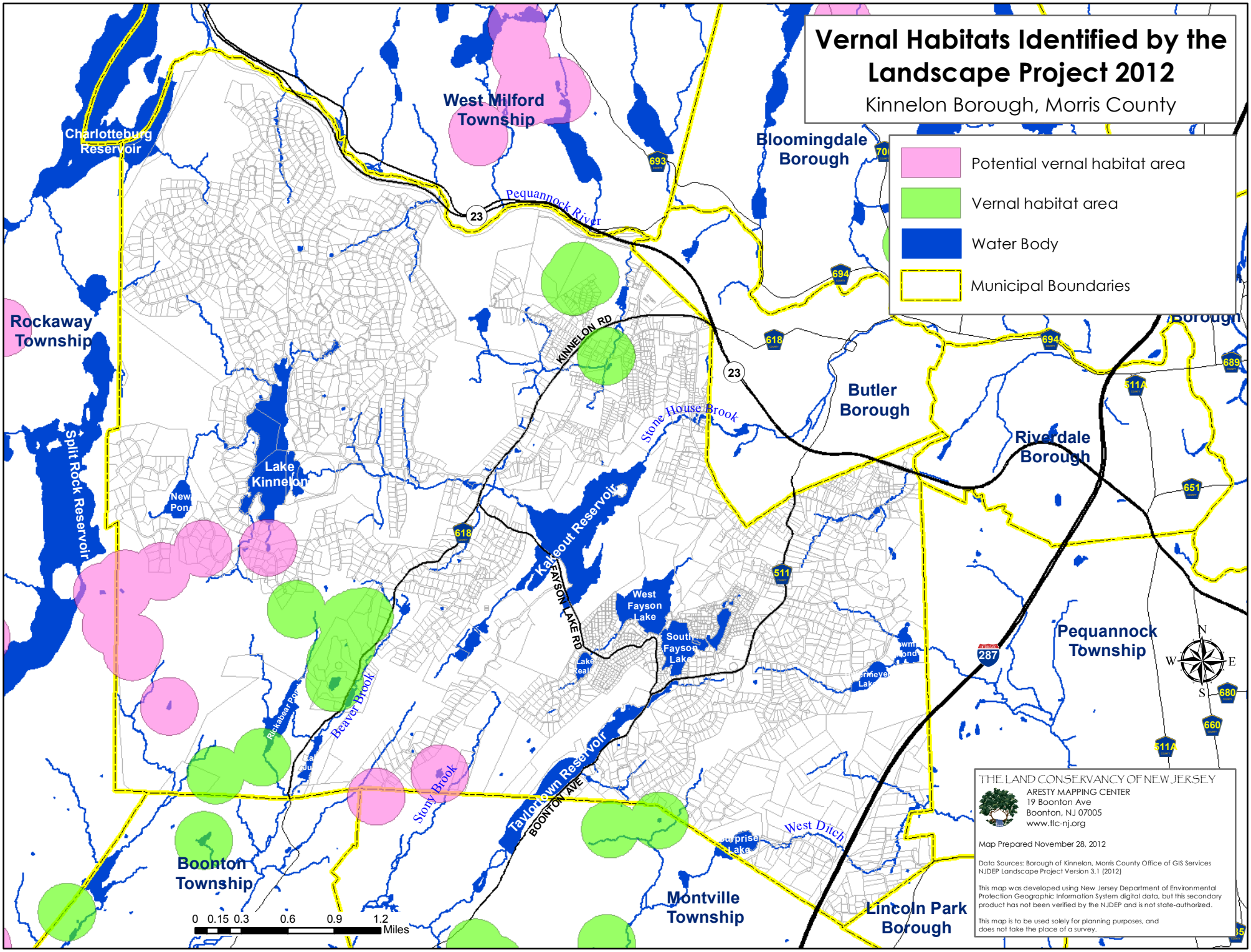
Map 15. Patches with Endangered Species Habitats Identified by the Landscape Project 2012




