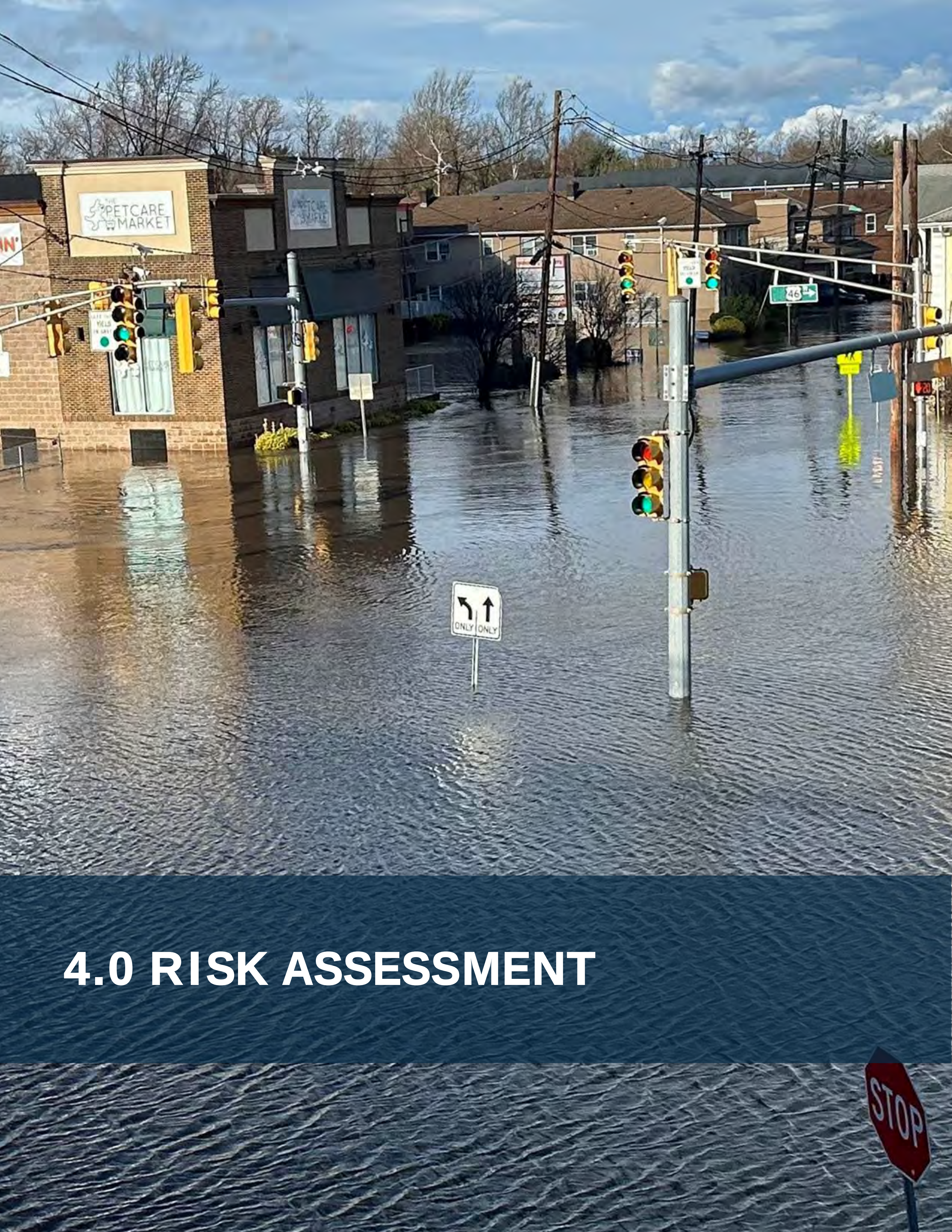


4.0 RISK ASSESSMENT

4.0 RISK ASSESSMENT

4.1 RISK ASSESSMENT OVERVIEW

The 2026 Bergen County hazard mitigation plan includes 12 natural hazards and 4 human-caused hazards. All hazards included in the 2021 Hazard Mitigation Plan were included during this plan update.

Changes to the identified hazard include:

- Separated Extreme Temperatures as a standalone hazard instead of characterized under severe weather, in alignment with the 2024 State Hazard Mitigation Plan;
- Added wave action to the flooding section based on the inclusion of coastal zones on the FEMA preliminary flood insurance rate maps for the county;
- Added pandemic and power failure to human-caused hazard category based on previous disaster declarations.

The final selection of hazards was based on the input from the steering committee, plan participants, and available data.

Table 4.1-1 Hazard Identification Crosswalk

2026 Hazards Profiled	Changes since 2021 plan
Natural Hazards	
Coastal Erosion	Same as Previous Plan
Dam and Levee Failure	Same as Previous Plan
Drought	Same as Previous Plan
Earthquake	Same as Previous Plan
Extreme Temperatures	Became standalone hazard
Flood (riverine, coastal, pluvial, storm surge, wave action)	Added Wave Action
Geological Hazards (landslides and subsidence/sinkholes)	Same as Previous Plan
Hurricane and Tropical Storms	Same as Previous Plan
Nor'easter	Same as Previous Plan
Severe Weather (high winds, tornadoes, thunderstorms, hail)	Removal of extreme temperatures
Winter Storms (snow, blizzards, and ice storms)	Same as Previous Plan
Wildfire	Same as Previous Plan
Human-Based Hazards	
Cyber Attack	Same as Previous Plan
Terrorism	Same as Previous Plan
Pandemic	Added
Power Failure	Added

Major Disaster Declarations

Since 1965, Bergen County has received 30 federal disaster and emergency management declarations. Of these events, 10 have been for Hurricanes, 6 for Severe Storms, and 5 for floods. Additionally, there have been 4 declarations for snowstorm, and 7 covering other causes including water shortage, September 11th, and health emergencies. Since the last HMP, Bergen has received three federal disaster declarations: Covid-19, Tropical Storm Isaias, and Hurricane Ida. These, and historical disaster declarations dating to 1965, are displayed below.

Table 4.1-2 FEMA Major Disaster Declarations in Bergen County

FEMA Disaster No.	Declaration Date	Type of Disaster
DR205	August 1965	Water shortage
DR245	June 1968	Heavy rains, flooding
DR310	September 1971	Heavy rains, flooding
DR477	July 1975	Heavy rains, high winds, hail, tornadoes
EM3083	October 1980	Water shortage

FEMA Disaster No.	Declaration Date	Type of Disaster
DR701	April 1984	Coastal storms, flooding
DR973	December 1992	Coastal storm
EM3106	March 1993	Severe blizzard
DR1088	January 1996	Snow, blizzard
DR1295	September 1999	Hurricane Floyd
EM3148	September 1999	Hurricane Floyd
EM3156	November 2000	Virus threat
EM3169	September 2001	Terrorist attack emergency declaration
EM3181	March 2003	Snowstorm
EM3188	September 2003	Power outage
DR1588	April 19, 2005	Severe storms and flooding
EM3257	September 2005	Hurricane Katrina evacuation
DR1694	April 26, 2007	Severe Storms/Coastal and Inland Flooding
DR1897	April 2, 2010	Severe Storms and Flooding
DR1954	February 4, 2011	Severe Winter Storm and Snowstorm
DR4021	August 31, 2011	Hurricane Irene
DR4048	November 30, 2011	Severe Storm
DR4086	October 30, 2012	Hurricane Sandy
DR4264	March 14, 2016	Severe Winter Storm and Snowstorm
DR4368	June 8, 2018	Severe Winter Storm and Snowstorm
DR4488	March 13, 2020	COVID-19
EM3451	March 25, 2020	COVID-19 Pandemic
DR4574	December 11, 2020	Tropical Storm Isaias
EM3573	September 2, 2021	Remnants of Hurricane Ida
DR4614	September 5, 2021	Remnants of Hurricane Ida

Source: FEMA, 2025

Risk Assessment Methodology

In compliance with 44 CFR § 201.6 the Bergen County Risk Assessment includes the description of the type, location, and extent of all natural hazards that can affect the jurisdiction. The plan must include information on previous occurrences of hazard events and on the probability of future hazard events. In compliance with New Jersey law, this probability of future hazard events includes detailing the impact of climate change on the location, extent, magnitude, and/or impacts of every identified hazard. Vulnerability for this risk assessment is assessed based on state requirements, designed to meet FEMA's requirements as outlined in 44 CFR § 201.6(c)(2). Each hazard includes an assessment of vulnerability to the built environment, including community lifelines; population and the economy, and the environment and natural ecosystems. Growth and future development is captured under population and the economy.

Built Environment

This plan update uses the community lifeline framework created by FEMA. A total of 1,111 lifelines were identified for this update. Participants from the municipalities and special districts verified the type, location, and ownership of each facility that was included in the analysis. All identified facilities, including those under private ownership, were included.

The eight categories of community lifelines are:

- Safety and Security: Law Enforcement, Security, Fire Service, Search and Rescue, Government Service, Community Safety
- Food, Hydration, Shelter: Food, Hydration, Shelter, Agriculture
- Health and Medical: Medical Care, Public Health, Patient Movement, Medical Supply Chain, Fatality Management
- Energy: Power Grid, Fuel
- Communications: Infrastructure, Responder Communications, Alerts, Warnings, and Messages, Finance, 911 and Dispatch
- Transportation: Highway/Roadway/Motor Vehicle, Mass Transit, Railway, Aviation, Maritime
- Hazardous Materials: Facilities, HAZMAT, Pollutants, Contaminants
- Water Systems: Potable Water Infrastructure, Wastewater Management

Table 4.1-3 Summary of Facilities by Community Lifeline Category

	Lifeline Category								
	Safety and Security	Food, Hydration and Shelter	Health and Medical	Energy	Communications	Transportation	Hazardous Materials	Water Systems	Total
Bergen County Total	**640**	**41**	**60**	**41**	**51**	**44**	**9**	**225**	**1,111**

Damage Estimates

This multi-jurisdictional vulnerability assessment was conducted utilizing FEMA National Risk Index data to provide estimates for the potential impact of hazards by using a common, systematic framework for evaluation. In the case of the dam failure hazard, which is not included in the NRI, FEMA's Resilience Analysis and Planning Tool (RAPT) was used to estimate impacts.

National Risk Index (NRI) Methodology

FEMA's National Risk Index dataset and online tool leverages data on natural hazards and community risk factors to develop a baseline risk measurement for 18 natural hazards by County and Census tract (FEMA, n.d.). Expected annual loss (EAL) is the natural hazards component of the National Risk Index; the EAL score and rating represent the average economic loss in dollars resulting from natural hazards each year for a community when compared to all other communities at the same level.

Loss estimates provided in this vulnerability assessment are based on best available data, and the methodologies applied result in an approximation of risk. These estimates should be used to understand relative risk from hazards and potential losses. Uncertainties are inherent in any loss estimation methodology, arising in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from approximations and simplifications that are necessary for a comprehensive analysis (i.e., incomplete inventories, demographics or economic parameters).

Additionally, because NRI data is available at the census tract level, in instances where one or more municipalities were located within the census tract, loss estimates were divided equally between all municipalities regardless of population or building density.

Resilience Analysis and Planning Tool (RAPT) Methodology

FEMA's Resilience Analysis and Planning Tool (RAPT) is a data and GIS mapping tool used to understand community risk. RAPT was used in the dam failure section as a vulnerability analysis of dam failure is not within the scope of the HAZUS or NRI methodologies. RAPT was used to conduct a spatial analysis of each high hazard potential dam to vulnerable populations and critical infrastructure within the planning area. In order to understand the impact of a potential dam failure, RAPT's incident analysis tool was used. The tool allows the user to create a buffer zone (or incident area) around an incident, in this case, dam failure, by setting an incident location. A 5-mile buffer was selected to estimate the at-risk area. The tool identifies critical facilities within the buffer zone. Additionally, the population counter tool was used which provides the estimated number of people with a specific characteristic within a drawn shape, by using the same 5-mile buffer around the dam. Findings for each hazard are detailed in the hazard-by-hazard vulnerability assessment that follows each Hazard Profile.

Population Growth and Development

Socially vulnerable population data is a census-derived dataset on population trends and demographic indicators to help illustrate potential vulnerability in Bergen County communities. Data in Table 4.1-4 was chosen to exemplify populations which may be particularly vulnerable to hazard events, may experience hazards differently, and/or who may require additional support in hazard response or recovery.

Population trends can illustrate potential hazard vulnerability through development pressures on the built environment, or through physical and social impacts of marked population loss. A community with a large share of population under age five may indicate vulnerabilities in hazard response, resource allocation, and evacuation – FEMA identifies that the pediatric population is disproportionately affected during disasters and requires special consideration in categories of anatomy and physiology, psychological, and education vulnerabilities (FEMA, 2022, NLM, 2022). Individuals over age 65 are a growing share of the country's population and often represent the greatest share of deaths from extreme weather events and other natural disasters. A larger share of population over 65 may indicate local vulnerabilities to hazard events both before and after a disaster occurs – these populations may have mobility needs, uneven access to resources, and limited social networks that makes pre-disaster engagement challenging (FEMA, 2023). A community which speaks a language other than English in the home will require more expansive messaging and outreach, and populations living with a disability or without access to a vehicle in the home will have differing evacuation needs than others with greater ease of movement. Populations living in poverty, with limited income or other housing instability, are disproportionately impacted by disasters; more affected by the hazards themselves, losing more when affected, and receiving less support during recovery (World Bank, 2019).

Table 4.1-4 Changes in Social Vulnerability from 2014 to 2023

Indicator of Social Vulnerability	2014-2018	2019-2023
Under 5 Years	5.30%	5.10%
Under 18 Years	21.40%	21.00%
Over 65 Years	16.70%	17.80%
Language Spoken at Home Other than English	39.70%	42.00%
Living with a Disability	8.10%	8.60%
Homeownership Rate	64.40%	65.40%
Housing Units in Multi-Unit Structures	41.40%	40.90%
Median Value of Owner-Occupied Housing Units	$459,200	$593,200
No Vehicles Accessible to Household	8.20%	7.60%
Median Household Income	$95,837	$123,715
Per Capita Mean Income (Past 12 Months)	$48,426	$62,986
Poverty Level	7.00%	6.70%

Hazard Ranking

Ranking hazards helps communities set goals and priorities for mitigation based on their vulnerabilities. A Risk Factor (RF) is a tool used to measure the degree of risk for identified hazards in a particular planning area. RF values were obtained by assigning varying degrees of risk to five categories for each of the hazards profiled. Those categories include *probability*, *impact*, *spatial extent*, *warning time* and *duration*. Each degree of risk was assigned a value ranging from 1 to 4. The weighting factor is shown below. To calculate the RF value for a given hazard, the assigned risk value for each category was multiplied by the weighting factor. The sum of all five categories equals the final RF value, as demonstrated in the example equation:

Risk Factor Value = [(Probability x .30) + (Impact x .30) +
(Spatial Extent x .20) + (Warning Time x .10) + (Duration x .10)]

Hazards identified as high risk have risk factors greater than 2.5. Risk Factors ranging from 2.0 to 2.4 were deemed moderate risk hazards. Hazards with Risk Factors 1.9 and less are considered low risk.

Table 4.1-5 Risk Factors for Hazard Profiles

Risk	Hazard	Risk Assessment Category					Risk Factor
		Probability (1-4)	Impact (1-4)	Spatial Extent (1-4)	Warning Time (1-4)	Duration (1-4)	
High	Flood	3	3	3	3	2	2.9
	Hurricane/Tropical Storms	3	3	3	1	2	2.7
	Nor'easter	3	3	3	1	2	2.7
Moderate	Drought	3	1	4	1	4	2.5
	Pandemic	1	3	4	1	4	2.5
	Extreme Temperature	3	1	4	1	3	2.4
	Dam Failure	2	3	2	4	1	2.4
	Power Failure	3	1	3	3	2	2.3
	Earthquake	1	2	4	4	1	2.2
	Severe Weather- Extreme Wind	3	1	3	3	1	2.2
	Wildfire	2	2	2	3	3	2.2
	Cyber Attack	3	1	2	4	1	2.1
Low	Terrorism	1	3	1	4	1	1.9
	Severe Weather-Tornado	2	2	1	4	1	1.9
	Coastal Erosion	3	1	1	1	1	1.6
	Landslide	2	1	1	4	1	1.6
	Severe Weather-Lightning	2	1	1	3	1	1.5

NATURAL HAZARDS

4.2 COASTAL EROSION

Hazard Description

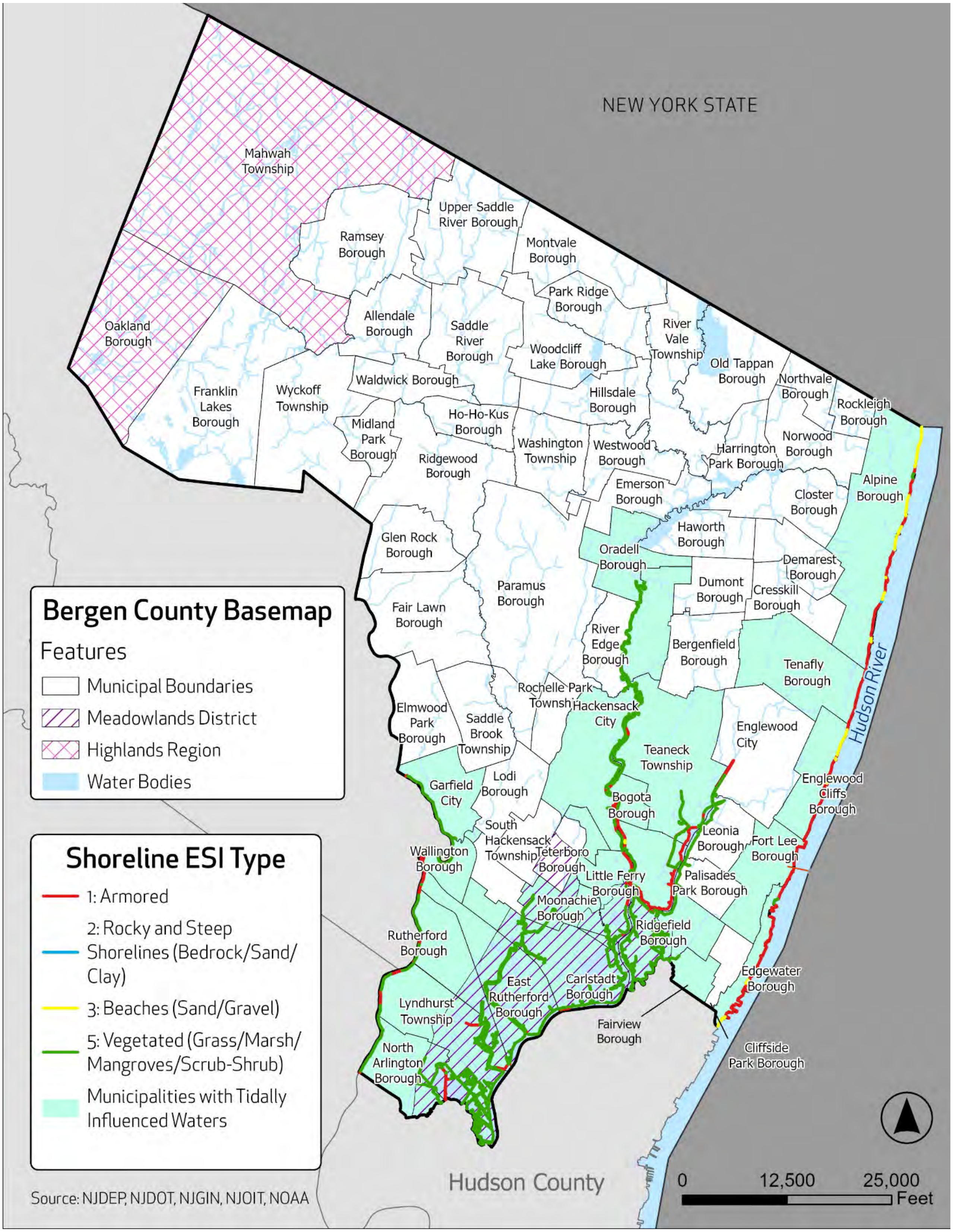
Coastal erosion is a natural process where land wears away resulting in beach, shoreline, or dune loss. It may occur as a result of flooding, hurricanes, or flooding associated with surges spawned by tropical and extratropical systems, and may be long- or short-term in scale. Coastal shorelines change constantly in response to wind, waves, tides, sea-level fluctuation, seasonal and climatic variations, human alteration, and other factors that influence the movement of sand and material within a shoreline system. Coastal erosion can occur rapidly during storm events, and may cause damage and potential danger to buildings, infrastructure, and populations. Many natural factors affect erosion of the shoreline, including shore and nearshore morphology, shoreline orientation, and how these factors respond to storm frequency and sea level rise.

Location, Extent and Magnitude

Bergen County has some susceptibility to coastal erosion along the tidally influenced shorelines. However, it is not a significant risk compared to other areas of New Jersey that have development along the Atlantic Oceanfront. In order to assess the location of shoreline potentially at-risk from coastal erosion within Bergen County, NOAA's environmental sensitivity index (ESI) was used. There are five main different types of shoreline in Bergen County. Armored (1) is the least vulnerable to erosion, followed by Rocky and Steep Shorelines (2). Beaches (3), Flats (4) and Vegetated (5) shorelines follow. Of the shoreline types in the county, these are the most sensitive to coastal erosion. Shorelines can also be a combination of categories. This data is used as a surrogate for direction erosion susceptibility.

A GIS analysis was run to calculate the total shoreline of each type within each municipality. **Figure 4.2-1** presents **Total Shoreline by Environmental Sensitivity Index (ESI) Category by Municipality**. About 76% of the total shoreline of Bergen County is considered environmentally sensitive for the purposes of this analysis (ESI of 3 or above). Lyndhurst Township had the highest amount of environmentally sensitive shoreline at 109,107.8 feet total, followed by Ridgefield Borough at 81,307 feet.

Figure 4.2-1 Bergen County Tidal Shoreline by ESI Category



Previous Occurrences and Losses

As previously mentioned, coastal erosion can occur gradually due to natural processes or from episodic events like hurricanes, Nor'easters, and tropical storms. A review of the NOAA NCEI Storm Events Database from 1950 to December 2024 yields instances of coastal flooding, high surf, hurricane, storm surge/tide, tropical depression, or tropical storm that would lead to instance of coastal erosion. The State HMP reports 24 instances of coastal erosion affecting New Jersey from 1962 to 2024. Many of these events were statewide and would presumably impact Bergen County.

Probability of Future Occurrences

In Bergen County, as has been predicted throughout coastal New Jersey, coastal erosion will continue to be an on-going hazard of concern. It is difficult to assign a probability to the ongoing small-scale erosion that may occur over a continuous period. However, a probability can be assigned to larger storm events such as nor'easters and hurricanes, which can result in significant, rapid coastal erosion and are certain to impact Bergen County in the future. Coastal erosion remains a natural, dynamic and continuous process for Bergen County's coastal jurisdictions and its probability of occurrence is certain. The damaging impacts of coastal erosion are lessened through continuous (and costly) structural shoreline protection measures.

Potential Effects of Climate Change

New Jersey's 2020 Scientific Report on Climate Change reported that the state should expect more frequent and intense precipitation events and sea level rise at a rate greater than the global average (NJDEP, 2020). Each of these predictions supports a higher potential occurrence of-- and resulting impact of—coastal erosion, making it likely that the impacts of coastal erosion will increase in severity due to future episodic storm events as well as the anticipated slow onset, long-term effects of climate change and sea level rise.

Vulnerability Assessment

Built Environment, Infrastructure and Community Lifelines

Average annual building damages directly attributable to the erosion hazard are considered to be negligible for the purposes of this risk assessment, assuming that ongoing nourishment and shoreline stabilization practices are expected to be maintained, implemented on an ongoing basis, and encouraged to continue.

Population and Economy

Death and injury are not typically associated with coastal erosion, as erosive processes along the coast occur over long durations during which people in the affected areas have sufficient time to evacuate. Erosion can negatively impact the local economies of communities that rely on the financial benefits of their coastal tourism.

Ecosystems and Natural Assets

Beaches, shorelines and wetlands and other coastal ecosystems are an important natural resource for Bergen County. They help protect the coast from storms and flooding, provide habitat for birds, small mammals, reptiles, amphibians, and insects. Coastal erosion can impact a variety of natural systems including beaches, wetlands, marshes, and coastal habitats, degrading their natural functions through loss of land, and conversion to open water areas. Additionally, shoreline hardening, while preventing erosion, can also have a negative impact on natural systems.

4.3 DAM FAILURE

Hazard Description

A dam is an artificial barrier with the ability to store water, wastewater, or liquid-borne materials for reasons including flood control, human or livestock water supply, irrigation, energy generation, containment of mine tailings, recreation, or pollution control.[1] Dam failures typically occur when spillway capacity is inadequate and excess water flow overtops the dam, or when internal erosion through the dam or foundation occurs. Complete failure occurs if internal erosion or overtopping results in a complete structural breach, releasing a high-velocity wall of debris-filled waters that rush downstream damaging and/or destroying anything in its path.[2]

Location, Extent and Magnitude

Location

NJDEP's Bureau of Dam Safety and Flood Control maintains a Dams Database for the state. The Bureau has identified and classified 70 state-regulated dams and eight other structures located within Bergen County. NJDEP classifies "other structures" as dams that are less than five feet, have been removed, never built, or failed. Of the 70 dams, seven dams have been classified as having "High Hazard Potential," meaning their failure may cause the probable loss of life or extensive property damage. This list includes the highest risk dams.

Of the 70 dams, ten dams have been classified as having "Significant Hazard Potential," meaning their failure may cause significant damage to property and project operation, but loss of human life is not envisioned. This classification applies to predominantly rural, agricultural areas, where dam failure may damage isolated homes, major highways or railroads or cause interruption of service of relatively important public utilities. The remaining 53 dams are classified as "low hazard potential" meaning their failure would cause loss of the dam itself but little or no additional damage to other property. It is important to note that dam hazard classification is based on the consequences of dam failure-not the condition, probability or risk of failure itself.

NJDEP's list is available in **Table 4.3-1 State-Regulated Dams and Other Structures in Bergen County**. Specific locations for all state-regulated dams that have been geo-referenced for mapping purposes are illustrated in **Figure 4.3-1 State-Regulated Dams and Other Structures in Bergen County.**

[2] FEMA. 1996. FEMA's Multi-Hazard Identification and Risk Assessment (MHIRA). On-Line Address: http://www.fema.gov/media-library/assets/documents/7251?id=2214

Figure 4.3-1 State-Regulated Dams and Other Structures in Bergen County

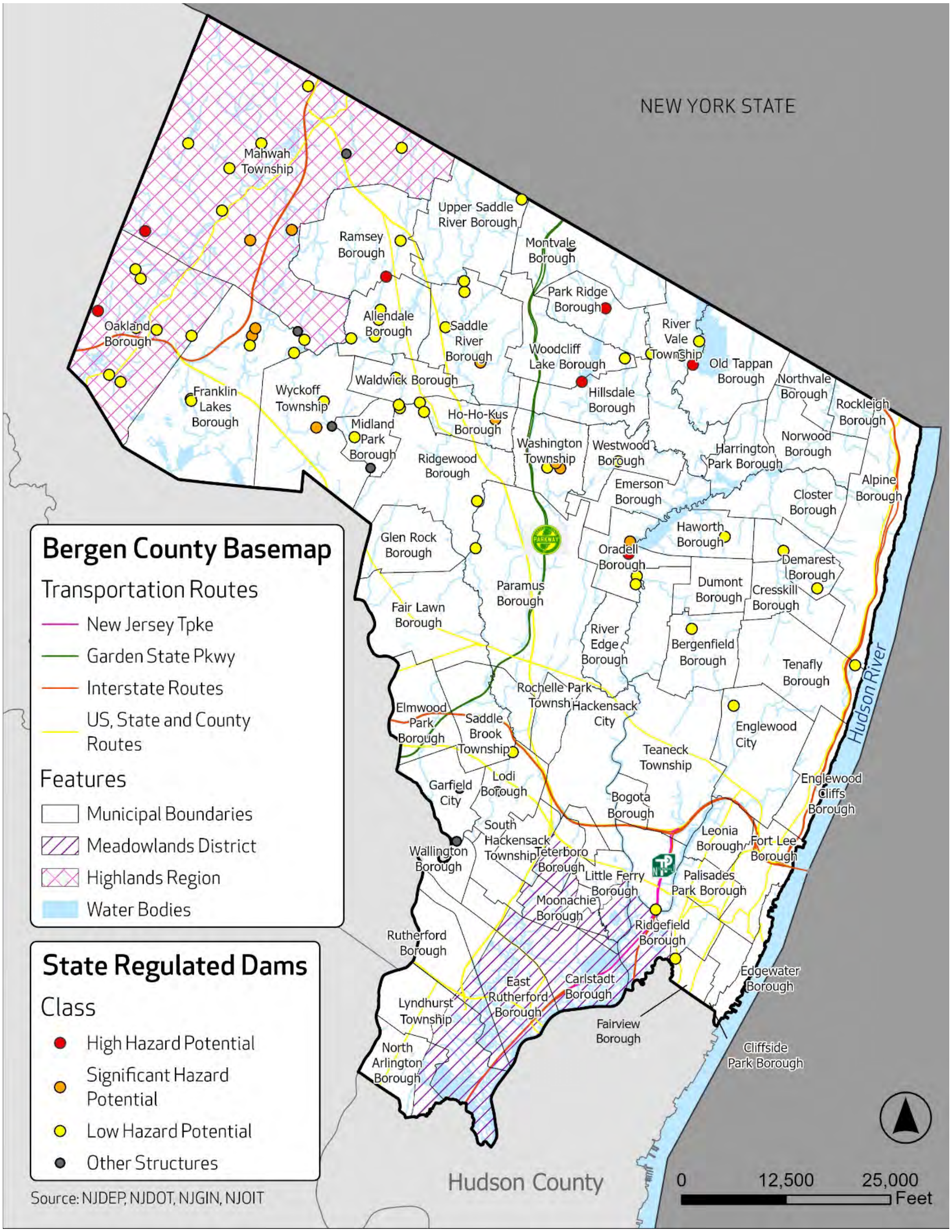


Table 4.3-1 State-Regulated Dams and Other Structures in Bergen County

Jurisdiction	Total High Hazard Dams	Total Significant Hazard Dams	Total Low Hazard Dams	Overall Total	Other Structures
Allendale Borough	0	0	4	**4**	0
Bergenfield Borough	0	0	1	**1**	0
Demarest Borough	0	0	2	**2**	0
Englewood City	0	0	1	**1**	0
Fairview Borough	0	0	1	**1**	0
Franklin Lakes Borough	0	2	5	**8**	1
Garfield City	0	0	0	**2**	2
Haworth Borough	0	0	1	**1**	0
Hillsdale Borough	1	0	0	**1**	0
Ho-ho-Kus Borough	0	1	2	**3**	0
Lodi Borough	0	0	0	**1**	1
Mahwah Township	1	2	6	**10**	1
Midland Park Borough	0	0	1	**2**	1
Montvale Borough	0	0	0	**1**	1
Oakland Borough	1	0	7	**8**	0
Old Tappan Borough	1	0	0	**1**	0
Oradell Borough	1	1	2	**4**	0
Paramus Borough	0	0	1	**1**	0
Park Ridge Borough	1	0	0	**1**	0
Ramsey Borough	1	0	1	**3**	0
Ridgefield Borough	0	0	1	**1**	0
Ridgewood Village	0	0	3	**3**	0
River Vale Township	0	0	3	**3**	0
Saddle Brook Township	0	0	1	**1**	0
Saddle River Borough	0	1	3	**4**	0
Tenafly Borough	0	0	1	**1**	0
Upper Saddle River Borough	0	0	1	**1**	0
Waldwick Borough	0	0	1	**1**	0
Washington Township	0	2	1	**3**	0
Westwood Borough	0	0	1	**1**	0
Woodcliff Lake Borough	0	0	1	**1**	0
Wyckoff Township	0	1	1	**3**	1
Bergen County Total	**7**	**10**	**53**	**70**	**8**

SOURCE: NJDEP 2024

Extent and Magnitude

The extent or magnitude of a dam failure event can be measured in terms of the classification of the dam. The NJDEP assigns one of four hazard classifications to state-regulated dams in New Jersey. The classifications relate to the potential for property damage and/or loss of life in the event of a dam failure:

- Class I (High Hazard Potential) - Failure of the dam may result in probable loss of life and/or extensive property damage.
- Class II (Significant Hazard Potential) - Failure of the dam may result in significant property damage; however, loss of life is not envisioned.
- Class III (Low Hazard Potential) - Failure of the dam is not expected to result in loss of life and/or significant property damage.
- Class IV (Small Dam Low-Hazard Potential) - Failure of the dam is not expected to result in loss of life or significant property damage.

Table 4.3-2 State Regulated Dams with High or Significant Hazard Potential lists information for all state-regulated dams in Bergen County reported as having high (H) hazard potential or significant (S) hazard potential. The municipalities with High Hazard Potential dams created mitigation actions to mitigate dam failure (see Appendix V. I – Jurisdictional Information).

Table 4.3-2 State-Regulated Dams with High Hazard Potential

Jurisdiction	Dam Name	Hazard Potential	River/Stream
Hillsdale Borough	Woodcliff Lake Dam	H	Pascack Brook
Mahwah Township	Lake Vreeland Dam	H	Fox Brook
Oakland Borough	Ramapo Lake Dam	H	Ramapo Lake Brook
Old Tappan Borough	Lake Tappan Dam	H	Hackensack River
Oradell Borough	Oradell Reservoir Dam	H	Hackensack River
Park Ridge Borough	Mill Pond Dam	H	Pascack Brook
Ramsey Borough	Crystal Spring Lake Dam	H	Ramsey Brook

Source: New Jersey Department of Environmental Protection, Bureau of Dam Safety and Flood Control

There are additional dams located within the County parks, which include Lake Tamarack Dam (Oakland Borough), Lake Todd (Oakland Borough), McMillian Reservoir Dam (Mahwah Township), Campgaw Mountain Dam (Mahwah Township), Wood Dale Park Dam, (Woodcliff Borough), Wild Duck Pond Dam (Ridgewood Village), and Dahnert's Lake Dam (Garfield)- all owned by the County. South and North Intake Dam (Oradell Borough), Bear Swamp Lake Dam (Mahwah Township), and Saddle River Diversion Dam (Paramus Borough) are also in the County parks and are owned by SUEZ Water, with the exception of Bear Swamp Lake Dam, which is owned by Division of Parks/Forestry.

Previous Occurrences and Losses

Based on all sources researched, Bergen County has not been included in any FEMA disaster declarations directly related to dam or levee failure events since the record of disaster declaration began in 1953. There have been no major dam or levee failure events in Bergen County. In October of 2021, a small privately owned dam located on Cresskill Brook in Demarest was damaged by a nor'easter. Local officials in neighboring Cresskill Borough reported that the event contributed to flooding in Cresskill, worsening the impacts of the nor'easter.

Probability of Future Occurrences

Dam failures are rare and hard to forecast future occurrence, however they normally coincide with events that cause them such as earthquakes, landslides, and excessive rainfall and snowmelt. Dam failures in New Jersey are often caused by heavy rains or other precipitation. The probability of dam failure in Bergen County is low (State HMP).

Potential Effects of Climate Change

As described in the State HMP, dams are designed partly based on assumptions about a river's flow behavior, expressed as hydrographs. Changes in weather patterns can have significant effects on the hydrograph used for the design of a dam. If the hygrograph changes, it is conceivable that the dam can lose some or its entire designed margin of safety, also known as freeboard. Loss of designed margin of safety may cause floodwaters to more readily overtop the dam or create unintended loads. Such situations could lead to a dam failure (State HMP).

Northern New Jersey has become wetter over the past century. Northern New Jersey's 1971-2000 precipitation average was over 5" (12%) greater than the average from 1895-1970[3]. Changes in climate may lead to higher intensity rainfall events. As a result, the failure probability of low, significant, and under-designed high hazard dams may increase (State HMP).

Vulnerability Assessment

Dams can fail with little warning. Intense storms may produce a flood in a few hours or even minutes for upstream locations. Flash floods can occur within six hours of the beginning of heavy rainfall, and dam failure may occur within hours of the first signs of breaching. Other failures and breaches can take much longer to occur, from days to weeks, as a result of debris jams, the accumulation of melting snow, buildup of water pressure on a dam with deficiencies after days of heavy rain, etc. Flooding can occur when a dam operator releases excess water downstream to relieve pressure from the dam.

Dam failure can cause severe downstream flooding, depending on the magnitude of the failure. Other potential secondary hazards of dam failure are landslides around the reservoir perimeter, bank erosion on the rivers, and destruction of downstream habitat. Dam failures can occur as a result of structural failures, such as progressive erosion of an embankment or overtopping and breaching by a severe flood (State HMP). Earthquakes may weaken dams. Floods caused by dam failures have caused loss of life and property damage. Dam and levee failures may also cause the release of hazardous materials into the environment when floodwaters infiltrate development and infrastructure. This may lead to widespread contamination resulting in costly remediation.

All assets located in a dam failure inundation zone could be exposed to the risk of a dam failure. The potential for loss of life is affected by the capacity and number of evacuation routes available to populations living in areas of potential inundation. Vulnerable populations are all populations downstream from dam failures that are incapable of escaping the area within the needed timeframe. This population includes the elderly and young who may be unable to get themselves out of the inundation area. Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions to evacuate based on the net economic impact to their family. The population over the age of 65 is also highly vulnerable because they are more likely to seek or need medical attention, which may not be available because of isolation during a flood event and difficulties in evacuating (State HMP).

There is often limited warning time for a dam failure event. While dam failure is rare, when events do occur, they are frequently associated with other natural hazard events such as earthquakes, landslides, or severe weather, which limits

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[3] Rutgers University. 2013. "New Jersey Climate Change Trends and Projection Summary." On-Line Address: http://www.sustainablejersey.com/fileadmin/media/Media___Publications/Publications/2011-09-26_SJ_CATF_CC_Impacts_Summary_final.pdf

their predictability and compounds the hazard. Populations without adequate warning of the event from a television or radio emergency warning system are highly vulnerable to this hazard.[4]

Dam and levee failure inundation maps and downstream hazard areas are considered sensitive information and are not made available within the Bergen County HMP. To approximate and assess vulnerability to dam failure in Bergen County, the Planning Team used FEMA's online Resilience Analysis and Planning Tool (RAPT) to conduct a spatial analysis of each high hazard dam to vulnerable populations and critical infrastructure within the planning area. In order to assess the impact of a potential dam failure, RAPT's incident analysis tool was used. The tool allows the user to create a buffer zone (or incident area) around an incident, in this case, dam failure, by setting an incident location. A five-mile buffer was selected to estimate the at-risk area. The tool identifies critical facilities within the buffer zone. Additionally, the population counter tool was used which provides the estimated number of people with a specific characteristic within a drawn shape, by using the same 5-mile buffer around the dam.

The table below summarizes the RAPT vulnerability assessment of all seven high hazard dams within the County. As shown in the table, Oradell Reservoir Dam has the most significant impact to People at Risk (PAR) and critical infrastructure in the county followed by Woodcliff Lake Dam and Mill Pond Dam.

