CITY OF SUMMIT
ENVIRONMENTAL RESOURCE INVENTORY

DRAFT

October 2025

THE LAND CONSERVANCY OF NEW JERSEY

CITY OF SUMMIT, UNION COUNTY

October 1, 2025

ENVIRONMENTAL RESOURCE INVENTORY UPDATE

PREPARED BY

THE LAND CONSERVANCY OF NEW JERSEY

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This original document will be appropriately signed and sealed in accordance with Chapter 41, Title 13 of the State Board of Professional Planners upon adoption by the Planning Board.

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Thank you to the Great Swamp Watershed Association and Reeves-Reed Arboretum for supporting the development of the Environmental Resource Inventory.

The update to the City of Summit Environmental Resource Inventory was prepared with the assistance of a 2024 Sustainable Jersey Grant funded by the PSEG Foundation.

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When considering the use and/or development of a property, the information provided within this report should be supplemented with onsite confirmation of the resources present on the property.

Cover Photo: Passaic River Park in Fall Colors, photographed by Donna Goggin Patel

Executive Summary Photo: Reeves-Reed Arboretum, photographed by Dwight Hiscano

Executive Summary

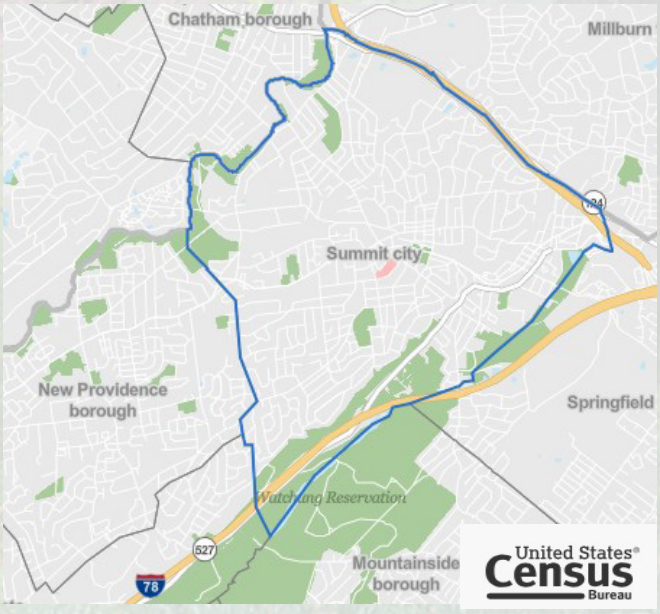
In 2011, the City of Summit collaborated with the Passaic River Coalition to produce an Environmental Resource Inventory (ERI). In 2024, the City received a Sustainable Jersey grant to update the ERI. Summit is a silver-certified municipality and has participated in the Sustainable Jersey program since 2009. The City has prepared this ERI to include a more in-depth discussion regarding climate change and to highlight the environmental benefit of local projects, such as the Native Seed Library at the Summit Free Public Library and the Tiny Forest behind the Community Center.

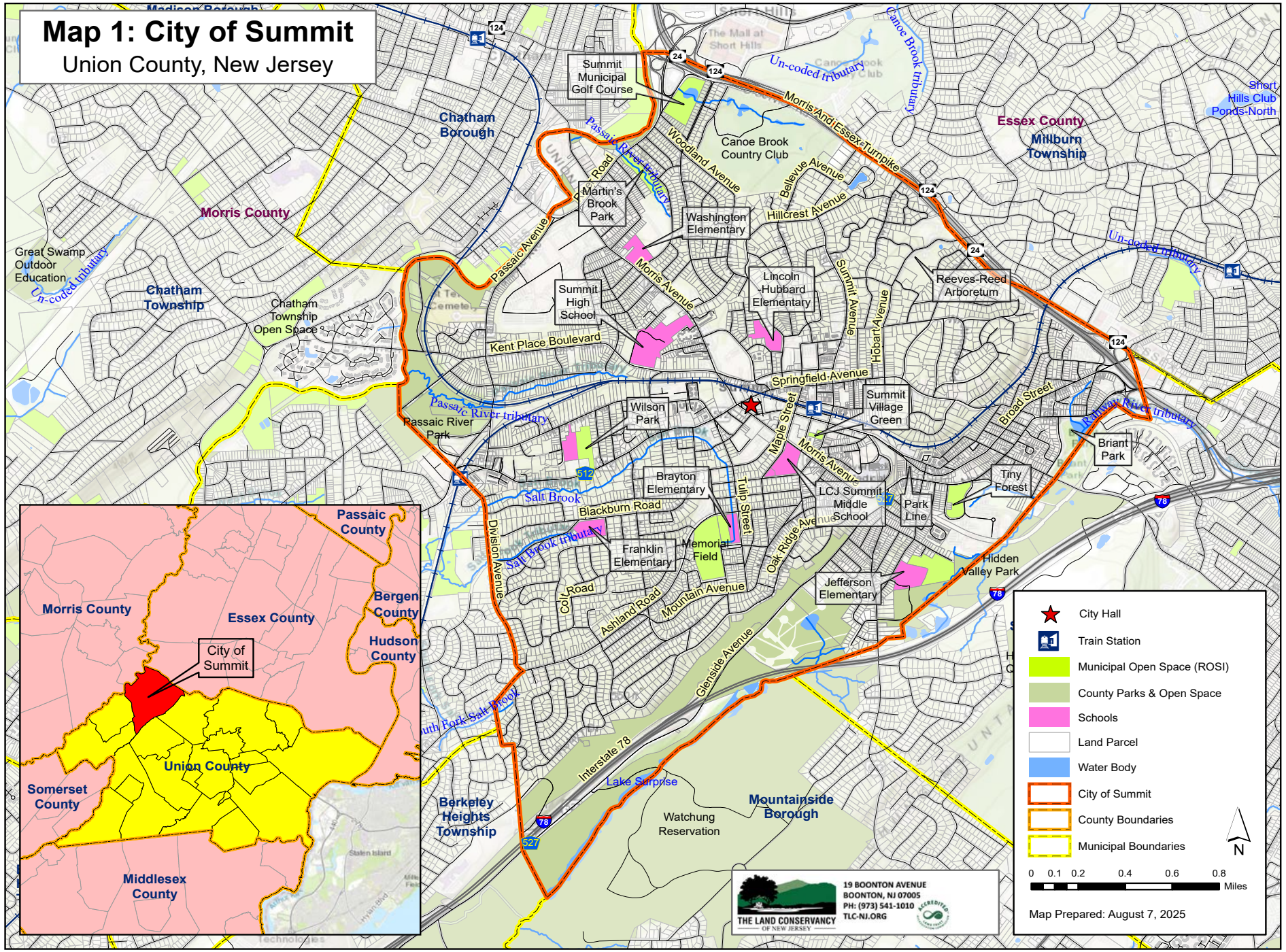
Summit is located in Union County and encompasses six square miles. It is home to 22,719 individuals (2020 Decennial Census). Over the past ten years it has grown by 1,262 people. It borders Chatham Borough and Township, New Providence, Mountainside, Springfield and Millburn. A portion of the Watchung Reservation falls within Summit as does the Passaic River Park and Reeves-Reed Arboretum (see the figure below and **Map 1**).

The ERI Update is based on the best available data from federal and state agencies, as well as municipal reports. Information on natural features, the geology, hydrology, ecology, and wildlife, conveys the scope and condition of the resources in Summit. Detailed mapping and tables document the City's environmental base Sections include information on topography, slopes, water resources, soils, flooding, wetlands, habitat, historic resources, air, and climate change.

The Environmental Commission views the update to the ERI as not only a tool for the local officials to use when assessing applications for development, but as an outreach medium to educate citizens and visitors about their town. It will assist the community as it makes choices regarding future planning and development.

Comprehensive knowledge of the environmental resources will allow for informed decisions as the City balances growth with protection and resiliency.




Map 1: City of Summit
Union County, New Jersey
Summit Municipal Golf Course
Chatham Borough
Canoe Brook Country Club
Un-coded tributary
Canoe Brook tributary
Morris And Essex Turnpike
Short Hills Club Ponds-North
Essex County
Millburn Township
Woodland Avenue
Bellevue Avenue
Hillcrest Avenue
Martin's Brook Park
Washington Elementary
Passaic Avenue
Passaic River tributary
Morris County
Great Swamp Outdoor Education
Chatham Township
Chatham Township Open Space
Summit High School
Morris Avenue
Lincoln-Hubbard Elementary
Summit Avenue
Hobart Avenue
Reeves-Reed Arboretum
Kent Place Boulevard
Springfield Avenue
Passaic River Park
Wilson Park
Summit Village Green
Broad Street
Maple Street
Briant Park
Brayton Elementary
Tiny Forest
LCJ Summit Middle School
Park Line
Salt Brook
Blackburn Road
Tulip Street
Division Avenue
Franklin Elementary
Memorial Field
Oak Ridge Ave
Hidden Valley Park
Jefferson Elementary
Coly Road
Ashland Road
Mountain Avenue
Glenside Avenue
Interstate 78
Lake Surprise
Watchung Reservation
Mountainside Borough
Berkeley Heights Township
Passaic County
Bergen County
Hudson County
Morris County
Essex County
City of Summit
Union County
Somerset County
Middlesex County
City Hall
Train Station
Municipal Open Space (ROSI)
County Parks & Open Space
Schools
Land Parcel
Water Body
City of Summit
County Boundaries
Municipal Boundaries
N
0 0.1 0.2 0.4 0.6 0.8
Miles
Map Prepared: August 7, 2025
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Bears at Village Green
Photo: Donna Goggin Patel

Chapter 1.

Land Use/Land Cover

Land Use/Land Cover (LU/LC) data describes the composition of land use types that are present in a given area. NJDEP maps six primary types of land cover: urban or built-up land, forest, agriculture, barren land, water, and wetlands. Land uses are mapped, delineated, and classified by the NJDEP using digital orthophotography and color infrared images. Full descriptions of the NJDEP major land use categories can be found on **page 11**.

LU/LC data reflects the composition of both natural and human-built land features in a municipality. This data illustrates what types of environments are present and how the composition has changed over time. Assessment of LU/LC has implications for development, environmental protection, and future planning.

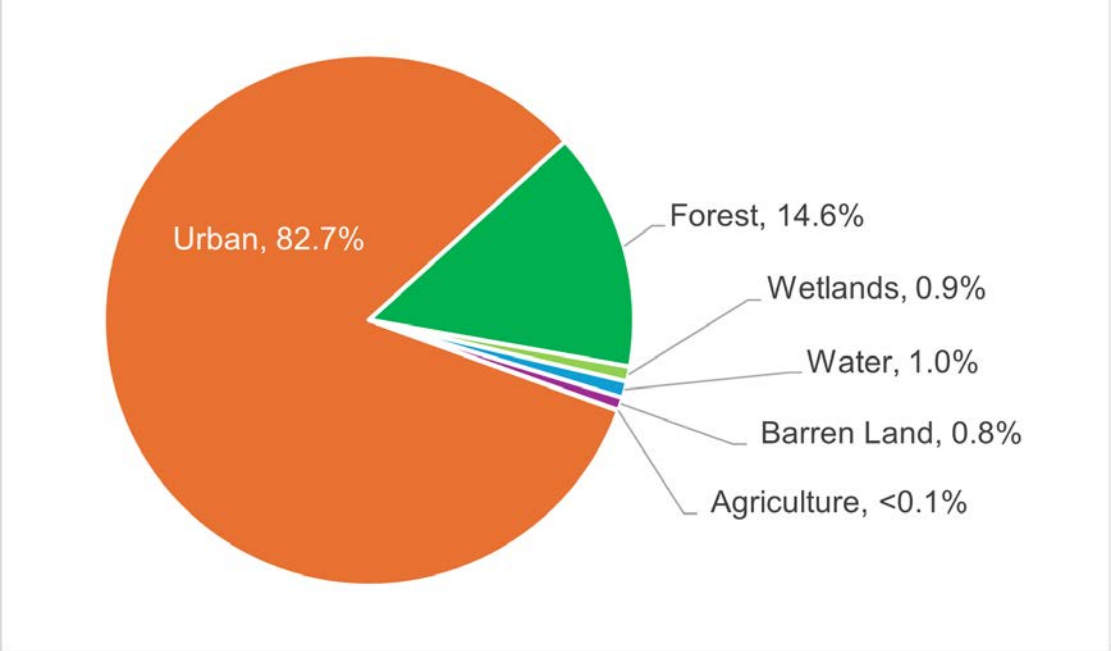
The distribution of land use categories in the City of Summit (**Figure 1, Map 2**) is as follows:

- **Urban or built-up land**: 83% of land in Summit is classified as urban or built-up land (3,192 acres). Urban land is characterized by intensive use where the landscape has been altered or developed by human activities. Urban land use in Summit is predominantly residential (86%), including; high density or multiple dwelling (50%), single-unit medium density (14%), single-unit low density (11%), rural (6%) and mixed (5%). Another 4% of urban land is dedicated to commercial use. For further details on urban land use types, see **Figure 2** and **Table 1** on **page 5**.

- **Forest**: 14.6% of land is classified as forest (563 acres). Much of this forested land is found along the city's

Figure 1. Land Use Types, City of Summit

Source: USGS LU/LC Data



southeastern edge and preserved as the Watchung Reservation. To the northwest is the second-largest continuous area of forest at Passaic River Park. Smaller portions of woodlands are found amidst residential neighborhoods. The dominant forest sub-type is deciduous forest with >50% crown closure (84%). For more information on forest types, see **Vegetation**.

• **Water**: 1.0% (39 acres) is open water, including sub-types of artificial lakes, streams and canals, and natural lakes. Streams include Salt Brook, tributaries of the Passaic and Rahway rivers. Briant Pond is a natural pond in the northeastern corner of the city; artificial lakes can be found within the Canoe Brook Country Club.

• **Wetlands**: 0.9% (35 acres) is wetlands, found in riparian areas around streams and other low-lying areas. The predominant type is deciduous wooded wetlands (86%).

• **Barren Land**: 0.8% (31 acres) of land is barren, characterized by thin soil, sand, or rocks, and a lack of vegetative cover in a non-urban setting. These are classified as "altered lands" and "transitional areas," indicating that land has been cleared and may be in the progress of land use change or development. Due to the nature of change, some of this area may be outdated in its labeling. The largest portion of barren land is associated with the Summit Transfer Station next to Passaic River Park.

• **Agriculture**: <0.1% (1 acre) is agricultural land. This small area is found near Hidden Valley Park, on the border with Springfield Township.

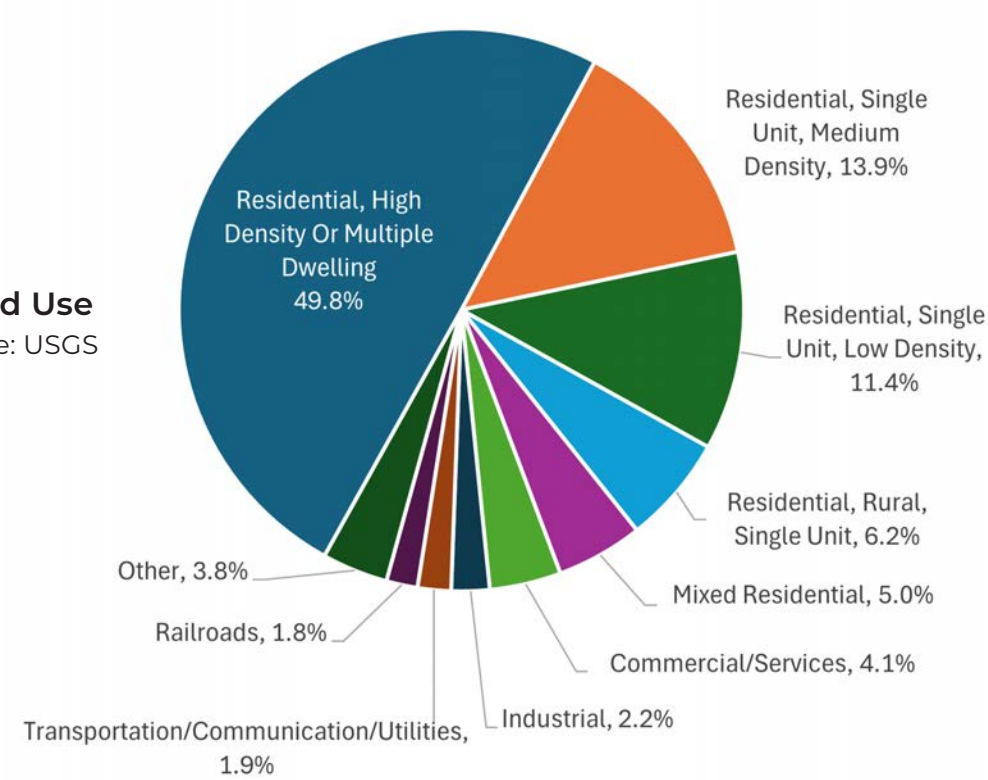


Figure 2. Urban Land Use Types, Summit Source: USGS LU/LC

Table 1. Urban Land Use Types, Summit

Urban Sub-Type	Acres	Percent
Residential, High Density Or Multiple Dwelling	1,588.5	49.8%
Residential, Single Unit, Medium Density	442.6	13.9%
Residential, Single Unit, Low Density	364.5	11.4%
Residential, Rural, Single Unit	198.8	6.2%
Mixed Residential	158.8	5.0%
Commercial/Services	130.5	4.1%
Industrial	69.8	2.2%
Transportation/Communication/Utilities	61.1	1.9%
Railroads	57.0	1.8%
Upland Rights-Of-Way Developed	41.1	1.3%
Upland Rights-Of-Way Undeveloped	28.6	0.9%
Stormwater Basin	23.1	0.7%
Other Urban Or Built-Up Land	19.0	0.6%
Cemetery	3.4	0.1%
Recreational Land	2.9	0.1%
Athletic Fields (Schools)	1.3	0.0%
Major Roadway	0.9	0.0%
Mixed Transportation Corridor Overlap Area	0.2	0.0%
Total Urban Land:	**3,192.2**	**100%**

LU/LC Change

LU/LC data helps to illustrate change over time. **Table 2** details land use change in City of Summit between the years 1986 and 2020.

Relative to other areas of the state, Summit has not experienced major changes in land use over the last 34 years. Urban land increased by about 30 acres. The acreage of barren land and water also increased. The proportion of agricultural land has been consistent over this timeframe. Forest and wetlands declined by about 30 acres and 15 acres respectively. This accounts for the expansion of urban land.

Figure 3 shows areas that were converted to urban land in years since 1980.

The consistency of land uses over time reflects the City's long-established form and early commitment to land preservation, in the case of its largest portion of forestland, the Watchung Reservation.

Table 2. Land Use Change Over Time, Summit, 1986 to 2020

	1986		2020	
LU/LC Category	Acres	%	Acres	%
Agriculture	0.7	0.0%	1.1	0.0%
Barren Land	14.5	0.4%	30.6	0.8%
Forest	592.1	15.4%	562.5	14.6%
Urban	3166.9	82.1%	3192.2	82.7%
Water	32.1	0.8%	38.8	1.0%
Wetlands	49.7	1.3%	35.2	0.9%

Source: USGS Land Use/Land Cover Data

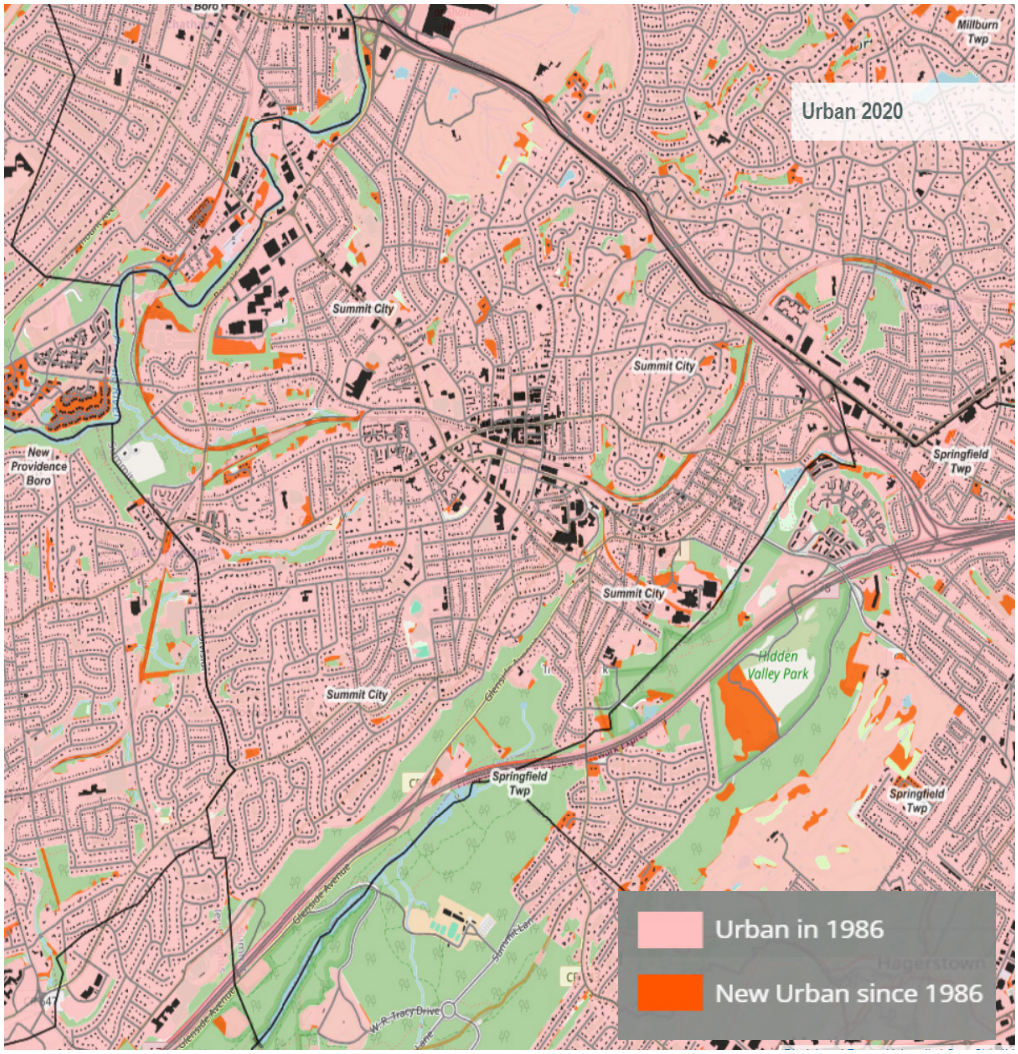
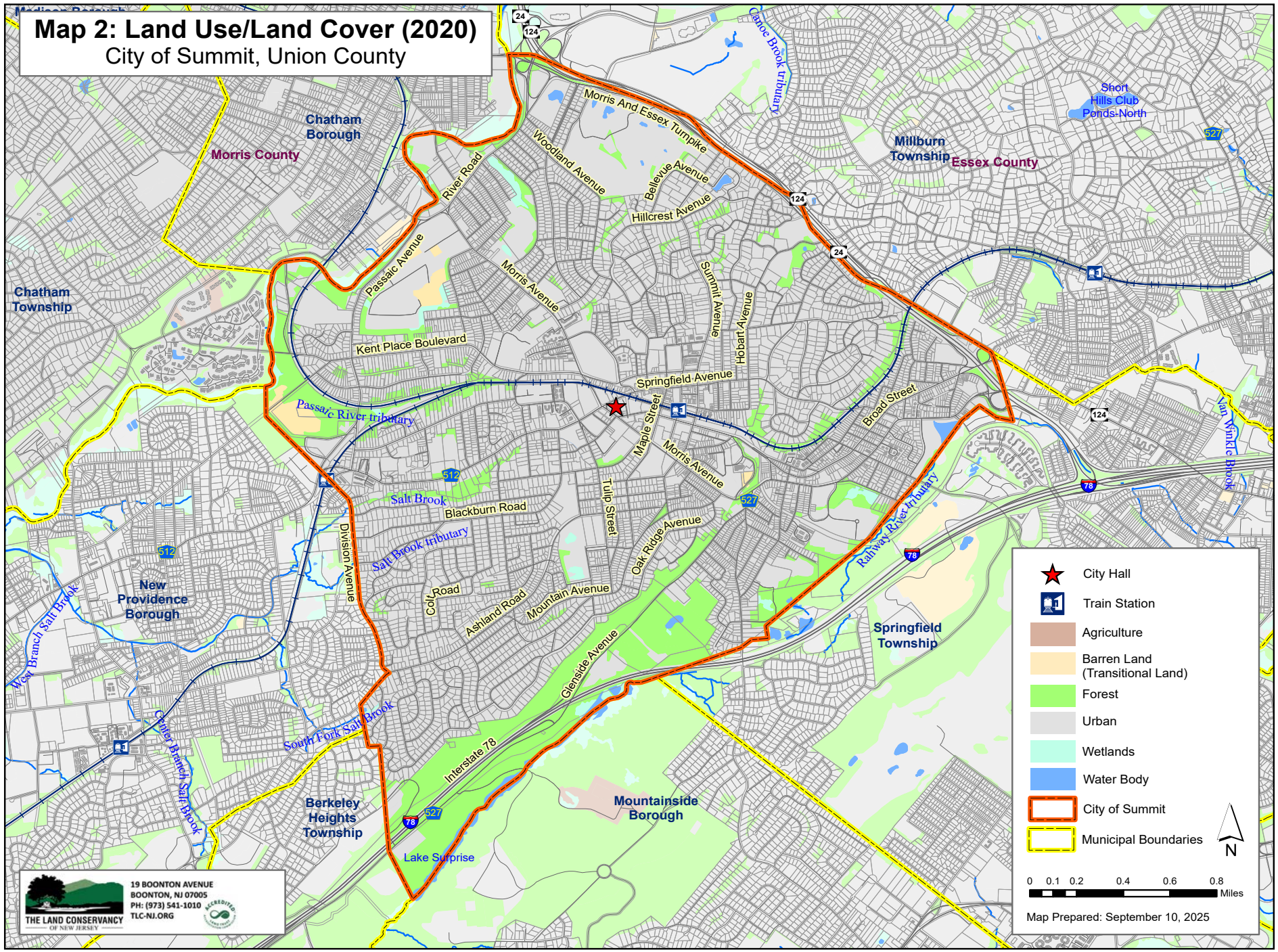


Figure 3. Urban Land Growth in City of Summit, 1986-2020

Source: NJ Conservation Blueprint[1]


Map 2: Land Use/Land Cover (2020)
City of Summit, Union County
Chatham Borough
Morris County
Chatham Township
New Providence Borough
Berkeley Heights Township
Mountainside Borough
Springfield Township
Millburn Township
Essex County
Short Hills Club Ponds-North
Canoe Brook tributary
Morris And Essex Turnpike
Woodland Avenue
Bellevue Avenue
Hillcrest Avenue
River Road
Passaic Avenue
Morris Avenue
Summit Avenue
Hobart Avenue
Kent Place Boulevard
Springfield Avenue
Broad Street
Maple Street
Passaic River tributary
Salt Brook
Blackburn Road
Salt Brook Tributary
Division Avenue
Tulip Street
Oak Ridge Avenue
Colt Road
Ashland Road
Mountain Avenue
Glenside Avenue
Railway River tributary
Van Winkle Brook
West Branch Salt Brook
Center Branch Salt Brook
South Fork Salt Brook
Interstate 78
Lake Surprise
City Hall
Train Station
Agriculture
Barren Land (Transitional Land)
Forest
Urban
Wetlands
Water Body
City of Summit
Municipal Boundaries
N
0 0.1 0.2 0.4 0.6 0.8 Miles
Map Prepared: September 10, 2025
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Impervious Surface

In forested watersheds, rainfall is absorbed by soils through the process of infiltration. It is then slowly discharged into streams, creating a steady flow of water. In areas that have undergone more development, this natural absorption process of the water cycle is interrupted.[2]

Impervious surface refers to roads, paved parking lots, sidewalks, and buildings, areas where stormwater cannot be absorbed by the ground. The result is a higher volume of runoff that requires management by human-built drainage systems. Storm sewers and ditches carry water to streams much more quickly than it would arrive through infiltration, causing higher frequency and severity of flooding.

Stormwater runoff is associated with the movement of pollutants, sediment, and small objects across the landscape.[3] Nutrients from fertilizers and agriculture are carried into streams, lakes, and groundwater, where heightened quantities of nitrogen and phosphorus affect water quality and ecosystems. Runoff can transport metals from built surfaces and bacteria from human and animal waste directly into bodies of water.

Map 3 illustrates the proportion of impervious surface on properties in Summit according to NJDEP 2020 Land Use/Land Cover Data. Areas with high amounts of impervious cover are the downtown core, commercial and industrial properties. These buildings tend to have large footprints and expansive parking lots.

Summit Impervious Surface Study

In 2015, an analysis of impervious surface cover in Summit was carried out by the Rutgers Cooperative Extension (RCE) of Union County. The report describes the degree of impact that impervious surface has on streams within a watershed, affecting the quality of lakes, reservoirs, estuaries, and aquifers.

According to RCE, stream impairment can be observed in watersheds where approximately 10% of the land cover is impervious.[4] Impacted streams in watersheds with 11-25% impervious coverage tend to show clear signs of degradation from urbanization; streams in areas of 25% or greater imperviousness are called non-supporting streams, where streams are no longer supportive of diverse native ecosystems, but simply conduits for stormwater flow.

Analysis of Summit's five subwatersheds finds that the majority of streams in the City are non-supporting. (See **Map 6** on **page 35** for the delineation of subwatersheds and further detail on the watershed framework.) Further analysis of the LU/LC data found that impervious cover ranges from 16.9% in the Green Brook subwatershed to 54.5% in the Canoe Brook subwatershed. A small sliver at the north the city, Green Brook is the only subwatershed where impervious cover (assessing land within city boundaries) does not exceed 25%. In an average year receiving 44 inches of rainfall, total impervious surface cover in the City creates a runoff volume of about 1,412 million gallons.

The RCE report advises a goal of 10% reduction of impervious surface in each subwatershed, which will reduce annual runoff volume by an estimated 134 million gallons. Strategic interventions are proposed that focus on disconnecting existing tracts of impervious surface, rather than eliminating or replacing paved areas, which can be difficult and

costly. Disconnection refers to redirecting surface runoff away from water bodies and stormwater sewers, and into pervious areas in the landscape. Simple disconnection can involve piping rooftop runoff into a grassed area.

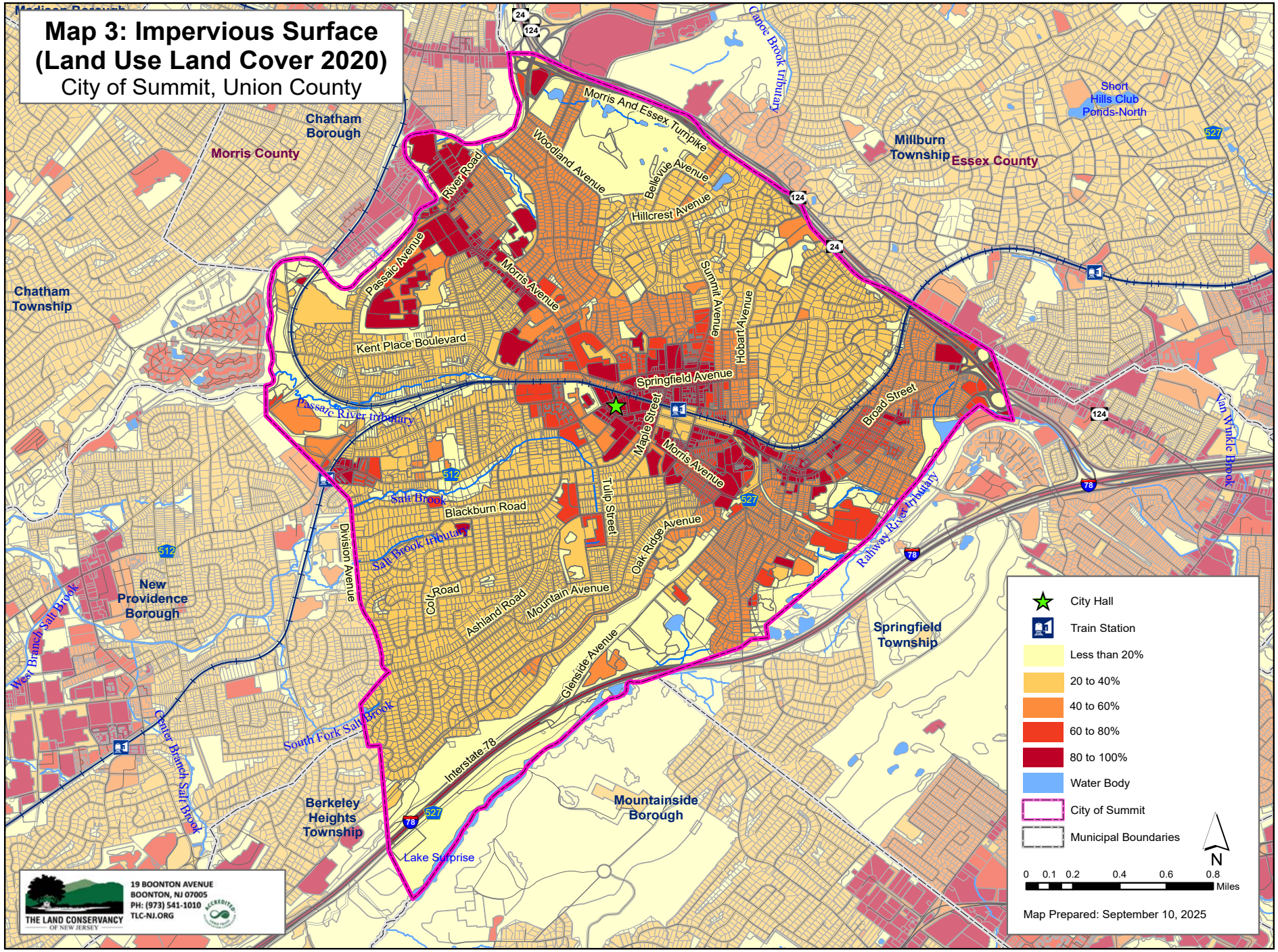
Additional strategies include creation of rain gardens and bioretention systems, as well as rainwater harvesting (in rain barrels or cisterns) which allows the water to be used as needed, for example, for watering plants. RCE Water Resources Program recommends green infrastructure practices to be designed for the 2-year design storm (3.4 inches of rain over 24-hours) in order to handle expected increases in storm intensity.

Green Infrastructure Projects

The City of Summit has taken action to implement green infrastructure and capture stormwater runoff. Guided by the suggestions and support of the RCE Service, three rain gardens were installed on municipal property in 2016. For details of the gardens and the installation process, see the presentation hosted by the Rahway River Watershed Association: https://rahwayriver.org/raingardensummit.html. The City of Summit recently launched a new website highlighting its rain gardens. For municipal updates, visit: https://www.cityofsummit.org/926/Rain-Gardens.

The New Jersey Green Infrastructure Municipal Toolkit offers guidance on best management practices (BMPs) for stormwater, including implementation of permeable surfaces. NJDEP's 2021 stormwater regulations require the use of decentralized green infrastructure for stormwater management in future land development. Resources for green infrastructure design and implementation can be found at gitoolkit.njfuture.org/.

Rain garden at City Hall
Photo: Donna Goggin Patel


Map 3: Impervious Surface (Land Use Land Cover 2020)
City of Summit, Union County
Chatham Borough
Morris County
Chatham Township
New Providence Borough
Berkeley Heights Township
Mountainside Borough
Springfield Township
Millburn Township
Essex County
Short Hills Club Ponds-North
Morris And Essex Turnpike
Canoe Brook Tributary
Woodland Avenue
Bellevue Avenue
Hillcrest Avenue
River Road
Passaic Avenue
Morris Avenue
Kent Place Boulevard
Summit Avenue
Hobart Avenue
Springfield Avenue
Broad Street
Maple Street
Passaic River tributary
Van Winkle Brook
Salt Brook
Blackburn Road
Salt Brook tributary
Division Avenue
Tulip Street
Oak Ridge Avenue
Railway River tributary
Colt Road
Ashland Road
Mountain Avenue
Glenside Avenue
West Branch Salt Brook
Center Branch Salt Brook
South Fork Salt Brook
Interstate 78
Lake Surprise
City Hall
Train Station
Less than 20%
20 to 40%
40 to 60%
60 to 80%
80 to 100%
Water Body
City of Summit
Municipal Boundaries
N
0 0.1 0.2 0.4 0.6 0.8
Miles
Map Prepared: September 10, 2025
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NJDEP Modified Anderson System of Land Use Classification (2015)[5]

Urban or Built-up Land - The Level I Urban or Built-up Land category is characterized by intensive land use where the landscape has been altered by human activities. Although structures are usually present, this category is not restricted to traditional urban areas. Urban or Built-up Land Level II categories include Residential; Commercial and Service; Industrial; Transportation, Communication and Utilities; Industrial and Commercial Complexes; Mixed Urban or Built-up; Other Urban or Build-up and Recreational. Included with each of the above land uses are associated lands, buildings, parking lots, access roads, and other appurtenances, unless these are specifically excluded. Urban or Built-up Land takes precedence over other categories when the criteria for more than one category are met. For example, recreational areas that have enough tree cover to meet Forest category criteria are placed in the Recreational category.

Forestland - The Level I Forestland category contains any lands covered by woody vegetation other than wetlands. These areas are capable of producing timber and other wood products, and of supporting many kinds of outdoor recreation. Forestland is an important category environmentally, because it affects air quality, water quality, wildlife habitat, climate, and many other aspects of the ecology of an area. The Level II categories under Forestland are Deciduous; Coniferous; Mixed Deciduous-Coniferous; and Brushland.

Agricultural Land - The Level I Agricultural Land category includes all lands used primarily for the production of food and fiber and some of the structures associated with this production. These areas are easily distinguished from the other categories and represent a significant land use in New Jersey. The Level II categories of Agricultural Land are: Cropland and Pastureland; Orchards; Vineyards; Nurseries and Horticultural Areas; Confined Feeding Operations; and Other environmental concern because of the non-point source pollution associated with confined feeding operations.

Barren Land - Barren lands are characterized by thin soil, sand or rocks and a lack of vegetative cover in a non-urban setting. Vegetation, if present, is widely spaced. Barren land such as beaches and rock faces are found in nature but also result as a product of man's activities. Extraction mining operations, landfills and other disposal sites compose the majority of man-altered barren lands.

Water - All areas within the landmass of New Jersey periodically water covered are included in this category. All water bodies should be delineated as they exist at the time of data acquisition, except areas in an obvious state of flood. Level I includes four (4) Level II categories; Streams and Canals; Natural Lakes; Artificial Lakes; and Bays and Estuaries and Other Tidal Waters. Not included in this category are water treatment and sewage treatment facilities.

Wetlands - The wetlands are those areas that are inundated or saturated by surface or ground waters at a frequency and duration sufficient to support vegetation adapted for life in saturated soil conditions. Included in this category are naturally vegetated swamps, marshes, bogs and savannas which are normally associated with topographically low elevations but may be located at any elevation where water perches over an aquiclude. Wetlands that have been modified for recreation, agriculture, or industry will not be included here but described under the specific use category.

Reeves-Reed Arboretum
Photo: Dwight Hiscano

Chapter 2.

Vegetation

Overview

Summit has areas of dense forest and a robust canopy of street trees, giving the City its uniquely green character amidst a region of dense suburban-urban development. Much of this forest is found within the Watchung Preserve, which runs along Summit's southeastern border. Embracing these assets, the City has made innovative strides with sustainability initiatives related to local vegetation, including its Tiny Forest, rain gardens, and the Native Seed Library, which encourages residents to plant native and support local ecosystems. The Reeves-Reed Arboretum is a local historic site dedicated to environmental education and stewardship. Its gardens and woodland trails showcase both native and ornamental flora, and they are open to the public year-round.[6]

Forest Land Cover

According to NJDEP Land Use/Land Cover Data, there are 563 acres of forest land in Summit, which account for 15% of its total land cover. The southern tip of the City is defined by the Watchung Reservation, which covers over 2,000 acres in Union County.[7] Tracts of forest can also be found along the northwestern edge of the City in Passaic River Park; as buffers around local streams; and in smaller portions among the city's neighborhoods.

Forest Types

Forestland is categorized by Land Use type according to NJDEP's Modified Anderson System, last updated in 2015.[8] Forests are classified by the predominant type of trees within: typically deciduous, coniferous, or mixed, and categorized further for their composition and density.

The full array of forest categories in Summit is shown in **Table 3** below.

The predominant forest type in Summit is deciduous forest, defined by trees that lose their leaves at the end of the growing season and sprout new leaves in the spring. Deciduous forest accounts for 90% of forest land in Summit or 506 acres. Forest stands in this category have an average height of at least 20 feet. They must have at least 75% deciduous trees in their canopy (<25% coniferous) to be placed in this category.

Crown closure refers to the percentage of forest area occupied by the vertical projections of tree crowns. Crown closure provides a reasonable estimate of stand density. 84% of deciduous forest in Summit has >50% crown closure, indicating high density forest. The remaining 6% of deciduous forest has lesser crown closure of 10-50%.

Some forests of Summit are of the Mixed Forest Type: 18 acres (3% of all forest) are mixed, with >50% coniferous species. 17 acres (3%) are categorized as "mixed deciduous/coniferous brush/shrubland," indicating lower canopy heights.

Mixed Oak Forests

The Watchung Mountains are the defining geologic feature of the area, forming uplands where most of the City's forest can be found. The dominant forest type in this area—and in much of North Jersey—is often described as mixed oak forest, defined by predominant species of red oak (*Quercus rubra*), chestnut

Leaves of a red oak tree
Photo: Andreas Rockstein/Flickr

Table 3. Forested Land Classifications, City of Summit

Forest Type Classification	Acres	Percent
Deciduous Forest:		
Deciduous Forest (>50% Crown Closure)	470.5	83.6%
Deciduous Forest (10-50% Crown Closure)	35.3	6.3%
Deciduous Brush/Shrubland	11.0	2.0%
Mixed Forest:		
Mixed Forest (>50% Coniferous w/ 10-50% Crown Closure)	18.3	3.2%
Mixed Deciduous/Coniferous Brush/Shrubland	17.3	3.1%
Deciduous Brush/Shrubland	11.0	2.0%
Other Forest Types (<5 acres each)	10.1	1.8%
Total Forested Acres:	**562.5**	**100%**
Source: USGS Land Use/Land Cover Data 2020		

oak (*Q. montana*), and black oak (*Q. velutina*), along with several species of beech, ash, hickory, and maple. Mature mixed oak trees form a canopy of 60 to 100 feet, supporting an understory of smaller trees up to 30 to 40 feet tall.[9]

Within the forests of the Watchungs, the composition of tree species can vary by geologic and hydrologic conditions. For example, drier, southeast-facing slopes are dominated by white and black oak, while other hillsides are dominated by red oaks.[10]

Common understory species in New Jersey's mixed oak forests include shrubs such as maple-leaved vibernum (*Vibernum acerifolium*), arrowwood (*V. dentatum*), spicebush (*Lindera benzoin*), and pinxter flower (*Rhododendrum periclymenoides*).

Common herbaceous species include wild sarsaparilla (*Aralia nudicaulis*), false Soloman's seal (*Maianthemum racemosum*), and Jack-in-the-Pulpit (*Arisaema triphyllum*).

Forest in Passaic River Park
Photo: Dwight Hiscano

Native Vegetation

Native plants species are those which have evolved over hundreds or thousands of years to be adapted to a particular region.[11] Over time, native plants have established complex relationships with other native species, including plants, insects, wildlife, fungi, and other organisms. Native plants play a key role in resilient, biodiverse ecosystems, serving as preferred food sources for pollinator species like butterflies, birds, and insects.[12] Compared to common horticultural plants, native species can thrive in their natural ecosystems once established, relying less on human inputs such as fertilizers and extra waterings.[13]

The Summit Environmental Commission (EC) promotes the use of native plants in residential and municipal landscapes to support healthy, balanced ecosystems. Two projects of the EC that put a spotlight on native plants are the Native Seed Library and the Tiny Forest, discussed further in this section. The EC website contains additional information and resources on native plants in New Jersey.

The Native Plant Society of New Jersey maintains lists of trees, shrubs, and vascular plants that are native to each county in New Jersey. For consideration in future planting projects, see the list online. Union County has also published a "Plant This, Not That" guide to help homeowners make environmentally friendly choices in their landscapes (**Table 4**).

Summit Native Seed Library

The City has taken intiative to encourage and enable residents to plant native. Within the Summit Free Library is the Native Seed Library, which makes seeds freely available to all library users.[15] Available species have included: black-eyed Susan, blue false indigo, dense blazing star, eastern purple coneflower, great blue lobelia, New England Aster, swamp milkweed, and wild bergamot.

Visitors of the library may take home up to three seed packets per season. The seeds are harvested from Summit's Tiny Forest and supplemented by Friends of

Native Seed Library
Photo: Summit Free Library

Table 4. Plant This, Not That! Guide for Union County

Native Alternatives (Plant This!)	Commonly Planted Invasives (Not That!)
Switchgrass (*Panicum virgatum*)	Chinese Silvergrass (*Miscanthus sinensis*)
Dense Blazing Star (*Liatris spicata*)	Purple Loosestrife (*Lythrum salicria*)
Fragrant Sumac (*Rhus aromatica*)	Morrow's Honeysuckle (*Lonicera morrowii*)
Possumhaw (*Viburnum nudum*)	Winged Burning Bush (*Euonymus alatus*)
Summer Sweet (*Clentha alnifolia*)	Butterfly Bush (*Morus alba*)
Virginia Sweetspire (*Itea virginica*)	Japanese Barberry (*Berberis thunbergii*)
Red Maple (*Acer rubrum*)	Norway Maple (*Acer platanoides*)
White Fringetree (*Chionanthus virginicus*)	Callery Pear (*Pyrus calleryana*)
Christmas Fern (*Polystichum acrostichoides*)	Common Periwinkle (*Vinca minor*)
Red Bearberry (*Arctostaphylos uva-ursi*)	English Ivy (*Hedera helix*)
Source: Union County Parks[14]	

the Library, giving all residents the power to grow their own native, biodiverse gardens and support local ecosystems.

Summit Tiny Forest

In 2021, the Summit Environmental Commission received a grant from the New Jersey American Water Environmental Grant Program to plant a Tiny Forest – about 11,000 square feet of densely-planted forest layered with native trees, shrubs, and bushes– amidst the residential neighborhoods. Located behind the Summit Community Center at 100 Morris Avenue, the Tiny Forest is not only an environmental asset but a community one, providing a centrally located space for programs and events, and for residents to enjoy the benefits of the forest.

The Tiny Forest was designed in the Miyawaki Method, developed by Japanese botanist Akira Miyawai, where native species are planted densely together in a small area. Through careful maintenance in the first two to three years, these forests grow quickly and should mature within a few years. The strategy of dense, biodiverse planting also facilitates higher rates of carbon capture, water filtration, and erosion control, while forming a more effective barrier against winds, storms, noise, and heat. Choosing native species means the forest will be able to thrive under natural conditions, requiring little to no inputs once established.

The forest planning process began in 2021, with site analyses by the EC, consultations with experts on native species and forestry, and soil testing through RCE. Trees and shrubs were acquired from the native plant sale of the Great Swamp Watershed Association, the NJ State Forestry Nursery, and the Pinelands Nursery. In April 2022, the Tiny Forest came together through the work of dozens of volunteers. The multi-layered forest contains over 700 native trees, shrubs, and bushes of over 55 different species, bringing biodiversity to an area that was once mown grass. A list of species can be found in **Table 5**.

Tiny Forest
Photo: Donna Goggin Patel

In the three years since its creation, the Tiny Forest has been actively managed (mostly in tasks of watering and weeding) by volunteers to improve the survival rate of the plantings, especially in times of drought. The forest has seen exceptional growth during this time, and is nearing the stage of self-sufficiency.

The Tiny Forest has garnered attention in the community and beyond for its innovative approach to environmental stewardship, boosting awareness of the value of healthy, biodiverse ecosystems in our communities. Additional benefits of the forest are beginning to take effect, including support for wildlife. Many species of birds and insects have been observed using the forest, including important local pollinators. The health of the floodplain has been improved; since

Tiny Forest in 2022

Tiny Forest in 2024

Photos: Dwight Hiscano

native trees can absorb large amounts of rainwater, the forest acts as a sponge, mitigating flooding and stormwater runoff. The forest also contributes to improved local air quality by pulling down carbon from the atmosphere. The trees in the forest are estimated to have already sequestered over 3,400 pounds of carbon dioxide equivalent, based on species profiles and quantity.

The Tiny Forest has become the basis for citizen science initiatives in the City. Residents can help monitor birds that visit the forest over time by recording bird songs using the BirdNET software, which will show the change in avian life over time as the forest develops to maturity.