Vernal Habitats Identified by the Landscape Project 2012
Kinnelon Borough, Morris County
Potential vernal habitat area
Vernal habitat area
Water Body
Municipal Boundaries
West Milford Township
Charlotteburg Reservoir
Bloomingdale Borough
Pequannock River
Rockaway Township
KINNELON RD
Butler Borough
Stone House Brook
Riverdale Borough
Split Rock Reservoir
Lake Kinnelon
Kakeout Reservoir
FAYSON LAKE RD
West Fayson Lake
Pequannock Township
Beaver Brook
Stony Brook
Taylortown Reservoir
BOONTON AVE
West Ditch
Boonton Township
Montville Township
Lincoln Park Borough
0 0.15 0.3 0.6 0.9 1.2 Miles
THE LAND CONSERVANCY OF NEW JERSEY
ARESTY MAPPING CENTER
19 Boonton Ave
Boonton, NJ 07005
www.tlc-nj.org
Map Prepared November 28, 2012
Data Sources: Borough of Kinnelon, Morris County Office of GIS Services
NJDEP Landscape Project Version 3.1 (2012)
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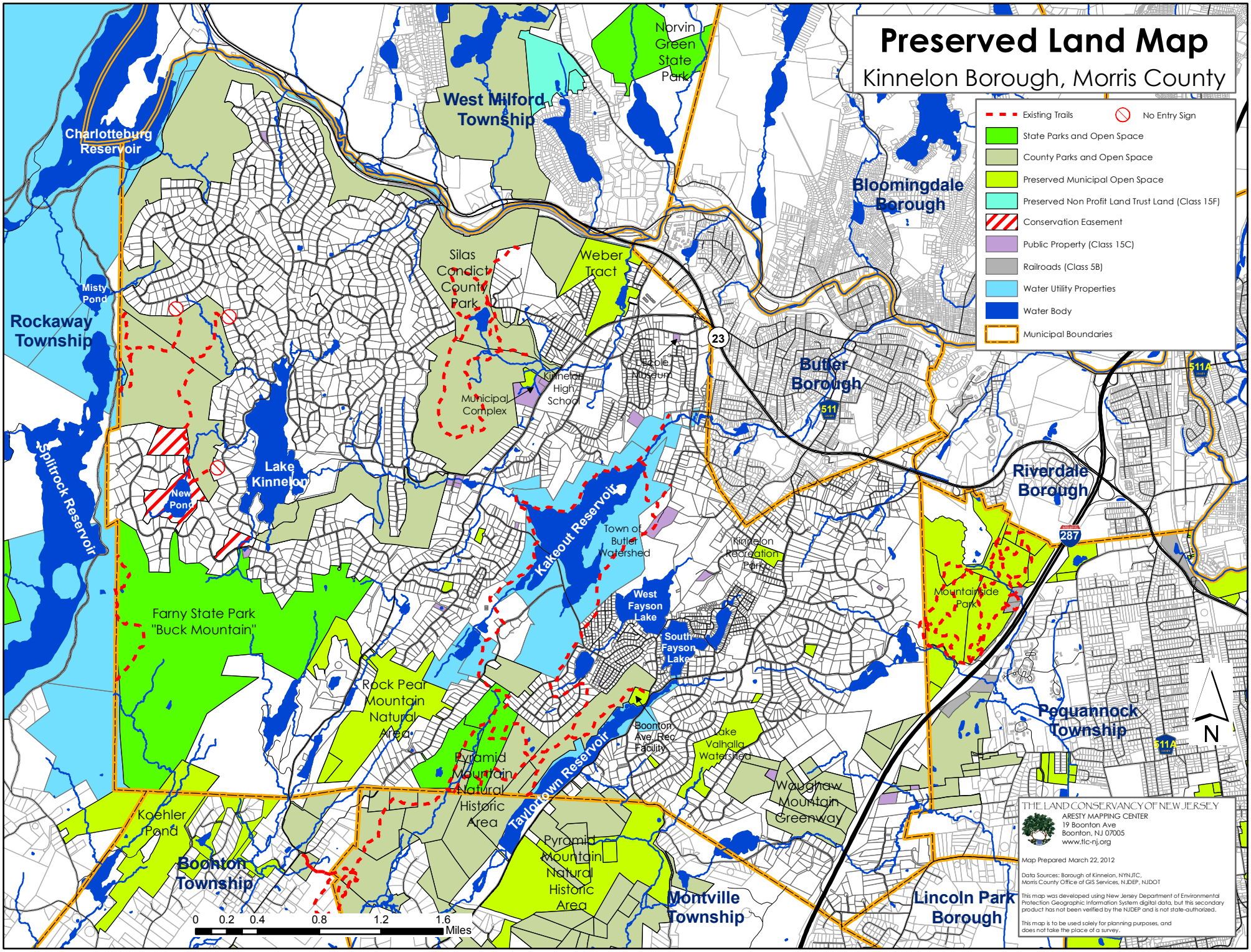
Preserved Land Map
Kinnelon Borough, Morris County
Existing Trails
No Entry Sign
State Parks and Open Space
County Parks and Open Space
Preserved Municipal Open Space
Preserved Non Profit Land Trust Land (Class 15F)
Conservation Easement
Public Property (Class 15C)
Railroads (Class 5B)
Water Utility Properties
Water Body
Municipal Boundaries
Norvin Green State Park
West Milford Township
Charlotteburg Reservoir
Bloomingdale Borough
Silas Condict County Park
Weber Tract
Misty Pond
Rockaway Township
Kinnelon High School
Public Museum
Municipal Complex
Butler Borough
Splitrock Reservoir
Lake Kinnelon
New Pond
Kakeout Reservoir
Town of Butler Watershed
Riverdale Borough
Kinnelon Recreation Park
Mountainside Park
West Fayson Lake
South Fayson Lake
Farny State Park "Buck Mountain"
Rock Pear Mountain Natural Area
Pyramid Mountain Natural Historic Area
Boonton Ave. Rec Facility
Lake Valhalla Watershed
Taylortown Reservoir
Waughaw Mountain Greenway
Pequannock Township
Koehler Pond
Boonton Township
Pyramid Mountain Natural Historic Area
Montville Township
Lincoln Park Borough
0 0.2 0.4 0.8 1.2 1.6 Miles
N
THE LAND CONSERVANCY OF NEW JERSEY
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Map Prepared March 22, 2012
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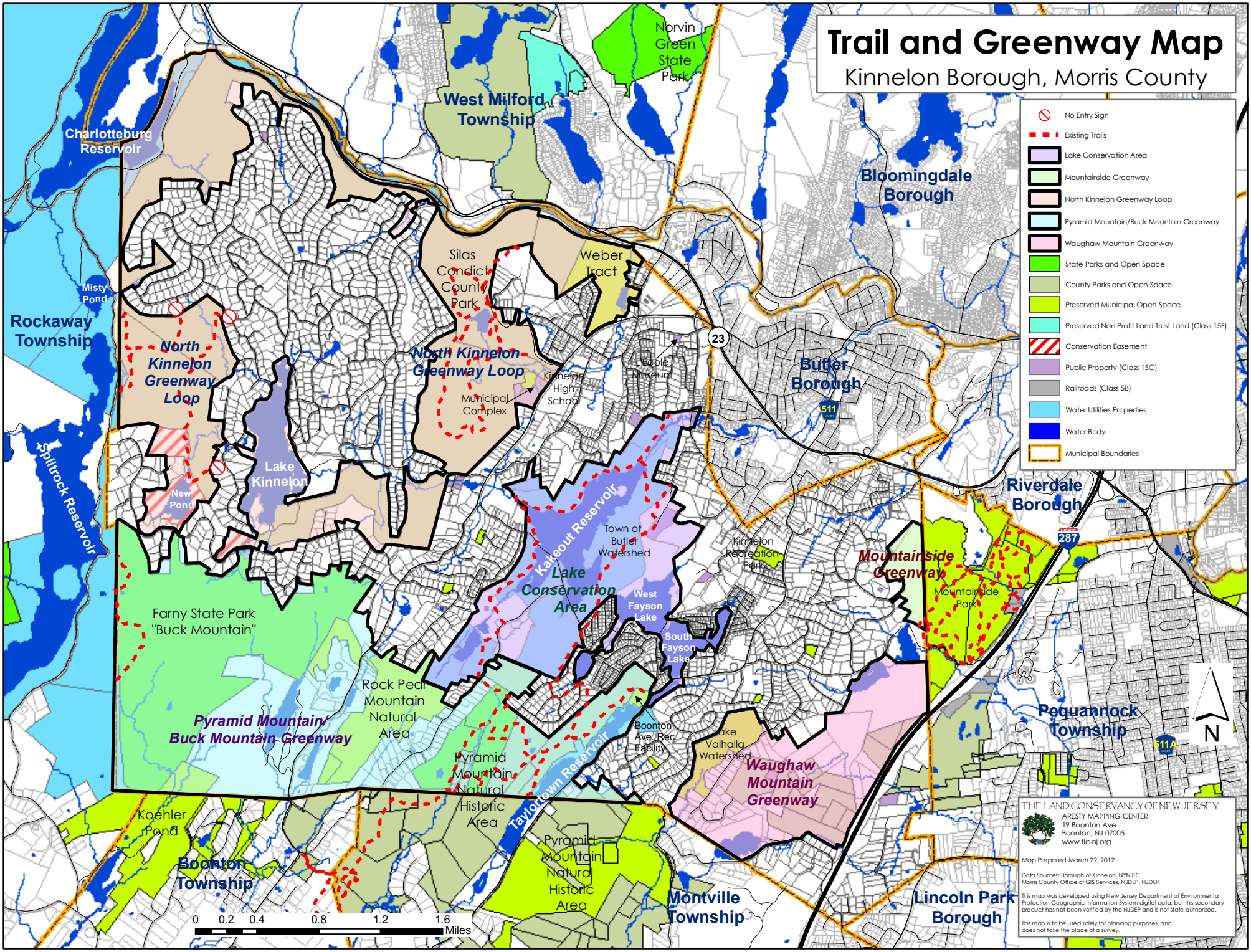
Trail and Greenway Map
Kinnelon Borough, Morris County
No Entry Sign
Existing Trails
Lake Conservation Area
Mountainside Greenway
North Kinnelon Greenway Loop
Pyramid Mountain/Buck Mountain Greenway
Waughaw Mountain Greenway
State Parks and Open Space
County Parks and Open Space
Preserved Municipal Open Space
Preserved Non Profit Land Trust Land (Class 15F)
Conservation Easement
Public Property (Class 15C)
Railroads (Class 5B)
Water Utilities Properties
Water Body
Municipal Boundaries
Charlotteburg Reservoir
West Milford Township
Norvin Green State Park
Bloomingdale Borough
Misty Pond
Rockaway Township
Silas Condict County Park
Weber Tract
North Kinnelon Greenway Loop
Municipal Complex
Kinnelon High School
Apple Museum
Butler Borough
North Kinnelon Greenway Loop
Lake Kinnelon
New Pond
Splitrock Reservoir
Kakeout Reservoir
Town of Butler Watershed
Lake Conservation Area
West Fayson Lake
South Fayson Lake
Kinnelon Recreation Park
Riverdale Borough
Mountainside Greenway
Mountainside Park
Farny State Park "Buck Mountain"
Rock Pea Mountain Natural Area
Pyramid Mountain/ Buck Mountain Greenway
Pyramid Mountain Natural Historic Area
Taylortown Reservoir
Boonton Ave. Rec. Facility
Lake Valhalla Watershed
Waughaw Mountain Greenway
Pequannock Township
Koehler Pond
Boonton Township
Pyramid Mountain Natural Historic Area
Montville Township
Lincoln Park Borough
0 0.2 0.4 0.8 1.2 1.6 Miles
N
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APPENDICES