Table 4.3-3 Populations At Risk (PAR) and Critical Infrastructure Within a 5-Mile Radius of High Hazard Dam

Dam Name	Total Population	Population 65+	Population with a Disability	Population Below Poverty Line	Population Living in Mobile Homes	Critical Facilities
Crystal Spring Lake Dam	168,156	30,377	12,949	6,979	537	267
Lake Tappan Dam	178,935	35,186	14,755	7,670	76	272
Lake Vreeland Dam	77,330	14,932	6,844	2,757	805	102
Mill Pond Dam	195,611	36,034	16,214	11,344	118	315
Oradell Reservoir Dam	343,372	62,721	27,419	18,303	618	597
Ramapo Lake Dam	92,959	17,607	8,206	4,369	717	132
Woodcliff Lake Dam	208,352	38,951	16,054	7,745	103	326

Source: FEMA RAPT, 2025

[4] Ibid.

4.4 DROUGHT

Hazard Description

Drought is a period typically characterized by long durations of below-normal precipitation. However, drought can also present as “flash” events which impact areas within months and weeks during warmer seasons. Drought is a temporary irregularity, and differs from aridity as the latter is restricted to low rainfall regions and is a permanent feature of climate. Drought conditions occur in virtually all climatic zones, yet characteristics of drought vary significantly from one region to another, as defining ‘drought’ is relative to the normal precipitation in that region. Drought can affect agriculture, water supply, aquatic ecology, wildlife, and plant life, causing far-reaching impacts on economic, environmental, and social systems.

Location, Extent and Magnitude

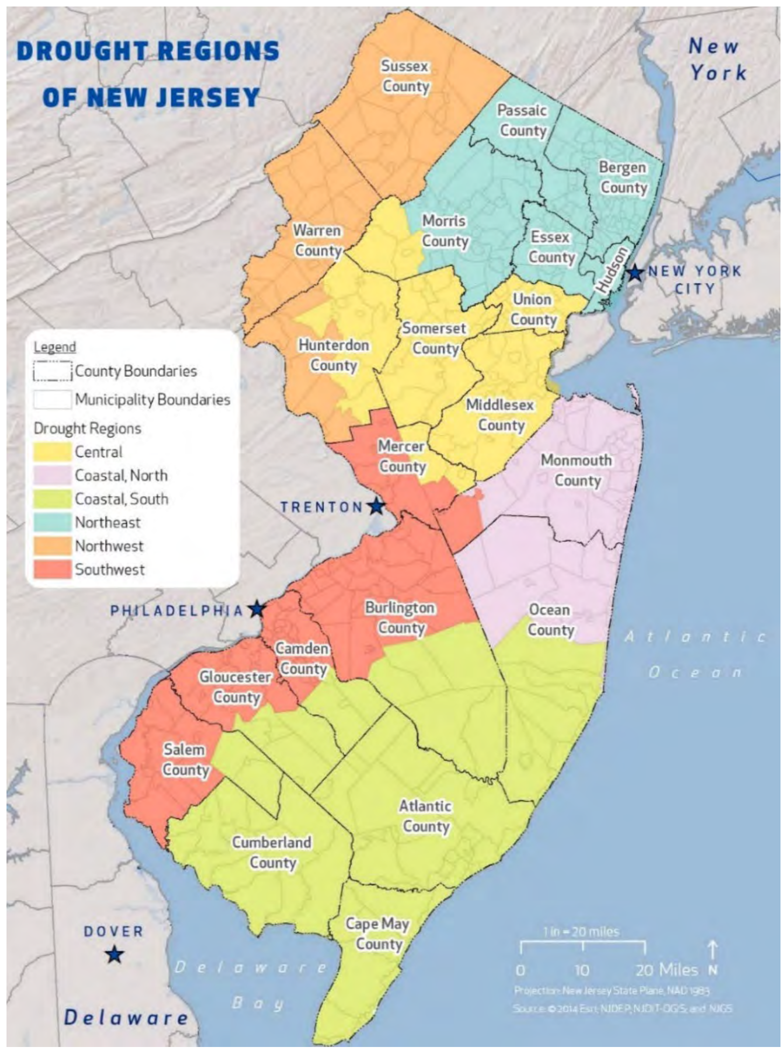
Location

Droughts occur in all parts of the county at any time of year, depending on temperature and precipitation over time. While arid regions of the United States are more susceptible to long-term or extreme drought conditions, other areas, including Bergen County, tend to be more susceptible to short-term, less severe drought.

For drought monitoring and preparedness purposes, New Jersey is divided into 6 drought regions. Bergen County is in the Northeast Drought Region. Municipalities in Bergen County are equally likely to be impacted by drought conditions.

The regions were created by New Jersey Department of Environmental Protection to respond to changing conditions in one region without imposing constraints in areas not experiencing a water shortage. The regions generally follow natural watershed boundaries and account for regional similarities in climate and water supply sources, among other things.

Figure 4.4-1 Drought Regions of New Jersey



Source: NJSHMP 2024

Extent and Magnitude

Drought is not an acute hazard, it is a condition created over time based on rainfall, water use, and The extent (i.e., magnitude or severity) of drought can depend on the duration, intensity, geographic range, and the regional water supply demands made by human activities and local vegetation. Drought in New Jersey is monitored by the Department of Environmental Protection using a number of indicators. The intensity of the impact from drought could be minor to extreme damage in a localized area or regional damage affecting human health and the economy.

The Palmer Drought Severity Index (PDSI) is one of many available drought indices used to assess the extent of a drought event (see **Table 4.4-1 PDSI Classification**).[5] The PDSI attempts to measure the duration and intensity of the long-term drought-inducing circulation patterns. Long-term drought is cumulative, so the intensity of drought during the current month is dependent on the current weather patterns plus the cumulative patterns of previous months. Since weather patterns can change almost overnight from a long-term drought pattern to a long-term wet pattern, the PDSI can respond fairly rapidly.[6]

The PDSI has become the semi-official drought index, and is an important tool for evaluating the scope, severity, and frequency of prolonged periods of abnormally dry or wet weather. PDSI drought classifications are based on observed drought conditions and will range from -0.5 (incipient dry spell) to -4.0 (extreme drought). The PDSI also reflects excess precipitation using positive numbers. The PDSI is the most effective in determining long-term droughts; but has limitations in terms of use for short-term forecasts.

Table 4.4-1 PDSI Classifications

Palmer Classifications	Description
4.0 or more	Extremely wet
3.0 to 3.99	Very wet
2.0 to 2.99	Moderately wet
1.0 to 1.99	Slightly wet
0.5 to 0.99	Incipient wet spell
0.49 to -0.49	Near normal
-0.5 to -0.99	Incipient dry spell
-1.0 to -1.99	Mild drought
-2.0 to -2.99	Moderate drought
-3.0 to -3.99	Severe drought

Source: National Drought Mitigation Center (NDMC) 2013

To improve monitoring and measurement of drought severity from region to region within the State of New Jersey, NJDEP implemented a unique set of indices in January 2001 specifically designed for the particular characteristics and needs of the State. This new set of statewide indicators supplements the PDSI with the measurement of regional precipitation, streamflow, reservoir levels, and groundwater levels. New Jersey currently measures the status of each indicator as near or above normal, moderately dry, severely dry, or extremely dry. The status is based on a statistical analysis of historical values with generally the driest 10% being classified as extremely dry, from 10% to 30% as severely dry, and 30% to 50% as moderately dry.

[5] "New Jersey Drought Summary." Northeast Regional Climate Center, Cornell University. www.nrcc.cornell.edu/drought/NJ_pdsi_smry.html
[6] NOAA National Climatic Data Center, http://www.ncdc.noaa.gov/oa/climate/research/prelim/drought/palmer.html

Previous Occurrences and Losses

Droughts of varying intensity occur several times a decade in New Jersey. However, Bergen County has never received a disaster or federal emergency management declaration for drought. Events of significance are noted in **Table 4.4-2 Historical Occurrences of Drought in Bergen County.**

Table 4.4-2 Historical Occurrences of Drought in Bergen County

Date(s) of Event	Counties Affected	Description
May 1929 to October 1,1932	Statewide	The drought was the second-most severe drought in New Jersey history. This regional drought affected most states in the Northeast. Stream flow deficits at gaging stations where data were analyzed had recurrence intervals greater than 25 years. In the Delaware River, the decreased volume of freshwater flow enabled saline water to move upriver from the Delaware Bay to the Camden area and endanger freshwater supplies.
February 1949 to October 1,1950	Hackensack and Passaic Rivers	The drought was much less widespread than the 1929 to 1932 drought. This drought was most severe in northeastern New Jersey, where it had a recurrence interval greater than 10 years. The driest June on record at most gaging stations throughout New Jersey was in 1949. The average statewide precipitation for the month was 0.2 inch, which was 3.6 inches less than normal.
May 1953 to July 1955	Statewide	The drought had recurrence intervals of about 15 years in northern and southern New Jersey, and five to 25 years in the south-central part of the State. Crop yields were decreased because the drought began in May.
June 1961 to August 1, 1966	Statewide	This event was the longest and most severe of the five previous droughts. Stream flow deficits were greatest in northern New Jersey, which had a recurrence interval exceeding 50 years. In the rest of the State, the recurrence interval ranged from 25 to 50 years. The recurrence interval of the stream flow deficit for the main-stem Delaware River was estimated to be much greater than 100 years. Water conservation was widely practiced, and a State of Emergency was declared by the governor on June 12, 1965, for most of northeastern New Jersey. On July 12, 1965, the Delaware River Basin Commission declared a drought emergency and decreased diversions by New York City and New Jersey from the Delaware River Basin. In August 1965, the President declared the Delaware River Basin a Federal drought-disaster area.
June 1980 to April 1981	Statewide	The drought was nearly statewide and had recurrence intervals that ranged from 10 to 25 years except in a few isolated areas. A ban on nonessential water use for 372 municipalities was ordered by the governor in January 1981. Boonton Reservoir, completed in 1904, had record-low water levels at the end of January 1981.
July 1984 to August 1, 1985	Statewide	The drought had a recurrence interval that ranged from 10 to 20 years in the northern and east-central parts of the State and from four to nine years in the north-central and southwestern parts. On January 23, 1985, the Delaware River Basin Commission declared the basin to be in a drought-warning condition. On April 17, 1985, the governor declared a State of Emergency for 93 municipalities in northeastern New Jersey.
November 2001	Statewide	The combined storage in the 13 major water supply reservoirs serving northeast New Jersey was 35.3 billion gallons, which was 43.9% capacity. This storage was 4.7 billion gallons less than one month prior and 23.4 billion gallons less than one year prior. Sussex and Atlantic County shallow wells were drying up while permits for deeper wells were increasing. Twenty-five residents in Wawayanda (Sussex County) ran out of water. Winter crops such as rye and grasses were struggling. On a county weighted average, monthly precipitation totals ranged from 0.7 inches in Cape May County to 1.2 inches in Sussex and Warren Counties. All were less than 31% normal.
January - February 2002	Statewide	Northern New Jersey reservoirs were at 42.9% of capacity rather than typical 80% capacity. Issues of saltwater intrusion and corrosion became an issue for industries. Water treatment costs for municipalities that depend on the river for their water supply became an issue. Precipitation was 50% of normal. The combined storage of three major reservoirs serving northeast New Jersey was at 44% capacity, or 36% below normal. In February, dry weather continued, the stream flow and groundwater levels dropped reducing levels in the New York State reservoirs. This forced the NJDEP to continue the drought warning for all New Jersey counties except Union, Middlesex and Somerset Counties. Unseasonably dry weather in February exacerbated the drought and forced several individual counties to declare water emergencies, especially in the northeast. Four northern New Jersey reservoirs remained at 43% capacity, half the normal level.

Date(s) of Event	Counties Affected	Description
August – September 2002	Statewide	The majority of the streams monitored had stream-flows in the 10 to 24 percentiles, which was well below normal. The combined storage in the 13 major reservoirs serving Northeast New Jersey was 67.7% capacity, which was 10% to 15% below normal. Capacities of reservoirs on September 30 were the following: Newark Reservoirs at 55.0% (percent capacity) Jersey City Reservoirs at 62.5%, North Jersey District at 67.6%, and United Water of New Jersey at 61.8%
October 2002	Statewide	Many New Jersey farmers suffered losses of 50% or more, notably in commodities such as corn and soybean. Combined farming losses approximately $125 million.
May to July 2006	Statewide	A statewide drought watch was declared on May 8, 2006. Significant precipitation in June led to lifting the drought watch on July 3, 2006.
August to October 2010	Statewide	On August 5, the NJDEP issued a drought watch for northeast New Jersey including Morris County. On a statewide average, August 2010 was the 15th driest August on record (dating back to 1895) with 2.37 inches of rain. The meteorological summer was the 10th driest (8.65 inches) on record dating back to 1895 in New Jersey and was also the driest summer since 1966. At the Atlantic City International Airport, it was the fourth driest August (1.09 inches) and fifth driest meteorological summer (5.92 inches) on record. In Trenton, it was the third driest August (0.80 inches) and fifth driest meteorological summer (5.90 inches) on record.
September 2015 to March 2016	Statewide	A drought watch was issued that impacted more than two-thirds of New Jersey's Population.
October 2016 to April 2017	Bergen, Essex, Hudson, Hunterdon, Mercer, Middlesex, Monmouth, Morris, Ocean, Passaic, Somerset, Sussex, Union and Warren Counties	Drought conditions were the worst faced by New Jersey in 14 years.
July to December 2022	Statewide	A statewide Drought Watch was instituted from early August to late December. September was the most severe month, as 67 percent of the state was under moderate drought conditions and an additional 29 percent were under severe drought conditions during the first two weeks of the month
June 2024 to continuing	Statewide	A record dry spell led to driest conditions the State has had in 120 years, with the southern half of the State experiencing the worst conditions. Bergen County has been classified as experiencing moderate drought with about 6 inches of rain below normal. As of Spring 2025, conditions are improving with the southern part of the county now categorized as "abnormally dry" rather than moderate drought.

Source: NJSHMP 2024, NJDEP; NRCC, 2013; Hardison 1968; NJDEP 1983; NOAA-NCDC 2017, New Jersey Drought Periods. Northeast Regional Climate Center, Cornell University, 2014. www.nrcc.cornell.edu/drought/NJ_drought_periods.html

Probability of Future Occurrences

Based upon risk factors for past occurrences, it is likely that droughts can occur across New Jersey in the future. In addition, as projected temperatures increase, the probability for future droughts will likely increase as well. Therefore, it is likely that droughts will occur in New Jersey of varied severity in the future[7].

Potential Effects of Climate Change

Northern New Jersey has become wetter over the past century. Northern New Jersey's 1971-2000 precipitation average was over 5" (12%) greater than the average from 1895-1970. Southern New Jersey became 2" (5%) wetter late in the 20th century.[8]

[7] Michael Baker International. 2019. State of New Jersey 2019 All Hazards Mitigation Plan.
[8] Rutgers University. 2013. "New Jersey Climate Change Trends and Projection Summary." On-Line Address: http://www.sustainablejersey.com/fileadmin/media/Media___Publications/Publications/2011-09-26_SJ_CATF_CC_Impacts_Summary_final.pdf

However, research from scientists at Rutgers University indicate that while heavy precipitation events are to increase with changing climate conditions, longer dry spells are also predicted to occur.[9]

Vulnerability Assessment

Because drought impacts large areas and crosses jurisdictional boundaries, all existing and future buildings, facilities and populations are considered to be exposed to this hazard and could potentially be impacted.

Built Environment, Infrastructure and Community Lifelines
Although drought typically has negligible impact on building stock and infrastructure, it can present a challenge to community lifelines. Water supply in the county is serviced by public water systems that use groundwater wells, local surface water supplies, and purchased surface water from other parts of the State. The New Jersey Drought Emergency Plan, prepared by the New Jersey Departments of Law and Public Safety and Environmental Protection, fully identifies authority, organization, concept of operations, and responsibilities for any drought emergency and is used as needed in response to potential drought situations. Drought status information is maintained at http://njdrought.org. Drought emergencies are implemented when drought begins to affect residents and businesses.

When emergencies are declared, all residents, including those with private wells, are urged to adhere to mandatory restrictions such as limiting or eliminating lawn watering, driveway washing, and car washing. Often, non-essential business use may be restricted. When waterways approach historic low flows, groundwater supplies may also be affected.

Population and the Economy
Water is integral to our ability to produce goods and provide services, so drought can produce a range of impacts that span many economic sectors and reach beyond an area experiencing physical drought. Direct impacts of drought include reduced crop yield, increased fire hazard, reduced water levels, and damage to wildlife and fish habitat. The consequences of these impacts illustrate indirect impacts that include reduction in crop, rangeland, and forest productivity that may result in reduced income for farmers and agribusiness, increased prices for food and timber, unemployment, reduced tax revenues due to reduced expenditures, increased crime, foreclosures, migration, and disaster relief programs.

The USDA 2017 Census of Agriculture for Bergen County was used to analyze the exposure of Bergen County crops to drought. There are 73 farms operating in Bergen County, with 771 acres of farmland operated (about 0.5% of county land. The total market value of agricultural products sold in Bergen County was $10,610,000 as of the 2022 Census of Agriculture. It was assumed that the exposure of crops was equal to the total value of crops sold ($10,610,000).[10] Using the Agriculture EAL Rate provided by FEMA's NRI of $1 per $74.88 of agriculture value, the expected annual loss to the county from Drought is $141,693.38.

Ecosystems and Natural Assets
Long periods without precipitation can alter the delicate balance of ecosystems. Examples of drought impacts to ecological systems may include reduced plant growth, local species reduction or extinction, and landscape-level transitions. Drought impacts to ecological systems may diminish the resources and services provided by those systems, including water filtration and quality, wildlife habitat, and sufficient water levels for recreation, tourism, and preponderance of aquatic species. High temperatures, high winds, and low humidity can worsen drought conditions and also make areas more susceptible to wildfire. The vulnerability of natural systems to withstand or adapt to drought disturbances depends on the sensitivity of the system, exposure to the hazard, and capacity to adapt and recover.

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[9] Broccoli, A.J. 2019. The Raritan Region's Climate Future [conference PowerPoint]. http://raritan.rutgers.edu/wp-content/uploads/2019/06/Broccoli_climate_change_Raritan_June_2019.pdf.
[10] United States Department of Agriculture (USDA) National Agricultural Statistics Service. 2017 Census of Agriculture. https://www.nass.usda.gov/Quick_Stats/CDQT/chapter/2/table/1/state/NJ/county/003

4.5 EARTHQUAKE

Hazard Description

An earthquake refers to a sudden slipping or movement of a portion of the earth's crust, accompanied and followed by a series of vibrations. An earthquake occurs below the earth's surface along a fault, this is referred to as the *epicenter.* Once fault slippage begins, it expands along the fault during the earthquake and can extend hundreds of miles before stopping. Damage from an earthquake can occur miles from the initial movement on the fault line. Vibrations that travel outward from the earthquake fault at speeds of several miles per second, referred to as seismic waves, cause most of the destruction during earthquakes. After a rupture occurs, there may be additional earthquakes in the hours, days, even months after the main earthquake. These *aftershocks* usually are a similar or lesser intensity.

Earthquakes can cause large and sometimes disastrous landslides and mudslides. Any steep slope is vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. Earthquakes can also cause dam failures. The most common mode of earthquake-induced dam failure is slumping or settlement of earth-fill dams where the fill has not been property compacted. If the slumping occurs when the dam is full, then overtopping of the dam, with rapid erosion leading to dam failure is possible. Overall, earthquake events may trigger landslides, mudslides, slope failure, dam failures, and tsunamis. For more information on the secondary and environmental effects of earthquakes, please refer to the State HMP.

Location, Extent and Magnitude

Location
The level of seismic hazard—the frequency and severity of earthquakes—is substantially lower in New Jersey than in more seismically active states such as California or Alaska. New Jersey has faults beneath its surface, but these faults are shorter than those in the Western United States, and generally produce few and smaller seismic events than elsewhere in the country.

The longest and most active geologic fault in New Jersey is the Border Fault. The fault, which divides the Highlands and Piedmont Physiographic Provinces, geologically unique regions, extends south from Stony Point, New York to Reading, Pennsylvania. In the north, it passes into New Jersey about half a mile west of State Route 202 in Bergen County, and passes out of northwestern New Jersey north of Stockton in Hunterdon County. The Ramapo section of this fault, known as the Ramapo Fault, extends south from the New Jersey-New York border along two thirds of the New Jersey portion of the Border Fault, and has been the most active section of the Border Fault. Over 25 percent of the earthquakes experienced in New Jersey over the past 200 years had their epicenters within 30 miles of the fault.

Extent and Magnitude
There are two common ways to measure earthquakes. Earthquake strength, or magnitude, is measured using networks of seismographs, instruments that precisely measure the shaking of the ground. The most well-known scale of magnitude is the Richter scale, designed by Charles F. Richter in 1935, in which an increase of one point represents a ten-fold increase in power of the earthquake and a thirty-two-fold increase in energy released for an equal duration of shaking.

Table 4.5-1 Richter Scale Magnitudes and Associated Earthquake Size Effects

Richter Magnitudes	Earthquake Effects
Less than 3.5	Generally not felt but recorded.
3.5-5.4	Often felt but rarely causes damage.
Under 6.0	At most, slight damage to well-designed buildings.
6.1-6.9	Can be destructive in areas where people live up to about 100 kilometers across.
7.0-7.9	Major earthquake; can cause serious damage over large areas.
8.0 or greater	Great earthquake; can cause serious damage in areas several hundred kilometers across.

Although magnitude measures earthquake strength well, it is not an accurate measure of damage or intensity. An earthquake in a densely populated area, resulting in many casualties and building collapses, may have the same magnitude as an earthquake which occurs in a remote, rural locale that does nothing more than flush grouse from the underbrush. The result of earthquake on the built environment is measured as intensity. Intensity measures the combined effects of magnitude, distance from the epicenter and local geology on earthquake effects. The most commonly used intensity scale is the Modified Mercalli Intensity Scale. Originally designed by Giuseppi Mercalli in 1902, the scale was modified in 1931 by American seismologists Harry O. Wood and Frank Neuman to better incorporate effects on modern infrastructure.

The Modified Mercalli scale is based on firsthand reports of people awakening, sound descriptions, timing of the event, movement experienced, and visible effects on structures and landscapes. It is reported in the Roman Numeral format, from I-to-XII, in order to differentiate it from measures of magnitude.

Table 4.5-2 Modified Mercalli Intensity Scale with Associated Impacts

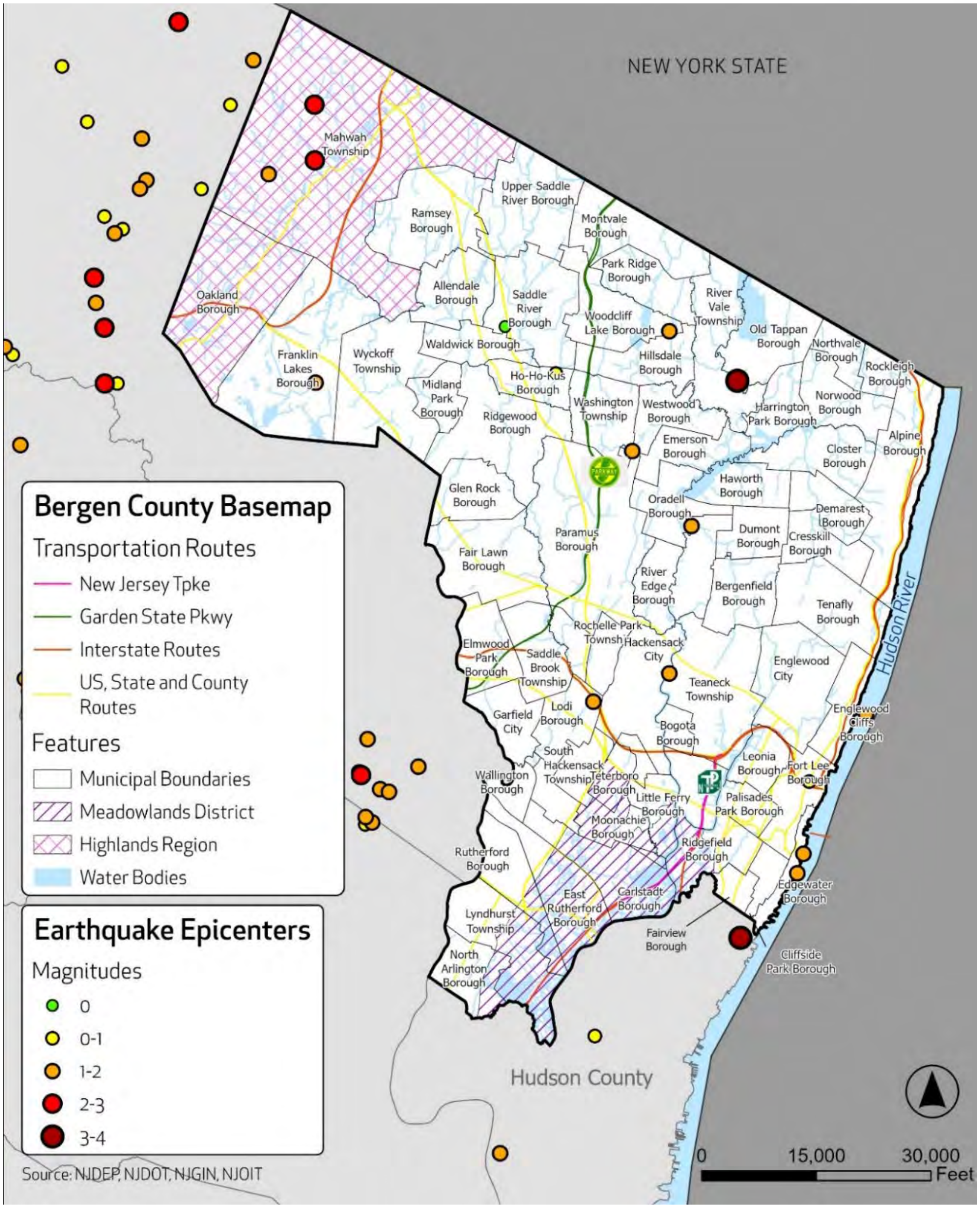
Scale	Intensity	Description of Effects	Corresponding Richter Scale Magnitude
I	Instrumental	Detected only on seismographs	<4.2
II	Feeble	Some people feel it	<4.2
III	Slight	Felt by people resting; like a truck rumbling by	<4.2
IV	Moderate	Felt by people walking	<4.2
V	Slightly Strong	Sleepers awake; church bells ring	<4.8
VI	Strong	Trees sway; suspended objects swing; objects fall off shelves	<5.4
VII	Very Strong	Mild alarm, walls crack, plaster falls	<6.1
VIII	Destructive	Moving cars uncontrollable, masonry fractures, poorly constructed buildings damaged	<6.9
IX	Ruinous	Some houses collapse, ground cracks, pipes break open	<6.9
X	Disastrous	Ground cracks profusely, many buildings destroyed, liquefaction and landslides widespread	<7.3
XI	Very Disastrous	Most buildings and bridges collapse, roads, railways, pipes and cables destroyed, general triggering of other hazards	<8.1
XII	Catastrophic	Total destruction, trees fall, ground rises and falls in waves	>8.1

Previous Occurrences and Losses

Figure 4.5-1 Historic Earthquake Epicenters in Bergen County by Magnitude shows the data on record for Bergen County. Bergen County has never had a federal emergency management or disaster declaration for earthquake. There is no record of Bergen County experiencing significant or widespread damage from earthquakes, at least since earthquake records have been formally maintained.

Not represented on the figure below are recent earthquakes experienced within Bergen County in 2025. According to data presented by the USGS, three earthquakes were epicentered within the county in January and August of 2025. On January 24, a 2.4 magnitude earthquake was measured 2 kilometers north of Paramus, within a 8.2 km depth. On August 3, 2025, a 3.0 magnitude event was felt just northeast of Hasbrouck Heights. This event had an estimated 10.0 km depth. Most recently, on August 5, 2025, a 2.7 magnitude earthquake was measured 2 kilometers southwest of Hillsdale, reaching a 12.4 kilometer depth. None of these events resulted in known property damage or injury.

Figure 4.5-1 Historic Earthquake Epicenters in Bergen County by Magnitude



Earthquakes are mapped based on epicenter, not the area where the impacts are felt. It is possible that a larger earthquake in New York state or Maryland may have more impact than a small earthquake with an epicenter within the County. However, this may furthers the assessment that earthquake is a low hazard of concern for the County. In 2024, a 4.8 magnitude earthquake occurred in Hunterdon County. It was felt in Bergen County, but minimal damage was reported. At the time, USGS reported that only 13 earthquakes within 300 miles have registered a magnitude of 4.5 or higher since 1950.

Probability of Future Occurrences

Earthquakes cannot be predicted and may occur any time of the day or year. The probability of damaging earthquakes affecting New Jersey is low. However, there is a definite threat of major earthquakes that could cause widespread damage and casualties in New Jersey including Bergen County. Major earthquakes are infrequent in the State and may occur only once every few hundred years or longer, but the consequences of a major earthquake could be very high. For the purposes of this plan update, the probability of future occurrences for earthquakes is defined by the number of events over a specified period of time. The entire historical record was consulted and there have been zero earthquake-related disasters declared for New Jersey. The historical record indicates 219 earthquakes recorded for New Jersey from 1783 to 2025.

Potential Effects of Climate Change

Providing projections of future climate change for a specific region is challenging. Shorter term projections are more closely tied to existing trends making longer term projections even more challenging. The further out a prediction reaches the more subject to changing dynamics it becomes. The potential impacts of global climate change on earthquake probability are unknown. Some scientists predict melting glaciers could induce tectonic activity. As ice melts and water runs off, tremendous amounts of weight are shifted on the Earth's crust. As newly freed crust returns to its original, pre-glacier shape, it could cause seismic plates to slip and stimulate volcanic activity according to research into prehistoric earthquakes and volcanic activity. National Aeronautics and Space Administration (NASA) and USGS scientists found that retreating glaciers in southern Alaska might be opening the way for future earthquakes[11].

Secondary impacts of earthquakes could be magnified by future climate change. Soils saturated by repetitive storms could experience liquefaction during seismic activity because of the increased saturation. Dams storing increased volumes of water from changes in the hydrograph could fail during seismic events. There are currently no models available to estimate these impacts[12].

Vulnerability Assessment

Built Environment, Infrastructure and Community Lifelines

Many buildings and infrastructure assets in Bergen County were built without seismic design provisions increasing potential vulnerability in the case of an event. **Table 4.5-3 Expected Annualized Losses from Earthquake by Jurisdiction** shows expected annualized losses for the earthquake hazard. This data was derived from FEMA's NRI. Expected EAL represents the average economic loss in dollars resulting from natural hazards each year. The table includes EAL for buildings as well as total EAL which includes building damage as well as damage to agriculture and population equivalency (the monetized cost of injury and fatality).

Table 4.5-3 Expected Annualized Losses from Earthquake by Jurisdiction

Municipality	Expected Annual Losses (Building)	Expected Annual Losses (Total)
Allendale Borough	$33,149.90	$38,686.48
Alpine Borough	$6,696.60	$7,110.19
Bergenfield Borough	$50,728.00	$62,743.18
Bogota Borough	$16,409.10	$20,119.89
Carlstadt Borough	$80,412.80	$84,536.78
Cliffside Park Borough	$21,162.40	$25,239.36
Closter Borough	$26,211.80	$29,529.36
Cresskill Borough	$15,649.80	$17,616.06
Demarest Borough	$8,770.80	$9,967.57
Dumont Borough	$32,325.70	$39,977.10
East Rutherford Borough	$59,694.70	$65,591.59
Edgewater Borough	$24,800.90	$28,766.96
Elmwood Park Borough	$80,557.80	$94,550.81

[11] Michael Baker International. 2019. State of New Jersey 2019 All-Hazards Mitigation Plan.

[12] Ibid.

Municipality	Expected Annual Losses (Building)	Expected Annual Losses (Total)
Emerson Borough	$26,998.00	$31,961.47
Englewood City	$69,109.00	$79,125.66
Englewood Cliffs Borough	$28,425.70	$31,127.17
Fair Lawn Borough	$115,597.80	$140,500.03
Fairview Borough	$14,945.30	$17,446.71
Fort Lee Borough	$69,383.30	$84,398.97
Franklin Lakes Borough	$54,345.30	$59,713.34
Garfield City	$73,131.80	$90,361.37
Glen Rock Borough	$45,513.70	$53,513.11
Hackensack City	$172,028.30	$203,272.50
Harrington Park Borough	$18,702.80	$21,878.54
Hasbrouck Heights Borough	$26,760.80	$31,976.88
Haworth Borough	$12,849.30	$14,530.03
Hillsdale Borough	$36,258.90	$43,485.78
Ho-Ho-Kus Borough	$20,683.50	$23,574.36
Leonia Borough	$10,180.90	$11,913.51
Little Ferry Borough	$39,172.30	$46,736.19
Lodi Borough	$68,030.50	$80,611.37
Lyndhurst Township	$69,678.80	$81,291.27
Mahwah Township	$86,086.10	$96,838.27
Maywood Borough	$24,251.30	$28,761.05
Midland Park Borough	$25,861.00	$30,426.06
Montvale Borough	$28,640.60	$31,518.60
Moonachie Borough	$60,040.00	$63,539.14
New Milford Borough	$33,958.00	$42,086.67
North Arlington Borough	$26,969.40	$31,465.05
Northvale Borough	$33,604.34	$36,630.74
Norwood Borough	$25,460.10	$29,284.45
Oakland Borough	$29,899.60	$35,177.91
Old Tappan Borough	$27,573.30	$31,319.23
Oradell Borough	$37,887.00	$44,156.63
Palisades Park Borough	$19,033.00	$22,793.31
Paramus Borough	$216,468.20	$251,908.59
Park Ridge Borough	$21,195.30	$24,090.91
Ramsey Borough	$65,148.80	$75,091.84
Ridgefield Borough	$23,138.30	$25,856.21
Ridgefield Park Village	$24,942.60	$31,513.61
Ridgewood Village	$105,507.40	$125,448.53
River Edge Borough	$33,100.90	$42,286.30
River Vale Township	$30,398.40	$35,736.42
Rochelle Park Township	$23,625.30	$27,894.95
Rockleigh Borough	$2,873.48	$3,132.26
Rutherford Borough	$38,712.60	$45,241.65
Saddle Brook Township	$72,812.20	$83,270.93
Saddle River Borough	$28,401.50	$31,293.41
South Hackensack Township	$25,391.77	$27,475.73
Teaneck Township	$101,274.90	$121,472.79
Tenafly Borough	$31,559.40	$35,663.41
Teterboro Borough	$50,783.53	$54,951.47
Upper Saddle River Borough	$47,524.50	$53,074.09
Waldwick Borough	$33,264.40	$38,964.34
Wallington Borough	$11,989.10	$13,921.80
Washington Township	$32,113.00	$38,496.19
Westwood Borough	$48,026.30	$55,943.76
Wood-Ridge Borough	$31,104.60	$34,104.54
Woodcliff Lake Borough	$13,717.10	$15,110.79
Wyckoff Township	$66,843.90	$76,451.81
Bergen County Total	**$3,067,556.50**	**$3,564,256.81**

Source: FEMA NRI

Population and Economy
The entire population is assumed to have equal vulnerability to earthquakes in Bergen County. The degree of exposure is dependent on many factors, including the age and construction type of the structures people live in, the soil types their homes are constructed on, and their proximity to fault locations. Earthquakes have the potential to impact economies at both the local and regional scale. Losses can include structural and non-structural damage to buildings, loss of business function, damage to inventory, relocation costs, wage loss, and rental loss caused by the repair and replacement of buildings. Roads that cross earthquake-prone soils have the potential to be significantly damaged during an earthquake event, potentially impacting commodity flows. Additionally, economic loss includes business interruption losses associated with the inability to operate a business because of damage sustained during an earthquake, as well as temporary living expenses for those displaced.

Ecosystems and Natural Assets
Earthquakes can impact damage or disturb ecosystems, negatively affecting plant and wildlife. In addition, secondary hazards such landslides, mudslides, slope failure, dam failures, and tsunamis may be triggered by earthquake events which can be harmful to the environment as well.

4.6 FLOOD

Hazard Description

Flood is the accumulation of water within a water body which results in the overflow of excess water onto adjacent lands, usually floodplains. The floodplain is the land adjoining the channel of a river, stream ocean, lake or other watercourse or water body that is susceptible to flooding. Most floods fall into the following three categories: riverine flooding, coastal flooding, or shallow flooding (e.g. sheet flow, ponding and urban drainage). For Bergen County, riverine flooding and coastal flooding are the most common types of flooding and are further discussed below. Additionally, sea level rise is discussed below as it relates to nuisance flooding and a risk of increased nuisance flooding in Bergen County.

Floods are frequent and costly natural hazards in New Jersey in terms of human hardship and economic loss, particularly to communities that lie within flood-prone areas or floodplains of a major water source. They can develop slowly over a period of days or develop quickly, with disastrous effects that can be local (impacting a neighborhood or community) or regional (affecting entire river basins, coastlines and multiple counties or states) (FEMA, 2008).

Coastal Flooding
Coastal flooding is a result of storm surge where local sea levels rise to inundate areas along the coasts of oceans, bays, estuaries, coastal rivers, and large lakes. Hurricanes and tropical storms, severe storms, and Nor'easters, especially during the winter and spring, cause most of the coastal flooding in New Jersey. Storm surge may overrun barrier islands and push sea water up coastal rivers and inlets, blocking the downstream flow of inland runoff. Thousands of acres of crops and forest lands may be inundated by both saltwater and freshwater. Emergency routes, particularly from barrier islands, may be cut off quickly, stranding residents in flooded areas and hampering rescue efforts.

Riverine Flooding
Periodic flooding of lands adjacent to non-tidal rivers and streams is a natural and inevitable occurrence. When stream flow exceeds the capacity of the normal water course, some of the above-normal stream flow spills over onto adjacent lands within the floodplain. Unlike coastal flooding, riverine flooding is a function of precipitation levels and water runoff volumes within the watershed of the stream or river. The recurrence interval of a flood is defined as the average time interval, in years, expected to take place between the occurrence of a flood of a particular magnitude and an equal or larger flood. Flood magnitude increases with increasing recurrence intervals.

Sea Level Rise

Sea level rise is described in terms of relative sea level change, defined as the height of the sea with respect to a specific point on land[13]. It is caused by the combination of eustatic and isostatic sea level effects. Eustatic effects are alterations in global sea level due to changes in the volume of water in ocean basins through processes such as thermal expansion, glacial melt, etc., or net changes in the size of ocean basins. Isostatic sea level effects refer to local changes in vertical land movement. Extreme weather events will continue to be the primary driver of increasing water levels. However, a consensus has not yet been reached on how the frequency and magnitude of storms may change in coastal regions of the United States, including New Jersey.