The City continues to publish updates on the Tiny Forest, including calls for volunteers and other events, on its social media and EC Facebook page.

Reeves-Reed Arboretum

The Reeves-Reed Arboretum, located at 165 Hobart Avenue in Summit, is open daily to the public as an educational, cultural, and environmental center.[16] The Arboretum contains preserved historic and contemporary landscaped gardens, horticultural exhibits, and natural woodlands across its 13.5 acres. On the Woodland Trails, there is a native eastern deciduous forest, including canopy trees, understory trees, shrubs, and herbaceous plants.[17] Reeves-Reed hosts classes for adults and children, art exhibits, tours, and other outdoor outings throughout the year.

Invasive Vegetation

Invasive plant species are not native to a particular ecosystem and can exhibit aggressive growth patterns, causing harm to the environment.[18] They are introduced through intentional or accidental transport and dispersion via human activity, wildlife, or other natural

Table 5. Select Trees and Shrubs of the Tiny Forest

Red oak (*Quercus rubra*)	Fragrant sumac (*Rhus aromatica*)
White oak (*Quercus alba*)	Hackberry (*Celtis occidentalis*)
Short leaf pine (*Pinus echinata*)	Tulip Tree (*Liriodendron tulipifera*)
Black gum (Nyssa sylvatica)	Wild Bergamot (*Monarda fistulosa*)
Swamp white oak (*Quercus bicolor*)	American elderberry (*Sambucus canadensis*)
Summersweet (*Clethra Alnifolia*)	Arrowwood vibernum (*Viburnum dentatum*)
Virginia Sweetspire (*Itea Virginica*)	Dense blazing star (*Liatris spicata*)
Eastern redbud (*Cercis canadensis*)	Anise Hyssop (*Agastache foeniculum*)
New Jersey Tea (*Ceanothus americanus*)	New England aster (*Symphyotrichum novae-angliae*)

Source: Summit Environmental Commission

processes.[19] Once introduced, invasive species may establish and spread quickly in an ecosystem, lacking natural predators.

Through this behavior, invasive plants compete with natives for space and resources, which damages the integrity and diversity of natural plant communities. This can lead to a reduction in the availability of food and habitat for native wildlife.[20]

By out-competing local species, invasive species can dramatically reduce native populations and overall biodiversity, altering landscapes and impeding their natural functions. The Summit Environmental Commission has made observations of established communities of invasive species at various sites throughout the City.

The following observations were reported by EC members in 2025:

- At Martin's Brook Park, a large area of the woods is covered with the early-sprouting Lesser Celadine (*Ficaria verna*). In part of the woods that has been deforested, there is a large invasion of garlic mustard (*Alliaria petiolate*). Other notable invasives at Martin's Brook Park are English ivy, pachysandra, and sweet myrtle.
- At Tatlock Park, common invasive species include non-native thistles, clovers, pineapple weed, multiflora rose, wineberry, plantains, and hawk weed.
- Along Butler Parkway, the invasive Japanese knotweed has an aggressive presence; the City is taking action to remove these bushes and restore the forest ecosystem. Other notable species that have taken hold in this area include oriental bittersweet, burdock, wineberry, Japanese honeysuckle, and hawk weed.

The potentially invasive character of non-native species should be considered and researched before planting in landscapes and gardens.

The non-profit organization Friends of Hopewell Valley Open Space has a comprehensive information center that includes "Do Not Plant" lists and guidance for controlling invasive plants in New Jersey. Find these resources online.

Invasive wisteria plants in Hidden Valley Park.
Photo: Dwight Hiscano

Forest Health

Emerald Ash Borer

The emerald ash borer (EAB) is an invasive wood-boring insect that has killed millions of ash trees in North America since its discovery in Michigan in 2002. The species was first detected in New Jersey in 2014, and by 2019, it made its way into Union County.[21]

In February 2019, Summit began its response to EAB infestations in the City and in county rights-of-way. Partnering with JCP&L, the City set out to remove approximately 80 ash trees to control the spread of the predatory insect. Trees less affected with infestation were to be treated with pesticides. The trees removed from public rights-of-way would be replaced with 70 trees.[22]

EAB affects all true ash species (*Fraxinus sp.*) as well as the white fringe tree (*Chionanthus virginicus*). The EAB lays its eggs among the bark, and juvenile larvae cause damage by feeding on the tree, interfering with its ability to circulate nutrients and water. EAB ultimately causes girdling to the trunk and branches, canopy loss, and dieback. Infested trees can die within 2-4 years if untreated.[23]

A guide to treatment options for the EAB is available from the NJDEP.

Bark damage and characteristic S-shaped galleries of the emerald ash borer.
Photo: Colorado Department of Agriculure

Beech Leaf Disease

Beech leaf disease (BLD) is an emerging disease that impacts trees in the beech genus, including the American beech (*Fagus grandiflora*) and ornamental beech varieties. The disease has spread through the Northeast over the last decade. It was first found in New Jersey in 2020, and in Union County in 2021.[24]

Beech tree affected by Beech Leaf Disease.
Photo: Matt Borden/Flickr

The disease has come to be associated with a newly recognized subspecies of the nematode *Litylenchus crenatae mccanii*. Symptoms include dark banding of leaves, visible throughout the lower canopy, and later leaves may become shrunken, crinkled, and thickened with a leathery texture. The effects of BLD can kill beech saplings in as little as 2-5 years and large trees within 6 years.[25]

Spotted lanternfly with late-stage nymphs.
Photo: USDA, Animal and Plant Health Inspection Service

Spotted Lanternfly

The spotted lanternfly (SLF), *Lycorma delicatula*, was first discovered in the United States in Pennsylvania in 2014. Since its arrival from Asia, it has spread throughout the mid-Atlantic states and beyond. SLF cause damage to trees and crops in several ways over the course of their life cycle. While they are primarily attracted to the invasive tree-of-heaven (*Ailanthus altissima*), they feed on over 70 different host species, including hardwood trees and important crops like grapevines and hops. [26]

SLF lay large egg masses on trees, rocks, and any large, flat outdoor surface. While feeding on trees and vegetation, they excrete large quantities of honeydew, a sugary substance that facilitates mold growth. Consumption of vegetation and the impacts of insect secretions can cause severe damage to trees and plants where the insects gather.[27]

SLF is a complex pest problem that requires careful management. SLF nymphs and adults are fairly susceptible to insecticides, including less-toxic oils and soaps. Treatment options should be considered according to the severity of an infestation and the vulnerability of plants present. For dealing with smaller populations, several actions can be taken before resorting to insecticides: these include removing favored hosts like the tree-of-heaven (cultural control), removing and smashing eggs, and stomping nymphs and adults (mechanical control). For more severe cases, less-toxic insecticides like soaps and neem oils can be effective.[28] The New Jersey Department of Agriculture has made grant funds available to counties and municipalities to battle the spotted lanternfly from 2024 to 2026.[29]

The Union County Department of Parks and Recreation has worked with the US Department of Agriculture and the Rutgers New Jersey Agricultural Experiment Station to develop methods to locate and trap lanternflies, and to prevent egg masses from hatching.[30] Traps in the Watchung Reservation have been successful in catching thousands of SLF.

Tree Protection Ordinance

Chapter 29 of the Summit Municipal Code outlines rules for tree removal, replacement, and protection in the City. The purpose of establishing requirements for tree removal and replacement is to reduce soil erosion and pollutant runoff, promote infiltration of rainwater into the soil, to protect the environment, public health, safety, and general welfare. Summit's tree-lined streets and tree canopy are characteristic assets that require regulation on public and private lands.

The most recent amendment to the Ordinance (effective date June 6, 2024) states that no person shall remove or damage any trees within the City without the express approval of the City Forester. In order to remove a tree, one must obtain a tree removal permit, with few exceptions. Tree replacement requirements are outlined in the ordinance along with a list of approved species; list of invasive trees that shall not be used for replacement; and the recommended method for tree planting.

View the full ordinance here:
§ 29 Protection of Trees

Forests as Carbon Storage

In addition to providing wildlife habitat, food sources, clean air, soil stabilization, and shade, forests perform the service of removing carbon from the atmosphere. Carbon, released in molecules such as carbon dioxide, is absorbed by trees and stored for long periods in its biomass (including live material such as leaves, bark, stems, branches, and roots; but also woody debris and other materials) and in soil.[31]

This process is referred to as carbon sequestration. Even without intentional carbon-focused management, forests in the United States are estimated to offset about 10-15% of annual U.S. CO2 emissions.[32]

The Nature Conservancy (TNC) provides estimates of current (2020) and future (2070) rates of carbon sequestration. The ability of forests to perform sequestration in the future will depend on management and land use change. Actual carbon sequestered may be higher or lower depending on management practices or the success of forest preservation efforts.[33]

In the highly developed region of northeastern New Jersey, forest ecosystems are fragmented and often subject to disturbance. As a result, they are generally low on TNC's ranking for ecological resilience, diversity, and connectivity. Yet all forests and natural land perform the essential service of carbon storage.

In 2010, the total forest and soil carbon held in Summit was estimated to be about 52,000 metric tons (mt). From this value, the estimated total carbon to be sequestered over 40 years from 2010-2050 is about 6,000 mt, at a rate of 144 mt/yr. The annual sequestration rate per forested acre is an estimated 0.27 mt/acre/year.[34] **Figure 4** shows the carbon sequestration levels of different forested areas in Summit, where blue areas sequester the most carbon.

Since these values were calculated in 2010, they do not account for changes to the landscape that have occurred in the last 15 years. While development and tree removal would lower carbon value, projects such as the Tiny Forest have added to Summit's carbon sequestration. The forest itself is designed in a dense

formation that aims for a higher rate of carbon drawdown than typical forests. Though still immature in 2025, the trees and vegetation are estimated to have already sequestered 3,400 pounds of CO2 equivalent, or 1.5 mt, on just one-quarter acre of land.

In the aim of achieving or exceeding these predicted carbon values, the Nature Conservancy emphasizes the importance of restoring and preserving forest, native trees and vegetation cover. In highly developed areas, carbon sequestration potential can be gained by increasing urban tree canopy cover and creating urban green space. These actions have other beneficial effects to nature and society, improving air quality, reducing the heat island effect, and other effects leading to improved physical and mental health.

The City of Summit has been a Tree City USA Community for 30 years.

Figure 4. Forest Carbon Map, City of Summit (2020)

Source: The Nature Conservancy[35]

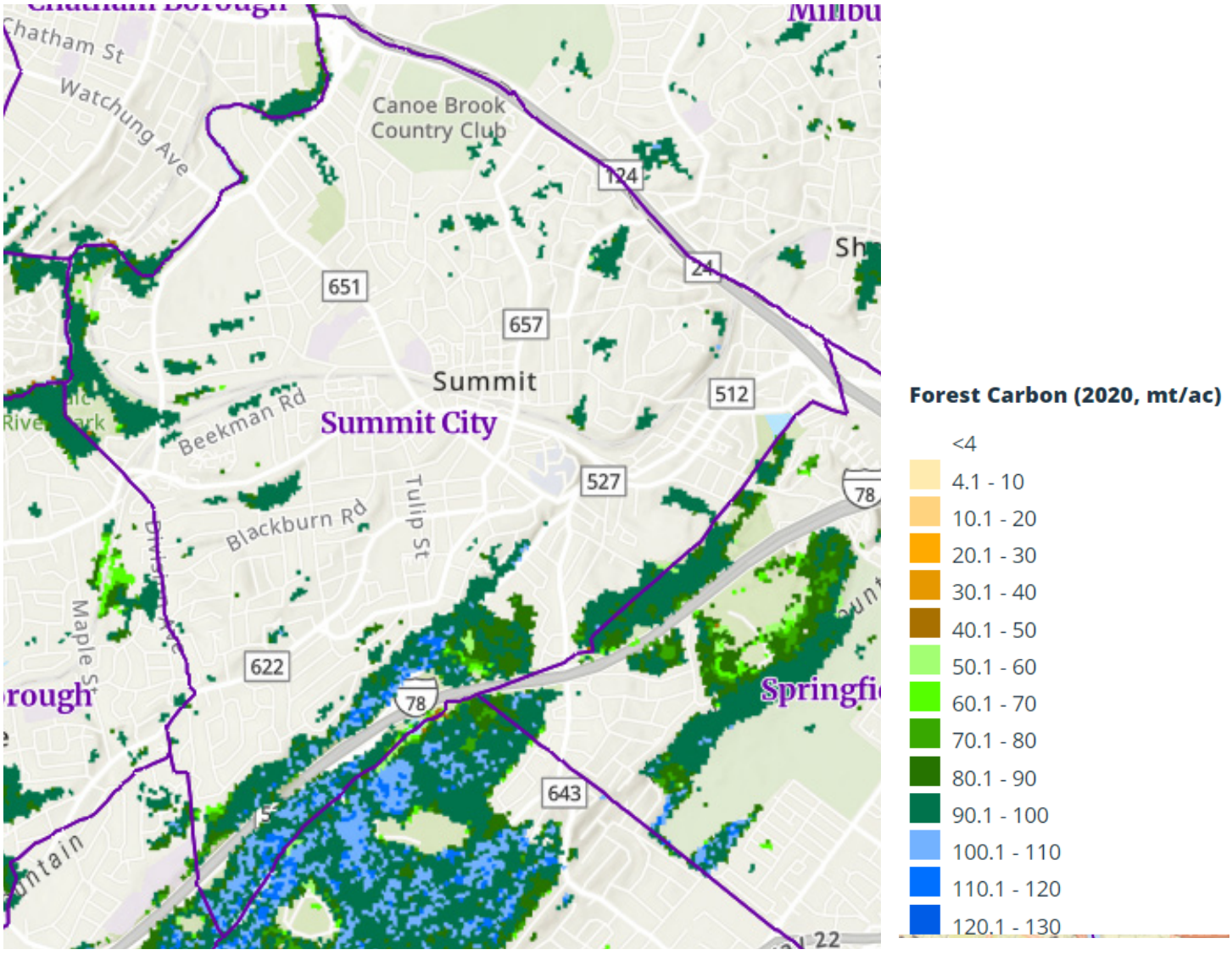


Photo: Reeves-Reed Arboretum

Chapter 3.

Wildlife

Summit supports a wide variety of wildlife species which coexist with human communities in different ways. While some species are perceived as pests, others are rare and protected due to declining habitat and development. Conservation efforts have helped restore populations of several species in the last decades. Education and conservation efforts are carried out in Union County by the Trailside Nature & Science Center at the Watchung Reservation.[36]

Threatened & Endangered Species

NJDEP Fish and Wildlife Endangered and Nongame Species Program (ENSP) manages and protects endangered, threatened, and special concern wildlife species in New Jersey.

Endangered Species as those whose prospects for survival in New Jersey are in immediate danger because of a loss or change in habitat, over-exploitation, predation, competition, disease, or disturbance of contamination.

Threatened Species are those at risk of endangered status if habitat conditions begin or continue to deteriorate.

Species of Special Concern are those who warrant attention due to evidence of decline or vulnerability, possibly due to habitat modification, or due to unknown population status in the state.

The NJDEP Landscape Project (V3.4) ranks patches of land using a numeric system to identify habitat that is suitable for threatened and endangered species. Habitat patches are given a ranking from 0 to 5 based on the occurrence of specific wildlife species and the presence

of suitable habitat for their populations, where 5 is the most environmentally sensitive:

- **Rank 5**: 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**: Species-specific patches with one or more occurrences of state endangered species.
- **Rank 3**: Species-specific patches containing one or more occurrences of state threatened species.
- **Rank 2**: Species-specific patches containing one or more occurrences of species of special concern.
- **Rank 1**: 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 confirmed occurrences of such species.
- **Rank 0**: Species-specific patches that do not contain any species occurrences and do not meet any habitat-specific suitability requirements.

Data on local species with endangered, threatened, or special concern status is obtained through the Natural Heritage Database and Landscape Project (V3.4).

Table 6 on the following page provides the complete list of these species whose habitat occurs in Summit, including species which have been actively sighted or have observed habitat. **Map 4** shows the locations of habitats that support threatened and endangered wildlife species.

Some typical wildlife sightings in Summit...

Red Fox

Groundhog
Photos: John Berine

Rose-breasted grosbeak
Photo: Doreen Schindler

Overall, the Natural Heritage Report for City of Summit indicates the presence of amphibians, birds, mammals, and reptiles that are rare, threatened, or endangered in the State of New Jersey. One Rank 5 species was observed, the Indiana Bat, which is endangered at both the state and federal level. In addition, there are four species of Rank 3 (threatened), and seven species of Rank 2 (special concern).

Bats of Summit

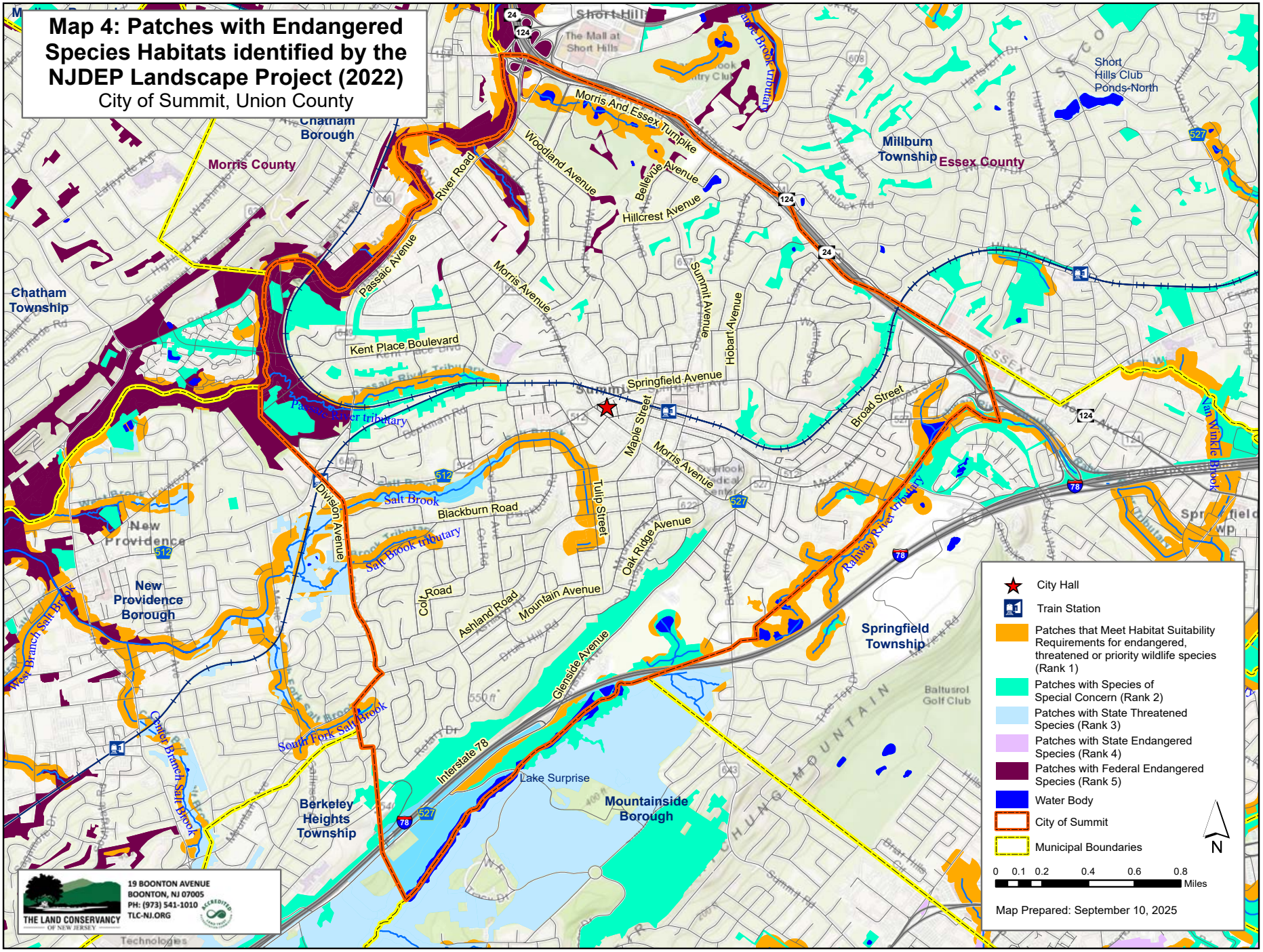
Two threatened and endangered species of bat are listed in Natural Heritage Database for their presence in Summit. Supplementing these findings, NJDEP biologists conducted an acoustic survey in the summer of 2024 to identify bat species that inhabit the surroundings of Martin's Brook and the greater Tatlock neighborhood. The collected data will inform DEP databases in the Biotics program, including the Natural Heritage Program. The information herein was communicated by a community resident.

Over the course of two months, seven distinct bat species were observed in the area: the big brown bat, little brown bat, silver-haired bat, hoary bat, evening bat, Eastern red bat, and the tri-colored bat. The tri-colored bat (*Perimyotis subflavus*)

Table 6. Rare Wildlife Species Habitat in Summit

Species Rank	Common Name	Scientific Name	Feature Type	Protection Status
Rank 5	Indiana bat	*Myotis sodalis*	Active Season Sighting	State & Federally Endangered
Rank 3	Eastern Long-tailed Salamander	*Eurycea longicauda longicauda*	Occupied Habitat	State Threatened
	Barred Owl	*Strix varia*	Non-breeding Sighting	State Threatened
	Bobcat	*Lynx rufus*	Live Individual Sighting	State Threatened
	Wood Turtle	*Glyptemys insculpta*	Occupied Habitat	State Threatened
Rank 2	Eastern Cricket Frog	*Acris crepitans*	Breeding Sighting	Special Concern
	New Jersey Chorus Frog	*Pseudacris kalmi*	Breeding Sighting	Special Concern
	Bald Eagle	*Haliaecetus leucocephalus*	Foraging	Special Concern
	Great Blue Heron	*Ardea Herodias*	Foraging	Special Concern
	Wood Thrush	*Hylocichla mustelina*	Breeding Sighting	Special Concern
	Silver-haired bat	*Lasionycteris noctivagans*	Inactive Season Sighting	Special Concern
	Woodland Box Turtle	*Terrapene Carolina carolina*	Occupied Habitat	Special Concern

Source: NJDEP Natural Heritage Database and Landscape Project 3.4


Map 4: Patches with Endangered Species Habitats identified by the NJDEP Landscape Project (2022)
City of Summit, Union County
Chatham Borough
Morris County
Chatham Township
New Providence
New Providence Borough
Berkeley Heights Township
Mountainside Borough
Springfield Township
Millburn Township
Essex County
Short Hills Club Ponds-North
The Mall at Short Hills
Morris And Essex Turnpike
Woodland Avenue
Bellevue Avenue
Hillcrest Avenue
River Road
Passaic Avenue
Morris Avenue
Kent Place Boulevard
Summit Avenue
Hobart Avenue
Springfield Avenue
Broad Street
Maple Street
Passaic River tributary
Salt Brook
Salt Brook tributary
Blackburn Road
Division Avenue
Tulip Street
Oak Ridge Avenue
Ashland Road
Mountain Avenue
Glenside Avenue
Cole Road
Interstate 78
Lake Surprise
Baltusrol Golf Club
Van Winkle Brook
Railway River tributary
West Branch Salt Brook
Central Branch Salt Brook
South Fork Salt Brook
City Hall
Train Station
Patches that Meet Habitat Suitability Requirements for endangered, threatened or priority wildlife species (Rank 1)
Patches with Species of Special Concern (Rank 2)
Patches with State Threatened Species (Rank 3)
Patches with State Endangered Species (Rank 4)
Patches with Federal Endangered Species (Rank 5)
Water Body
City of Summit
Municipal Boundaries
N
0 0.1 0.2 0.4 0.6 0.8 Miles
Map Prepared: September 10, 2025
THE LAND CONSERVANCY OF NEW JERSEY
19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973) 541-1010
TLC-NJ.ORG

and little brown bat (*Myotis lucifugus*) are classified as endangered species in New Jersey. The big brown bat (*Eptesicus fuscus*), Eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), and silver-haired bat (*Lasionycteris noctivagans*) are species of special concern. Site observation and sound monitoring during the study also confirmed the presence of two threatened migratory birds, the veery and the wood thrush.

Habitat for bats, particularly those which are endangered, can be managed and improved to support the survival of the species. NJDEP recommends maintaining 60% canopy closure, preserving snags, dead or dying trees, protecting valuable roost trees, and creating artificial roosts like bat boxes. In known habitat locations, disturbance can be prevented by regulating forestry operations during the hibernation period, and limiting operations near water sources and known hibernacula.[37]

In addition to habitat disruption, bats in New Jersey and the United States face the threat of white-nose syndrome, a fungal infection that is often deadly.[38] The fungus attacks bats during hibernation, causing a white fuzz to appear on the face. The condition disrupts the hibernation cycle, causing active behavior during odd times, where the bats burn the fat that would be used to survive winter months.

Vernal Habitat

Vernal pools are confined wetland depressions that fill with water for at least two consecutive months, usually in the fall rainy season, and later become completely dry, making them unable to sustain fish species. Without predatory fish that would eat larvae, vernal habitat is crucial for amphibian species to reproduce and thrive. There are over twenty species of amphibians in New Jersey that use vernal pools for breeding, including seven "obligate vernal pool breeders" whose survival is dependent upon them.

Vernal habitat can take different forms, for example: isolated depressions in upland forests, seasonally flooded meadows, floodplain swamps, or abandoned gravel pits. Vernal pools in New Jersey tend to be found in rural areas of the Skylands, Piedmont, and Coastal Plain regions.

The NJDEP initiated the Vernal Pool Survey Project in the year 2000 to identify, monitor, and protect vernal habitat in the state. New Jersey's Freshwater Wetlands Protection Act Rules (N.J.A.C. 7:7A-1.4) defines vernal habitat as a wetland that meets all of the following criteria:

- Must consist of or contain a confined basin or depression without a permanently flowing outlet.
- Must feature evidence of breeding by at least one facultative vernal habitat species (identified in N.J.A.C. 7:7A.)
- Must contain ponded water for at least two continuous months between March and September of a normal rainfall year.
- Must remain free of fish populations throughout the year, or dry up for some time in a normal rainfall year.

Mapping of vernal habitat is carried out by the Landscape Project of the NJDEP. In this process, vernal habitat is categorized in two ways, as potential habitat and certified habitat:

- **Potential vernal habitat areas** are 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 are sites which have been field-inspected and found to meet the physical characteristics of a vernal habitat, but for which biological criteria is not yet measured; as well as sites that have not been checked by NJDEP staff.

- **Vernal habitat areas** contain pools that have been field-verified by the NJDEP and determined to meet both physical and biological characteristics of a vernal habitat in accordance with N.J.A.C. 7:7A-1.4. The Act protects vernal habitat as wetland areas requiring a 50-foot buffer, or a 150-foot buffer if the pool supports a state threatened or endangered species.

Map 5 shows the locations of potential vernal habitat in and around Summit. One area of observed vernal habitat is found on the northern border, centered in Millburn Township. Another potential vernal habitat area is found near Hidden Valley Park, centered in Springfield Township.

Wildlife Conservation

Supporting biodiverse ecosystems requires the protection and stewardship of native habitat. The use of native plants in landscaping, construction of pollinator gardens, and habitat restoration projects are some ways that wildlife diversity is being supported in Summit and beyond. The preserved land of the Watchung Reservation supports biodiverse wildlife in its landscape. Included in its 2,000-acre expanse are several natural overpasses that traverse Interstate 78. The unique infrastructure expands the contiguous area of the preserve, offering more area for wildlife to travel and forage.[39]

The Trailside Nature & Science Center at the Watchung Reservation educates the public on the environment and stewardship of healthy ecosystems, with community programming to engage visitors in their work. The Center contains exhibits on forest communities, vernal pools, meadows, and wetlands among many others, as well as a wildlife viewing area and bird exhibit.[40]

A recent restoration project in the Watchung Reservation was completed in 2022 by the Conserve Wildlife Foundation. Together with volunteers, the Union County Parks and Recreation Department, and the Trailside Nature Center, a garden overgrown with invasive vines was cleared and landscaped with native wildlife-friendly plants to attract bees, butterflies, hummingbirds, and other birds.[41] An exclusion fence was installed to protect the new plantings from deer browse.

Statewide Conservation Efforts

New Jersey Bald Eagle Project

The recovery and return of the American bald eagle (*Haliaeetus leucocephalus*) over the last 30 years has been wildlife ecology success story. By 1970, the number of nesting pairs of bald eagles in the state had fallen to only one, due to damage caused by the pesticide dichloro-diphenyl-trichloroethane (DDT) and a legacy of persecution.[42] Since the ban of DDT in 1972, the national population has slowly recovered through state and federal protection programs.[43]

The ENSP began multifaceted restoration efforts in the early 1980s, and an increase in nesting pairs was finally seen beginning in 1990. Human disturbance, pesticides, and heavy metals in the environment continue to pose the greatest threats to bald eagle populations. The ENSP and its Landscape Project continue to map critical habitat, including areas used for foraging, roosting, and nesting.

The federal government removed the bald eagle from its list of Endangered Species in 2007 due to its national resurgence.[44] In January 2025, the bald eagle was officially removed from the list of endangered species at the state level in New Jersey.[45] Bald eagles will still receive attention as species of special concern, but the population has experienced a statewide resurgence. Bald eagles can now be found in all areas of the state, with a record 293 nesting pairs observed in 2024. The Bald Eagle Project continues to monitor nesting pairs, taking protective measures when appropriate.

Deer Management

Overabundant populations of white-tailed deer in Summit and New Jersey as a whole have been acknowledged as problematic for local ecosystems, forest health, and human communities. The Union County Parks system conducts an annual deer management program to control populations of deer in county and municipal properties and bring them to sustainable levels.[46]

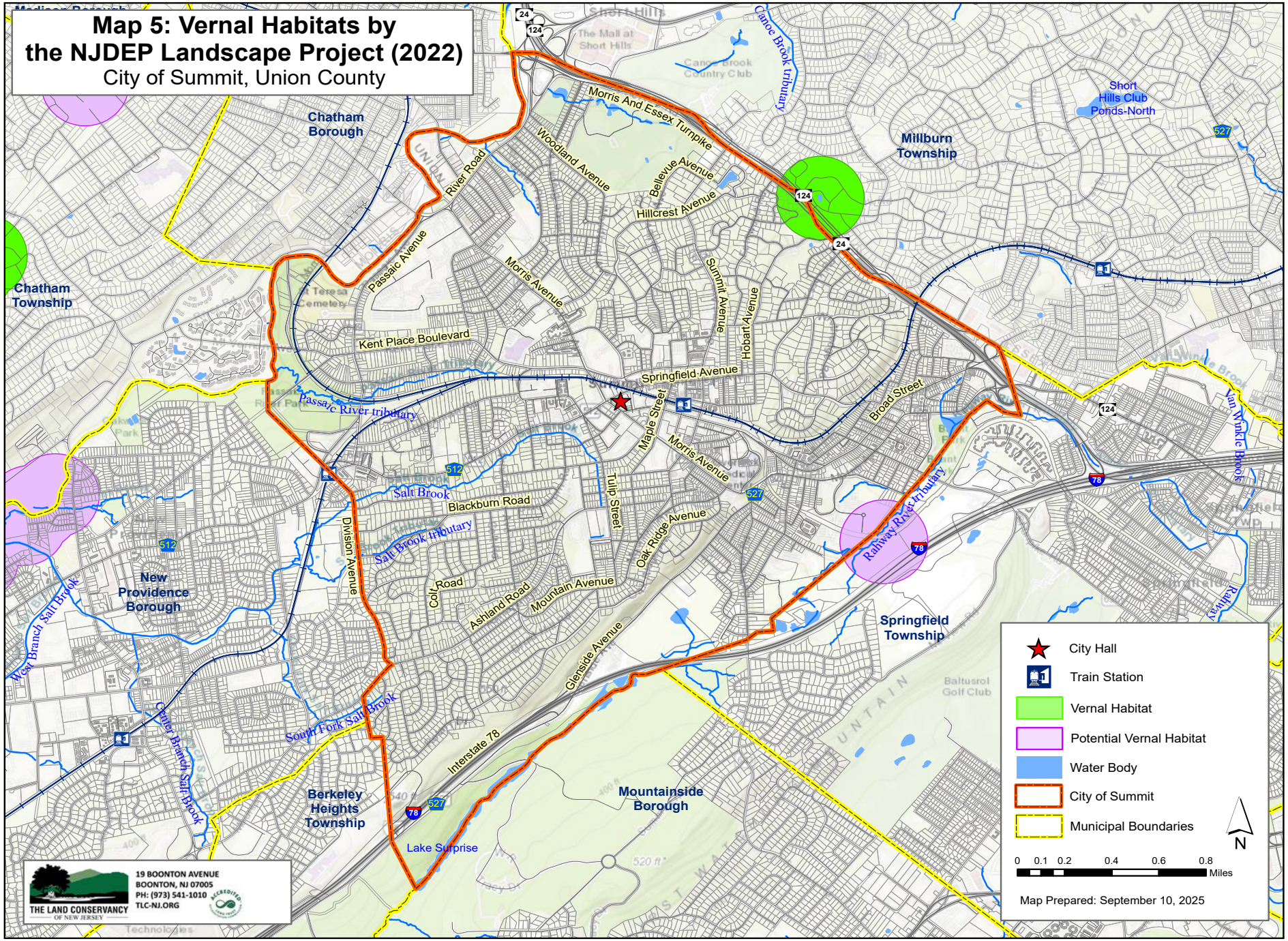
Studies have shown that a healthy and sustainable population of white-tailed deer consists of approximately 10-20 animals per square mile.[47] This is the level that allows the forest understory to recover from deer browsing and regenerate itself while continuing to support other wildlife. Surveys from the New Jersey Farm Bureau found deer populations of over one-hundred deer per square mile on average from sampling areas across eight counties.[48]

In areas supporting high-density deer populations, the forest ecosystem can be heavily degraded. Effects of overbrowsing by deer include the local disappearance of native species, minimal tree regeneration, and loss of forest structure.[49] These impacts threaten birds and other wildlife that rely on the understory for foraging and nesting. By consuming vegetation in large amounts, deer create a physical disturbance in the ecosystem that facilitates the entry and establishment of invasive plant species. These plants are typically unfavorable to the diets of deer, which allows them to thrive.[50]

Deer overpopulation also poses problems for human communities. As forest habitat decreases, deer and other wildlife encroach further into developed areas in search of alternative food sources, which may come from residential landscapes. The increased presence of deer in urban and suburban areas can pose a public safety hazard, as the risk of deer-vehicle collisions increases.[51]

Union County has sponsored a successful state-regulated deer management program since 1995, beginning with culls in the Watchung Reservation.[52] The program has grown over the years and now includes over a dozen parks in Union County. In Summit, these locations include the Watchung Reservation, Passaic River Park, Reeves-Reed Arboretum, and Hidden Valley Park. The County recruits volunteer community-minded licensed hunters to reduce populations of deer in key parks each fall-winter season.[53]

The aims of the program are to minimize the incidence of deer-related motor vehicle accidents, prevent overbrowsing of native vegetation in the park areas, allow forest regeneration, and minimize browsing of residential landscaping in the surroundings. In the 2023-2024 season, a total of 168 deer were killed, and 108 of them were butchered for Community FoodBank donations, culminating in over 7,000 meals for food insecure families.[54]


Map 5: Vernal Habitats by the NJDEP Landscape Project (2022)
City of Summit, Union County
Chatham Borough
Chatham Township
Millburn Township
New Providence Borough
Springfield Township
Berkeley Heights Township
Mountainside Borough
Short Hills Club Ponds-North
Morris And Essex Turnpike
Woodland Avenue
Bellevue Avenue
Hillcrest Avenue
River Road
Passaic Avenue
Morris Avenue
Summit Avenue
Hobart Avenue
Kent Place Boulevard
Springfield Avenue
Broad Street
Maple Street
Tulip Street
Oak Ridge Avenue
Blackburn Road
Division Avenue
Colt Road
Ashland Road
Mountain Avenue
Glenside Avenue
Interstate 78
Salt Brook
Salt Brook tributary
Passaic River tributary
Canoe Brook tributary
Railway Right tributary
Van Winkle Brook
West Branch Salt Brook
Center Branch Salt Brook
South Fork Salt Brook
Lake Surprise
City Hall
Train Station
Vernal Habitat
Potential Vernal Habitat
Water Body
City of Summit
Municipal Boundaries
N
0 0.1 0.2 0.4 0.6 0.8 Miles
Map Prepared: September 10, 2025
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BOONTON, NJ 07005
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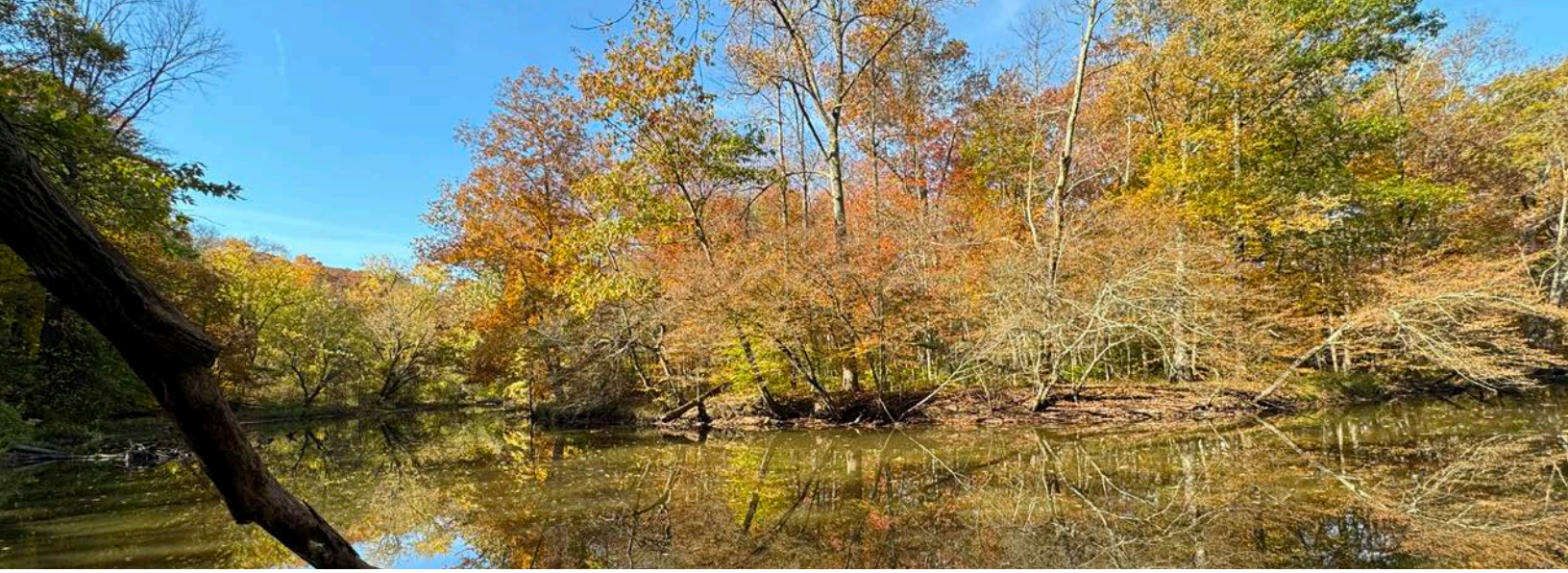


Passaic River
Photo: Donna Goggin Patel

Chapter 4.

Hydrology

Overview

The City of Summit is divided by three watersheds: the Upper Passaic River, the Rahway River, and the Lower Raritan River. About 60% of the City, including the northern and eastern portions, drains to the Passaic River watershed. Drinking water in Summit and the surrounding Short Hills region comes in part from the Passaic River and Canoe Brook, both of which are in NJDEP's Watershed Management Area 6. To protect the quality and quantity of water in its watersheds, the City has enacted several ordinances meant to control stormwater, limit pollution and nutrient runoff from its developments.

The Watershed Framework

A watershed is a topographic area in which surface water runoff drains to a specific point on a stream or other body of water.[55] Rainfall in a watershed is channeled within its geography and eventually drains into the ground or a known body of water. As a geographic unit, a watershed defines an area based on similar hydrological characteristics. Because of the way that water flows through a watershed, the environmental health of its land plays a key role in the health of local surface waters and groundwater.[56]

For this reason, the delineation of watersheds is useful for understanding water systems and the factors that affect the quality and quantity of water in a given area. In the management of water resources, watershed boundaries serve as a more science-based framework than political jurisdictions, enabling cooperation among a watershed.[57]

Summit's Watersheds

Summit lies in three different watersheds. Outlined in **Table 7**, these are: Passaic River Upper (above the Pine Brook Bridge); Rahway River/Woodbridge Creek; and Raritan River Lower (from Lawrence to Millstone). Watersheds are described by the NJDEP using 14-digit hydrologic units (HUC14) in order to identify the area that drains to a point of interest.

Beyond the watershed or HUC14 distinction, areas are further divided into localized sub-watersheds. Multiple watersheds are also aggregated into Watershed Management Areas (WMAs). The three watersheds found in Summit align with three separate WMAs, visualized in **Map 6** and described further below:

- **WMA6:** The northern and western parts of Summit lie in the Upper Passaic, Whippany, and Rockaway WMA (WMA6). In Summit, the Passaic River watershed contains the Passaic River, Martin's Brook, Salt Brook, and other unnamed tributaries. The larger WMA6 is drained by waters from the upper reaches of the Passaic River Basin, including the Passaic River from its headwaters in Morris County, to the confluence of the Pompton River. This watershed is a source of drinking water for much of northeastern New Jersey.[58]

- **WMA7:** The eastern part of Summit lies in the Arthur Kill WMA (WMA7) and the Rahway River watershed. Associated waterways within Summit are Briant Pond, Briant Brook, and unnamed tributaries. WMA7 stretches across Essex, Union, and Middlesex Counties. It is defined by the Rahway River, which flows from Union County into the Arthur Kill near Linden.[59]

- **WMA9:** The southeastern edge of Summit lies in the Lower Raritan, South River, Lawrence WMA (WMA9). In Summit, this contains Green Brook and unnamed tributaries. WMA9 covers Middlesex, Somerset, and Monmouth Counties following the Lower Raritan, South, and Lawrence Rivers. It stretches north into Union County around Green Brook, a tributary of the Rahway that rises in the Watchungs.[60]

Table 7. HUC14 Watersheds in City of Summit

WMA	Watershed Name	Sub-Watershed Name	Acres	% Total
06 - Upper Passaic, Whippany, and Rockaway	Passaic River Upper (above Pine Brook bridge)	Passaic River Upper	2,462	64%
		Canoe Brook	17	0.5%
07 - Arthur Kill	Rahway River / Woodbridge Creek	Baltusrol Tributary (above Springfield Station)	858	22%
09 - Lower Raritan, South River, Lawrence	Raritan River Lower (Lawrence to Millstone)	Green Brook (above / including Blue Brook)	524	13.5%
		Total	**3,861**	**100%**

Source: NJDEP HUC14 Watershed Tabular Data

Watershed Management

Great Swamp Association (GSWA)

Across the western border from Summit into Morris County begins the Great Swamp watershed. This watershed is home to the headwaters of the Passaic River and contains five main streams that drain to their lowest point in the Great Swamp. The Great Swamp is a protected 7,580-acre National Wildlife Refuge managed by the U.S. Fish and Wildlife Service. The swamp stores floodwaters and supports rare and biodiverse ecosystems, containing over 800 species of plants and animals.

The Great Swamp watershed is a sub-watershed of WMA6, which begins to the west of Summit and includes parts of 10 municipalities.[61] The Great Swamp Watershed Association (GSWA) serves communities in the watershed area by supporting and guiding efforts to manage water resources. Some activities of GWSA include community outreach and education, green infrastructure projects, land preservation and stewardship. GSWA also monitors water quality along the Passaic River, giving particular attention to its downstream portions that are impacted by heavy development. Below Dundee Dam, the water and sediment are heavily impacted by contamination of dioxins, PHA, and PCBs.[62]

GSWA published its most recent Water Quality Report Card in 2023, reporting the results of chemical monitoring, bacteria monitoring, macroinvertebrate sampling, microplastics sampling, and visual assessments of the water.
View the 2023 GSWA Report Card.

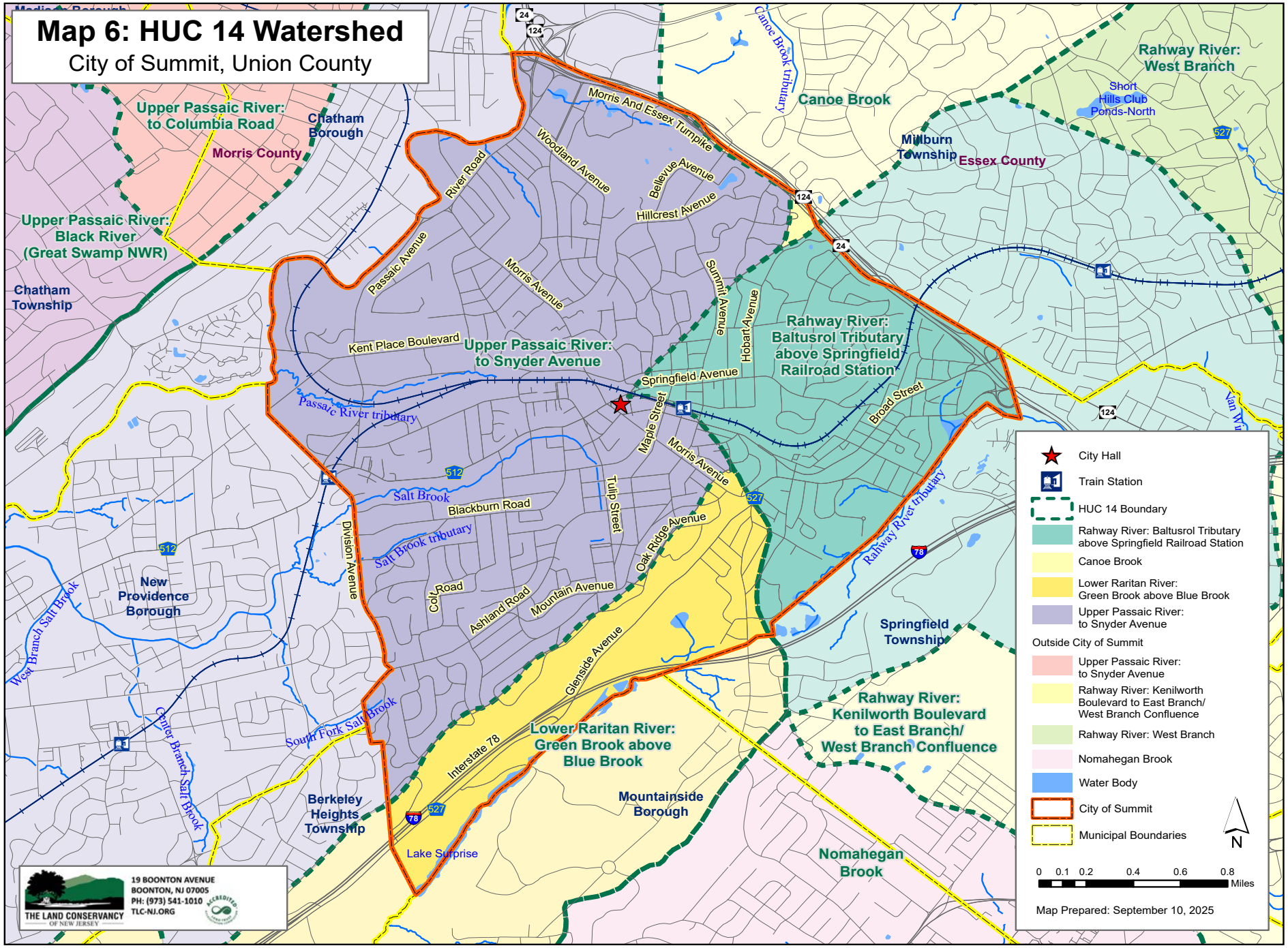
Rahway River Association (RRWA)

Summit is one of 24 municipalities in the Rahway River Watershed, which spans portions of Essex, Middlesex, and Union Counties.[63] The watershed is a part of WMA7 (Arthur Kill), and it incorporates the eastern part of Summit, where a tributary of the Rahway runs along the municipal border through Briant Park. Water from this watershed drains to the Rahway River and to the Arthur Kill.

The Rahway River Watershed Association (RRWA) works to protect and restore the Rahway River and its ecosystems, which are important to the quality of life of communities of the watershed. The Rahway River provides drinking water to the City of Rahway, supports biodiverse wildlife across three urban counties, and provides recreational and aesthetic value to its communities.