A. Sustainable Land Use Pledge and Certification for the Borough of Kinnelon (March 21, 2013)

B. Section I – Vegetation: Subsection II. Inventory of Flora Found Growing in Kinnelon (Natural Resource Inventory of Kinnelon, N.J. 1973-1974, pages I-23 – I-36)

C. Section J – Wildlife: Subsection I. Inventory of Flora Found Growing in Kinnelon (Natural Resource Inventory of Kinnelon, N.J. 1973-1974, pages J-1 – J-10)

D. Local Observations on Flora and Fauna in the Borough of Kinnelon – prepared January-February 2013 by Carol Vreeland and Mary Derstine, Borough of Kinnelon

Borough of Kinnelon
Resolution # 3.05.13

Sustainable Land Use Pledge

WHEREAS, land-use is an essential component of overall sustainability for a municipality;

WHEREAS, poor land-use decisions can lead to increased greenhouse gas emissions, loss of open space and the degradation of natural resources;

WHEREAS, well planned land-use can create transportation choices, preserve open space and allow for continued use of vital natural resources;

WHEREAS, Given New Jersey's strong tradition of home rule and local authority over planning and zoning, achieving a statewide sustainable and-use pattern will require municipalities to take the lead;

NOW THEREFORE BE IT RESOLVED, by the Mayor and Council of the Borough of Kinnelon, the following steps shall be taken with regard to our municipal land-use decisions with the intent of making Kinnelon a truly sustainable community:

Facilities Siting
We pledge, to the extent feasible, to take into consideration factors such as walkability, bikability, access to transit and proximity to other uses when siting new or relocated municipal facilities. The actions of a municipality when locating their own facilities can set a positive precedent and encourage other public and private sector entities to consider sustainable land use considerations into account when locating their own facilities.

Natural Resource Preservation
We pledge to promote the conservation of open space and historic sites, and to create recreational opportunities within our municipality. If feasible, we pledge to complete a Natural Resources Inventory to identify and assess the extent of our natural resources and to link natural resource management and protection to carrying capacity analysis and land use planning and zoning.

Transportation Choices
We pledge to create transportation choices within our municipality by considering all modes of transportation and encouraging the location and design of transportation routes that will provide the free flow of traffic while discouraging routes which will result in congestion, blight and unsafe conditions. Given that emissions from transportation, mainly passenger cars, make up the largest share of the state's carbon footprint, creating transportation alternatives at the local level is critical to reducing the state's overall carbon footprint.

Regional Cooperation
We pledge to ensure development within the Borough that does not conflict with development and general welfare of neighboring municipalities, Bergen County and the state as a whole.

Mix of Land Uses

We pledge to promote the establishment of appropriate densities and concentrations that will contribute to the well being of persons, neighborhoods, communities and regions and preservation of the environment. We pledge to provide sufficient space in appropriate locations for a variety of uses and open space, both public and private, in a manner compatible with the character of the borough and the environment.

Dated: March 21, 2013

Robert W. Collins, Mayor

RESOLUTION 3.04.13

SUSTAINABLE JERSEY MUNICIPAL CERTIFICATION PROGRAM

WHEREAS, the Mayor and Council of the Borough of Kinnelon is seeking to become certified under the "Sustainable Jersey Municipal Certification Program" (hereinafter, "SJMCP"); and

WHEREAS, SJMCP is a partnership between the New Jersey League of Municipalities' Mayors' Committee for a green future, the New Jersey Sustainable State Institute at Rutgers University, the Municipal Land Use Center at the College of New Jersey, the New Jersey Department of Environmental Protection, the Rutgers Center for Green Building, the New Jersey Board of Public utilities and a coalition of New Jersey non-profits, State Agencies, and various experts in the field; and

WHEREAS, SJMCP is organized for the purposes of supporting a stable, sustainable future and a model of government which benefits residents by exploring and adopting sustainable, economically-sound, local government practices; and

WHEREAS, SJMCP requires that the Kinnelon Mayor and Council adopt a Sustainable Land Use Pledge Resolution; and

WHEREAS, the Mayor and Council of the Borough of Kinnelon has prepared a Sustainable Land Use Pledge that it believes is in the best interest of the residents of the Borough of Kinnelon and has come to a consensus on the form and content of such a Pledge; and

NOW, THEREFORE BE IT RESOLVED, by the Mayor and Council of the Borough of Kinnelon that it does hereby adopt a Sustainable Land Use Pledge Resolution in the form attached hereto.