Global sea level is rising, due to rising temperatures and other processes such as ocean circulation, and is putting coastal residents, economies, and natural resources at risk. One of the most noticeable consequences of sea-level rise is an increase in coastal and nuisance flooding. Sea-level rise contributes in this way by making flooding more likely as it inundates low-lying areas and wetlands, erodes shorelines, and increases the flow of salt water into estuaries and groundwater aquifers (EPA, 2021). The impacts of sea-level rise are intensified during storm events. Studies have suggested that higher sea levels contributed to greater impacts from Superstorm Sandy, attributing around $3.7 billion of nearly $30 billion in damage directly to sea-level rise and the resulting storm surge (NJDEP, 2021). The state is considering further revisions to its Flood Hazard Area Control Act Rules, which will increase the regulatory flood elevations in tidally controlled flood hazard areas.

Location, Extent, and Magnitude

Coastal Flooding

The Flood Insurance Study (FIS) differentiates between coastal flooding and riverine flooding. Coastal flooding, often caused by hurricanes and nor'easters, is isolated to the following locations according to the report and related FIRMs:

Hackensack River

- Village of Ridgefield Park (Portions of Major Flooding Due to Coastal Surges)
- Borough of Bogota (All Due to Coastal Surges)
- Borough of North Arlington (Portions)
- Township of Lyndhurst (Portions)
- Borough of Little Ferry (All)
- Borough of Teterboro (All)
- Borough of Rutherford (Portions)
- Borough of East Rutherford (Portions)
- Borough of Moonachie (All)
- Borough of Carlstadt (All)
- City of Hackensack (Portions)
- Township of Teaneck (Portions)
- Township of South Hackensack (All)
- Borough of Hasbrouck Heights (All)

Hudson River

- Borough of Edgewater (All)

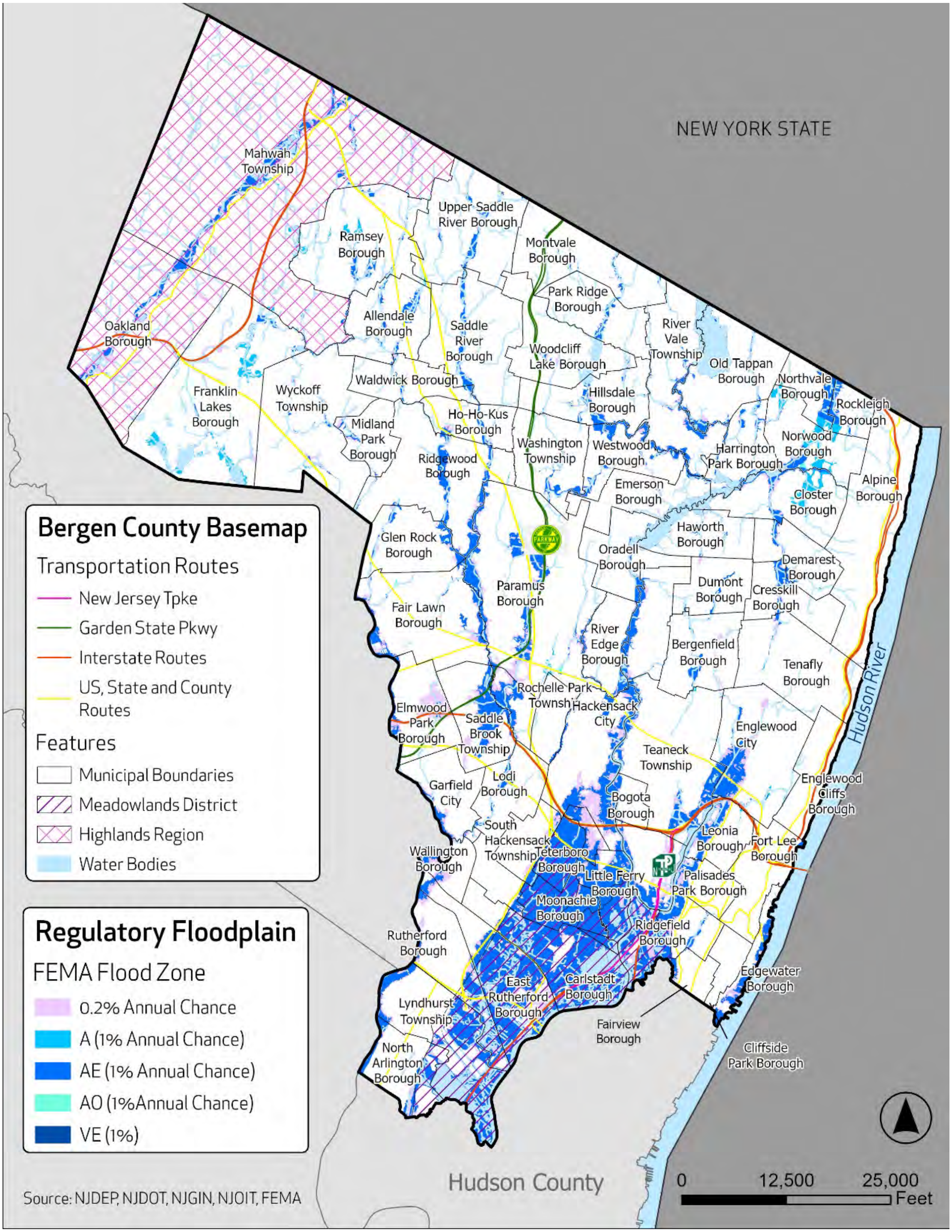
[13] Parris, Global Sea Level Rise Scenarios for the United States National Climate Assessment, 2012. http://scenarios.globalchange.gov/sites/default/files/NOAA_SLR_r3_0.pdf

- Borough of Fort Lee (flooded sections are located at the bottom lower elevated areas within the Palisades Interstate Park)
- Borough of Englewood Cliffs (flooded sections are located at the bottom lower elevated areas within the Palisades Interstate Park)
- Borough of Tenafly (Portions)
- Borough of Alpine (All)

Note on the Passaic River: According to FEMA, all portions of the Passaic River within Bergen County are identified as *non-coastal*. Though coastal flooding effects potentially impact upriver portions of the Passaic within the county, from a regulatory perspective, this portion of the Passaic is defined as a *fluvial hazard* and will align with a different set of regulatory requirements than if the river were regulated as a coastal environment.

Figure 4.6-1 Special Flood Hazard Area (SHFA) for Bergen County shows FEMA’s Special Flood Hazard Area (SFHA) for Bergen County, including the 1% Annual Chance Flood (Regulatory Floodway, Zone A, AE, AO, AH, and VE) and 0.2% Annual Chance Flood (Zone X). The flood hazard area boundaries represent the extent of inundation caused by a coastal surge with a 1% and 0.2% annual probability of occurrence (also known as the 100-year and 500- year events, respectively). Data used to compile Figure 4.6-1 are a composite from two sources: FEMA’s Preliminary FIRMs (08-29-24) and 2024 Preliminary FIRMs (dated 05-05-24). The elevations used to develop these extents are based on the findings of the above FIS. In the past, FEMA's FIRMs were updated every 10-15 years in the New York metropolitan area. The new digital format (DFIRM) allows for more accurate floodplain determinations, and the capability to update the maps more frequently Appendix Volume I contains individual maps of each Bergen County municipality, showing municipal flood vulnerability based on FEMA’s FIRMs and NOAA’s Sea Level Rise projections. Note that the terms “Flood Zone” and “Special Flood Hazard Area” are used interchangeably in this Bergen County HMP update.

Figure 4.6-1 Special Flood Hazard Area (SHFA) for Bergen County



Source: FEMA's 2014 Preliminary FIRM And 2017 Preliminary Firm, NJDEP

The percentage of lands area in the SFHA, Zone A, and Zone V by municipality are displayed in **Table 4.6-1 Total Land Area in the Special Flood Hazard Area (SFHA)** by Municipality.

Table 4.6-1 Total Land Area in the Special Flood Hazard Area (SFHA) by Municipality

Jurisdiction	Total Municipal Land Area (Acres)	Total Land Area in 1% Floodplain (Acres)	% Land Area in 1% Floodplain	Total Land Area in .2% Floodplain (Acres)	% Land Area in .2% Floodplain	% Land Area in Floodplain (either .2% or 1%)
Allendale Borough	1,994.55	229.12	11.49%	41.17	2.06%	13.55%
Alpine Borough	4,095.95	52.84	1.29%	0.00	0.00%	1.29%
Bergenfield Borough	1,860.52	87.63	4.71%	56.99	3.06%	7.77%
Bogota Borough	511.67	64.17	12.54%	2.69	0.53%	13.07%
Carlstadt Borough	2,690.54	2079.32	77.28%	1.84	0.07%	77.35%
Cliffside Park Borough	611.88	0.00	0.00%	0.00	0.00%	0.00%
Closter Borough	2,109.78	414.59	19.65%	46.24	2.19%	21.84%
Cresskill Borough	1,326.76	127.43	9.60%	22.66	1.71%	11.31%
Demarest Borough	1,330.51	88.75	6.67%	18.38	1.38%	8.05%
Dumont Borough	1,252.35	57.63	4.60%	9.50	0.76%	5.36%
East Rutherford Borough	2,589.26	1701.17	65.70%	33.08	1.28%	66.98%
Edgewater Borough	620.19	304.35	49.07%	22.70	3.66%	52.73%
Elmwood Park Borough	1,751.26	128.86	7.36%	256.13	14.63%	21.98%
Emerson Borough	1,547.83	152.81	9.87%	24.23	1.57%	11.44%
Englewood	3,166.14	341.95	10.80%	178.43	5.64%	16.44%
Englewood Cliffs Borough	1,332.56	14.49	1.09%	4.20	0.32%	1.40%
Fair Lawn Borough	3,340.64	306.39	9.17%	135.83	4.07%	13.24%
Fairview Borough	540.79	27.11	5.01%	2.79	0.52%	5.53%
Fort Lee Borough	1,606.42	11.42	0.71%	1.10	0.07%	0.78%
Franklin Lakes Borough	6,324.34	661.10	10.45%	181.49	2.87%	13.32%
Garfield	1,402.68	107.97	7.70%	44.40	3.17%	10.86%
Glen Rock Borough	1,739.09	142.74	8.21%	46.89	2.70%	10.90%
Hackensack	2,779.93	499.17	17.96%	55.98	2.01%	19.97%
Harrington Park Borough	1,319.23	313.11	23.73%	18.93	1.43%	25.17%
Hasbrouck Heights Borough	979.47	27.54	2.81%	0.74	0.08%	2.89%
Haworth Borough	1,502.09	317.58	21.14%	39.82	2.65%	23.79%
Hillsdale Borough	1,878.28	211.22	11.25%	47.02	2.50%	13.75%
Ho-Ho-Kus Borough	1,120.27	97.07	8.66%	22.20	1.98%	10.65%
Leonia Borough	1,042.45	169.06	16.22%	0.06	0.01%	16.22%
Little Ferry Borough	1,070.41	859.58	80.30%	38.46	3.59%	83.90%
Lodi Borough	1,466.24	115.22	7.86%	30.50	2.08%	9.94%
Lyndhurst Township	3,178.68	1618.43	50.92%	35.86	1.13%	52.04%
Mahwah Township	16,566.59	964.47	5.82%	158.64	0.96%	6.78%
Maywood Borough	824.62	26.13	3.17%	5.63	0.68%	3.85%
Midland Park Borough	1,012.16	43.71	4.32%	23.18	2.29%	6.61%
Montvale Borough	2,581.50	89.42	3.46%	14.26	0.55%	4.02%
Moonachie Borough	1,115.07	860.46	77.17%	40.35	3.62%	80.78%
New Milford Borough	1,485.29	204.99	13.80%	45.21	3.04%	16.85%
North Arlington Borough	1,619.78	344.85	21.29%	34.06	2.10%	23.39%
Northvale Borough	807.18	210.22	26.04%	12.13	1.50%	27.55%
Norwood Borough	1,791.88	372.56	20.79%	25.64	1.43%	22.22%
Oakland Borough	5,612.76	355.06	6.33%	131.46	2.34%	8.67%
Old Tappan Borough	2,664.39	706.21	26.51%	41.76	1.57%	28.07%
Oradell Borough	1,637.41	158.80	9.70%	35.29	2.16%	11.85%

Jurisdiction	Total Municipal Land Area (Acres)	Total Land Area in 1% Floodplain (Acres)	% Land Area in 1% Floodplain	Total Land Area in .2% Floodplain (Acres)	% Land Area in .2% Floodplain	% Land Area in Floodplain (either .2% or 1%)
Palisades Park Borough	820.99	60.98	7.43%	0.72	0.09%	7.52%
Paramus Borough	6,721.47	782.11	11.64%	308.17	4.58%	16.22%
Park Ridge Borough	1,682.11	97.76	5.81%	7.89	0.47%	6.28%
Ramsey Borough	3,566.90	289.49	8.12%	55.99	1.57%	9.69%
Ridgefield Borough	1,826.96	892.28	48.84%	7.51	0.41%	49.25%
Ridgefield Park Village	1,230.02	295.63	24.03%	10.94	0.89%	24.92%
Ridgewood Village	3,712.92	399.79	10.77%	61.49	1.66%	12.42%
River Edge Borough	1,204.11	128.52	10.67%	33.51	2.78%	13.46%
River Vale Township	2,761.28	401.45	14.54%	59.22	2.14%	16.68%
Rochelle Park Township	656.28	209.95	31.99%	89.60	13.65%	45.64%
Rockleigh Borough	646.71	153.37	23.72%	14.74	2.28%	25.99%
Rutherford Borough	1,850.10	537.94	29.08%	54.56	2.95%	32.03%
Saddle Brook Township	1,758.27	346.99	19.73%	159.97	9.10%	28.83%
Saddle River Borough	3,175.86	194.99	6.14%	14.99	0.47%	6.61%
South Hackensack Township	476.37	107.75	22.62%	8.13	1.71%	24.33%
Teaneck Township	3,993.66	391.37	9.80%	40.23	1.01%	10.81%
Tenafly Borough	2,916.23	41.76	1.43%	18.35	0.63%	2.06%
Teterboro Borough	714.65	346.40	48.47%	98.39	13.77%	62.24%
Upper Saddle River Borough	3,374.37	213.87	6.34%	25.31	0.75%	7.09%
Waldwick Borough	1,324.01	81.55	6.16%	19.77	1.49%	7.65%
Wallington Borough	670.57	117.85	17.58%	93.14	13.89%	31.46%
Washington Township	1,921.19	143.35	7.46%	15.84	0.82%	8.29%
Westwood Borough	1,473.20	272.44	18.49%	75.15	5.10%	23.59%
Woodcliff Lake Borough	2,270.32	193.95	8.54%	41.30	1.82%	10.36%
Wood-Ridge Borough	709.08	35.94	5.07%	1.44	0.20%	5.27%
Wyckoff Township	4,255.69	113.97	2.68%	73.44	1.73%	4.40%

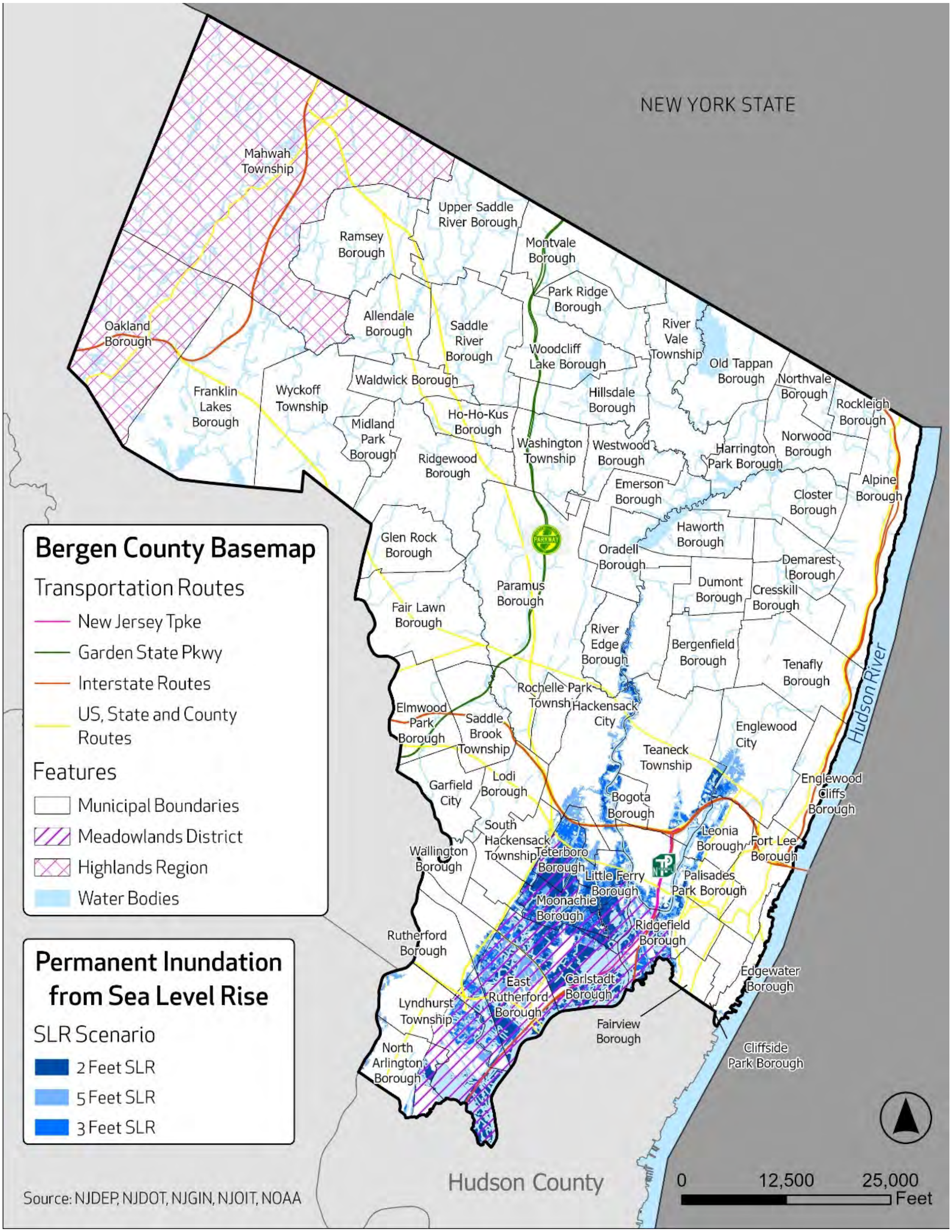
SOURCE: FEMA PFIRMS AND FIRMS 2024

As with coastal flooding, floodplains are divided into areas that experience different levels of flooding depending on their elevation. A 100-year riverine flood will inundate the 100-year zone of that floodplain, and a 500-year flood will inundate the 500-year flood zone. The 500-year floodplain is higher in elevation. Several methods were used by FEMA to develop the inundation extents. For smaller watersheds, with drainage areas less than 1 square mile, the Rational Method was used. The Rational Method is a very simplified peak flow analysis. For larger watersheds, the hydrology was based on Special Report No. 38, a method developed by NJDEP and the USGS. Input parameters include drainage area, main channel slope, surface storage area, and impervious cover. Lastly, when a sufficient amount of data was available, flood-flow frequency data was established using actual discharges from local gauging stations.

As shown in the figures above, the extent of coastal flooding (with the exception of the Borough of Edgewater) from a surge in the Hudson River is extremely limited due to the steep topography along the New Jersey banks.

Figure 4.6-2 Permanent Inundation from Sea Level Rise shows the inundation in Bergen County from three distinct Sea Level Rise (SLR) scenarios – 2’ Rise SLR, 3’ Rise SLR, and 5’ Rise SLR. Much of the southeastern portion of the county, particularly in the low-lying Meadowlands ecosystem, may be inundated under these SLR predictions.

Figure 4.6-2 Permanent Inundation from Sea Level Rise



Previous Occurrences and Losses

Flooding is a frequent occurrence in Bergen County. From 1950 to August 2024, there have been 90 noted flash flood events. Flash flooding during this time period has caused a total of three direct deaths, one direct injury, and over $17.5 million in property damage. Excluding flash floods, there have been 56 days with a flood event between 1950 and April 2019. Flooding has caused one reported death and $52.410 million in property damage. Recorded coastal flooding has also indicated one additional fatality. A sample of some notable floods, including all documented flash floods and coastal floods, are included in **Table 4.6-2 Precious Flood Occurrences and Losses in Bergen County**.

Table 4.6-2 Previous Flood Occurrences and Losses in Bergen County (1950-April 2019)

Date(s) of Event	Event Type	Area Affected	Deaths	Injuries	Property Damage	Description
9/16/1999-9/17/1999	Flash Flood	Countywide	2	0	$17.5 million	Torrential record rainfall, which caused serious widespread urban, small stream, and river flooding, preceded the remnants of Hurricane Floyd, which passed over Western Suffolk County on Long Island from 7 pm to 9 pm on September 16th. In Bergen County, a 53-year-old man and a 27-year-old man drowned in their cars. For Passaic, Bergen, Essex, Hudson, and Union Counties, the initial cost estimates were $35.5 million dollars. These estimates do not account for damage in the private sector.
8/13/2001	Flood	Lodi	0	0	$0	On Monday, August 13th, a weak cold front approached northern New Jersey from the west. In advance of the front, a warm, moist, and very unstable air mass was in place. Scattered thunderstorms developed during the early afternoon hours and moved very slowly. With abundant moisture in place, these slow-moving thunderstorms produced torrential downpours in highly isolated locations, leading to scattered flooding of roadways and highways in portions of Bergen County. Main Street and Route 46 in Lodi were particularly affected. In Garfield, three cars were stuck when their drivers tried to maneuver through large pools of water. The local fire department rescued all three vehicles. Flooding also occurred on Railroad Avenue in Hackensack.
8/14/2001	Flood	Countywide	0	0	$0	On Tuesday, August 14th, a strong upper atmospheric disturbance approached northern New Jersey from the northwest during the evening hours. As this disturbance approached, locally strong thunderstorms developed across portions of northern New Jersey during the early evening. Thunderstorms produced very heavy downpours, which led to numerous flooded roadways and highways, and subsequent road and highway closures. This flooding also trapped several people in vehicles. In Bergen County, numerous cars were stuck on Route 46 in the vicinity of Elmwood Park due to flooding. Also, in Saddle Brook, a six-block area was impassable due to flooding. Strong wind gusts also accompanied these thunderstorms. In Bergen County, strong winds led to a downed tree which fell onto a vehicle in Lyndhurst.
7/19/2002	Flood	Countywide	0	0	$0	Brief periods of heavy rain produced by strong thunderstorms caused widespread urban flooding of low lying and poor drainage areas in Bergen County. Radar estimated rainfall rates between 1 and 2 inches per hour. Spotters reported up to 2 feet of water at the Hillsdale Toll Plaza on the Garden State Parkway. Widespread street flooding was reported in Dumont, and four cars were left underwater in a parking lot in East Rutherford after nearby swamp land flooded and another two were stuck in a rising tide on Route 17.

Date(s) of Event	Event Type	Area Affected	Deaths	Injuries	Property Damage	Description
7/11/2007	Flash Flood	Glen Rock and Midland Park	0	1	$0	A passing cold front produced showers and thunderstorms ahead of it, producing heavy rainfall across Northeast New Jersey. Rainfall amounts ranged from around 0.75 to just under 2.25 inches across the region, producing areas of flash flooding. Widespread street flooding, with one person hospitalized after water rescue from flooded underpass.
4/15/2007	Flood	Rutherford and Lodi	1	0	$6,900,000	See Nor'easter section for details.
9/6/2008	Flood	Garfield	0	0	$0	Tropical Storm Hanna. See Hurricanes and Tropical Storms section for details.
10/24/2009	Flood	Midland Park	0	0	$0	A frontal system associated with low pressure moving through the Great Lakes region, produced rainfall over a period of 18 to 24 hours which caused flooding in parts of Bergen County. The railroad underpass at Franklin Avenue was closed by local authorities due to flooding with 2 cars stranded in high water. The intersection of Ackerman Ave and Delmar Ave. was also closed due to flooding. Water from street flooding entered a house and garage at 607 Prospect St. in Glen Rock. Total rainfall across Bergen County ranged from 1.83 inches in Mahwah to 2.05 inches in Teterboro and Ridgewood.
3/13/2010	Flood	Mahwah and Upper Saddle River	0	0	$45,500,000	A Nor'easter caused $45,500,000 in property damage. See Nor'easters for details.
3/14/2010	Flood	Garfield	0	0	$0	Nor'easter. See Nor'easters for details.
3/29/2010	Flood	East Rutherford	0	0	$0	Nor'easter. See Nor'easters for details.
3/30/2010	Flood	Fort Lee	0	0	$0	Nor'easter. See Nor'easters for details.
10/1/2010	Flood	Fair Lawn	0	0	$10,000	See Nor'easters for details.
10/1/2010	Flood	Ridgewood and Teterboro	0	0	$0	Low pressure tracked up the east coast and interacted with a stalled frontal boundary and approaching upper level low pressure system. Strong southerly flow allowed for the transport of tropical moisture including the remnants of Tropical Storm Nicole, up the coast which resulted in heavy rain and flooding across portions of Bergen, Hudson, and Passaic Counties. Glen Ave. was closed due to flooding between North Maple Ave. and Northern Parkway near the Ho-Ho-Kus Brook Bridge in Ridgewood. All lanes on Route 46 westbound near Route 17 in Hasbrouck Heights were closed due to flooding. Total rainfall amounts ranged from 3.25 inches in Midland Park to 4.65 inches in Rivervale.
4/17/2011	Flood	Ramsey	0	0	$0	As an area of low pressure tracked from the Great Lakes into Southeast Canada, a triple point low pressure system developed in the Ohio Valley. This storm system brought flooding rains to portions of Northeast New Jersey as it tracked north and west of the local area. Basement flooding occurred at some residences on Wyckoff Ave., Nottingham Rd. and Buckingham Rd. in Ramsey.
8/27/2011	Flood	Kingsland				Hurricane Irene. There were no injuries or fatalities. See Hurricanes and Tropical Storms for details.
8/28/2011	Flood	Teterboro, Elmwood Park, Glen Rock, Bergenfield	0	0	$0	Hurricane Irene. See Hurricanes and Tropical Storms for details.

Date(s) of Event	Event Type	Area Affected	Deaths	Injuries	Property Damage	Description
10/29/2012	Coastal Flood	Countywide	1	0	$0	Superstorm Sandy. The most widespread damage occurred in the towns of Moonachie, Little Ferry, and Carlstadt, which were inundated with 4 to 5 feet of water as the surge up the Hackensack River Monday night overtopped the protective levees. This affected about 2,000 residents in this area with approximately 200 residents having to be rescued from their homes. In addition, Teterboro airport was inundated with a few feet of water across most of the airport.
6/7/2013	Flood	Hillsdale	0	0	$0	Tropical Storm Andrea.
6/8/2013	Flood	Northvale and New Milford	0	0	$0	Tropical Storm Andrea. See Hurricanes and Tropical Storms for details.
5/30/2019	Flash Flood	Countywide	0	0	$0	Low pressure moving along a nearly stationary boundary triggered an area of convection that moved across the region during the evening of May 30th, resulting in isolated flash flooding across northeast New Jersey. Rainfall totals generally ranged from 1-1.5 inches, with the majority of the rain falling in a one to two hour period.
6/25/2019	Flash Flood	Countywide	0	0	$0	Warm advection associated with an approaching warm front produced a line of showers and thunderstorms that moved through northeast New Jersey during the early morning hours of June 25th. Between three quarters of an inch and one inch of rain fell within a two hour time span, resulting in isolated flash flooding across portions of northeast New Jersey.
7/11/2019	Flash Flood	Countywide	0	0	$0	Showers and thunderstorms developed across the area during the afternoon in response to an approaching warm front. These showers developed within an environment with increasing precipitable water values, resulting in a several hour period of heavy rain. Widespread rainfall totals of 1-2 inches were reported across northeast New Jersey, with several reports of 2.5-3 inches. A CoCoRaHS observer in Oakland, NJ reported 3.46 inches of rain in this event.
7/23/2019	Flash Flood	Countywide	0	0	$0	Another wave of low pressure moved along a frontal boundary stalled over the region during the early morning hours of Tuesday, July 23rd. After widespread rainfall totals of 1-2 inches the night before, additional rainfall amounts of around one inch increased the two day rainfall totals to 2-3 inches across much of the area, with the majority of that rain falling within roughly an 18 hour period. This resulted in additional flash flooding, particularly across urban areas. Two day rainfall totals included 2.38 inches at Newark Airport and 3.32 inches at Teterboro Airport.
8/3/2019	Flash Flood	Countywide	0	0	$0	Showers and thunderstorms developed along a pre-frontal trough ahead of an approaching cold front. With weak steering flow in place, these storms were able to produce 1-2 inches of rainfall in a short amount of time, leading to isolated reports of flash flooding across portions of Bergen County. The ASOS at Teterboro Airport reported 1.52 inches of rain during this event.
8/7/2019	Flash Flood	Countywide	0	0	$0	Showers and thunderstorms developed across northeast New Jersey ahead of a cold front during the afternoon of August 7th. These storms developed in an environment with precipitable water values close to 2 inches. Multiple rounds of showers and storms exacerbated the flash flood threat, with many locations receiving 1-3 inches of rain, much of which fell in only a few hours. CoCoRaHS observers reported 2.76 inches of rain near Little Falls and 3.21 inches of rain near Livingston

Date(s) of Event	Event Type	Area Affected	Deaths	Injuries	Property Damage	Description
						Township, and a trained spotter reported 3.05 inches in Cedar Grove.
7/6/2020	Flash Flood	Countywide	0	0	$0	Showers and thunderstorms developed during the afternoon across northeast New Jersey ahead of an approaching backdoor cold front. With relatively weak flow aloft, these storms moved slowly, resulting in heavy rain across some areas. CoCoRaHS observations indicate a widespread 0.5-2 inches of rain in areas that received storms, with the ASOS at Teterboro Airport reporting 2.89 inches of rain. Much of this rain fell over a 1-2 hour time period, resulting in flash flooding.
7/10/2020	Flash Flood	Countywide	0	0	$0	Tropical Storm Fay tracked northward along the New Jersey coast before passing west of New York City. Several rounds of heavy rain occurred over the New York City metro area as the storm approached. This rain developed in a tropical airmass, with precipitable water values over 2 inches, resulting in numerous reports of flash flooding. Rainfall totals ranged from 1-3 inches across northeast New Jersey, with the ASOS in Caldwell, NJ reporting 2.75 inches, Newark Airport reporting 2.68 inches, and Teterboro Airport reporting. 2.62 inches.
7/11/2020	Flash Flood	Countywide	0	0	$0	Showers and thunderstorms developed in a warm and humid environment along and ahead of a stationary front/prefrontal trough during the early afternoon hours of July 11th. With much of northeast New Jersey receiving 2-3 inches of rain the previous day during Tropical Storm Fay, flash flood guidance values were as low as one half inch per hour in some locations, allowing the additional rainfall to result in isolated flash flooding.
8/4/2020	Flood	Countywide	0	0	$0	Tropical Storm Isaias moved northward along the East Coast, passing west of New York City during the afternoon. With a tropical airmass in place, heavy rainfall on the leading edge of the storm resulted in isolated flash flooding in parts of northeast New Jersey. Rainfall amounts ranged from 1-3 inches, with Teterboro Airport reporting 1.45 inches of rain from the storm.
12/26/2020	Flood	Countywide	0	0	$0	A strong area of low pressure impacted the region Christmas Eve into Christmas Day. Moderate to heavy rain developed out ahead of the approaching cold front in an anomalously moist environment, leading to river flooding along the Ramapo River. Precipitable water values on the 12Z 12/25 sounding from Upton, NY were around 1.5 inches, a record for the date based on the Storm Prediction Center's sounding climatology. This resulted in widespread rainfall totals of 1-2 inches across northeast New Jersey.
6/8/2021	Flash Flood	Countywide	0	0	$0	A passing shortwave combined with a surface trough resulted in the development of showers and thunderstorms across northeast New Jersey during the early afternoon hours. These thunderstorms developed in an environment with weak steering flow and high precipitable water values, resulting in several reports of flash flooding. Based on upper air soundings from Upton, NY, precipitable water values increased from around 1.75 inches on the morning of June 8th to just over 2 inches that evening. Rainfall amounts varied widely across the area. The ASOS at the Teterboro Airport reported 1.66 inches of rain, while the Newark Airport ASOS reported 2.19 inches.

Date(s) of Event	Event Type	Area Affected	Deaths	Injuries	Property Damage	Description
7/8/2021	Flash Flood	Countywide	0	0	$0	A predecessor rainfall event resulted in flash flooding across portions of the area as moisture streaming northward ahead of Tropical Storm Elsa encountered a stationary boundary draped across the area. Rainfall amounts ranged 1.5-4 inches, with the ASOS at Teterboro Airport reporting 2.37 inches of rain from this event.
7/29/2021	Flash Flood	Countywide	0	0	$0	A warm front lifting north and an approaching shortwave trough combined to produce scattered showers and thunderstorms across northeast New Jersey during the late afternoon and early evening hours. These storms resulted in isolated reports of flash flooding in Essex, Passaic, and Bergen Counties. CoCoRaHS observations show a localized area of 1-3 inches of rain along the boarder of Passaic and Essex Counties, with reports of 1.69 inches 0.5 miles WNW of Little Falls Township, 1.95 inches 1.3 miles NE of West Caldwell Township, and 2.55 inches 0.7 miles north of Montclair.
8/21/2021	Flash Flood	Countywide	0	0	$0	Showers and thunderstorms streaming northward well ahead of approaching Hurricane Henri resulted in flash flooding across portions of northeast New Jersey. This rainfall developed in a moisture-rich environment, with the 8pm sounding from Upton, NY recording precipitable water values around 2.25 inches. Rainfall totals from this predecessor rainfall event ranged from 1-4 inches, with the ASOS at Teterboro Airport reporting 2.40 inches and a COOP observer in Harrison reporting 2.91 inches.
8/22/2021	Flash Flood	Countywide	0	0	$0	Rainfall from Tropical Storm Henri resulted in widespread flash flooding across portions of northeast New Jersey With a tropical airmass in place (precipitable water values greater than 2 inches), rainfall totals generally ranged from 2-4 inches, with this rain coming in addition to the 1-3 inches that fell during the predecessor rainfall event the night before. This resulted in widespread rainfall amounts of 3-7 inches in many locations over a 24-36 hour period. The ASOS at Newark Airport recorded a total of 4.67 inches across the two days, while the COOP observer in Harrison reported a two day total of 8.02 inches.
8/23/2021	Flood	Countywide	0	0	$0	Rainfall from Tropical Storm Henri resulted in widespread flash flooding across portions of northeast New Jersey With a tropical airmass in place (precipitable water values greater than 2 inches), rainfall totals generally ranged from 2-4 inches, with this rain coming in addition to the 1-3 inches that fell during the predecessor rainfall event the night before. This resulted in widespread rainfall amounts of 3-7 inches in many locations over a 24-36 hour period. The ASOS at Newark Airport recorded a total of 4.67 inches across the two days, while the COOP observer in Harrison reported a two day total of 8.02 inches.
9/1/2021	Flash Flood	Countywide	0	0	$0	Extremely heavy rainfall associated with the remnants of Hurricane Ida overspread northeast New Jersey during the evening of September 1 and continued through the early morning hours of September 2. Rainfall totals ranged from 5-8+ inches across much of the region, with much of that rain falling in just a few hours. The ASOS at Newark Airport recorded 8.44 inches of rain, while the ASOS at Teterboro Airport recorded 7.14 inches. A COOP observer in Harrison recorded 8.72 inches of rain. This resulted in widespread flash flooding leading to numerous road closures and water rescues

Date(s) of Event	Event Type	Area Affected	Deaths	Injuries	Property Damage	Description
						in addition to extensive river flooding. Eight people died as a result of the flash flooding and one person remains missing.
9/3/2021	Flood	Countywide	0	0	$0	Extremely heavy rainfall associated with the remnants of Hurricane Ida overspread northeast New Jersey during the evening of September 1 and continued through the early morning hours of September 2. Rainfall totals ranged from 5-8+ inches across much of the region, with much of that rain falling in just a few hours. The ASOS at Newark Airport recorded 8.44 inches of rain, while the ASOS at Teterboro Airport recorded 7.14 inches. A COOP observer in Harrison recorded 8.72 inches of rain. This resulted in widespread flash flooding leading to numerous road closures and water rescues in addition to extensive river flooding. Eight people died as a result of the flash flooding and one person remains missing.
10/26/2021	Flash Flood, Flood	Countywide	0	0	$0	A low pressure system developing over the area brought rounds of thunderstorms over the area during the evening on October 25th and into the 26th. Thunderstorms dropped 1-3 of rain over a several hour period. The low pressure then allowed for moderate to heavy rain to persist through the morning hours on October 26th. Total rainfall amounts of 2-4 were observed.
4/7/2022	Flood	Countywide	0	0	$0	A cold front moving through the area brought multiple rounds of rain on April 7th. The front approached and a low pressure system developed over the area resulting in moderate to heavy rain over Northeast New Jersey. 2 to 3 inches of rain fell over a several hour period. This resulted in river and poor drainage flooding.
6/2/2022	Flash Flood	Countywide	0	0	$0	A cold front sparked off heavy thunderstorms that slowly moved though northeast New Jersey and the NYC metro area. These thunderstorms dropped between 1.5 and 2.5 inches of rain in less than 2 hours which resulted in areas of flash flooding.
7/16/2022	Flash Flood	Countywide	0	0	$0	Thunderstorms developed ahead of a developing low pressure along a stationary front on July 16th. These thunderstorms quickly dropped 1-2 inches of rain in less than an hour resulting in localized flash flooding.
7/18/2022	Flash Flood	Countywide	0	0	$0	Several rounds of heavy thunderstorms developed in the warm sector of a frontal system on July 18th, 2022. These thunderstorms developed in an environment with 2 to 2.3 inch PWAT values and CAPE near 3000 J/kg. Training thunderstorms produced a widespread 1 to 3 inches of rainfall with localized spots up to 4 inches.
12/23/2022	Flood	Countywide	0	0	$0	A frontal system moving through the area produced several rounds of heavy rainfall during the early morning of December 23rd. These rounds of heavy rainfall resulted in a widespread 1.5 to 3 inches of rainfall with localized areas of flash flooding and river flooding.
6/25/2023	Flash Flood	Countywide	0	0	$0	A trough of low pressure over the area sparked slow moving thunderstorms with heavy rainfall over Northeast New jersey during the early afternoon of June 25th. A quick 1 to 2 inches of rainfall fell which resulted in very localized flash flooding.
9/8/2023	Flash Flood	Countywide	0	0	$0	A stationary front provided the focus for the development of slow moving heavy thunderstorms on the afternoon of September 8th 2023. The thunderstorms developed in an unstable environment with CAPE values of 3000-4000 J/kg and PWATs near 1.7 - 1.8 inches. These thunderstorms produced

Date(s) of Event	Event Type	Area Affected	Deaths	Injuries	Property Damage	Description
						rainfall rates of 1-2 inches per hour with a total accumulation of 1-3 inches of rain.
9/29/2023	Flash Flood	Countywide	0	0	$0	Heavy rainfall was focused in an area near the New York City Metropolitan area on September 29th, 2023. A bulk of the widespread flash flooding was in New York but was close enough to result in localized flash flooding in New Jersey. Rainfall totals in New Jersey were 1-2.5 inches, mainly near the NYC metro.
12/18/2023	Flash Flood	Countywide	0	0	$0	A warm front ahead of a developing coastal low pressure system positions itself over the area late on December 17th and into December 18th. As the low pressure intensified and approached, significant amounts of moisture focused along the warm front ahead of the coastal low resulting in widespread areas of heavy rainfall that occurred over a 12-18 hour period. PWATs were 1.5-1.7 inches which were near record values. A widespread 2-5 inches of rain fell over the area. This resulted in many areas of flash flooding as well as significant rises in rivers.
7/17/2023	Flash Flood	Countywide	0	0	$0	An approaching cold front and trough produced thunderstorms during the afternoon and evening on July 17th that resulted in localized flash flooding in northern New Jersey. MUCAPE values of 1000-2000 J/kg and PWATs of 2-2.2 inches allowed the thunderstorms to produce heavy rainfall rates of 1-2 per hour. The thunderstorms produced rainfall totals of 1 to 2.5 inches.
8/3/2024	Flash Flood	Countywide	0	0	$0	A stationary front over the area on August 3rd was the focus for the development of several rounds of heavy thunderstorms across the area. These thunderstorms produced flash flooding in portions of northeast New Jersey. CAPE values of near 2000 J/kg with PWATs of around 2 inches resulted in thunderstorms producing torrential rainfall with rates upwards of 2 per hour. Rainfall totals were 1-3 inches.
8/6/2024	Flash Flood	Countywide	0	0	$0	Several rounds of heavy thunderstorms developed over the area on the afternoon of August 6th. A slow moving frontal system stalled out over the area. PWATs of 2-2.2 inches and a sharp gradient of MUCAPE peaking out over the area near 2500 J/kg allowed for the development of strong thunderstorms producing torrential rainfall with rates upwards of 1.5-2.5 inches per hour. Total rainfall was 1-3 inches with localized amount up to 4-5 inches.
8/18/2024	Flash Flood	Countywide	0	0	$0	A frontal system over the area on August 18th produced heavy thunderstorms that were fairly slow moving over northeast New Jersey. A cold front moving in from the west late in the afternoon produced heavy thunderstorms with an environmental MUCAPE of 2000-3000 J/kg and PWAT values of 1.7-1.8 inches. These slow moving thunderstorms produce rainfall rates of 1-3 inches per hour over New Jersey with total rainfall amounts of 2-4 inches. This resulted in widespread flash flooding during the evening of August 18th.