Improvements to water quality and the health of the river ecosystem are mainly achieved through stormwater

> The New Jersey Department of Environmental Protection adopted a watershed management approach in 1996, in order to maintain the physical, chemical, and biological integrity of the state's waters.[86] The methods of this approach are three-fold: defining geographic boundaries of watersheds, basing water policy on scientific principles, and developing public partnerships to involve people in the management of their watersheds. Further advancing this approach, the NJDEP created the Watershed and Land Management Program in 2020 to integrate elements of the Land Use Management and Water Resource Management programs.[87]


Map 6: HUC 14 Watershed
City of Summit, Union County
Upper Passaic River: to Columbia Road
Chatham Borough
Morris County
Upper Passaic River: Black River (Great Swamp NWR)
Chatham Township
Canoe Brook tributary
Canoe Brook
Rahway River: West Branch
Short Hills Club Ponds-North
Millburn Township
Essex County
Morris And Essex Turnpike
Woodland Avenue
River Road
Bellevue Avenue
Hillcrest Avenue
Passaic Avenue
Morris Avenue
Summit Avenue
Hobart Avenue
Rahway River: Baltusrol Tributary above Springfield Railroad Station
Kent Place Boulevard
Upper Passaic River: to Snyder Avenue
Springfield Avenue
Broad Street
Passaic River tributary
Maple Street
Morris Avenue
Salt Brook
Blackburn Road
Tulip Street
Salt Brook tributary
Division Avenue
Oak Ridge Avenue
Rahway River tributary
Colt Road
Ashland Road
Mountain Avenue
New Providence Borough
West Branch Salt Brook
Springfield Township
Glenside Avenue
Rahway River: Kenilworth Boulevard to East Branch/ West Branch Confluence
South Fork Salt Brook
Center Branch Salt Brook
Interstate 78
Lower Raritan River: Green Brook above Blue Brook
Mountainside Borough
Berkeley Heights Township
Lake Surprise
Nomahegan Brook
City Hall
Train Station
HUC 14 Boundary
Rahway River: Baltusrol Tributary above Springfield Railroad Station
Canoe Brook
Lower Raritan River: Green Brook above Blue Brook
Upper Passaic River: to Snyder Avenue
Outside City of Summit
Upper Passaic River: to Snyder Avenue
Rahway River: Kenilworth Boulevard to East Branch/ West Branch Confluence
Rahway River: West Branch
Nomahegan Brook
Water Body
City of Summit
Municipal Boundaries
N
0 0.1 0.2 0.4 0.6 0.8
Miles
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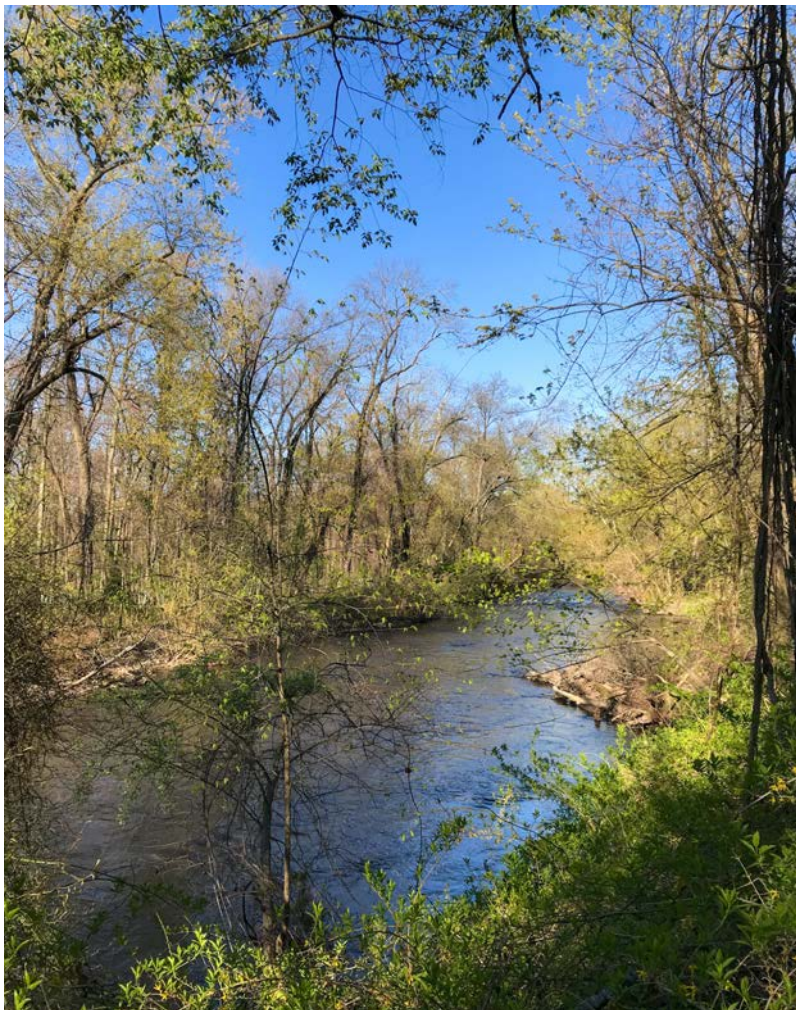
management strategies. By capturing and controlling stormwater runoff, the health of the river and quality of water is protected from pollution, excess nutrients, and other impacts of human development. RRWA provides resources and support to towns that wish to undertake green infrastructure projects, including infiltration systems like rain gardens and swales, rainwater harvesting systems, downspout disconnection, and planting native trees and vegetation.[64]

RRWA has a longstanding Water Quality Monitoring Program, which publishes reports periodically on water quality in major streams of the watershed. The assessments track water clarity, visual appearance, and water temperature; these factors indicate the ability of aquatic and riparian wildlife and vegetation to thrive and support a healthy stream.

View the 2018 RRWA Report Card.



Passaic River Park in Summit
Photo: Dwight Hiscano

Lower Raritan Partnership (LRWP)

The Raritan River extends through seven counties and 100 municipalities, with about 30,000 streams comprising the entire river system. Municipalities in the Lower Raritan Watershed (WMA9) drain to the lower portion of the Raritan, where it flows to the Raritan Bay.[65]

The Lower Raritan Watershed Partnership (LRWP) aims to conserve, enhance, and restore WMA9 (Lower Raritan) through stewardship, community based participatory science, and ecological education. LRWP group conducts water monitoring at several points along the river, tracking concentrations of pollutants, pathogens, and visual quality.

View the work of LRWP, including reports on river health, biodiversity, flooding, and climate change impacts.

Surface Water

Surface water found in lakes, ponds, rivers, and streams performs essential services for aquatic ecosystems as well as humans. It serves as habitat for diverse plant and animal life and regulates water quality, used for drinking water, irrigation, wastewater treatment, industrial and recreational uses.[66]

NJ Surface Water Quality Standards (SWQS) [N.J.A.C. 7:9]classify streams

based on their functions and establish quality criteria for monitoring surface waters. SWQS are the basis for legislation to protect water quality in the state, including general, technical, antidegradation, nutrient, and mixing zone policies. Surface waters are categorized according to the type and quality of waterbody and its designated use.[67]

Summit's Surface Waters

All 10.7 stream miles of surface water in Summit are classified as FW2-NT, or non-trout-supporting freshwaters (**Table 8**). Locations of surface water bodies are shown in **Map 7**.

Classification Types

Fresh Water 2 (FW2) encompasses all freshwaters that are not of uniquely high quality. These waters are further classified based on their ability to support trout production (FW2-TP), trout maintenance (FW2-TM), or as nontrout waters (FW2-NT). Dual classification (e.g., FW2-NT/SE2) indicates that waters change from freshwater to saline as they drain into an estuary or ocean. Saline waters are classified as saline estuarine (SE) and saline coastal (SC). Classes SE1, SE2, and SE3 indicate ability to support recreation, shellfish harvesting, and warm water fish species.

Other Surface Water Classes

Fresh Water 1 (FW1) is a higher classification of freshwaters, reserved for surface waters distinguished by unique ecological significance, recreational value, or aesthetic quality. They are not subject to any man-made wastewater discharges. There are no FW1 waters in or around Summit.

Category 1 Waters (C1) are further protected for exceptional ecological significance. Antidegradation policies are set forth in N.J.A.C. 7:9B-1.5(d) to protect surface waters from measurable changes in quality characteristics related to clarity, color, scenic setting, other characteristics of aesthetic, ecological, or recreational value, exceptional water supply or fisheries resources. There are no C1 waters in Summit, but the nearby streams of Great Swamp are FW2-NT C1.[68]

Supporting a Healthy Watershed at Home

Households and individuals can play a part in protecting and restoring watershed health by practicing responsible use of water resources and reducing nutrient runoff from their property.[88]

- Plant native, multi-stemmed plants at the bottom of sloped areas.
- Break up large areas of mowed lawn with gardens of native plants, which absorb more water than lawn grasses and ornamental plans.
- Use road and sidewalk salt sparingly. Consider alternatives such as calcium magnesium acetate.
- Pick up pet waste, including in the yard.
- Perform regular maintenance on septic tanks to reduce bacteria levels.

In 2020, the NJDEP Division of Water Monitoring amended the SWQS (N.J.A.C. 7:9B) to designate an additional 600 miles of rivers and streams as Category One (C1) waterways.[69] New Jersey has approximately 23,500 river miles, of which 6,800 are designated as C1 waters. This rule widened the riparian zone around newly listed C1 waters. 547 of the 600 river miles are listed for their ecological significance; 53 miles are for exceptional fisheries resources. These changes do not affect the surface water bodies of Summit, as there are no C1 waters within city boundaries.

Table 8. Surface Waters in Summit

Class	Stream	Miles	% Total
FW2-NT	Blue Brook	0.4	3.7%
	Blue Brook UNT	0.3	2.4%
	Briant Pond	0.2	2.0%
	Lake Surprise	1.4	12.6%
	Passaic River	2.6	24.6%
	Passaic River UNT	1.9	17.5%
	Rahway River UNT	1.3	11.7%
	Salt Brook	1.6	15.3%
	Salt Brook UNT	0.4	4.0%
	South Fork Salt Brook	0.1	0.8%
	Uncoded Tributary	0.6	5.8%
	Total FW2-NT:	**10.7**	**100%**

UNT = Unnamed tributary
Source: NJDEP Surface Water Data

Surface Water Quality Factors

Pollution

Surface water quality can be affected by pollution, including point sources and non-point sources; air deposition, erosion and sedimentation, and the presence of invasive species.

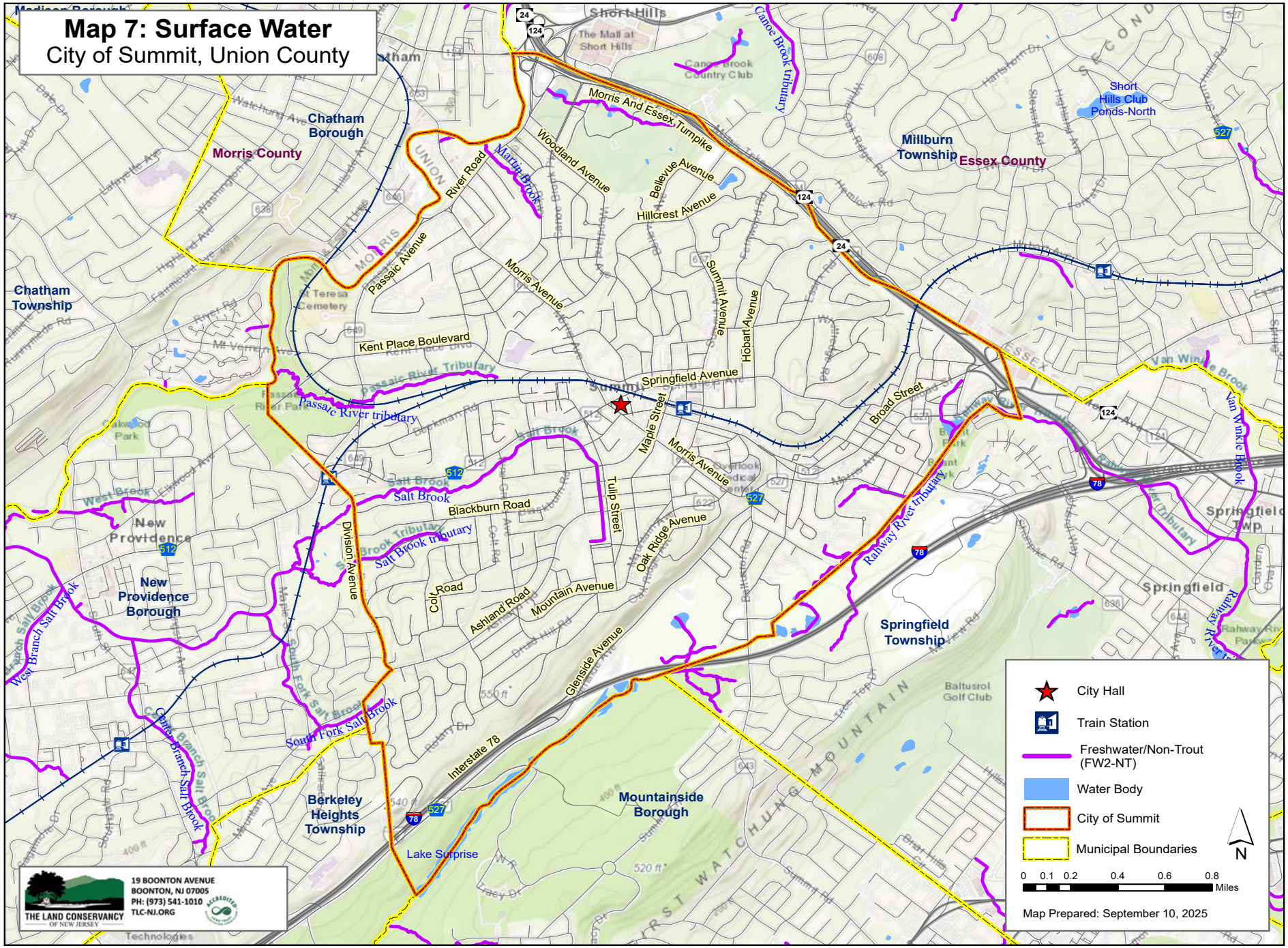
Point sources of pollution are any discernible, confined, and discrete point from which pollutants may be discharged.[70] This includes discharges from sewage treatment plants and factories, stormwater runoff, illegal dumping, malfunctioning underground storage tanks and septic tanks.

Non-point source pollution can come from many different sources. As rainfall or snowmelt moves over and through the ground, it 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 pollution creates overall negative outcomes for drinking water supplies, recreation, fisheries, and wildlife.

Eutrophication

One effect of runoff is known as eutrophication, which refers to the addition of substances, either human-made or natural, to a freshwater body that affect its primary productivity.

The introduction of excess nutrients, such as nitrates and phosphates found in fertilizers, promote large-scale growth of cyanobacteria. Though sometimes called “algal blooms,” this phenomenon does not involve true algae, but harmful bacteria that resemble it.[71]


Map 7: Surface Water
City of Summit, Union County
Chatham Borough
Morris County
Chatham Township
New Providence
New Providence Borough
Berkeley Heights Township
Mountainside Borough
Springfield Township
Millburn Township
Essex County
Short Hills
The Mall at Short Hills
Canoe Brook Country Club
Short Hills Club Ponds-North
Morris And Essex Turnpike
Woodland Avenue
Bellevue Avenue
Hillcrest Avenue
River Road
Martin Brook
Passaic Avenue
Morris Avenue
Summit Avenue
Hobart Avenue
Kent Place Boulevard
Springfield Avenue
Broad Street
Maple Street
Passaic River tributary
Salt Brook
Blackburn Road
Tulip Street
Oak Ridge Avenue
Division Avenue
Colt Road
Ashland Road
Mountain Avenue
Glenside Avenue
Interstate 78
Lake Surprise
Railway River tributary
Van Winkle Brook
West Branch Salt Brook
South Fork Salt Brook
Canoe Brook tributary
Passaic River Tributary
Salt Brook tributary
Baltusrol Golf Club
City Hall
Train Station
Freshwater/Non-Trout (FW2-NT)
Water Body
City of Summit
Municipal Boundaries
N
0 0.1 0.2 0.4 0.6 0.8 Miles
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Harmful algal blooms (HAB) cause surface water to become cloudy and discolored, which prevents light penetration and inhibits the growth of aquatic plants. When cyanobacteria die, excess nutrient availability from decomposition can cause depleted levels of dissolved oxygen (hypoxia or anoxia), threatening life in the water.[72] Human exposure to cyanobacteria cells can cause a range of health effects, including allergy-like reactions, respiratory and gastrointestinal irritation. Ingestion can cause more serious health effects, especially in children and pets. Recreational lakes and other water bodies are monitored for algal blooms and restricted accordingly.

NJDEP maintains a dashboard to monitor algal blooms across the state. See the HAB Alert Dashboard for more information.

Sedimentation

Water quality can also be impacted by sedimentation, or the transportation and deposition of eroded materials.[73] A primary cause of sedimentation is land development near streams and on steep slopes that reduce vegetative cover and results in exposed soil. The vegetative cover can typically absorb the impact of raindrops, but when it is removed the exposed soil can easily be eroded. Eroded soil can then be transported to surface waters, where it contaminates and increases the turbidity of the water, blocking sunlight to plant species and damaging the health of the aquatic ecosystem.

Local Water Quality

As a densely populated and developed state, New Jersey has long faced issues with water quality. Areas of the state with unimpaired waters tend to be those that have less development, where riparian zones and stream buffers are left fully intact. Much of Union County is characterized by urban development and a long history of industrial and commercial activity, particularly around the Rahway River. Past and present contamination problems, regular sources of point and nonpoint pollution, and hazardous waste sites affect the health of local surface waters.

The NJ Integrated Water Quality Assessment Report for 2022 focuses on the Northeast Water Region, including Summit and its watersheds. The water quality trend analysis in the report indicates that overall water quality has improved since the 1970s, particularly in regard to total nitrogen and phosphorus content.[74]

At the same time, there has been an upward trend in the level of nitrates, total dissolved solids (TDS), and chlorides. The increase in nitrates can be attributed in part to oxidation measures that are used to reduce ammonia at waste treatment plants. Increased TDS and chloride concentrations are likely caused by runoff from urban areas, including salt used for ice control on roadways.

USEPA: How's My Waterway?

The USEPA Community Waterway Program monitors the quality of surface water for physical, chemical, and biological factors, weighing them against EPA-approved standards or thresholds[75]. While treated drinking water is assessed separately, the waterway quality has implications for not only drinking water,

but aquatic habitat and wildlife, fish and shellfish consumption, and swimming and boating activities.

In reports since 2022, EPA monitoring of the Passaic River in Summit has found impairments in multiple categories. Identified issues include excess bacteria and microbes, degraded aquatic life, low oxygen, murky water, metals, nitrogen and/or phosphorus. For more information on the condition of local waterways and suitability for different activities, visit mywaterway.epa.gov.

Surface Water Discharge

The NJDEP Division of Water Quality regulates wastewater discharge points through the NJ Discharge Elimination System (NJPDES) permitting program. This program ensures proper treatment and discharge of wastewater (and its residuals) and stormwater from various types of facilities and activities.

Surface water discharge locations are classed as major or minor, where major sources see flows of 50 million gallons per day (mgd). NJDEP monitors 10 surface water discharge points in Summit and along its municipal boundaries (**Figure 5, Table 9**). Four of these are major discharge points along the Passaic River, with flows of 50 mgd or more. The other six, found at various locations throughout the City, are minor discharge points.[76]

Outfalls

Stormwater outfalls are structures that transfer water during storm events into a subsurface drainage system and/or stormwater basin. The proper construction of outfalls ensures stability of drainage systems and minimizes erosion at the point of discharge.

According to city data, there are 104 stormwater outfalls in Summit (**Figure 6**). Of these, 80 drain into the Passaic River and are located in the Upper Passaic, Whippany and Rockaway watershed management area. The remaining 24 flow to the Rahway River.[77] The City maintains a list of stormwater drainage sites that are in need of improvement in the **Citywide Drainage Report**, discussed in **Chapter 4.**

Table 9. Surface Water Discharge Points

Facility	Receiving Waters
Summit Property Co LLC (4 locations)	Passaic River
Exxon S/S 3-6259	Passaic River via storm sewer
Former Exxon #33411	Martin's Brook via storm sewer
Texaco S/S 100118	Salt Brook via storm sewer
Former Exxon Facility #33411	Passaic River via UNT & storm sewer
Exxon S/S 3-3426	Passaic River via UNT & storm sewer
Ticona LLC	Briant Pond (Rahway River) via UNT

Source: NJDEP Bureau of GIS[89]

Sites and owners may be different than what is reported by the NJDEP.

Figure 5. NJPDES Surface Water Discharge Points

Source: NJDEP Bureau of GIS

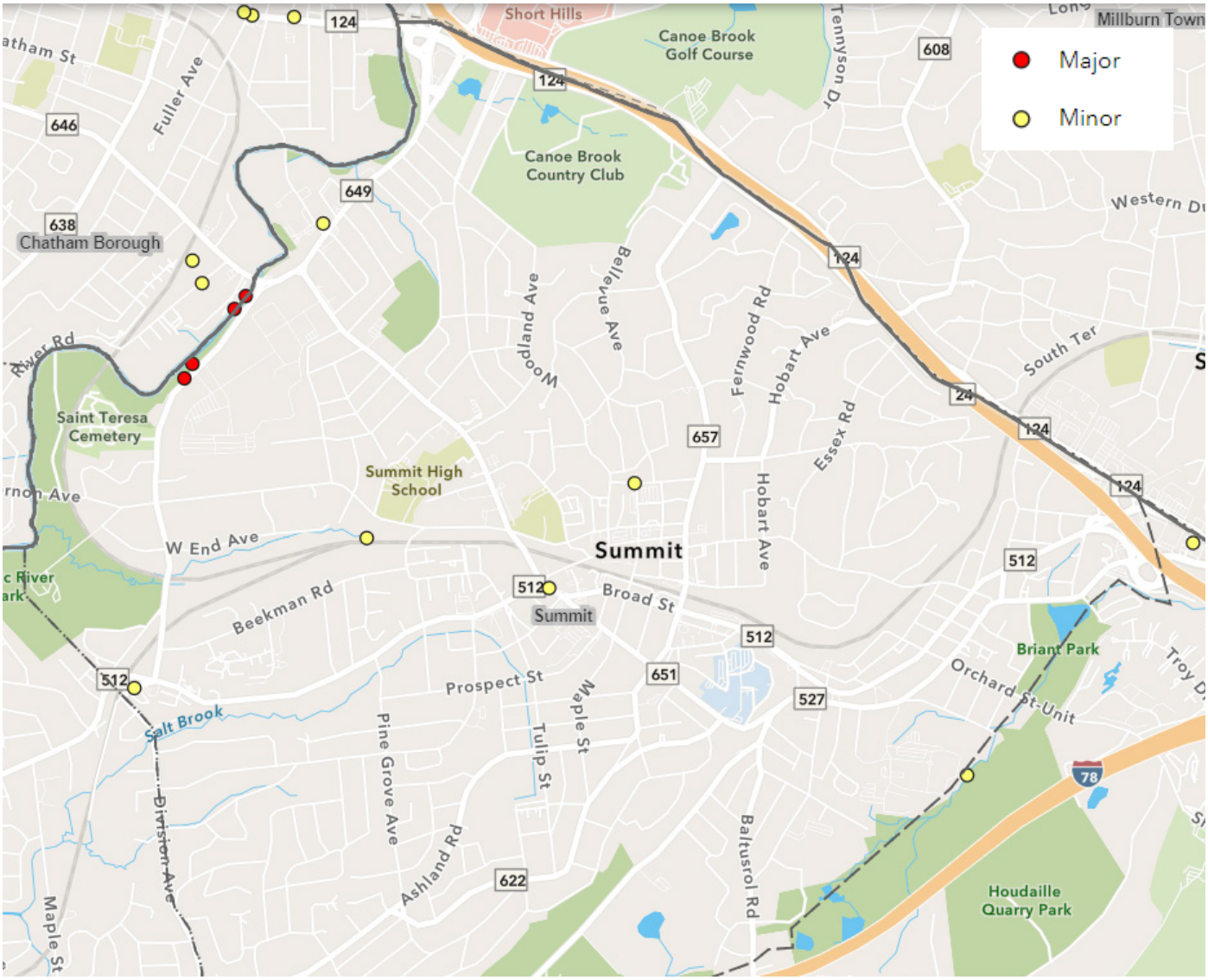
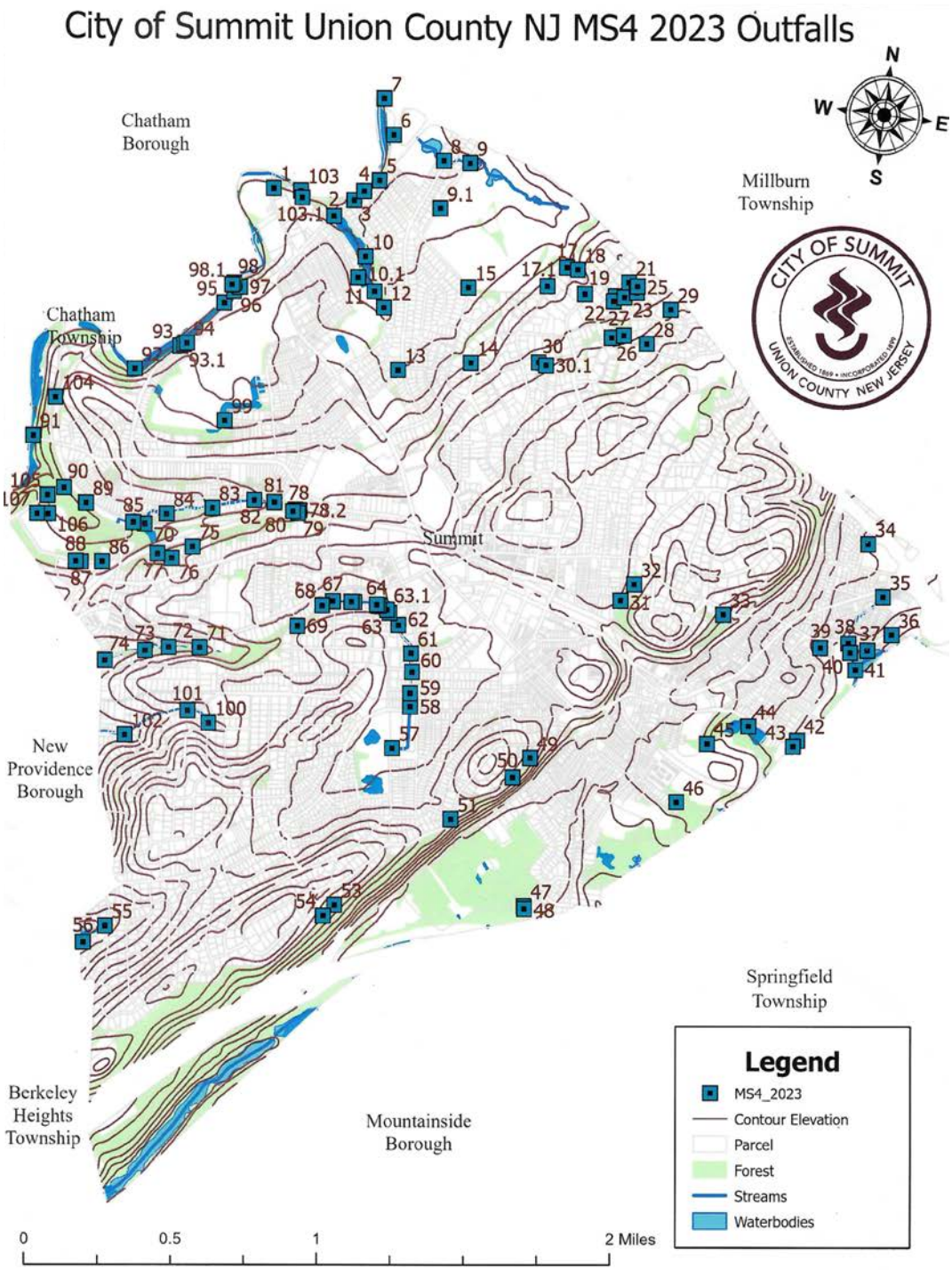


Figure 6. City of Summit MS4 2023 Stormwater Outfalls

Source: City of Summit Engineering Division



Stormwater Ordinance

The City of Summit has several ordinances aimed at controlling stormwater runoff. **§ 26-1: Stormwater Management** of the municipal code enacts rules to help manage the increased rate of surface water runoff created by alterations in ground cover and natural runoff patterns.

By adhering to green infrastructure best management practices (GI BMP), the code aims to achieve flood control, groundwater recharge, and pollutant reduction in appropriate contexts. The ordinance includes sections regarding the proper disposal of pet waste (§ 26-3), prohibiting improper disposal of wastes (§ 26-5), prohibiting illicit sewer connections (§ 26-9), and restrictions on fertilizer applications (§ 26-10).[78]

Aquifers & Aquifer Recharge

An aquifer is an underground formation of permeable rock or unconsolidated materials that can yield significant quantities of water to wells or springs. Aquifer recharge refers to natural or human-controlled process by which water is conveyed underground, replenishing the groundwater stored in aquifers.[79] The rate of recharge is not the same for all aquifers, and that must be considered when pumping well water. Pumping too much water too quickly draws down the water in the aquifer and eventually causes a well to yield less water or run dry.

Aquifers are characterized by the type of geologic formation that underlies an area. Bedrock aquifers consist of rock formations while surficial aquifers are formed from unconsolidated materials, such as sand, gravel, or glacial sediment. Several different bedrock aquifer units underlie Summit, and most of these are confining units, which consist of sand and silt with localized water-table aquifers.

Mapping of aquifers in Summit is as follows: **Map 8** shows bedrock aquifers, **Map 9** shows surficial aquifers, and **Map 10** shows aquifer recharge potential.

Aquifers are ranked based on their ability to yield groundwater to high-capacity wells for water supply, irrigation, and industrial supply wells that are sited and tested for maximum yield.[80] The five aquifer rank values (A, B, C, D, E) are based on the median yields for over 8,000 high-capacity wells (**Table 10**). Each aquifer or confining unit is assigned a rank based on its median yield or, where data is lacking, professional judgment. Aquifers of rank A have the highest median yield of over 500 gallons per minute (gpm), while the rank E yield is less than 25 gpm. Data with more than one ranking value (e.g., B/C) variations in well-yield throughout the area based on lithologic and structural conditions.

Table 10. Statewide Aquifer Well Yield Rankings

Statewide Well Yield Rankings	
Aquifer Rank	**Median Well Yield (Gallons/Minute)**
A	>500
B	250-500
C	100-250
D	25-100
E	<25

Source: NJGS
No recharge is calculated for hydric soils (L/L), wetlands and open water (W/W).

Bedrock Aquifers

Bedrock aquifers are categorized by geologic composition and ranked based on capacity to yield groundwater to high-capacity wells for water supply, irrigation, and industrial-supply wells. Summit lies in the Newark Basin part of the Piedmont region, which consists of several aquifers made of shale and sandstone.[81]

There are two types of bedrock aquifers underlying the City of Summit, which coincide with the contours of the Watchung Mountains (**Map 8**).

The upland Second Watchung Ridge, which trends southwest-northeast under most of the City, is defined by the basalt aquifer. In this aquifer, groundwater is stored and transmitted through the system of fractures in the igneous bedrock, which is hard, dense, and highly-fractured. Water in this aquifer tends to be fresh, slightly to highly alkaline, moderately hard, and characterized by calcium-bicarbonate.[82]

The basalt aquifer has a ranking of D, indicating a well yield of 25 to 100 gallons per minute.

Lower areas of Summit are underlain by the Brunswick aquifer, which consists of sandstone, siltstone, and shale of the Passaic, Towaco, Feltville, and Boonton bedrock formations. Groundwater is stored and transmitted in fractures, and it is normally fresh, slightly alkaline, hard, and non-corrosive. These waters are typically calcium-bicarbonate, but calcium-sulfate waters are also found.

The Brunswick aquifer has a C ranking, with a well yield of 100 to 250 gallons per minute.

Surficial Aquifers

Some areas of New Jersey have a surficial aquifer atop the bedrock aquifer. This refers to an uppermost aquifer layer formed from glacial or fluvial deposits in the surficial geology. Groundwater in surficial aquifers is exchanged with surface water, supporting stream base flow and sensitive wetland ecosystems.

Contaminants and waste pollutants from human activities typically enter groundwater systems in the surficial aquifer before flowing to deeper confined aquifers.[83]

Surficial aquifers in North Jersey are mainly formed in glacial sediments that exceed 50 feet in depth. In Summit, surficial aquifers are limited to the northwestern half of the City and along the Rahway tributary to the east. The remaining surficial sediments do not contain adequate water-bearing formations that are hydrogeologically different than the underlying bedrock aquifer.[84]

Map 9 shows the locations and rankings of surficial aquifers in Summit. Surficial aquifers can be found in much of northern half of the City and along the southeastern edge. Other areas lack a surficial aquifer.

In the northernmost corner, the surficial aquifer consists of till with an aquifer ranking of D, signifying well yields of 25 to 100 gallons per minute (gpm). The rest of the surficial aquifer alternates between sand and gravel (rank B) and morainic deposits (rank B), each of which may yield between 250-500 gpm.

Drinking Water Quality

Public 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 Plan for both public community and public non-community water-supply wells.[85] Groundwater resources provide drinking water to over 40% of the population in New Jersey. By defining Well Head Protection Areas (WHPA), steps can be taken to prevent contamination of groundwater resources, controlling pollutants that are most likely to contaminate drinking water.

WHPAs are delineated in tiers that reflect the average time of travel to the well so that the closest pollution sources and remedies can be prioritized. Tier 1 areas have a time of travel of two years; Tier 2 is five years, and Tier 3 is twelve years.

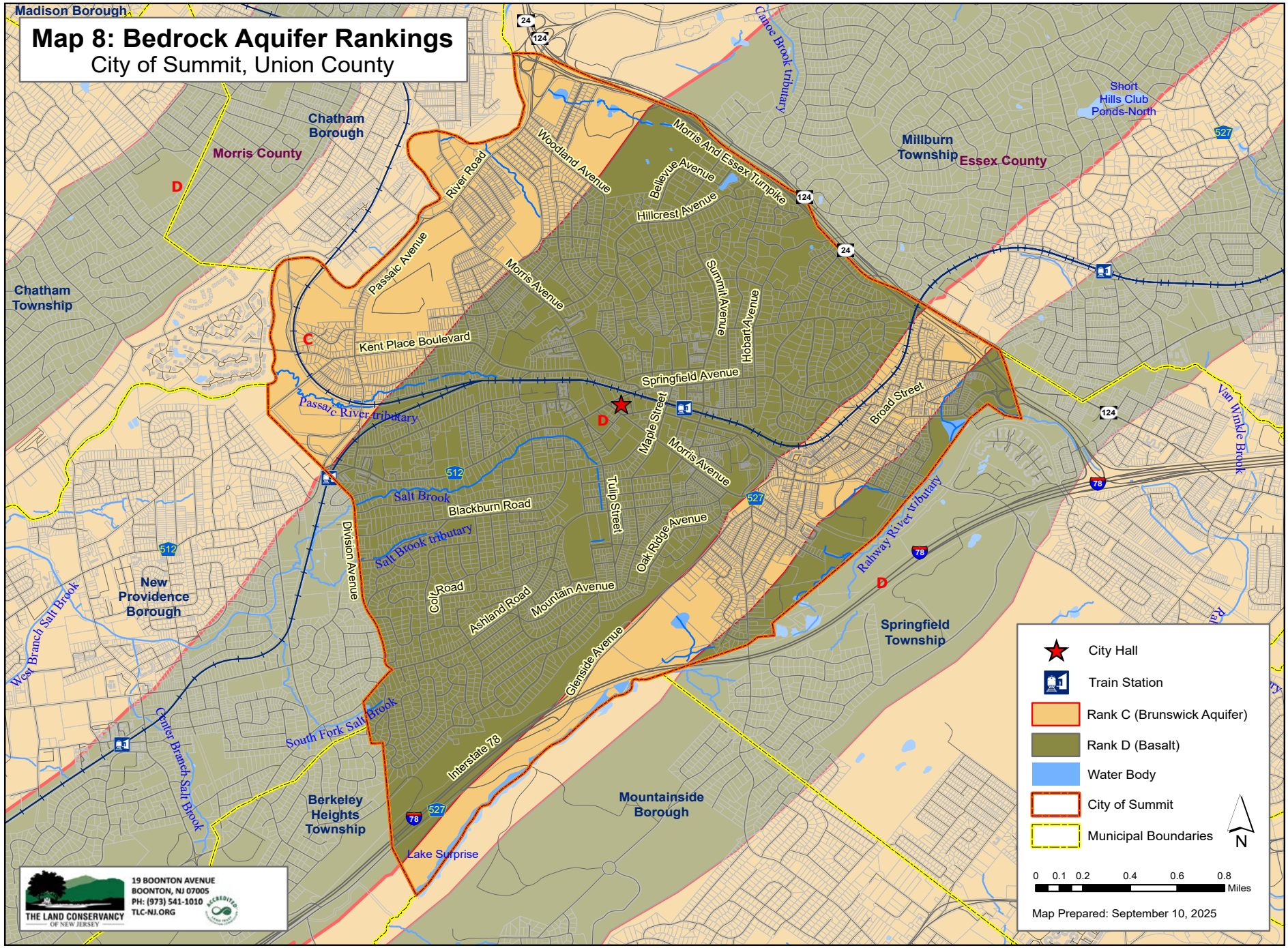
The City of Summit contains five public wellheads, all of which are located around Blue Brook, to the southeast of Glenside Avenue. The northernmost corner of the City also lies in WHPA for Wellheads in Chatham Borough and Millburn Township (**Map 11**).

NJ American Water

Drinking water in Summit is provided by NJ American Water as part of the Short Hills System. The Short Hills System is a public community water system consisting of 25 wells, 4 surface water intakes, 12 purchased groundwater sources, and 3 purchased surface water sources. Source water comes from the following aquifers and surface water bodies: Passaic River, Canoe Brook, Brunswick aquifer, glacial sand and gravel, igneous and metamorphic rock. Purchased water comes from several systems: Southeast Morris County Utilities Authority, Newark, Montclair, NJ American Water Raritan System, and Passaic Valley Water Commission.

Groundwater supplies are disinfected with chlorine, and surface water supplies are treated with chlorine or chloramines to maintain water quality in the distribution system. NJ American Water monitors water contaminant levels and provides annual reports, including data and information on typical pollution sources. In 2024, all tests for primary regulated substances were in compliance with state and federal drinking water requirements.

The full report can be viewed online.


Map 8: Bedrock Aquifer Rankings
City of Summit, Union County
Madison Borough
Chatham Borough
Morris County
Chatham Township
Millburn Township
Essex County
Short Hills Club Ponds-North
New Providence Borough
Springfield Township
Berkeley Heights Township
Mountainside Borough
Lake Surprise
Canoe Brook tributary
Woodland Avenue
River Road
Morris And Essex Turnpike
Bellevue Avenue
Hillcrest Avenue
Passaic Avenue
Morris Avenue
Summit Avenue
Hobart Avenue
Kent Place Boulevard
Springfield Avenue
Broad Street
Maple Street
Passaic River tributary
Van Winkle Brook
Salt Brook
Blackburn Road
Salt Brook tributary
Tulip Street
Oak Ridge Avenue
Division Avenue
Colt Road
Ashland Road
Mountain Avenue
Glenside Avenue
Rahway River tributary
West Branch Salt Brook
Center Branch Salt Brook
South Fork Salt Brook
Interstate 78
D
C
City Hall
Train Station
Rank C (Brunswick Aquifer)
Rank D (Basalt)
Water Body
City of Summit
Municipal Boundaries
N
0 0.1 0.2 0.4 0.6 0.8
Miles
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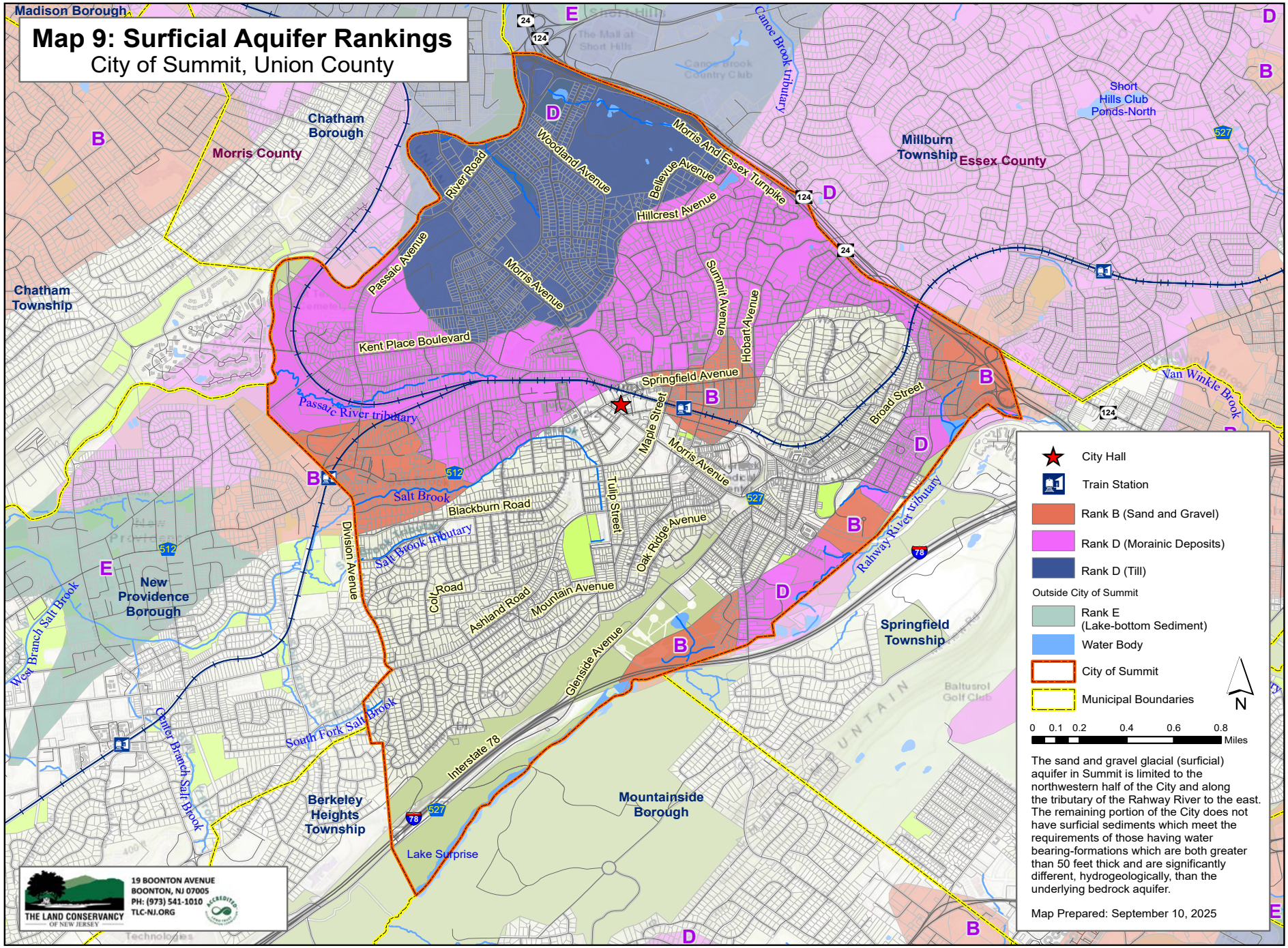
Map 9: Surficial Aquifer Rankings
City of Summit, Union County
Madison Borough
Chatham Borough
Morris County
Chatham Township
New Providence Borough
Berkeley Heights Township
Mountainside Borough
Springfield Township
Millburn Township
Essex County
Short Hills Club Ponds-North
Canoe Brook tributary
Woodland Avenue
River Road
Bellevue Avenue
Morris And Essex Turnpike
Hillcrest Avenue
Passaic Avenue
Morris Avenue
Summit Avenue
Hobart Avenue
Kent Place Boulevard
Springfield Avenue
Broad Street
Maple Street
Passaic River tributary
Van Winkle Brook
Salt Brook
Blackburn Road
Tulip Street
Oak Ridge Avenue
Salt Brook tributary
Division Avenue
Colt Road
Ashland Road
Mountain Avenue
Rahway River tributary
West Branch Salt Brook
South Fork Salt Brook
Center Branch Salt Brook
Glenside Avenue
Interstate 78
Lake Surprise
Baltusrol Golf Club
City Hall
Train Station
Rank B (Sand and Gravel)
Rank D (Morainic Deposits)
Rank D (Till)
Outside City of Summit
Rank E (Lake-bottom Sediment)
Water Body
City of Summit
Municipal Boundaries
N
0 0.1 0.2 0.4 0.6 0.8
Miles
The sand and gravel glacial (surficial) aquifer in Summit is limited to the northwestern half of the City and along the tributary of the Rahway River to the east. The remaining portion of the City does not have surficial sediments which meet the requirements of those having water bearing-formations which are both greater than 50 feet thick and are significantly different, hydrogeologically, than the underlying bedrock aquifer.
Map Prepared: September 10, 2025
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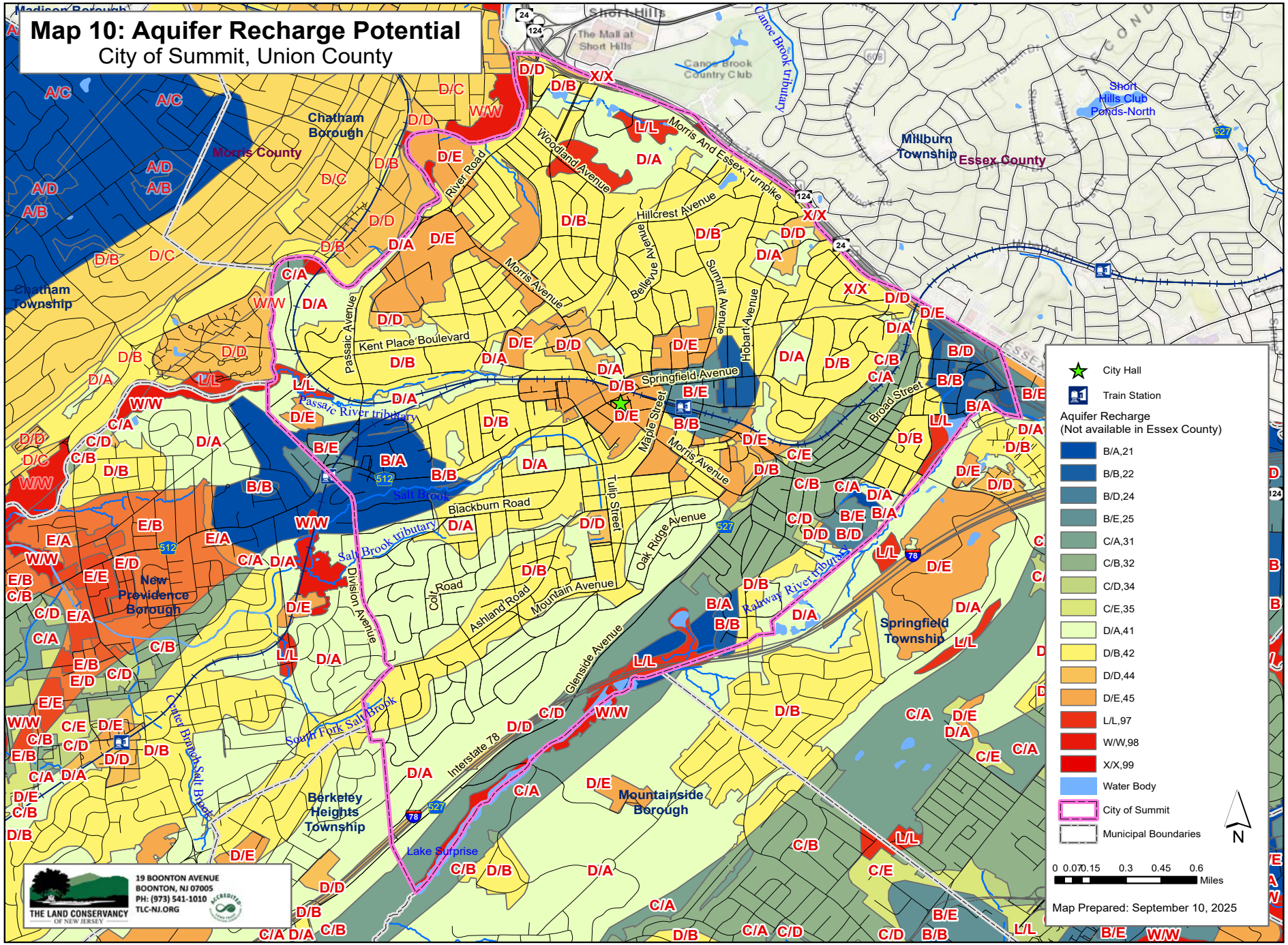
Map 10: Aquifer Recharge Potential
City of Summit, Union County
Chatham Borough
Chatham Township
Morris County
Millburn Township
Essex County
Short Hills Club Ponds-North
New Providence Borough
Berkeley Heights Township
Mountainside Borough
Springfield Township
Short Hills
The Mall at Short Hills
Canoe Brook Country Club
Canoe Brook tributary
Woodland Avenue
River Road
Morris And Essex Turnpike
Hillcrest Avenue
Bellevue Avenue
Summit Avenue
Hobart Avenue
Morris Avenue
Passaic Avenue
Kent Place Boulevard
Springfield Avenue
Maple Street
Broad Street
Passaic River tributary
Salt Brook
Blackburn Road
Salt Brook tributary
Tulip Street
Oak Ridge Avenue
Colt Road
Ashland Road
Mountain Avenue
Glenside Avenue
Division Avenue
Rahway River tributary
South Fork Salt Brook
Center Branch Salt Brook
Interstate 78
Lake Surprise
City Hall
Train Station
Aquifer Recharge
(Not available in Essex County)
B/A,21
B/B,22
B/D,24
B/E,25
C/A,31
C/B,32
C/D,34
C/E,35
D/A,41
D/B,42
D/D,44
D/E,45
L/L,97
W/W,98
X/X,99
Water Body
City of Summit
Municipal Boundaries
N
0 0.07 0.15 0.3 0.45 0.6
Miles
Map Prepared: September 10, 2025
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BOONTON, NJ 07005
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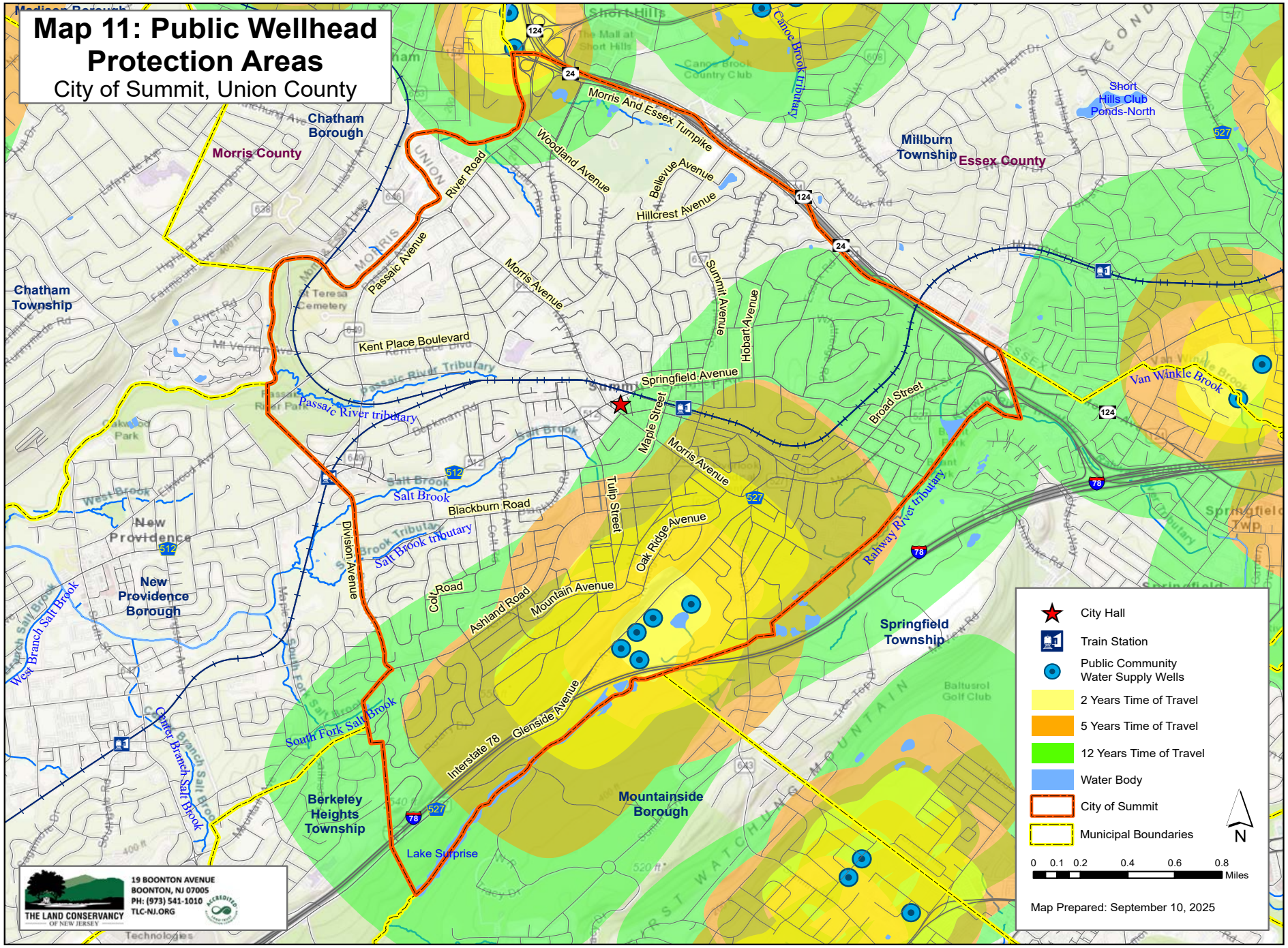
Map 11: Public Wellhead Protection Areas
City of Summit, Union County
Chatham Borough
Morris County
Chatham Township
New Providence
New Providence Borough
Berkeley Heights Township
Mountainside Borough
Springfield Township
Millburn Township
Essex County
Short Hills Club Ponds-North
Short Hills
The Mall at Short Hills
Canoe Brook Country Club
Canoe Brook Tributary
Morris And Essex Turnpike
Woodland Avenue
Bellevue Avenue
Hillcrest Avenue
River Road
Passaic Avenue
Morris Avenue
Summit Avenue
Hobart Avenue
Kent Place Boulevard
Passaic River Tributary
Passaic River tributary
Springfield Avenue
Maple Street
Broad Street
Van Winkle Brook
Salt Brook
Salt Brook tributary
Blackburn Road
Division Avenue
Tulip Street
Oak Ridge Avenue
Railway River tributary
Colt Road
Ashland Road
Mountain Avenue
Glenside Avenue
Interstate 78
West Branch Salt Brook
South Fork Salt Brook
Center Branch Salt Brook
Lake Surprise
St Teresa Cemetery
Mt Vernon Ave
Oakwood Park
Baltusrol Golf Club
City Hall
Train Station
Public Community Water Supply Wells
2 Years Time of Travel
5 Years Time of Travel
12 Years Time of Travel
Water Body
City of Summit
Municipal Boundaries
N
0 0.1 0.2 0.4 0.6 0.8
Miles
Map Prepared: September 10, 2025
19 BOONTON AVENUE
BOONTON, NJ 07005
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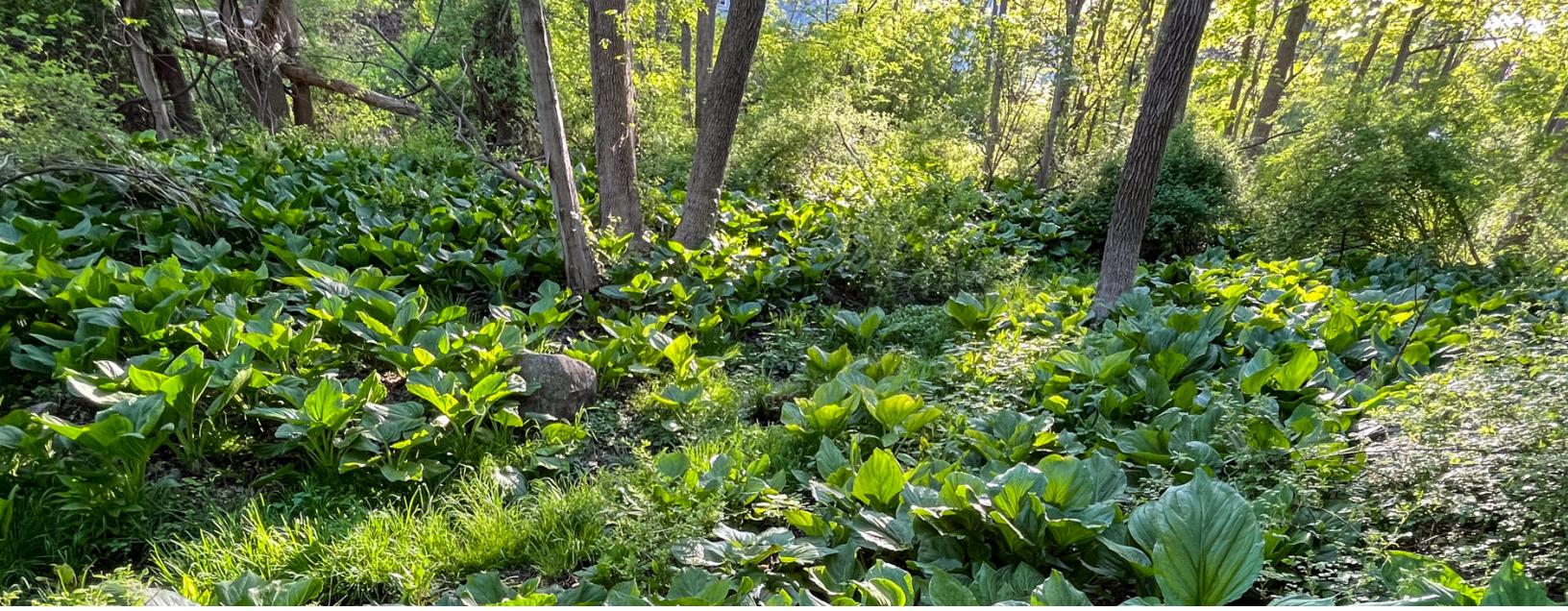