Dated: March 21, 2013

Robert W. Collins, Mayor

II. INVENTORY OF FLORA FOUND GROWING IN KINNELON

Trees and Shrubs:

*Azalea, swamp	Rhododendron viscosum
Arrowood	Vibunnum dentatum
Ash, White	Fraxinus americana
Aspen, Quaking	Populus tremuloides
Basswood, American (Linden)	Titia americana
Beech, American	Fagus grandifolia
Adler, smooth	Alnus serrulata
Birch, Black (Sweet Birch)	Betual lenta
Birch, Gray	Betula Populifolia
Birch, River (Red)	Betula nigra
Birch, Yellow	Betula lutea
Brambles (Blackberries, etc.)	Rubus
Blackhaw	Viburnun prunifolium
Butternut (White Walnut)	Juglans cinerea
Blueberry - various types	Vaccinium
Buttonbush	Cephalanthus occidentalis
Cedar, Eastern Red	Juniperus virginiana
Cherry, Black	Prunus serotina
Cherry, Choke	Prunus virginiana
Chestnut, American	Castanea dentata
Chokeberry, Black	Pyrus melanocarpa
Chockecherry, Common	Prunus virginiana
Cinquefoil, shrubbery	Pontentilla fruiticasa
Cottonwood, common	Populus deltoides
Dogwood, Silky	Cornus amomum

*These are on New Jersey State Protected List

*Dogwood, Flowering	Cornus florida
Dogwood, Red-Ozier	Cornus stolonifera
Elderberry, Common	Sambucus canadensis
Elm, American	Ulmus americana
Elm, Slippery	Ulmus rubra
Grapes, Fox (& other)	Vitis labrusca
Greenbrier, common	Similax rotundifolia
Hazelnut, American	Corylus americana
Hemlock, Eastern	Tsauga canadensis
Hickory, Pignut	Carya glabra
Hickory, Shagbark	Carya ovuta
Honeysuckle, Swamp	Rhododendron viscosum
Hophornbeam, Eastern	Ostrya virginiana
Ironwood	Carpinus caroliniana
Juneberry, roundleaf	Amelanchier sanguinea
*Laurel, Mountain	Kalmia latifolia
Locust, Black	Robinia pseudo-acacia
Maple, Red	Acer, Rubrun
Maple, Sugar	Acer, Saccharum
Maple, Silver	Acer, Saccharinum
New Jersey Tea	Geanothus americanus
Oak, Black	Quercus velutina
Oak, Chestnut	Quercus prinus
Oak, Red (Northern)	Quercus boraelis
Oak, Pin	Quercus palustris
Oak Scarlet	Quercus coccinea

Oak, Scrub	Quercus ilicifolia
Oak, Swamp White	Quercus bicolor
Pepperbush, coast	Clenthra alnifolia
Pepperidge (Tupelo, Black Gum)	Nyssa salvatica
Pinxter Flower Pink Azalea	Rhododendrum nudiflorum
Pine, Eastern White	Pinus strobus
Poison Ivy	Rhus radicans
Sassafras	Sassafras albidum
Shadbush (Serviceberry, Juneberry)	Amelanchier canadensis
Spice Bush	Lindera benzoin
Spruce, Norway	Picea abies - not native but prolific
Squashberry	Viburnum edule
Sumac, Staghorn	Rhus typhina
Sumac, Smooth	Rhus glabra
Sweet Fern	Comptonia peregrina
Sycamore, American (Plane tree)	Platanus occidentalis
Tulip Tree (Yellow Poplar)	Lirodendrum tulipifera
Viburnum, Mapleleaf	Viburnum acerifolium
Virginia Creeper	Parthenocissus quinquefolia
Walnut, Black	Juglans nigra
Willow, Black	Salix nigra
Willow, Pussy	Salix discolor
*Winterberry	Ilex verticillata
Witch Hazel	Hamamelis virginiana

Wildflowers:

Alussum, Hoary	Beteroa incana
Alumroot	Heuchera americana
*Anemone, Wood	Anemone Quinquefolia
*Anemone, Rue	Anemonella Thalictroides
Aster - Numerous varieties	Aster vimineus and others
Amarath, Green	Amaranthus retroflexus
*Baneberry, White	Actaea alba
Beechdrops	Epifagus virginiana
*Bellwort, Perfoliate	Uvularia perfoliata
Bedstraws	Galium boreale and others
*Bellwort, Large Flowered	Uvularia grandiflora
Bellflower, creeping	Campanula rapunculoides
Bishop's Cap (Miterworth)	Mitella Diphylla
Beggar Ticks	Bidens frondosa and others
*Bittersweet	Celastrus scandens
Black-eyed Susan	Rudbeckia hirta
Bladder Campion	Silene cucubalus
Bur-reed	Sparganium
Blue Cohosh	Caulophyllum thalictroides
Blue-eyed Grass	Sisykinghium graminoides
Blue Flag	Iris Versicolor
Boneset	Eupatorium perfoliatum
Bouncing Bet (Soapwort)	Saponaria officinalis
*Bunchberry	Cornus canadensis
Burdock, great	Arctium lappa
Buttercup, creeping	Ranunculus repens (and other buttercups)

*On the State Conservation List

Butter and Eggs (Toadflax)	Linoria vulgaris
*Butterfly Weed	Asclepias tuberosa
Canada Mayflower (Wild Lily of the Valley)	Maionthemom canadense
Clover, hop	Trifolium agrarium
Clover, white sweet	Malitotus alba and others
Clover, round-headed bush	Lepedeza capitata
*Cardinal Flower	Lobelia cardinalis
Cattail, common	Typha latifolia
Celandine	Chelidonium majus
Chicory	Chichorium intybus
Coltsfood	Tussilago farfara
*Columbine	Aquilegia canadensis
Cheeses, common mallow	Mulva neglecta
Cinquefoil (many varieties)	Pontentilla arguta
*Corydalis	Corydalis flavula
Cinquefoils, common	Pontetilla, simplex and others
Creeping bellflower	Campanula rapunculoides
Cow-wheat	Melampyrum lineare
Daisy, Oxeye	Chrysantheumum Leucanthemum (and others)
Dandelion, common	Taraxacum officinale
Dame's Rocket	Hesperis matronalis
Dayflower (spiderwort)	Commelina virginica
Dayflower, Asiatic	Commelina communis
Detford, pink	Dianthus armenia
Dittany	Cunila origanoides
Dogbane, spreading	Apocynum androsaemifolium