Source: NCDC-NCEI 2025

The flood of record on the Hackensack River occurred on April 16, 2007. The USGS gauge located on the Hackensack River at New Milford, New Jersey (01378500) recorded a flow of 11,600 cfs with an associated gauge height of 12.36 feet. This flow of record is much higher than the estimated 1% annual chance of exceedance peak flow on the Hackensack River at this location. The next highest discharge of 10,500 cfs occurred during Hurricane Irene. The discharge measured following Tropical Storm Floyd in September 1999 was 9,760 cfs.

National Flood Insurance Program (NFIP) Community Rating System (CRS)

Table 4.6-3 lists the municipalities in Bergen County that participate(d) in FEMA's Community Rating System (CRS) program. It should be noted that the Bergen County municipalities in the Meadowlands District (Carlstadt, East Rutherford, Little Ferry, Lyndhurst, Moonachie, North Arlington, Ridgefield, Rutherford, South Hackensack, and Teterboro) may participate in CRS through the New Jersey Sports and Exposition Authority[14].

Table 4.6-3 CRS Participation in Bergen County (effective April 1, 2025)[15]

CRS Number	Jurisdiction	Participation Status	Date Entered CRS	Current Effective Date	CRS Class (As of April 1, 2025)	% Discount For SFHA	% Discount For Non-SFHA
340026	Dumont, Borough of	Active	10/1/2017	10/1/2017	9	5	0
340031	Englewood, City of	Active	10/1/1991	10/1/2001	10	0	0
340037	Garfield, City of	Active	5/1/2012	10/1/2014	10	0	0
340046	Little Ferry, Borough of	Active	10/1/2015	10/1/2015	7	15	5
340047	Lodi, Borough of	Active	10/1/1992	10/1/1993	10	0	0
340067	Ridgewood, Village of	Active	10/1/1992	10/1/2018	6	20	10
340070	Rochelle Park, Township of	Active	10/1/2006	10/1/2019	7	15	5
340081	Westwood, Borough of	Active	10/1/2016	10/1/2016	8	10	5
340570	New Jersey Sports & Exposition Authority	Active	10/1/1992	5/1/2009	7	15	5
345309	Oakland, Borough of	Active	5/1/2017	5/1/2017	7	15	5

SOURCE: FEMA 2025

National Flood Insurance Program (NFIP) Policies

Table 4.6-4 NFIP Participation in Bergen County lists the number of policies, total number of losses, and the total number of closed paid losses on properties insured under the National Flood Insurance Program (NFIP) as of October 17, 2024[16]. **Table 4.6-5 Repetitive Loss (RL) and Severe Repetitive Loss Statistics** summarize statistics on Bergen County's Repetitive Loss (RL) and Severe Repetitive Loss (SRL) properties. There are 2,026 RL and SRL properties in Bergen County, but only 55 RL properties have been mitigated. There are no mitigated SRL properties in Bergen County[17].

Table 4.6-4 NFIP Participation in Bergen County

NFIP CID	Jurisdiction	Total Number of Active NFIP Policies as of 10/17/2024	Total Number of Losses as of 10/17/2024
340019	Allendale, Borough Of	38	48
340020	Bergenfield, Borough Of	78	171
340021	Bogota, Borough Of	9	29
340022	Carlstadt, Borough Of	9	79
340582	Cliffside Park, Borough Of	0	0
0340023	Closter, Borough Of	24	46

[14] NJSEA. 2019. Floodplain Management. https://www.njsea.com/floodplain-management/; NJSEA. 2019. The Meadowlands District. https://www.njsea.com/meadowlands-district/.
[15] FEMA. 2019. April 2019 NFIP Flood Insurance Manual. https://www.fema.gov/media-library-data/1559830308363-e690ed2aea6606fb81826904e4a7bd7f/app-f_crs_508_apr2019.pdf.
[16] FEMA. 2018. Loss Statistics from Jan 1, 1978 through report "AS OF" date below. https://bsa.nfipstat.fema.gov/reports/1040.htm#34; FEMA. 2019. Policy & Claim Statistics for Flood Insurance. https://www.fema.gov/policy-claim-statistics-flood-insurance.
[17] FEMA. 2018. SRL Statistics (Confidential).

NFIP CID	Jurisdiction	Total Number of Active NFIP Policies as of 10/17/2024	Total Number of Losses as of 10/17/2024
340024	Cresskill, Borough Of	37	88
340025	Demarest, Borough Of	21	30
340026	Dumont, Borough Of	68	144
340028	East Rutherford, Borough Of	62	256
340029	Edgewater, Borough Of	1,610	110
340500	Elmwood Park, Borough Of	38	115
340030	Emerson, Borough Of	12	34
340031	Englewood, City Of	495	392
340033	Fair Lawn, Borough Of	139	362
340034	Fairview, Borough Of	5	23
340035	Fort Lee, Borough Of	11	22
340036	Franklin Lakes, Borough Of	23	31
340037	Garfield, City Of	70	364
340038	Glen Rock, Borough Of	35	39
340039	Hackensack, City Of	483	504
340040	Harrington Park, Borough Of	19	18
340041	Hasbrouck Heights, Borough Of	14	25
340042	Haworth, Borough Of	11	7
340043	Hillsdale, Borough Of	67	409
340044	Ho-Ho-Kus, Borough Of	35	56
340045	Leonia, Borough Of	26	20
340046	Little Ferry, Borough Of	531	1,376
340047	Lodi, Borough Of	194	1,107
340048	Lyndhurst, Township Of	187	498
340049	Mahwah, Township Of	159	241
340050	Maywood, Borough Of	20	49
340051	Midland Park, Borough Of	16	21
340052	Montvale, Borough Of	20	14
340053	Moonachie, Borough Of	128	265
340570	New Jersey Meadowlands Commission	732	528
340054	New Milford, Borough Of	100	797
340055	North Arlington, Borough Of	25	57
340056	Northvale, Borough Of	62	46
340057	Norwood, Borough Of	23	24
345309	Oakland, Borough Of	89	683
340059	Old Tappan, Borough Of	11	37
340060	Oradell, Borough Of	22	35
340061	Palisades Park, Borough Of	2	23
340062	Paramus, Borough Of	136	194
340063	Park Ridge, Borough Of	104	25
340064	Ramsey, Borough Of	53	35
340066	Ridgefield Park, Village Of	210	246
340065	Ridgefield, Borough Of	82	126

NFIP CID	Jurisdiction	Total Number of Active NFIP Policies as of 10/17/2024	Total Number of Losses as of 10/17/2024
340067	Ridgewood, Village Of	164	435
340068	River Edge, Borough Of	26	103
340069	River Vale, Township Of	37	136
340070	Rochelle Park, Township Of	245	899
340071	Rockleigh, Borough Of	7	4
340072	Rutherford, Borough Of	89	268
340074	Saddle Brook, Township Of	238	448
340073	Saddle River, Borough Of	26	101
340515	South Hackensack, Township Of	18	75
340075	Teaneck, Township Of	98	109
340076	Tenafly, Borough Of	52	59
340537	Teterboro, Borough Of	6	3
340077	Upper Saddle River, Borough Of	47	71
340078	Waldwick, Borough Of	29	36
340079	Wallington, Borough Of	165	725
340080	Washington, Township Of	26	60
340081	Westwood, Borough Of	230	685
340082	Woodcliff Lake, Borough Of	32	29
340083	Wood-Ridge, Borough Of	24	46
340084	Wyckoff, Township Of	28	38
	Bergen County Total	11,187	12,526

Source: FEMA 2018; FEMA 2024

Table 4.6-5 Repetitive Loss (RL) and Severe Repetitive Loss (SRL) Statistics

Jurisdiction	Total Number of RL Properties	Total Number of SRL Properties	Total Number of RL and SRL Combined	Total Number of Mitigated Properties	Total Number of RL Payments
Allendale, Borough Of	4	1	5	0	$150,344
Alpine, Borough of	0	0	0	0	$0
Bergenfield, Borough Of	7	0	7	0	$218,453
Bogota, Borough Of	3	1	4	0	$238,975
Carlstadt, Borough Of	4	2	6	0	$1,061,162
Cliffside Park, Borough of	0	0	0	0	$0
Closter, Borough Of	4	1	5	0	$260,349
Cresskill, Borough Of	5	2	7	0	$430,064
Demarest, Borough Of	4	1	5	0	$183,931
Dumont, Borough Of	9	0	9	0	$149,116
East Rutherford, Borough Of	34	13	47	0	$3,810,298
Edgewater, Borough Of	2	2	4	0	$2,421,538
Elmwood Park, Borough Of	7	3	10	0	$1,207,506
Emerson, Borough Of	2	1	3	0	$109,874
Englewood Cliffs, City of	0	0	0	0	$0
Englewood, City Of	42	2	44	0	$4,519,681

Jurisdiction	Total Number of RL Properties	Total Number of SRL Properties	Total Number of RL and SRL Combined	Total Number of Mitigated Properties	Total Number of RL Payments
Fair Lawn, Borough Of	23	7	30	0	$1,795,901
Fairview, Borough Of	3	0	3	0	$1,220,102
Franklin Lakes, Borough Of	4	0	4	0	$69,063
Garfield, City Of	30	6	36	0	$2,656,906
Glen Rock, Borough Of	1	0	1	0	$9,230
Hackensack, City Of	60	15	75	0	$10,168,758
Harrington Park, Borough Of	2	0	2	0	$52,127
Hasbrouck Heights, Borough Of	3	0	3	0	$456,608
Haworth, Borough Of	2	0	2	0	$29,595
Hillsdale, Borough Of	27	21	48	0	$5,028,854
Ho-Ho-Kus, Borough Of	3	1	4	0	$100,252
Leonia, Borough Of	1	0	1	0	$79,592
Little Ferry, Borough Of	99	10	109	0	$13,846,911
Lodi, Borough Of	90	43	133	0	$21,107,106
Lyndhurst, Township Of	90	21	111	5	$9,114,972
Mahwah, Township Of	14	10	24	0	$2,369,747
Maywood, Borough Of	5	0	5	0	$104,879
Midland Park, Borough Of	2	0	2	0	$70,820
Montvale, Borough Of	1	0	1	0	$40,467
Moonachie, Borough Of	11	3	14	0	$9,948,972
New Jersey Meadowlands Commission	110	0	110	2	$20,985,889
New Milford, Borough Of	11	49	60	0	$22,421,164
North Arlington, Borough Of	10	1	11	0	$984,021
Northvale, Borough Of	9	0	9	0	$1,664,417
Norwood, Borough Of	2	1	3	0	$196,640
Oakland, Borough Of	31	22	53	0	$5,284,926
Old Tappan, Borough Of	3	0	3	0	$116,209
Oradell, Borough Of	1	0	1	0	$76,453
Palisades Park, Borough Of	2	0	2	0	$4,365,066
Paramus, Borough Of	13	1	14	0	$1,054,714
Ridgefield Park, Village Of	43	4	47	0	$2,530,407
Ridgefield, Borough Of	11	2	13	0	$915,675
Ridgewood, Village Of	23	6	29	0	$2,003,465
River Edge, Borough Of	13	3	16	0	$3,487,188
River Vale, Township Of	16	5	21	0	$3,535,307
Rochelle Park, Township Of	106	40	146	2	$19,230,652
Rutherford, Borough Of	37	17	54	0	$4,217,3834
Saddle Brook, Township Of	41	9	50	0	$8,223,295
Saddle River, Borough Of	5	4	9	0	$762,945
South Hackensack, Township Of	12	0	12	0	$1,148,181
Teaneck, Township Of	11	0	11	0	$227,120

Jurisdiction	Total Number of RL Properties	Total Number of SRL Properties	Total Number of RL and SRL Combined	Total Number of Mitigated Properties	Total Number of RL Payments
Tenafly, Borough Of	8	0	8	0	$146,983
Upper Saddle River, Borough Of	6	0	6	0	$170,700
Waldwick, Borough Of	1	0	1	0	$6,651
Wallington, Borough Of	81	23	104	0	$8,434,024
Washington, Township Of	4	1	5	0	$204,216
Westwood, Borough Of	59	36	95	0	$10,409,679
Woodcliff Lake, Borough Of	3	0	3	0	$131,246
Wood-Ridge, Borough Of	11	0	11	0	$456,302
Wyckoff, Township Of	1	0	1	0	$53,071
Bergen County Total*	**1,896**	**130**	**2,026**	**55**	**$190,633,770**

Source: FEMA 2024

Probability of Future Occurrences

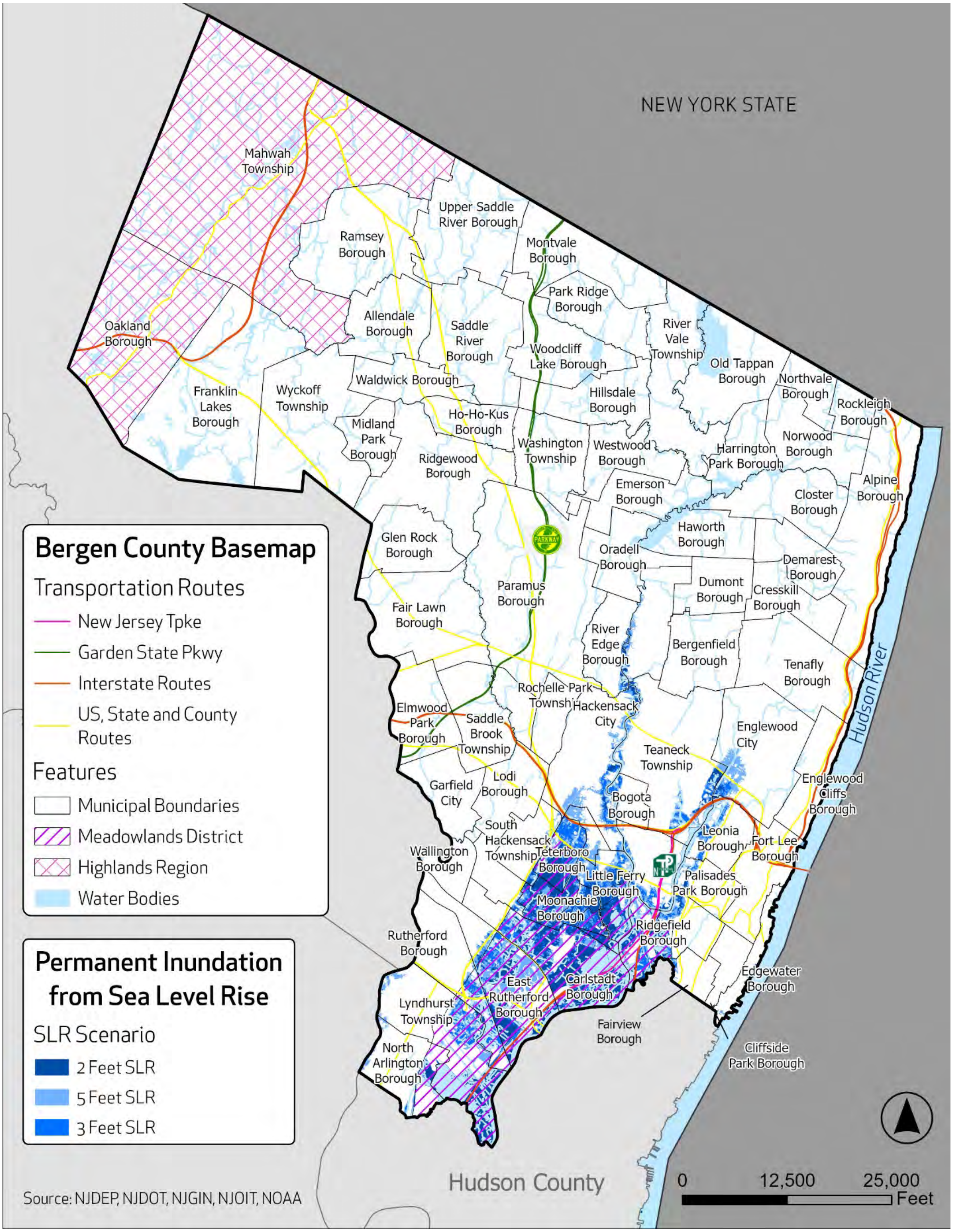
Flooding will continue to have a high probability of occurrences in Bergen County, and the probability of future occurrences in Bergen County is certain. The probability of future flood events based on magnitude and according to best available data is illustrated.

Potential Effects of Climate Change

Climate change is expected to significantly exacerbate flooding in Bergen County through increased precipitation intensity, more frequent flash floods, and sea level rise influencing tidal backflow in the lower Hackensack River basin. Urbanization compounds this risk by limiting natural infiltration and overwhelming outdated stormwater systems. More frequent extreme rainfall events could transform historically moderate floodplains into high-risk zones, increasing the frequency of repetitive loss properties and straining local drainage infrastructure.

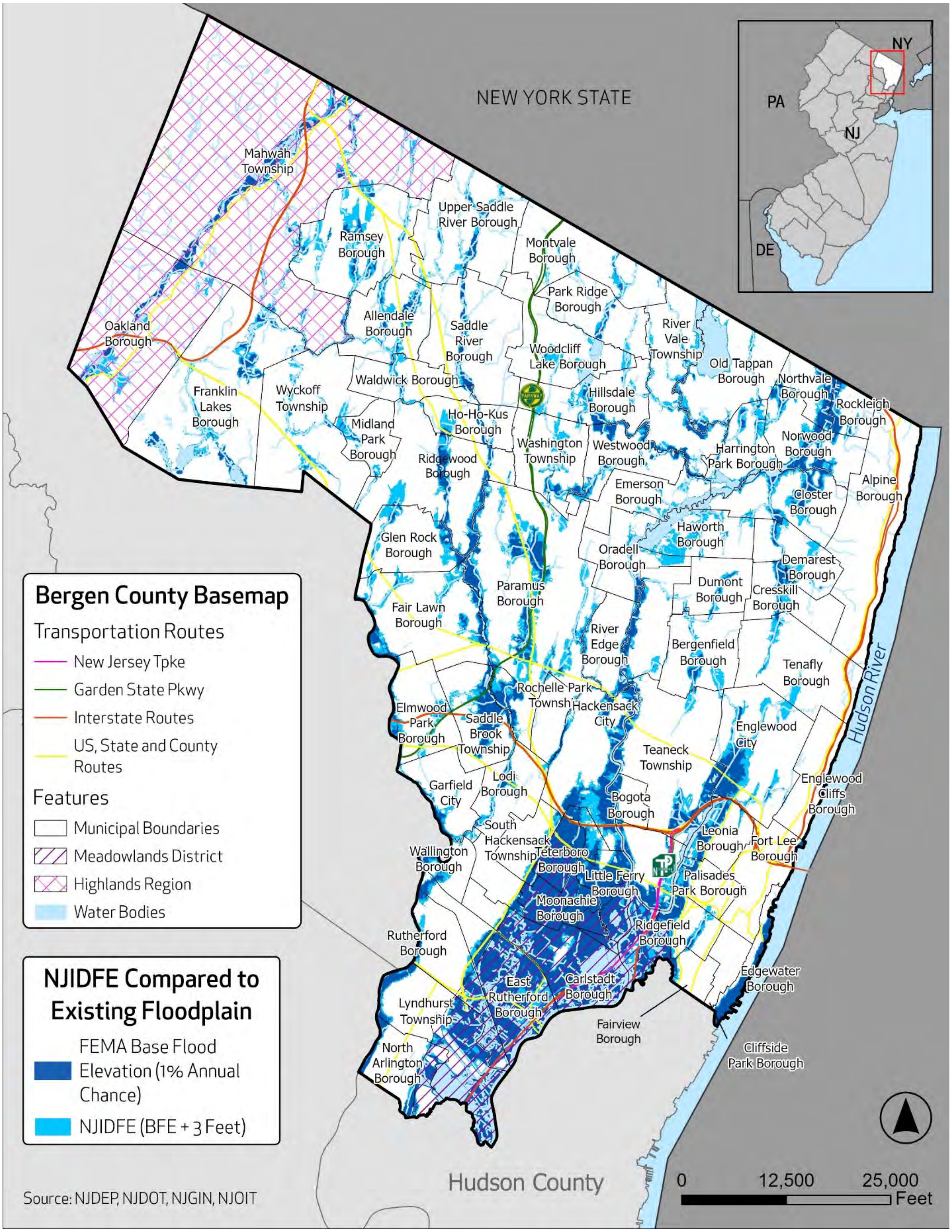
Sea level rise continues to impact areas along the Atlantic Coast of New Jersey. These effects will reach some low lying and inland communities (including wetlands geographies of southern Bergen County) as rivers that empty into either the Atlantic or coastal bays, including the Hackensack River, Saddle River, and Hudson River, will experience a subsequent rise in their water levels**. Figure 4.6-3 Permanent Inundation from Sea Level Rise in Bergen County** visualizes three potential flooding from sea level rise scenarios, at 2- , 3-, and 5- foot levels (measured from current mean high-water levels), and their resulting areas of permanent inundation in Bergen County. Inundation in these scenarios follows the low-lying wetlands ecosystems of the Meadowlands District as well as follows the Hackensack River north to central Bergen County.

Figure 4.6-3 Permanent Inundation Under Sea Level Rise Scenarios in Bergen County



On July 17, 2023, NJDEP adopted its Inland Flood Protection Rule, which, among other actions, established a new Design Flood Elevation (DFE) standard for specific types of new construction and redevelopment. The new DFE is 3 feet above the elevation of the 1% Chance Annual Flood for New Jersey (which is also known as the '100-year flood') or, where NJDEP flood mapping is available, 2 feet above NJDEP's flood hazard area design flood elevation, if that results in a DFE higher than FEMA's 1% flood plus 3 feet. To help visualize the new rule, Rutgers University created the NJ Inland Design Flood Elevation Layer, which can be used as a non-regulatory planning tool to help visualize potential future conditions in the State. **Figure 4.6-4 NJ Inland Design Flood Elevation** shows the recent New Jersey Inland Design Flood Elevation in bright sky blue, in comparison to the existing BFE which is depicted in navy blue.

Figure 4.6-4 NJ Inland Design Flood Elevation



Sea Level Rise Exposure and Damage Estimates

Table 4.6-6 shows the number and percentage of critical facilities with risk of sea level rise. Georeferenced critical facility data points were then intersected with the estimated inundation zone caused by an increase of 1 foot and an increase of 3 feet above the current mean higher high-water level (MHHW) in Northern New Jersey as determined by the NOAA Office of Coastal Management. Only the jurisdictions whose critical facilities are at risk of sea level rise are included in the table below. Notably, an additional 3 feet of sea level rise is projected to inundate 69% of Little Ferry's critical facilities, 50% of Teterboro's critical facilities, and 100% of Moonachie's critical facilities[18].

Table 4.6-6 Total Number and Percent of Critical Facilities, Critical Infrastructure, and Historic & Cultural Resources Vulnerable to Sea Level Rise

Jurisdiction	Number of Critical Facilities at Risk of Sea Level Rise		Percentage of Critical Facilities at Risk of Sea Level Rise	
	1 FT Rise	3 FT Rise	1 FT Rise	3 FT Rise
Fairview Borough	0	1	0%	20%
Hackensack City	0	1	0%	6%
Hasbrouck Heights Borough	0	1	0%	11%
Leonia Borough	0	2	0%	13%
Little Ferry Borough	0	9	0%	69%
Moonachie Borough	2	7	29%	100%
Palisades Park Borough	0	1	0%	10%
Ridgefield Park Borough	1	0	6%	0%
River Edge Borough	0	1	0%	9%
Teaneck Township	0	1	0%	2%
Teterboro Borough	0	3	0%	50%
Wood-Ridge Borough	0	1	0%	20%
Closter Borough	1	1	17%	17%
Leonia Borough	1	1	20%	20%
Little Ferry Borough	1	6	9%	55%
Moonachie Borough	0	4	0%	100%
New Milford Borough	10	10	100%	100%
South Hackensack Township	0	1	0%	50%
Teterboro Borough	0	1	0%	100%

Vulnerability Assessment

Since the creation of New Jersey's Coastal Zone Management (CZM) Program in 1980, the NJDEP has regulated development and other related activities in coastal areas to reduce the probability of impact from coastal erosion and flooding, as well as to protect the sensitive coastal environment from human disturbance. These areas include:

- Lands regulated under the Coastal Area Facility Review Act (CAFRA);
- State tidal waters from mean high water (MHW) to the 3-mile limit;
- New Jersey Meadowlands District;
- Tidal wetlands; and
- Properties located between the MHW line landward to the first public roadway, if between 100 and 500 feet of the MHW line.

As noted earlier in the Bergen County HMP, parts of ten Bergen County municipalities are located within the New Jersey Meadowlands District - Carlstadt, East Rutherford, Little Ferry, Lyndhurst, Moonachie, North Arlington, Ridgefield, Rutherford, South Hackensack, and Teterboro. The majority of these municipalities have properties located along the Hackensack River or

[18] NOAA Office of Coastal Management. 2017. NOAA Office for Coastal Management Sea Level Rise Data: 1-10 ft Sea Level Rise Inundation Extent. https://www.coast.noaa.gov/slr

tidal tributaries of the river. They also contain numerous tidal wetlands. These municipalities have been some of the most severely impacted by coastal flooding in the County in the past and remain susceptible.

Built Environment, Infrastructure, and Community Lifelines

Flooding is one of the most significant and recurring natural hazards in Bergen County, with a long history of damage to the built environment. Low-lying areas along the Hackensack River, Saddle River, Ramapo River, Passaic River, and their tributaries are particularly susceptible to riverine flooding, while urban centers such as Hackensack, Ridgewood, Lodi, Little Ferry, Moonachie, and Fair Lawn often experience flash flooding due to aging or undersized stormwater systems and high impervious surface coverage.

Repeated flood events, including remnants of hurricanes like Ida (2021), have caused widespread basement flooding, roadway washouts, damage to building foundations, and infiltration of sewer systems. In communities with older housing stock or dense development, water damage is more difficult to mitigate, and post-flood mold issues create long-term structural and health concerns.

Public infrastructure is also highly vulnerable. Roads, culverts, bridges, and stormwater systems may be overrun or structurally compromised during high-intensity rainfall or prolonged storm events. Critical transportation corridors such as Route 17, Interstate 80, and local NJ Transit lines are frequently disrupted. Water treatment facilities and electrical substations located within or adjacent to floodplains may also be affected, creating cascading service interruptions.

Population and Economy

Flooding in Bergen County frequently impacts residential areas, including neighborhoods with higher concentrations of low- to moderate-income households, renters, and non-English-speaking populations. These groups often lack the resources for timely evacuation, mitigation retrofits, or post-disaster recovery. Multifamily housing, mobile homes, and subsidized housing developments in flood-prone areas face elevated risk due to limited options for relocation or elevation.

Repetitive loss properties—homes or buildings that have received multiple flood insurance claims—are concentrated in municipalities like Lodi, New Milford, Rochelle Park, South Hackensack, and River Edge, underscoring persistent exposure despite past events. Residents in these areas may experience long-term housing instability, reduced property values, and financial strain.

Economically, floods cause direct losses to businesses through property damage, inventory loss, and operational downtime. Commercial and industrial zones in flood-prone areas, particularly in the Meadowlands District and along Route 46 and Route 17 corridors, may suffer significant disruption. The impacts on small businesses and warehouse distribution centers—especially those without adequate insurance—can have ripple effects on employment and supply chains.

Ecosystems and Natural Assets

Flooding affects both natural ecosystems and the services they provide. Wetlands along the Hackensack Meadowlands, Saddle River, and Ramapo River serve critical roles in flood storage, water filtration, and habitat provision. However, repeated flood exposure—particularly in urbanized watersheds—can lead to sedimentation, invasive species introduction, and wetland degradation.

Riparian buffers and floodplain forests, especially in county parks and conservation lands like the Teaneck Creek Conservancy and Ramapo Valley Reservation, are at risk from both floodwater scouring and human encroachment. Streambank erosion from high-energy flows during storm events increases downstream sediment loads, negatively impacting water quality and aquatic habitats.

Urban stormwater runoff, often laden with pollutants (e.g., oil, metals, road salt), exacerbates the ecological impact of flood events, especially in degraded watersheds. Natural assets in flood-prone areas also face pressure from stormwater infrastructure expansion, which may fragment habitats and alter natural hydrology.

4.7 HURRICANES, TROPICAL STORMS, AND NOR'EASTERS

Hazard Description

Hurricanes, tropical storms, and nor'easters are low-pressure systems that can result in damaging winds, precipitation, and other hazardous weather phenomenon such as tornadoes and lightning strikes. These storms have enormous potential for damage due to the variety of weather outcomes.

These storms are all considered cyclonic storms, which have winds that spiral around a central low-pressure zone. Hurricanes and tropical storms are considered tropical cyclones, as they originate over warmer waters and thrive on warmer air. Nor'easters are fueled by cold air, as they are formed when colder air, typically originating in Canada, interacts with warmer coastal air above the Atlantic Ocean. These storms strengthen when water evaporated from the ocean is released as the saturated air rises, resulting in condensation of water vapor contained in the moist air. This requirement of warm coastal air results in coastal regions being the most susceptible for significant damage, while inland regions tend to be relatively safe from receiving strong winds.

Tropical Storm
According to NOAA, tropical storms and tropical depressions, while generally less dangerous than hurricanes due to their slower wind speeds, can be deadly. The winds of tropical depressions/storms are usually not the greatest threat; rather, the rains, flooding, and severe weather such as thunderstorms associated with them are what customarily cause more significant problems.

Hurricane
A hurricane is a tropical storm that attains hurricane status when its wind speed reaches 74 or more miles an hour. Because of its northern location on the Atlantic coastline, direct hits by storms of hurricane strength have a relatively low probability in New Jersey compared to the Southern coastal and Gulf States. They tend to either travel up the coastline or over land through the United States. It is possible, though rare, for the entire State to be impacted by hurricanes. As stated above, wind effects tend to be concentrated in coastal areas of New Jersey. Storms of this intensity develop a central eye that is an area of relative calm and the lowest atmospheric pressure. Surrounding the eye is a circulating eye wall and the strongest thunderstorms and winds (NJOEM, 2011).

Nor'easter
A nor'easter is a cyclonic storm that moves along the East Coast of North America, receiving its name due to the damaging winds over coastal areas that blow from a northeasterly direction. These storms usually develop between Georgia and New Jersey within 100 miles of the coastline and typically move from southwest to northeast along the Atlantic Coast of the United States (NOAA, 2013). To be called a nor'easter, a storm must have the following conditions, as per the Northeast Regional Climate Center (NRCC):

- Must persist for at least a 12-hour period
- Have a closed circulation
- Be located within the quadrilateral bounded at 45°N by 65° and 70°W and at 30°N by 85°W and 75°W
- Show general movement from the south-southwest to the north-northeast
- Contain wind speeds greater than 23 miles per hour (mph)

The intensity of a nor'easter can rival that of a tropical cyclone in that, on occasion, it may flow or stall off the mid-Atlantic coast resulting in prolonged episodes of precipitation, coastal flooding, and high winds. Nor'easters are a common winter occurrence in New Jersey and these storms repeatedly result in erosion damage to structures and natural resources, such as beaches, dunes, and coastal bluffs. The erosion of coastal features commonly results in greater potential for damage to shoreline development from future storms.

Location, Extent, and Magnitude

New Jersey and its coastal communities are vulnerable to the damaging impacts of major storms along its 127 miles of coastline. Within Bergen County, the state's coastal zone includes the New Jersey Meadowlands. A Category 1 hurricane event would predominantly impact the Hackensack Meadowlands District and the Hackensack River communities in general, up to the Oradell Reservoir in Oradell, NJ. While the New Jersey's Hudson River communities are marginally impacted – even up to a Category 4 hurricane – communities around both the Passaic River and the Overpeck Creek (a tributary of the Hackensack River) are likely affected. As development and redevelopment increase, less-intense storms and potential sea level rise may lead to costly storm damage.

As a hurricane develops, barometric pressure (measured in millibars or inches) at its center falls and winds increase. If the atmospheric and oceanic conditions are favorable, it can intensify into a tropical depression. When maximum sustained winds reach or exceed 39 mph, the system is designated a tropical storm, given a name and is closely monitored by the National Hurricane Center in Miami, Florida. When sustained winds reach 74 mph the storm is deemed a hurricane.

Hurricane intensity is further classified by the Saffir-Simpson Scale (**Table 4.7-1 Saffir-Simpson Hurricane Scale**), which rates hurricane intensity in categories on a scale of 1 to 5, with Category 5 being the most intense. The Saffir-Simpson Scale categorizes hurricane intensity linearly based upon maximum sustained winds, barometric pressure and storm surge potential, which are combined to estimate potential damage. Categories 3, 4 and 5 are classified as "major" hurricanes; while hurricanes within this range comprise only 20 percent of total tropical cyclone landfalls, they account for over 70 percent of the damage in the United States.

Table 4.7-1 Saffir-Simpson Hurricane Scale

Storm Category	Sustained Winds	Types of Damage Due to Hurricane Winds
1	74-95 mph	Very dangerous winds will produce some damage: Homes with well- constructed frames could have damage to roof, shingles, vinyl siding, and gutters. Large branches of trees will snap, and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110 mph	Extremely dangerous winds will cause extensive damage: Homes with well-constructed frames could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3 (Major)	111-129 mph	Devastating damage will occur: Homes with well-built frames may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4 (Major)	130-156 mph	Catastrophic damage will occur: Homes with well-built frames can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted, and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Storm Category	Sustained Winds	Types of Damage Due to Hurricane Winds
5 (Major)	>157 mph	Catastrophic damage will occur: A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Source: National Oceanic and Atmospheric Administration 2013

While there are a variety of indicators to describe nor'easter intensity, **Table 4.7-2 Dolan-Davis Nor'easter Intensity Scale** describes intensity classifications based on resulting coastal storm erosion, degradation, and property damage.

Table 4.7-2 Dolan-Davis Nor'easter Intensity Scale

Storm Class	Beach Erosion	Dune Erosion	Overwash	Property Damage
1-WEAK	Minor changes	None	No	No
2-MODERATE	Modest; mostly to lower beach	Minor	No	Modest
3-SIGNIFICANT	Erosion extends across beach	Can be significant	No	Loss of many structures at local level
4-SEVERE	Severe beach erosion and recession	Severe dune erosion or destruction	On low beaches	Loss of structures at community-scale
5-EXTREME	Extreme beach erosion	Dunes destroyed over extensive areas	Massive in sheets and channels	Extensive at regional scale; millions of dollars

Source: FEMA

Previous Occurrences and Losses

Bergen County has a history of hurricanes and tropical storms. For each event, **Table 4.7-3 Past Occurrences of Tropical Storms and Hurricanes in Bergen County** provides the date of occurrence, storm name (if applicable), counties affected, and a brief description. Notable storms are described in further detail below.

Hurricane Irene

Hurricane Irene came ashore in Little Egg Inlet in Southern New Jersey on August 28, 2011. Mandatory evacuations were ordered throughout the State of New Jersey. Wind speeds were recorded at 75 mph and rainfall totals reached over 10 inches in many parts of the State. Extensive flooding throughout Bergen County caused damage to homes, businesses, and public infrastructure. The flooding was exacerbated by high water levels in reservoirs and wetlands as a result of previous heavy rains. Over 1 million customers lost power during the storm. Overall damage estimates for the State of New Jersey came to over $1 billion, with over 200,000 homes and buildings being damaged. The County received more than $48 million in Federal loans and grants to cover the storm damages.

Superstorm Sandy

Superstorm Sandy came ashore as an immense tropical storm in Brigantine, New Jersey, on October 29, 2012. Although rainfall was limited to less than 2 inches within Bergen County, wind gusts were recorded up to 76 mph. A full moon made the high tides 20 percent higher than normal and amplified the storm surge. Sandy wreaked havoc on Bergen County with surges that registered approximately 4-5 feet above average high tide (NAVD88). Approximately 346,000 homes in New Jersey were damaged – of which 22,000 were uninhabitable – and nearly 19,000 businesses sustained damage of $250,000 or more[19]. The New Jersey shore suffered the most damage. Seaside communities were damaged and destroyed up and down the coastline. Although protected from severe waves, the Bergen County shoreline within the New York-

[19] Blake, et al, Tropical Cyclone Report, Hurricane Sandy, National Hurricane Center, February 12, 2013.

New Jersey Harbor experienced record storm surge elevations. Some 2.7 million households within New Jersey lost power. Superstorm Sandy was estimated to cost the State of New Jersey over $36 billion.