Wetland Vegetation at Martin's Brook
Photo: Dwight Hiscano

Chapter 5.

Wetlands

Wetlands are unique ecosystems that protect and improve water quality, support biodiverse habitat for fish and wildlife, store flood waters, and help maintain the flow of surface water in times of low rainfall. Wetlands are classified and protected by the NJDEP due to their high ecological value and important regulatory function in water resource protection.

To receive wetlands classification, an area must be inundated with surface water or groundwater with a regular frequency to support hydrophytic vegetation, or vegetation which is adapted to saturated soil conditions. A three-parameter approach is used to perform identification, including assessments of hydrology, soil saturation, and vegetation. For more information on wetland regulations in New Jersey, see **page 56**.

Wetlands of Summit

Wetlands account for less than one percent of land cover in Summit. According to the NJDEP 2020 Land Use/Land Cover data, there are 35 acres of wetlands in total. The locations of wetlands are shown in **Map 12**.

About 30 acres of these wetlands are classified by NJDEP as deciduous wooded wetlands. These are closed-canopy swamps dominated by deciduous trees. Common tree species of these New Jersey wetlands include red maple (*Acer rubrum)*, black gum (*Nyssa sylvatica),* green ash (*Fraxinus pennsylvanica)*, and swamp white oak (*Quercus bicolor)*.[90]

While wetland ecosystems are scarce among the developed city, the portions that remain serve important roles in maintaining water quality and providing

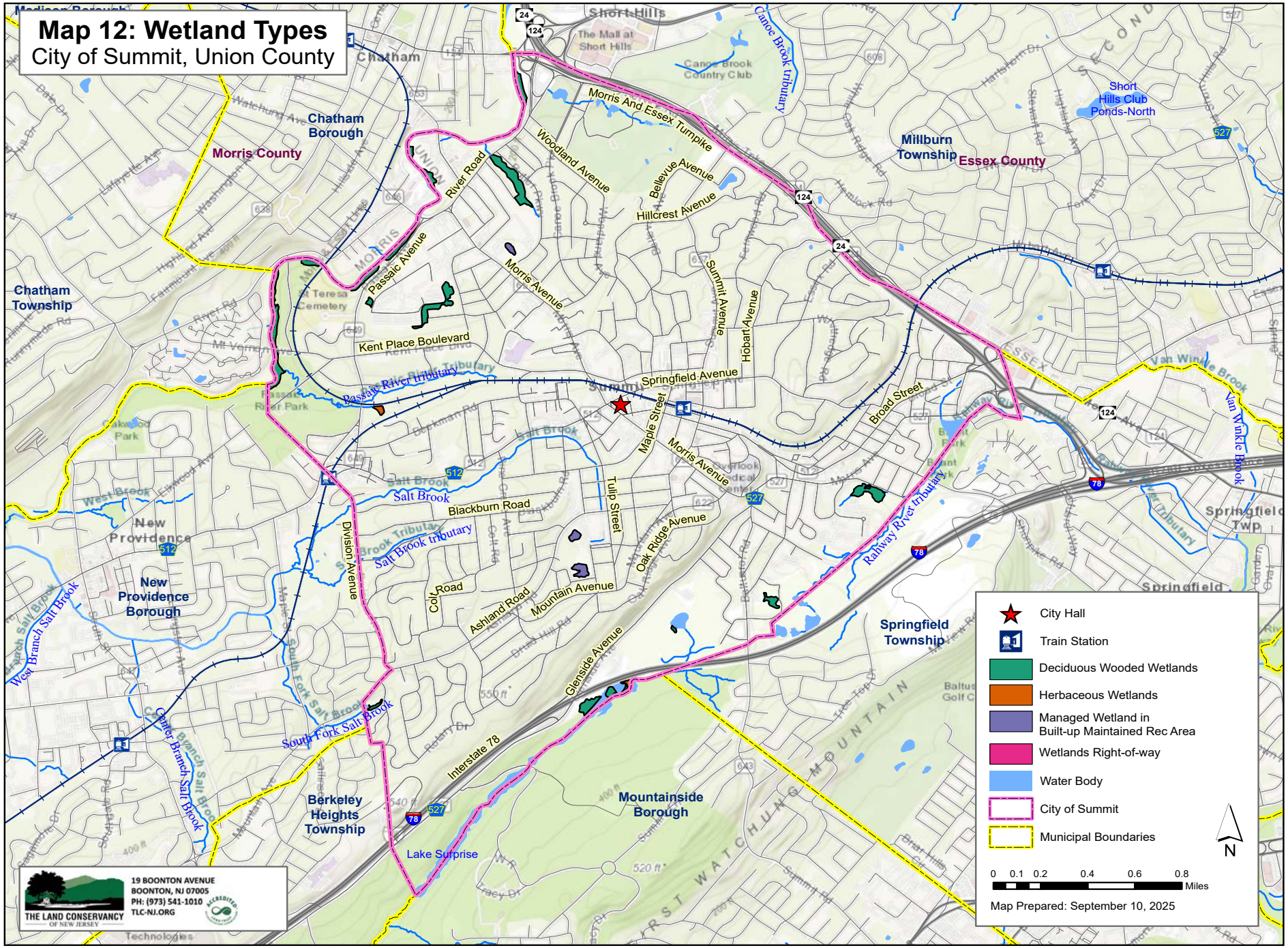
habitat for wildlife. Wetlands can be found in local parks as buffers around stream corridors. These areas correspond to riparian zones, which have an added importance of storing floodwaters and preventing stream bank erosion. See **page 54** for more information on riparian zones and wetlands.

Figure 7. Wetlands in Martin's Brook Park (Center)

Figure 8. Wetlands in Passaic River Park

Riparian wetlands surround Martin's Brook, comprising most of the land in Martin's Brook Park (**Figure 7**). The Passaic River, which runs along the northern and western borders of the City, is also surrounded by riparian wetlands along much of its run (**Figure 8**). These can be observed in Passaic River Park.

Table 10: Wetland Types in Summit		
Wetland Classification Category	**Acres**	**% of Wetlands**
Deciduous Wooded Wetlands	30.4	86.2%
Managed Wetland in Built-Up Maintained Recreation Area	3.6	10.1%
Herbaceous Wetlands	1.2	3.4%
Wetland Rights-of-Way	0.1	0.3%
Total Wetlands	**35.2**	**100%**
Source: NJGS Wetland Types		


Map 12: Wetland Types
City of Summit, Union County
Short Hills
The Mall at Short Hills
Canoe Brook Country Club
Canoe Brook tributary
Morris And Essex Turnpike
Short Hills Club Ponds-North
Millburn Township
Essex County
Chatham
Chatham Borough
Morris County
Woodland Avenue
River Road
Bellevue Avenue
Hillcrest Avenue
Passaic Avenue
Morris Avenue
Summit Avenue
Hobart Avenue
Chatham Township
Kent Place Boulevard
Passaic River tributary
Springfield Avenue
Broad Street
Maple Street
Van Winkle Brook
Salt Brook
Blackburn Road
Tulip Street
Oak Ridge Avenue
Railway River tributary
New Providence
New Providence Borough
West Branch Salt Brook
Division Avenue
Salt Brook tributary
Colt Road
Ashland Road
Mountain Avenue
Springfield Township
Glenside Avenue
South Fork Salt Brook
Center Branch Salt Brook
Interstate 78
Berkeley Heights Township
Mountainside Borough
Lake Surprise
City Hall
Train Station
Deciduous Wooded Wetlands
Herbaceous Wetlands
Managed Wetland in Built-up Maintained Rec Area
Wetlands Right-of-way
Water Body
City of Summit
Municipal Boundaries
N
0 0.1 0.2 0.4 0.6 0.8
Miles
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Riparian Wetlands

Riparian areas describe the transitional land adjacent to a river or waterway that bridges the aquatic and upland terrestrial ecosystems.[91] Like other wetlands, they support biodiverse communities of plants and other species that require a degree of hydric conditions. Beyond serving as habitat, riparian wetlands serve a variety of critical environmental functions[92]:

- Stream ecology: moderating water temperatures and increasing the amount of available oxygen helps to support fish and other aquatic organisms.
- Water quality: trapping and removing sediment, nutrients, and other contaminants that would otherwise enter the waterway.
- Erosion: stabilizing streambanks, reducing channel erosion.
- Hydrology: replenishing groundwater resources.
- Flood protection: capturing and storing floodwaters.

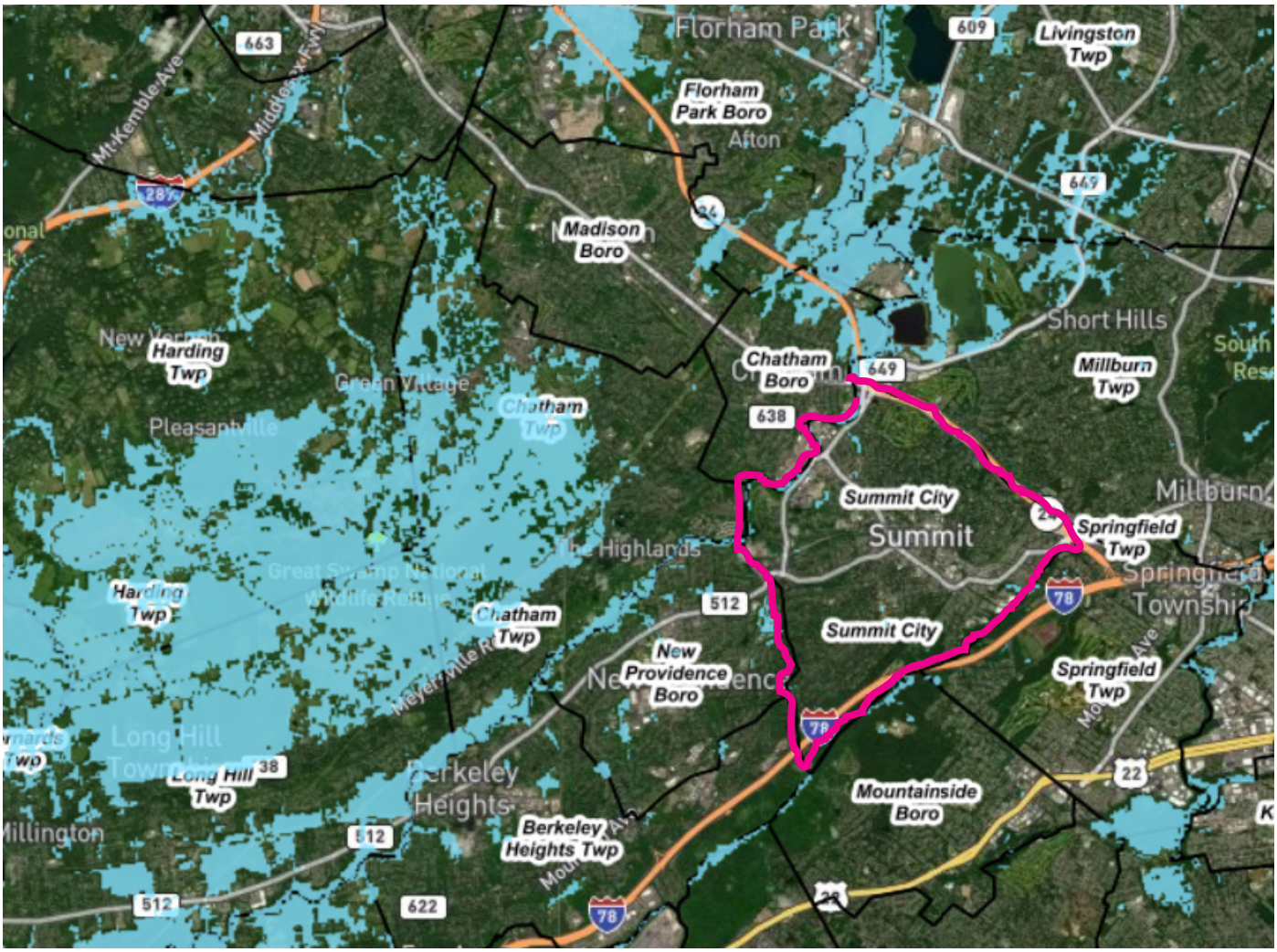
Preservation of Wetlands

Beyond Summit's boundaries are large swaths of preserved wetlands, constituting some of northern New Jersey's most unique ecosystems (**Figure 9**). About 1.5 miles west of Passaic River Park, in neighboring Morris County, is the Great Swamp National Wildlife Refuge. This 12-square mile preserve is managed by the U.S. Fish and Wildlife Service. The Great Swamp was established as a refuge in 1960 by Congress. It forms part of a network of 567 federal wildlife refuges across the United States.[93]

Along the Passaic River, wetland habitat has been acquired and preserved through collaborative partnerships.[94] Nearby preserved wetlands along the Passaic include the Central Valley Wetlands in Florham Park and the Long Hill Wetlands, which span several towns in Union County.[95]

Southeast of Summit, the Watchung Reservation contains portions of wetlands. About 20 acres of deciduous wooded wetlands are found in the Watchung Reservation, managed by the Union County Parks System.

Figure 9. Wetlands Map
Source: NJDEP Bureau of GIS



Wetland Buffers & Regulations

The NJDEP regulates virtually all activities in a wetland, including removing vegetation, filling, and placing obstructions. Depending on the environmental value of a wetland, there may also be a transition area, or buffer, around the wetland that requires 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 transition area, whereas a small wetland in a ditch may not require any transition area. Most freshwater wetlands will require a 50-foot transition area. The NJDEP has adopted the **1989 Federal Manual (N.J.A.C. 7:7A)** as the technical basis for identifying and delineating wetlands.[96]

The criteria for wetland classifications in New Jersey are used to determine the appropriate regulatory conditions. The three classifications are:

1. 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 remains suitable for breeding, resting, or feeding by the species during the normal period these species would use the habitat.

2. Ordinary Resource Value Wetland

- A freshwater wetland which does not exhibit any of the characteristics of an exceptional resource value wetland, and is one of the following:
- An isolated wetland (N.J.A.C. 7:7A-1.4) smaller than 5,000 square feet, with the uses covering more than 50% of the area within 50 feet of the wetland boundary: lawns, maintained landscaping, impervious surfaces, active railroad right-of-way, and graveled or stoned parking/storage area and roads. NJDEP will consider a use that was legally existing in that location prior to July 1, 1988, or was permitted since that date.
- A drainage ditch.
- A swale.
- A detention facility that was uplands at the time it was created regardless of the wetland resource classification of the wetlands under these rules, or classification of the body of water, as FW-1 or FW-2 trout production, to which it discharges.

3. Intermediate Resource Value Wetland

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

Wetland mapping from the NJDEP is approximate and to be used for preliminary planning purposes. Unmapped wetlands may exist in Summit and are still subject to NJDEP regulation. The assessment of wetlands and their boundaries requires a professional delineation through the Presence/Absence or Line Verification Letter of Interpretation (LOI) Application with the NJDEP Division of Land Use Regulation before a regulated activity can occur in or around the area.

Passaic River Park Trail
Photo: Beth Lovejoy

Chapter 6.

Riparian & Flood Zones

Overview

Located at the intersection of the Passaic, Rahway, and Raritan watersheds, Summit contains numerous areas that are subject to flood risk and drainage issues. These areas largely correspond to the riparian zones of the rivers and tributaries that flow through Summit and around its boundaries. Riparian zones are subject to regulations in order to maintain vegetated buffers along streambanks, which store floodwaters, support healthy streams, and protect against erosion.

At the state level, riparian and flood hazard areas are regulated to mitigate the effects of flooding through the Flood Hazard Area Control Act Rules (N.J.A.C. 7:13). Flood zones are further mapped by FEMA and monitored according to risk level to inform insurance requirements and protect against flood damages.

In Summit, areas prone to flooding are further identified and monitored by the City in the Citywide Drainage Assessment Report. The report serves as an ongoing guide for drainage improvement projects. This report is updated periodically to reflect flood conditions and events, ensuring that urgent issues are prioritized in Capital Improvement Projects.

Flood Hazard & Riparian Zones

In the State of New Jersey, the **Flood Hazard Area Control Act (FHACA) Rules**, N.J.A.C. 7:13, serve to protect and control land use in flood hazard areas and adjacent surface waters in order to mitigate the intensity of floods and flood damages. These rules apply to riparian and flood hazard areas, both of which exist along any regulated surface water, with few exceptions.[97]

FHACA Rules define **flood hazard areas** as those which are inundated by the 100-year flood plus a factor of safety in non-tidal areas (7:13-3). A flood hazard area exists along every regulated water that has a drainage area of 50 acres of more. Properties that lie in a flood hazard area will be periodically inundated by floodwaters.

FHACA rules further define **riparian zones** as the land and vegetation within and adjacent to a regulated water, extending from the top of the bank along both sides of the regulated water according to a set buffer distance. The size of the buffer zone is dependent on the quality of the surface water as defined in the Surface Water Quality Standards. As vegetated areas along a watercourse, riparian areas perform many important ecological, hydrological, and structural functions. State regulations on riparian buffer zones are summarized on **page 59**.

Development and disturbance can negatively impact the integrity of ecosystems and their natural capacity to absorb flood waters. For example, vegetation adjacent to surface waters is essential for maintaining bank stability and water quality. The destabilization of banks leads to erosion and sedimentation which can exacerbate flooding. In addition, the loss of vegetation reduces the capacity for filtration of stormwater runoff and causes increased sun exposure, affecting habitat of fish and wildlife.

For these reasons, the NJDEP enforces rules for development in riparian and flood hazard areas. Per N.J.A.C. 7:13-2.4, regulated activities in these areas include:

- The alteration of topography through excavation, grading, and/or placement of fill;
- The clearing, cutting, and/or removal of vegetation in a riparian zone;
- The creation of impervious surface;
- The storage of unsecured material;
- The construction, reconstruction and/or enlargement of a structure;
- The conversion of a building into a private residence, multi-residence building, or critical building.

Appropriate permits must be obtained to engage in any of these activities in a regulated area. There are several different categories of permits: permit-by-rule, general permits, and individual permits. Area-specific standards will affect the necessary measures, depending on the presence of a channel, floodway, flood fringe, fishery resource, threatened and endangered species, or acid producing soils. Construction is not necessarily prohibited in a regulated area; more specific regulations depend on the type of flood hazard present, and whether it is a riparian zone.

FEMA Flood Mapping

Areas prone to flooding are monitored at the federal level to assess and minimize the risk of flood damage. The United States Geological Survey (USGS) works with FEMA (Federal Emergency Management Agency) and NOAA (National Oceanic and Atmospheric Administration) to produce official flood maps for insurance purposes and for forecasting future flood

The full rules governing delineation and regulation of flood hazard areas are included in Title 7, Chapter 13 of the New Jersey Administrative Code, available on NJDEP's website.

Protection of Riparian Zones

Riparian areas (or zones), which largely overlap with flood zones, are subject to regulation by state and federal authorities. NJDEP regulations establish buffer zones along surface water bodies in order to prevent development in critical riparian zones. The disturbance of riparian zones for development activities can have major effects on water and land. Disruption to riparian ecosystems may cause, for example:

- Intensified stormwater flow.
- Increased frequency and intensity of flooding and low stream flows.
- Destabilization of streambanks and erosion.
- Increased levels of sedimentation and other nonpoint pollutants in water bodies.
- Rise in water temperatures.
- Damaged stream habitat.
- Reduced infiltration of rainwater into soils.

Riparian Zones & Buffer Regulations

NJDEP regulates riparian zones and flood hazard areas under the Flood Hazard Area Control Act Rules (N.J.A.C. 7:13).[106] Along a regulated water, the riparian zone refers to the land and vegetation within the water and extending to the the top of the bank along both sides of the water. Riparian zones exist along both sides of every regulated water and include the regulated water itself, with few exceptions. Riparian areas beyond the surface water body are measured landward from the top of the bank, or in the case that there is no discernible bank, from the centerline of the stream or swale. In the case of a lake or pond, it is measured landward of the normal surface water limit; in a bay or inlet, it is measured landward of the mean water line. The extent of a riparian zone and its buffer is based on the quality of its associated surface water body in accordance with Surface Water Quality Standards (SWQS) [N.J.A.C 7:9B]. As a baseline buffer, all surface waters require the maintenance of a riparian zone of 50 feet or more along both sides of the waterway.[107] For more environmentally sensitive areas, riparian zones shall measure:

- 300 feet along Category One (C1) waters and all upstream waters/tributaries situated in the same HUC14 watershed;
- 150 feet along non-C1 waters that are trout-producing or maintaining, including all upstream waters/tributaries within one linear mile as measured along the length of the water body;
- 150 feet along any segment of water flowing through an area with documented protected species habitat, including all upstream waters/tributaries within one linear mile measured along the length of the surface water body;
- 150 feet along any segment of a water body flowing through an area with acid-producing soils.

In 2020, the NJDEP Division of Water Monitoring amended the SWQS (N.J.A.C. 7:9B) to designate an additional 600 miles of rivers and streams as C1 waterways.[108] This rule widened the riparian zone around newly listed C1 waters. New Jersey has approximately 23,500 river miles, of which 6,800 are currently designated as C1 waters. These changes do not affect the surface water bodies of Summit, as there are no C1 waters within municipal boundaries.

risks.[98] FEMA manages the National Flood Insurance Program (NFIP) to provide insurance protection for property owners at risk of flood damage.[99]

To inform the NFIP, FEMA defines geographic areas according to varying levels of flood risk, which are determined based on past flooding events:

- Special Flood Hazard Areas (SFHA) are defined as high risk areas within the 100-year floodplain. This refers to an area that has a 1% annual chance of inundation by floodwaters. SFHA may be defined as zone A, AE, AH, AO, or A99; or as coastal high risk zones V, VE, or V1-30.
- Moderate to low risk areas fall between the limits of the 100-year and 500-year floodplain, with a 0.2% (or 1 in 500) chance of flooding. These include zones B and X. Areas at the 500-year floodplain may be zone C or X.[100]

SFHA and Flood Hazard Areas designated by NJDEP are delineated by different methods, but the intended areas are overlapping; both capture lands that would be inundated in a 100-year flood. However, NJDEP estimates for 100-year floods do include a higher margin of safety, factoring potential increased flow due to upstream development.[101]

SFHA in Summit

Map 13 illustrates SFHA in City of Summit, which includes floodways and flood hazard areas of Zone A and AE (100-year flood) and Zone X (500-year flood). These areas lie primarily adjacent to surface water bodies in the City, including the Passaic River and its tributaries, the Rahway River and its tributaries, Salt Brook, and Blue Brook. According to the Union County Multi-Jurisdictional Hazard Mitigation Plan (HMP), about 7.5% of the parcels in City of Summit fall in SFHA.[102]

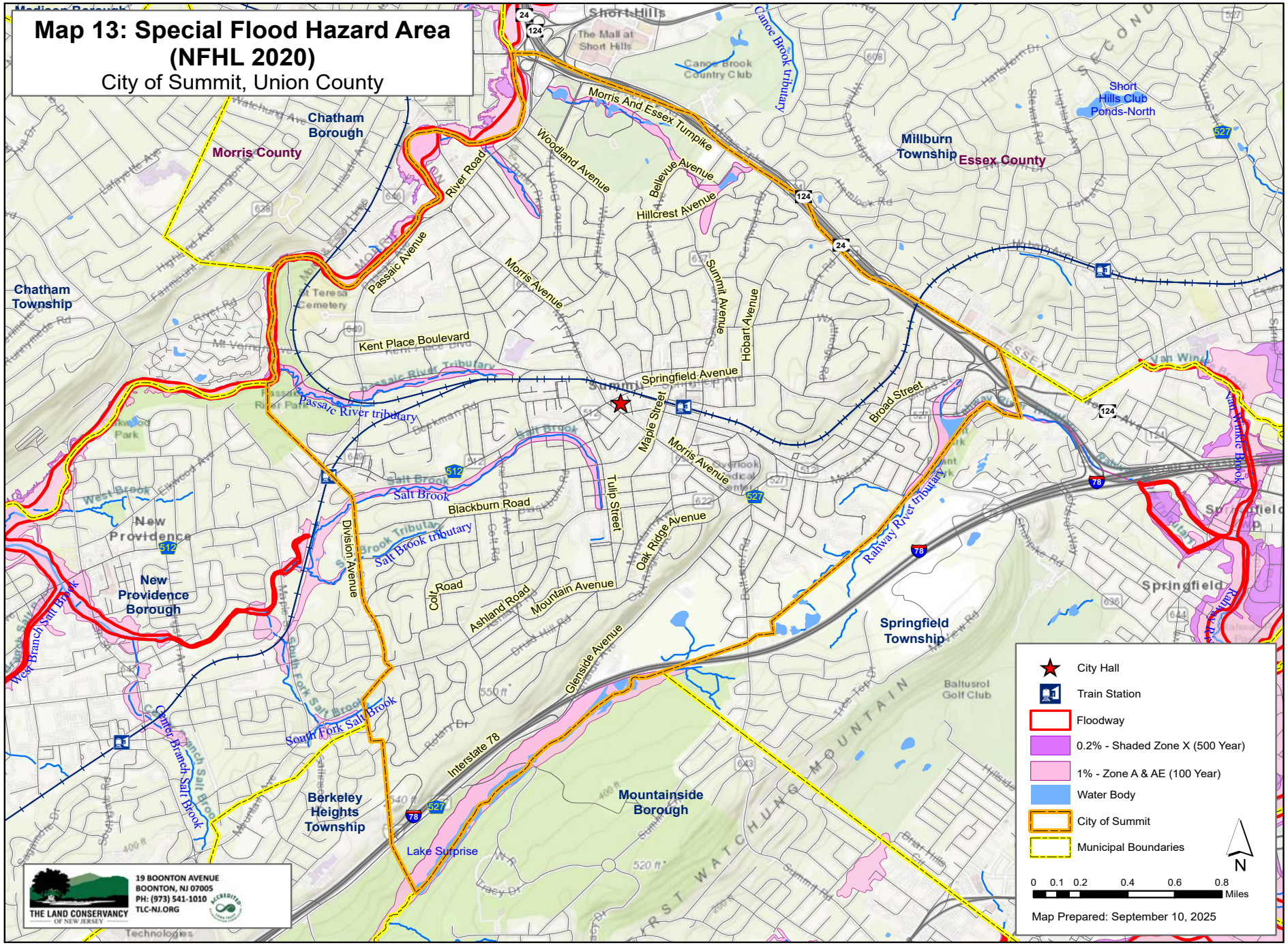
More detailed images of SFHA maps from FEMA are included at the end of this chapter. Areas that have experienced persistent flooding-related issues are discussed in the following sections and in **Table 11**.

Stormwater Management

The City of Summit is actively working to improve stormwater management and drainage infrastructure to reduce flooding and improve the quality of surface waters. The City first published its Stormwater Management Plan (MSWMP) in 2005 in accordance with the Municipal Stormwater Regulation Program, N.J.A.C. 7:14A-25.[103] The plan addressed groundwater recharge, stormwater quantity, and stormwater quality impacts related to new major development and the addition of impervious surface cover.

Since the issue of the MSWMP twenty years ago, the City of Summit has updated its ordinances and detailed plans for stormwater management. The Drainage Assessment Report was first published in 2007 and last updated in 2020. It serves as a working document to monitor drainage problems and infrastructure improvement projects related to stormwater drainage.[104] Further details of the Drainage Assessment Report are contained in the following section.

The City also released its Stormwater Pollution Prevention Plan (2020) which outlines stormwater-related regulations that aim to reduce pollution and stormwater runoff in the municipality.[105] These include regulations on major development, implementation and enforcement of ordinances, cleaning of streets and catchment basins, and the maintenance of stormwater facilities.


Map 13: Special Flood Hazard Area (NFHL 2020)
City of Summit, Union County
Chatham Borough
Morris County
Chatham Township
Millburn Township
Essex County
Short Hills
The Mall at Short Hills
Canoe Brook Country Club
Canoe Brook tributary
Short Hills Club Ponds-North
Morris And Essex Turnpike
Woodland Avenue
Bellevue Avenue
Hillcrest Avenue
River Road
Passaic Avenue
Morris Avenue
Summit Avenue
Hobart Avenue
Kent Place Boulevard
Springfield Avenue
Broad Street
Maple Street
Passaic River tributary
Salt Brook
Blackburn Road
Tulip Street
Oak Ridge Avenue
Division Avenue
Salt Brook tributary
Color Road
Ashland Road
Mountain Avenue
Glenside Avenue
Rahway River tributary
New Providence
New Providence Borough
West Branch Salt Brook
South Fork Salt Brook
Center Branch Salt Brook
Interstate 78
Berkeley Heights Township
Mountainside Borough
Springfield Township
Springfield
Baltusrol Golf Club
Lake Surprise
City Hall
Train Station
Floodway
0.2% - Shaded Zone X (500 Year)
1% - Zone A & AE (100 Year)
Water Body
City of Summit
Municipal Boundaries
N
0 0.1 0.2 0.4 0.6 0.8
Miles
Map Prepared: September 10, 2025
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City Drainage Assessment Report

The City of Summit maintains a Citywide Drainage Assessment Report (DAR) to inventory and monitor active drainage problems. The DAR accounts for areas that have experienced flooding and serves as a guide for improvement projects to be undertaken by the Engineering Department. Areas are ranked in three categories depending on the severity of flooding and drainage issues and the magnitude of required solutions:

- Category I: include flooding of streets, private property and structures that require a significant engineering study and design to develop solutions. Multi-phase projects with complex solutions, challenging permitting and design.
- Category II: include flooding of streets and private property and other drainage related issues; typically single contract projects.
- Category III: include minor drainage issues or issues on streets with construction remedies occurring as a part of a larger project like road improvement.

Since the creation of the DAR in 2007, the City of Summit Engineering Division has identified 74 locations in need of drainage improvement projects. As of the 2020 update, 52 projects have been completed, leaving 22 sites that await improvements. Six of these have projects in progress.

Category I locations are described in **Table 11** (continued on the following page). Locations of Category II or III sites, as well as a full list of completed projects, can be found on the City of Summit website.

Table 11. Category I Locations, Citywide Drainage Assessment Report

Location	Description
Golf Course Pond (Canoe Brook Parkway & Wallace Road)	Residents experience flooding during intense rain events. The spillway for the pond at the Municipal Golf Course must be redesigned to increase flow capacity and alleviate upstream flooding (**Figure 10**).
Salt Brook (Sunset Drive & Springfield Avenue)	The banks of Salt Brook are undergoing erosion and flooding along private properties between Sunset Drive and Springfield Avenue. The City has worked with a Consulting Engineer to explore private improvements like bank stabilization (**Figure 11**).
West End Avenue (West End & Colonial Road)	Erosion is evident along the banks of the brook behind the private properties on West End Avenue and the cul-de-sac of Colonial Road. The area is being monitored as erosion and flooding worsens during heavy rain events (**Figure 12**).

Continued on next page.

Source: City of City of Summit Wide Drainage Assessment Report

Table 11. Category I Locations, Citywide Drainage Assessment Report	
Location	**Description**
Railroad Culvert (Maple Street & Colonial Road)	The entire downtown storm sewer system and its surroundings drain into a large culvert constructed into the railway retaining wall, bringing water from Maple Street to a discharge near Colonial Road. The culverts are owned by NJ Transit. When obstructed or damaged, there is risk of drainage problems.
Middle Avenue Culvert (Middle & Grove Street)	A culvert behind the properties on Middle Avenue, crossing the dead-end portion of Grove Street, discharges large volumes of stormwater into Briant Pond. Damage has been noticed on the culvert (**Figure 13**).
Beekman Road Culvert (Beekman Road & O'Shea Lane)	A culvert at the corner of Beekman Road and O'Shea Lane, which carries drainage from the area into the West End Avenue stream, is inspected to be well over one-hundred years old. The culvert is beginning to fail. It has been repaired in portions by the public works department, but will need to be fully replaced.
Source: City of City of Summit Wide Drainage Assessment Report	

Inland Flood Protection Rule

The NJDEP adopted the Inland Flood Protection Rule in July 2023, updating the methods used to delineate Flood Hazard Areas to account for stormwater flow risks due to climate change and upstream development.[109] This change expands the scope of areas subject to regulation by the NJDEP, including all lands up to two feet higher than the current 100-year flood areas in DEP maps and three feet higher than current 100-year areas in FEMA maps.[110] New rules also require that all new major developments address stormwater runoff using an updated NJDEP data set for peak flow rates of streams and rivers, to account for changes in regional precipitation patterns since the previous 1999 data.[111]

In connection with this rule, the NJDEP has created an online Flood Indicator Tool to provide information about potential flood risks on or near a property of interest. The tool is intended for use only as a reference, and does not show precise DEP standards, calculate actual risk, or demarcate a zone where DEP regulations apply.[112]

Flood Disclosure

The 2023 Flood Disclosure Bill (S3110/A4783) created tools for home buyers and renters in New Jersey to protect themselves from flood risks. The law requires that landlords and home sellers disclose flood risk to prospective tenants or buyers, including the property's history of flooding and its location in a FEMA-designated (100- or 500-year) Flood Hazard Area. The law also requires landlords to notify tenants of the availability of insurance for renters through the National Flood Insurance Program.[113]

Municipal Stormwater Ordinances

The City of Summit has several ordinances aimed at controlling stormwater and curbing pollution that could end up in waterways. These include:

- Stormwater Control Ordinance (SCO)
- Riparian Ordinance
- Fertilizer Ordinance
- Pet Waste, Wildlife Feeding, Litter Control, Improper Disposal, Containerized Yard Waste, and Illicit Connection Ordinance
- Private Dumpster Ordinance
- Retro Inlet Ordinance

NJDEP Stormwater Management Rules specify standards that are mandatory for new major development. The Best Management Practices Manual also includes guidance on retrofitting stormwater infrastructure on existing development sites.

Figure 10. SFHA Zone A: Municipal Golf Course, Canoe Brook County Club, and Martin's Brook (left); Zone AE: Passaic River

Source: FEMA Flood Map Service Center[114]

Figure 11. SFHA Zone A & AE: Passiac River (top & left); Zone A: Passaic River Tributary (bottom)

Source: FEMA Flood Map Service Center

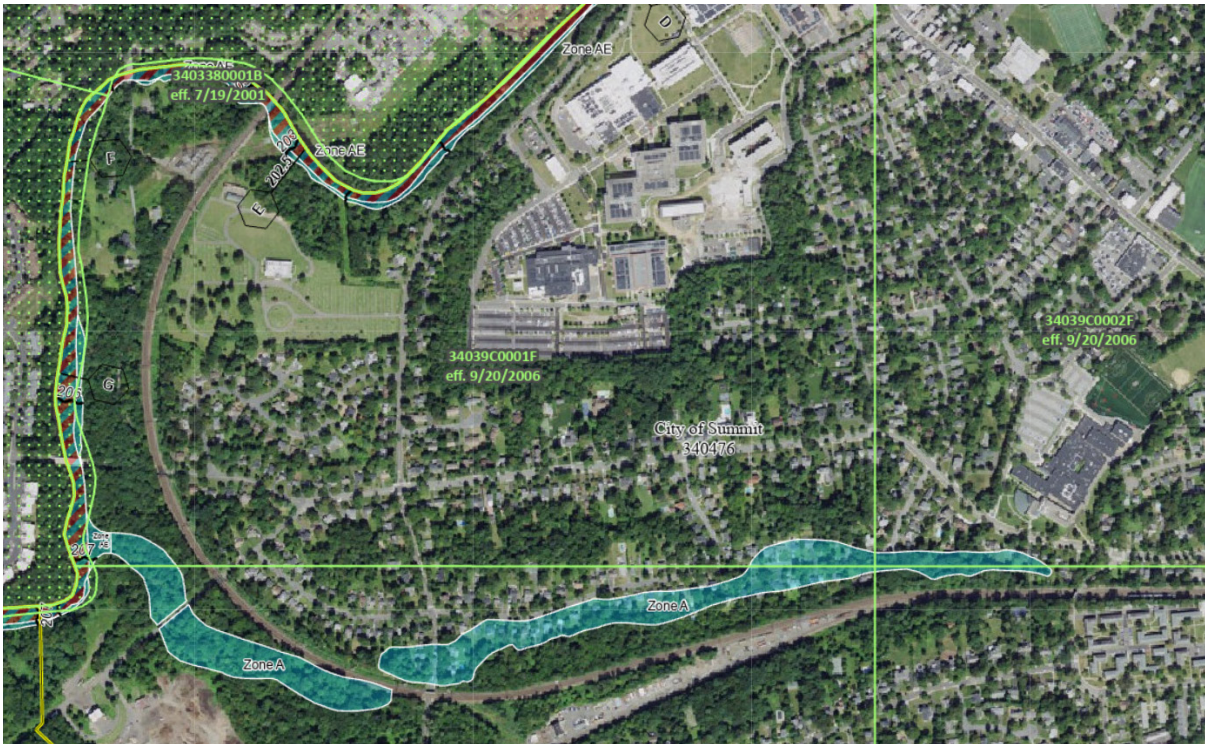


Figure 12. SFHA Zone A: Salt Brook

Source: FEMA Flood Map Service Center

Figure 13. SFHA Zone A: Around Rahway River Tributary (Briant Brook/Baltusrol) and Briant Pond

Source: FEMA Flood Map Service Center

Figure 14. SFHA Zone A: Around Lake Surprise and Blue Brook

Source: FEMA Flood Map Service Center

Reeves-Reed Arboretum
Photo provided by the Arboretum

Chapter 7.