*Dutchman's Breeches	Dicenyra cucullaria
Dock curled	Rumex crispus
Evening Primrose	Oenothera biennis
False Solomon's Seal	Smilacina racemosa
False Foxglove	Gerardia laevigata
Firepink	Silene virginica
Flag, Blue	Iris versicolor
Forget-me-not, true	Myosotis scorpiodes & laxa
Fleabane	Erigeron philadephicus
Gall-of-the-Earth	Prenanthes serpentaria
Garlic Mustard	Alliaria officinalis
Garlic, field	Allium vineale
*Gentian, Closed (Bottle)	Gentiana andrewsii
Germander, Wood Sage	Teucrium canadense
*Gentian, Fringed	Gentiana crinita
Ginger, wild	Asarum canadense
*Geranium, Wild	Geranium maculatum
Gerardia, Purple	Gerardia purpurea
Ginseng, Dwarf	Panax trifolium
Goat's-Beard	Tragopogon pratensis
Goldenrod, Canadian	Solidago canadense (& others)
Glasswort	Salicornia
Goldthread	Coptis groenlandica
Greenbrier, Catbrier	Smilax rotundifolia
Groundnut	Apios americana
Harebell, North Carolina	Campanula Divaricata
Hawkweed, orange	Hieracium avrantiacum

Hawkweed	Hieracium Cronovii (& others)
*Hepatica, round leaf	Hepatica acutiloba
Hyssop, Skullcap	Scutellaria integrifolia
Horsebalm	Collinsonia canadensis
Horsewood	Erigeron canadensis
Indian Cucumber Root	Medeola virginiana
*Indian Pipe	Monotropa uniflora
Indian Poke (False Hellebore)	Veratrum viride
Indian Tobacco	Lobelia inflata
Iris, Crested	Iris cristata
Ironweed	Veronia noveboracensis
*Jack-in-the-Pulpit	Arisaema triphyllum
Joe-Pye-Weed	Eupatorium Aubium
Knapweed, Black	Centaurea Nigra
Knotweeds	Polygonum (many varieties)
Lamb's Quarters, Pigweed	Chenopodium album
Ladyslippers -	
*Moccasin Flower, Pink Ladyslipper	Cypripedium acaule
*Showy Ladyslipper	Cypripedium reginae
*Showy Orchis	Orchis spectabilis
*Ladies Tresses	Spiranthes
Lettuce, white and tall	Prenanthesalba (& others)
Lettuce, wild	Lactucca canadense
Lettuce, prickly	Lactuga scariola
*Lily, Canada	Lillium canadense
Lily, Day	Hemerocallis, fulva
*Lily, Wood	Lilium philadelphicum

Lobelia, Blue	Lobelia siphilitica
Loosestrife, Whorled	Lysimachia Quadrifolia
Loosestrife, Purple	Lysimachia salicaria
Loosestrife, Yellow (Swamp)	Lysimachia terrestris
*Marsh Marigold (Cowslip)	Caltha palustris
Mayweed	Anthemia cotula
Milkweed, Common	Asclepias syriaca
Milkweed, Poke	Asclepias exaltata
Moth Mullein	Verbascum blattaria
Miterwort	Mitella diphylla
Mugwort	Antemisia vulgaris
Mountain Mints	Pycnanthemum
Mullein, common	Verbasum thapsus
Milkweed, Four-leaved	Asclepias quadrifolia
Mustards	Brassica Nigra, hirta, rapa & others
Milkwort	Polygala verticittata
Nettle, Stinging	Urtica dioica
Nightshade, Common	Solanum nigrum
Pokeweed	Phytolocca decandra
Nightshade, Bittersweet	Solanum dulcamara
Orpine (Live Forever)	Sedum telephium
Parsnip, Wild	Pastinaca sativa
*Partridgeberry	Mitchella repens
Partridge - Pea	Cassia fasciculata
Pearly Everlasting	Anaphalis margaritacea
Peppergrass, roadside	Lepidium ruderate

Purple flowered raspberry	Rubus adoratus
Pennyroyal	Hedeoma pulegioides
Peppergrass,(Poor-Man's Pepper)	Lepidium virginicum
Pickerelweed	Pontederia cordata
*Pipsissewa Striped (Spotted Wintergreen)	Chimaphila maculata
Prince's feather	Polygonum orientale
*Pipsissewa	Chimaphila umbellata
Plantain	Plantago major
Pokeweed	Phytolacca americana
Pennycress, Field	Thlaspi arvense
*Polygala, Fringed	Polygala paucifolia
Pussytoes	Antennaria neglecta
Purslane	Portulaca oleracea
*Pyrola, Shinleaf	Pyrola elliptica
*Pyrola, round leaved	Pyrola rotunderfolia
Queen Anne's Lace (Wild Carrot)	Daucus carota
Ragweed, common and great	Ambrosia artemisii folia
Ragged Robin	Lychnis flos-cuculi
Ragwort-Golden	Senecio aureus
*Rattlesnake Plantain	Goodyera pubescens
Rattlesnake Weed	Hieracium venosum
Raspberry, purple flowered	Rubus odoratus
Rock cress, Hairy	Arobis hirsuta (& others)
Robin Plantain	Erigeron pulchellua
Rough Avens	Geum peckii
Rue, Tall Meadow	Thalicrum polygamum
Rue, Early Meadow	Thalicrum dioicum

Saint Johnswort	Hypericum perforatum
Saint Johnsworth, Canadian	Hypericum canadense
Salsify (Goatsbeard, Oysterplant)	Tragopodom porrifolius
Sarsaparilla, Wild	Analia nudicaulis
*Saxifrage, Early	Saxifraga virginiensis
Selfheal,(Heal All)	Prunella vulgaris
Sheep Sorrel	Rumey acetocella
Silver Rod	Solidago bicolor
Shepherd's Purse	Capsella bursa - pastoris
Skunk Cabbage	Symplocarpus foetidus
Snakeroot, white	Eupatorium sessilifolium
Snakeroot, black	Saniculo marilandica
Soapwort (Bouncing Bet)	Saponaria officinalis
*Solomon's Seal	Polygonatum biflorum
Spatterdock	Nuphar advena
Speedwell	Veronica officinalis (& others)
Spikenard	Aralia racemosa
*Spring Beauty	Claytonia virginica
Star of Bethlehem	Ornithogalum umbellatum
Skullcap, Mad Dog	Soutellaria lateriflora (& others)
Star Flower	Trientalis borealis
Sweet Everlasting	Gnaphalium obtusifolium
Squawroot	Conopholis americana
Star Grass	Hypoxis Hirsuta
Strawberry, Common	Fragaria virginiana
Starry Campion	Silene stellata
Steeplebush	Spirea tomentosa