In Bergen County, Little Ferry and Moonachie flooded significantly due to the tidal surge which overtopped berms and the edge of the Hackensack River. The massive volume of water was pushed inland from Newark Bay to the Hackensack River. The height of the berms, which were constructed by the Bergen County Mosquito Commission to control standing water, allowed water to flow into Little Ferry and surrounding municipalities, and also prevented the water from receding. Little Ferry's Main Street Pump Station did not have a generator, which prevented any water from being pumped out and prolonged the "bathtub effect[20]."

Superstorm Sandy highlighted the deficiencies facing many Bergen municipalities regarding disaster preparedness and the ability to recover from such a natural disaster: issues with lack of jurisdiction to control floodwaters; lack of flood capacity in such a highly developed county; a wide range of infrastructure issues including those related to deficiencies with ditches, grates, pumps, outfalls, and sewer systems; critical facilities located in hazard areas; lack of early warning systems in many areas; dependence upon electricity (and the lack of backup power for critical facilities); and the existing natural gas infrastructure. Issues such as these led to a very difficult recovery for many Bergen towns in the

Table 4.7-3 Past Occurrences of Tropical Storms and Hurricanes in Bergen County (1950 to April 2019)

Date(s) of Event	Event Type	Counties Affected	Description
September 11-12, 1950	Hurricane Dog	Statewide	Average rainfall amounts were 1.07 inches. Maximum rainfall total was 4.34 inches at the Canton station.
August 20-21, 1950	Hurricane Able	Statewide	Average rainfall amounts were 1.29 inches. Maximum rainfall total was 3.5 inches at the Freehold Marlboro
August 31-September 1, 1952	Hurricane Able	Statewide	Average rainfall amounts were 2.42 inches. Maximum rainfall total was 5.64 inches at the Oak Ridge Reservoir (Morris County) station.
February 04, 1952	Tropical Storm	Statewide	Average rainfall amounts were 1.13 inches. Maximum rainfall total was 1.99 inches at the Vineland station.
August 14-15, 1953	Hurricane Barbara	Statewide	Average rainfall amounts were 1.23 inches. Maximum rainfall total was 5.98 inches at the Tuckerton (Ocean County) station.
October 15-16, 1954	Hurricane Hazel	Statewide	Average rainfall amounts were 0.35 inch. Maximum rainfall total was 1.24 inches at the Pleasantville station.
September 10-11, 1954	Hurricane Edna	Statewide	Average rainfall amounts were 3.55 inches. Maximum rainfall total was 6.38 inches at the Lakehurst station.
August 30-31, 1954	Hurricane Carol	Statewide	Average rainfall amounts were 2.61 inches. Maximum rainfall total was 5.25 inches at the Midland Park (Bergen County) station.
September 19-20, 1955	Hurricane Ione	Statewide	Average rainfall amounts were 0.65 inch. Maximum rainfall total was 4.17 inches at the Berlin station.
August 17-19, 1955	Hurricane Diane	Statewide	Average rainfall amounts were 2.91 inches. Maximum rainfall total was 8.1 inches at the Sussex (Sussex County) station.
August 12-13, 1955	Hurricane Connie	Statewide	Average rainfall amounts were 6.28 inches. Maximum rainfall total was 10.89 inches at the Canistear Reservoir (Sussex County) station.
September 27-28, 1956	Hurricane Flossy	Statewide	Average rainfall amounts were 0.47 inch. Maximum rainfall total was 3.41 inches at the Shiloh station.
August 28-29, 1958	Hurricane Daisy	Statewide	Average rainfall amounts were 0.06 inch. Maximum rainfall total was 0.4 inch at the Belmar/Bass River State Forest station.
September 27-28, 1958	Hurricane Helene	Statewide	Average rainfall amounts were 1.68 inches. Maximum rainfall total was 3.41 inches at the Shiloh station.
September 30-October 1, 1959	Hurricane Gracie	Statewide	Average rainfall amounts were 0.99 inch. Maximum rainfall total was 2.87 inches at the Oak Ridge Reservoir (Morris County) station.

[20] Clark Caton Hintz, Strategic Recovery Report for the Borough of Little Ferry, April 8, 2014.

Date(s) of Event	Event Type	Counties Affected	Description
July 10-11, 1959	Hurricane Cindy	Statewide	Average rainfall amounts were 0.9 inch. Maximum rainfall total was 8.43 inches at the Belleplain SF (Cape May County) station.
September 12, 1960	Hurricane Donna	Statewide	Avg rainfall amounts were 4.91 inches. Maximum rainfall total was 8.99 inches at the Hammonton (Atlantic County) station. Maximum wind gust of 100 mph was observed in Wildwood (Cape May County). Max storm surge of seven feet was reported in Long Branch (Monmouth County). Tides were 5.7 feet above normal. Considerable damage to piers and beach front homes. Hurricane Donna caused three fatalities and $6.9 million in damages in New
July 29-30, 1960	Hurricane Brenda	Statewide	Average rainfall amounts were 3.65 inches. Maximum rainfall total was 6.27 inches at the Cedar Grove station.
September 20-21 and 25, 1961	Hurricane Esther	Statewide	Average rainfall amounts were 1.62 inches. Maximum rainfall total was 5.6 inches at the Tuckerton (Ocean County) station. Maximum wind gust of 68 mph was observed in Atlantic City (Atlantic County). High surf and rip tides were also reported.
August 28-29, 1962	Hurricane Alma	Statewide	Average rainfall amounts were 2.14 inches. Maximum rainfall total was 4.85 inches at the Pemberton (Burlington County) station. Maximum wind gusts were below 20 mph. High surf and rip tides were reported.
October 16-18, 1964	Hurricane Isabell	Statewide	Average rainfall amounts were 0.72 inch. Maximum rainfall total was 2.01 inches at the Belleplain SF (Cape May County) station. Maximum wind gusts were below 20 mph.
September 13-14, 1964	Hurricane Dora	Statewide	Average rainfall amounts were 0.44 inch. Maximum rainfall total was 2.9 inches at Hightstown station. Maximum wind gusts were below 20 mph. High surf and rip tides were reported.
June 12-13, 1966	Hurricane Alma	Statewide	Average rainfall amounts were 0.18 inch. Maximum rainfall total was 0.91 inch at the Bass River State Forest station. Maximum wind gusts of 26 mph in Atlantic City (Atlantic County). Maximum storm surge of 4.5 feet was reported in Atlantic City (Atlantic County).
September 15-17, 1967	Hurricane Doria	Statewide	The avg rainfall for this event was 0.26 inch, with a max of 0.94 inch at the Lakehurst station. A maximum wind gust of 39 mph in Atlantic City (Atlantic County). High surf and rip tides were associated with this storm. Three boaters drowned on their way to Boston due to this event.
August 19-21, 1969	Hurricane Camille	Statewide	The average rainfall for this event was 0.19 inch, with a maximum of 1.25 inches at the Fortescue (Cumberland County) station. Maximum wind gusts were below 20 mph.
September 8-9, 1969	Hurricane Gerda	Statewide	The average rainfall for this event was 0.58 inch, with a maximum total of 1.78 inches at the Fortescue (Cumberland County) station. Maximum wind gusts were below 20 mph.
August 27-29, 1971	Hurricane Doria	Statewide	The average rainfall for this event was 7.09 inches, with a maximum total of 10.29 inches at the Little Falls (Passaic County) station. A maximum wind gust of 54 mph was reported at Atlantic City (Atlantic County). A maximum storm surge of 5.3 feet was also reported at Atlantic City (Atlantic County). Total damages in New Jersey were estimated at $772 M. Three deaths were attributed to this event.
October 2-4, 1971	Hurricane Ginger	Statewide	The average rainfall for this event was 0.23 inch, with a maximum total of 1.64 inches at the Sea Brooks Farms (Cumberland County) station. Maximum wind gusts were below 20 mph. High surf and rip tides were associated with this storm.
June 21-25, 1972	Hurricane Agnes	Statewide	The average rainfall for this event was 3.4 inches, with a maximum total of 6.44 inches at the Canton station. Maximum wind gusts were below 20 mph. Total damages in New Jersey were estimated at $15 M. One death was attributed to this storm.

Date(s) of Event	Event Type	Counties Affected	Description
September 3-4, 1972	Hurricane Carrie	Statewide	The average rainfall for this event was 0.28 inch, with a maximum total of 1.73 inches at the Cape May (Cape May County) station. Maximum wind gusts were below 20 mph.
September 24-28, 1975	Hurricane Eloise	Statewide	The average rainfall for this event was 5.45 inches, with a maximum total of 8.94 inches at the Hightstown (Mercer County) station. Maximum wind gusts were below 20 mph. High surf and rip tides were associated with this event.
June 30-31, 1975	Hurricane Amy	Statewide	The average rainfall for this event was 0.08 inch, with a maximum total of 0.63 inch at the Morris Plains (Morris County) station. Maximum wind gusts were below 20 mph.
October 27-28, 1975	Hurricane Hallie	Statewide	The average rainfall for this event was 0.02 inch, with a maximum of 0.3 inch at the Fortescue station. Maximum wind gusts were below 20 mph.
August 9-10, 1976	Hurricane Belle	Statewide	The average rainfall for this event was 2.66 inches, with a maximum of 5 inches at the Mays Landing (Atlantic County) station. A maximum wind gust of 90 mph was reported at Ship Bottom. A maximum storm surge of 8.85 feet was reported in Atlantic City (Atlantic County). New Jersey had approximately $50 million in damages from this event.
September 16-18, 1976	Tropical Depression #8	Statewide	The average rainfall for this event was 1.32 inches, with a maximum of 3.44 inches at the Oak Ridge Reservoir (Morris County) station. Maximum wind gusts were below 20 mph.
September 7-8, 1977	Hurricane Clara	Statewide	The average rainfall for this event was 0.11 inch, with a maximum total of 1.03 inches at the Jersey City (Hudson County) station. Maximum wind gusts were below 20 mph.
September 10-11, 1977	Hurricane Babe	Statewide	The average rainfall for this event was 0.04 inch, with a maximum total of 1.22 inches at the Hammonton (Atlantic County) station. Maximum wind gusts were below 20 mph.
July 15-16, 1979	Hurricane Bob	Statewide	The average rainfall for this event was 0.26 inch, with a maximum total of 1.92 inches at the Hightstown (Atlantic County) station. Maximum wind gusts were below 20 mph.
July 29-30, 1979	Hurricane Claudette	Statewide	The average rainfall for this event was 0.37 inch, with a maximum of 2.05 inches at the Princeton Water Work station. Maximum wind gusts were below 20 mph.
September 14-16, 1979	Hurricane Frederic	Statewide	The average rainfall for this event was 0.47 inch, with a maximum of 1.25 inches at the High Point Park (Sussex County) station. Maximum wind gusts were below 20 mph.
September 6-8, 1979	Hurricane David	Statewide	The average rainfall for this event was 2.94 inches, with a maximum of 5.83 inches at the Ringwood (Passaic County) station. A maximum wind gust of 54 mph was reported in Trenton (Mercer County). High surf and rip tides were associated with this storm. This event caused a tornado outbreak in New Jersey.
November 15-17, 1981	Tropical Depression #12	Statewide	The average rainfall for this event was 0.48 inch, with a maximum of 1.35 inches at the Cape May (Cape May County) station. Maximum wind gusts were below 20 mph.
June 19-20, 1982	Tropical Storm #2	Statewide	The average rainfall for this event was 0.02 inch, with a maximum of 0.27 inch at the Atlantic City (Atlantic County) station. Maximum wind gusts were below 20 mph.
September 30-October 2, 1983	Hurricane Dean	Statewide	The average rainfall for this event was 1.25 inches, with a maximum of 2.35 inches at the Newark (Essex County) station. Maximum wind gusts were below 20 mph.
July 26-27, 1985	Hurricane Bob	Statewide	The average rainfall for this event was 1.92 inches, with a maximum of 3.52 inches at the Canistear Reservoir (Sussex County) station. Maximum wind gusts were below 20 mph.
August 19-20, 1985	Hurricane Danny	Statewide	The average rainfall for this event was 0.2 inch, with a maximum of 2.32 inches at the Cape May (Cape May County) station. Maximum wind gusts were below 20 mph.

Date(s) of Event	Event Type	Counties Affected	Description
September 23-25, 1985	Hurricane Henri	Statewide	The average rainfall for this event was 0.51 inch, with a maximum of 2.27 inches at the Belvidere (Warren County) station. Maximum wind gusts were below 20 mph.
September 27-28, 1985	Hurricane Gloria	Statewide	The average rainfall for this event was 3.69 inches, with a maximum of six inches at the Charlotteburg Reservoir (Passaic County) station. A maximum wind gust of 45 mph was reported at Ocean City (Cape May County). A maximum storm surge of 1.4 feet was reported at Ventor City Pier. Gloria paralleled the coast of New Jersey, downing trees and leaving 230,000 people without power. Approximately 100,000 coastal residents were evacuated. New Jersey had approximately $14.7 million in damages from this event.
June 8-9, 1986	Hurricane Andrew	Statewide	The average rainfall for this event was 0.14 inch, with a maximum of 0.6 inch at the Pottersville (Morris County) station. Maximum wind gusts were below 20 mph.
August 18-19, 1986	Hurricane Charley	Statewide	The average rainfall for this event was 0.89 inch, with a maximum of 3.32 inches at the Split Rock Pond station. A maximum wind gust of 54 mph was reported in Atlantic City (Atlantic County). A maximum storm surge of 1.65 feet was reported at Atlantic City (Atlantic County). Two deaths were attributed to this event.
August 7-8, 1988	Hurricane Alberto	Statewide	The average rainfall for this event was 0 inch, with a maximum total of 0.7 inch at the High Point Park (Sussex County) station. Maximum wind gusts were below 20 mph.
August 29-30, 1988	Hurricane Chris	Statewide	The average rainfall for this event was 0.88 inch, with a maximum total of 2.19 inches at the High Point Park (Sussex County) station. Maximum wind gusts were below 20 mph.
September 22-24, 1989	Hurricane Hugo	Statewide	The average rainfall for this event was 0.43 inch, with a maximum total of 2.83 inches at the Belleplain SF (Cape May County) station. Maximum wind gusts were below 20 mph.
October 14-15, 1990	Hurricane Lili	Statewide	The average rainfall for this event was 0.55 inch, with a maximum total of 2.28 inches at the Canoe Brook (Essex County) station. Maximum wind gusts were below 20 mph.
August 18-19, 1991	Hurricane Bob	Statewide	The average rainfall for this event was 1.25 inches, with a maximum total of 3.16 inches at the Millville (Cumberland County) station. Maximum wind gusts were below 20 mph. High surf and rip tides were associated with this event.
September 26-27, 1992	Hurricane Danielle	Statewide	The average rainfall for this event was 0.91 inch, with a maximum total of 2.83 inches at the Belleplain SF (Cape May County) station. Maximum wind gusts were below 20 mph. High surf and rip tides were associated with this event. Two boaters drown from this storm.
September 1-2, 1993	Hurricane Emily	Statewide	The avg rainfall for this event was 0.03 inch, with a maximum total of 0.26 inch at the Atlantic City International Airport (Atlantic County) station. Maximum wind gusts were below 20 mph.
August 17-19, 1994	Hurricane Beryl	Statewide	The average rainfall for this event was 1.09 inches, with a maximum total of 3.82 inches at the Sussex (Sussex County) station. Maximum wind gusts were below 20 mph.
November 17-19, 1994	Hurricane Gordon	Statewide	The average rainfall for this event was 0.2 inch, with a maximum total of 1.07 inches at the Cape May (Cape May County) station. Maximum wind gusts were below 20 mph.
June 7-8, 1995	Hurricane Allison	Statewide	The average rainfall for this event was 0.21 inch, with a maximum total of 2.04 inches at the Millville (Cumberland County) station. Maximum wind gusts were below 20 mph.

Date(s) of Event	Event Type	Counties Affected	Description
August 6-8, 1995	Hurricane Erin	Statewide	The average rainfall for this event was 0.79 inch, with a maximum total of one inch at the Belleplain SF (Cape May County) station. Maximum wind gusts were below 20 mph.
October 5-7, 1995	Hurricane Opal	Statewide	The average rainfall for this event was 2.36 inches, with a maximum total of 4.92 inches at the Sussex (Sussex County) station. Maximum wind gusts were below 20 mph.
June 20-22, 1996	Hurricane Arthur	Statewide	The average rainfall for this event was 0.54 inch, with a maximum total of 2.3 inches at the Mays Landing (Atlantic County) station. Maximum wind gusts were below 20 mph.
July 13-15, 1996	Hurricane Bertha	Statewide	Bertha was an unusually long-lasting and strong supercell. The average rainfall for this event was 2.94 inches, with a maximum total of 6.59 inches at the Estell Manor (Atlantic County) station. A maximum wind gust of 55 mph was reported at Harvey Cedars. A maximum storm surge of 2.27 feet was reported at Atlantic City (Atlantic County). One death was reported in New Jersey because of Bertha.
August 31-September 2, 1996	Hurricane Edouard	Statewide	The average rainfall for this event was zero inches, with a maximum total of 0.07 inch at the Sussex (Sussex County) station. Maximum wind gusts were below 20 mph. High surf and rip tides were associated with this event. There were two deaths in New Jersey due to Edouard.
September 7-9, 1996	Hurricane Fran	Statewide	The average rainfall for this event was 1.1 inches, with a maximum total of 2.72 inches at the Lambertville (Hunterdon County) station. Maximum wind gusts were below 20 mph.
October 9-10, 1996	Hurricane Josephine	Statewide	The average rainfall for this event was 1.69 inches, with a maximum total of three inches at the Canistear Reservoir (Sussex County) station. A maximum wind gust of 70 mph was reported at Atlantic City (Atlantic County).
July 24-26, 1997	Hurricane Danny	Statewide	The average rainfall for this event was 3.32 inches, with a maximum total of 7.76 inches at the Cranford (Union County) station. Maximum wind gusts were below 20 mph.
August 28-29, 1998	Hurricane Earl	Statewide	The average rainfall for this event was zero inches with a maximum total of 0.02 inch at the Moorestown (Burlington County) station. Maximum wind gusts were below 20 mph.
September 05, 1998	Hurricane Bonnie	Statewide	The average rainfall for this event was 0.08 inch, with a maximum total of 0.92 inch at the Estell Manor (Atlantic County) station. Maximum wind gusts were below 20 mph. High surf and rip tides were associated with this event.
September 5-9, 1999	Hurricane Dennis	Statewide	The average rainfall was 1.22 inches for this event. Maximum rainfall totaled 5.59 inches at the Greenwood Lake (Passaic County) station. Maximum wind gusts were less than 20 mph. High surf and rip tides were also reported from this storm.
October 18-19, 1999	Hurricane Irene	Statewide	The average rainfall total was 0.39 inch for this event, with a maximum total of 2.5 inches at the Brant Beach Haven station. Maximum wind gusts were below 20 mph.
June 15-19, 2001	Hurricane Allison	Statewide	The average rainfall total was 2.38 inches for this event, with a maximum total of 4.62 inches at the Canoe Brook station. Another source indicated 4.86 inches of rain fell in Howell. A maximum wind gust of 36 mph was reported in Atlantic City (Atlantic County).
September 10-12, 2002	Hurricane Gustav	Statewide	The maximum rainfall total of 0.08 inch was recorded at the New Milford station. A maximum wind gust of 60 mph was reported in Keansburg.
October 12, 2002	Hurricane Kyle	Statewide	The average rainfall total for this event was 1.72 inches, with a maximum total of 4.71 inches at the Rahway station. Maximum wind gusts were below 20 mph.
September 13, 2003	Tropical Storm Henri	Statewide	Caused up to three inches of rain across the State.

Date(s) of Event	Event Type	Counties Affected	Description
August 3-4, 2004	Hurricane Alex	Statewide	Average rainfall totals were 0.09 inch and the maximum rainfall total of 1.89 inches at the West Deptford station. Maximum wind gusts were below 20 mph.
August 14-16, 2004	Hurricane Charley	Statewide	Average rainfall totals were 0.1.26 inches and the maximum rainfall of 3.49 inches was reported at the Ringwood station. Maximum wind gusts were below 20 mph.
August 30-31, 2004	Hurricanes Gaston and Hermin	Statewide	Average rainfall totals were 0.48 inch and the maximum rainfall of 4.06 inches was reported at the Indian Mills station. Maximum wind gusts were below 20 mph.
September 08, 2004	Hurricane Francis	Northern New Jersey	Extra-tropical storm dropped around three inches of rain in northern New Jersey.
September 28, 2004	Hurricane Jeanine	Statewide	Passed to the south of the State as an extra-tropical storm, causing up to five inches of rainfall across New Jersey.
September 7-8, 2005	Hurricanes Maria and Nate	Statewide	Rip currents from storms killed one and seriously injured another.
October 24-25, 2005	Hurricane Wilma	Statewide	Wilma brought an average rainfall of 1.2 inches, with a maximum rainfall total of 2.66 inches in Atlantic City (Atlantic County). Wind gusts were below 20 mph.
September 06, 2008	Tropical Storm Hanna	Northeast New Jersey	Tropical Storm Hanna impacted Northeast New Jersey, making landfall near the Nassau/Suffolk County border around 10:35 pm on the 6th. Storm total rainfall ranged from 2.52 inches at Ridgewood to 5.50 inches at River Edge. Periods of torrential rainfall from heavy showers and thunderstorms caused flash flooding of many urban areas, small streams, and rivers. The Ho-Ho-Kus River at Ho-Ho-Kus exceeded its flood stage of 3.0 ft. at 6:15 pm local time. The river crested at 3.98 ft. at 10 pm and fell below flood stage on 9/7/08 at 2:45 am. The Saddle River at Lodi exceeded its flood stage of 6.0 ft. at 6:15 pm local time. The river exceeded moderate flood stage at 11:45 pm and crested at 7.77 ft. on 9/7/08 at 4:15 am. The river fell below flood stage on 9/7/08 at 8 am.
August 22-23, 2009	Hurricane Bill	Statewide	Average rainfall total of 1.77 inches for this event with a maximum rainfall total of 6.49 inches at the Estell Manor (Atlantic County) station. Maximum wind gusts were below 20 mph. High surf and rip tides were associated with this event.
September 3-4, 2010	Hurricane Earl	Statewide	A maximum rainfall total of 0.04 inches was reported at the Cape May station. A maximum wind gust of 65 mph was reported in Cape May. High surf and rip tides were also reported. The storm caused two fatalities in New Jersey, both because of the rough surf from Earl.

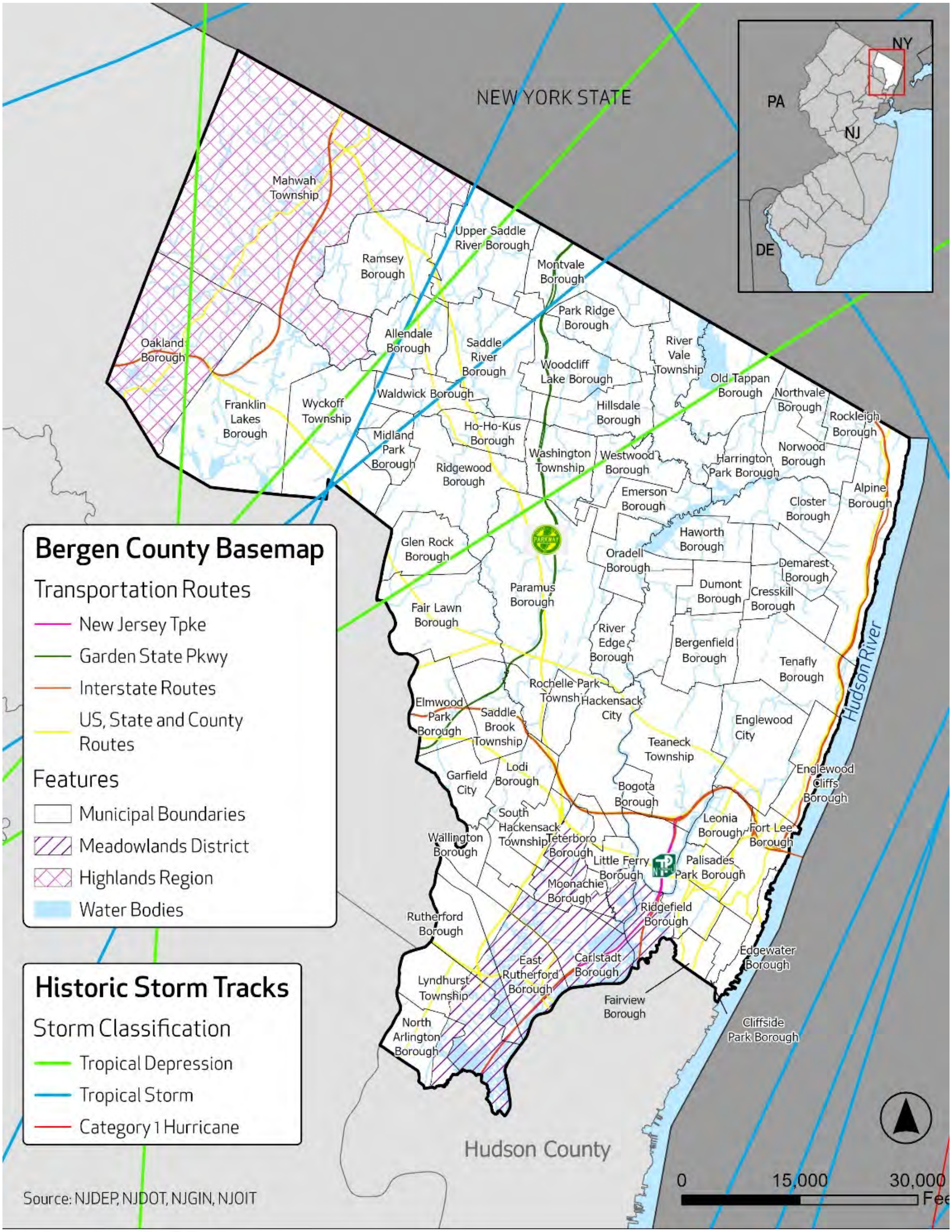
Date(s) of Event	Event Type	Counties Affected	Description
August 27-28, 2011	Hurricane Irene	Statewide	Hurricane Irene moved made its second landfall as a tropical storm near Little Egg Inlet along the southeast New Jersey coast at around 5:35 a.m. on August 28, 2011 Irene brought tropical- storm force winds, destructive storm surge, and record-breaking freshwater inland flooding across northeast New Jersey that resulted in three deaths, thousands of mandatory, and voluntary evacuations along the coast and rivers from surge and freshwater flooding, and widespread power outages that lasted for up to two weeks. The storm surge of three to five feet caused moderate-to-severe tidal flooding along the ocean side and moderate tidal flooding in Delaware Bay and tidal sections of the Delaware River. Major flooding occurred on the Raritan, Millstone, Rockaway, and Passaic Rivers. Overall, Irene brought an average rainfall total of 7.03 inches with a maximum rainfall total of 9.85 inches in Cranford (Union County). Another source indicated a maximum rainfall total of 11.27 inches in Freehold. A maximum wind gust of 65 mph was reported in Cape May (Cape May County). A maximum storm surge of 4.63 feet was reported in Sandy Hook. Irene caused approximately $1 billion in damages in New Jersey and seven deaths in the State.
September 6-8, 2011	Tropical Storm Lee	Northeast New Jersey	The combination of showers and thunderstorms in association with a slow-moving cold front and deep tropical moisture moving up the east coast from the remnants of Tropical Storm Lee, produced a prolonged period of rainfall, which led to flooding across portions of Northeast New Jersey. Route 17 was closed in both directions at Williams Ave. due to flooding. Total reported rainfall amounts in Bergen County ranged from 4.67 inches in Park Ridge to 6.42 inches in Lodi. Route 46 was closed in both directions at Main St. in Lodi due to flooding. In Hasbrouck Heights, all lanes on NJ 17 southbound, north of US 46, were closed due to flooding.
October 26 - November 8, 2012	Superstorm Sandy	Statewide	Superstorm Sandy was the costliest natural disaster by far in the State of New Jersey. Record- breaking high tides and wave action combined with sustained winds as high as 60 to 70 mph with wind gusts as high as 80 to 90 mph to batter the State. Statewide, Sandy caused an estimated $29.4 billion in damage, destroyed or significantly damaged 30,000 homes and businesses, affected 42,000 additional structures, and was responsible directly or indirectly for 38 deaths. A new temporary inlet formed in Mantoloking (Ocean County) where some homes were swept away. About 2.4 million households in the State lost power. It would take two weeks for power to be fully restored to homes and businesses that were inhabitable. Also devastated by the storm was New Jersey's shellfish hatcheries including approximately $1 million of losses to buildings and equipment, and product losses in excess of $10,000 at one location alone. Overall, average rainfall totals were 2.78 inches with a maximum rainfall of 10.29 inches at the Cape May (Cape May County) station. Another source indicated a maximum rainfall total of 12.71 inches in Stone Harbor (Cape May County). A maximum wind gust of 78 mph was reported in Robbins Reef. A maximum storm surge of 8.57 feet was reported in Sandy Hook. Superstorm Sandy caused approximately $30 billion in damages in New Jersey and caused 12 deaths in the State.

Date(s) of Event	Event Type	Counties Affected	Description
June 7-8, 2013	Tropical Storm Andrea	Northeast New Jersey	The remnants of Tropical Storm Andrea tracked up the eastern seaboard in early June, resulting in a prolonged period of heavy rain, which caused flooding of low lying and poor drainage areas and several rivers and streams in portions of Union and Bergen Counties. The Pascack Brook flooded multiple surrounding streets in Hillsdale. The river gauge, located in Westwood, rose above its flood stage of 5 feet at 0030 EST on June 8, crested at 5.27 feet at 0245 EST, and fell below flood stage at 0400 EST. Total reported rainfall amounts in Bergen County ranged from 2.58 inches in North Arlington to 3.90 inches in Northvale.

Source: NCDC 2019

Figure 4.7-1 Historic Hurricane Tracks shows historic storm tracks throughout Bergen County, including Tropical Depressions, Tropical Storms, and Hurricanes (Category 1).

Figure 4.7-1 Historic Hurricane Tracks



Bergen County also has a long history with the devastating impacts wrought by nor'easters. This includes damages caused by the effects of extreme wind, heavy rain, snow, wave action, storm surge, coastal flooding, and beach erosion. The FIS notes that the Hackensack Meadowlands District is impacted yearly by nor'easter storm events. Nor'easters and hurricanes have produced the largest stream elevations but not the largest rainfall events. Historically, the maximum historical tide was produced by a hurricane on September 3, 1821 – the surge was approximately 10 – 11' above the normal tide.

Table 4.7-4 Previous Nor'easter Occurrences and Losses summarizes nor'easter events that affected Bergen County through March 2018. Many sources provided information regarding previous occurrences and losses in New Jersey associated with nor'easter events. With so many sources reviewed for the purpose of this hazard mitigation plan, loss and impact information for many events could vary depending on the source. Therefore, the accuracy of monetary figures discussed is based only on the available information identified during research for the Bergen County HMP.

Table 4.7-4 Previous Nor'easter Occurrences and Losses

Date	Area Affected	Deaths	Injuries	Property Damage	Description
4/15/2007-4/16/2007	Mahwah, Rutherford and Lodi	1	0	$6,900,000	A nor'easter occurred during Sunday and Monday, April 15th and 16th. It brought heavy rain that caused widespread and significant river, stream, and urban flooding of low lying and poor drainage areas. Significant river flooding lasted through April 23rd. A 43-year-old woman was found in her flooded car when it was pulled from the Ramapo River in Mahwah. Bergen County rainfall ranged from 4.60 inches in Woodcliff Lake to 8.04 inches at Lodi. The Saddle River at Lodi rose to its' flood stage of 6 feet at 1:40 pm on April 15th, crested at 11.6 feet at 4:15 pm on April 16th, then fell below flood stage at 1:15 am on April 17th.The Ramapo River at Mahwah rose to its' flood stage of 8.0 feet at 10:15 pm on April 15th, crested at 10.99 feet at 1 pm on April 16th, then fell below flood stage at midnight on April 18th. Street flooding was reported along Route 17 in Rutherford between Union Ave. and Highland Cross streets. A land slide damaged a house near Hughes Street and Farnham Avenue in Lodi.
3/13/2010-3/14/2010	Mahwah, Upper Saddle River, Garfield	0	0	$45,500,000	A nor'easter developed off the Delmarva peninsula which produced an extended period of heavy rainfall across the area as it tracked very slowly to the northeast. This caused widespread flooding across portions of northeast New Jersey. The Ramapo River at Mahwah exceeded bankfull and crested at 11.90 feet at 0500 EST on March 14, just below its major flooding threshold of 12.0 ft. The Saddle River at Lodi exceeded flood stage and crested at 7.25 ft, moderate flooding, at 0935 EST on March 14. Total rainfall amounts received across Bergen County ranged from 2.90 inches in Teterboro to 4.10 inches in Oakland. Several rivers and small streams exceeded bankfull causing flooding of roads and damage to nearly 5,000 homes, 20 of which were condemned. There were no fatalities, no injuries, and no assessed property damage.

Date	Area Affected	Deaths	Injuries	Property Damage	Description
3/29/2010-3/30/2010	East Rutherford and Fort Lee	0	0	0	A nor'easter centered off the Delmarva coast produced an extended period of heavy rainfall across the area as it tracked very slowly to the northeast. This caused widespread flooding across portions of Bergen and Passaic counties. Route 17 was closed due to flooding in both directions between Highland Cross and Union Avenue East. The westbound ramp on Route 4 at mile marker 10.2 in Fort Lee was closed due to flooding. The ramp on Route 9W was also closed in both directions in Fort Lee at mile marker 0.0 due to flooding. Total rainfall amounts received across Bergen County ranged from 2.63 inches in Saddle Brook to 3.87 in Rivervale.
10/29/2011	Bergen County	0	0	0	A historic and unprecedented early-season winter storm impacted the area on Saturday, October 29, with more than one foot of heavy wet snow falling on interior portions of northeast New Jersey. This is the first time a winter storm of this magnitude has ever occurred in October. Widespread tree damage and power outages occurred due to 4 to 9 inches of heavy wet snow. The heavier amounts fell in the higher elevations. In Paramus, wires were downed on Paramus Road at Morningside at around 1:35 pm, while in Ridgewood, Maple at Ackerman Roads were closed due to downed trees and powerlines. In Midland Park, numerous trees and powerlines were reported down at 230 pm. A tree was reported down on a house on Woodland Avenue in Ramsey at 720 pm EST, with three other reports of damaged cars due to falling trees. In North Arlington at around 1pm EST, a tree was reported down on a car at the intersection of Ridge Road and Crystal Street, and a tree down on a house at Morgan Place. In Park Ridge, large tree branches were reported down with popping transformers around 1 pm. In Palisades Park, NJ 93 was closed in both directions at County Road 501.
11/7/2012	Eastern Bergen	0	0	0	This nor'easter came on the heels of Superstorm Sandy. It produced heavy wet snow, strong winds, and minor coastal

Date	Area Affected	Deaths	Injuries	Property Damage	Description
					flooding. Snowfall amounts ranged from 3 to 6 inches, with isolated amounts of over 7 inches. Most areas had an average snowfall of less than 6 inches. Snowfall of 7.5 inches was measured in Ridgefield.
3/6/2013	Bergen County	0	0	0	Surface low pressure brought sustained northeast winds of 30 to 39 mph and wind gusts of 40 to 55 mph to the region during the day on March 6th, then produced some light snow the night of the 6th. An upper level low moving southeast from the upper Great Lakes region interacted with the offshore surface low to produce more significant snowfall on March 7th and 8th. Spotters reported snowfall ranging from 4.8 inches at River Vale, to 7.5 inches at East Rutherford and North Arlington, to 8 inches in Paramus. This snow fell over a relatively long duration from late evening on 3/7 to early afternoon on 3/8.
1/26/2015-1/27/2015	Eastern Bergen	0	0	0	A potent Alberta Clipper low moved from southwestern Canada on January 24th to the Plains states and Ohio Valley on the 25th. The low then redeveloped off the Mid Atlantic coast on the 26th and rapidly intensified into a strong Nor'easter, bringing heavy snow and strong winds to parts of northeast New Jersey just west of New York City. The public reported snowfall of 6.8 inches in East Rutherford. North winds gusted up to 30 mph at Teterboro Airport, with blowing and drifting of snow.
2/9/2017	Bergen County	0	0	0	Low pressure developed along a cold front over the Middle Atlantic early Thursday, February 9th. The low rapidly intensified as it moved off the Delmarva coast in the morning and then to the south and east of Long Island late morning into the afternoon. The low brought heavy snow and strong winds to portions of Northeast New Jersey. A CoCoRaHS observer reported 9.4 inches of snow in Tenafly. Trained spotters also reported 6 to 8 inches of snowfall.
3/14/2017	Bergen County	0	0	0	Rapidly deepening low pressure tracked up the eastern seaboard on Tuesday March 14, bringing blizzard conditions to Western Passaic county. Heavy snow and sleet along with strong winds occurred across the rest of Northeast New Jersey. Large trees fell onto homes in Bergen county and approximately 4,500 power outages resulted from the strong winds and heavy snow. Trained spotters reported 9 to 14 inches of snow and sleet.
3/1/2018-3/3/2018	Bergen County	0	0	$100,000	A rapidly intensifying low pressure developed along the Middle Atlantic during the early morning hours on March 2, 2018. The storm brought winter storm conditions to portions of Northeast New Jersey, especially in the higher elevations. The public reported 5.1 inches of snow in Franklin Lakes. Amateur radio reported a tree down across the Palisades Parkway

Date	Area Affected	Deaths	Injuries	Property Damage	Description
					closing the road in both directions at 12:25 pm. Around 3:45 pm in the town of Hackensack, a large tree was knocked down on to power lines according the social media.
3/21/2018	Bergen County	0	0	0	A large and slow-moving low pressure developed along the Middle Atlantic coast on Wednesday, March 21st and moved slowly north and east along the coast through Thursday, March 22nd. Moderate to occasionally heavy snow bands moved across portions of northeast New Jersey. Trained spotters reported 8 to 9 inches of snow in Eastern Bergen and 5 to 8 inches of snow in Western Bergen
11/15/2018	Bergen County	0	0	0	A wave of low pressure developed along the Middle Atlantic coast, eventually moving up the northeast coast. Once the low drew warmer air from the south, the precipitation gradually changed to a wintry mix and then plain rain, especially for the New York City metro and Long Island. The moderate to heavy wet snowfall significantly impacted the evening rush hour with 1-2 inch per hour snowfall rates. Hundreds of trees, tree limbs, and branches were brought down by the weight of the snow, which caused many power outages. Numerous accidents were reported, and many motorists were stranded on roads until the early morning hours the next day.
3/3/2019-3/4/2019	Statewide	0	0	0	An offshore low-pressure system brought a period of heavy precipitation to the mid-Atlantic. A mix of rain, sleet, and snow was observed, with snow confined mainly to interior areas and sleet and rain more abundant near the coast. Snowfall totals inland approached 10in, with snowfall rates exceeding one inch per hour for several hours. A sharp gradient in snowfall with a steep drop in snow totals was observed just west of the Interstate 95 corridor.
12/16/2020-12/17/2020	Statewide	0	0	0	Low pressure developed along the Middle Atlantic coast on Wednesday December 16, 2020. Arctic high pressure situated over southeast Canada provided a cold and dry air mass ahead of the low supporting moderate to locally heavy snowfall throughout much of the storm. The storm significantly impacted travel during the evening commute on Wednesday December 16, 2020, and the morning commute on Thursday December 17, 2020. Many accidents resulted from the snow-covered roads and poor visibilities. Snowfall rates ranged from 1 to 2 inches per hour Wednesday evening. Total snowfall ranged from around 6 to 12 inches with strong wind gusts ranging from 35 to 50 mph
1/31/2021 – 2/3/2021	Statewide	0	0	0	Low pressure developed over the Ohio Valley and Middle Atlantic on Sunday, January 31, 2021, before intensifying and slowly tracking to the north-northeast. The low brought a major winter storm to northeast New Jersey, with the most significant impacts occurring on Monday, February 1, 2021. Three to six inches of snow had already accumulated by the start of the morning commute. Near blizzard conditions then

Date	Area Affected	Deaths	Injuries	Property Damage	Description
					occurred through the rest of the morning into the early afternoon with snowfall rates of 1 to 3 inches per hour. Snowfall totals ranged 15 to 20 inches of snow with some locations receiving around two feet. Winds gusted 40 to 55 mph at times, which caused power outages. Travel was also severely impacted as many flights were cancelled and travel by train was suspended. COVID testing and vaccination sites were closed.
1/3/2022	Statewide	0	0	0	A strengthening area of low pressure developed over the Southeast US late on January 2 and moved northeast, tracking offshore of the mid-Atlantic in a typical Nor'eastertype setup. A widespread 6 to 12 inches of snow with locally higher amounts fell across the Eastern Shore of Maryland, most of Delaware, and several counties of southern New Jersey. The storm was notable for having a very sharp cutoff in the northern extent of accumulating snow. The passage of a strong cold front brought rapid cooling in the hours leading up to the storm, and very heavy snowfall rates, at times well more than 1 inch per hour, overwhelmed any lingering warm ground from previous days of higher temperatures and caused accumulation to occur.
1/28/2022	Statewide	0	0	0	A nor'easter tracked just east of the benchmark bringing snow and gusty winds. Strong winds also occurred, with gusts of 40 to 50 mph and a few over 60 mph observed. The combination of strong winds and heavy snow led to whiteout conditions along the coast and was sufficient for blizzard criteria to be met along both the New Jersey coast and the Delaware Beaches, making this the first blizzard to affect any portion of the region since 2018.