Geology & Topography

Physiographic Provinces

The landscape of New Jersey is divided into four distinctive regions known as physiographic provinces, each defined by unique geologic processes and landforms. Physiographic classifications depend on terrain texture, rock type, geologic structure, and history. These attributes play an important role in determining the natural resources of an area. New Jersey's physiographic provinces form diagonal bands across the state. From the northwest to southeast, these provinces are: the Valley and Ridge, Highlands, Piedmont, and Coastal Plain, sometimes further divided into the Inner and Outer Coastal Plain.[115]

City of Summit and the rest of Union County lie in the Piedmont Province (**Figure 15**). This region of New Jersey is part of a larger Piedmont formation of the

Figure 15. Physiographic Provinces and Counties of New Jersey
Source: New Jersey Geological Survey

eastern United States, which stretches from Alabama to southern New York at the foot of the Appalachian Mountains.[116]

In New Jersey, the Piedmont covers 1,600 square miles of land area, or approximately 20% of the state. The province is characterized by low rolling hills, winding river valleys with well-developed floodplains, and sudden steep, rocky ridges that trend northeast-southwest.[117] Its southeastern boundary meets with the lower Coastal Plain region in a line that runs between Carteret and Trenton. The overlap of the provinces forms a ridge marked by waterfalls and rapids, known along the East Coast as the Fall Line.[118]

To the northwest, the Highlands Province sits an average of 1,000 feet above sea level, making the Piedmont a relative lowland. The Piedmont slopes gently south-eastward, from an average of 400 feet elevation at its northern margin, to sea-level where it meets the Newark Bay. To the south where it meets the Delaware River, the Piedmont averages about 100 feet above sea level.[119]

Bedrock Geology

Geologic composition is classified in two main layers: bedrock geology, which is consolidated, underlying rock that extends deep into the earth's crust; and surficial geology, mainly unconsolidated sedimentary materials that overlie bedrock formations and serve as the parent material for soils. Bedrock of the Piedmont was deposited during the late Triassic and early Jurassic eras between 230 and 190 million years ago, when the breakup of Pangaea formed the Newark Basin.[120] The rock formations of the Newark Basin, which coincides with 95% of New Jersey's Piedmont Province, consist of shale, sandstone, and argillite formations that are typically brownish-red in color.[121] Though masked by a relatively thick surficial cover, the bedrock strike of the region controls the direction of the northeasterly-trending topography.[122]

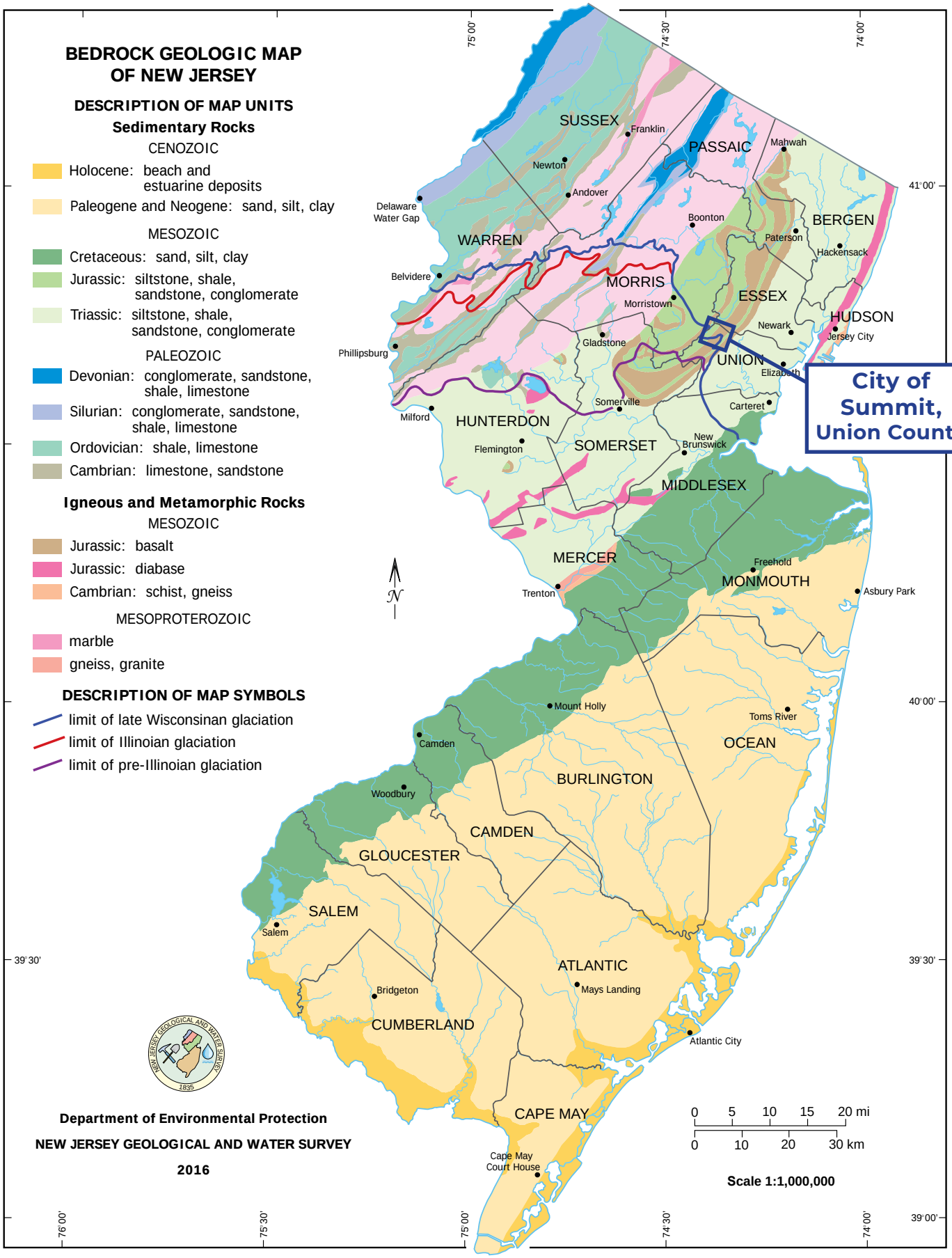
Several ridges run northeast-southwest through the Piedmont, including the three Watchung Mountains (at 850, 650, and 350 feet above sea-level), the Sourlands, and the Palisades. These ridges are made up of hard lava rock known as diabase and basalt. Between the ridges, formations of sandstone and shale are less hard and resistant to erosion, resulting in the gradual wearing of their elevations.[123]

Much of the Summit is underlain by the Second Watchung Mountain and its bedrock layer of Preakness Basalt (**Figure 16**). Overlying the Preakness Basalt to the northwest is the Towaco Formation of the Early Jurassic period, composed of sandstone, siltstone, and conglomerate.[124] On the southeastern margin of the City, the Preakness Basalt overlies the

The ridgeline of the First Watchung Mountain demarcates the "Newark Purchase," the tract of land that the Hackensack band of the Munsee Lenape deeded to English settlers in 1667 and 1678. Native people saw such deeds as agreements to share the land, and they continued to live, fish, and gather in the area until the mid-1700s. Non-Natives gradually became the dominant population in the region, causing the spread of disease, forced displacement, and colonial violence.

Source: Montclair Art Museum

Figure 16. Bedrock Geology of New Jersey[136]



Feltville Formation. The sedimentary valley formation of the Feltville contains a tributary of the Rahway River, and it is composed of a mix of sandstone, siltstone, and silty mudstone (**Table 12**; **Map 14**). A cross-section of these layers of the Newark Basin is shown in **Figure 17**.

Specific properties of bedrock layers determine the physical extent of aquifers and the chemical quality of water that they yield; affect the movement of groundwater and contaminants through soils; and can indicate areas where natural hazards like sinkholes, radon, and seismic instability may occur. Such properties may suggest an area's suitability for septic systems, stormwater and surface runoff management systems, and degree of stability for building foundations, bridges, tunnels, and other structures.

There are numerous quarry sites in the Watchungs, which were historically used to mine basalt or trap rock. The Houdaille Quarry complex can be found in what is now Hidden Valley Park in the First Watchung Mountain neighboring the Watchung Reservation. Originally named the Commonwealth Quarry, it was mined for crushed stone

Figure 17. Newark Basin Along Interstate 80

Source: United States Geological Survey[137]

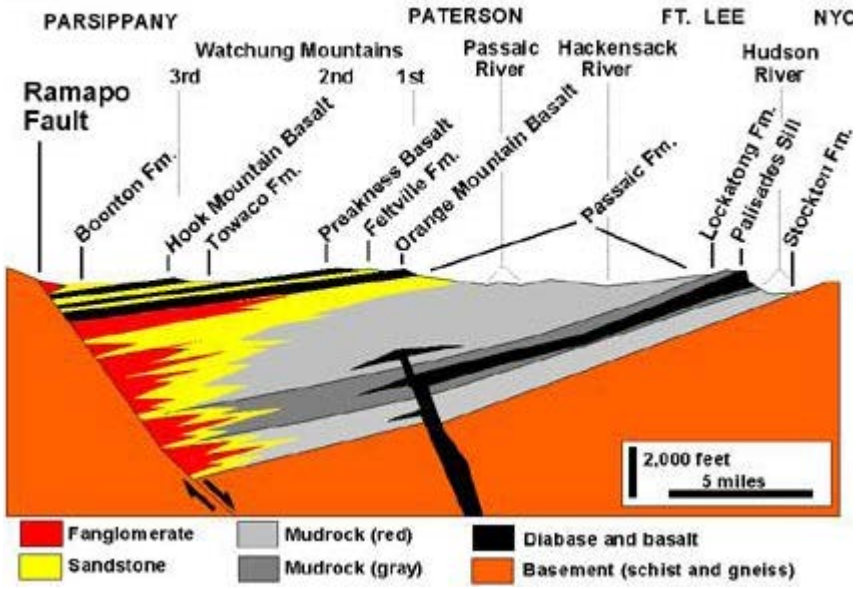
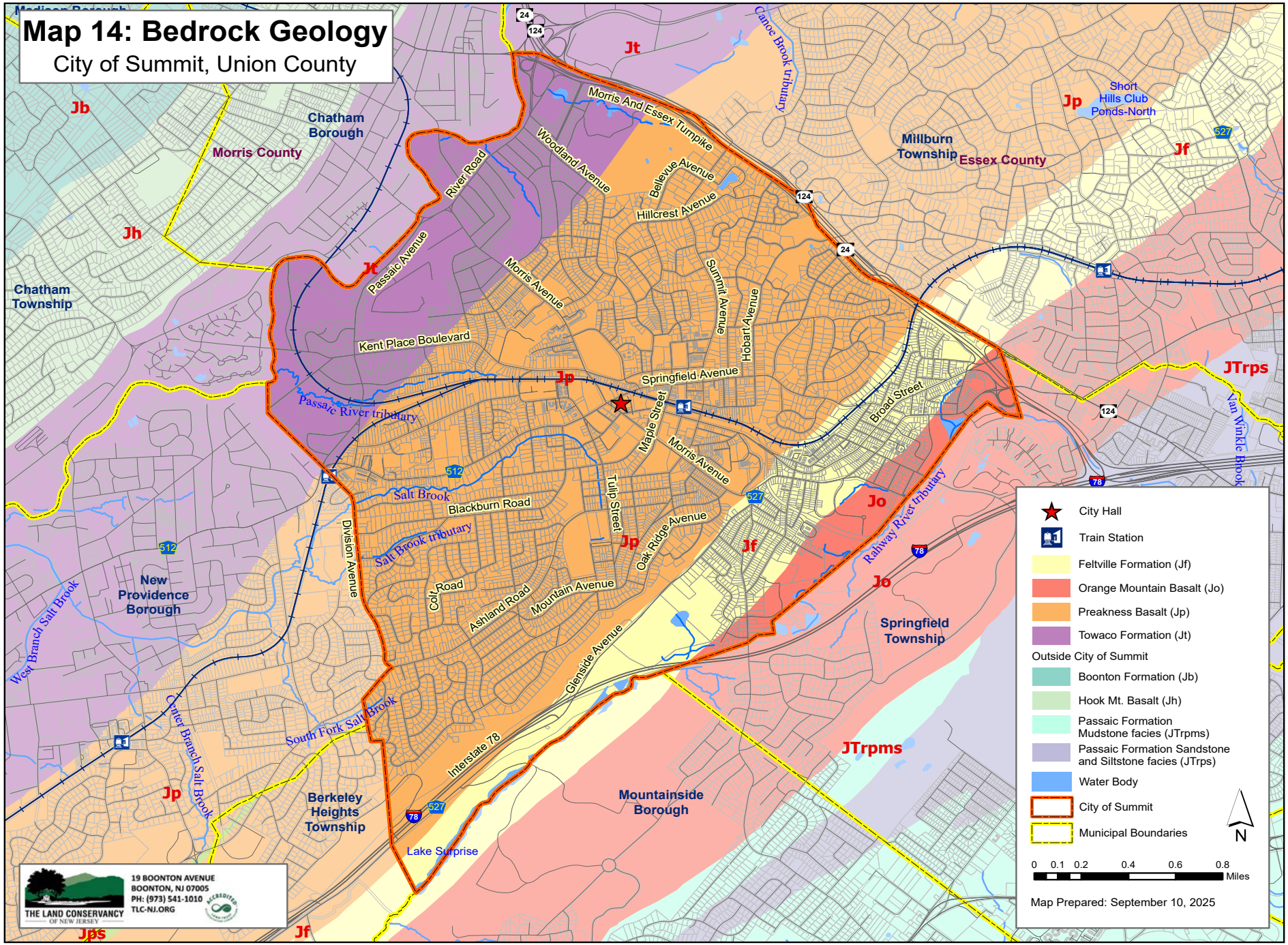


Table 12. Bedrock Geology of Summit				
Abbrev.	**Name**	**Lithology**	**Acres**	**%**
Jp	Preakness Basalt	basalt, fine- to coarse-grained	2,460	63.7%
Jt	Towaco Formation	sandstone, siltstone, silty mudstone, fine- to medium-grained; less abundant calcareous siltstone and mudstone	689	17.8%
Jf	Feltville Formation	sandstone, siltstone, silty mudstone, fine- to coarse-grained, and less abundant calcareous siltstone and mudstone, carbonaceous limestone	538	13.9%
Jo	Orange Mountain Basalt	basalt, fine- to medium-grained	174	4.5%
		Total	**3,861**	**100%**
Source: New Jersey Geologic Survey. Bedrock Geology				


Map 14: Bedrock Geology
City of Summit, Union County
Jb
Jh
Jt
Jp
Jo
Jf
JTrps
JTrpms
Jps
Chatham Borough
Morris County
Chatham Township
New Providence Borough
Berkeley Heights Township
Mountainside Borough
Springfield Township
Millburn Township
Essex County
Short Hills Club Ponds-North
Canoe Brook tributary
Morris And Essex Turnpike
Woodland Avenue
River Road
Bellevue Avenue
Hillcrest Avenue
Passaic Avenue
Morris Avenue
Summit Avenue
Hobart Avenue
Kent Place Boulevard
Springfield Avenue
Broad Street
Maple Street
Passaic River tributary
Salt Brook
Blackburn Road
Tulip Street
Oak Ridge Avenue
Salt Brook tributary
Division Avenue
Colt Road
Ashland Road
Mountain Avenue
Glenside Avenue
Railway River tributary
Van Winkle Brook
West Branch Salt Brook
Center Branch Salt Brook
South Fork Salt Brook
Interstate 78
Lake Surprise
City Hall
Train Station
Feltville Formation (Jf)
Orange Mountain Basalt (Jo)
Preakness Basalt (Jp)
Towaco Formation (Jt)
Outside City of Summit
Boonton Formation (Jb)
Hook Mt. Basalt (Jh)
Passaic Formation Mudstone facies (JTrpms)
Passaic Formation Sandstone and Siltstone facies (JTrps)
Water Body
City of Summit
Municipal Boundaries
N
0 0.1 0.2 0.4 0.6 0.8
Miles
Map Prepared: September 10, 2025
19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973) 541-1010
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that was used to create gravel for road construction. Rare minerals could also be found in the basalt, including notable crystals of greenockite.[125]

Surficial Geology

Atop the bedrock, the surficial geology of the Piedmont Province is made up of stratified sand, gravel, silt, and clay that was deposited by glacial streams and ice, as well as swamp sediments of the postglacial age, estuarine, and alluvial fill.[126] These surficial deposits formed during the Pleistocene era and through Wisconsinan glaciation. Surficial geologic layers of New Jersey are less than 30 feet thick over much of the state, though they can be as much as 400 feet thick in some areas.[127]

The Wisconsin Glacial Stage saw glacial lakes and streams lain over the volcanic formations of northern New Jersey. The pressure of thick ice formations affected these landforms, creating depressions that later eased as the ice melted. Over the rise and fall of water levels, layers of sediment were left behind.[128]

The surficial coverage of Summit is a mix of alluvium, colluvium, late Wisconsinan glacial deposits, Rahway till, and weathered basalt. The Wisconsinan deposits that underlie Summit are classified in four ways, reflecting the progression of glacial flows throughout the period: these are delta deposits, glacial lake-bottom deposits, glaciofluvial terrace deposits, and terminal moraine deposits.

The terminal moraine marks the limit of Wisconsinan glaciation in most locations, where glacial progression stopped and deposits of till were left at the margin.[129] The terminal moraine runs through Summit, illustrated in the surficial layers of **Map 15**. The Late Wisconsinan Terminal Moraine Deposits of Rahway Till (Qwmtr) layer indicates the transition from Late Wisconsinan glacial formations to deposits of Rahway Till (Qwtr).

This delineation can also be seen in **Figure 16** on **page 69**, indicated in the key as the "limit of late Wisconsinan glaciation." Following these patterns of glacial lake and valley deposits, the surficial geologic layers under Summit are approximately 50 to 150 feet thick (**Table 13**).

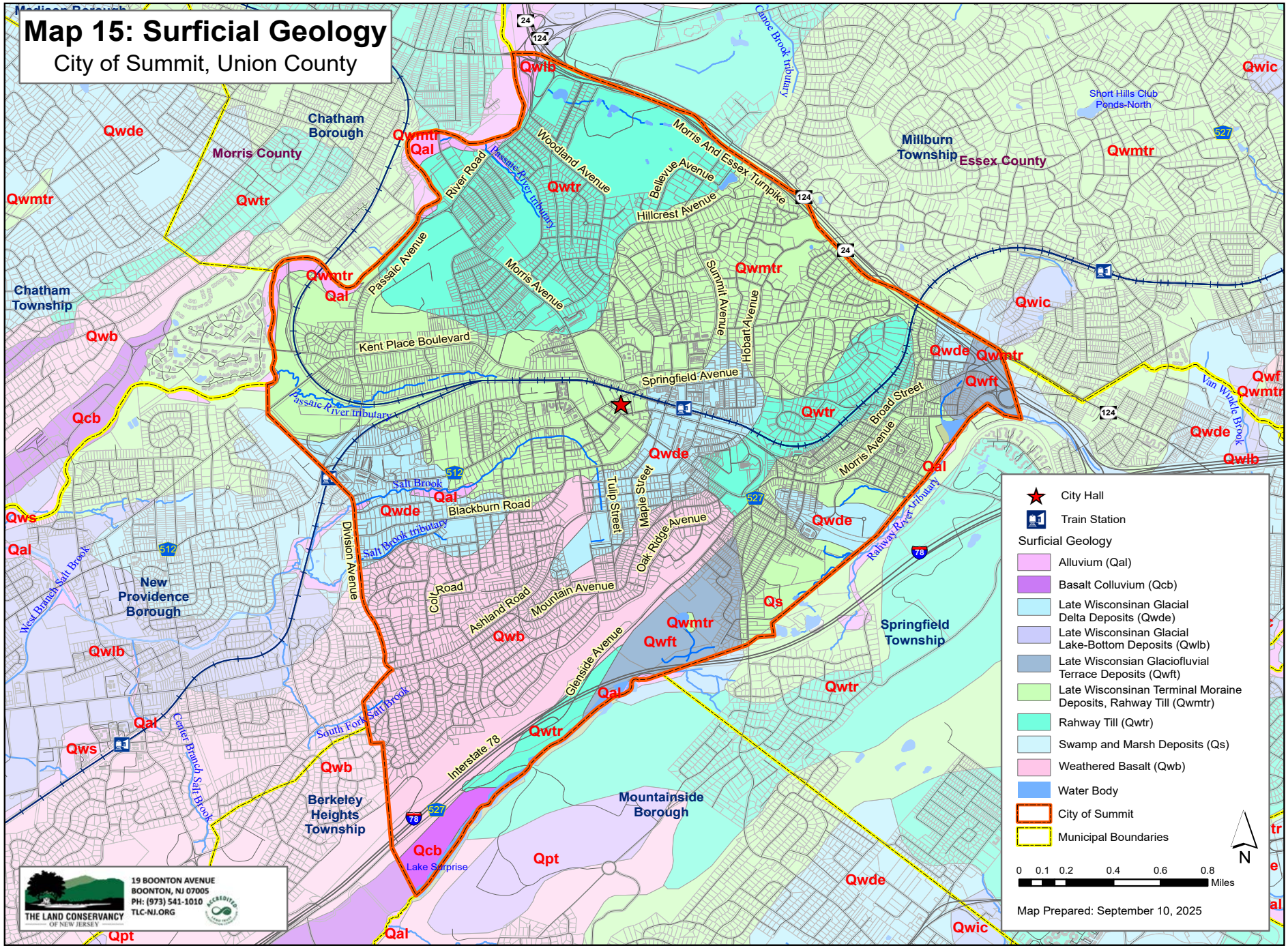
Explore the geologic history of the Watchung Reservation on the **Ruth Canstein Yablonsky Self-Guided Geology Trail**. Visitors can follow the trail guide to discover unique features and uncover the geologic processes that have shaped the reservation over millions of years. Information is offered by the Trailside Nature & Science Center, located at the entrance to the Watchung Reservation in Mountainside. **Find the guide here.**

Topography

Topography refers to the slope and level of the land. Topographic maps are created by connecting contour lines that each represent a level of elevation on the surface of the land.[130] Slope is the measure of the distance from one contour point to another, divided by the lateral distance between them. **Map 16** shows the contours and topography of Summit.

The topographic land formations of the

Table 13. Surficial Geology				
Name	**Description**	**Geologic Age**	**Acres**	**%**
Late Wisconsinan Terminal Moraine Deposits, Rahway Till (Qwmtr)	Rahway Till as in unit Qwtr forming morainic ridges and knolls. As much as 200 feet thick.	late Pleistocene, late Wisconsinan	1,468	38.2%
Rahway Till (Qwtr)	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	878	22.8%
Weathered Basalt (Qwb)	Clayey silt with basalt fragments, reddish yellow to brown. As much as 10 feet thick.	Pleistocene	764	19.8%
Late Wisconsinan Glacial Delta Deposits (Qwde)	Sand, pebble-to-cobble gravel, minor silt; yellowish brown, reddish brown, light gray. As much as 150 feet thick.	late Pleistocene, late Wisconsinan	464	12.1%
Late Wisconsinan Glaciofluvial Terrace Deposits (Qwft)	Sand, pebble-to-cobble gravel, minor silt; yellowish brown to reddish brown. As much as 40 feet thick.	late Pleistocene, late Wisconsinan	168	4.4%
Alluvium (Qal)	Sand, gravel, silt, minor clay and peat; reddish brown, yellowish brown, brown, gray. As much as 20 feet thick.	Holocene and late Pleistocene	66	1.7%
Basalt Colluvium (Qcb)	Clayey silt with basalt fragments, reddish yellow to yellowish brown. As much as 50 feet thick.	Pleistocene	38	1.0%
Late Wisconsinan Glacial Lake-Bottom Deposits (Qwlb)	Silt, clay, fine sand; gray, brown, yellowish brown, reddish brown. As much as 200 feet thick.	late Pleistocene, late Wisconsinan	<1	0.0%
Swamp and Marsh Deposits (Qcb)	Peat and organic clay, silt, and minor sand; gray, brown, black. As much as 40 feet thick.	late Pleistocene and Holocene	<1	0.0%
		Total:	**3,848**	**100%**
Source: NJGS Surficial Geology				


Map 15: Surficial Geology
City of Summit, Union County
Chatham Borough
Morris County
Chatham Township
New Providence Borough
Berkeley Heights Township
Mountainside Borough
Springfield Township
Millburn Township
Essex County
Short Hills Club Ponds-North
Canoe Brook tributary
Passaic River tributary
Salt Brook
Salt Brook tributary
West Branch Salt Brook
Center Branch Salt Brook
South Fork Salt Brook
Rahway River tributary
Van Winkle Brook
Lake Surprise
River Road
Woodland Avenue
Bellevue Avenue
Hillcrest Avenue
Morris And Essex Turnpike
Passaic Avenue
Morris Avenue
Kent Place Boulevard
Springfield Avenue
Summit Avenue
Hobart Avenue
Broad Street
Tulip Street
Maple Street
Oak Ridge Avenue
Blackburn Road
Division Avenue
Colt Road
Ashland Road
Mountain Avenue
Glenside Avenue
Interstate 78
Qwtr
Qwmtr
Qal
Qwde
Qwlb
Qwb
Qcb
Qws
Qwft
Qwic
Qs
Qpt
City Hall
Train Station
Surficial Geology
Alluvium (Qal)
Basalt Colluvium (Qcb)
Late Wisconsinan Glacial Delta Deposits (Qwde)
Late Wisconsinan Glacial Lake-Bottom Deposits (Qwlb)
Late Wisconsian Glaciofluvial Terrace Deposits (Qwft)
Late Wisconsinan Terminal Moraine Deposits, Rahway Till (Qwmtr)
Rahway Till (Qwtr)
Swamp and Marsh Deposits (Qs)
Weathered Basalt (Qwb)
Water Body
City of Summit
Municipal Boundaries
N
0 0.1 0.2 0.4 0.6 0.8
Miles
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Piedmont Province are the result of the gradual erosion of ancient uplands during the opening of the Atlantic Ocean.[131] The upland ridges consist of igneous rock formed by lava flows, which deposited basalt over millions of years. The dropping of sediment resulted in valleys known as rift basins, where sediment continues to be deposited along rivers and lakes.

The highest point of the Piedmont region is the Barren Ridge on the northern side of the Hunterdon Plateau at 914 feet above sea level.[132] Other high points include High Mountain at 885 feet; the Watchung Mountains, which reach 850, 750, and 350 feet at their highest points; and the Palisades, which form cliffs overlooking the Hudson River with a maximum elevation of 550 feet.

Situated near the gap in the Second Watchung Mountain, most of Summit has an elevation of 200 to 350 feet above sea level, reflecting the low slopes of the mountains. The Second Watchung's highest point within the city reaches about 500 feet, found to the west of Interstate 78, around Rotary Drive and Oak Ridge Avenue (**Map 16**).

Steep Slopes

Where the Watchung ridges turn to valleys, some steep slopes are present. In Summit, sleep slopes are primarily found in the southeastern edge of these ridges and hills. The most severe slope is found above Glenside Avenue, where the land has been acquired by the City for conservation purposes, due to the geological and ecological risks of disturbing the slope.[133]

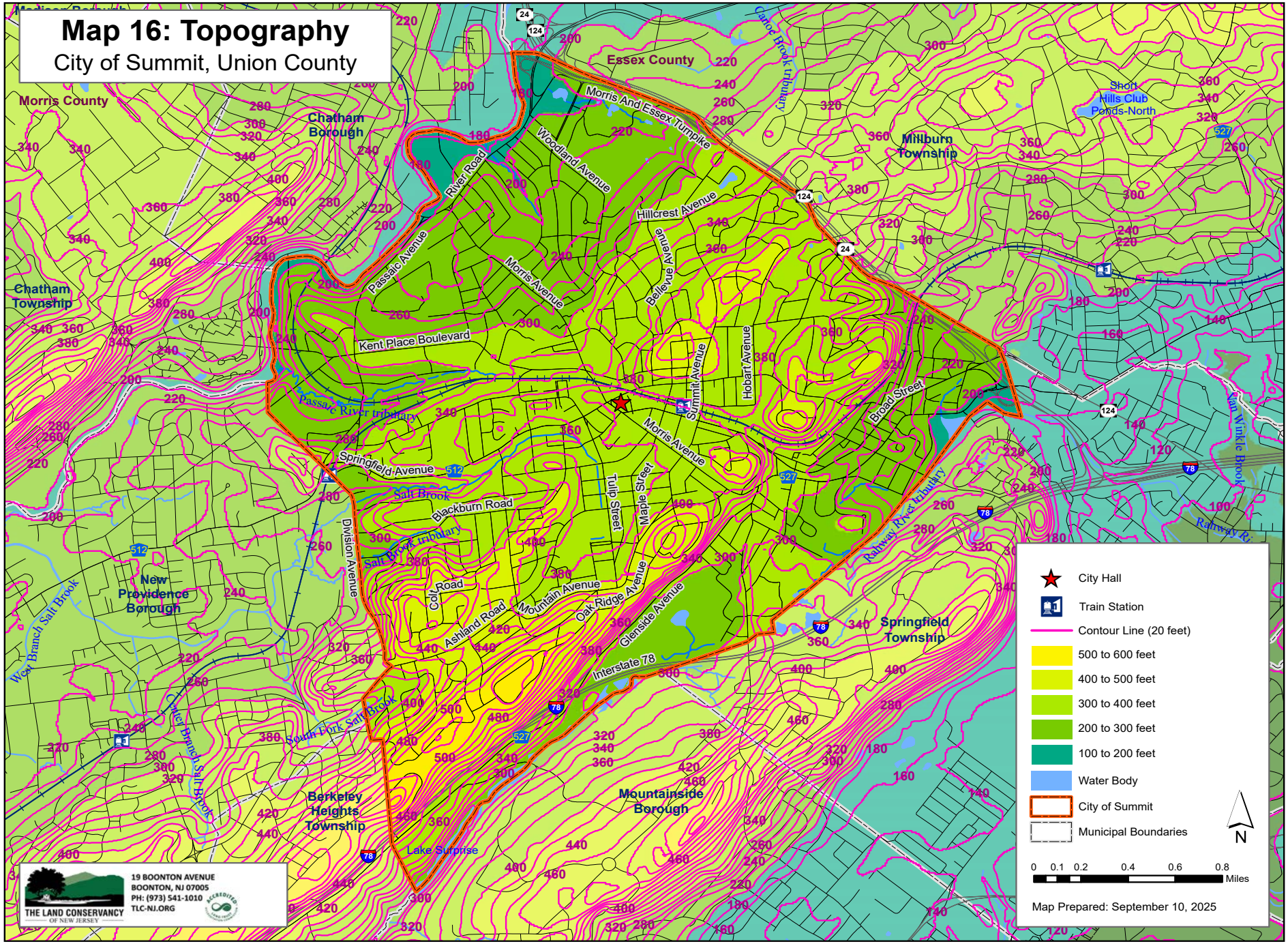
Steep slopes are associated with geological hazards. The term landslide captures a range of slope movements, including rock falls, slope failures, debris flow or mudslides. Contributing factors that may induce landslides include: weather-induced erosion that steepens the slope; saturation of slopes by heavy rains or snowmelt; earthquakes; stream erosion; or disturbance of the slope or its vegetation by human activities.

According to the 2019 New Jersey Hazard Mitigation Plan, the northwestern portion of Union County may be highly susceptible to landslides.[134] Two major landslides occurred in Summit in the last 30 years, each causing NJ Transit tracks to close, affecting the Morris & Essex Line. Both instances were the result of heavy rains causing debris flows: one occurred in 1991, and the other in 2011 during Tropical Storm Irene.[135]

Changes in storm patterns due to climate change may cause higher risks of landslides in the future. For more information on landslides, see **Chapter 9: Climate** on **page 92**.

Steep Slope Ordinance

Summit Municipal Code (§ 35-16.1) establishes requirements and restrictions for development within steep slope areas in order to minimize adverse impacts including erosion, siltation, flooding, surface water runoff, and pollution of potable water from point and nonpoint sources. The ordinance defines steep slopes as those 15% or greater, in accordance with the definition set by the Soil Conservation Service of the USDA. Applications for subdivision, site plan approval, or permits for construction, grading, or clearing require evaluation of risks required per § 35-16.1D.[138]


Map 16: Topography
City of Summit, Union County
Morris County
Essex County
Chatham Borough
Chatham Township
Millburn Township
Short Hills Club Ponds-North
New Providence Borough
Springfield Township
Berkeley Heights Township
Mountainside Borough
Lake Surprise
Morris And Essex Turnpike
Woodland Avenue
River Road
Passaic Avenue
Hillcrest Avenue
Bellevue Avenue
Morris Avenue
Kent Place Boulevard
Passaic River tributary
Summit Avenue
Hobart Avenue
Broad Street
Springfield Avenue
Salt Brook
Blackburn Road
Salt Brook tributary
Tulip Street
Maple Street
Division Avenue
Cole Road
Mountain Avenue
Ashland Road
Oak Ridge Avenue
Glenside Avenue
Interstate 78
Railway River tributary
Garrow Brook tributary
West Branch Salt Brook
South Fork Salt Brook
Canoe Brook Salt Brook
Nun Wimble Brook
City Hall
Train Station
Contour Line (20 feet)
500 to 600 feet
400 to 500 feet
300 to 400 feet
200 to 300 feet
100 to 200 feet
Water Body
City of Summit
Municipal Boundaries
N
0 0.1 0.2 0.4 0.6 0.8
Miles
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Tiny Forest
Photo: Donna Goggin Patel

Chapter 8.

Soil

Soil is the unconsolidated mineral or organic matter on the surface of the earth that has been subjected to and shows the effects of genetic and environmental factors (including climate) of micro-and macro-organisms acting on parent material over a period of time. The Natural Resources Conservation Service (NRCS) Soil Survey identifies and maps over 20,000 different soil types in the United States. Most soils are given names from the local area where they were first mapped, and these named soils are referred to as soil series.

Soil forming factors include:

- **Parent Material**: Some soils weather directly from the underlying rocks. The residual soils have the same general chemistry as the original rocks.
- **Climate**: Temperature and moisture can cause different patterns of weathering and leaching. The intensity, timing, and amount of rain also influences soil formation.
- **Topography**: The slope and aspect (direction the physical slopes face) affect the temperature and moisture content of the soil.
- **Biological Factors**: Plants, animals, micro-organisms, and humans affect soil formation. Native vegetation depends on biology, topography, and climate factors, as well as soil factors (density, chemistry, depth, temperature, and moisture).
- **Time**: Soil formation is continuous, always altering according to climate, landscape position, and biological activity.

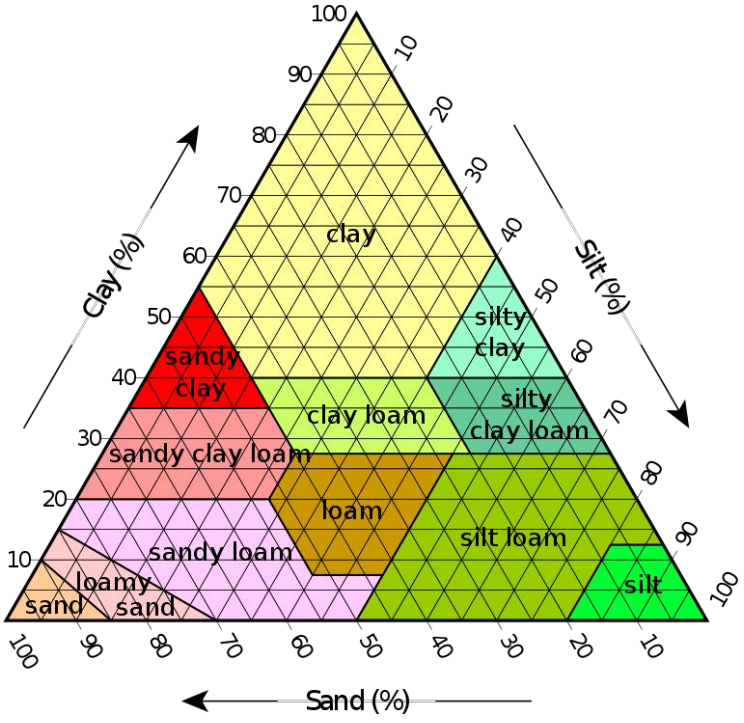
Soil Classifications

Soils are named and classified on the basis of physical and chemical properties in their layers (horizons). Soil taxonomy uses the color, texture, structure, and other properties of the surface two meters deep to key the soil into a classification system to help the public use soil information.

The United States Department of Agriculture (USDA) defines 12 major soil texture classifications (loam, loamy sand, sandy loam, loam, silt loam, silt sandy, clay loam, silty clay, and clay). Soil textures are classified by the fractions of sand, silt, and clay in soil (**Figure 18**). Classifications are typically named for the primary constituent particle size or the most abundant particle size. For illustrations of soil type, size, and texture, see **Figure 19**.

Figure 18. Soil Texture Triangle

Source: USDA



Soils data and mapping included in this chapter are sourced from the NRCS Official Soil Survey for Union County. The NRCS Survey plots soils by map unit based on the characteristics of the dominant soils within that unit. The map unit names identify soils by their soil series classification(s). Each named map unit has an associated abbreviation that offers a shorthand version of the naming/ classification system. These abbreviations identify soil types by steepness, stoniness, and frequency of flooding. Conventions include:

- The **first three letters** of the abbreviation name the soil or complex. For example, Dun refers to Dunellen.
- **Capital letters at the end** of the abbreviation indicate the slope, with "A" being less steep and "E" being steeper. For example, Boonton loam with 0 to 8 percent slopes is BogB, while Boonton loam with 8 to 15 percent slopes is BogC.
- The **small "t"** at the end of an abbreviation indicates soils are frequently flooded. For example, the Hatboro-Codorus complex, frequently flooded, is HcuAt.

The NRCS categorizes each map unit as one of four types: consociations, complexes, associations, and undifferentiated groups. Soils are specifically categorized as consociations or complexes:

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. An example is Haledon loam, which includes HakA and HakB.

Complexes (Cx) 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. Complexes are often in reference to urban complexes, where urban land is mixed with the soil, such as the Neshaminy-Urban land complex (NenB, NenC, NenD).

Soils of City of Summit

Soils are analyzed in terms of map units, where the dominant soils in a unit share similar characteristics. The lowest classification of map units is a soil series, where all soils have horizons similar in composition, thickness, and arrangement.

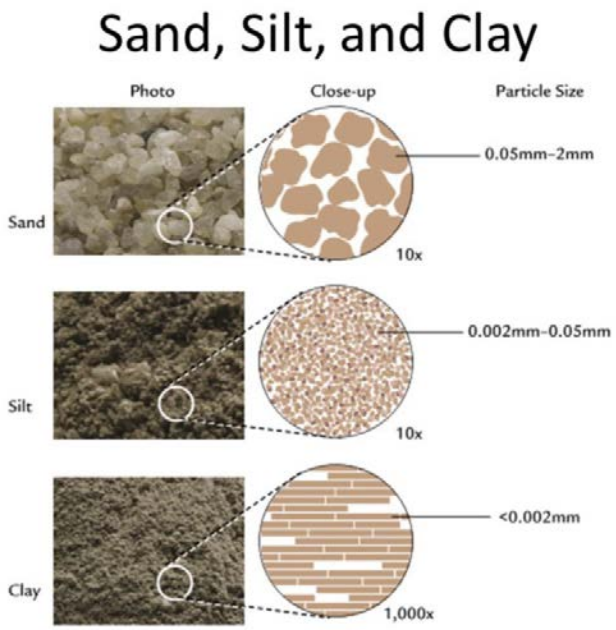
The data in **Table 14** illustrates major soil series in Summit. Excluded from this assessment are areas of water, rock outcrops, and urban land, except for when they form complexes with other soils, in which case they are classified by the dominant soil components. The soils of Summit have been highly modified by urban development, with much of the land area defined by urban land (UR, 307 acres, excluded from soil analysis) and urban land complexes. The characteristics and functions of a soil type may be impacted by the presence of urban components.

There are six predominant soil series, including their consociations and complexes, that account for 85% of soils in the municipality (3,302 acres). In order, these are:

- Boonton series (1,742 acres, 45%),
- Neshaminy series (583 acres, 15%),
- Haledon series (453 acres, 12%),
- Amwell series (231 acres, 6%),
- Whippany series (152 acres, 4%), and
- Dunellen series (142 acres, 4%).

Figure 19. Soil Types (top), Soil Size (middle), Soil Texture (bottom)

Source: Noble Research Institute



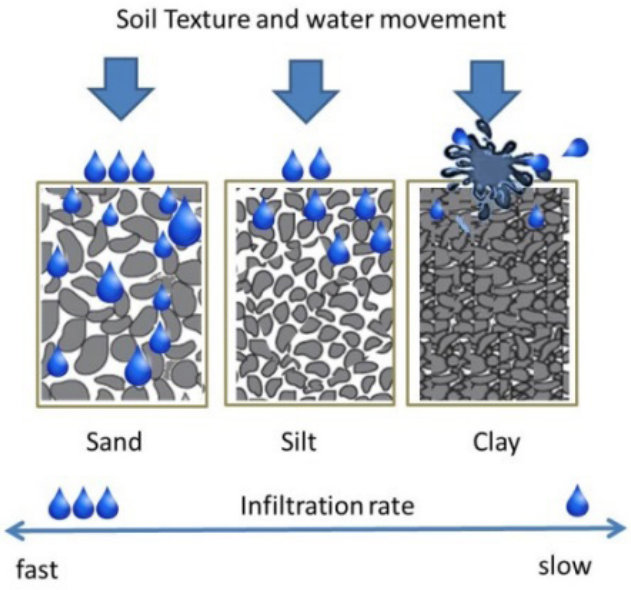


Table 14 lists common soil types, organized by series which cover more than 100 acres. A complete list of all major and minor soil units can be found in **Appendix A: Soil Units of Summit** on **page 132**.

Table 14. Major Soil Series of Summit			
Soil Series	**Acres**	**%**	**Total Acres**
Boonton Series			1,741.8 (45%)
Boonton sandy loam, terminal moraine (BoeDc)	16.4	0.4%	
Boonton loam (BogB)	62.0	3.6%	
Boonton moderately well drained gravelly loam (BohC, BohD)	96.8	2.5%	
Boonton-Urban land complex (BouB, BouD)	74.5	1.9%	
Boonton-Urban land-Haledon complex (BovB)	871.0	22.6%	
Boonton-Urban land, Boonton substratum complex (BowtB)	324.8	8.4%	
Boonton-Urban land complex, terminal moraine (BowtC, BowtD)	296.2	7.7%	
Neshaminy Series			582.6 (15%)
Neshaminy silt loam, extremely stony (NehBc, NehDc, NehEc)	176.1	4.6%	
Neshaminy-Urban land complex (NenB, NenD)	406.5	10.5%	
Haledon Series			452.9 (12%)
Haledon loam (HakA, HakB)	253.8	6.6%	
Haledon-Urban land complex (HasB)	3.5	0.1%	
Haledon-Urban land-Hasbrouck complex (HatB)	195.6	5.0%	
Amwell Series			230.7 (6%)
Amwell silt loam (AmhB, AmhCb)	48.6	1.2%	
Amwell-Urban land complex (AmuB)	182.1	4.7%	
Whippany Series			152.2 (4%)
Whippany silt loam, rarely flooded (WhpAr, WhpBr)	57.5	1.5%	
Whippany-Urban land complex, rarely flooded (WhrBr)	94.7	2.5%	
Dunellen Series			141.6 (3.7%)
Dunellen sandy loam (DunB)	21.3	0.6%	
Dunellen-Urban land complex (DuuA, DuuB)	85.0	2.2%	
Top 6 Series Total:	**3,302**	**85.5%**	
Other soils:	**559**	**14.5%**	
Source: NRCS Soil Survey			

Several other series are present with less than 100 acres of area, including the Udorthents and Parsippany series. The complete list of soil units can be found in **Appendix A: Soil Units of Summit**.

Map 17 shows the locations of different soil types in Summit. The six major soil series are detailed in the section below, including their basic characteristics, drainage and permeability, typical uses and vegetation.

Boonton Series

The Boonton Series is the most abundant in Summit, totaling 1,742 acres or 45% of soils. The largest unit is Boonton-Urban land-Haledon complex (BovB, 871 acres), which is 50% Boonton soil, 30% urban land, and 20% Haledon soil.[139] A description of the Haldeon series can be found below.

Other present Boonton series units include Boonton sandy loam (BoeDc), Boonton loam (BogB), Boonton moderately well drained gravelly loam (BohC, BohD), and Boonton-Urban land complex (BouB, BouD, BowtB, BowtC, BowtD).

The Boonton series consists of deep or very deep moderately well and well drained soils formed in till on uplands. They are moderately deep to a fragipan or restrictive layer. The series is of moderate extent, making up 62,000 acres in northeastern New Jersey and southeastern New York. Slopes range from gentle to very steep, with gradients up to 50 percent.[140]

- **Drainage and permeability**: soils are moderately well and well drained, with slow to rapid runoff. Saturated hydraulic conductivity is moderately low to high in the mineral soil above the fragipan, low or very low in the fragipan, and low to high in the substratum. There is a perched water table at a depth of 46 to 91 centimeters (cm) in most years from November to May.

- **Use and vegetation**: Most soils are in highly urbanized areas, though some undeveloped sites are wooded or idle fields. Wooded areas consist of oaks, red maple, white ash, hickory, gray birch, and dogwood trees.

Neshaminy Series

Second most common is the Neshaminy series, with its largest unit being Neshaminy-Urban land complex, 12 to 18 percent slopes (NenD, 233 acres). Other units include Neshaminy-Urban land complex, 0 to 6 percent slopes (NenB), Neshaminy silt loam with slopes from 0 to 6 percent (NehBc), 12 to 18 percent (NehDc), and 18 to 35 percent (NehEc). In total, the Neshaminy series comprises 583 acres or 15% of soils in Summit.

The Neshaminy series consists of deep and very deep well-drained soils formed in materials weathered from diabase and other dark colored basic rocks. Slopes can range from 0 to 70 percent. Solum thickness ranges from 35 to 60 inches; depth to bedrock is 48 inches or more. Diabase fragments are up to 20 inches in size, and quartzite fragments are generally less than 3 inches. Where unlimed, soils are moderately to very strongly acid.[141]

- **Drainage and permeability**: Soils are well drained. Saturated hydraulic conductivity is moderately slow. Runoff ranges from slow to very rapid, depending on slopes.

- **Use and vegetation**: Stony and steep areas are mostly in woodland of mixed hardwoods, dominated by oaks and hickories. Some less steep or stony

areas are used for cropland, hay, and pasture. Some has been developed for urban and suburban communities.

Haledon Series

The Haledon series is the third most common in Summit, with its largest unit being Haledon loam, 3 to 8 percent slopes (HakB, 237 acres). Also present are Haledon loam, 0 to 3 percent slopes (HakA), Haledon Urban-land complex (HasB), and Haledon-Urban land-Hasbrouck complex (HatB).In total, the Haledon series comprises 452 acres or 12% of soils in Summit.

The Haledon series consists of very deep, somewhat poorly drained soils. The soils developed in coarse glacial will composed of basalt, red sandstone, and shale, and granitic gneiss with some minor components. Haledon soils are found at lower points of steep sloping uplands and in shallow drainage ways, ranging from northeastern New Jersey to the New York City metropolitan area.[142]

- **Drainage and permeability**: Haledon soils are somewhat poorly drained with medium to very high surface runoff. Saturated hydraulic conductivity is moderately high or high above the fragipan and very slow in the fragipan. A perched high water table is within 30 cm of the surface in the late winter and early spring of most years, and following extended periods of rainfall.

- **Use and vegetation**: Most areas are wooded or in idle fields, used for housing and urban development. Vegetation is largely forest, dominated by oak and maple with some birch and ash.

Amwell Series

Fourth most common is the Amwell Series, with its largest unit being Amwell-Urban land complex, 0 to 6 percent slopes (AmuB, 182 acres). Other units are Amwell silt loam, 2 to 6 percent slopes (AmhB, 16 acres), and 6 to 12 percent slopes, very stony (AmhCb, 33 acres). In total, the Amwell series comprises 231 acres or 6% of soils in Summit.

The Amwell series consists of deep and very deep, somewhat poorly and moderately well drained silt loam soils on uplands. They formed mainly in colluvial material derived from igneous rocks, with slopes ranging from 0 to 15 percent. Solum thickness ranges from 30 to 50 inches; depth to bedrock is over 40 inches; depth to the top of the fragipan is between 18 and 30 inches.[143]

- **Drainage and permeability**: Amwell soils are somewhat poorly and moderately well drained. Saturated hydraulic conductivity is moderately high above the fragipan and moderately low in the lower solum. Surface runoff is high where poorly drained and low to high where moderately well drained, depending on slope.

- **Use and vegetation**: Dominant use is woodland. Common trees are pin oak, red maple, elm, ash, and red oak.

Whippany Series

The Whippany series is fifth most common in Summit, with its largest unit being Whippany-Urban land complex, 0 to 8 percent slopes, rarely flooded (WhrBr, 95 acres). Other units present are Whippany silt loam with 0 to 3 percent slopes (WhpAr, 51 acres) and 3 to 8 percent slopes (WhpBr, 7 acres). In total, Whippany soils account for 152 acres or 4% of soils in the City of Summit.

Whippany soils are very deep, somewhat poorly drained soils formed in silty and

clayey sediments. They are derived mainly from shale, basalt, and granite, with slopes from 0 to 8 percent. Coarse fragments are often lacking but can be up to 30 percent at depths below 40 inches. Solum thickness ranges from 30 to 50 inches; depth to bedrock is more than 5 feet. They are found on slight elevations or gently sloping peripheral areas.[144]

- **Drainage and permeability**: Soils are somewhat poorly drained. Runoff is negligible to very high and permeability is slow. Saturated hydraulic conductivity ranges from moderately low to moderately high. The water table is at or near the surface for brief times in late winter or early spring, dropping to at least 4 feet deep in the summer.

- **Use and vegetation**: Natural vegetation includes maple, sweet gum, pin oak, elm and swamp white oak.

Dunellen Series

The last of the major soils series is Dunellen, with its largest unit being Dunellen-Urban land complex with 3 to 8 percent slopes (DuuB, 55 acres). Other units are Dunellen-Urban land with 0 to 3 percent slopes (DuuA, 30 acres), 15 to 25 percent slopes(DuuD, 35 acres), and Dunellen sandy loam, 3 to 8 percent slopes (DunB, 21 acres). In total, Dunellen soils account for 142 acres or just under 4% of soils.