Sunflower	Helianthus annuus (& others)
Sweet Cecily	Osmorhiza daytoni
Thimbleweed	Anemone virginiana
Touch-Me-Not (Jewelweed)	Impatiens capensis
*Trailing Arbutus	Epigaea repens
Tick Trefoil	Desmondium canadense (& others)
*Trout Lily (Adder's Tongue)	Erythronium americanum
*Turtlehead	Chelone glabra
Two-flowered Cynthia	Krigia biflora
Twisted Stalk	Streptopus amplexifolius
Thistle, Bull (& others)	Cirsium vulgare (& others)
Toothwort	Dentaria diphylla
Venus Looking Glass	Specularia perfoliata
Vervain	Verbena hastata
Vetch, purple	Vicia americana
*Violets	
Birdsfoot	Viola pedata
Blue Marsh	Viola cucullata
Canada Tall White	Viola canadensis
Common Blue	Viola papilionacea
Dog	Viola comspersa
Downy Yellow	Viola pubescens
Smooth Yellow	Viola pennsylvania
Northern Blue	Viola Septentrionalis
Northern Downy	Viola fimbriatula
Northern White	Viola pallens
Round-leaved	Viola rotundifolia

*Violets (cont'd.)	
Sweet White	Viola blanca
Wooly Blue	Viola sororia
Three-lobed	Viola triloba
(and others)	
Valerian	Polemonium reptans
Vetch, cow or tufted	Vicia cracca
Vipers Bugloss	Echium vulgare
*Water Lily	Nymphaea odorata
Wild Leek	Alium tricoccum
Wild Oats	Uvularia sessilifolia
Wild White Licorice	Galium circaezans
Wild Roses	Rosa multiflora (& others)
Wood Betony (Lousewort)	Pedicularia canadensis
Wood Strawberry	Fragaria vesca
White avens	Geum canadense
*Whorled Pogonia	Isutria verticillata
Wood Sorrel, common	Oxalis montana
*Wintergreen (Checkerberry)	Gaultheria procumbens
Water hemlock	Cicuta maculata
Wild Sensitive Plant	Cassia nictitans
Yarrow	Achillea millefolium

Ferns:

American Shield Fern,(Fancy Fern, Evergreen Woodfern Spinulose Wood Fern)	Dryopteris spinulosa van. intermedia
Bracken	Pteridium aquilinum van latiusculum
Brittle Fern (Fragile Fern)	Crystopteris fragilis
Broad Beechfern	Thelypteris hexagonoptera
*Christmas Fern	Polystichum acrostichoides
Cinnamon Fern	Osmunda cinnamonea
Crested Fern	Dryopteris cristata
*Ebony Spleenwort	Asplenium platyneuron
Grape Fern,(Common Cut-leaved)	Botrychium dissectum, var. obliquum
Grape Fern, Cut-leaved	Botrychium dissectum, var. typicum
Hay Scented Fern	Dennstaedtia punctilobula
Interrupted Fern	Osmunda claytoniana
Lady Fern (Upland and Rubrum)	Athyrium felix femina
*Maidenhair Fern	Adiantum pedatum
Marginal Woodfern;(Leatherleaf Woodfern; Marginal Shield Fern)	Dryopteris marginalis
New York Fern	Dryopterus noveboracensis
Oak Fern	Gymnocarpium dryopteris
Polypody,(Common Rock Cap Fern)	Polypody Vulgare
Royal Fern	Osmunda regalis
Sensitive Fern	Onoclea sensibilis
Silvery Athyrium,(Silvery Spleenwort)	Athyrium thelypteroides
Dwarf Grape Fern	Bohychuron simplex

Triangle Grape Fern	Bohychuron lanceolatum
Leathery Grape Fern	Botrychuim multifidum
Rattlesnake Grape Fern	Botrychium verginianum
Spinulose Wood Fern	Dryopteris Spinulosa
Marsh Fern	Thelypteris palustris

Clubmosses:

*Shining Clubmoss	Lycopodium lucidulum
*Running Ground Pine, Christmas Green	Lycopodium complanatum
*Flat Branch Ground Pine, Tree Clubmoss	Lycopodium obscurum
*Ground Cedar (Ground Pine)	Lycopodium Treslachyum
*Staghound Clubmoss	Lycopodium clayvatum

Note: The mosses, fungi, algae, lichens and grasses are not listed in this report.

SECTION J

WILDLIFE

I. INVENTORY OF THE FAUNA OF KINNELON

Anyone closely associated with biology or zoology knows that a person could spend his lifetime analyzing and classifying the animal life present in a drop of pond water. Also, the parasitic life forms found within each animal would itself tend to double, triple, or even quadruple the variety of animal life present.

This inventory is intended to be an open-ended survey that can be lengthened or shortened as necessary. This inventory will be a listing of animals found in Kinnelon, but not with specific location or specie identification. Some of the animals listed may well be transients. No domesticates will be listed. The phyla below are those which have representatives found in Kinnelon:

1. Chordata
2. Arthropoda
3. Annelids
4. Mollusca
5. Bryozoa
6. *Nemathelminthes*
7. Platyhelminthes
8. Coelenterata
9. Porifera
10. Protozoa

PHYLUM - CHORDATA

I. Class - Osteichthyes (Bony Fishes)

a. Clupeiformes (Trout)

b. Cypriniformes (Suckers - Carp - Catfish)

c. Anguilliformes (Eels)

d. Perciformes (Perches - Bluegills - Bass)

II. Class - Amphibia (Amphibians)

a. Candata (Bed-backed Salamander, Five-lined Skink)

b. Salienta

1. Bufonidae (Toad)

2. Hylidae (Peeper)

3. Panidae (Bull Frog - Green Frog - Leopard Frog)

III. Class - Reptilia (Reptiles)

a. Squanmata (Hog-nosed Snake - DeKay Snake - Garter Snake - Copperhead Snake - Pine Snake - Ribbon Snake)

b. Testudinata (Musk-Snapping-Box-Painted Turtles Eastern Snapper)