Source: NCDC 2019, NCEI 2024, NJSHMP 2024

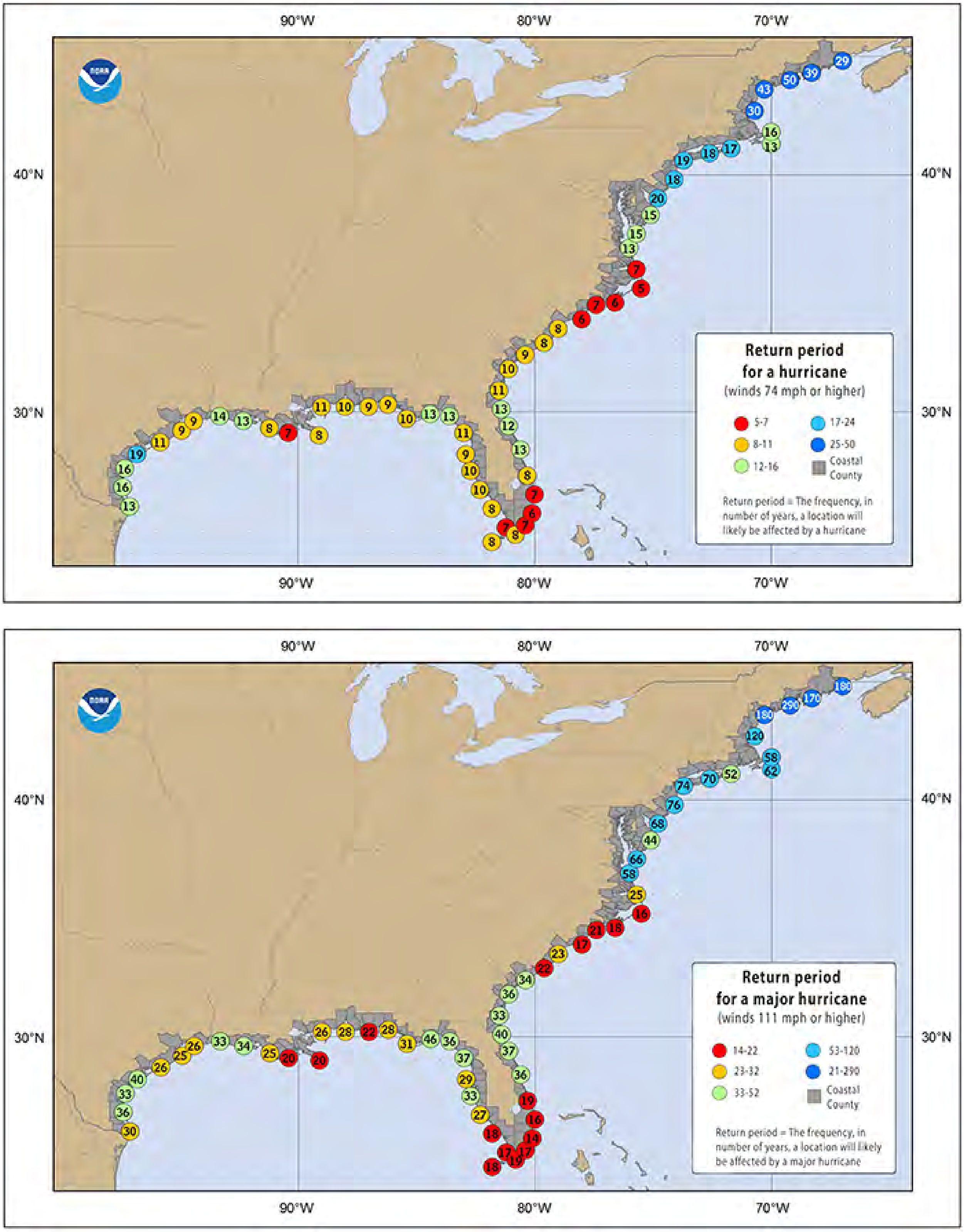
Probability of Future Occurrences

Hurricanes, Tropical Storms

In 2018, NOAA issued seasonal outlook that predicts the number of named tropical storms, hurricanes, and major hurricanes (Category 3 or higher on the Saffir-Simpson Wind Scale) expected over the entire Atlantic basin during the six-month season (NOAA, 2018). The northern coastal areas (including northern New Jersey) are expected to experience a hurricane once every 19 years. This decreases to once every 18 years for the central coastal areas and increases to once every 20 years for southern coastal areas. Inland counties (including much of Bergen County) were not included in this coastal analysis, but it is reasonable to assume that hurricanes that impact coastal counties will have some impact on adjacent inland counties.

A similar analysis was conducted to determine the probability that a major hurricane (Category 3, 4, or 5) will directly affect the area. This analysis indicates that the state of New Jersey has even more varied probabilities for major hurricanes. The southern coastal areas are anticipated to experience a major hurricane once every 68 years. The return period for central coastal areas is 76 years, while northern areas' is 74 years. Major hurricanes are rare along the mid-Atlantic coast; therefore, determining and obtaining a realistic probability is extremely difficult. Once again, inland counties were not included in this analysis but if adjacent coastal areas are impacted, it is reasonable to assume inland counties will also experience some impacts (NJSHMP, 2024). This analysis is modeled for hurricanes along the Atlantic Coast in **Figure 4.7-2** below.

Figure 4.7-2 Atlantic Basin Hurricane Return Periods (All Hurricanes, Major Hurricanes)



Source: NOAA, 2018

Nor'easters
According to the NJ State HMP, nor'easter activity is difficult to predict, and is categorized into high activity seasons and low activity seasons:

"High activity seasons are when storm activity exceeds the historical 75th percentile. This means that seasons with this number of storms are expected to occur during one out of four years. Lower activity seasons are defined as when storm activity falls below the historical 75th percentile; meaning this number of storms are expected to occur during three out of four years" (East Coast Winter Storms, 2013).

Approximately 20 to 40 nor'easters occur in the northeastern United States every year, with at least two considered severe (Storm Solution). Since these storms only impact the east coast, this means New Jersey can expect to be impacted by at least one nor'easter each year, with several occurrences being possible.

Potential Effects of Climate Change

While Bergen County is not directly along the Atlantic Coast, the county remains vulnerable to inland impacts of hurricanes and tropical storms, including heavy rainfall, high winds, and flooding. Climate change is likely to increase the intensity and moisture content of tropical systems, resulting in more severe inland flooding and longer lasting impacts on infrastructure and power grids. Events like Tropical Storm Ida (2021) are projected to become more frequent, posing growing threats to riverine systems and built infrastructure throughout the county.

Climate change is also expected to intensify the impacts of nor'easters in Bergen County, with warmer oceans contributing to increased storm moisture and longer storm durations. As sea levels rise and atmospheric circulation shifts, nor'easters may bring heavier precipitation, stronger winds, and greater inland flooding risks. While snow may decrease in some events due to warmer air temperatures, mixed precipitation and rain-on-snow scenarios could worsen flooding and infrastructural damage in Bergen County.

Vulnerability Assessment

Built Environment, Infrastructure, and Community Lifelines
While Bergen County is not a coastal county, it is still significantly affected by the inland impacts of hurricanes, tropical storms, and nor'easters. These events often bring intense rainfall, strong winds, and localized or widespread flooding, particularly in low-lying and flood-prone areas such as Little Ferry, Moonachie, Lodi, and Ridgefield Park. Buildings in these communities—especially older residential structures and commercial properties within FEMA Special Flood Hazard Areas (SFHAs)—are vulnerable to water intrusion, structural damage, and mold.

Critical infrastructure, including electrical substations, water treatment facilities, and stormwater pump stations, can be overwhelmed or damaged during high-intensity tropical systems and nor'easter storms. Transportation corridors such as Route 46, Route 17, and I-80 may experience flooding or debris blockages, delaying emergency response and disrupting access to healthcare, supply chains, and other lifelines. Above-ground power lines, common in many municipalities, are particularly susceptible to damage from falling trees and wind-blown debris, leading to long-duration power outages.

Facilities such as schools, hospitals, and assisted living centers may require evacuations or sheltering-in-place strategies if utility disruptions or flooding occur. Communities with limited stormwater capacity or aging infrastructure face elevated risks, particularly during back-to-back storm events or rain-on-saturated-ground scenarios.

In relation to other New Jersey jurisdictions, FEMA's National Risk Index for Natural Hazards rates Bergen's hazard to Hurricanes and Tropical Storms as "Relatively Moderate" (FEMA NRI, 2023). **Table 4.7-5 Expected Annualized Losses from Hurricane by Jurisdiction** shows expected annualized losses for the hurricane hazard for municipalities within Bergen County. This data was derived from FEMA's NRI. Expected EAL represents the average economic loss in dollars resulting from natural hazards each year. The table includes EAL for buildings as well as total EAL which includes building damage as well as damage to agriculture and population equivalency (the monetized cost of injury and fatality).

Table 4.7-5 Expected Annualized Losses from Hurricane by Jurisdiction

Municipality	Expected Annual Losses (Building)	Expected Annual Losses (Total)
Allendale Borough	$273,472.22	$277,369.06
Alpine Borough	$228,474.89	$230,238.56
Bergenfield Borough	$977,964.44	$1,008,950.10
Bogota Borough	$291,046.37	$300,654.21
Carlstadt Borough	$843,863.28	$850,849.61
Cliffside Park Borough	$811,472.42	$839,573.13
Closter Borough	$522,237.15	$530,617.20
Cresskill Borough	$544,483.56	$554,101.65
Demarest Borough	$317,766.89	$327,262.26
Dumont Borough	$590,994.24	$609,936.38
East Rutherford Borough	$746,241.45	$757,197.88
Edgewater Borough	$544,634.22	$560,352.63
Elmwood Park Borough	$639,932.76	$656,237.41
Emerson Borough	$351,783.72	$358,868.97
Englewood City	$1,469,246.23	$1,501,370.88
Englewood Cliffs Borough	$641,318.78	$647,174.23
Fair Lawn Borough	$1,150,706.11	$1,177,800.32
Fairview Borough	$461,126.73	$477,571.46
Fort Lee Borough	$1,351,244.40	$1,395,264.65
Franklin Lakes Borough	$633,697.29	$640,155.61
Garfield City	$964,363.04	$998,060.39
Glen Rock Borough	$495,185.13	$504,005.99
Hackensack City	$2,228,323.48	$2,278,791.26
Harrington Park Borough	$278,252.64	$282,874.57
Hasbrouck Heights Borough	$496,923.35	$510,217.33
Haworth Borough	$226,918.46	$230,176.50
Hillsdale Borough	$503,757.88	$513,618.77
Ho-Ho-Kus Borough	$172,596.25	$175,032.88
Leonia Borough	$385,943.95	$396,141.17
Little Ferry Borough	$423,234.23	$435,280.75
Lodi Borough	$965,638.13	$994,343.25
Lyndhurst Township	$945,742.58	$970,453.99
Mahwah Township	$989,506.46	$1,004,058.12
Maywood Borough	$435,244.79	$446,300.56
Midland Park Borough	$212,088.39	$216,075.80
Montvale Borough	$567,943.70	$575,453.05
Moonachie Borough	$492,775.20	$496,210.26
New Milford Borough	$658,971.46	$677,478.62
North Arlington Borough	$610,403.03	$628,446.66
Northvale Borough	$193,476.70	$195,995.07
Norwood Borough	$344,134.41	$349,632.53
Oakland Borough	$443,039.58	$450,303.34
Old Tappan Borough	$448,657.26	$454,403.61
Oradell Borough	$527,281.61	$535,862.61
Palisades Park Borough	$666,627.40	$688,863.43
Paramus Borough	$2,221,880.63	$2,249,567.76
Park Ridge Borough	$511,385.27	$520,036.97
Ramsey Borough	$554,851.72	$563,269.01
Ridgefield Borough	$530,737.68	$543,347.50
Ridgefield Park Village	$524,001.73	$538,477.44
Ridgewood Village	$870,908.15	$886,427.00
River Edge Borough	$556,371.33	$569,584.35
River Vale Township	$530,376.46	$540,035.76
Rochelle Park Township	$275,069.22	$281,443.75
Rockleigh Borough	$193,476.70	$195,995.07

Municipality	Expected Annual Losses (Building)	Expected Annual Losses (Total)
Rutherford Borough	$800,589.17	$821,238.96
Saddle Brook Township	$747,085.65	$762,281.64
Saddle River Borough	$231,830.35	$233,775.87
South Hackensack Township	$138,802.59	$139,535.82
Teaneck Township	$2,056,797.47	$2,111,339.39
Tenafly Borough	$1,000,772.77	$1,017,687.09
Teterboro Borough	$277,605.18	$279,071.63
Upper Saddle River Borough	$381,948.06	$386,700.64
Waldwick Borough	$261,929.08	$267,642.86
Wallington Borough	$389,209.40	$402,221.60
Washington Township	$467,465.33	$476,512.82
Westwood Borough	$521,289.42	$532,284.94
Wood-Ridge Borough	$414,531.54	$419,830.31
Woodcliff Lake Borough	$467,263.65	$478,382.35
Wyckoff Township	$649,764.92	$659,325.59
Bergen County Total	**$43,783,482.31**	**$44,725,178.63**

Population and Economy

Populations with limited mobility, language barriers, or low access to resources are disproportionately vulnerable to hurricane and tropical storm impacts as well as effects of nor'easters. These include elderly residents, low-income households, renters, and undocumented individuals who may lack access to timely warnings, reliable transportation, or adequate shelter. Residents of manufactured homes or ground-level apartments are particularly susceptible to storm-related damage and post-event displacement.

Economically, Bergen County is at risk of significant disruption during and after these storms. Small businesses—especially those located in flood-prone downtowns such as those in Hackensack, Garfield, and Bogota—can suffer from property damage, lost inventory, and prolonged closures. Repetitive flooding, like that seen during Tropical Storm Irene (2011) and Tropical Storm Ida (2021), has resulted in millions of dollars in damage and has elevated insurance premiums, increased floodplain development restrictions, and reduced property values in affected areas. Recovery periods can strain municipal resources and increase reliance on federal disaster assistance programs.

Ecosystems and Natural Assets

Hurricanes, tropical storms, and nor'easters can significantly alter Bergen County's natural environments, particularly its riparian corridors, wetlands, and urban forests. High volumes of rainfall over short durations contribute to streambank erosion, wetland scouring, and floodplain degradation, especially along the Hackensack, Saddle, and Ramapo Rivers as well as marshy geographies of southern Bergen County. Upland forests in northern Bergen County may also be damaged by strong winds, leading to canopy loss and increased vulnerability to invasive species and drought.

Saltwater intrusion from downstream tidal surge, though limited in Bergen County, may affect parts of the Hackensack Meadowlands over time, especially as sea levels rise and storm surge pushes farther inland. Wetland areas that typically mitigate flood risk may become overwhelmed or permanently degraded, reducing their natural buffering capacity and diminishing ecosystem services.

Additionally, storm debris and hazardous materials washed into waterbodies can harm water quality and aquatic life. Recovery of natural assets post-storm is often prolonged and may require active restoration to preserve biodiversity, water regulation, and recreational value. **Table 4.7-6 Hurricane Damage Classifications** describes the damage that could be expected for each category of hurricane. Damage during hurricanes might also result from spawned tornadoes, storm surge, and inland flooding associated with heavy rainfall that usually accompanies these storms.

Table 4.7-6 Hurricane Damage Classifications

Storm Category	Damage Level	Description of Damages	Photo Example
1	MINIMAL	No real damage to building structures. Damage primarily to unanchored mobile homes, shrubbery and trees. Also, some coastal flooding and minor pier damage.	
2	MODERATE	Some roofing material, door and window damage. Considerable damage to vegetation, mobile homes, etc. Flooding damages piers and small craft in unprotected moorings might break their moorings.	
3	EXTENSIVE	Some structural damage to small residences and utility buildings, with a minor amount of curtainwall failures. Mobile homes are destroyed. Flooding near the coast destroys smaller structures, with larger structures damaged by floating debris. Terrain might be flooded well inland.	
4	EXTREME	More extensive curtainwall failures with some complete roof structure failure on small residences. Major erosion of beach areas. Terrain might be flooded well inland.	
5	CATASTROPHIC	Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. Flooding causes major damage to lower floors of all structures near the shoreline. Massive evacuation of residential areas might be required.	

Source: NOAA, FEMA

Exposure and Damage Estimates

The probability of Bergen County being struck by a tropical storm or hurricane is difficult to predict. Because much of Bergen County is developed, the vulnerability is extremely high if an event were to occur. Tropical storms and hurricanes do not need to have a direct path over Bergen County to affect the residents. Table shows the potential magnitude of impact that may occur if a tropical storm or hurricane were to hit the area. **Figure 4.7-3 Modelled Storm Surge Extent and Depth in Bergen County (Category 1)** and **Figure 4.7-4 Modelled Storm Surge Extent and Depth in Bergen County (Category 2)** map the limits of potential tidal flooding from Categories 1 through 4 hurricanes as calculated by the National Weather Service-National Hurricane Center's SLOSH Model. Each map shows the limits of potential flooding from Category 1-4 hurricanes and the numbers of housing units in the Category 1-4 inundation areas. This information is provided in order to facilitate the drawing or re-drawing of evacuation zones by county and municipal emergency management officials.

Figure 4.7-3 Modelled Storm Surge Extent and Depth in Bergen County (Category 1)

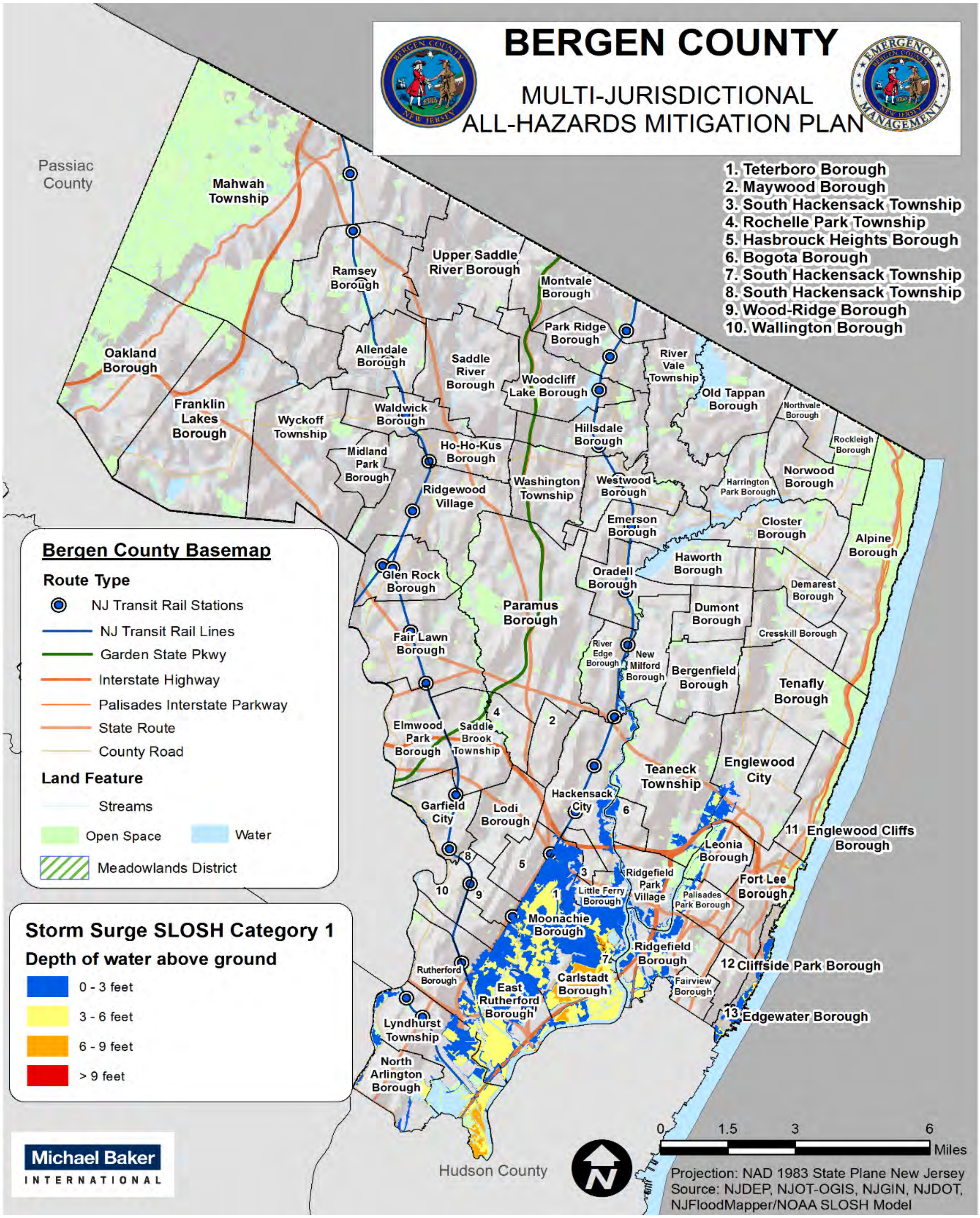


Figure 4.7-4 Modelled Storm Surge Extent and Depth in Bergen County (Category 2)

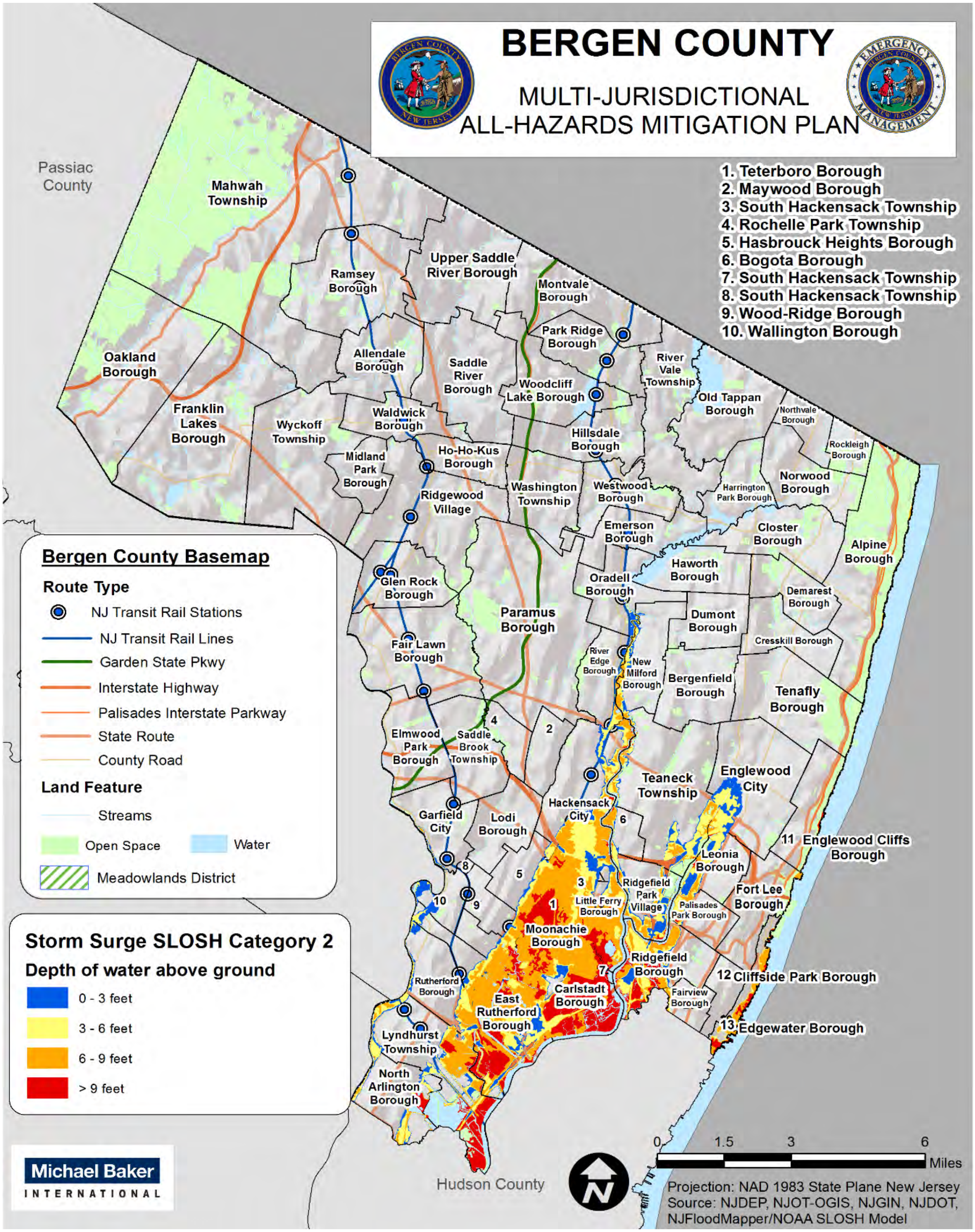


Table 4.7-7 Total Number and Percentage of Critical Facilities, Critical Infrastructure, and Historic & Cultural Resources with Risk of Storm Surge shows the number and percentage of critical facilities with risk of storm surge from Category 1, Category 2, Category 3, and Category 4 Hurricanes. This dataset was created by critical facility data points that intersected with NOAA storm surge inundation zones, downloaded from NJFloodMapper[21].

Table 4.7-7 Total Number and Percentage of Critical Facilities, Critical Infrastructure, and Historic & Cultural Resources with Risk of Storm Surge

Jurisdiction	Number of Critical Facilities with Risk of Storm Surge				Percentage of Critical Facilities with Risk of Storm Surge			
	Category 1	Category 2	Category 3	Category 4	Category 1	Category 2	Category 3	Category 4
Allendale Borough	0	0	0	0	0%	0%	0%	0%
Alpine Borough	0	0	0	0	0%	0%	0%	0%
Bergenfield Borough	0	0	0	0	0%	0%	0%	0%
Bogota Borough	5	5	5	6	31%	31%	31%	38%
Carlstadt Borough	0	2	2	2	0%	40%	40%	40%
Cliffside Park Borough	0	0	0	0	0%	0%	0%	0%
Closter Borough	0	0	0	0	0%	0%	0%	0%
Cresskill Borough	0	0	0	0	0%	0%	0%	0%
Demarest Borough	0	0	0	0	0%	0%	0%	0%
Dumont Borough	0	0	0	0	0%	0%	0%	0%
East Rutherford Borough	1	3	5	7	8%	23%	38%	54%
Edgewater Borough	12	10	12	13	71%	59%	71%	76%
Elmwood Park Borough	0	0	0	0	0%	0%	0%	0%
Emerson Borough	0	0	0	0	0%	0%	0%	0%
Englewood City	0	5	17	20	0%	13%	45%	53%
Englewood Cliffs Borough	3	3	3	3	43%	43%	43%	43%
Fair Lawn Borough	0	0	0	0	0%	0%	0%	0%
Fairview Borough	0	1	1	3	0%	20%	20%	60%
Fort Lee Borough	0	0	0	0	0%	0%	0%	0%
Franklin Lakes Borough	0	0	0	0	0%	0%	0%	0%
Garfield City	0	0	0	0	0%	0%	0%	0%
Glen Rock Borough	0	0	0	0	0%	0%	0%	0%
Hackensack City	6	14	14	14	38%	88%	88%	88%
Harrington Park Borough	0	0	0	0	0%	0%	0%	0%
Hasbrouck Heights Borough	1	1	1	1	11%	11%	11%	11%
Haworth Borough	0	0	0	0	0%	0%	0%	0%
Hillsdale Borough	0	0	0	0	0%	0%	0%	0%
Ho-Ho-Kus Borough	0	0	0	0	0%	0%	0%	0%
Leonia Borough	3	2	3	3	19%	13%	19%	19%
Little Ferry Borough	10	12	12	13	77%	92%	92%	100%
Lodi Borough	0	0	1	1	0%	0%	14%	14%
Lyndhurst Township	1	1	1	2	8%	8%	8%	15%
Mahwah Township	0	0	0	0	0%	0%	0%	0%
Maywood Borough	0	0	0	0	0%	0%	0%	0%
Midland Park Borough	0	0	0	0	0%	0%	0%	0%
Montvale Borough	0	0	0	0	0%	0%	0%	0%
Moonachie Borough	7	7	7	7	100%	100%	100%	100%
New Milford Borough	0	0	14	23	0%	0%	56%	92%
North Arlington Borough	0	2	2	2	0%	13%	13%	13%

[21] National Weather Service (NWS) National Hurricane Center. Sea, Lake, and Overland Surge from Hurricanes (SLOSH) model; NJFloodMapper. 2019. CoastalFlooding/StormSurge (MapServer). https://njmaps1.rad.rutgers.edu/arcgis/rest/services/CoastalFlooding/StormSurge/MapServer

Jurisdiction	Number of Critical Facilities with Risk of Storm Surge				Percentage of Critical Facilities with Risk of Storm Surge			
	Category 1	Category 2	Category 3	Category 4	Category 1	Category 2	Category 3	Category 4
Northvale Borough	0	0	0	0	0%	0%	0%	0%
Norwood Borough	0	0	0	2	0%	0%	0%	25%
Oakland Borough	0	0	0	0	0%	0%	0%	0%
Old Tappan Borough	0	0	0	0	0%	0%	0%	0%
Oradell Borough	0	0	1	5	0%	0%	10%	50%
Palisades Park Borough	1	1	2	2	10%	10%	20%	20%
Paramus Borough	0	0	0	0	0%	0%	0%	0%
Park Ridge Borough	0	0	0	0	0%	0%	0%	0%
Ramsey Borough	0	0	0	0	0%	0%	0%	0%
Ridgefield Borough	0	1	1	4	0%	10%	10%	40%
Ridgefield Park Village	2	3	3	8	11%	17%	17%	44%
Ridgewood Village	0	0	0	0	0%	0%	0%	0%
River Edge Borough	0	3	3	3	0%	27%	27%	27%
River Vale Township	0	0	0	0	0%	0%	0%	0%
Rochelle Park Township	0	0	0	0	0%	0%	0%	0%
Rockleigh Borough	0	0	0	0	0%	0%	0%	0%
Rutherford Borough	1	1	1	1	13%	13%	13%	13%
Saddle Brook Township	0	0	0	0	0%	0%	0%	0%
Saddle River Borough	0	0	0	0	0%	0%	0%	0%
South Hackensack Township	0	16	17	17	0%	94%	100%	100%
Teaneck Township	1	5	8	12	2%	8%	13%	20%
Tenafly Borough	0	0	0	0	0%	0%	0%	0%
Teterboro Borough	4	6	6	6	67%	100%	100%	100%
Upper Saddle River Borough	0	0	0	0	0%	0%	0%	0%
Waldwick Borough	0	0	0	0	0%	0%	0%	0%
Wallington Borough	0	0	1	5	0%	0%	14%	71%
Washington Township	0	0	0	0	0%	0%	0%	0%
Westwood Borough	0	0	0	0	0%	0%	0%	0%
Wood-Ridge Borough	1	1	1	1	20%	20%	20%	20%
Woodcliff Lake Borough	0	0	0	0	0%	0%	0%	0%
Wyckoff Township	0	0	0	0	0%	0%	0%	0%

Jurisdiction	Number of Critical Infrastructure with Risk of Storm Surge				Percentage of Critical Infrastructure with Risk of Storm Surge			
	Category 1	Category 2	Category 3	Category 4	Category 1	Category 2	Category 3	Category 4
Allendale Borough	0	0	0	0	0%	0%	0%	0%
Alpine Borough	0	0	0	0	0%	0%	0%	0%
Bergenfield Borough	0	0	0	0	0%	0%	0%	0%
Bogota Borough	0	0	0	0	0%	0%	0%	0%
Carlstadt Borough	0	0	0	0	0%	0%	0%	0%
Cliffside Park Borough	0	0	0	0	0%	0%	0%	0%
Closter Borough	0	0	0	0	0%	0%	0%	0%
Cresskill Borough	0	0	0	0	0%	0%	0%	0%
Demarest Borough	0	0	0	0	0%	0%	0%	0%
Dumont Borough	0	0	0	0	0%	0%	0%	0%
East Rutherford Borough	0	0	0	0	0%	0%	0%	0%
Edgewater Borough	0	0	0	0	0%	0%	0%	0%
Elmwood Park Borough	0	0	0	0	0%	0%	0%	0%
Emerson Borough	0	0	0	0	0%	0%	0%	0%
Englewood City	0	0	0	0	0%	0%	0%	0%

Jurisdiction	Number of Critical Infrastructure with Risk of Storm Surge				Percentage of Critical Infrastructure with Risk of Storm Surge			
	Category 1	Category 2	Category 3	Category 4	Category 1	Category 2	Category 3	Category 4
Englewood Cliffs Borough	0	0	0	0	0%	0%	0%	0%
Fair Lawn Borough	0	0	0	0	0%	0%	0%	0%
Fairview Borough	0	0	0	0	0%	0%	0%	0%
Fort Lee Borough	0	0	0	0	0%	0%	0%	0%
Franklin Lakes Borough	0	0	0	0	0%	0%	0%	0%
Garfield City	0	0	0	0	0%	0%	0%	0%
Glen Rock Borough	0	0	0	0	0%	0%	0%	0%
Hackensack City	0	0	0	0	0%	0%	0%	0%
Harrington Park Borough	0	0	0	0	0%	0%	0%	0%
Hasbrouck Heights Borough	0	2	2	2	0%	100%	100%	100%
Haworth Borough	0	0	0	0	0%	0%	0%	0%
Hillsdale Borough	0	0	0	0	0%	0%	0%	0%
Ho-Ho-Kus Borough	0	0	0	0	0%	0%	0%	0%
Leonia Borough	0	1	2	2	0%	20%	40%	40%
Little Ferry Borough	10	11	11	11	91%	100%	100%	100%
Lodi Borough	0	0	0	0	0%	0%	0%	0%
Lyndhurst Township	0	0	0	0	0%	0%	0%	0%
Mahwah Township	0	0	0	0	0%	0%	0%	0%
Maywood Borough	0	0	0	0	0%	0%	0%	0%
Midland Park Borough	0	0	0	0	0%	0%	0%	0%
Montvale Borough	0	0	0	0	0%	0%	0%	0%
Moonachie Borough	4	4	4	4	100%	100%	100%	100%
New Milford Borough	0	2	2	10	0%	20%	20%	100%
North Arlington Borough	0	0	0	0	0%	0%	0%	0%
Northvale Borough	0	0	0	0	0%	0%	0%	0%
Norwood Borough	0	0	0	0	0%	0%	0%	0%
Oakland Borough	0	0	0	0	0%	0%	0%	0%
Old Tappan Borough	0	0	0	0	0%	0%	0%	0%
Oradell Borough	0	0	0	0	0%	0%	0%	0%
Palisades Park Borough	0	0	0	0	0%	0%	0%	0%
Paramus Borough	0	0	0	0	0%	0%	0%	0%
Park Ridge Borough	0	0	0	0	0%	0%	0%	0%
Ramsey Borough	0	0	0	0	0%	0%	0%	0%
Ridgefield Borough	1	3	3	3	25%	75%	75%	75%
Ridgefield Park Village	0	0	0	0	0%	0%	0%	0%
Ridgewood Village	0	0	0	0	0%	0%	0%	0%
River Edge Borough	0	0	0	0	0%	0%	0%	0%
River Vale Township	0	0	0	0	0%	0%	0%	0%
Rochelle Park Township	0	0	0	0	0%	0%	0%	0%
Rockleigh Borough	0	0	0	0	0%	0%	0%	0%
Rutherford Borough	1	1	1	1	50%	0%	0%	0%
Saddle Brook Township	0	0	0	0	0%	0%	0%	0%
Saddle River Borough	0	0	0	0	0%	0%	0%	0%
South Hackensack Township	1	1	2	2	50%	0%	0%	0%
Teaneck Township	0	0	0	0	0%	0%	0%	0%
Tenafly Borough	0	0	0	0	0%	0%	0%	0%
Teterboro Borough	1	1	1	1	100%	0%	0%	0%

Jurisdiction	Number of Critical Infrastructure with Risk of Storm Surge				Percentage of Critical Infrastructure with Risk of Storm Surge			
	Category 1	Category 2	Category 3	Category 4	Category 1	Category 2	Category 3	Category 4
Upper Saddle River Borough	0	0	0	0	0%	0%	0%	0%
Waldwick Borough	0	0	0	0	0%	0%	0%	0%
Wallington Borough	0	0	0	0	0%	0%	0%	0%
Washington Township	0	0	0	0	0%	0%	0%	0%
Westwood Borough	0	0	0	0	0%	0%	0%	0%
Wood-Ridge Borough	0	0	0	0	0%	0%	0%	0%
Woodcliff Lake Borough	0	0	0	0	0%	0%	0%	0%
Wyckoff Township	0	0	0	0	0%	0%	0%	0%