The Dunellen series consists of very deep, well drained soils formed in stratified materials on outwash pains and stream terraces, with slopes ranging from 0 to 35 percent. Solum thickness ranges from 25 to 40 inches, and depth to bedrock is typically greater than 10 feet. Rock fragments are found from 0 to 15 percent in the upper solum and 0 to 30 percent in the lower solum; typically, they are rounded pebbles of red shale, sandstone, or siltstone, including basalt, granitic gneiss, quartzite and conglomerates. Soils can be moderately to very strongly acid, unless limed.[145]

- **Drainage and permeability**: Soils are well drained. Saturated hydraulic conductivity ranges from moderately high to very high. Runoff is negligible to high, depending on slopes.

- **Use and vegetation**: Dunellen soils are largely used for development. Remaining areas are on the urban fringe. In wooded areas, trees include red, white, and black oak, hickory, red maple, and ash.

Soil Characteristics

Erodibility

K-Factor. Soils are also characterized by their susceptibility to erosion, or the natural processes 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 degree of soil erodibility is defined by the K factor, which accounts for soil texture, composition, and permeability. K values range from 0.02 (least susceptible to erosion) to 0.69 (most susceptible):

- Clayey soils have the lowest K values (between 0.05 and 0.15 generally), as they are resistant to detachment and have low rates of runoff.
- Coarse textured soils, such as those with sandy compositions, also have low K values ranging from 0.05 to 0.2. With coarse soils, rates of runoff are low, but the materials are easily detachable.

- Medium textured soils such as silty loams have moderate K values ranging from 0.25 to 0.4. These soils are moderately susceptible to detachment and have moderate rates of runoff.
- Loose, silty soils have the highest K values between 0.4 and 0.69, as they are easily detached and have high rates of runoff.

K values for major soil units are included in **Table 15**. Most soils of Summit are moderately susceptible to erosion, with K values from 0.24 to 0.37. Amwell soils have higher erodibility, with AmuB having K-value of 0.43.

T-Factor. The T factor is an estimate of the maximum annual rate of soil erosion that can occur without affecting crop productivity over a sustained period. The rate is expressed in tons per acre per year. T values in Summit range from 3 to 5.

Topographic Protection (Wind)

Some soils are more vulnerable to erosion by wind. Wind erosion most often affects soils on bare lands, where the force of winds detaches particles that protrude from the soil surface. Maintaining surface cover helps to minimize damage due to wind erosion. Wind erodibility is measured in two ways, using groupings and an index.

Groups are assigned based on similar properties affecting susceptibility to wind erosion in cultivated areas. Soils assigned to group 1 are most susceptible to wind erosion, and those assigned to group 8 are least erodible. Soils in Summit range from group 3 to group 6. The wind erodibility index measures the tons of soil per acre per year that can be expected to be lost to wind erosion. Expected soil loss ranges from 48 to 86 tons per acre per year.

Table 15. Soil and Wind Erodibility Classifications of Major Soil Units

Largest Map Units (By acreage)	Acres	K-Factor (erodibility, 0.02=least erodible, 0.69=most)	T-Factor (soil loss tolerance, tons/acre/ year)	Wind Erodibility	
				Group (1=least erodible, 8=most)	Index (expected soil loss, tons/acre/ year)
Boonton-Urban Haledon (BovB)	871	0.32	4	5	56
Boonton-Urban, Boonton (BowtB)	325	n/a	4	3	86
Haledon loam (HakB)	237	0.24	4	5	56
Neshaminy-Urban (NenD)	233	0.37	5	5	56
Boonton-Urban, t.m. (BowtD)	223	n/a	4	3	86
Haledon-Urban-Hasbrouck (HatB)	196	0.24	4	5	56
Amwell-Urban complex (AmuB)	182	0.43	3	5	56
Neshaminy-Urban complex (NenB)	173	0.37	5	5	56
Neshaminy silt loam, stony (NehEc)	125	0.37	5	5	56
Whippany-Urban complex (WhrBr)	95	0.37	3	6	48

Source: NRCS Soil Survey

Hydric Soils

The National Technical Committee for Hydric Soils (NTCHS) defines hydric soils as soils that formed under conditions of saturation, flooding, or ponding for long enough during the growing season to develop anaerobic conditions in the upper part. As a result, these soils are regularly inundated and able to support hydrophytic vegetation.

Hydric soils are an important element of wetland areas, providing natural support to wetland vegetation. Due to the ecological importance of wetlands, areas with hydric soils may be subject to federal/state regulations, including restrictions on land use and development.

Soils are rated by the percentage of hydric components. In Summit, there are four types of predominantly hydric soil units:

- (PbpAt) Parsippany silt loam, 0 to 3 percent slopes, frequently flooded: 49.6 acres (100%)
- (PcsAt) Passaic silt loam, 0 to 3 percent, frequently flooded: 7.0 acres (90%)
- (PbpuAt) Parsippany-Urban land complex, 0 to 3 percent slopes: 10.6 acres (80%)
- (HcuAt) Hatboro-Codorus complex, 0 to 3 percent slopes, frequently flooded: 28.0 acres (60%)

Limitations for Use

There are measurable characteristics that determine the suitability of soils for certain types of development. These are not limited to the risk of corrosion of construction materials (steel and concrete), limits for septic systems, depth to restrictive layers, and hydrological characteristics such as a shallow water table, tendency towards ponding or flooding, and potential for frost heaving.

Such limitation assessments account for factors such as soil composition, texture, water retention, and overall stability based on these factors. For example, clayey or wet soils are poorly suited for septic tank absorption fields, and a water table limits the suitability of underground construction such as basements.

Limitations for use include the following characteristics (**Table 16**):

Depth to restrictive feature refers to the vertical distance between the soil surface and the upper boundary of a restrictive layer. The restrictive layer is a nearly continuous layer that significantly impedes the movement of water and air through the soil or otherwise provides an unfavorable root environment. Examples are bedrock, cemented layers, dense layers, and frozen layers. Depth to restrictive layer may vary throughout a unit, so a representative value is given, indicating the most common or most likely measurement for a chosen point.

In Summit, major soil units range from 46 cm to restrictive layer to >200 cm to restrictive layer, with the shallowest being of the Amwell series and the deepest being of the Neshaminy series.

Drainage refers to the relative wetness of the soil under natural conditions of the 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, where water is removed very rapidly from coarse or shallow soils, to very poorly drained, where water is removed very slowly so that free water is

left at or near the surface during much of the growing season. The major soil units of Summit are variable in their drainable capability.

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

The major soil units of Summit are variable in their depth to water table. Some are >200 cm to water table, including the Boonton series and Neshaminy series, while others, like the Haledon series, are shallow (31 cm).

Available water capacity is the quantity of water that the soil is capable of storing for use by plants. This capacity is measured in centimeters of water per centimeter of soil. Available water capacity varies according to soil properties, including the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in selecting plants or crops, as well as in the design and management of irrigation systems.

Among major soil units of Summit, the range of available water capacity is between 0.09 and 0.13 cm of water per centimeters of soil.

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. The frequency of flooding 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 zero 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 one percent in any year.
- **Rare** means that flooding is unlikely but possible under unusual weather conditions. The chance of flooding is one to five percent in any year.
- **Occasional** means that flooding occurs infrequently under normal weather conditions. The chance of flooding is five to 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** is flooding which is likely to occur often under normal weather conditions. The chance of flooding is more than 50% in all months of any year.

All major soil units of Summit have a flooding frequency of “none.” Across more minor units, hydric soils experience frequent flooding: Parsippany silt loam, Passaic silt loam, Parsippany-Urban land complex, and Hatboro-Codorus complex.

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), leading to the collapse of the soil and loss of strength upon thawing. Frost action occurs when moisture moves into the freezing zone of the soil. During thawing periods, this results in damage to pavement and other rigid structures.

Evaluating the potential for frost action requires consideration of temperature, texture, density, saturated hydraulic conductivity (Ksat), content of organic matter, and depth to the water table. This assessment assumes that the soil is not insulated by vegetation or snow and is not artificially drained. Most susceptible to frost action are silty, highly-structured, clayey soils that have a high water table in winter. Well drained, very gravelly or sandy soils are the least susceptible.

Major soils of Summit have moderate frost action potential.

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

- **None**: Ponding is not probable.
- **Rare**: It is unlikely but possible under unusual weather conditions (the chance of ponding is nearly 0 to 5% in any year).
- **Occasional**: It occurs, on the average,

Table 16. Soil Limitations in Summit

	Major Soil Units							
	AmuB	BovB	BowtB	BowtD	HakB	HatB	NenB	NenD
Depth to Restrictive Feature (cm)	46	91	61	61	71	71	>200	>200
Drainage	Somewhat poorly drained	Moderately well drained	Well drained	Well drained	Somewhat poorly drained	Somewhat poorly drained	Well drained	Well drained
Depth to Water Table (cm)	76	76	>200	>200	31	31	>200	>200
Available Water Capacity (cm/cm)	0.11	0.10	0.09	0.09	0.13	0.13	0.12	0.12
Flooding	None							
Frost Action Potential	Moderate							
Ponding	None							
Risk of Corrosion - Steel	High	Moderate	Moderate	Moderate	High	High	Moderate	Moderate
Risk of Corrosion - Concrete	Moderate	Moderate	High	High	Moderate	Moderate	Moderate	Moderate
Septic Limitations	Very limited							
Source: NRCS Soil Survey								

once or less in two years (the chance of ponding is 5-50% in any year).

- **Frequent**: It occurs, on the average, more than once in two years (the chance of ponding is more than 50% in any year).

All major soil units of Summit have a ponding frequency of "none." Across more minor units, the hydric soils experience frequent ponding: Parsippany silt loam, Passaic silt loam, Parsippany-Urban land complex, and Hatboro-Codorus complex.

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. Generally, steel or concrete installations that intersect soil layer boundaries are more susceptible to corrosion than ones that are entirely within one kind or layer of soil.

Major soil units in Summit range from moderately to highly corrosive of steel and concrete. Amwell and Haledon soils are highly corrosive to steel, while Boonton soils are highly corrosive to concrete.

Septic limitations reflect the suitability of a soil type to effectively manage septic tank absorption. Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tile or perforated pipe. Only the part of the soil between depths of 24 and 60 inches is evaluated. Septic suitability ratings are based on the soil properties that affect absorption of the effluent, construction and maintenance of the system, and broader factors of public health.

The most important soil properties that determine septic limitations are saturated hydraulic conductivity (Ksat), depth to water table, depth to restrictive layers, frequency of ponding, and frequency of flooding. Restrictive layers such as stones and boulders, ice, bedrock or cemented pan interfere with system installation. Subsidence interferes with installation and maintenance. Excessive slope may cause lateral seepage and surfacing of the effluent in downslope areas.

All major soil types in Summit are identified as very limited suitability for septic systems.

Soil Limitations for Building Site Development

Soils are also rated for their ability to support dwellings (single-family homes of three stories or fewer) based on properties that affect the capacity of a soil to support a load without movement, and properties that affect excavation and construction costs. Ratings as separately considered for dwellings with and without basements, as well as small commercial buildings of three stories or fewer. These ratings differ for several reasons:

- For dwellings without basements and small commercial buildings, the foundation is assumed to consist of spread footing of reinforced concrete, built on undisturbed soil at a depth of two feet or at a 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 in undisturbed soil at a depth of about seven feet.

The properties that affect the load-supporting capacity of soils include depth to a water table, ponding and flooding, subsidence, linear extensibility (shrink-swell potential), and compressibility. Properties that affect excavation and construction costs are depth to a water table, ponding and flooding, slope, depth to bedrock or cemented pan, hardness of bedrock or cemented pan, and the amount and size of rock fragments. Taking all factors into account, an area's soils may be rated:

- **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**: the soil has features that are moderately favorable for 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**: 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.

The NRCS summary of values for City of Summit indicates that approximately 69% of soils by land area are very limited for dwellings with basements. About 20% are not limited, while 2% are somewhat limited. Other soil types are null or have not been rated. Prevalent soil types with high limitations include the Amwell-Urban land complex, Haledon loams and urban complexes, and soils with slopes over 12%.

For dwellings without basements, limitations are similar. Approximately 71% of soils are rated as very limited; 18% are not limited, and 2% are somewhat limited. Others are null or not rated. Very limited soils include Boonton loams, Amwell soils and complexes, Haledon loams and urban complexes, and soils with slopes over 12%.

For small commercial buildings, about 73% of soils by area are very limited, 11% are somewhat limited, and 7% are not limited. Very limited are Amwell, Boonton, and Haledon soils, and soils with slopes over 12%.

Limitations - Recreational Use

Different types of recreational amenities can require different supportive functions of soils. Recreational development is thus similarly ranked and advised according to soil properties (**Table 17**).

Picnic areas are used for preparing food and eating outdoors. They require soils that can remain firm under heavy foot traffic, absorb rainfall readily, and not be dusty when dry. Soil slope and stoniness are the main concerns affecting the development of picnic areas.

Playgrounds are intensively used for games and similar activities. They require soils that are nearly level, free of stones, and can withstand heavy foot traffic. Playground surfaces should absorb rainfall, remain firm under heavy foot traffic, and not be dusty when dry. Very limited areas are due to the presence of slopes, the factor of being too dusty or sandy, slow water movement, and the depth to cemented pan.

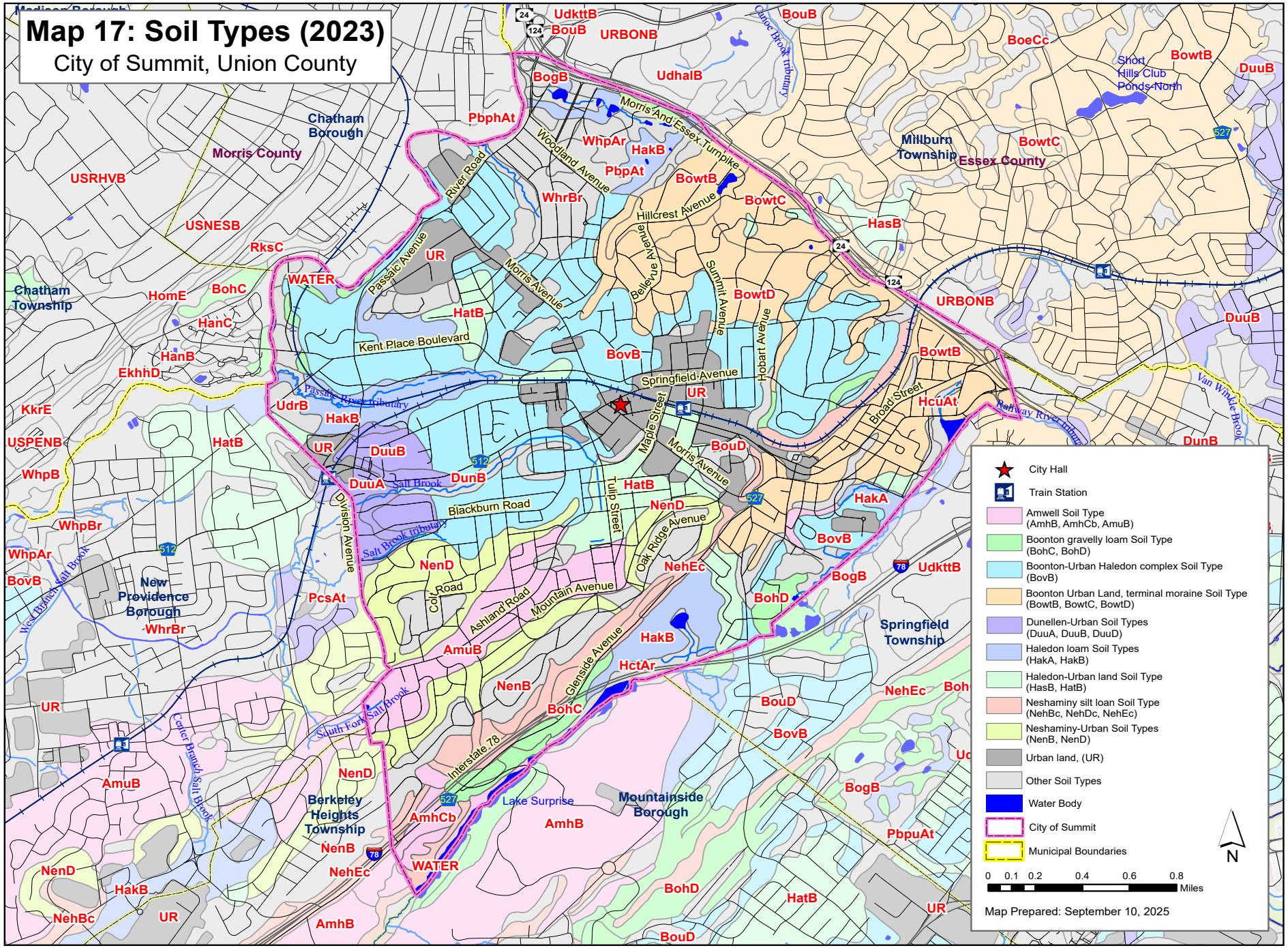
Table 17 summarizes the limits for recreational land use for the ten largest soil units of Summit. In summary:

- 46% of soil area is somewhat limited for camp areas, while 45% are very limited.
- 62% of soil area is somewhat limited for picnic areas, while 29% is very limited.
- 73% of soil area is very limited for playgrounds, while 18% is somewhat limited.

Table 17. Soil Limitations for Recreational Use

Soil Units of Summit	Camp Area	Picnic Area	Playground
Boonton-Urban land-Haledon complex, 0-8% (BovB)	Somewhat limited	Somewhat limited	Very limited
Boonton-Urban land, Boonton subst., 0 to 8% (BowtB)	Somewhat limited	Somewhat limited	Somewhat limited
Haledon loam, 3-8% (HakB)	Very limited	Somewhat limited	Very limited
Neshaminy-Urban land, 12-18% slopes (NenD)	Very limited	Very limited	Very limited
Boonton-Urban land, 15-25% (BowtD)	Somewhat limited	Somewhat limited	Very limited
Haledon-Urban land-Hasbrouck, 0-8% (HatB)	Very limited	Somewhat limited	Very limited
Amwell-Urban land, 0-6% (AmuB)	Somewhat limited	Somewhat limited	Somewhat limited
Neshaminy-Urban land, 0-6% (NenB)	Very limited	Very limited	Very limited
Neshaminy silt loam, 18-35% (NehEc)	Very limited	Very limited	Very limited
Whippany-Urban land, 0-8% (WhrBr)	Very limited	Somewhat limited	Very limited

Source: NRCS Soil Survey


Map 17: Soil Types (2023)
City of Summit, Union County
City Hall
Train Station
Amwell Soil Type (AmhB, AmhCb, AmuB)
Boonton gravelly loam Soil Type (BohC, BohD)
Boonton-Urban Haledon complex Soil Type (BovB)
Boonton Urban Land, terminal moraine Soil Type (BowtB, BowtC, BowtD)
Dunellen-Urban Soil Types (DuuA, DuuB, DuuD)
Haledon loam Soil Types (HakA, HakB)
Haledon-Urban land Soil Type (HasB, HatB)
Neshaminy silt loan Soil Type (NehBc, NehDc, NehEc)
Neshaminy-Urban Soil Types (NenB, NenD)
Urban land, (UR)
Other Soil Types
Water Body
City of Summit
Municipal Boundaries
0 0.1 0.2 0.4 0.6 0.8 Miles
N
Map Prepared: September 10, 2025
Chatham Borough
Chatham Township
Morris County
Millburn Township
Essex County
Springfield Township
New Providence Borough
Berkeley Heights Township
Mountainside Borough
Lake Surprise
Short Hills Club Ponds North
Morris And Essex Turnpike
Woodland Avenue
River Road
Passaic Avenue
Morris Avenue
Hillcrest Avenue
Bellevue Avenue
Summit Avenue
Hobart Avenue
Springfield Avenue
Kent Place Boulevard
Maple Street
Broad Street
Tulip Street
Oak Ridge Avenue
Blackburn Road
Division Avenue
Colt Road
Ashland Road
Mountain Avenue
Glenside Avenue
Interstate 78
Salt Brook
Salt Brook tributary
Passaic River tributary
Canoe Brook tributary
Van Winkle Brook
Railway River tributary
South Fork Salt Brook
Center Branch Salt Brook
West Branch Salt Brook

Passaic River Park in Winter
Photo: Dwight Hiscano

Chapter 9.

Climate

New Jersey's Climate

New Jersey has a diverse climate that can vary across its geography, while experiencing the extremes of all four seasons. Atmospheric circulation over North America is dominated by prevailing westerly winds, which move air from west to east in a broad, undulating flow. New Jersey's weather is influenced by its geography in relation to these winds, known as the jet stream, which gives the state its characteristic varied weather. The result is hot and humid summers, frigid winters, frequent precipitation and intense storms as warm continental air masses meet the cooler masses of the western Atlantic Ocean.[146]

Climate Zones & Data Collection

The Office of the NJ State Climatologist (ONJSC) publishes climate data for the state through Rutgers University, using data from the National Centers for Environmental Information (NCEI).

For purposes of record keeping and data analysis, NCEI and the National Oceanic and Atmospheric Administration (NOAA) divide New Jersey into three climatic zones based on similar characteristics: Northern (Division 1), Southern (Division 2), and Coastal (Division 3). Summit and all of Union County lie in Division 1 (**Figure 20**). The ONJSC gathers and reports climate data using a cooperative network of monitoring stations located throughout the state, supported by the National Weather Service (NWS).[147]

These sites report local data and compile data averages for the division, county, and state. For current and historic climate reporting, the nearest monitoring station is found at Canoe Brook, just north of

Summit in Millburn Township. Canoe Brook has recorded temperature and precipitation data since 1931, and snowfall data since 1950.[148]

Temperature

From older stations in Climate Division 1 and Union County, average climate data values have been recorded consistently since 1895. **Table 18** displays the average temperature for each month in the history of record keeping for Division 1, Union County, and Canoe Brook station.

The "Period of Record" Mean (POR) represents the total mean value across all 129 years of record-keeping for Division 1 and Union County. Below that, the "30-Year Normal" represents the average temperature recorded over 30 recent years, from 1991-2020. The disparity between the POR and 30-year normal indicates a gradual rise in year-round temperatures.

Figure 20. NOAA Climate Divisions of New Jersey

Source: NOAA Climate Prediction Center

Table 18. Average Monthly & Annual Temperatures

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	YEAR
Monthly Average Temperature, NJ Division 1 (North), 1895-2024													
POR Mean	27.1	28.4	37.3	48.3	58.8	67.4	72.3	70.3	63.5	52.4	41.4	31.1	49.9
30yr Normal	28.9	31.3	38.8	49.9	59.9	68.6	73.7	71.9	64.9	53.3	43.1	34.1	51.5
Monthly Average Temperature, Union County, 1895-2024													
POR Mean	30.0	31.3	39.7	50.2	60.6	69.6	74.8	72.8	66.0	54.7	44.0	34.0	52.3
30yr Normal	31.8	34.0	41.2	51.9	61.7	70.9	76.3	74.4	67.5	55.7	45.5	36.9	54.0
Monthly Average Temperature, Canoe Brook, 1931-2024													
Mean	29.1	30.6	39.0	49.7	59.8	69.1	74.2	72.5	65.3	54.0	43.4	33.2	51.8

Source: ONJSC Monthly Climate Tables

Figure 21 shows the history of average year-round temperatures for Union County. In 2024, the average annual temperature in Union County was 56.8, making it the warmest year in state recordkeeping.

Heating & Cooling Degrees

Temperature patterns are also captured by the number of heating and cooling degree days recorded in a given year. Heating and cooling degrees refer to the number of degrees required to reach comfortable indoor temperatures of 65°F during the winter or summer months. Heating/cooling days are reflected in the use of household heating/cooling systems.

The annual heating and cooling degree days for Union County are shown in **Figure 22** and **Figure 23**, respectively, on the following page.

There has been a decline in the amount of annual heating degree days over the last 20 years, meaning fewer days have required the use of indoor heating systems. Conversely, the amount of annual cooling degree days has risen, indicating an increase in the number of hot days.

All data in this chapter was retrieved from the Office of the New Jersey State Climatologist at Rutgers University.

Figure 21. Average Annual Temperature for Union County, NJ, 1895-2024

Source: ONJSC Climate Tables

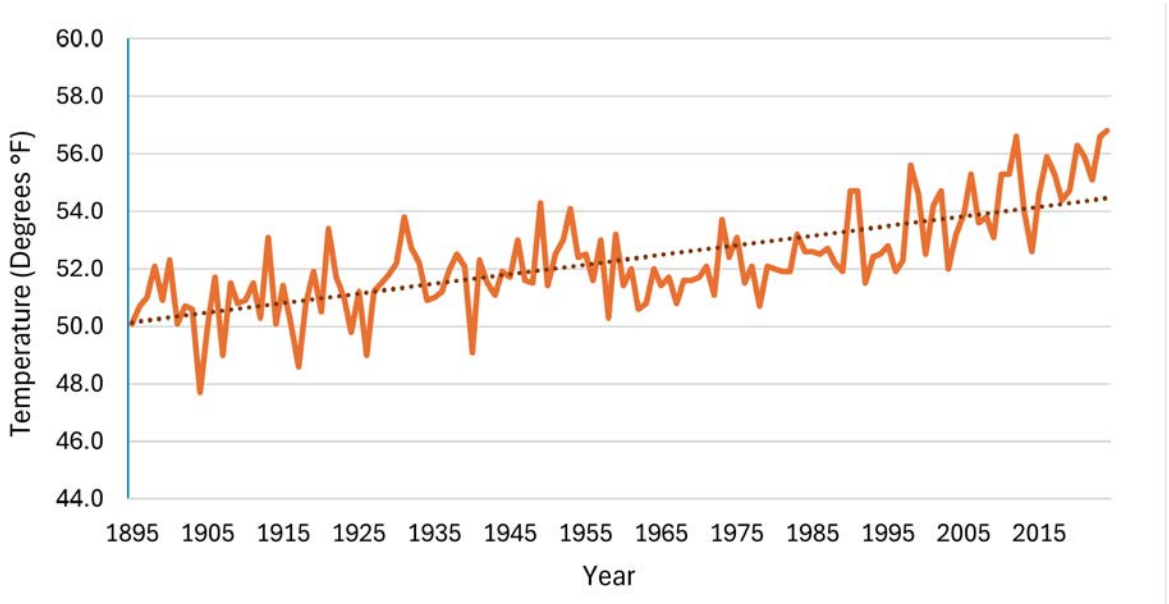


Figure 22. Annual Heating Degree Days, Union County, 1895-2024

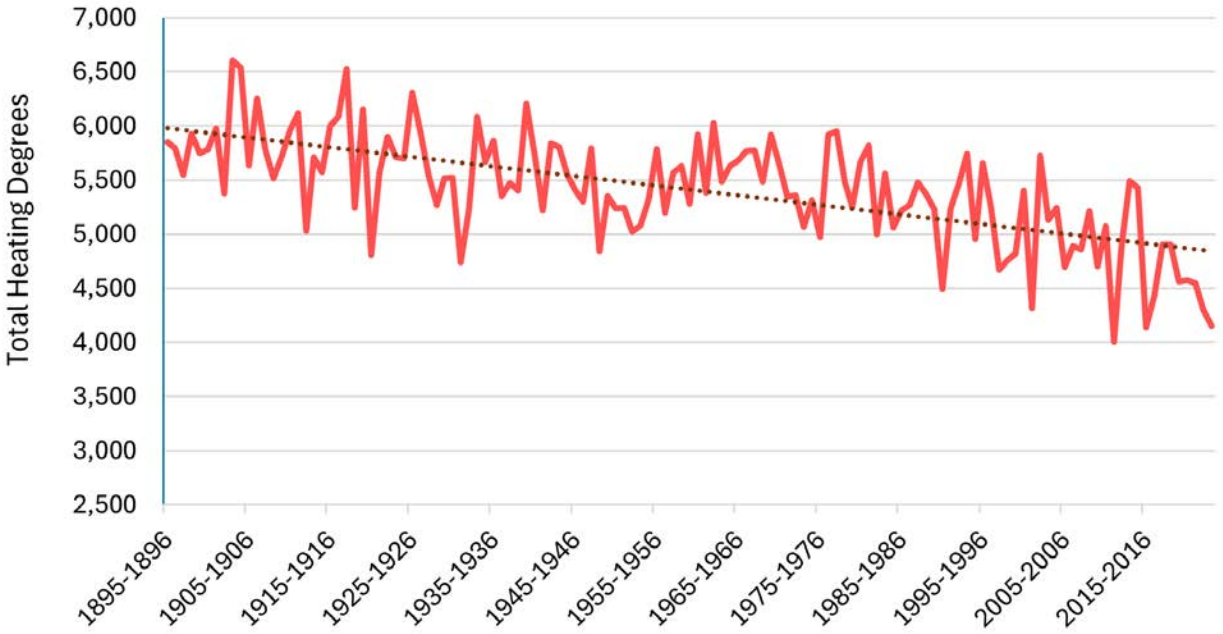
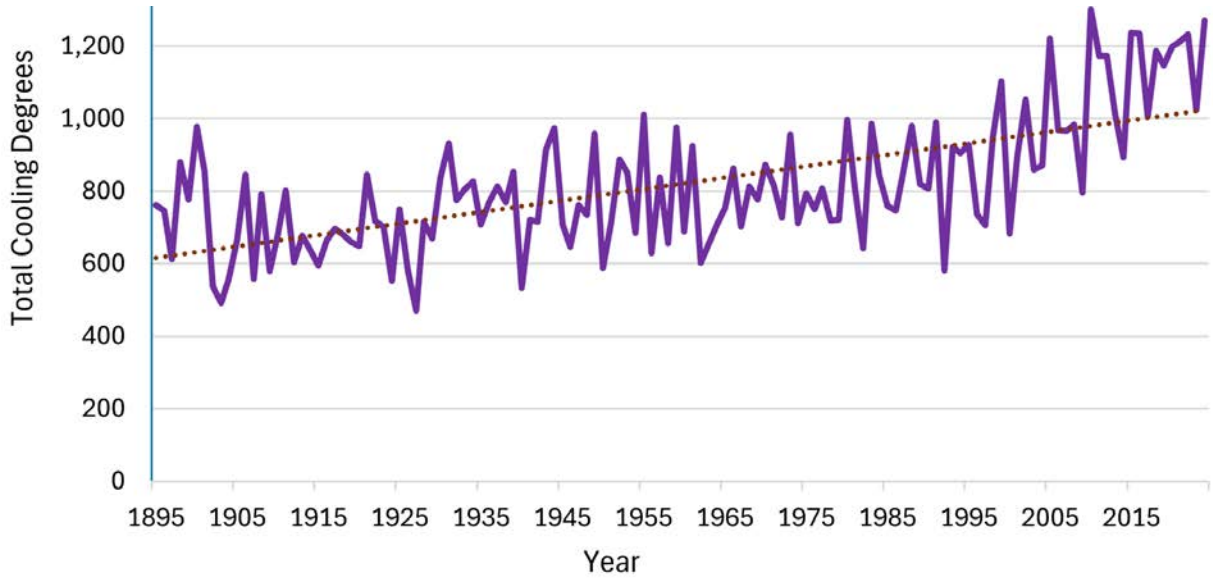


Figure 23. Annual Cooling Degree Days, Union County, 1895-2024



Heating or cooling degree days are measured by adding or subtracting the number of degrees needed to reach 65°F on a given day. The yearly total is the sum of all degrees.

Precipitation

Table 19 displays the historic average amount of precipitation that fell during each month in the history of record keeping for Climate Division 1, Union County, and the weather station at Canoe Brook. On average, the total annual precipitation in Division 1 is 47.20 inches, with a 30-year normal of 48.72 inches. In Union County, the yearly average precipitation is 47.16 inches, with a 30-year normal of 48.17 inches. The average annual total precipitation measured at Canoe Brook is 49.68 inches. On average, the months of July and August see the most rainfall – over 4.5 inches on average.

While precipitation is highly variable by nature, data from the last century shows that interannual rainfall is becoming even more variable, with some years being drier and others being very wet. The graph of total annual precipitation in Union County from 1895-2024 is shown in **Figure 24**.

Snowfall

Figure 25 shows the average annual total snowfall recorded at the Newark Airport monitoring station in years since 1931. Annual snowfall data is recorded on a seasonal basis; in the case of records from Newark Airport, this captures the 1931-1932 season to the 2023-2024 season. A total of 12.2 inches of snow was measured in 2023-2024.

While the station at Canoe Brook is closer in proximity to Summit, its records are missing data for several months and years. The station at Newark Liberty International Airport has kept more consistent records over the years since 1931/1932.

Table 19. Average Monthly & Annual Total Precipitation

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Average Precipitation (in.), NJ Division 1 (North), 1895-2024													
POR Mean	3.41	3.05	3.84	3.94	4.09	4.09	4.79	4.64	4.11	3.77	3.61	3.85	47.20
30yr Normal	3.50	2.79	4.01	3.90	4.02	4.61	4.72	4.56	4.46	4.45	3.47	4.25	48.72
Average Precipitation (in.), Union County, 1895-2024													
POR Mean	3.48	3.19	3.99	3.91	4.06	3.88	4.85	4.63	4.00	3.68	3.56	3.90	47.16
30yr Normal	3.47	2.91	4.13	3.83	4.04	4.41	4.80	4.44	4.20	4.22	3.39	4.33	48.17
Average Temperature (in.), Canoe Brook, 1931-2024													
Mean	3.62	3.02	4.19	4.07	4.32	4.21	4.67	4.86	4.52	3.90	3.99	4.07	49.68

Source: ONJSC Monthly Climate Tables

Figure 24. Annual Precipitation, Union County, 1895-2024

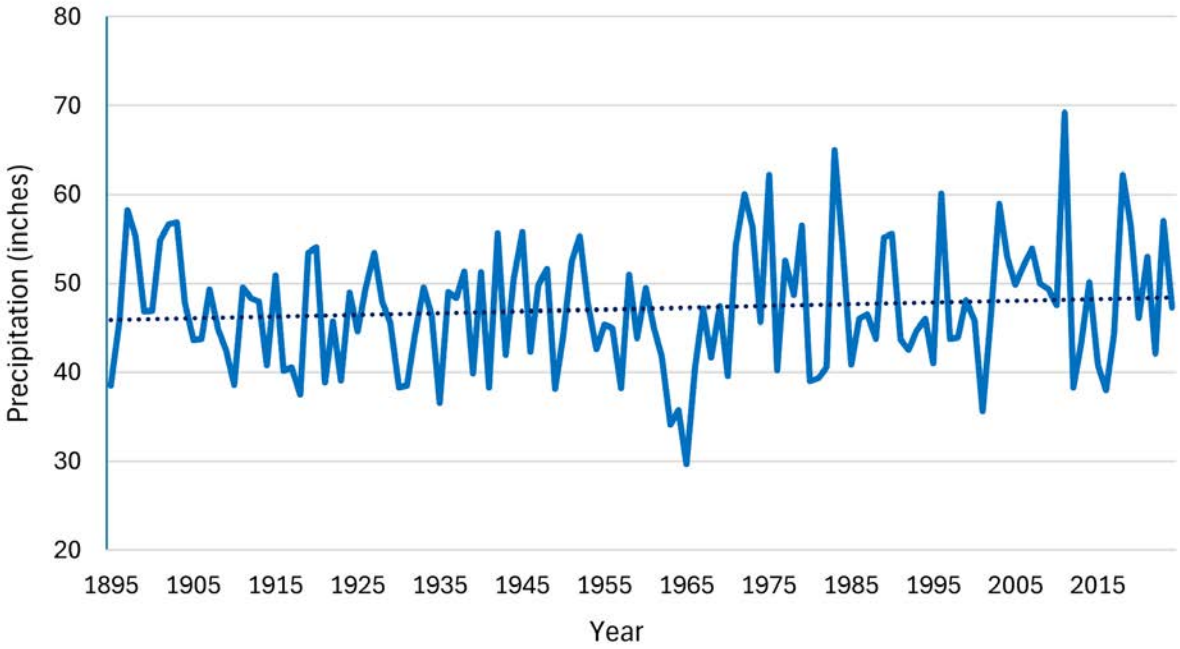
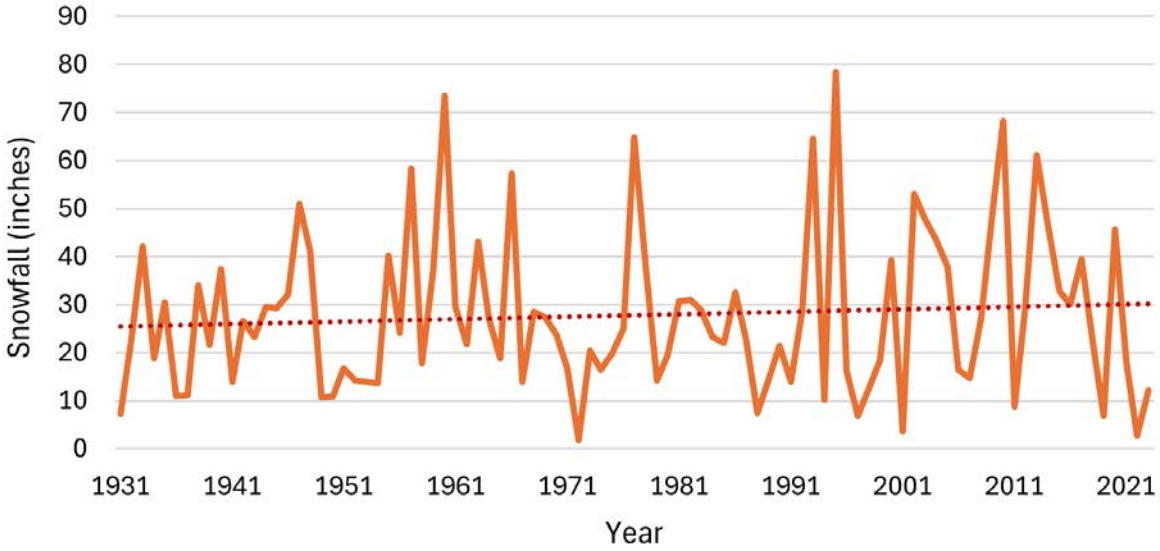


Figure 25. Annual Snowfall, Newark Liberty International Airport, 1931-2024



Climate Extremes

Rising Temperatures

Temperature data for Union County has been recorded since 1895. **Table 20** displays the record high average temperatures for each month of the calendar year and the year in which that record high was recorded. For example, the hottest January on record occurred in 2023; the average temperature for the month was 41.5°F. This value is taken from the mean of daily (24-hour) average temperatures.

All twelve months of the year have seen their highest average temperature in years since 2007. January, June, July, and August have experienced record high averages just within the last five years (2020-2024). The most recent record-breaking month was June of 2024, which had an average temperature of 75.0°F.

No new record average low temperatures have been recorded since 1989, although 1918 and 1934 recorded equally low temperatures. Overall, the data indicates a steady increase in average year-round temperatures, with new highs being reached in both the summer and winter months.

Drought

A drought is a period characterized by long durations of below-normal precipitation that can affect the water supply, agriculture, aquatic ecology, wildlife, and plant life. Drought can affect virtually all climate zones.

Like much of New Jersey, Summit has a typically water-rich environment with frequent and substantial precipitation. While annual precipitation totals are on a rising trend overall, there have been changes in the intensity and distribution

Table 20. All-time Record Monthly Average Temperatures, Union County, 1895-2024

Month	Highest Monthly Average (°F)	Year of Record High	Lowest Monthly Avg. (°F)	Year of Record Low
January	42.4	2023	18.8	1918
February	40.3	2017	17.2	1934
March	50.4	2012	30.4	1916
April	56.6	2017	44.4	1907
May	66.9	2015	53.0	1917
June	75.0	2024	63.3	1903
July	79.9	2020	70.0	1895
August	78.6	2022	66.6	1927
September	72.2	2015	60.8	1917
October	62.1	2007	47.6	1925
November	50.3	2015	36.5	1904
December	48.3	2015	23.0	1989

Source: Office of the New Jersey State Climatologist

of precipitation events as they occur throughout the year. Large storms are occurring more frequently and with greater intensity. However, this is coupled with an increase in dry conditions during other times of the year.[149]

Drought conditions in the U.S. are assessed by the U.S. Drought Monitor, which assigns ranked categories of drought, ranging from Abnormally Dry (D0) to Exceptional Drought (D4).[150]

This assessment clarifies conditional risks for environmental, social, and economic factors:

- In Moderate Drought (D1) conditions, irrigation use increases, and trees, vegetation, and fish become stressed. Reservoir and lake levels are below normal capacity and water conservation is requested. There is greater risk for wildfire and ground fires.
- Severe Drought (D2) conditions have negative effects on water quality and groundwater availability, crop yields, wildlife survival, and forest health. There is a higher risk for fires and poor air quality.
- Extreme Drought (D3) conditions bring widespread loss of crops, dry wells and extremely reduced flows of surface water, high river temperatures, and wildlife disease. Efforts to conserve water are recommended, warnings are issued, and outdoor activities such as hunting and water recreation may be limited.

In the fall of 2024, New Jersey entered historic drought conditions. There was less rainfall in October than in any previous year on record—measuring a statewide total of 0.02 inches. September was the third driest month on record, bringing total precipitation for September and October 2024 to just 0.8". This is 0.55" lower than the previous month-pair record of December 1980/January 1981.

Following this dry spell, Union County was between D2-D3 conditions for much of November and December 2024. The county remained in at least D1 conditions until April 2025. As of June 2025, parts of southern New Jersey remain in drought conditions.

Without agricultural land, Summit and most of Union County tend to not face wider economic effects of drought. However, droughts will decrease the availability of groundwater, especially in aquifers that do not have abundant recharge. The level of water in lakes and reservoirs falls, as well as the depth to water in wells.[151]

Tropical Storms

Tropical storms, nor'easters, hurricanes, seasonal thunderstorms, and flooding rains are the typical extreme weather events in New Jersey. These are low-pressure weather systems that bring heavy rain, high speed winds, and potentially other hazardous phenomena like lightning strikes and tornadoes. The state experiences at least one coastal storm event per year, but some years see as many as 5 to 10 storms.[152]

NOAA defines tropical cyclones, including tropical storms and hurricanes, as rotating, organized systems of clouds and thunderstorms that originate over tropical or subtropical waters.[153]

Hurricanes are distinguished by maximum sustained winds of over 74 mph. They typically occur between summer and late fall. On the other hand, nor'easters are fueled by the interaction of colder air with warmer coastal air

above the Atlantic Ocean. They travel northeastward along the East Coast, typically between the months of October and April.

Summit has faced the effects of several hurricanes in recent years. In 2011, Hurricane Irene brought torrential rain and flooding to Summit, along with many downed trees and electrical wires throughout the city.[154] Hurricane Ida brought flash floods to the City in 2021, resulting in a brief closure of schools.[155] Besides property damage, flooding can trap residents in their homes and vehicles and create dangerous circumstances. Hurricane Ida resulted in over two dozen deaths in New Jersey, including five in Union County.[156]

Flooding

Flooding is defined by the partial or complete inundation of normally dry land that results from the overflow of excess water, typically flowing from a water body into its surrounding floodplain.[157] Flooding is a common risk associated with tropical storms and other storm surges. For Information on flood hazard areas in Summit, including FEMA mapping, see **Chapter 8: Riparian & Flood Zones**.

Landslides

The NJDEP defines landslides as geologic hazards that occur in areas with steep to moderate slopes, or under geologic units that are prone to failure. Landslides are triggered by destabilization of the slope, which may be attributed to heavy rains, earthquakes, undercutting water, or human activity, such as construction and development, deforestation, and other disturbances. In New Jersey, landslides have mainly occurred in areas of construction, development, mining, deforestation, or undercutting by ocean waves.[158]

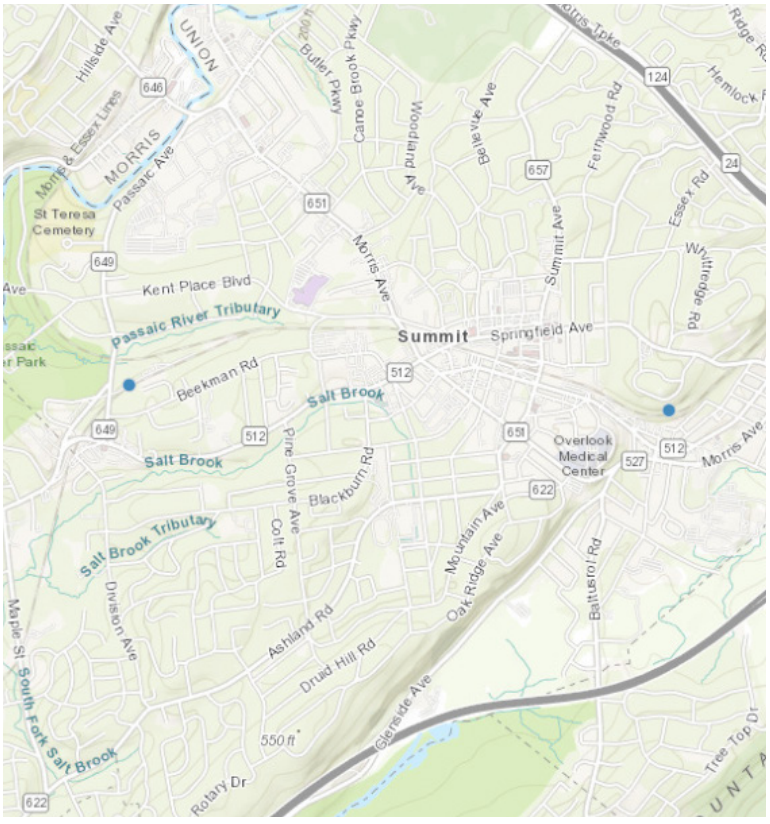
NJDEP has recorded two landslides in Summit, with locations marked in **Figure 26**. The 1991 landslide was a debris flow triggered by heavy rains. The flow occurred approximately near Passaic Avenue where it meets the NJ Transit railroad tracks, covering the tracks and interrupting service of the Morris & Essex Line. In 2011, Tropical Storm Irene caused a debris flow southward behind Edgewood Road, also resulting in a temporary closure of the tracks.[159]

Earthquakes

While infrequent and typically minor, earthquakes have been recorded for over two centuries in New Jersey. Earthquakes

Figure 26. Landslides in Summit, 1991-2024

Source: NJDEP Bureau of GIS



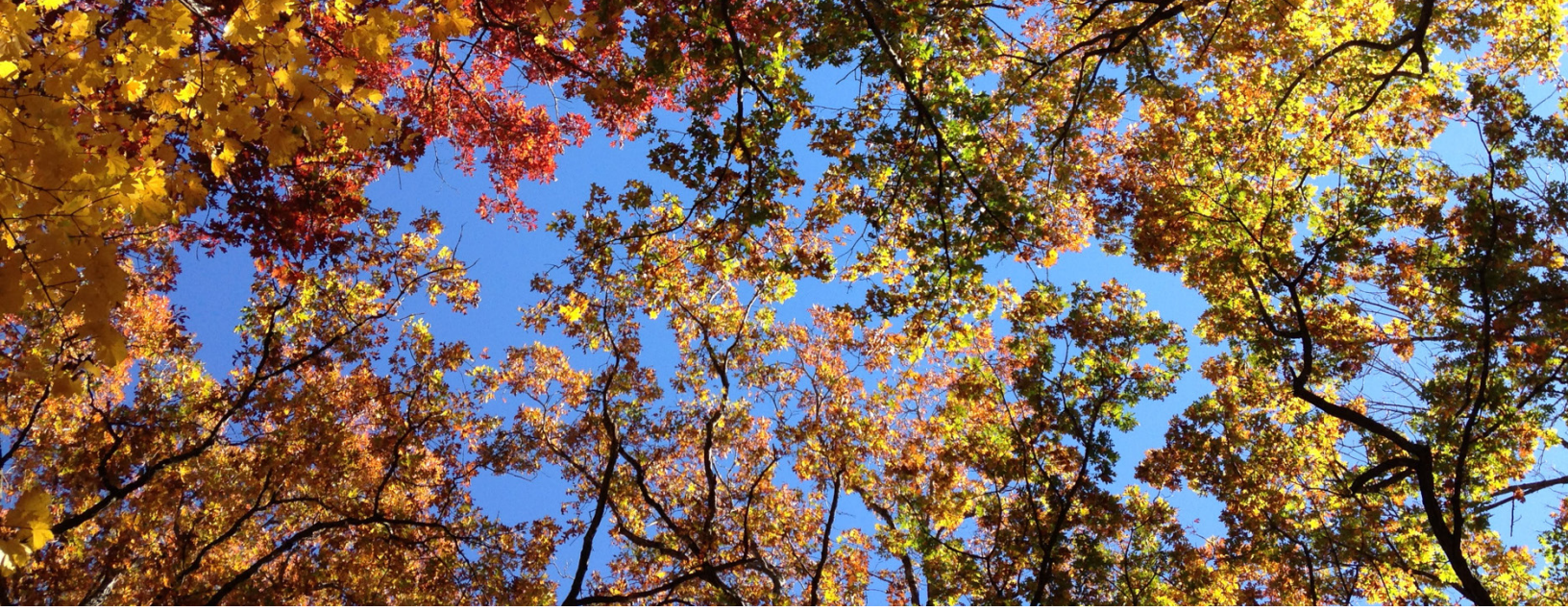
tend to occur more frequently along the fault lines in North-Central New Jersey, such as the Ramapo Fault.[160] Several small earthquakes (magnitude of 2 or lower) have been recorded with epicenters near Summit in recent years, in towns such as Orange and Clifton City.[161]

The largest earthquake on record in New Jersey struck in April 2024 and had several aftershocks. The magnitude 4.8 earthquake saw its epicenter in Tewksbury Township, approximately 30 miles west of Summit.[162] It caused damage to buildings and infrastructure in northern New Jersey and New York City. Effects could be felt in Summit, but no damage or injuries were reported.[163]

Tornadoes

A tornado may form during severe storms, appearing as a rotating, funnel-shaped cloud that extends to the ground. Tornado wind speeds are typically between 30 and 125 miles per hour, but they can exceed 200 miles per hour in extreme cases. While tornadoes do occur in New Jersey, they tend to be relatively weak and infrequent. Since 1952, there have been 14 tornadoes that originated in Union County.[164] The most recent occurred in 2013 and 2019.