IV. Class - Aves

a. Ciconiiformes (Herons)

b. Anseriformes

1. Anatidae (Swans - Geese - Ducks)

Anserinae (Canada Goose)
Anatidae (Mallard - Black Duck - Wood Duck - Hooded Merganser)
Aythyinae (Bufflehead)

c. Falconiformes

1. Cathartidae (Turkey Vulture)

d. Accipiters (Sharp-shinned Hawk, Cooper's Hawk)

e. Buteos (Red-tailed Hawk, Red-shouldered Hawk, Broad-winged Hawk, Sparrow Hawk)

f. Tetraonidae (Ruffed Grouse)

g. Galliformes

1. Phasianidae (Ring Neck Pheasant)

h. Charadriiformes

1. Scolopacidae (Woodcock - Spotted Sandpiper)

i. Columbiformes

1. Columbidae (Mourning Dove)

j. Strigiformes

1. Strigidae (Screech Owl)

k. Caprimulgiformes

1. Caprimulgidae (Whippoorwill)

l. Micropodiformes

1. Trochilidae (Ruby-throated Hummingbird)

m. Coraciiformes

1. Alcedinidae (Kingfisher)

n. Piciformes

1. Picidae (Flicker - Pileated Woodpecker - Red-bellied Woodpecker - Hairy Woodpecker - Downy Woodpecker)

o. Passeriformes

1. Tyrannidae (Crested Flycatcher - Kingbird - Wood Pewee - Phoebe)

2. Hirundinidae (Tree Swallow - Barn Swallow)

3. Corvidae (Blue Jay - Crow)

4. Paridae (Chickadee - Tufted Titmouse -

5. Sittidae (White-breasted and Red-breasted Nuthatch)

6. Mimidae (Brown Thrashers - Mockingbirds - Catbirds)

7. Turdidae (Wood Thrush - Hermit Thrush - Swainson's Thrush - Robins - Bluebirds)

8. Troglodytidae (House Wren)

9. Bombycillidae (Cedar Waxwing)

10. Sturnidae (Starlings)

11. Vireonidae (Vireos - Warbling, Philadelphia, Red-eyed, Yellow-throated, White-eyed)

12. Parulidae (Wood Warblers - Pine Warbler - Blackpoll and others)

13. Icteridae (Red-winged Blackbirds - Baltimore Orioles - Meadow-larks - Grackles - Brown-headed Cowbird)

14. Fringillidae (Indigo Buntings - Cardinals - Redpoll - Slate-colored Junco - Rose-breasted Gorsbeak - Evening Grosbeak - Towhee - Purple Finch - Song Sparrow - Chipping Sparrow - Field Sparrow - White-throated Sparrow)

15. Composthlypidae (Warblers)

16. Thraupidae (Scarlet Tanagers)

V. Class - Mammalia (Mammals)

a. Marsupialia - Opossums

b. Insectivora - Moles

c. Chiroptera - Bats (Hoary Bat)

d. Lagomorpha - Rabbits

e. Rodentia - Rodents (Ground Hog - Chipmunk - Gray and Red Squirrel - Muskrat - House Mouse - Norway Rat - Beaver - White-footed Mouse - Weasel)

f. Artiodactyla - Deer (White-tailed Deer)

g. Carnivora - Carnivors (Red Fox - Black Bear - Racoon - Bobcat - Skunk)

PHYLUM - ARTHROPODA

I. Class - Crustacea

- a. Cladocera (Water Fleas)
- b. Copepoda (Sub-Class)
- c. Isopoda (Pill Bugs)
- d. Decapoda (Crayfish)

II. Class - Insecta

- a. Dermaptera (Earwig)
- b. Collembola (Springtails)
- c. Thysanura (Silverfish)
- d. Odonata
  - 1. Anisoptera (Dragon Flies)
  - 2. Zygoptera (Damsel Flies)
- e. Ephemeroptera (May Flies)
- f. Orthoptera
  - 1. Blattidae (Cockroaches)
  - 2. Mantidae (Praying Mantis)
  - 3. Phasmidae (Walkingstick)
  - 4. Acrididae (Grasshoppers)
  - 5. Tettingoniidae (Katydids)
  - 6. Gryllidae (Crickets)
- g. Plecoptera (Stone Flies)
- h. Isoptera (Termites)
- i. Mallophaga (Chewing Lice)
- j. Anoplura (Sucking Lice)
- k. Hemiptera (True Bugs)

1. Corixidae (Water Boatmen)
2. Notonectidae (Back Swimmers)
3. Nepidae (Water Scorpion)
4. Gerridae (Water Striders)

l. Homoptera

1. Cicadidae (Cicadas)
2. Cercopidae (Spittle Bugs)
3. Cicadellidae (Leafhoppers)
4. Membracidae (Treehoppers)
5. Aphidae (Aphids)
6. Aleyrodidae (White Flies)
7. Coccidae (Scale Insects and Mealy Bugs)

m. Neuroptera (Dodson Flies)

n. Trichoptera (Caddis Flies)

o. Lepidoptera (Moths and Butterflies)

1. Lasiocampidae (Tent Caterpillars)
2. Sphingidae (Sphinx)
3. Geometridae (Measuring and Canker Worms)
4. Arctiidae (Tiger Moth)
5. Lymantriidae (Tussock Moth)
6. Hesperiidae (Skippers)
7. Papilionidae (Swallowtails)
8. Pieridae (White and Sulphur Butterfiles)
9. Nymphalidae (Monarchs - Mourning Cloak - Viceroy
10. Lycaenidae (Blues)
11. Satyridae (Numphs, Satyrs)

p. Diptera (Flies)

1. Tipulidae (Crane Flies)
2. Culicidae (Mosquitoes)
3. Chironomidae (Midges - Gnats)
4. Tabanidae (Horsefly)
5. Bombyliidae (Bee Flies)
6. Trypetidae (Fruit Flies)
7. Muscidae (House Flies)
8. Sarcophagidae (Flesh Flies)

q. Diphonaptera (Fleas)

r. Coleoptera (Beetles)

1. Dytiscidae (Water Beetles)
2. Lampyridae (Firefly)
3. Elateridae (Click Beetle)
4. Psephenidae (Water Penny)
5. Coccinellidae (Ladybird Beetle)
6. Scarabaeidae (June Beetle)
7. Curculionidae (Acorn Weevil)
8. Scolytidae (Bark Beetle)
9. Carabidae (Ground Beetle)

s. Hymenoptera (Wasps - Ants - Bees)

1. Siricidae (Horn-tail)
2. Ichneumonidae (Ichneumon Fly)
3. Cynipidae (Gall Wasp)
4. Formicidae (Ants)
5. Vespidae (Hornet)

6. Sphecidae (Mud-Dauber)

7. Bombidae (Bumblebee)

8. Apidae (Honeybee)

III. Sub-Phylum - Chelicerata (Spiders)

Class Arachinida

a. Araneae (Spiders)

b. Phalangida (Daddy Longlegs)

c. Acarina (Mites - Ticks - Chiggers)

Class Chilopoda (Centipedes)

Class Diplopoda (Millipedes)

PHYLUM - ANNELIDA

I. Class - Oligochaeta

a. Plesiopora (Tubifex)

b. Opisthopora (Earthworms)