Jurisdiction	Number of Historic & Cultural Resources with Risk of Storm Surge				Percentage of Historic & Cultural Resources with Risk of Storm Surge			
	Category 1	Category 2	Category 3	Category 4	Category 1	Category 2	Category 3	Category 4
Allendale Borough	0	0	0	0	0%	0%	0%	0%
Alpine Borough	0	0	0	0	0%	0%	0%	0%
Bergenfield Borough	0	0	0	0	0%	0%	0%	0%
Bogota Borough	2	2	2	2	40%	40%	40%	40%
Carlstadt Borough	3	4	4	4	20%	27%	27%	27%
Cliffside Park Borough	0	0	0	0	0%	0%	0%	0%
Closter Borough	0	0	0	0	0%	0%	0%	0%
Cresskill Borough	0	0	0	0	0%	0%	0%	0%
Demarest Borough	0	0	0	0	0%	0%	0%	0%
Dumont Borough	0	0	0	0	0%	0%	0%	0%
East Rutherford Borough	6	6	7	7	67%	67%	78%	78%
Edgewater Borough	11	9	12	12	79%	64%	86%	86%
Elmwood Park Borough	0	0	0	0	0%	0%	0%	0%
Emerson Borough	0	0	0	0	0%	0%	0%	0%
Englewood City	2	4	8	10	10%	20%	40%	50%
Englewood Cliffs Borough	2	2	2	2	14%	14%	14%	14%
Fair Lawn Borough	0	0	0	0	0%	0%	0%	0%
Fairview Borough	0	0	0	0	0%	0%	0%	0%
Fort Lee Borough	1	1	1	3	5%	5%	5%	14%
Franklin Lakes Borough	0	0	0	0	0%	0%	0%	0%
Garfield City	0	0	0	0	0%	0%	0%	0%
Glen Rock Borough	0	0	0	0	0%	0%	0%	0%
Hackensack City	3	5	5	5	60%	100%	100%	100%
Harrington Park Borough	0	0	0	0	0%	0%	0%	0%
Hasbrouck Heights Borough	0	0	0	0	0%	0%	0%	0%
Haworth Borough	0	0	0	0	0%	0%	0%	0%
Hillsdale Borough	0	0	0	0	0%	0%	0%	0%
Ho-Ho-Kus Borough	0	0	0	0	0%	0%	0%	0%
Leonia Borough	6	42	71	76	6%	43%	73%	78%
Little Ferry Borough	0	0	0	0	0%	0%	0%	0%
Lodi Borough	0	0	0	0	0%	0%	0%	0%
Lyndhurst Township	1	3	4	6	14%	43%	57%	86%
Mahwah Township	0	0	0	0	0%	0%	0%	0%
Maywood Borough	0	0	0	0	0%	0%	0%	0%
Midland Park Borough	0	0	0	0	0%	0%	0%	0%
Montvale Borough	0	0	0	0	0%	0%	0%	0%
Moonachie Borough	0	0	0	0	0%	0%	0%	0%

Jurisdiction	Number of Historic & Cultural Resources with Risk of Storm Surge				Percentage of Historic & Cultural Resources with Risk of Storm Surge			
	Category 1	Category 2	Category 3	Category 4	Category 1	Category 2	Category 3	Category 4
New Milford Borough	1	11	29	42	2%	22%	59%	86%
North Arlington Borough	0	1	1	1	0%	14%	14%	14%
Northvale Borough	0	0	0	0	0%	0%	0%	0%
Norwood Borough	0	0	0	0	0%	0%	0%	0%
Oakland Borough	0	0	0	0	0%	0%	0%	0%
Old Tappan Borough	0	0	0	0	0%	0%	0%	0%
Oradell Borough	0	2	2	2	0%	100%	100%	100%
Palisades Park Borough	0	0	0	0	0%	0%	0%	0%
Paramus Borough	0	0	0	0	0%	0%	0%	0%
Park Ridge Borough	0	0	0	0	0%	0%	0%	0%
Ramsey Borough	0	0	0	0	0%	0%	0%	0%
Ridgefield Borough	0	1	1	1	0%	50%	50%	50%
Ridgefield Park Village	1	1	2	4	20%	20%	40%	80%
Ridgewood Village	0	0	0	0	0%	0%	0%	0%
River Edge Borough	0	1	1	1	0%	50%	50%	50%
River Vale Township	0	0	0	0	0%	0%	0%	0%
Rochelle Park Township	0	0	0	0	0%	0%	0%	0%
Rockleigh Borough	0	0	0	0	0%	0%	0%	0%
Rutherford Borough	0	0	0	0	0%	0%	0%	0%
Saddle Brook Township	0	0	0	0	0%	0%	0%	0%
Saddle River Borough	0	0	0	0	0%	0%	0%	0%
South Hackensack Township	1	4	4	5	20%	80%	80%	100%
Teaneck Township	0	1	1	1	0%	100%	100%	100%
Tenafly Borough	0	0	0	0	0%	0%	0%	0%
Teterboro Borough	0	0	0	0	0%	0%	0%	0%
Upper Saddle River Borough	0	0	0	0	0%	0%	0%	0%
Waldwick Borough	0	0	0	0	0%	0%	0%	0%
Wallington Borough	0	0	2	2	0%	0%	40%	40%
Washington Township	0	0	0	0	0%	0%	0%	0%
Westwood Borough	0	0	0	0	0%	0%	0%	0%
Wood-Ridge Borough	1	1	1	1	33%	33%	33%	33%
Woodcliff Lake Borough	0	0	0	0	0%	0%	0%	0%
Wyckoff Township	0	0	0	0	0%	0%	0%	0%

Sources: National Weather Service (NWS) National Hurricane Center; NJFloodMapper, 2019; NJSEA; Bergen County Jurisdictions; NJOIT, 2017; NJ division of Taxation, 2017

4.8 LANDSLIDE

Hazard Description

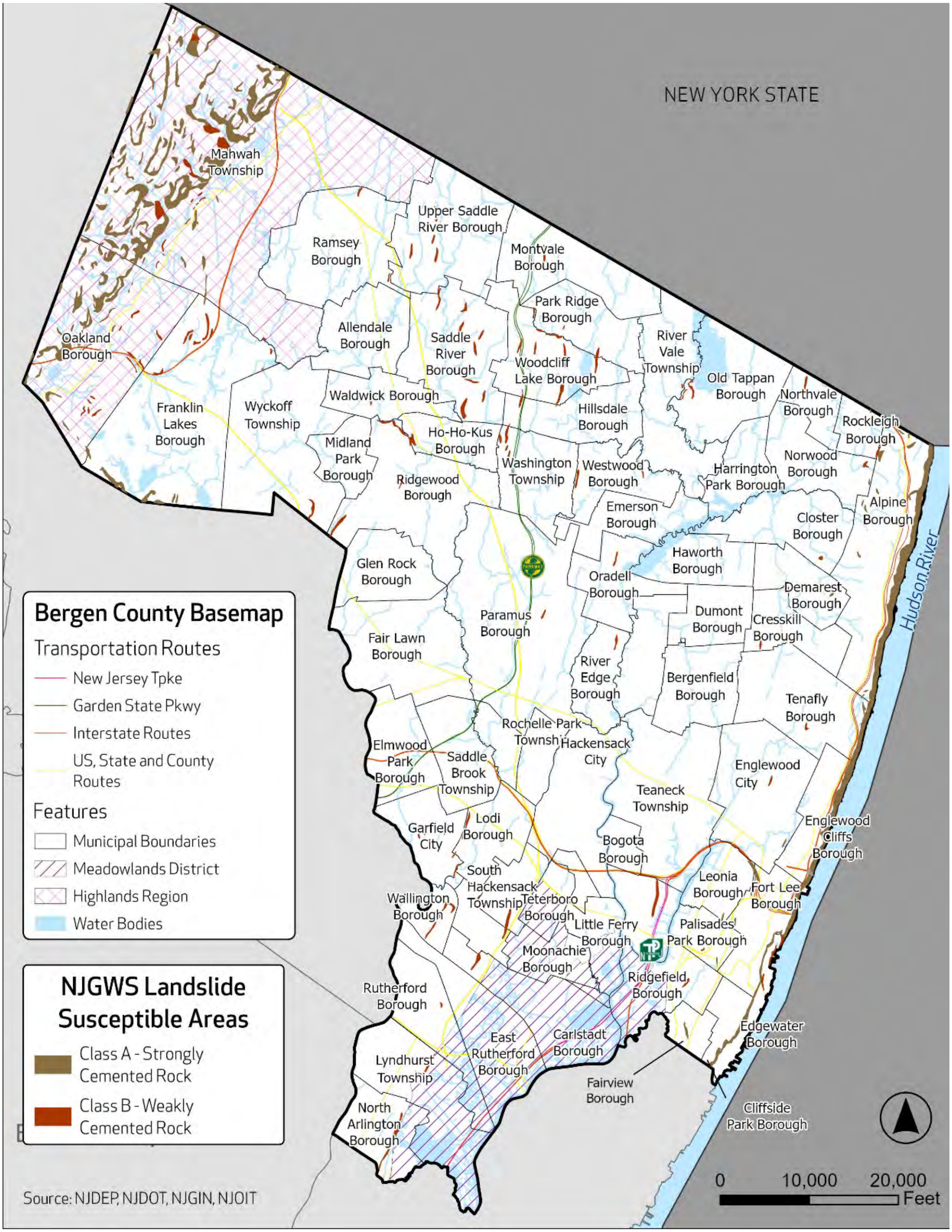
A landslide is a geological phenomenon which includes a wide range of ground movement, such as rock falls, deep failure of slopes and shallow debris flows. Although gravity's action on an over-steepened slope is the primary reason for a landslide, there are other contributing factors affecting the original slope stability such as a heavy rainfall event, earthquake, or human activity. The rate of landslide movement ranges from rapid to very slow. A landslide can involve large or small volumes of material. Material can move practically intact or be greatly deformed and rearranged. The slope may be nearly vertical or fairly gentle.

The USGS defines landslide as the movement of rock, debris or earth down a slope. The term landslide encompasses events such as rock falls, topples, slides, spreads and flows, such as debris flows commonly referred to as mudflows and mudslides. Landslides can be initiated by rainfall, earthquakes, volcanic activity, changes in groundwater, disturbance and change of a slope by man-made construction activities, or any combination of the above. Failure of a slope occurs when the force that is pulling the slope downward (gravity) exceeds the strength of the earth materials that compose the slope. Materials can move slowly, (millimeters per year) or can move quickly and disastrously, as is the case with debris-flows. Debris-flows can travel down a hillside of speeds up to 200 miles per hour (more commonly, 30 - 50 miles per hour), depending on the slope angle, water content, and type of earth and debris in the flow. These flows are initiated by heavy, usually sustained, periods of rainfall, but sometimes can happen as a result of short bursts of concentrated rainfall in susceptible areas. Burned areas charred by wildfires are particularly susceptible to debris flows, given certain soil characteristics and slope conditions.

Location, Extent and Magnitude

Figure 4.8-1 Landslides Susceptible Areas of Bergen County displays areas of the county deemed susceptible to landslide by the New Jersey Geological and Water Survey (NJGWS). Susceptibility was mapped based on grain-size, compaction, and degree of saturation of soils as determined from published and unpublished geologic-map and well-log data. The susceptible areas are categorized using classifications from the HAZUS User's Manual, table 9.2 (National Institute of Building Sciences, 1997). The map below groups these categories into Class A (Strongly Cemented Rock) and Class B (Weakly Cemented Rock). Further variations exist within these categories based on the angle of the slope and groundwater level which are not reflected in the map.

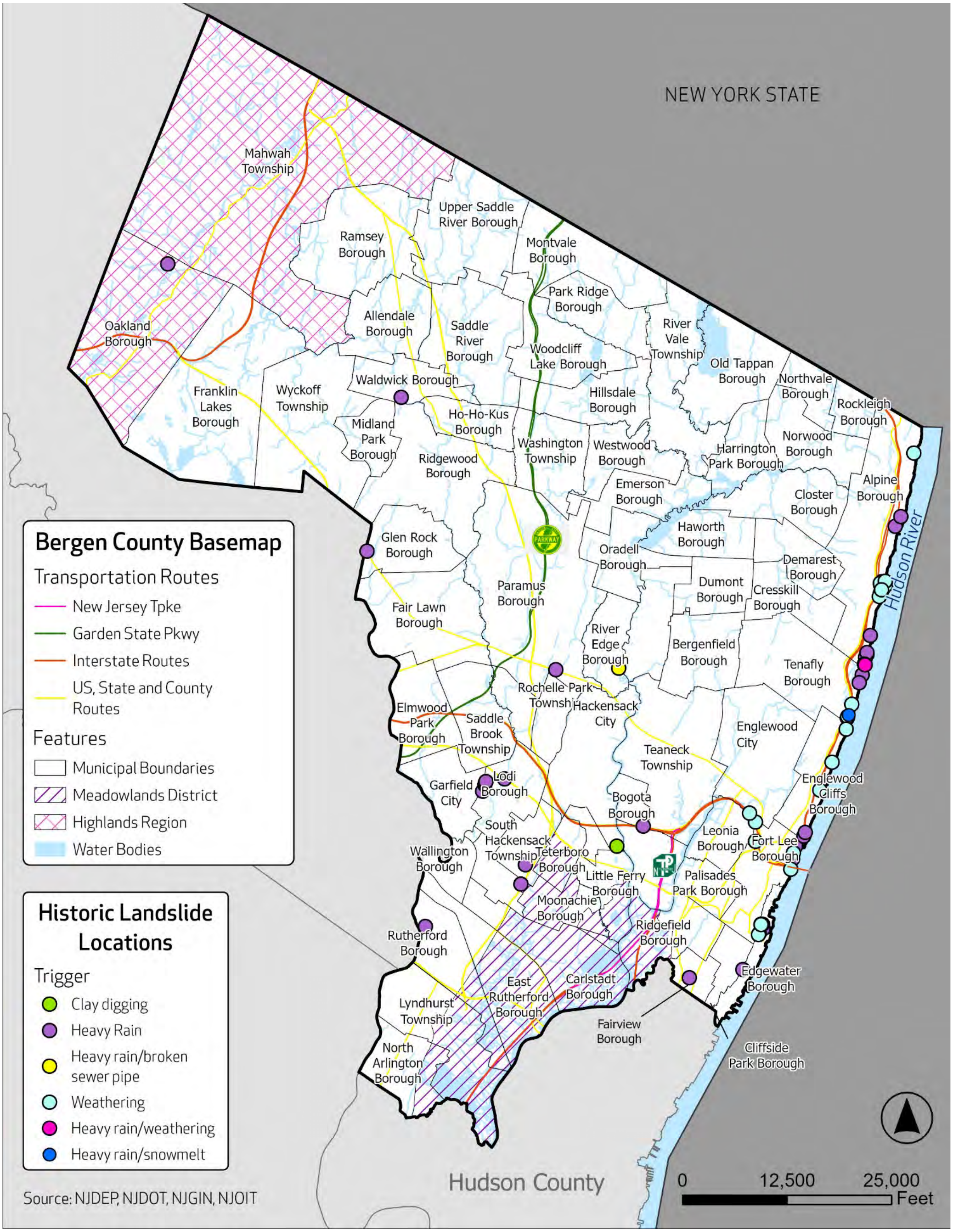
Figure 4.8-1 Landslide Susceptible Areas of Bergen County



According to the State HMP, the Palisades, located in Bergen County, is "one of the most active landslide areas" in the State. The cliffs of the Palisades, located on the eastern coast of Bergen County along the Hudson River, is prone to large rockfalls and rockslides in the winter and spring.[22] The western portion of the county in the highlands region also contains a concentration of landslide susceptible areas. **Figure 4.8-2 Previous Occurrences of Landslides in Bergen County and their Triggers** depicts a concentration on previous landslide events along the Palisades in Alpine Borough, Tenafly Borough, Englewood Cliffs Borough, Fort Lee Borough and Edgewater Borough.

[22] Hansen, Michael C. 2001. "New Jersey Landslides." New Jersey Geological Survey Information Circular. 2009; Michael Baker International. 2019. State of New Jersey 2019 All-Hazards Mitigation Plan.

Figure 4.8-2 Previous Occurrences of Landslides in Bergen County and their Triggers



Landslide extent is a function of the possible area affected by a landslide event, and the probability of the landslide occurring in that area within a specific time period. Soil properties, topographic position and slope, and historical incidence influence the possible extent of a landslide event.

The New Jersey Geologic Survey (currently known as the New Jersey Geological and Water Survey) determined landslide susceptibility for Bergen County. The total land area located in each class was calculated for each municipality, as presented in **Table 4.8-1 Total Land Located in Landslide Areas** below. Based upon the analysis using NJGWS data, Mahwah Township has the greatest area delineated with landslide susceptible soils, while Edgewater Borough has the greatest percent of their land area delineated with landslide susceptible soils.[23] Using the USGS data, Franklin Lakes is also identified as being highly susceptible to landslide.

Table 4.8-1 Total Land Located in Landslide Areas

Jurisdiction	Total Area of Municipality (sq. miles)	NJGWS-Defined Landslide Susceptible Area					
		Class A (sq. miles)	% Total	Class B (sq. miles)	% Total	Overall Total (sq. miles)	% Total
Allendale Borough	3.12	0	0%	0	0%	0	0%
Alpine Borough	6.40	0.76	11.92%	0.02	0.34%	0.78	12.26%
Bergenfield Borough	2.91	0	0%	0	0%	0	0%
Bogota Borough	0.80	0	0%	0	0%	0	0%
Carlstadt Borough	4.20	0	0%	0.02	0.53%	0.02	0.53%
Cliffside Park Borough	0.96	0.04	3.72%	0	0%	0.04	3.72%
Closter Borough	3.30	0	0%	0.01	0.20%	0.01	0.20%
Cresskill Borough	2.07	0	0%	0.01	0.41%	0.01	0.41%
Demarest Borough	2.08	0.01	0.26%	0	0%	0.01	0.26%
Dumont Borough	1.96	0	0%	0	0%	0	0%
East Rutherford Borough	4.05	0	0%	0	0%	0	0%
Edgewater Borough	0.97	0.13	13.65%	0.04	4.10%	0.17	17.75%
Elmwood Park Borough	2.74	0	0%	0	0%	0	0%
Emerson Borough	2.42	0	0%	0	0%	0	0%
Englewood City	4.95	0.01	0.13%	0.01	0.19%	0.02	0.32%
Englewood Cliffs Borough	2.08	0.30	14.57%	0	0%	0.30	14.57%
Fair Lawn Borough	5.22	0	0%	0	0%	0	0%
Fairview Borough	0.85	0.02	1.84%	0	0%	0.02	1.84%
Fort Lee Borough	2.51	0.16	6.41%	0	0%	0.16	6.41%
Franklin Lakes Borough	9.88	0.13	1.36%	0.08	0.86%	0.22	2.22%
Garfield City	2.19	0	0%	0.03	1.25%	0.03	1.25%
Glen Rock Borough	2.72	0	0%	0	0%	0	0%
Hackensack City	4.34	0	0%	0	0%	0	0%
Harrington Park Borough	2.06	0	0%	0	0%	0	0%
Hasbrouck Heights Borough	1.53	0	0%	0.04	2.64%	0.04	2.64%
Haworth Borough	2.35	0	0%	0	0%	0	0%
Hillsdale Borough	2.94	0	0%	0.01	0.45%	0.01	0.45%
Ho-Ho-Kus Borough	1.75	0	0%	0.02	1.10%	0.02	1.10%
Leonia Borough	1.63	0.02	1.39%	0	0%	0.02	1.39%
Little Ferry Borough	1.67	0	0%	0	0%	0	0%
Lodi Borough	2.29	0	0%	0.02	1.03%	0.02	1.03%
Lyndhurst Township	4.97	0	0%	0.02	0.49%	0.02	0.49%
Mahwah Township	25.89	2.70	10.43%	0.26	0.99%	2.96	11.42%
Maywood Borough	1.29	0	0%	0	0%	0	0%

[23] New Jersey Geological and Water Survey. 2016. bergslide. [shapefile]. https://www.nj.gov/dep/njgs/geodata/dgs15-2.htm

Jurisdiction	Total Area of Municipality (sq. miles)	NJGWS-Defined Landslide Susceptible Area					
		Class A (sq. miles)	% Total	Class B (sq. miles)	% Total	Overall Total (sq. miles)	% Total
Midland Park Borough	1.58	0	0%	0	0%	0	0%
Montvale Borough	4.03	0	0%	0.02	0.40%	0.02	0.40%
Moonachie Borough	1.74	0	0%	0	0%	0	0%
New Milford Borough	2.32	0	0%	0	0%	0	0%
North Arlington Borough	2.53	0	0%	0.05	2.13%	0.05	2.13%
Northvale Borough	1.26	0	0%	0.01	0.92%	0.01	0.92%
Norwood Borough	2.80	0	0.14%	0.01	0.35%	0.01	0.48%
Oakland Borough	8.77	0.65	7.45%	0.11	1.25%	0.76	8.70%
Old Tappan Borough	4.16	0	0%	0.03	0.62%	0.03	0.62%
Oradell Borough	2.56	0	0%	0.01	0.43%	0.01	0.43%
Palisades Park Borough	1.28	0.02	1.80%	0	0.27%	0.03	2.07%
Paramus Borough	10.50	0	0%	0.01	0.08%	0.01	0.08%
Park Ridge Borough	2.63	0	0%	0.02	0.85%	0.02	0.85%
Ramsey Borough	5.57	0	0%	0.01	0.27%	0.01	0.27%
Ridgefield Borough	2.86	0	0%	0.01	0.36%	0.01	0.36%
Ridgefield Park Village	1.92	0	0%	0.05	2.48%	0.05	2.48%
Ridgewood Village	5.80	0	0%	0.07	1.27%	0.07	1.27%
River Edge Borough	1.88	0	0%	0.02	1.00%	0.02	1.00%
River Vale Township	4.32	0	0%	0	0.07%	0	0.07%
Rochelle Park Township	1.03	0	0%	0	0%	0	0%
Rockleigh Borough	1.01	0	0.21%	0	0.48%	0.01	0.69%
Rutherford Borough	2.89	0	0%	0	0.15%	0	0.15%
Saddle Brook Township	2.75	0	0%	0	0%	0	0%
Saddle River Borough	4.96	0	0%	0.12	2.49%	0.12	2.49%
South Hackensack Township	0.74	0	0%	0	0.16%	0	0.16%
Teaneck Township	6.24	0	0%	0	0%	0	0%
Tenafly Borough	4.56	0.14	3.01%	0.01	0.17%	0.14	3.18%
Teterboro Borough	1.12	0	0%	0	0%	0	0%
Upper Saddle River Borough	5.27	0	0%	0.06	1.08%	0.06	1.08%
Waldwick Borough	2.07	0	0%	0	0.20%	0	0.20%
Wallington Borough	1.05	0	0%	0.04	4.25%	0.04	4.25%
Washington Township	3.00	0	0%	0.05	1.52%	0.05	1.52%
Westwood Borough	2.30	0	0%	0.03	1.09%	0.03	1.09%
Woodcliff Lake Borough	1.11	0	0%	0.10	2.95%	0.10	2.95%
Wood-Ridge Borough	3.55	0	0%	0.02	1.85%	0.02	1.85%
Wyckoff Township	6.65	0	0%	0.02	0.35%	0.02	0.35%
Bergen County Total	**196.10**	**5.10**	**2.60%**	**1.51**	**0.77%**	**6.60**	**3.37%**

SOURCE: NJGWS 2024

Previous Occurrences and Losses

Table 4.8-2 Past Occurrences of Landslides in Bergen County, New Jersey (1896 to 2025) lists past occurrences of landslides in Bergen County, which mostly occur in the Palisades Cliffs area of the County. The primary causes were weathering and heavy rain. Note that previous occurrences of landslides in Bergen County have not resulted in any reported injuries; two events have resulted in fatalities.

Table 4.8-2 Past Occurrences of Landslides in Bergen County, New Jersey (1896 to 2025)

Date	Type	Municipality	Trigger	Damage	Fatalities	Description
4/18/1896	Rockfall	Alpine	Weathering	No	0	A large boulder fell on the south side of the Blackledge Kearney House. It has an inscription on it that the rock fell on April 18, 1896.
7/5/1928	Rockslide	Alpine	Heavy rain	Yes	0	Report of a large rockslide: 100 feet of Henry Hudson Drive destroyed, $15,000 in damage in 1928. Estimated location.
5/17/1935	Rockslide	Edgewater	Weathering	Yes	0	A 50-ton rock fell from the Palisades onto Rt. 5. The road was closed for five hours.
7/14/1936	Rockslide	Alpine	Heavy rain	No	0	A small rock slide occurred in the Palisades Interstate Park near the Yonkers-Alpine Ferry. Triggered by heavy rain from thunderstorms. Estimated location.
1/10/1937	Rockslide	Alpine	Weathering	No	0	A rockslide on the Alpine Approach Road closed traffic for one hour. Estimated location.
7/23/1938	Rockslide	Alpine	Heavy rain	No	0	Large rockslide north of Twombley's Landing. Estimated location.
7/23/1938	Debris flow	Lodi	Heavy rain	No	0	Report of Rt. 6 (now Rt. 46) closed for several hours by landslides after heavy rain. Estimated location.
7/23/1938	Debris flow	Paramus	Heavy rain	No	0	Report of a landslide, road restricted to one lane by a landslide of mud and stone. Estimated location.
7/23/1938	Rockslide	Alpine	Heavy rain	No	0	A rockslide on the Palisades creates the likeness of Hitler on the cliffs. Estimated location.
9/21/1938	Rockslide	Alpine	Heavy rain	Yes	0	Landslides caused by the rain from The Great Hurricane of 1938 closed Henry Hudson Drive between Alpine and the boat basin. Estimated location.
4/1/1939	Rockslide	Tenafly	Heavy rain	No	0	Heavy rain caused a rockslide on Henry Hudson Drive covering 20 feet of the road. Estimated location.
3/15/1947	Rockslide	Englewood Cliffs	Weathering	No	0	Rockslide destroyed the likeness of Hitler on the Palisades. Estimated location.
8/6/1952	Rockslide	Alpine	Heavy rain	Yes	0	Heavy rains caused a rockslide on the Alpine Approach Road blocking the road for 28 hours. Estimated location.
4/8/1957	Rockslide	Alpine	Heavy rain/ weathering	Yes	0	Report of a rockslide triggered by weathering from rain and melting snow, Henry Hudson Drive closed for two days. Estimated location.
1/27/1959	Rockslide	Tenafly	Weathering	Yes	0	Large rockslide slid off the Palisades triggered by freezing and thawing, road closed. Estimated location.
3/6/1959	Rockfall	Alpine	Heavy rain	Yes	0	A rockfall blocked the Alpine Approach Road; heavy rains combined with early thawing caused the rockfall. Estimated location.
3/6/1959	Rockfall	Fort Lee	Heavy rain	Yes	0	A rockfall on Henry Hudson Drive just north of George Washington Bridge, traffic blocked, heavy rains and early thawing triggered rockfall. Estimated location.
8/6/1961	Rockslide	Alpine	Weathering	Yes	0	Rockslide caused thousands of dollars in damage, 100 feet of road destroyed; rocks stopped 100 feet short of 50 people at the water’s edge. Estimated location.
9/12/1971	Debris flow	Wood-Ridge	Heavy rain	No	1	A 24-year-old man was killed when the earth collapsed on the cliffside parking lot where he worked burying him under three feet of mud and rocks.

Date	Type	Municipality	Trigger	Damage	Fatalities	Description
9/3/1974	Debris flow	Fort Lee	Heavy rain	No	0	A landslide on Rt. 4 blocked a westbound lane from the George Washington Bridge, estimated location.
3/18/1998	Rockslide	Fort Lee	Weathering	Yes	0	Rockslide on Rt. 95 Southbound local lanes, damage to one car from debris in the roadway, right lane closed to install fencing and remove debris.
8/5/2003	Debris flow	Edgewater	Heavy rain	Unknown	0	Reported debris flow down the mountain triggered by heavy rain covered a 100-foot section of River Road.
7/23/2004	Rockfall	Fort Lee	Heavy rain	Unknown	0	Rockslide after heavy rain.
3/29/2005	Rockslide	Englewood	Weathering	No	0	Rockslide on Rt. 95 Southbound local lanes, right lane was closed for 65 minutes to remove debris. Estimated location.
10/8/2005	Debris flow	Lodi	Heavy rain	Yes	0	Landslide caused some property damage to a two family house on Farnham Avenue.
12/17/2005	Rockslide	Alpine	Weathering	Yes	0	Significant rockslide, road closed for repairs, location taken at the toe of the landslide in the parking lot where a large boulder bounced into the Hudson River.
7/22/2006	Debris flow	River Edge	Heavy rain/ broken sewer pipe	Yes	0	Heavy rain caused a storm sewer line to break triggering a debris flow which damaged a fence and closed Kinderkamack Road for two days.
4/15/2007	Debris flow	Glen Rock	Heavy rain	Yes	0	Heavy rain triggered a debris flow on Rt. 208 Southbound near Lincoln Avenue which caused a multiple vehicle accident on the highway, road temporarily closed.
4/15/2007	Debris flow	Hasbrouck Heights	Heavy rain	No	0	A small debris flow at the bottom of Passaic Avenue and Burr Place was triggered by heavy rain.
4/15/2007	Debris flow	Lodi	Heavy rain	Yes	0	Landslide after heavy rain on Farnham Avenue. Some property damage, backyard covered in mud, 50 families displaced.
4/15/2007	Debris flow	Alpine	Heavy rain	Yes	0	Heavy rain triggered a landslide on Henry Hudson Drive which was closed for one month, damage to road and retaining walls.
4/15/2007	Debris flow	Fort Lee	Heavy rain	Yes	0	Heavy rain caused a small landslide near Ross Dock causing damage to retaining walls. Henry Hudson Drive closed for one month.
4/15/2007	Debris flow	Englewood Cliffs	Heavy rain	Yes	0	Heavy rain caused a small landslide near Ross Dock causing damage to retaining walls. Henry Hudson Drive closed for one month.
1/5/2009	Debris flow	Tenafly	Heavy rain/ snowmelt	Yes	0	Rock slide on Henry Hudson Drive at Englewood Cliffs, Tenafly border triggered by rain and snow. Road closed for cleanup. Estimated location.
9/16/2009	Debris flow	Oakland	Heavy rain	Yes	0	Landslide after heavy rain during Hurricane Floyd, three houses damaged, 100 people evacuated. Estimated location.
5/5/2010	Rockfall	Edgewater	Weathering	Yes	0	Rockslide closed Rt. 5 for two days at the Undercliff Avenue section. About 20 yards of rocks and some trees fell onto the road.
8/28/2011	Debris flow	Englewood Cliffs	Heavy rain	Yes	0	Debris flow of mud, rock and trees triggered by Tropical Storm Irene. Temporary road closure of River Road up to one week.

Date	Type	Municipality	Trigger	Damage	Fatalities	Description
8/28/2011	Debris flow	Tenafly	Heavy rain	Yes	0	Debris flow of mud, rock and trees triggered by Tropical Storm Irene. Temporary road closure of River Road up to one week.
8/28/2011	Debris flow	Alpine	Heavy rain	Yes	0	Debris flow of mud, rock and trees triggered by Tropical Storm Irene. Temporary road closure of River Road up to one week.
5/12/2012	Rockslide	Alpine	Weatherin g	Yes	0	A large chuck of the Palisades Interstate Park's cliff wall broke off Saturday, May 12, at about 7:45 p.m., causing a rock slide into the Hudson River at the State Line Lookout. The Shore Trail was closed temporarily.
01/2016	Rockslide	Englewood Cliffs	Weatherin g	No	0	Large Rockslide along the Palisades. A huge piece of rock had sheared away from the cliff.
04/2016	Rockslide	Alpine	Weatherin g	Yes	0	Small rockslide south of the State line lookout on the Alpine Approach Road.
05/2016	Rockslide	Alpine	Weatherin g	Yes	0	Large rockslide closed the Alpine Approach road for over a week. The Debris field that covered the road was 75 feet long by 20 feet wide.
02/2017	Rockslide	Alpine	Weatherin g	Yes	0	Rockslide on Henry Hudson Drive.
08/2018	Debris Flow	Fairview	Heavy Rain	Yes	0	Retaining wall collapse with a mix of fill and glacial till, although most of the failed material was from the wall itself
2018	Rockslide	Fort Lee	Weatherin g	No	0	Small Rockslide along henry Hudson Drive.
2018	Rockslide	Fort Lee	Weatherin g	No	0	Small Rockslide along henry Hudson Drive.
09/2021	Debris Flow	Bogota	Heavy Rain	Yes	0	A mudslide shut down the local lanes along I-80 in the roadcut near the Queen Anne Road overpass. It resulted in abandoned cars on the side of the road The road was close for several hours for cleanup.
09/2021	Debris Flow	Waldwick	Heavy Rain	Yes	0	The landslide was due to an eroded bank from floodwater from Tropical Storm Ida in till along Hohokus Brook behind a house.
09/2021	Debris Flow	Rutherford	Heavy Rain	Yes	0	Rain fell at a record pace in Rutherford, and it all triggered a mudslide. Parts of a three-layer retaining wall were swept across Jackson Avenue.
09/2021	Debris Flow	Edgewater	Heavy Rain	Yes	0	A debris flow on a slope at the base of the Palisades trigger by rain from Hurricane Ida.. The material seems to be mostly fill and rubble. 154A Undercliff Ave, Edgewater.
Unknown	Rockslide	Alpine	Weatherin g	No	0	Historic rockslide area, thousands of rockslides and rockfalls over the years created a talus slope called the Giant Stairs.
Unknown	Debris flow	Hackensack	Clay digging	No	1	A laborer, while digging in a brick yard pit, at Hackensack, was crushed to death by a mass of clay which fell upon him. Estimated location.
Unknown	Rockfall	Edgewater	Weatherin g	Unknown	0	Small rockfall.
Unknown	Rockfall	Alpine	Weatherin g	Yes	0	Roadway damage. Estimated location.
Unknown	Rockfall	Edgewater	Weatherin g	Unknown	0	Small rockfall.
Unknown	Rockfall	Tenafly	Weatherin g	Yes	0	Roadway damage. Estimated location.

Date	Type	Municipality	Trigger	Damage	Fatalities	Description
Unknown	Rockfall	Fort Lee	Weathering	Unknown	0	Small rockfall.
Unknown	Rockfall	Tenafly	Weathering	Yes	0	Roadway damage. Estimated location.
Unknown	Rockfall	Alpine	Weathering	Yes	0	Roadway damage. Estimated location.

SOURCE: NJDEP 2024

Probability of Future Occurrences

Data to estimate the probability of future occurrences of landslides is not available at the time of this plan update, however the frequency of hazards such as earthquakes, heavy rain, floods, or wildfire events, are known to trigger landslides and can be used as an indicator of future landslide events. Of these hazards, frequent heavy rain events are most likely to precipitate landslides because ground saturation before a significant storm is a necessary prerequisite for a major landslide event[24].

Based on past occurrence described in **Table 4.8-2 Past Occurrences of Landslides in Bergen County, New Jersey (1896 to 2025)** and landslide susceptibility as described in **Table 4.8-1 Total Land Located in Landslide Areas** it is likely that Bergen County will continue to experience landslides. In addition to climate change (explained below), future development may also impact the frequency of landslide events[25].

Potential Effects of Climate Change

As previously mentioned, landslide frequency may be influenced by the frequency of other natural hazards also influenced by climate change. Climate change may increase the frequency and severity of precipitation events and thus landslide events as well. Warming temperature may also cause drought and wildfire events that burn stabilizing vegetation along steep slopes[26].

Vulnerability Assessment

The speed of a landslide event can vary from a change in inches per year to feet per second based on topographic conditions. An analysis of climate and geologic conditions landslide monitoring methods may help to determine the location, type of movement, and movement speed before a landslide event occurs. That said, “there is no practical warning system for individual landslides” . For more information on severity and warning time, please refer to the State HMP.

Buildings, Infrastructure and Community Lifelines

Landslides can have significant effects on the built environment, as they can cause extensive damage to roads, bridges, utilities, and buildings, leading to disruptions in transportation, communication, and energy. **Table 4.8-3 Expected Annualized Losses from Landslide by Jurisdiction** shows expected annualized losses for the landslide hazard. This data was derived from FEMA’s NRI. Expected EAL represents the average economic loss in dollars resulting from natural hazards each year. The table includes EAL for buildings as well as total EAL which includes building damage as well as damage to agriculture and population equivalency (the monetized cost of injury and fatality).

Table 4.8-3 Expected Annualized Losses from Landslide by Jurisdiction

Municipality	Expected Annual Losses (Building)	Expected Annual Losses (Total)
Allendale Borough	$639.68	$697.33
Alpine Borough	$12,780.47	$13,417.67
Bergenfield Borough	$324.39	$395.82
Bogota Borough	$-	$-

[24] Michael Baker International. 2019. State of New Jersey 2019 All-Hazards Mitigation Plan.
[25] Ibid.
[26] Ibid.

Municipality	Expected Annual Losses (Building)	Expected Annual Losses (Total)
Carlstadt Borough	$943.53	$1,031.21
Cliffside Park Borough	$6,719.43	$8,155.30
Closter Borough	$1,110.15	$1,257.07
Cresskill Borough	$1,040.99	$1,169.47
Demarest Borough	$153.61	$176.83
Dumont Borough	$791.77	$951.54
East Rutherford Borough	$2,182.08	$2,376.03
Edgewater Borough	$4,738.14	$5,592.24
Elmwood Park Borough	$38.00	$40.58
Emerson Borough	$1,892.14	$2,131.68
Englewood City	$1,455.53	$1,582.42
Englewood Cliffs Borough	$6,026.60	$6,377.47
Fair Lawn Borough	$414.70	$440.50
Fairview Borough	$1,987.45	$2,547.31
Fort Lee Borough	$7,167.60	$8,491.86
Franklin Lakes Borough	$6,934.77	$7,370.17
Garfield City	$402.98	$518.31
Glen Rock Borough	$2,882.98	$3,163.35
Hackensack City	$5,639.47	$6,862.80
Harrington Park Borough	$36.37	$41.11
Hasbrouck Heights Borough	$3,080.12	$3,577.02
Haworth Borough	$314.76	$343.38
Hillsdale Borough	$1,915.79	$2,120.27
Ho-Ho-Kus Borough	$2,462.10	$2,672.10
Leonia Borough	$-	$-
Little Ferry Borough	$-	$-
Lodi Borough	$2,165.22	$2,679.32
Lyndhurst Township	$2,648.67	$2,925.41
Mahwah Township	$7,821.40	$8,430.93
Maywood Borough	$794.55	$955.72
Midland Park Borough	$274.64	$296.38
Montvale Borough	$2,617.95	$2,893.00
Moonachie Borough	$122.59	$137.00
New Milford Borough	$525.78	$620.17
North Arlington Borough	$847.68	$944.91
Northvale Borough	$1488.57	1645.24
Norwood Borough	$12.00	$13.31
Oakland Borough	$4,331.75	$4,784.58
Old Tappan Borough	$2,068.70	$2,226.73
Oradell Borough	$1,849.66	$1,995.08
Palisades Park Borough	$1,928.26	$2,385.52
Paramus Borough	$4,062.81	$4,444.82
Park Ridge Borough	$2,539.77	$2,829.41
Ramsey Borough	$2,384.69	$2,569.28
Ridgefield Borough	$1,620.91	$1,945.80
Ridgefield Park Village	$694.75	$797.15
Ridgewood Village	$2,544.46	$2,770.76
River Edge Borough	$359.98	$414.69
River Vale Township	$1,711.16	$1,884.03
Rochelle Park Township	$-	$-
Rockleigh Borough	$127.29	$140.68
Rutherford Borough	$1,919.90	$2,201.44
Saddle Brook Township	$190.52	$212.26
Saddle River Borough	$1,161.81	$1,236.81
South Hackensack Township	$73.05	$73.29
Teaneck Township	$2,631.66	$2,975.78
Tenafly Borough	$3,059.98	$3,419.78
Teterboro Borough	$657.49	$659.65
Upper Saddle River Borough	$2,372.94	$2,560.12

Municipality	Expected Annual Losses (Building)	Expected Annual Losses (Total)
Waldwick Borough	$971.83	$1,141.59
Wallington Borough	$2,977.02	$3,595.76
Washington Township	$1,764.06	$1,959.45
Westwood Borough	$1,901.99	$2,200.95
Wood-Ridge Borough	$2,223.75	$2,531.65
Woodcliff Lake Borough	$2,193.41	$2,392.41
Wyckoff Township	$3,295.03	$3,620.46
Bergen County Total	**$147,017.19**	**$165,013.74**

SOURCE: FEMA NRI

Population and the Economy

The population within the landslide areas may be vulnerable, especially those located downslope of the identified hazard areas. When populations are impacted, the landslide hazard can result in injury and even death. The health hazards associated with landslides and mudflows include rapidly moving water and debris that can lead to trauma; broken electrical, water, gas, and sewage lines that can result in injury or illness; and disrupted roadways and railways that can endanger motorists and disrupt transport and access to health care. Landslides can lead to financial losses when businesses are impacted.