The tornado in 2013 traveled into Summit from Berkeley Heights, where it touched down near the Passaic River just west of Garfield Street. It caused extensive tree damage on its nearly five-mile path through New Providence and Summit.[165] The National Weather Service confirmed it to have been of strength EF0, with winds between 65 and 85 miles per hour (mph).[166]



Tree Canopy at Passaic River Park
Photo: Dwight Hiscano

Chapter 10.

Climate Change

The release of carbon dioxide and other greenhouse gases (GHGs) into the atmosphere has come to impact climate conditions across the planet, having complex effects on ecosystems, natural resources, the health of communities, and the economy. The effects of climate change are already being felt in New Jersey. Due to geography, high population density, urbanization, and the abundance of coastline, New Jersey will continue to see these impacts more strongly and quickly than other places.[167]

GHGs affect the rate at which heat from the Earth radiates back into space. Most GHGs are naturally occurring, playing a regulatory function in atmospheric temperature. However, human and industrial activities release excess GHGs and other climate pollutants, creating an increased concentration in the atmosphere. As a result, more heat is retained in the atmosphere for longer periods. This phenomenon impacts planetary temperatures and weather patterns, causing many spillover effects.

The most direct impacts of climate change include:

- Rising temperatures;
- Increasing precipitation;
- Sea-level rise;
- Ocean acidification;
- Decreased water quality;
- Extreme weather;
- Drought;
- Decreased air quality.

The NJDEP has a multi-level strategy to monitor and manage the impacts of climate change, to support climate adaptation efforts throughout the state, and curb emissions statewide. Several reports have been published to help state and local decision-makers respond to climate change, including the **2020 New Jersey Scientific Report on Climate Change**.[168] Informing these efforts, the New Jersey Climate Change Resource Center at Rutgers University releases an annual **State of the Climate Report** which provides up-to-date information on climate trends and projections.[169]

Warming Temperatures

Global temperatures have increased by roughly 2°F since the late nineteenth century and have been rising more rapidly since the 1970s. New Jersey's temperatures have risen by approximately 4°F, roughly 1.4 times the global average over land.[170] The World Meteorological Organization confirmed 2024 as the warmest year on record, topping the previous record of 2023.[171]

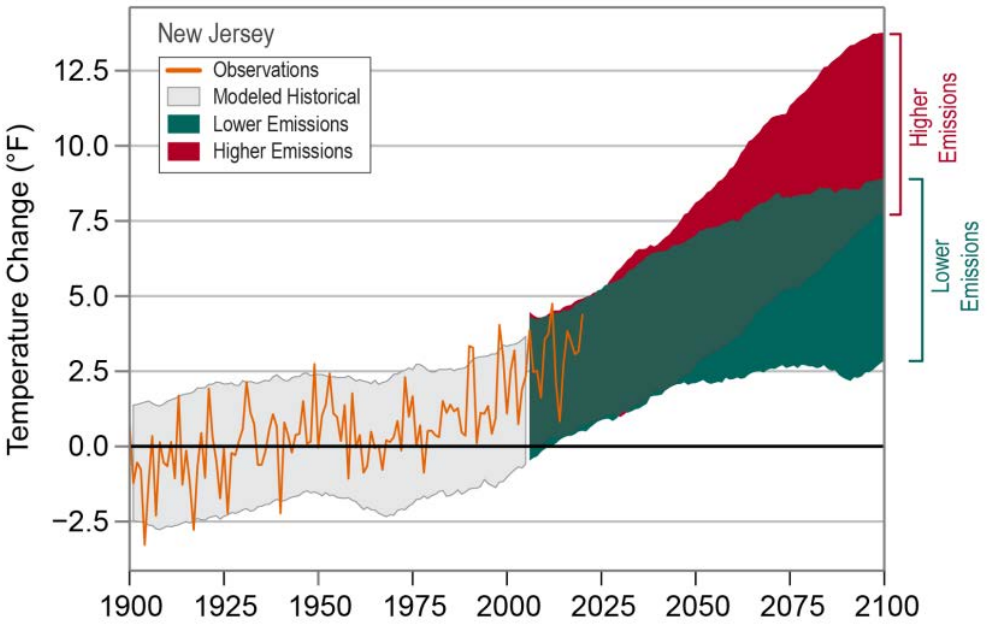
Climate data from the ONJSC indicates that New Jersey is warming faster than the rest of the northeastern U.S. and the world. New Jersey is projected to warm by 4.1 to 5.7°F by 2050.[172]

Figure 27 from the NOAA State Climate Summary shows the gradual historic rise in near-surface air temperatures in New Jersey and projects two future scenarios: one where GHG emissions continue to increase (higher emissions), and one where GHG emissions increase at a slower rate (lower emissions).[173]In future decades, warming is expected to occur at unprecedented rates. If emissions are reduced, warming would be reduced, as shown in the lower emissions scenario.[174]

The effects of rising temperatures will lead to more intense heatwaves, causing increased water and energy demand, air pollution, stress on agriculture and crop yields, and human health effects associated with heat-related illness, declining urban air quality, and ozone exposure.

Figure 27. Observed and Projected Temperature Change in New Jersey, 1900-2100

Source: NOAA, Climate Summary for NJ



Urban Heat Island Effect

The heat island effect causes areas of dense urban development to experience higher temperatures than surrounding areas, especially during the hot summer months. Concrete and other impervious materials tend to absorb more heat from the sun and retain it for longer, causing hotter days as well as nights. On a hot summer day, exposed urban surfaces like roofs and pavement can be 50 to 90°F warmer than the air, while shaded or moist surfaces remain close to air temperatures.[175]

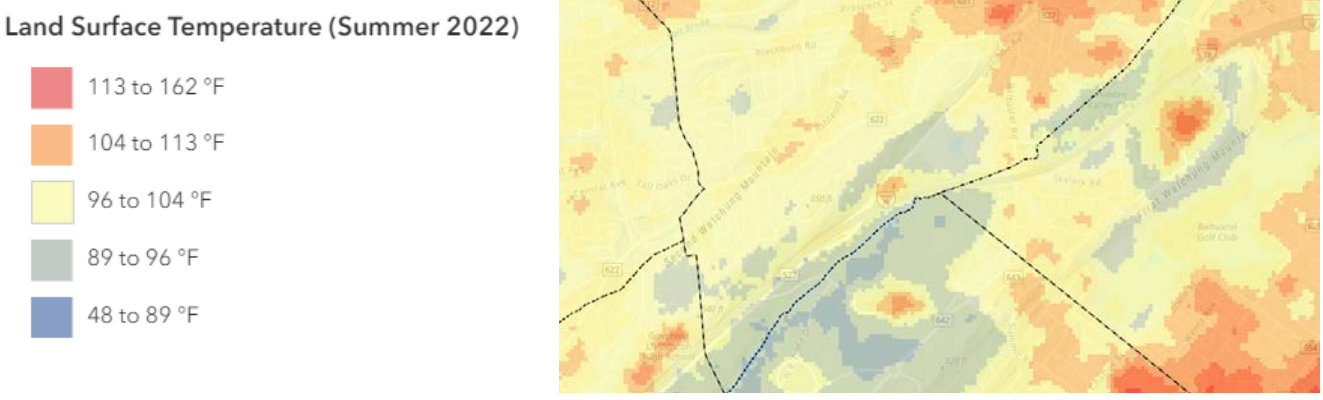
As a result, heat-related risks to human health can be much higher among people who live and work in urban areas. These risks are exacerbated by the increase in air pollutants that is observed during hot conditions, due to high energy usage and increased evaporation of particulate matter components.[176]

Figure 28 shows typical land surface temperatures on hot days in Summit using data from the summer of 2022.[177] The City has a relatively high proportion of tree canopy and vegetation in its residential neighborhoods, resulting in less extreme temperatures compared to other parts of northeastern New Jersey. More extreme surface temperatures (113 to 162°F) still occur in select areas with high concentrations of pavement and little tree coverage.

Several heat islands are located at the large parking lots and building complexes, on sites such as Overlook Medical Center, Summit High School, and the Bristol Myers Squibb campus. Heat risks are likely to be higher in these areas affected by urban heating. Conversely, lower surface temperatures are found in forestlands and bodies of water, which absorb heat and mitigate temperatures in the surrounding areas. These can be seen in the forests along the Watchung Reservation, Hidden Valley Park, and Passaic River Park.

Figure 28. Land Surface Temperatures, City of Summit, Summer 2022

Source: NJDEP Urban Heat Island Mapping[188]



The effects of severe heat islands can be curbed through green infrastructure and urban design interventions. Some strategies to reduce urban temperatures while improving community health and wellbeing include: the addition of vegetation and street trees to increase canopy cover and shade, light-colored roof surfaces, green roof projects, and reduction of paved impervious surface where possible.[178]

Health Effects of Heat

The increased frequency and severity of heatwaves pose direct risks to human health and wellbeing, increasing rates of heat stress and air pollution in the summer, and causing higher spread of disease in winter.[179] These risks are higher in densely populated urban areas that tend to be warmer and have fewer sources of shade to mitigate temperatures. It is estimated that within the 2020s, climate change could lead to a 55% increase in summer heat-related mortality.[180]

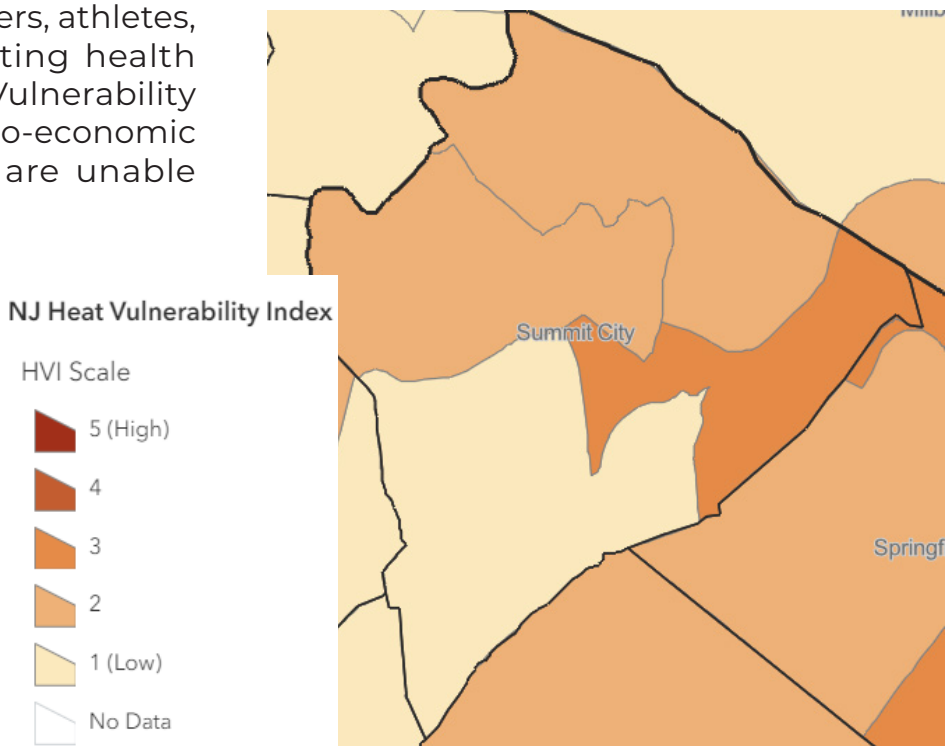
Populations who may be more vulnerable to heat risks include infants and children, older adults, workers, athletes, and individuals with existing health conditions or disabilities. Vulnerability can be exacerbated by socio-economic conditions when people are unable to improve their living or working conditions during times of extreme heat. Heat stress can cause short- and long-term damage to physical, mental, and behavioral health. Cardiovascular and respiratory problems are known to worsen with exposure to extreme heat.

The Heat Vulnerability Index (HVI) was created at the NJ Climate Change Resource Center at Rutgers University. The HVI accounts for population demographics such as age and health status, as well as overburdened community indicators, in addition to environmental factors like tree canopy cover and air pollution exceedances. **Figure 29** shows the census tracts with the highest heat vulnerability in Summit. This dark orange area could best benefit from heat-mitigation strategies like urban greening.

Several New Jersey-based initiatives, including the Interagency Council on Climate Resilience, are working to mitigate extreme heat risks in communities and increase protective measures for vulnerable populations. Heat mitigation is built into the State of New Jersey's Climate Change Resilience Strategy, which advocates for heat-

Figure 29. NJ Heat Vulnerability Index, Map of City of Summit

Source: NJ Heat Vulnerability Index[189]



resistant infrastructure adaptations, the deployment of urban greening, and community forestry.[181]

For more information on extreme heat, urban heating, health risks, and mitigation in New Jersey, see the Extreme Heat Resilience Action Plan.

Extreme Weather Events

Climate change is associated with the increased frequency and severity of tropical storms, thunderstorms, hailstorms, windstorms, and tornadoes. New Jersey's location on the northeastern coast exacerbates the risk of tropical storms and exposure to high-speed winds. Northern New Jersey's 1971-2000 precipitation average was over five inches higher than the average from 1895-1970,[182] and the average annual precipitation in the region is projected to increase by 4 to 11% by the 2050s.[183] Higher temperatures and humidity can bring about more severe storms whose effects pose threats to people and property.

The rivers of Union County are susceptible to flooding during extreme weather events. The flooding of these waterways can cause damage to utilities and buildings, road blockages, erosion, and other costly problems for communities.

The Rahway River has been addressed as a particular concern for flood hazards. Mayors from communities along the Rahway River have met with officials from the NJDEP and U.S. Army Corps of Engineers to discuss a potential Flood Mitigation Plan for the Rahway River.[184]

With the predicted increase in number and severity of storms, there is a higher likelihood of impacts to power infrastructure. Higher summer temperatures also increase the potential for power overload as demand rises. Power failure events can lead to health impacts, including risks from lack of refrigeration and exposure to carbon monoxide from misuse of generators. Power failure events can also interrupt the function of water purification systems, impacting access to potable water from private wells.

Wildfires

With increased temperatures and frequency of drought conditions, wildfires are worsening across North America. There are three main weather factors that contribute to fire risk: relative humidity, hot temperatures, and wind.[185] All three conditions are prone to increase with the trends of climate change. As such, the number and magnitude of wildfires is expected to increase in the United States and in New Jersey.

In 2023, major wildfires in Quebec, Canada burned over 32 million acres of land over the course of May and June.[186] Several fires sparked from the mix of hot temperatures and dry conditions, though one was triggered by a lightning strike. The fires spread rapidly due to dry, hot temperatures and strong southeasterly winds. Smoke from these wildfires was carried southeastward over New Jersey, causing severe levels of particulate matter in the air and reduced visibility. The USEPA reported “very unhealthy” air quality levels on several days (**Figure 30**). Wildfires affect human health when particulate matter enters the lungs. Especially in people prone to illness, smoke has potential to trigger asthma attacks, heart attacks, strokes, and mortality. Wildfires can also cause exposure to carbon monoxide and black carbon (soot), as they release several greenhouse gases into the air.

About 85% of wildfires in the United

States are caused by human activity, such as burning debris, unattended campfires, improper disposal of cigarettes, or other irresponsible fire uses. In New Jersey, nearly 99% of wildfires are attributed to human causes. With the increase of storms and dry conditions, wildfires can be expected to cause future risks to human health, property, and ecosystems.

Ecosystem Impacts

Climate change will have a wide range of impacts on the health and integrity of natural ecosystems. Changes in temperature and weather patterns cause shifts in species populations as they migrate and adapt to new conditions. Loss of critical habitat and resources may cause species to fall into threatened conditions.

The USDA Forest Service modeled the impacts climate change will have on forests and trees of the Mid-Atlantic region, from Maryland to New York State.[187] They predict that forests will continue to be affected by increased temperature and precipitation, drought, and wildfire risk; and that these risks will increase over time.

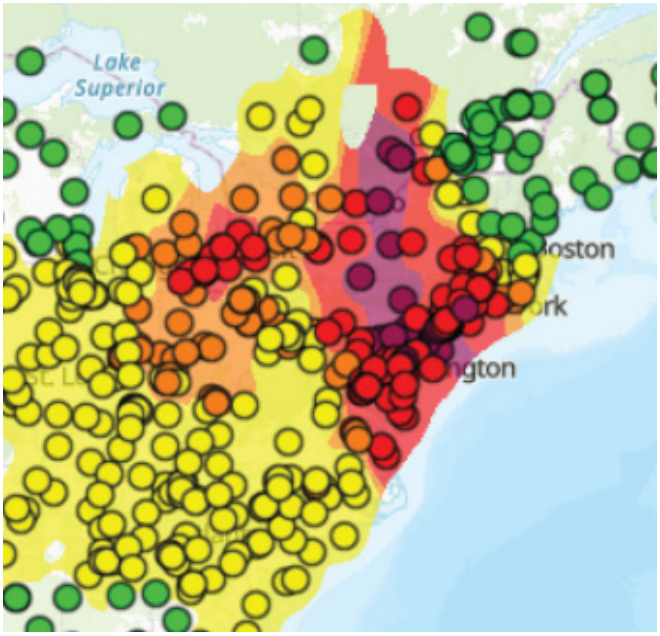
Changing conditions will alter patterns of tree regeneration and recruitment, while increasing suitabilitiy of southern species and decreasing suitability for northern species. Damage to forest ecosystems from invasive plants, pests, and pathogens is anticipated to increase.

With 560 acres of forest and a robust canopy of street trees, the environment of Summit could see changes to its character under long term climate change. Alteration and loss of forest habitat may threaten the survival of species that rely on these ecosystems.

For information on local wildlife species that are currently threatened or endangered, see **Chapter 3.**

Figure 30. PM2.5 Air Quality Index in Northeastern US, June 7, 2023

Source: NJ State of the Climate 2023



AQI Number:	Level of Health Concern:	Color:
0-50	Good	Green
51-100	Moderate	Yellow
101-150	Unhealthy for Sensitive Groups	Orange
151-200	Unhealthy	Red
201-300	Very Unhealthy	Purple
301-500	Hazardous	Maroon

Plant Hardiness Zones

The USDA defines geographic areas into plant hardiness zones. Hardiness indicates the extent of overwintering stress that plants can survive in a given area, which is measured based on average annual extreme minimum temperatures.[190] Hardiness zones are used by horticulturists to evaluate the cold hardiness of plants and their suitability for growing in a given area. The USDA delineates plant hardiness zones in increments of 10°F (5.56 °C), dividing the country into 11 different zones. Warming temperatures have caused these zones to shift, altering the geographic ranges in which different plant varieties can grow. The USDA updated its Plant Hardiness Zone Map in 2023 (**Figure 31**). The new map designates Summit as Zone 7a, indicating that the City has an annual minimum temperature of 0 to 5°F. This changes its previous designation of Zone 6b (-5 to 5°F), reflecting a general temperature increase of 3°F.[191]

The shift in temperature zones has implications for plant varieties that are suitable for growing in Summit. The new 7a Zone description should be taken into account when selecting plant varieties for gardens, parks, and nearby agriculture.

Species Migration

The natural ranges of species and ecosystems are shifting with complex effects on local plants and wildlife.[192] Higher temperatures cause native plants to experience more heat-related stress and higher water demand in their natural environments, and these conditions are exacerbated by longer periods of drought. Under these conditions, native plants will either adapt to new conditions, migrate to more favorable environments (often northward or to higher altitudes), or go extinct.[193] At the same time, warmer temperatures and higher concentrations of atmospheric CO2 tend to promote the growth of invasive plants, which can quickly spread in disturbed or changed environments.

Passaic River Park
Photo: Dwight Hiscano

Wildlife face the effects of changing food sources and habitat, and other environmental stressors such as heat, wildfire, and floods, which can decrease reproductive rates.[194] Migration patterns are shifting; for example, some migratory birds have sought refuge farther north than their typical range.[195]

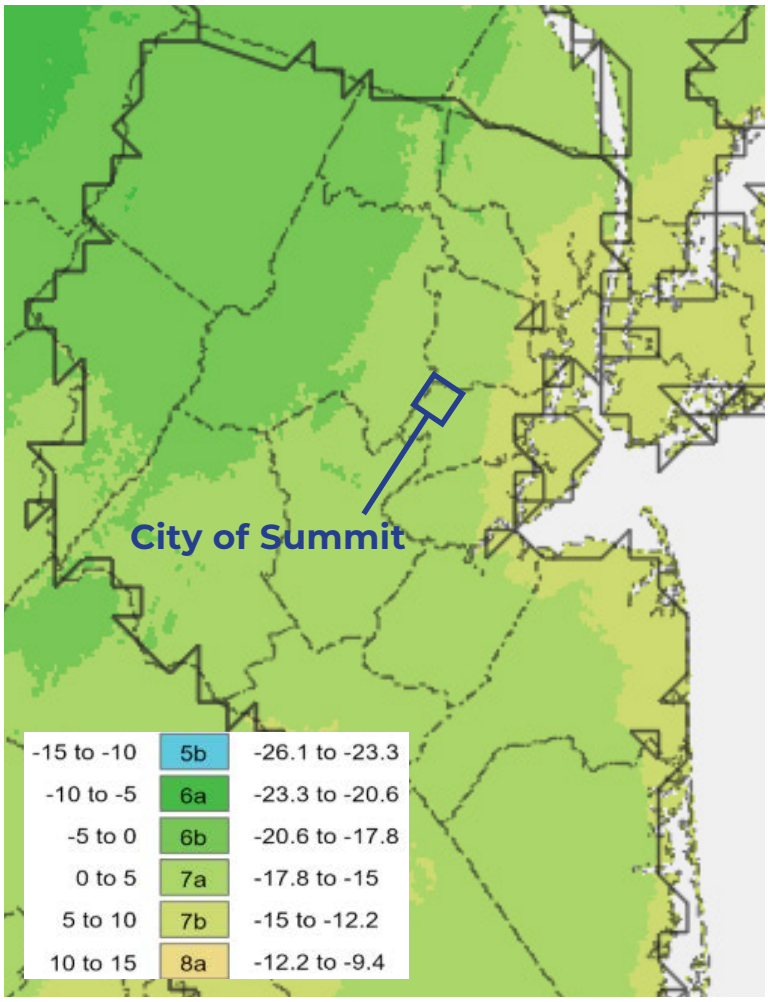
Climate Mitigation

Reducing Greenhouse Gas Emissions

New Jersey is especially vulnerable to the impacts of climate change due to its coastal geography and population density. Curbing these impacts will require significant permanent reductions in global GHG emissions in the coming years. The effects of lowered emissions will take time to show, however; even in the case of moderate emission reductions, the Intergovernmental Panel on Climate Change (IPCC) estimates a 5.4°F (3.0°C) rise in global temperatures by 2100.[196]

Figure 31. Updated USDA Plant Hardiness Zones, 2023

Source: USDA[230]



The NJ Legislature enacted the Global Warming Response Act (GWRA) in 2007 to address the need to reduce GHG emissions. The GWRA establishes the aim to reduce statewide greenhouse gas emissions to 80% below the 2006 level by the year 2050 (the "80x50" goal).[197] In 2006, NJ's net CO2 emissions totaled 120.6 million metric tons (MMT), which sets the 80x50 net emission goal at 24.1 MMT CO2 by 2050.

In 2020, the State of New Jersey published the 80x50 Report to illustrate current emission levels and promote reduction strategies across sectors. **Figure 32** shows the breakdown of GHG emissions by sector. The largest source of GHG emissions in New Jersey is transportation (42%), followed by residential and commercial sectors (26%) and electric generation (19%). The 80x50 Report identifies strategies and opportunities for reduction in each sector.

The sequestration value (-8%) reflects the amount of carbon that is absorbed by natural carbon sinks. Ecosystems such as forests, grasslands, wetlands, and the ocean remove carbon from the atmosphere and store it as a part of natural processes.[198] Carbon sequestration will continue to play an important role in offsetting carbon emissions. The NJDEP estimates that land management to

conserve and protect carbon sinks could increase carbon sequestration to 10.8 MMT CO2e by 2050.[199] This would require the use of all currently available open space for carbon sequestration.

Climate policies are continuing to push New Jersey in the direction of GHG reduction goals. The Energy Master Plan: Pathway to 2050 was released in 2019, outlining strategies to transition New Jersey's electrical grid to 100% renewable by 2050.[200] These include steps to reduce reliance on fossil fuels, expedite the deployment of wind and solar energy generation, amend building codes to promote electrification, and facilitate the adoption of electric vehicles.

Protecting Against Climate Threats

In 2020, Governor Murphy signed Executive Order 100: Protecting Against Climate Threats (PACT), which authorizes the NJDEP to make regulatory reforms to pursue the state's climate goals.[201]

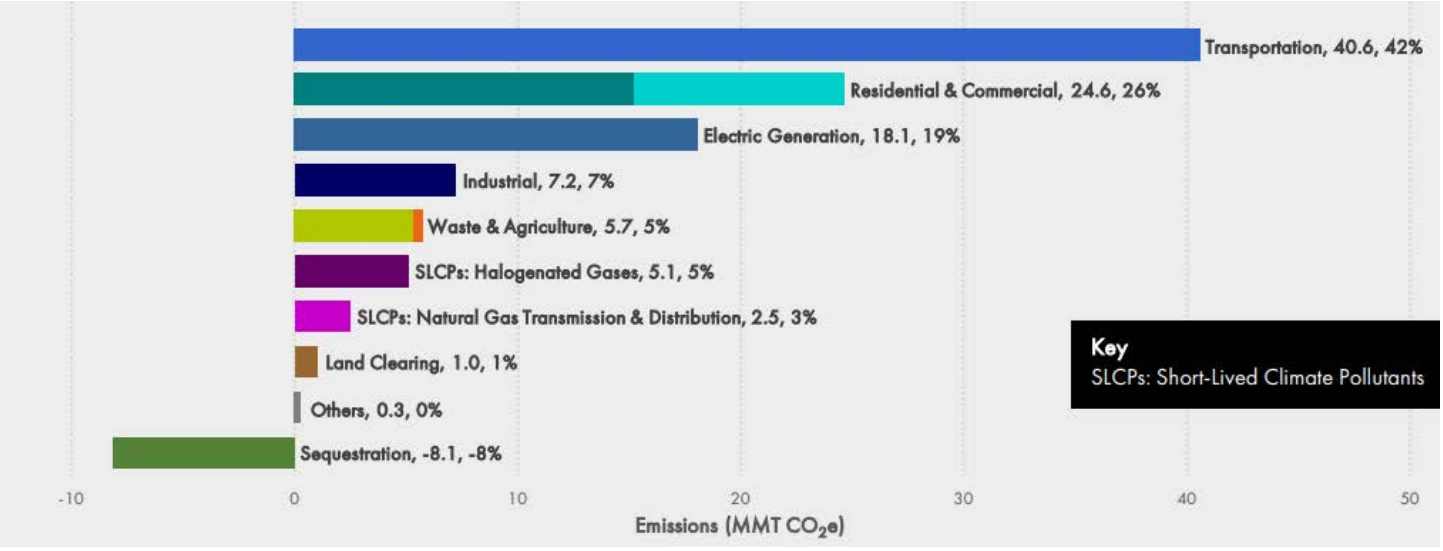
The PACT initiative consists of two main parts: Climate Pollutant Reduction (CPR) and Resilient Environments and Landscapes (REAL).

CPR, whose first phase has been enacted, is focused on monitoring, reducing and eliminating pollutants in industrial facilities and transportation.[202] REAL is in the process of adoption as of June 2025. It proposes rules to address sea-level rise, coastal storm surge, flooding, and stormwater management concerns while improving water quality, protecting natural resources, and streamlining permitting processes to expedite investments in resilience.[203]

More information on greenhouse gas emissions and reduction strategies in New Jersey can be found in the NJDEP 2024 Greenhouse Gas Inventory Report (1990-2021).

Figure 32. New Jersey GHG Emissions Inventory for 2018 (MMT CO_2, Sector %)

Source: 2020 New Jersey 80x50 Report



Clean Energy Initiatives

State and municipal programs are available to help reduce greenhouse gas emissions and improve efficiency in homes and businesses. In New Jersey, renters, homeowners, and businesses can take advantage of state rebates and energy-efficiency partnerships through their local utility.[204]

The City of Summit's Home Energy Insight Program offers discounted home energy audits through Ciel Power LLC, which assess building performance and identify ways for homeowners to save energy and the cost of utilities.[205] Incentives and low-interest loans are available to pay for retrofits and other efficient home improvements. The program was featured as a Sustainability in Action Success Story by Sustainable Jersey.[206]

Community Adaptation

While climate change is a global issue, its impacts are experienced locally. The first priority of the New Jersey Climate Change Resilience Strategy is to build sustainable and healthy communities by integrating resilience into local and regional planning.[207] The State of New Jersey continues to provide technical and financial support for municipalities to invest in resilient infrastructure, community development programs, and public health initiatives aimed at environmental, social, and economic resilience.

In Summit, sustainability initiatives are spearheaded by the Environmental Commission with help from Sustainable Jersey and other organizations. The following section details some of these efforts along with several resources that can help the community to be engaged in sustainability actions.

Local Sustainability Planning

The City of Summit is dedicated to the preservation of the environment through environmentally-focused boards and commissions, and green programs such as the Summit Free Market.[208] The Summit Environmental Commission (EC) actively participates in the city planning process, researches and reports on environmental topics; develops educational outreach activities and materials; responds to inquiries from businesses and residents; coordinates with municipal planning and zoning boards, committees and other organizations on issues of mutual interest, and works with neighboring communities on environmental issues of regional importance.[209]

The EC website contains resources to support green practices in the community, including guides for recycling and composting waste, green building, and landscaping. Additionally, the Summit Community Asset Map promotes public and social spaces for the community, in addition to businesses that are aligned with sustainability goals.

Community Energy Plan

In 2023, the City of Summit developed its Community Energy Plan in line with the Sustainable Jersey Guide for Sustainable Energy Communities.[210] The plan establishes how the municipality will promote the transition to sustainable energy over the next several years. Using strategies outlined in the New Jersey Energy Master Plan: Pathway to 2050, the plan addresses local opportunities, including:

- Electric vehicle infrastructure: installation of additional public EV infrastructure and charging stations (**Figure 33**); establishing an electric municipal fleet; encouraging workplace EV infrastructure;

- Renewable energy: adopt supportive zoning and permitting for solar; installation of on-site municipal renewable energy generation; purchasing renewable energy for municipal facilities; maximize efficiency in public and residential buildings;

- Reduce consumption and emissions: requiring green building checklist for developers;

- Environmental justice: encouraging community engagement and participate from low- and moderate-income communities, including energy efficiency outreach;

- Clean energy innovations: solar energy storage projects; establish local microgrid.[211]

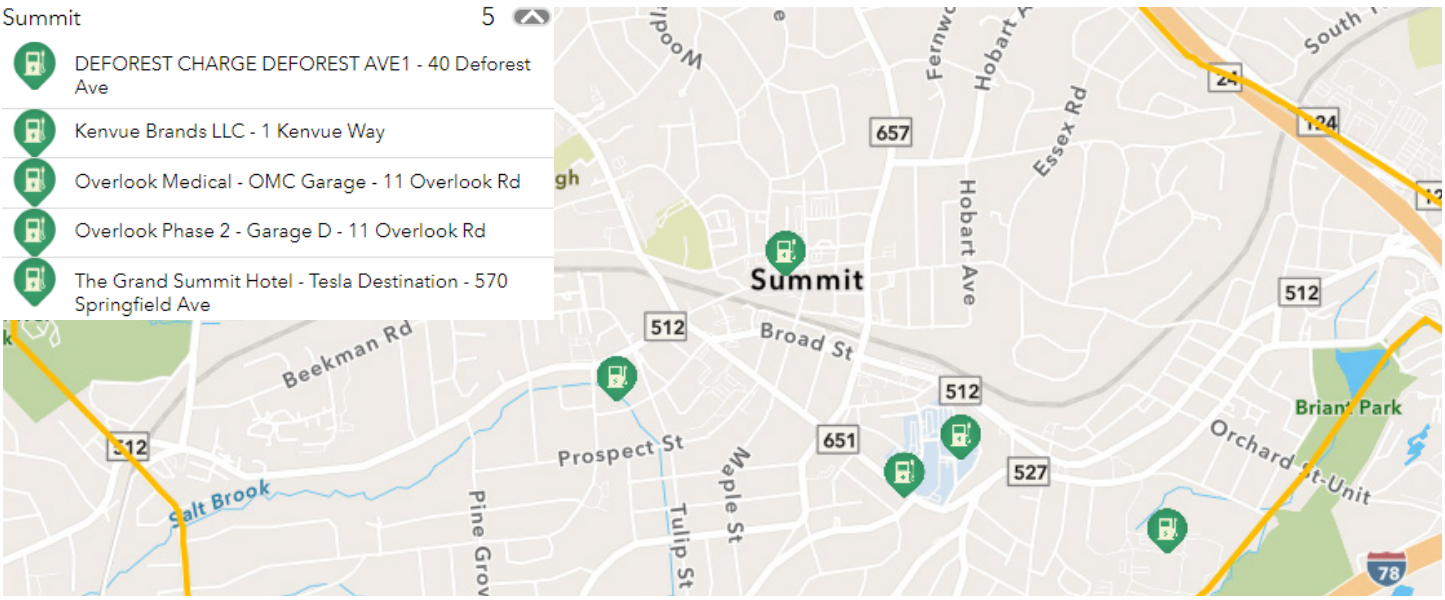
Sustainable Jersey

Sustainable Jersey certifies actions taken by municipalities to reduce waste, cut greenhouse gas emissions, and improve environmental equity. It provides tools, training, and incentives needed for municipalities to achieve sustainable actions. Of the 564 municipalities in New Jersey, 467 have been registered with Sustainable Jersey; in June 2025, 186 municipalities have a current certification.[212]

The City of Summit was one of the first municipalities to register with Sustainable Jersey, attaining bronze certification in 2009.[213] Summit has since achieved certification in 2010, 2011, 2014, 2017, 2019, and 2022, earning silver status. Summit has once again met silver certification in 2025.

Figure 33. Locations of Public EV Charging Stations, (Updated 6/5/25)

Source: NJDEP Bureau of Climate Change & Clean Energy[231]



In 2022, Summit received 620 points from a total of fifty sustainability actions across categories such as Waste Management; Public Information and Engagement; Emergency Management and Resiliency; and Natural Resources.[214] See the 2022 Certification Report for the full list of sustainability actions, initiatives, and projects that earned the City its silver status. In 2025, the City will have achieved either 670 to 680 points.

Since the 2022 certification, several projects and collaborations have been added to the City's portfolio. In addition to the publication of this updated Environmental Resource Inventory, these actions include: municipal energy efficiency audits, the Native Seed Library partnership with Summit Free Library (see **page 15**), and the Book Barn overflow at the Transfer Station in partnership with BookSmiles.[215]

Select Projects

Summit Free Market

Founded in 2008, the Summit Free Market (SFM) is a volunteer, student-run program that works to reduce the amount of reusable material that enters Summit's waste stream.[216] The SFM has a permanent location at the Transfer Station site, where residents with a Transfer Station permit can drop off yard sale-quality items that they no longer need or want. Residents can browse donated items, including household goods, sports equipment, electronics, furniture, toys, books, and clothing, and take them home at no cost.

Since 2008, over 180 tons of material have been recycled in the community through the SFM. By keeping these items out of the waste stream, the program has saved the City more than $30,000 in garbage tipping fees.[217] In 2021, The Summit Free Market was honored by NJDEP with one of eight annual Governor's Environmental Excellence Awards for its success in student-led environmental education.[218]

For operational hours, volunteer opportunities, and other important information, visit the City's website. SFM also operates on Facebook, visit Virtual Summit Free Market.

Summit Park Line

The Summit Park Line was first envisioned in 2014 as a plan to replace a historic elevated railroad corridor with a unique public amenity that generates value for the community and provides local and regional connectivity. Since its conception, the Park Line has been partially completed and recognized by Sustainable Jersey as an innovative community project.[219] The Summit Park Line Feasibility Study was published in 2016 to outline opportunities and constraints of the Park Line project.[220] Building upon Summit's Complete Streets Resolution, which passed in 2014, the Park Line is intended to expand mobility options and creative, multi-functional public space. The full envisioned Park Line would connect a number of Summit's community assets and provide a traffic-free route to places such as the train station, downtown, the Summit Family Aquatic Center, and Jefferson Elementary School. The Park Line improves the ease of travel on foot or by bicycle and reduces auto-dependence, while connecting people more in touch with their community. These factors anticipate economic, health, and social benefits for the community.

Phase I of the Park Line was completed in 2019, and the bridge across Morris Avenue was replaced in 2022.[221] The completed sections of the Park Line offer a paved bicycle and walking route

through a vegetated corridor, with views of the New York City skyline. Gardens have been constructed along the line, adding ecological and aesthetic value to the community. Most recently, a butterfly garden was installed at the Park Line entrance on Broad Street in 2024, adding protected habitat for pollinators.[222]

Passaic River Greenway

The idea for a Passaic River Greenway began with an initiative between the City of Summit, Township of Berkeley Heights, and the Passaic River Coalition to develop and implement programs that protect and enhance the recreational values of the Passaic River Corridor.[223] The dual aim is to increase access to recreational opportunities of the Passaic for surrounding communities, and to help improve the quality of water in the Passaic River, which is a source of drinking water for over a million people.

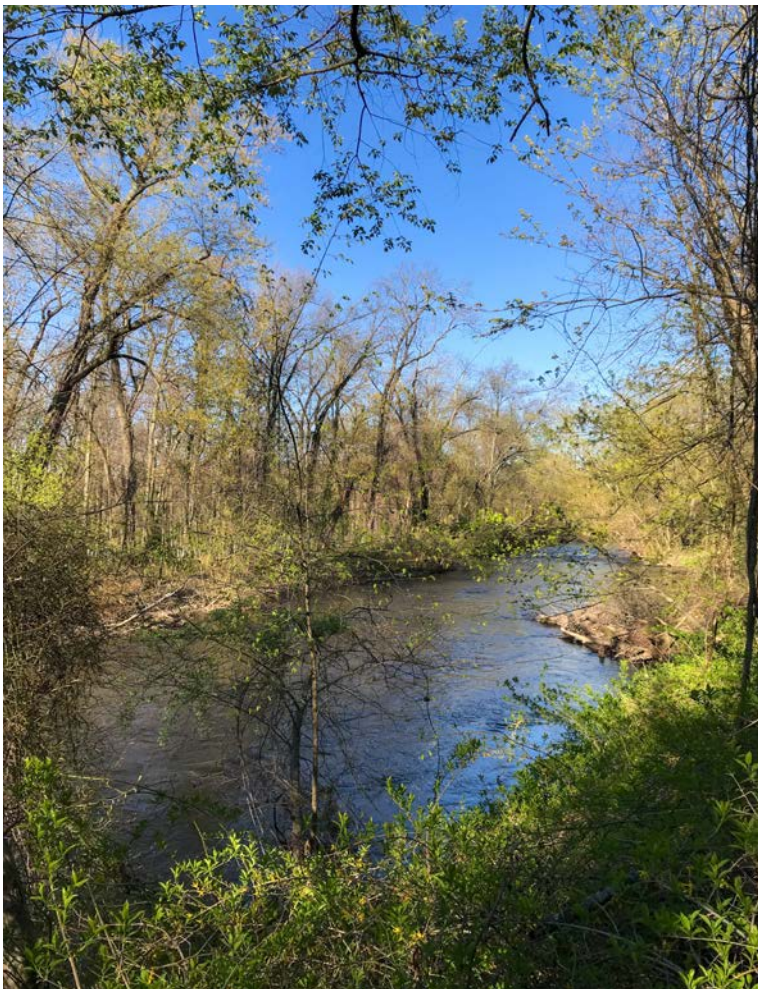
The Summit EC report on the possibility for a Passaic River Greenway offers six recommendations for the project: to further assert the City's riparian buffer ordinance; de-snagging the river to create a viable canoe and kayak trail; to create better canoe and kayak access; to research potential access points and fishing spots; to run an education program on best practices for protecting the health of the river; and to cooperate with neighboring New Providence Borough to extend trails and access points.[224]

Environmental Justice

In the pursuit of climate resilience, the State has identified environmental justice as a priority concern for funding and policy initiatives, supported by the Environmental Justice Advisory Council (EJAC) in 2016. The U.S. EPA defines environmental justice (EJ) as "the just treatment and meaningful involvement of all people, regardless of income, race, color, national origin, Tribal affiliation, or disability, in agency decision-making and other Federal activities that affect human health."[225] The pursuit of EJ is to ensure that communities who have been disproportionately affected by environmental harms and risks—including pollution, poor air quality, extreme heat and other climate hazards—will be fairly protected in the future. It promotes climate adaptation measures that support healthy, equitable, and resilient communities.

Summit Park Line, Phase I
Photo: Summit Park Line Foundation

In September 2020, Governor Murphy signed the Environmental Justice Law, the first of its kind, which authorizes NJDEP to deny or condition certain permits based on an assessment of a facility's contribution to environmental and public health stressors in the State's overburdened communities.



Passaic River Corridor in Summit
Photo: Dwight Hiscano

Overburdened Communities

Using Census data, NJDEP has identified overburdened communities (OBC) as areas to be addressed in environmental justice and climate adaptation efforts. These are communities who have historically faced disproportionate negative effects of environmental and public health stressors, while lacking environmental and public health benefits.[226] Such stressors may include high concentrations of air pollution, sites with contamination, waste facilities, water quality issues or combined sewer overflows, maternal and prenatal health stressors, and vulnerability to climate change stressors, such as high temperatures, the urban heat island effect, and sea level rise.[227]

Census block groups are defined as OBC if they meet one of the following criteria: At least 35% low-income households.

- At least 40% of the residents identify as minority or as members of a state-recognized tribal community.
- At least 40% of the households have limited English proficiency.

Several census tracts in Summit are identified as OBC, highlighted blue in **Figure 34**. These are areas that may be in greatest need of environmental justice interventions, being home to populations who have historically faced disproportionate effects of environmental stressors (such as poor air quality and pollution) that are projected to worsen with climate change.

Some of these OBC overlap with areas highlighted by the Heat Vulnerability Index (**Figure 29** on **page 105**). In addition to OBC indicators, the HVI accounts for impervious surface cover, tree canopy cover, air pollution, and demographic vulnerabilities such as age and health status. Areas highlighted in the HVI map could receive the most benefit from heat-mitigation strategies like urban greening.

OBCs are prioritized by state planning and climate adaptation policies, which make additional resources available for improving environmental health in these areas. Healthy Community Planning, a partnership between the NJDEP and Department of Health, is one strategic resource for municipalities to incorporate environmental and community health in planning decisions.[228]

Resilient NJ

NJDEP offers an assistance program to support local and regional climate resilience planning. Impacts of climate change can vary based on decisions around zoning, redevelopment, housing, and open space.[229]

- The Local Planning for Climate Change Toolkit helps municipalities assess vulnerability and develop appropriate strategies for building resilience.

- The Resilience Action Matrix contains 300 examples of resilience and adaptation projects from around the country that can be adapted for local use.

- The Climate Resilience Funding Directory is a platform that compiles key funding opportunities for improving climate resilience, including state and federal grants. The directory simplifies the process of identifying funding for local and state governments and community organizations.

Figure 34. Overburdened Communities, Summit, NJ (June 2025)

Source: NJDEP[232]

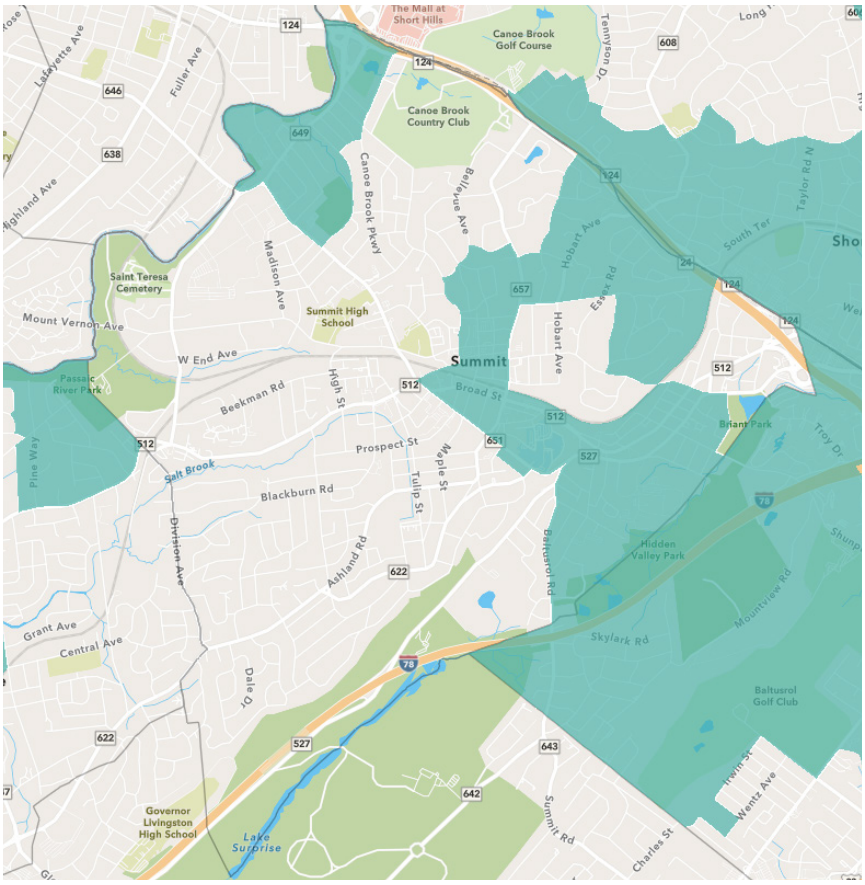


Photo: Dwight Hiscano

Chapter 11.

Air Quality

Air quality in New Jersey is monitored by the NJDEP Division of Air Quality (DAQ). Levels of pollutants are measured to ensure that air quality levels meet national standards set by the federal Clean Air Act as well as state laws and local regulations. As of January 2025, there are 29 air quality monitoring stations across the state.[233] Local monitoring stations help the NJDEP to assess the:

- Impacts of major pollution sources
- Population's exposure to pollution
- Background levels of pollutants
- Regional pollutant transport
- Secondary impacts in rural areas

The recorded levels of many pollutants can vary greatly across seasons and even from day to day, depending on weather conditions and traffic patterns.