II. Class - Hirudinea (Leeches)

a. Rhynchobdellida

PHYLUM - MOLLUSCA

I. Class - Gastropoda (Snails and Slugs)

Sub-Class (Fresh Water or Land Snails and Slugs)

a. Pulmonata

II. Class - Pelecypoda (Mussels)

a. Eulamellibranchia

PHYLUM - BRYOZOA

I. Class - Phylactolaemata (Moss Animals)

PHYLUM - NEMATHELMINTHES

I. Class - Nematoda (Roundworms)

a. Rhabditida

PHYLUM - PLATYHELMINTHES

I. Class - Turbellaria (Flatworms)

a. Tricladida

II. Class - Trematoda (Flukes)

a. Monogenea

III. Class - Cestoidea (Tapeworms)

a. Porteocephaloidea

PHYLUM - COELENTERATA

I. Class - Hydrozoa

a. Hydroida

PHYLUM - PORIFERA

I. Class - Spongillidae

PHYLUM - PROTOZOA

I. Class - Mastigophora

a. Euglenoidina

b. Hypermastigina

c. Trichomonadina

d. Phytomonadina

II. Class - Sarcodina

a. Amoebena

b. Mycetozoa

III. Class - Opalinata

a. Opalina

IV. Class - Sporozoa

a. Gregarinida

b. Coccidia

V. Class - Ciliata

a. Hymenostomatidia

b. Pertitrichida

Local Observations on Flora and Fauna in the Borough of Kinnelon

Prepared January-February 2013
Carol Vreeland and Mary Derstine
Borough of Kinnelon

A SAMPLING OF WOODLAND SHRUBS AND TREES OF KINNELON

The common woodland shrubs of Kinnelon include Mountain Laurel, Native Pink Azalea, High Bush and Low Bush Blueberry and Viburnum. Mountain Laurel was noted in the *1973-1974 Kinnelon Environmental Resource Inventory* as being on the state protected list. It is now growing prolifically on many of our preserved lands. Native Pink Azalea is a lovely, fragrant shrub which also can be found in Kinnelon woodlands. Low Bush and High Bush Blueberry are found in many areas of Kinnelon and provide food for birds and animals. Viburnum is a native shrub with many varieties, the most beautiful being the Maple leaved Viburnum. It also has blue berries which provide food for wildlife.

A tree familiar to most residents of Kinnelon is the oak, which has several varieties. Oak tree numbers have been declining in every county of New Jersey. They have been under attack by bacterial leaf scorch, treehoppers and periodic defoliation by the gypsy moth. All have contributed to the lessening number of oak trees. Many oaks in Kinnelon were uprooted during the 2012 Hurricane Sandy.

Also found in Kinnelon are ash, elm, hemlock, white cedar, maple, chestnut and flowering dogwood trees. The preceding trees have all been afflicted by various parasites and diseases and have been under varying degrees of duress. The American Beech tree is increasing in numbers and grows easily and rapidly.

Carol Vreeland

February 3, 2013

A SAMPLING OF KINNELON'S MANY WILDFLOWERS AS NOTED BY LOCAL RESIDENTS IN RECENT YEARS

Asters (various varieties)

Black-eyed Susan

Bottled or Closed Gentian

Brambles (various varieties)

Cardinal Flower

Common Blue Eyed Grass

Common Milkweed

Downy Rattlesnake Plantain

Dwarf Ginseng

Ferns (various varieties)

Fringed Gentian

Goldenrod (various varieties)

Indian Pipe

Jack-in-the-pulpit

Little Bluestem Grass

Mayapples

Moss (various varieties)

Nodding Ladies' Tresses

Pale or Pink Corydalis

Partridge Berry

Pink Lady Slipper

Purslane

Pussytoes

Pyrolas

Queen Anne's Lace

Skunk Cabbage

Spotted or Stripped Wintergreen

Squawroot

Star of Bethlehem

Swamp Milkweed

Trailing Arbutus

Trout Lilly

Violets (various varieties)

White or Foxglove Beardtongue

Wild Columbine

Wild Leek or Ramps

Wood Betony

Compiled by Mary Derstine and Carol Vreeland

February 2013

INVASIVE PLANTS OF KINNELON

Two of the most common invasive plants found in Kinnelon are garlic mustard and Japanese barberry. They have both been identified by the New Jersey Department of Environmental Protection as a threat to the native plants of New Jersey. They are also both deer resistant which gives them an advantage over most woodland plants.

Garlic mustard is an aggressive invader of wooded areas. It can dominate forested woodlands and prevent indigenous species from growing. It is found statewide and in many areas of Kinnelon. Removing and disposing of the white flowering portion of the plant is the safest and most effective form of control.

Japanese Barberry is an invasive shrub whose seeds are spread by birds and small mammals. It grows in sun or shade and in most kinds of soil. It is a threat to indigenous plants because of its density and rapid growth. It can be controlled by repeated cutting back, but care must be taken due to the thorns.

Carol Vreeland

February 2, 2013

COMMON WILDLIFE SPECIES OF KINNELON

The abundant wildlife of Kinnelon frequently seen by Borough residents includes wild turkey, white tailed deer, black bear, red fox, coyote, various bats, squirrel, raccoon, beaver, and chipmunk. Other animals that can be seen are skunk, opossum, river otter, mink and beaver. Many bird species such as tanagers, vireos, warblers, thrushes and sparrows make their home in and around Kinnelon's expansive forests. Also in abundance are numerous species of raptors, reptiles, amphibians, invertebrates and insects.

Wild turkeys were reintroduced to the area in 1977 by the New Jersey Division of Fish and Wildlife. The program began with 22 turkeys and now number between 20,000 and 23,000. There is a large concentration of the turkeys in Kinnelon.

The white tailed deer have multiplied over the last few decades. Over-browsing by deer is causing destruction to the undergrowth of forested areas which may affect future forest growth. The black bear population also has increased over the last 20 years. Their loss of habitat and natural food (mast) may cause the bears to turn to residential trash to look for food.

Coyote population in New Jersey has significantly increased in New Jersey since 1988. Their howling can often be heard at night in KInnelon. Coyotes are beneficial in keeping rodents (rabbits, voles, mice) as well as deer populations in check. They will feed on garbage that is left outside, pet food and bird seed, and they may pose a threat to domestic animals.

Bats always have been a very common species in Kinnelon. A recent outbreak of white-nose syndrome has killed almost 90% of New Jersey's bats. The Morris County Hibernia Mine is the location of a large bat cave where 30,000 bats normally spend the winter months. A recent count of only 1,700 bats has resulted in the sighting of a bat as a rare occurrence in Kinnelon. Bats will consume large quantities of insects. Their demise is a concern for the health of local residents.

Monarch and other butterfly species are no longer frequently seen. Some blame deteriorating habitat in Mexico, pesticides and colder winters (no official numbers found). The honeybee population has been struck by Colony Collapse Disorder over the last few years, according to the New Jersey Department of Agriculture and the Mid-Atlantic Agricultural Research and Extension Consortium. Their absence has been noted by Kinnelon flower and vegetable gardeners.

Carol Vreeland

January 2013