National Clean Air Standards

In 1970, the federal government passed the Clean Air Act, which set air quality standards to be met throughout the country. The act was amended in 1990, with a focus on four specific areas of pollution:

- Acid rain
- Urban air pollution
- Toxic air emissions
- Stratospheric ozone depletion[234]

The amendment also introduced a permit program and strengthened the enforcement of regulations. Under the Clean Air Act, it is the responsibility of the USEPA to set **National Ambient Air Quality Standards (NAAQS)** for six common pollutants: ozone (O_3), carbon monoxide (CO), sulfur dioxide(SO_2), nitrogen

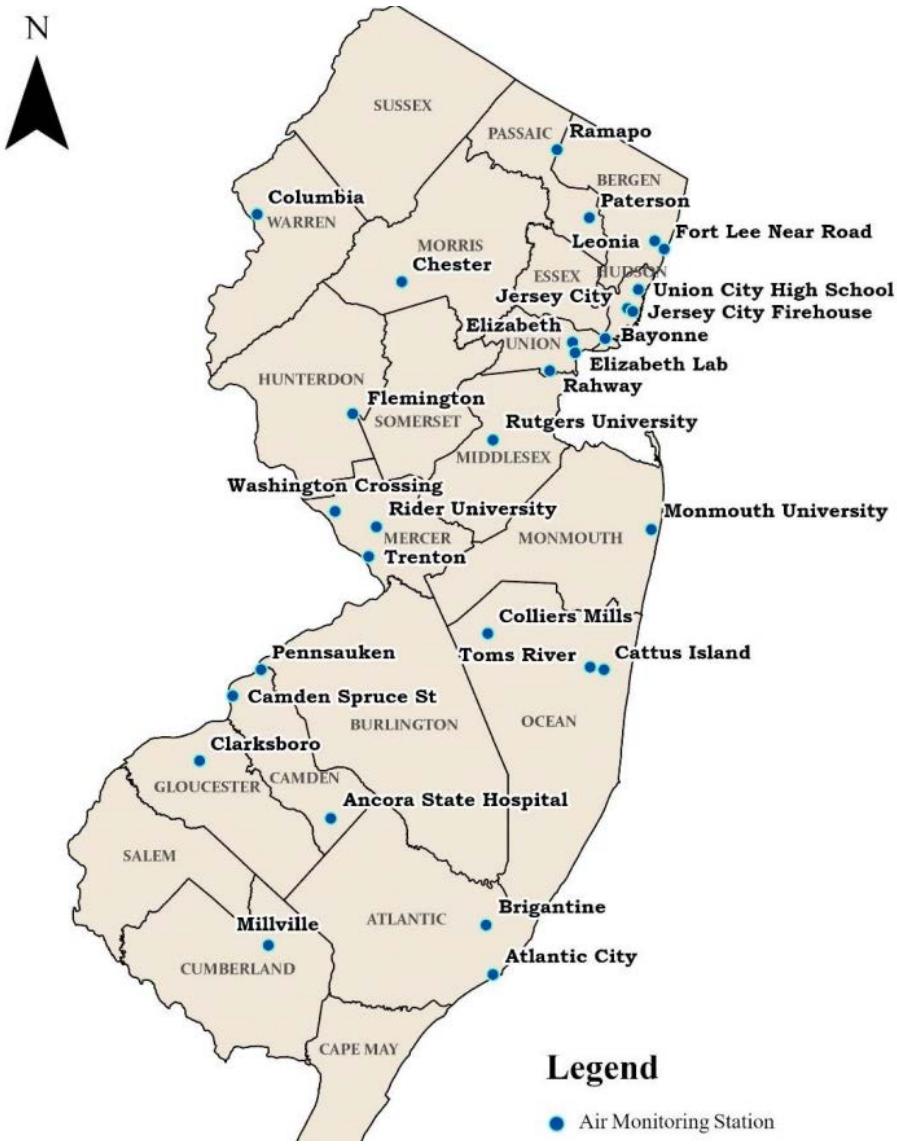
dioxide (NO_2), fine particulates ($PM_{2.5}$), and lead. It is the responsibility of each state to develop **State Implementation Plans (SIPs)** to attain and maintain the established standards. In New Jersey, that role is assigned to the DAQ.

When NAAQS are established or revised, the USEPA formally assesses all areas of the country as in attainment or in nonattainment.[235] Nonattainment areas for ozone, carbon monoxide, and particulate matter are classified by the magnitude of ambient air pollution in an area. Nonattainment designations may be used to specify what pollution reduction measures must be adopted in order to reach attainment.

Regional/Local Statistics

The state uses air quality data from the monitoring network to determine which areas are compliant with NAAQS and to see overall trends in air pollution levels. The NJDEP produces the yearly New Jersey Air Quality Reports and provides real-time reporting through the Air Quality Index website, which draws data from air quality monitoring stations across the state.

Figure 35. New Jersey Air Monitoring Sites
Source: NJDEP 2023 Air Quality Report



The locations of air quality monitoring stations in New Jersey are shown in **Figure 35**. In Union County, air quality is monitored at Elizabeth, Elizabeth Lab, and Rahway.[236] State air quality data is aggregated from different sites, as no one site monitors all pollutants.

The station at Elizabeth Lab has the most comprehensive air monitoring in the area, tracking CO, NO_2, SO_2, $PM_{2.5}$, air toxics, mercury, and urban pollutants. The nearest station monitoring ozone, O_3, is in Bayonne. Further from the urban centers of North Jersey, the station at Chester monitors NO_2, SO_2, O_3, $PM_{2.5}$, and air toxics.

Figure 36. NJDEP Air Quality Index Guide

Source: NJDEP 2023 NJ Air Quality Report

AQI Level of Health Concern	Numerical Value	Meaning	Color Code
Good	0 to 50	Air quality is considered satisfactory, and air pollution poses little or no risk.	Green
Moderate	51 to 100	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.	Yellow
Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is not likely to be affected.	Orange
Unhealthy	151 to 200	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.	Red
Very Unhealthy	201 to 300	Health warnings of emergency conditions. The entire population is more likely to be affected.	Purple
Hazardous	301 to 500	Health alert: everyone may experience more serious health effects.	Maroon

Air Quality Index

The Air Quality Index (AQI) produces a value that reflects overall air quality at a given time. The index is calculated from the NAAQS, accounting for ozone, particulate matter, carbon monoxide, sulfur dioxide, and nitrogen dioxide. The AQI uses a scale of 0 to 500, where 500 is most hazardous (**Figure 36**).

An AQI value of 100 corresponds to the NAAQS threshold for a specific principal pollutant. AQI values from 101 to 150 are unhealthy for sensitive populations, such as asthmatics, children, and the elderly. AQI values above 150 are unhealthy for the general public.[237]

In 2023, there were 20 individual days which exceeded NAAQS. There were 17 days which exceeded the standards for ozone, with 15 days being unhealthy for sensitive groups, and 2 days being unhealthy. There were 9 days which exceeded the NAAQS for fine particulate matter, with 4 days being unhealthy for sensitive groups, 4 days being unhealthy, and 1 day being very unhealthy.[238]

2020 saw the healthiest AQI values in recent years, likely reflecting the decrease in polluting activity during the COVID-19 pandemic. This year saw reduced traffic flows and limited business operations. At the annual public hearing of the New Jersey Clean Air Council in April 2022, data was presented to show that COVID-19 measures most strongly

Number of days where AQI values exceeded 100:

20 in 2023

9 in 2022

15 in 2021

6 in 2020

14 in 2019

affected concentrations of ozone, nitrogen dioxide, and particulate matter. However, AQI returned to pre-pandemic levels in 2021.[239]

Criteria Pollutants

The six pollutants which are targeted by the NAAQS (ozone, carbon monoxide, sulfur dioxide, nitrogen dioxide, fine particulates, and lead) are known as criteria pollutants. The concentration of air pollutants has declined significantly since the enactment of the Clean Air Act in 1970. While there are periodic exceedances of NAAQS, New Jersey has generally maintained good air quality in recent years, in attainment with all criteria pollutants with the exception of ozone.[240] NAAQS for criteria pollutants are listed in **Figure 37**.

Figure 37. National Ambient Air Quality Standards (NAAQS)

Source: USEPA[241]

Pollutant [links to historical tables of NAAQS reviews]		Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide (CO)		primary	8 hours	9 ppm	Not to be exceeded more than once per year
			1 hour	35 ppm	
Lead (Pb)		primary and secondary	Rolling 3 month average	0.15 µg/m^3 (1)	Not to be exceeded
Nitrogen Dioxide (NO_2)		primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		primary and secondary	1 year	53 ppb (2)	Annual Mean
Ozone (O_3)		primary and secondary	8 hours	0.070 ppm (3)	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Particle Pollution (PM)	$PM_{2.5}$	primary	1 year	9.0 µg/m^3	annual mean, averaged over 3 years
		secondary	1 year	15.0 µg/m^3	annual mean, averaged over 3 years
		primary and secondary	24 hours	35 µg/m^3	98th percentile, averaged over 3 years
	PM_{10}	primary and secondary	24 hours	150 µg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO_2)		primary	1 hour	75 ppb (4)	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		secondary	1 year	10 ppb	annual mean, averaged over 3 years

Ozone

Ozone (O_3) is a gas consisting of three oxygen atoms. It occurs naturally in the upper atmosphere, where it protects from ultraviolet rays. Since the late 1980s, ozone has been the subject of environmental protections to restore the atmospheric ozone layer, which plays an important role in Earth's climate regulation.[242]

In 2023, the ozone monitoring season (March 1 - October 31) had 17 days that exceeded NAAQS. This included 15 days that were unhealthy for sensitive groups and 2 that were unhealthy for the general public. The highest 8-hour average concentration of ozone recorded at Bayonne was 0.096 ppm.

The NAAQS value that determines attainment or nonattainment for ozone standards uses data from the most recent three-year period. It is taken from the fourth highest daily maximum 8-hour average concentration for each monitoring site in the state for each year. These values are then used to calculate a three-year average. If this average exceeds the NAAQS at any site, the state is determined to be in nonattainment.

New Jersey is currently in nonattainment for ozone. Union County falls in the Northern NJ-NY-CT nonattainment area.[243] The effort to lower ozone concentrations has focused on reducing emissions of volatile organic compounds (VOCs), but further improvements will require additional reductions in both VOCs and nitrogen oxides (NO_x). New Jersey falls within the USEPA's Ozone Transport Region, where local ozone levels are particularly impacted by the regional transport of ozone-forming NO_x. Continued interstate cooperation may be required to achieve further reductions in New Jersey's ozone levels.

Sulfur Dioxide

Sulfur dioxide (SO_2) is a heavy, colorless gas with a suffocating odor that easily dissolves in water to form sulfuric acid. SO_2 gases are often formed when fuels that contain sulfur are burned, or when gasoline is extracted from crude oil. Most of the sulfur dioxide released into the air comes from the combustion of fossil fuels in power plants and industrial processes. It is particularly associated with the burning of coal.[244]

SO_2 and its dissolved forms are harmful to the health of people and the environment. SO_2 irritates mucous membranes and can cause trouble breathing, especially among sensitive groups. SO_2 reacts with other gases and particulates in the air to form sulfates, which are the primary cause of reduced visibility when air quality is poor. Acids formed from SO_2 become precipitation, falling to the earth as acid rain or snow. Acid rain damages forests and crops, acidifies lakes and streams, and accelerates the decay of buildings.

A state is considered in attainment for sulfur dioxide in a given year if its 1-hour SO_2 concentration does not exceed 25 parts per billion (ppb). The value is taken from a three-year average of annual 99th percentile daily maximum concentrations.

Portions of New Jersey which were previously in nonattainment were redesignated to attainment status in 2021, putting the entire state in attainment for SO_2 NAAQS. Regulations which require the use of low sulfur fuels have been effective in lowering SO_2 concentrations, along with the closing of coal-fired electric generating units.[245]

Carbon Monoxide

Carbon monoxide (CO) is a colorless, odorless, poisonous gas formed when the carbon molecules in fuel are not burned completely. The primary sources of CO emissions in New Jersey are on-road and off-road vehicles, boilers, incinerators, and forest fires. Outdoor CO levels can reach dangerous levels in cases of a weather inversion, where a layer of air becomes trapped at the earth's surface, allowing pollutants to build up without the usual circulation.[246]

Carbon monoxide reduces the oxygen-carrying capacity of blood, slowing the flow of oxygen to critical parts of the body. CO does not occur in outdoor air at the lethal concentrations that can be recorded in indoor air. However, even at lower concentrations, exposure to CO can result in headaches and nausea. CO is often more harmful to individuals with cardiovascular disease, causing chest pain and reducing the ability to exercise.

There are two primary health-based NAAQS for carbon monoxide: a 1-hour standard of 35 ppm, and an 8-hour standard of 9 ppm. These values are not to be exceeded more than once in a given year, so standards are calculated using the second-highest 1-hour and 8-hour values. New Jersey has been fully in attainment with carbon monoxide levels since 2002, though many counties achieved attainment/maintenance in 1996.[247] There were no recorded exceedances of any CO standards at any New Jersey monitoring site in 2023.[248]

> 90% of New Jersey's CO comes from internal combustion engines.

The highest average concentration of CO at any time or location in 2023 was recorded at the Fort Lee Near Road station, with a 1-hour average concentration of 3.1 ppm. The highest 8-hour average concentration was recorded at Jersey City as 2.6 ppm. The highest CO concentration recorded at Elizabeth Lab was a 1-hour concentration of 2.4 ppm and 8-hour concentration of 1.5 ppm.

Though unhealthy levels of CO used to be recorded on a regular basis, levels in outdoor air have improved dramatically since 1990. This reduction is primarily due to cleaner-running cars and other vehicles. The last violation of the 8-hour NAAQS was recorded in 1994.[249]

Nitrogen Dioxide

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 pollutant compounds. NO_2 is generally used as an indicator for the group of gases known as nitrogen oxides (NO_x), which are emitted by the combustion of fossil fuels in vehicles, power plants, home heating and cooking, and industrial processes.[250]

Since NO_x is released by motor vehicles, concentrations tend to peak during and immediately after the morning and evening rush hours. Concentrations are likely to be higher near major roadways, such as NJ Route 24/124. Concentrations of NO_x also tend to be higher in the winter, due to weather conditions and the heating of buildings.[251]

NO_x can aggravate and cause respiratory illness, and prolonged exposure can cause permanent damage to the lungs. NO and NO_2 can also irritate the eyes,

nose, throat and lungs, and cause nausea and tiredness. It is known to cause health problems especially for sensitive individuals, such as children, the elderly, and people with asthma.

The environmental effects of NO_x can include:

- Acidification of freshwater bodies
- Eutrophication of coastal waters
- Increases in levels of toxins that are harmful to fish and aquatic life

New Jersey has long been in attainment with NAAQS for NO_2.[252] The primary standards in a 1-hour averaging period are 100 ppb NO_2, calculated using a 3-year average of the annual 98th percentile daily maximums. The annual measurement requires a calendar year average concentration below 53 ppb. Nitrogen dioxide is monitored at 10 sites in New Jersey. In 2023, the highest daily maximum concentration of NO_2 was 75 ppb, recorded at Elizabeth Lab.[253]

New Jersey began monitoring NO_2 in 1966. The last year in which the average annual NO_2 concentration exceeded the NAAQS was 1974. Although concentrations have been well within the NAAQS, there is concern regarding the role of nitrogen oxides in the formation of other pollutants such as ozone and particulate matter, which still reach problematic levels. Reductions of NO_2 levels are likely necessary to reduce levels of ozone and fine particulate matter.

Nitrogen oxides can also cause decreased visibility and react in the air to form both ozone and particulate matter.

Particulate Matter

Particulate air pollution consists of any artificial or natural particles suspended in the air which may affect the environment. Some key terms for the assessment of particulate matter are:

- **Total suspended particulates (TSPs)** refer to the total of all particulates of any size.
- **Inhalable particulate matter (PM_{10})** includes particles less than 10 micrometers in diameter that can be inhaled and accumulated in the respiratory system. PM_{10} can irritate the eyes, nose, and throat.
- **Fine particulate matter ($PM_{2.5}$)** are particulates less than 2.5 micrometers in size that are believed to pose the greatest health risks. With the potential to penetrate into the lungs, heart, and bloodstream, fine particulates can exacerbate heart and lung diseases and cause heart attacks.[254]

The NAAQS for $PM_{2.5}$ were established 1997 and have been revised several times, as we become more knowledgeable of the harms of fine particulate matter. As of 2024, the primary annual standard for PM2.5 is 9 µg/m3 (micrograms per cubic unit of air), measured by taking the three-year average of annual means. The 24-hour standard is 35 µg/m3, taking the three-year average of the annual 98th percentile values.[255]

New Jersey is typically in attainment/ maintenance of $PM_{2.5}$ standards. In 2022, the annual mean concentrations of $PM_{2.5}$ ranged from 5.1 µg/m3 at the Chester monitoring site to 8.7 µg/m3 at the Elizabeth Lab monitoring station. There was one exceedance of the 24-hour standard, captured by the Brigantine monitor station, that is attributable to smoke from a nearby wildfire.

In June of 2023, New Jersey was declared Code Red for AQI due to high concentrations of particulate matter.[256] This event saw wildfire smoke carried across the northeastern United States due to atmospheric conditions and the proximity to the burning in Quebec. The smoke caused $PM_{2.5}$ concentrations to reach unhealthy and very unhealthy levels, with several days of exceedances. On June 7, NAAQS exceedances were recorded at 15 air monitoring stations, with a highest recorded value of 187.1 µg/m^3 at Flemington.[257]

For inhalable particles (PM_{10}), the primary NAAQS are 150 µg/m3 for a 24-hour period and 50 µg/m3 for an annual period.[258] This value is derived from the 2nd highest annual average over three years. These values are recorded by the stations at Camden Spruce Street, Jersey City Firehouse, and until September 2022, the Newark Firehouse. The state of New Jersey is has been in attainment with standards of PM_{10} for more than a decade.

Lead

Lead is hazardous to the health of humans and the environment, whether it is found in the air, in materials such as paint, in water, or in soils.[259] Though action standards are defined for lead exposure, there is a consensus that no level of lead exposure can be considered safe. Lead has its main impacts on the nervous system, particularly in children. Exposure to lead is linked with learning disabilities, mood issues, and lowered IQ. In adults, lead exposure can also impact the cardiovascular system, and it is considered a probable human carcinogen. Lead present in the air or water may accumulate in soils and sediments.

On February 7, 2024, the USEPA announced that the annual standard for fine particulate matter is being lowered from 12 µg/m^3 to 9 µg/m^3. Each state is expected to submit a SIP for achieving more stringent standards. Focus will be on Overburdened Communities, who on average are subject to higher levels of particulate matter in the air.[264]

Before the 1970s, lead was a common air pollutant due to its use as an additive in gasoline. New Jersey no longer has any significant industrial sources of lead, however, small airplanes continue to use leaded gasoline. In 2017, planes were estimated to release over four tons of lead annually into New Jersey's skies.[260] In 2008, the NAAQS level for lead was set at 0.15 µg/m3 for a rolling 3-month average. As of 2022, there are 21 areas nationwide that are in non-attainment. The closest location is in Berks County, Pennsylvania.

Since 2012, there has been one lead monitoring station in New Jersey, at the Newark Firehouse. The measurements taken in 2021 ranged between 0.001 and 0.003 µg/m3, well below the NAAQS level. And as of September 2022, this site was closed. NJDEP expects to have a site reestablished in Newark, where lead monitoring will resume.

Since 1980, the phase-out of leaded gasoline has led to a 99% decrease in the average lead air concentration nationwide.

Air Toxics

Air pollutants that are not criteria pollutants but may still cause adverse health effects are known as air toxics, or Hazardous Air Pollutants (HAPs). [261] There are almost 200 different air toxics included in the list of HAPs maintained by the EPA.[262]

In New Jersey, on-road mobile sources (vehicles) account of 23% of air toxics emissions, and non-road mobile sources (airplanes, trains, construction equipment, lawnmowers, boats, offroad vehicles, etc.) contribute 31%. Another 43% of air toxics are emitted from nonpoint sources, including residential, commercial, and small industrial sources. The remaining 3% come from point sources, which include factories and power plants. In 2020, Union County had more air toxics emitted from non-point sources than any other source type.[263]

There are four sites that monitor air toxics in New Jersey: Rutgers University, Elizabeth Lab, Chester, and Camden Spruce Street. While the other three are located in urban areas, the rural Chester station acts as a sort of background monitor. Each of these sites measures volatile organic compounds (VOCs), carbonyls (a subset of VOCs that includes formaldehyde, acetaldehyde and other related compounds), and toxic metals.

The EPA sets health benchmarks for HAPs, indicating the concentration that is generally considered safe to breathe on a daily basis. NJDEP calculates a Risk Ratio by dividing annual average concentrations of each HAP by its health benchmark. Risk ratios greater than one suggest the pollutant level may be of concern to human health.

In 2023, several monitored pollutants were above health benchmarks. These measurements were captured at all four monitoring sites. Air toxics with risk ratios greater than one for at least one monitoring site in 2023 are detailed in **Table 21**.

Table 21. Air Toxics Above Health Benchmark in 2023

Pollutant	Health Benchmark (µg/m³)	Annual Average Risk Ratios (Concentrations)			
		Camden	Chester	Elizabeth	Rutgers
Acetaldehyde	0.45	4.6	3.3	3.9	2.2
Acrolein	0.02	31.4	29.3	36.4	30.8
Benzene	0.13	5.5	3.2	6.2	4.1
1,3-Butadiene	0.033	1.3	0.4	1.7	0.7
Carbon Tetrachloride	0.17	2.9	2.9	2.9	2.9
Chloroform	0.043	2.8	2.3	3.4	3.1
Chloromethane	0.56	1.8	1.8	1.8	1.9
1,2-Dichloroethane	0.038	2.4	1.8	1.8	1.9
Formaldehyde	0.08	36.4	45.2	35.1	20.4
Source: 2023 New Jersey Air Quality Report					

Acrolein and formaldehyde were measured with the highest risk ratio statewide. Acrolein is a colorless or yellowish liquid that is used to make tear gas, drugs, and plastics.[265] Formaldehyde is a colorless gas with a strong odor that is sold commercially in a methanol and water solution. It is a known carcinogen. Both chemicals are listed on the NJ Department of Health's Hazardous Substance List.[266]

Radon

Radon is an invisible and odorless radioactive gas resulting from the breakdown of naturally occurring uranium in soil and rock. Unlike other air pollutants, radon is primarily a concern for indoor air quality. It builds up in homes as it seeps out of bedrock and through cracks or openings in a home's foundation. Radon releases radioactive energy, causing lung damage and lung cancer.[267] In the United States, radon is the second main cause of lung cancer and kills at least 15,000 people per year.

NJDEP estimates radon risk by municipality based on real occurrences of radon contamination. In the 2015 potential map, the City of Summit is identified as having moderate radon potential. This means that at least 25 homes were tested with 5 to 24% having radon concentrations greater than or equal to 4 picocuries per liter. [268, 269] The EPA recommends action in homes with a radon level of 4 pCi/L or more. However, it also notes that there are no safe levels of radon, and that it may be appropriate to take action for detected levels above 2 pCi/L. As residents better insulate and seal their homes to reduce energy usage, they may cause elevated levels of radon to accumulate. Although testing for radon is only required at the time a home is sold, improving the structure's insulation or doing foundation work, may change the radon level in a home.[270]

Odors

The NJDEP classifies odor as air pollution when it is severe enough to unreasonably interfere with the enjoyment of life or property.[271] In many cases, odor pollution is an indicator of chemicals described above, which are regulated separately by the NJDEP. However, there is also a procedure for odor issues, based on complaints and inspection by an NJDEP official. Fines range from $150 to $1,400 for a first offense. The U.S. Center for Disease Control notes that the best strategy for addressing odor issues is prevention zoning, time of day operating restrictions, filtering, and emission control.[272]

Meteorology and Pollution

Pollution levels are affected by meteorological attributes like wind speed and direction, temperature, and solar radiation.[273] Meteorology is an important factor in the levels of ozone, as it is mainly a secondary pollutant created from the chemical reaction of other pollutants in the presence of heat and sunshine. Other pollutants, such as particulate matter and sulfur dioxide, can reach elevated levels across the state due to downwind sources such as coal-fired power plants in midwestern states and wildfires in the West and Canada. Nitrogen dioxide, on the other hand, is a localized problem occurring where there is heavy traffic and other use of internal combustion.

Of note is the effect of dominant westerly winds, which carry weather patterns and pollution from states to the west over and across New Jersey. These winds migrate substantially from north to south, bringing in different levels of pollution from outside the state. This causes substantial variation in air quality from day to day.

Cleanup Project on Chatham Road

Chapter 13.

Known Contaminated Sites

Land contamination can result from a variety of intended, accidental, or naturally occurring activities. Sites can be contaminated by improper handling or disposal of toxic and hazardous materials and wastes, such as in manufacturing or mining; by accidental release of toxic or hazardous materials; or by inadvertent deposit of hazardous materials, such as by natural disasters.[274]

Contamination of soils can travel to groundwater and surfacewater, causing a range of effects. Some contamination is low-level, with minor risk of exposure to contaminants, while other cases pose dangerous risks to human and environmental health. Chemicals may be highly toxic, present in high concentrations, or have a high propensity to move or persist in the environment. Contaminants can be taken up by plants and animals, ingested by humans in the water supply, or volatilized in the air.[275]

Soil and groundwater contamination is tracked by state and federal governments at varying degrees of contamination or potential contamination. Remediation of a contaminated site under New Jersey's cleanup programs include identifying the source, nature, and extent of contamination of a site, and conducting appropriate cleanup work.[276]

Categories of contamination include:

- Point source occurrence of pollution that are specific and limited (Known Contaminated Sites);
- Point source facilities that require continuous monitoring (Community Right to Know Sites); and
- Brownfields, which require long-term of extensive remediation.

Known Contaminated Sites

The Known Contaminated Sites (KCS) list for New Jersey includes properties within the state where contamination of soil or groundwater has been confirmed at levels equal to or greater than applicable standards. KCS may include:

- **Active Sites** are those with confirmed contamination that have one or more active cases ore remedial action permits and any number of pending and/or closed cases;
- **Pending Sites** are those with one or more pending cases, no active cases, and any number of closed cases; and
- **Closed Sites** are those with only closed cases and no active or pending cases.

The **Brownfield and Contaminated Site Remediation Act (N.J.S.A. 58:10-23.16-17)** requires the preparation a list of sites affected by hazardous substances in the state. Maintenance of the KCS list also meets obligations set by the New Jersey New Residential Construction Off-Site Conditions Disclosure Act (N.J.S.A. 46:3C1 et seq.).

The **Site Remediation Reform Act, N.J.S.A. 58:10C-1 et seq. (SRRA)** was enacted in 2009 to improve the process of site remediation in New Jersey. It establishes the program of Licensed Site Remediation Professionals (LSRPs) who have oversight of environmental investigation and cleanup.[277]

Contaminated sites can undergo a wide variety of remedial activities, ranging from relatively simple “cut and scrape” cleanups to highly complex cleanups. Sites with more complex contamination issues often have several sources of contamination affecting multiple media, including soil and groundwater.

Active contamination sites are given a ranking from B to D based on the Site Remediation Program's 1989 Case Assignment Manual:

- **B**: Remedial level associated with emergency response, simple removal activities of contaminants usually no impact to soil or groundwater.
- **C1**: Remedial levels are associated with simple sites, one or two contaminants localized to soil and the immediate spill or discharge area.
- **C2**: Remedial levels are associated with more complicated contaminant discharges, multiple site spills and discharges and more than one contaminant, with both soil and groundwater impacted or threatened.
- **C3**: Remedial levels are associated with high complexity and threatening sites; multiple contaminants, some at high concentrations with unknown sources continuing to impact soils, groundwater, and possibly surface waters and potable water resources. These sites are dangerous for direct contact with contaminated soils.
- **D**: Same conditions as C3; often dedicated as Federal Superfund sites.[278]

Sites with documented groundwater contamination may also include a Classification Exception Area (CEA) in cases where "constituent standards are not being met or will not be met in a localized area due to: natural quality; localized effects of discharge approved through a NJPDES permit action; pollution caused by human activity within a contaminated site as defined by the Department of an applicable regulatory program (e.g., Site Remediation Program); or an ACL (Alternative concentration limit) as approved by the Department pursuant to NJPDES.“[279]

Table 22 shows Known Contaminated Sites in Summit, including homeowner and non-homeowner, that are active or closed. Active, non-homeowner sites are shown in **Map 18**. More detailed information on these sites can be found in **Appendix B**.

Community Right to Know Sites

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.[280] Companies or organizations which store certain hazardous substances in levels above specific threshold amounts are required by state and federal law to file annual reports.

The Release and Pollution Prevention Report (RPPR) is used to collect information for the NJDEP CRTK and Pollution Prevention programs. The Emergency Planning Community Right-to-Know Act (EPCRA) is a federal regulation that establishes requirements regarding emergency planning and CRTK reporting on hazardous toxic chemicals to increase public knowledge and information about chemical uses.
In 2024, there were 32 active sites in Summit that met the State thresholds for CRTK. All but six sites are regulated under CRTK/RPPR; five are exempt; one is subject to EPCRA only. The detailed list of CRTK sites can be found in **Appendix C**.

Brownfields

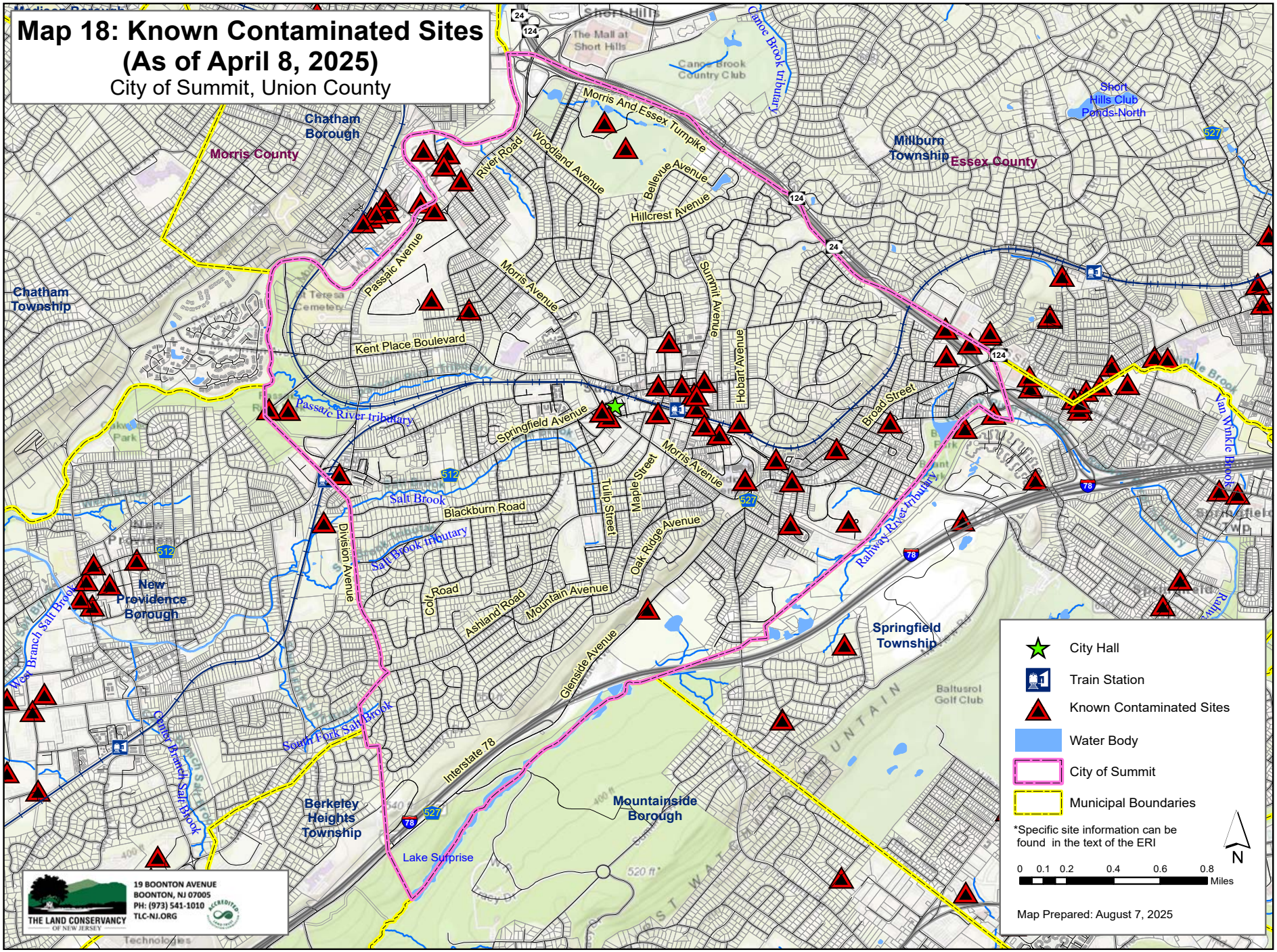
A brownfield is any former or current commercial or industrial site, currently vacant or underutilized and on which there has been, or there is suspected to have been, a discharge of a contaminant. The State of New Jersey encourages municipalities and counties to redevelop brownfields as part of Smart Growth initiatives. [281] The NJDEP Brownfield Development Area (BDA) program enables communities to coordinate initiatives for remediation and reuse of clustered brownfield sites.[282] Funding is available at from the State and Federal Government to support brownfield site remediation and redevelopment.

There are no brownfield sites within the City of Summit. In Union County, brownfields are found in the Cities of Rahway, Elizabeth, and Plainfield.

Table 22. Known Contaminated Sites, City of Summit

Category	Status			Total
	Active	Pending	Closed	
Homeowner	1	0	326	327
Non-Homeowner	34	0	228	262
Total	35	0	554	589

Source: NJDEP Data Miner


Map 18: Known Contaminated Sites
(As of April 8, 2025)
City of Summit, Union County
Chatham Borough
Morris County
Chatham Township
Millburn Township
Essex County
Short Hills Club Ponds-North
The Mall at Short Hills
Canoe Brook Country Club
Canoe Brook tributary
Morris And Essex Turnpike
River Road
Woodland Avenue
Bellevue Avenue
Hillcrest Avenue
Passaic Avenue
Morris Avenue
Summit Avenue
Hobart Avenue
Kent Place Boulevard
Passaic River tributary
Springfield Avenue
Broad Street
Van Wyckle Brook
Salt Brook
Blackburn Road
Salt Brook tributary
Division Avenue
Tulip Street
Maple Street
Oak Ridge Avenue
Railway River tributary
New Providence Borough
West Branch Salt Brook
Colt Road
Ashland Road
Mountain Avenue
Glenside Avenue
Springfield Township
Baltusrol Golf Club
South Fork Salt Brook
Interstate 78
Berkeley Heights Township
Mountainside Borough
Lake Surprise
City Hall
Train Station
Known Contaminated Sites
Water Body
City of Summit
Municipal Boundaries
*Specific site information can be found in the text of the ERI
N
0 0.1 0.2 0.4 0.6 0.8 Miles
Map Prepared: August 7, 2025
THE LAND CONSERVANCY OF NEW JERSEY
19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973) 541-1010
TLC-NJ.ORG

Appendix

Appendix A: Soil Units of Summit

Table 23. Soil Units of Summit			
Abbrv.	**Map Unit Name**	**Total Acres**	**% of Total**
AmhB	Amwell silt loam, 2 to 6 percent slopes	15.99	0.41%
AmhCb	Amwell silt loam, 6 to 12 percent slopes, very stony	32.61	0.84%
AmuB	Amwell-Urban land complex, 0 to 6 percent slopes	182.10	4.72%
BoeDc	Boonton sandy loam, terminal moraine, 15 to 25 percent slopes, extremely stony	16.41	0.43%
BogB	Boonton loam, 3 to 8 percent slopes	61.95	1.60%
BohC	Boonton moderately well drained gravelly loam, 8 to 15 percent slopes	41.13	1.07%
BohD	Boonton moderately well drained gravelly loam, 15 to 25 percent slopes	55.64	1.44%
BouB	Boonton-Urban land complex, 0 to 8 percent slopes	4.99	0.13%
BouD	Boonton-Urban land complex, 15 to 25 percent slopes	69.50	1.80%
BovB	Boonton-Urban land-Haledon complex, 0 to 8 percent slopes	871.05	22.56%
BowtB	Boonton - Urban land, Boonton substratum complex, terminal moraine, 0 to 8 percent slopes	324.83	8.41%
BowtC	Boonton-Urban land complex, terminal moraine, 8 to 15 percent slopes	72.84	1.89%
BowtD	Boonton-Urban land complex, terminal moraine, 15 to 25 percent slopes	223.39	5.79%
DunB	Dunellen sandy loam, 3 to 8 percent slopes	21.30	0.55%
DuuA	Dunellen-Urban land complex, 0 to 3 percent slopes	30.03	0.78%
DuuB	Dunellen-Urban land complex, 3 to 8 percent slopes	55.01	1.42%
DuuD	Dunellen-Urban land complex, 15 to 25 percent slopes	35.23	0.91%
HakA	Haledon loam, 0 to 3 percent slopes	17.05	0.44%
HakB	Haledon loam, 3 to 8 percent slopes	236.81	6.13%
HasB	Haledon - Urban land complex, 0 to 8 percent slopes	3.51	0.09%
HatB	Haledon-Urban land-Hasbrouck complex, 0 to 8 percent slopes	195.59	5.07%
HctAr	Hasbrouck silt loam, 0 to 3 percent slopes, rarely flooded	30.11	0.78%
HcuAt	Hatboro-Codorus complex, 0 to 3 percent slopes, frequently flooded	27.87	0.72%
Source: NRCS Soil Survey			

Appendix A: Soil Units of Summit

Table 23. Soil Units of Summit			
Abbrv.	**Map Unit Name**	**Total Acres**	**% of Total**
NehBc	Neshaminy silt loam, 0 to 6 percent slopes, extremely stony	16.35	0.42%
NehDc	Neshaminy silt loam, 12 to 18 percent slopes, extremely stony	34.39	0.89%
NehEc	Neshaminy silt loam, 18 to 35 percent slopes, extremely stony	125.34	3.25%
NenB	Neshaminy-Urban land complex, 0 to 6 percent slopes	173.30	4.49%
NenD	Neshaminy-Urban land complex, 12 to 18 percent slopes	233.18	6.04%
PbpAt	Parsippany silt loam, 0 to 3 percent slopes, frequently flooded	49.54	1.28%
PbpuAt	Parsippany-Urban land complex, 0 to 3 percent slopes	10.58	0.27%
PcsAt	Passaic silt loam, 0 to 3 percent slopes, frequently flooded	7.00	0.18%
TunE	Tunkhannock gravelly loam, 25 to 45 percent slopes	4.51	0.12%
UdhalB	Udorthents, haledon substratum, 0 to 8 percent slopes	2.60	0.07%
UdkttB	Udorthents, loamy substratum, 0 to 8 percent slopes	50.23	1.30%
UdrB	Udorthents, refuse substratum, 0 to 8 percent slopes	19.23	0.50%
UR	Urban land	306.63	7.94%
URBONB	Urban land, boonton substratum, 0 to 8 percent slopes	9.95	0.26%
USBONB	Urban land-Boonton complex, 0 to 8 percent slopes	3.05	0.08%
WATER	Water	37.47	0.97%
WhpAr	Whippany silt loam, 0 to 3 percent slopes, rarely flooded	50.51	1.31%
WhpBr	Whippany silt loam, 3 to 8 percent slopes, rarely flooded	6.96	0.18%
WhrBr	Whippany-Urban land complex, 0 to 8 percent slopes, rarely flooded	94.74	2.45%
	Total:	**3,860.5**	**100%**
Source: NRCS Soil Survey			

Appendix B: Active Sites with Confirmed Contamination, Non-Homeowner

Table 24. Active Sites with Confirmed Contamination, City of Summit					
Site ID	**PI Number**	**PI Name**	**Address**	**Status**	**Remedial Level**
22343	000142	RAYMOND F FLYNN INC	31 EUCLID AVE	Active	C2
13162	004165	PSE&G SUMMIT DISTRICT GAS	48 MIDDLE AVE	Active	B
19787	006407	SMYTHE VOLVO INC	326 MORRIS AVE	Active	C2
689	013637	CELGENE CORP	86 90 MORRIS AVE	Active	B
673	013729	SUNOCO SUMMIT	42 MORRIS TPKE	Active	C2
685	016963	STEPHENS-MILLER CO	38 RUSSELL PL	Active - Post Rem	
676	015330	EXXON R/S 34139	10 ASHWOOD AVE	Active	C2
44770	011139	BOB'S SUMMIT GULF	67 SUMMIT AVE	Active - Post Rem	
13164	007916	EXXON R/S 33426 FORMER	795 OLD SPRINGFIELD AVE	Active - Post Rem	
21463	009994	JCPL SUMMIT DISTRICT	52 CHATHAM RD	Active	C2
687	007941	RACEWAY SUMMIT	1 CHATHAM & RIVER RD	Active - Post Rem	
355775	008155	MUNICIPAL COMPOST AREA	40 NEW PROVIDENCE AVE	Active	C2
695	008156	CITY GARAGE	41 CHATHAM RD	Active	C2
690	011695	NJ0190	336 MORRIS AVE	Active	C2
14453	014650	CIBA-GEIGY CORP	556 MORRIS AVE	Active	
47467	018431	SUMMIT MAIN POST OFFICE	61 MAPLE ST	Active - Post Rem	
13160	025529	COLUMBIA CLEANERS INC FORMER	29 - 31 CHATHAM RD	Active - Post Rem	C2
221880	1092002	SUMMIT CLEANERS	92 SUMMIT AVENUE	Active	B
450353	566317	DEFRANCO LIMOUSINE	5 MORRIS AVE	Active	C2
679	531733	YOUNGS DRY CLEANERS FORMER	329 SPRINGFIELD AVE	Active	C2
709559	1010898	40 PARK AVE	40 PARK AVE	Active - Post Rem	
Source: NJDEP CSRR Geographic Information Systems[283]					

Appendix B: Active Sites with Confirmed Contamination, Non-Homeowner

Table 24. Active Sites with Confirmed Contamination, City of Summit					
Site ID	**PI Number**	**PI Name**	**Address**	**Status**	**Remedial Level**
14698	020136	OVERLOOK HOSPITAL	99 BEAUVIOR AVE & SYLVAN RD	Active	C1
672	025211	P & K FUEL LLC DBA EXXON	18 MORRIS ST & ESSEX TPKE	Active	C1
671	021991	CANOE BROOK COUNTRY CLUB	34 WALLACE RD	Active	B
121271	159534	RUSSELL HULSIZER PROPERTY	97 SUMMIT AVE	Active	C1
746400	1100539	JCP&L TRANSFORMER AT 166 GLENSIDE AVE	166 GLENSIDE AVE	Active	B
94095	292450	SUMMIT TRANSFER STATION	1 NEW PROVIDENCE AVE	Active	C3
31075	135107	SUPERIOR OLDSMOBILE FORMER	290 306 BROAD ST	Active - Post Rem	
55957	030188	MELROSE REALTY	361 365 SPRINGFIELD AVE	Active - Post Rem	
702	95889	CCK & K REALTY	233 BROAD ST	Active - Post Rem	
68340	G000024566	NJ DOT MAINTENANCE YARD City of Summit	46 SPRINGFIELD AVE (RTE 24)	Active	C2
690882	982322	SUMMIT FIREHOUSE	281 BROAD ST	Active	B
590015	740597	22 RIVER ROAD	22 RIVER RD	Active - Post Rem	
79977	G000040810	ECKERD DRUG STORE	417 SPRINGFIELD AVE	Active - Post Rem	
66438	G000005387	CARRIAGE HOUSE REFINISHING & RESTORATION	24 FRANKLIN PL	Active - Post Rem	
Source: NJDEP CSRR Geographic Information Systems[283]					

Appendix C: Community Right to Know Sites

Table 25. Community Right to Know Sites, City of Summit, 2024			
PI Number	Facility Name	Physical Address	Eligibility
00000004185	THE ORATORY SCHOOL OF SUMMIT	1 BEVERLY RD	EXEMPT
00000039369	SUMMIT AUTO CENTER INC-NJ0190	336 MORRIS AVE	CRTK/RPPR
00000040023	ALED PETROLEUM LTD	19 SUMMIT AVE	CRTK/RPPR
00000066334	SUMMIT WEST CELGENE, LLC.	556 MORRIS AVE	CRTK/RPPR
00000072917	CANOE BROOK COUNTRY CLUB	30 WALLACE RD	EPCRA ONLY (NAICS Exempt)
00000073734	BULL N BEAR BREWERY LLC	425 SPRINGFIELD AVE	CRTK/RPPR
00000075402	City of Summit OF - CHATHAM RD PS	50 CHATHAM RD	EPCRA ONLY
00000076035	T. MAGERS LANDSCAPING LLC	19 MIELE PL	CRTK/RPPR
00000076980	SALERNO DUANE INC	123 PARK AVE	CRTK/RPPR
00000076992	J HIDALGO HARDSCAPE & DESIGN LIMITED LIABILITY COMPANY	17 SOUTH ST	CRTK/RPPR
00000079228	KARMA WESTFIELD	40 RIVER RD	CRTK/RPPR
00000079304	ASTON MARTIN SUMMIT	326 MORRIS AVE	CRTK/RPPR
00000079983	N.J.MOLD TESTING AND REMEDIATION,LLC	11 EUCLID AVE 1A	CRTK/RPPR
00000080111	DAVID'S RUG CLEANING INC	22 BRAINERD RD	EXEMPT
00244304879	VERIZON NEW JERSEY, INC. (NJ00879)	544 SPRINGFIELD AVE	CRTK/RPPR
00504000011	JERSEY CENTRAL POWER AND LIGHT	44 - 52 CHATHAM RD	CRTK/RPPR
00585211112	PUBLIC SERVICE ELECTRIC & GAS CO	48 MIDDLE AVE	CRTK/RPPR
12224100000	DOUGLAS VOLKSWAGON OF SUMMIT	491 MORRIS AVE	EXEMPT
12224100001	DOUGLAS AUTO	485 MORRIS AVE	EXEMPT
28760000000	DOUGLAS AUTO	430 MORRIS AVE	CRTK/RPPR
Source: NJDEP Data Miner			

Appendix C: Community Right to Know Sites

Table 25. Community Right to Know Sites, City of Summit, 2024			
PI Number	**Facility Name**	**Physical Address**	**Eligibility**
38392200001	DANNY PETROLEUM LLC	6 RIVER RD	CRTK/RPPR
43469500000	DOUGLAS AUTO	430 MORRIS AVE	EXEMPT
62564600000	M & A AMOCO INC	18 MORRIS & ESSEX TPKE	CRTK/RPPR
66970200001	SALERNO DUANE, INC.	282 BROAD ST	CRTK/RPPR
66970200002	SALERNO DUANE INC	267 BROAD ST	CRTK/RPPR
67254700000	HOSOKAWA MICRON INTERNATIONAL INC	10 CHATHAM RD	CRTK/RPPR
71102100043	NEW JERSEY AMERICAN WATER	GLENSIDE AVE	CRTK/RPPR
88729800000	BROOKSIDE FRIENDLY SERVICE INC	35 SUMMIT AVE	CRTK/RPPR
91740400000	SCOTCH 22 LLC	42 MORRIS TPKE	CRTK/RPPR
92200000000	OVERLOOK MEDICAL CENTER	193 MORRIS AVE	CRTK/RPPR
92658100000	RACEWAY - SUMMIT	36 RIVER RD & CHATHAM RD	CRTK/RPPR
93660800000	NJ FUEL LLC	8-10 ASHWOOD AVE	CRTK/RPPR
Source: NJDEP Data Miner			

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Maps

All maps in the report were produced using the ESRI ArcPro digital mapping software. They were developed using NJDEP Office of Geographic Information Systems (NJOGIS) digital data and New Jersey Geographic Information Network (NJGIN) tax parcel and road network information. The maps are to be used solely for planning purposes and do not take the place of an on-the-ground survey.

- Map 1 (Base Map): City of Summit, Union County, NJOGIS, NJGIN Road Network 2
- Map 2 (Land Use/Land Cover): Map 3 (Impervious Surface) & Map 12 (Wetland): NJDEP Land Use/Land Cover 2020
- Map 4 (Endangered Species Habitats) & Map 5 (Vernal Species): NJDEP Landscape Project version 3.4 (2025)
- Map 6 (HUC 14 Watersheds): 14 Digit Hydrologic Unit Code Delineations for New Jersey (2023)
- Map 7 (Surface Water Quality): Surface Water Quality Classification of New Jersey (2020)
- Map 8 (Bedrock Aquifer):Bedrock Aquifers in New Jersey (Published 1998)
- Map 9 (Surficial Aquifer): Surficial Aquifers of New Jersery (Published 2005)
- Map 10 (Aquifer Recharge): DGS07-1 Aquifer-Recharge Potential for New Jersey (2023)
- Map 11 (Well Head Protection): Well Head Protection Areas For Public Community Water Supply Wells In New Jersey (Published 2018)
- Map 13 (Flood Hazard): FEMA NFHL 2020 of Union County
- Map 14 (Bedrock Geology): Bedrock Geology of New Jersey (2023)
- Map 15 (Surficial Geology): Surficial Geology of New Jersey (Published 2006)
- Map 16 (Topo): Developed from DEP Digital Elevation Model (10m)
- Map 17 (NRCS Soil Types): NRCS Soil Data of New Jersey (2023)
- Map 18 (Known Contaminated Sites): NJDEP Known Contaminated Sites as of April 8, 2025

Executive Summary

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