Ecosystems And Natural Assets

Landslide events disrupt and damage ecosystems, by destroying terrestrial and riverine habitats, changing topography, and causing soil and sediment runoff. [27].

4.9 SEVERE WEATHER

Hazard Description

Severe weather events in Bergen County are common and can occur at any time. This profile of Severe Weather includes information and analysis on extreme temperatures, high winds, lightning, and tornadoes.

Extreme Temperatures

The Centers for Disease Control and Prevention (CDC) defines extreme heat as summertime temperatures that are much hotter and or more humid than average. FEMA considers an extreme heat event to be a period where temperatures hover above 90 degrees for at least two days, and an extreme heat wave as temperatures that hover 10 degrees or more above the average high temperature for the region and last for several weeks. Humid or muggy conditions, which add to the discomfort of high temperatures, occur when a dome of high atmospheric pressure traps hazy, damp air near the ground. Extremely dry and hot conditions can provoke dust storms and low visibility. Droughts occur when a long period passes without substantial rainfall. A heat wave combined with a drought is a very dangerous situation.

Extreme cold events are when temperatures drop well below normal in an area. Extreme cold temperatures are typically characterized in temperate zones by the ambient air temperature dropping to approximately 0 degrees or below (CDC, 2005). Winters in New Jersey can be extremely hazardous. Temperatures often reach well below freezing point and wind chills can make it feel as though it is below zero degrees Fahrenheit.

High Winds

Winds are generated by differences in air pressures, caused by uneven heating of the earth's surface. High winds may result from hurricanes and tropical storms, nor'easters, severe thunderstorms, and tornadoes. Rapidly moving thunderstorms may produce an extended windstorm known as a derecho, which creates straight-line winds of 58 mph or

[27] Ibid.

greater and persists for 240 miles or longer. Effects from high winds can include downed trees and power lines, as well as damage to structures, roofs, and windows (Ilicak, 2005).

Lightning

Lightning is a sudden electrostatic discharge that occurs during thunderstorms, capable of causing injury or death, igniting fires, damaging structures and utilities, and disrupting critical services. While often short in duration, lightning events can result in significant localized impacts, particularly when striking buildings, communications systems, or forested areas. In Bergen County, lightning typically accompanies strong convective storms in late spring and summer months.

Tornadoes

The American Meteorological Society defines a tornado as a violently rotating column of air, in contact with the ground, either pendant from a cumuliform cloud or underneath a cumuliform cloud, and often (but not always) visible as a funnel cloud. Damage paths can be greater than 1 mile in width and 50 miles in length. Tornadoes typically develop from either a severe thunderstorm or hurricane as cool air rapidly overrides a layer of warm air. Tornadoes move at speeds which appear stationary to speeds of 60 mph. and can generate internal winds exceeding 300 mph (NWS, 2023).

Tornadoes do appear in New Jersey, although tornadoes within the state have been relatively weak and short lived. Climatologically, past occurrences indicate that the state experiences about two tornadoes per year. Tornado season in New Jersey is typically March through October, though tornadoes can occur at any time of year.

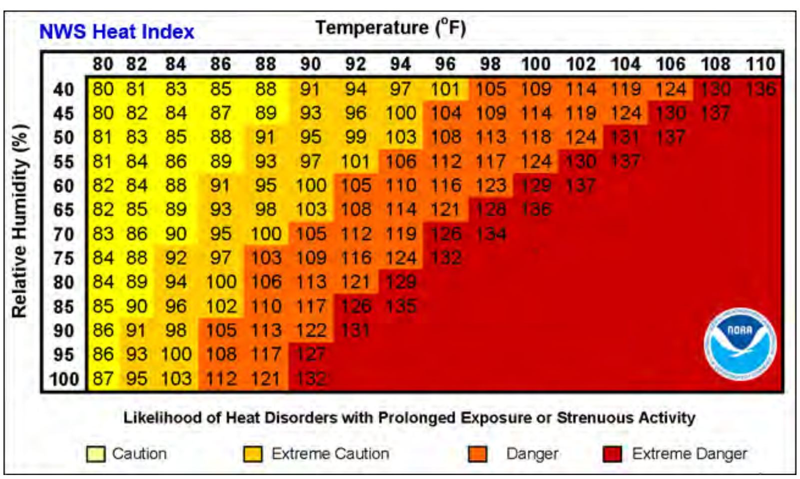
Location, Extent, and Magnitude

Extreme Temperatures

Extreme heat can affect any jurisdiction within Bergen County. While extreme temperature events may affect a region as a whole, inland urban areas are more vulnerable to heat waves due to the urban heat island effect, the phenomenon of increased average temperature in more developed areas[28].

NOAA's heat alert procedures are based mainly on Heat Index values. The Heat Index is given in degrees Fahrenheit. The Heat Index is a measure of how hot it really feels when relative humidity is factored in with the actual air temperature. To find the Heat Index temperature, the temperature and relative humidity need to be known. Once both values are known, the Heat Index will be the corresponding number with both values (**Figure 4.9-1 NWS Heat Index Chart**). The Heat Index indicated the temperature the body feels. It is important to know that the Heat Index values are devised for shady, light wind conditions. Exposure to full sunshine can increase heat index values by up to 15°F. Strong winds, particularly with very hot dry air, can also be extremely hazardous (NWS, 2013).

Figure 4.9-1 NWS Heat Index Chart



NWS Heat Index

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution | Extreme Caution | Danger | Extreme Danger

[28] Ibid.

The NWS states that the extent (severity or magnitude) of extreme cold temperatures are generally measured through the Wind Chill Temperature (WCT) Index. Wind Chill Temperature is the temperature that people and animals feel when outside and it is based on the rate of heat loss from exposed skin by the effects of wind and cold. As the wind increases, the body is cooled at a faster rate causing the skin's temperature to drop.

The latest WCT Index attempts to more accurately calculate how cold air feels on human skin. This includes a frostbite indicator, showing points where temperature, wind speed, and exposure time will produce frostbite in humans. **Figure 4.9-2 National Weather Service Wind Chill Chart** shows three shaded areas of frostbite danger. Each shaded area shows how long a person can be exposed before frostbite develops (NWS 2013).

In New Jersey temperatures fall below freezing as many as 150 days each year in the northwest portion of the State, with less than 75 days below freezing along the southern coast. The average is between 90 and 100 days over two-thirds of the State.

Figure 4.9-2 National Weather Service Wind Chill Chart

NWS Windchill Chart

Temperature (ºF)

Wind (mph) \ Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes | 10 minutes | 5 minutes

$$\text{Wind Chill (ºF)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (ºF) V= Wind Speed (mph)

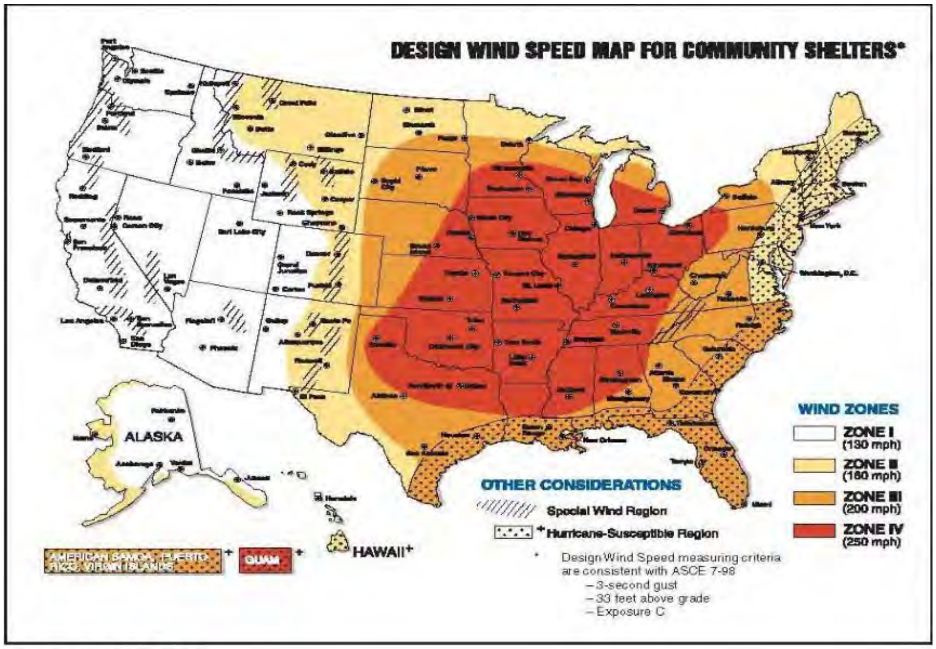
Effective 11/01/01

Source: NWS 2009

High Winds

Bergen County is in a low risk zone for high winds, and all municipalities in Bergen County are equally likely to be impacted by high winds. High winds will occur as part of severe weather events in Bergen County and across the State of New Jersey. Bergen County is located within Wind Zone II, which may experience wind speeds up to 160 mph. **Figure 4.9-3 Design Wind Speed Map for Community Shelters** indicates that in Zone II community shelters are the preferred method of protection from high winds events, as homes could also be susceptible to a hurricane.

Figure 4.9-3 Design Wind Speed Map for Community Shelters



Source: ASCE 7-98

High winds in a severe thunderstorm may exceed 100 mph, causing severe damage to a community; high winds called downbursts may even cause damage similar to that of a tornado[29]. The National Weather Service (NWS) predicts wind speeds using a one-minute average, but actual wind gusts may be 25% to 30% higher than predicted. The NWS issues wind advisories for sustained winds 25 to 29 mph and/or gusts of 46 to 57 mph. NWS also issues wind watches and wind warnings. NWS also issues high wind advisories, watches, and warnings when wind speeds may pose a hazard or are life threatening[30].

The extent of a severe storm is largely dependent on sustained wind speed. The following **Table 4.9-1: NWS Wind Descriptions** provides the descriptions of wind classifications used by the NWS.

Table 4.9-1 NWS Wind Descriptions

Descriptive Term	Sustained Wind Speed (mph)
Strong, Dangerous, or Damaging	>40
Very Windy	30-40
Windy	20-30
Breezy, Brisk, or Blustery	15-25
None	5-15 or 10-20
Light or Light and Variable Wind	0-5

Lightning

Lightning can occur countywide and is not confined to specific topographic or geographic features. Suburban areas with dense development, high tree cover, and above-ground utilities are particularly susceptible to lightning -related damage. The magnitude of a lightning event is typically measured by frequency, voltage, and resulting damage. Although individual

[29] Northern Virginia Regional Commission (NRVC). 2006. "Hazard Identification." On-Line Address: http://www.novaregion.org/documentcenter/view/1735

[30] NWS. 2010. "Glossary." National Oceanic & Atmospheric Administration. On-Line Address: http://w1.weather.gov/glossary/

lightning strikes have limited geographic extent, their effects can be severe, including structure fires, power outages, and localized service disruptions.

Tornadoes

Tornado season in New Jersey is generally March through August, although tornadoes can occur at any time during the year, according to the State HMP. Bergen County is in a low risk zone for tornadoes but is vulnerable to tornado damage due to the dense development in the County. All municipalities in Bergen County are equally likely to be impacted by a tornado. F**igure 4.9-4 Tornado Risk by Wind Zone** indicates that Bergen County is in a moderate risk zone for tornadoes.

Figure 4.9-4 Tornado Risk by Wind Zone

NUMBER OF TORNADOES PER 1,000 SQUARE MILES (See Figure I.1)	WIND ZONE (See Figure I.2) I	II	III	IV
<1	LOW RISK	LOW RISK ★	LOW RISK ★	MODERATE RISK
1 - 5	LOW RISK	MODERATE RISK ★	HIGH RISK	HIGH RISK
6 - 10	LOW RISK	MODERATE RISK ★	HIGH RISK	HIGH RISK
11 - 15	HIGH RISK	HIGH RISK	HIGH RISK	HIGH RISK
>15	HIGH RISK	HIGH RISK	HIGH RISK	HIGH RISK

LOW RISK: Need for high-wind shelter is a matter of homeowner preference

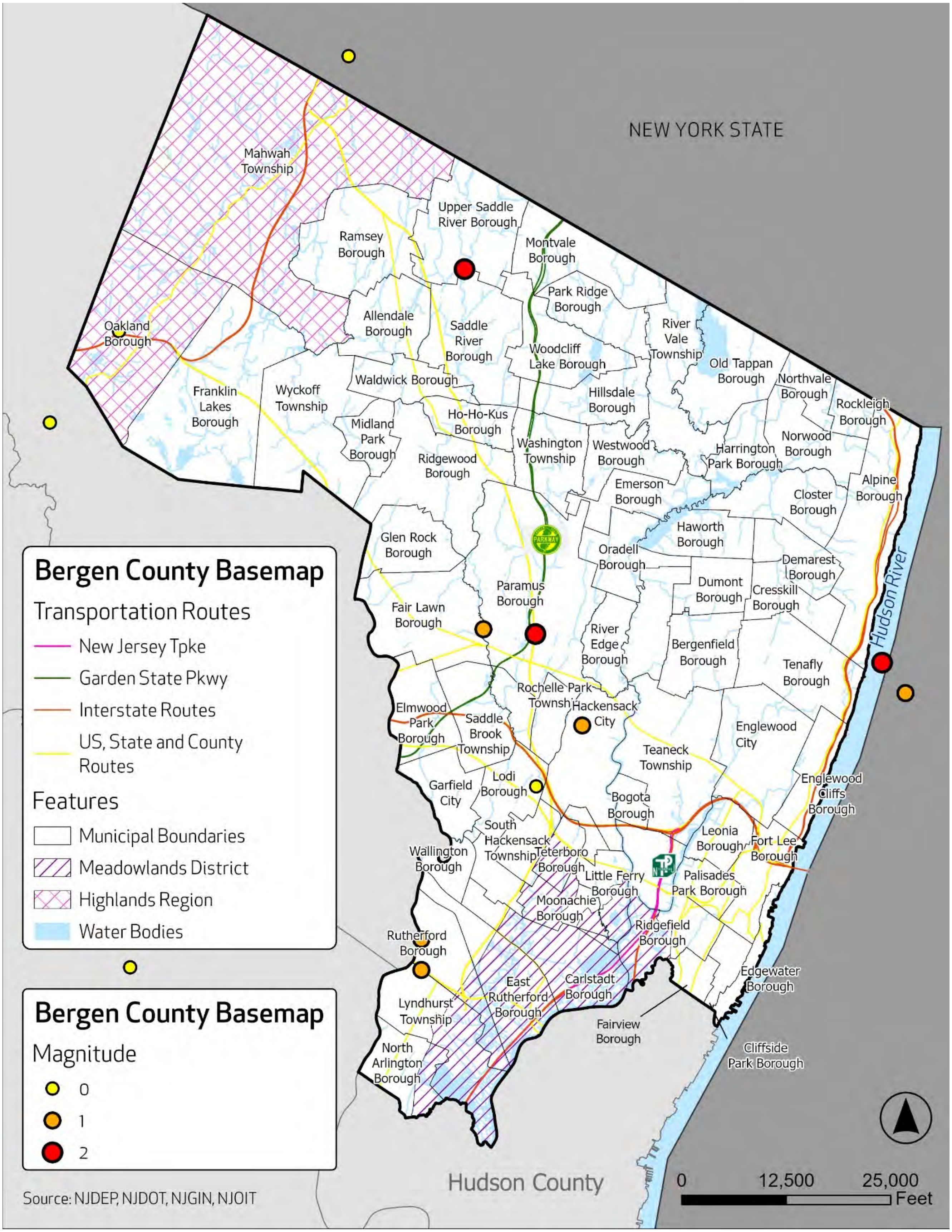
MODERATE RISK: Shelter should be considered for protection from high winds

HIGH RISK: Shelter is preferred method of protection from high winds

★ Shelter is preferred method of protection from high winds if house is in hurricane-susceptible region

The locations of previous tornado touchdowns in Bergen County can be found in **Figure 4.9-5 Historic Touchdown Locations in Bergen County.**

Figure 4.9-5 Historic Tornado Touchdown Locations in Bergen County



Tornadoes vary in intensity regardless of shape, size, and location, though strong tornadoes are typically larger than weak tornadoes. Tornado intensities are rated by the damage on a scale known as the Enhanced Fujita Scale, found in **Table 4.9-2 The Enhanced Fujita Scale**.

Table 4.9-2 The Enhanced Fujita Scale

EF-Scale Number	Intensity Phrase	Wind Speed	Typical Observations
EF0	Gale tornado	65-85 mph	Light damage. Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.
EF1	Moderate tornado	86-110 mph	Moderate damage. Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	Significant tornado	111-135 mph	Considerable damage. Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF3	Severe tornado	136-165 mph	Severe damage. Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	Devastating tornado	166-200 mph	Devastating damage. Whole frame houses Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
EF5	Incredible tornado	Over 200 mph	Incredible damage. Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly in excess of 100 m (109 yd); high-rise buildings have significant structural deformation; incredible phenomena will occur.

Previous Occurrences and Losses

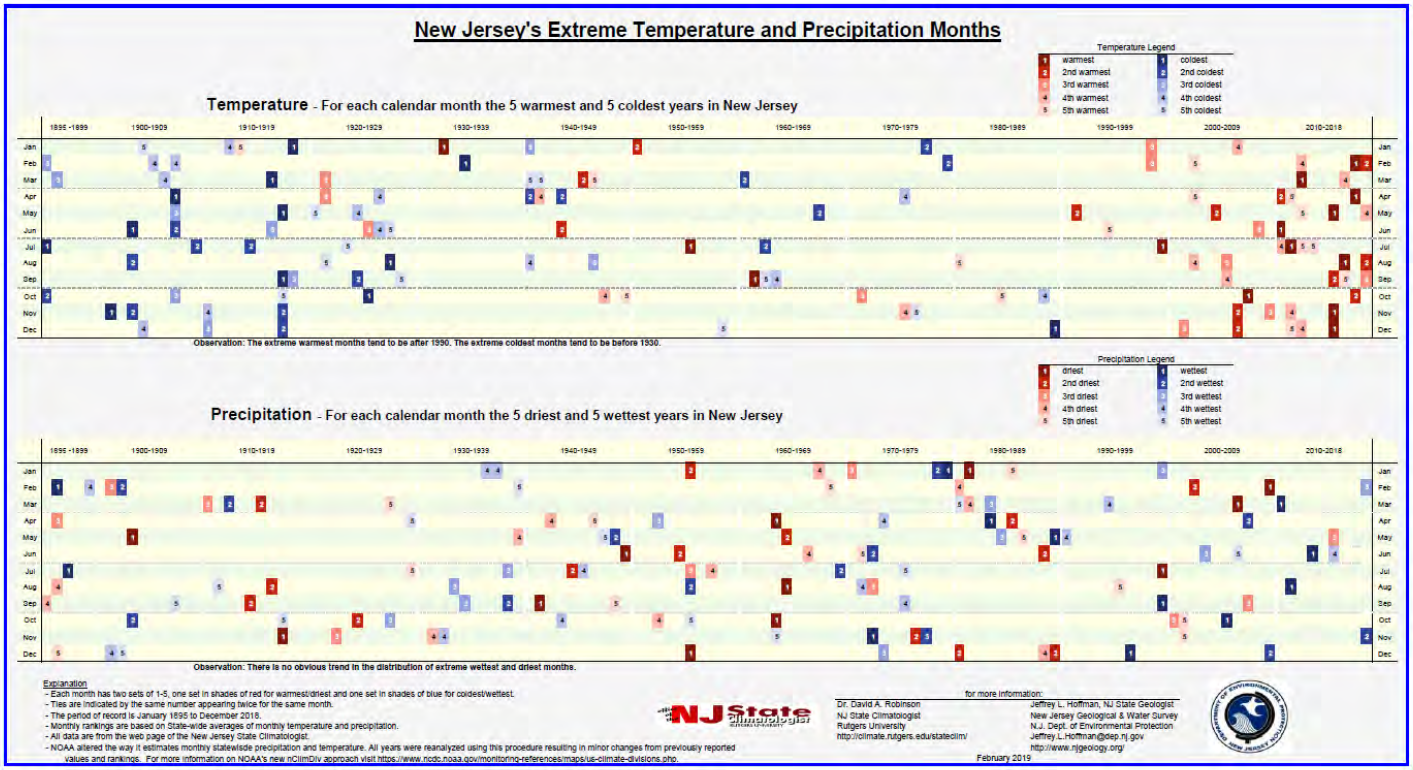
Extreme Temperature

Many sources provided historical information regarding previous occurrences and losses associated with extreme temperature events throughout the state, and loss and impact information for events vary depending on the source. Therefore, the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP.

The New Jersey Scientific Report notes that the state's annual temperatures have risen by about 4°F since 1900 (NJDEP, 2020). The majority of warming has occurred since 1980. Conversely, the months which set records for extreme cold temperatures tended to have occurred prior to 1930. **Figure 4.9-6 Historical Extreme Temperatures** details historical extreme heat as well as extreme cold temperatures in New Jersey[31]. **Table 4.9-3 Extreme Temperature Events in Bergen County** details extreme temperature events (both heat and cold) that occurred from July 1995 through December 2022 as reported by State HMP and the NOAA Storm Events Database queried in May 2025. The resulting table may not include all incidents in Bergen County. From the data through 2021, there have been no reported injuries, fatalities, or property damage due to excessive heat in Bergen County; data from the State HMP did not report these indicators.

[31] ONJSC Rutgers University 2013c; New Jersey Geological and Water Survey (NJGWS), 2013.

Figure 4.9-6 Historical Extreme Temperatures



Source: ONJSC, 2019

Table 4.9-3 Extreme Temperature Events in Bergen County, July 1995 through August 2021

Date(s) of Event	Event Type	Area Affected	Description
7/15/1995	Excessive Heat	Statewide	Heat index reached 128°F in Newark when the temperature reached 103°F and the dew point reached 84°F. There were 16 hours with the heat index ≥100°F, 12 hours of ≥110°F, and three hours of ≥120°F. ONJSC stated that this was the most uncomfortably hot day at Newark since weather observations began to be collected in the early 1930s.
7/5/1999	Excessive Heat	Statewide	The index was ≥100°F for 14 hours, ≥105°F for nine hours, and ≥110°F for four hours. This culminated with the July 4 to 7 period of having 58 hours with a heat index ≥90°F, with never more than four consecutive hours of less than 90°F.
January 27 to 28, 2000	Extreme Cold	Statewide	Temperatures ranged from 9°F to 14°F
May 2 to 4, 2001	Extreme Heat	Statewide	Temperatures ranged from 89°F to 96°F
February 5 to 7, 2007	Extreme Cold	Statewide	Temperatures ranged from -4°F to 12°F
June 26 to 28, 2007	Extreme Heat	Statewide	Temperatures ranged from 92°F to 96°F
July 8 to 10, 2007	Extreme Heat	Statewide	Temperatures ranged from 93°F to 100°F
August 7 to 8, 2007	Extreme Heat	Statewide	Temperatures ranged from 93°F to 101°F
8/25/2007	Extreme Heat	Statewide	Temperatures ranged from 91°F to 94°F
June 7 to 10, 2008	Extreme Heat	Statewide	Temperatures ranged from 92°F to 100°F
July 16 to 22, 2008	Extreme Heat	Statewide	Temperatures ranged from 93°F to 98°F

Date(s) of Event	Event Type	Area Affected	Description
8/10/2009	Extreme Heat	Statewide	Temperatures ranged from 93°F to 104°F
June 23 to 24, 2010	Extreme Heat	Statewide	Temperatures ranged from 97°F to 99°F
June 27 to 28, 2010	Extreme Heat	Statewide	Temperatures ranged from 95°F to 99°F
July 4 to 7, 2010	Extreme Heat	Statewide	Temperatures ranged from 90°F to 105°F. One fatality was reported from this event. In Newark, four straight days of temperatures ≥100°F (101°F, 102°F, 103°F, and 101°F respectively). This led to 65 consecutive hours of temperatures of ≥80°F. The low temperature on July 6 was 84°F.
1/24/2011	Extreme Cold/ Wind chill	Statewide	An arctic high-pressure system brought in the coldest air mass of the season to New Jersey. Many places saw morning lows that were the coldest during that winter. Northwest winds produced wind chill factors below zero in most of the State. Sussex County experienced a wind chill of -15°F. Actual low temperatures in the Raritan Basin and northwest New Jersey were below 0°F. Temperatures throughout the State ranged from -14°F in Warren County to 9°F in Cape May Co.
07/22/2011	Excessive Heat	Bergen County	An oppressive hot humid air mass produced excessive heat that resulted in day time temperatures 100 to 105 degrees with night time lows in the 80s. Heat indices peaked between 115 and 120 degrees during record heat on Friday afternoon, July 22.
July 21 to 24, 2011	Heat Wave	Statewide	One of the most oppressive heat waves since July 1995. It caused two deaths and hundreds of heat-related injuries. Many locations had high temperatures that were in excess of 100°F. July 22 was the hottest, with heat index values of 110°F to 120°F. Many counties and municipalities opened cooling centers for its residents. Temperatures ranged from 100°F in Cumberland and Cape May Counties, to 106°F in Mercer County.
3/1/2012	Record Warmth	Statewide	The warmest March in history, breaking nearly 15,000 warm temperature records.
June 20 to 22, 2012	Heat Wave	Statewide	A three-day heat wave occurred throughout the entire State, bringing temperatures between 94°F and 99°F. The heat wave broke dramatically when a series of severe thunderstorms impacted New Jersey. Excessive heat between 100 and 105 degrees, along with heat indices in excess of 105 degrees occurred for a couple of days. The heat index was as high as 111 degrees at 3 PM at Teterboro Airport (KTEB) on July 22nd.
6/29/2012	Extreme Heat	Statewide	An unseasonably hot and humid day produced high temperatures in the mid to upper 90s in most of New Jersey. Maximum hourly heat indices reached between 100°F and 105°F. High temperatures ranged from 93°F in Hunterdon, Warren, Cape May and Atlantic Counties, to 99°F in Burlington County.
July 17 to 18, 2012	Extreme Heat	Statewide	Temperatures ranged from 97°F in Sussex County, to 102°F in Morris, Ocean and Camden counties. The heat index reached or exceeded 108 degrees at Teterboro airport.
7/19/2013	Excessive Heat	Eastern Bergen County	A large area of high pressure remained nearly stationary to the south resulting in excessive heat across the area. The combination of high heat and humidity resulted in a heat index of 107 degrees for a few afternoon hours at Teterboro Airport. No injuries or fatalities were assessed for this incident. No property damage occurred.
July 15 to 20, 2013	Extreme Heat	Statewide	The most oppressive hot spell of the summer season affected New Jersey from July 15 to the 20th. Widespread high temperatures reached into the mid to upper 90s.
September 9, 2013	Extreme Heat	Statewide	An unseasonably hot and humid air mass cause most high temperatures to reach 90 – 95 degrees F.
1/4/2014	Cold/Wind Chill	Statewide	Cold/Wind Chill. A high-pressure system that moved over New Jersey coupled with fresh snow cover from the winter storm on the 2nd and 3rd gave the area one of its coldest winter mornings in years. This was the first of three arctic blasts in the state during the month
1/7/2014	Cold/Wind Chill	Statewide	Cold/Wind Chill. Some record calendar day low temperatures occurred and combined with strong northwest winds produced wind chill factors as low as 15 to 25 degrees below zero in most areas.
1/22/2014	Cold/Wind Chill	Statewide	Cold/Wind Chill. Strong northwest winds behind the departing strong low-pressure system coupled with another arctic air mass dropped low temperatures.
June 17, 2014	Extreme Heat	Statewide	High temperatures in the lower to mid-90s were reported. Afternoon heat index values were in the mid 90s.

Date(s) of Event	Event Type	Area Affected	Description
July 2, 2014	Extreme Heat	Statewide	High temperatures in the lower to mid- 90s were reported. Afternoon heat index values were in the mid-90s.
1/7/2015	Cold/Wind Chill	Statewide	Cold/Wind Chill. The arrival of an arctic air mass brought one of the coldest mornings of the month of January to most of New Jersey. Morning low temperatures were mainly in the single numbers above zero.
2/13/2015	Cold/Wind Chill	Statewide	Cold/Wind Chill. Northwest winds that persisted into the morning of the 13th combined with an arctic air mass to produce wind chill factors of around 10 degrees below zero and low temperatures in the positive single numbers.
2/15 – 2/16, 2015	Cold/Wind Chill	Statewide	Cold/Wind Chill. The near arrival of the center of the arctic air mass brought some of the lowest wind chills and temperatures of the winter season. This produced wind chill factors as low as around 20 degrees below zero in most of the state
2/19-2/20, 2015	Extreme Cold	Statewide	Extreme Cold. The arrival of another arctic air mass brought some of the lowest wind chills as well as the lowest temperatures of the winter season. Actual lowest temperatures on either the 20th or 21st included 17 degrees below zero in Sussex County.
2/24/2015	Cold/Wind Chill	Statewide	Cold/Wind Chill. The high-pressure system responsible for third and last arctic blast of the month. Air and wind chill temperatures were nearly the same. The calm conditions and snow cover combined to give many locations in northwest New Jersey the coldest morning of the winter season.
July 19-20, 2015	Extreme Heat	Statewide	High temperatures in most areas reached into the lower to mid-90s both days. The combination of heat and humidity brough afternoon heat index values as high as 100F to 105F on the 19th.
2/14/2016	Cold/Wind Chill	Statewide	Cold/Wind Chill. Bitter cold temperatures and strong northwest winds associated with an Arctic outbreak combined to create dangerous wind chill temperatures.
July 28, 2016	Extreme Heat	Statewide	The State Emergency Operations Center reported 17 heat related illnesses, due to heat exposure during the PGA tournament in Springfield NJ. The combination of temperatures and humidity made it feel like the mid-90s.
8/13/2016	Excessive Heat	Eastern Bergen County	High pressure over the western Atlantic Ocean ushered in hot and humid air northward across the area. Hot temperatures along with high humidity resulted in a heat index of 107 at Teterboro Airport during the afternoon.
July 20, 2017	Extreme Heat	Statewide	A Bermuda high pressure system ushered in hot and humid weather across the east coast.
July 1-3, 2018	Extreme Heat	Northern New Jersey	Temperatures in the middle to upper 90s and dew points in the upper 60s to lower 70s led to excessive heat across northern and western New Jersey.
July 19-21, 2019	Extreme Heat	Northeastern New Jersey	A Bermuda high pumped in a hot and humid air mass into the area.
July 29-30, 2021	Extreme Heat	Northern New Jersey	High temperatures in the mid to upper 90s combined with dew points in the upper 60s caused heat index values to reach 105 to 110 over much of the region.
August 11-12, 2021	Extreme Heat	Statewide	Temperatures in the mid to upper 90s combined with dew point values near 70 caused widespread heat index values near to above 105F on both days, and locally into August 13, before a cold front brought relief.
12/23/2022	Cold/Wind Chill	Statewide	Cold/Wind Chill. An Arctic cold front swept through the region on December 23rd ushering in a very cold and dry airmass. Temperatures fell into the single digits and teens with wind chills ranging from -5 to -20 degrees in New Jersey.

Source: NOAA-NCDC 2024; NCEI 2025, ONJSC Rutgers University 2013a NCDC 2019

Bergen County also reported additional extreme heat events in Summer 2025 which are not yet represented in the NOAA-NCEI Events Database. According to the National Weather Service, extreme heat in Bergen County affected all jurisdictions in late June, with heat index temperatures reaching 110 degrees Fahrenheit, and during the last week of July 2025, when heat index values reached up to 107 degrees Fahrenheit. During the first week of August 2025, extreme temperatures yet again impacted Bergen residents, with heat index temperatures reaching over 90 degrees. To combat impacts from these heat events, Bergen County and municipalities issued extreme heat warnings and opened temporary cooling centers for relief.

High Winds

High wind events that have impacted Bergen County are detailed below in **Table 4.9.4 High Wind Incidents Affecting Bergen County.**

Table 4.9-4 High Wind Incidents Affecting Bergen County

Date(s) of Events	Event Type	Deaths	Injuries	Property Damage	Description
11/20/1989	Derecho	0	1 (Statewide)	$20 million (tri-state area)	Maximum wind gusts exceeded 58 mph and there were numerous gusts measuring at greater than 70 mph. In New Jersey, wind gusts of 86 mph were recorded in the southern portion. A steeple was blown off a church in Trenton and a roof was blown off of a high-rise apartment building in Burlington County. A falling tree seriously injured a man in Princeton. Overall, this event caused more than $20 million in damages to Pennsylvania, New Jersey, and New York.
9/7/1998	Derechos (“The Labor Day Derechos of 1998”)	0	0	$130 million (area-wide)	A derecho formed over western New York State and moved east in the early morning on September 7. Wind damage occurred in much of the area, with some of the worst storm damage occurring in a band across western and central New York State. Along the path of the derecho, tens of thousands of trees were blown down and over 1,000 homes and businesses were damaged. Damage was estimated at approximately $130 million. Many homes and businesses were without power.
1/3/2010	Strong Winds	0	0	0	Strong and gusty west to northwest winds occurred for nearly twenty-four hours across New Jersey. Peak wind gusts averaged around 50 mph, with some gusts of 70 mph in the higher terrain of Sussex County. Strong winds downed weak trees, tree limbs, and power lines resulting in power outages.
3/13/2010	High Winds	0	3 (Statewide)	Amount not reported	Strong to high winds downed thousands of trees and tree limbs, hundreds of telephone poles. Over half a million utility customers throughout the state lost power. Dozens of homes were damaged by fallen trees, a few other homes were damaged by the high winds themselves and crane damage occurred in Atlantic City. There were three reported injuries. A 78 mph wind gust was reported at Robbins Reef at 7:18 pm.
12/1/2010	Wind Gusts	0	0	Amount not reported	A wind gust to 59 mph was reported at Teterboro airport in the early afternoon of December 1. Strong winds knocked down some trees and tree limbs which caused scattered power outages across the region.
12/26/2010	High Winds	0	0	0	Strong to high winds that started in the afternoon of the winter storm on December 26 persisted into the next evening. Peak wind gusts were around 50 mph, except along some shore points and in the higher terrain of Sussex County where gusts reached 60 mph and greater.
10/29/2012	High Winds	0	0	$1,800,000	Winds related to Post Tropical Storm Sandy. Near Teaneck, a wind gust up to 76 mph was reported at 7:31 pm. A wind gust up to 72 mph was measured at Teterboro Airport at 7:47 pm. In North Arlington, a wind gust up to 63 mph was reported at 3:48 pm. A wind gust up to 80 mph was reported in Clifton at 930 pm.
12/21/2012	High Winds	0	0	Amount not reported	High winds and river flooding occurred across portions of Northeast New Jersey. An emergency manager spotter measured a wind gust of 60 mph in North Arlington at 7:30 am. At Teterboro Airport, a wind gust of 59 mph was measured at 8:16 am.
1/31/2013	High Winds	0	0	$21,000	High south winds preceding a strong cold front resulted in areas of damage and disruptions to power. In Ridgewood, a tree was knocked down at Franklin and Walnut Streets at 4:35 am. Scattered power outages were reported throughout the area. At 5:35 am, a chimney collapsed on a house in Lyndhurst due to high winds. The house was located on Thomas Avenue. Scattered power outages were reported throughout the area.
4/3/2016	High Winds	0	0	$50,000	Deep low pressure tracked just to the east of the area. At 9:45 am, trees were knocked down, as reported by the broadcast media, on Franklin Avenue in Ramsey.
2/13/2017	High Winds	0	0	$550,000	Low pressure passed to the east and rapidly deepened. A mesonet station in Englewood Cliffs measured sustained winds of 41 mph at 1239 pm. Another mesonet station located in Cliffside Park measured 40 mph sustained winds at 925 am. At 3 pm, a trained spotter reported a large tree was downed, which crushed the front half of a house. This occurred in the town of Saddle Brook on Saddle River Road and Rochelle Parkway.

Date(s) of Events	Event Type	Deaths	Injuries	Property Damage	Description
					The ASOS at Teterboro Airport reported a wind gust up to 53 mph at 1204 pm.
3/2/2018	High Winds	0	0	$100,000	A deep area of low pressure passed off the coast. Amateur radio reported a tree down across the Palisades Parkway closing the road in both directions at 1225 pm. Around 345 pm in the town of Hackensack, a large tree was knocked down on to power lines according the social media.
2/25/2019	High Winds	0	0	$100,000	High winds occurred behind a strong cold front and deepening low pressure. A trained spotter reported a small tree and tree limb down on Sylvan Avenue in the town of Englewood Cliffs around 1135 am. A mesonet station in the same town reported sustained winds of 44 mph at 409 pm.
10/17/2019	High Winds	0	0	$100,000	High winds occurred behind a deep low pressure.
4/13/2020	High Winds	0	0	$400,000	Deep low pressure passed to the west of the area resulting in high winds.
12/25/2020	High Winds	0	0	0	A cold front with high winds ahead of it passed through during the early morning hours of December 25, 2020.
12/23/2022	High Winds	0	0	0	A strong low pressure system centered near the eastern Great Lakes Region continued to strengthen as it moved northeast on December 23, 2022. This brought high winds over northeastern New Jersey that morning as the pressure gradient tightened over the area.
01/09/2024	High Winds	0	0	0	A strong area of low pressure moved northeast from the Mid-Atlantic Region to southern New England during the night of January 9, 2024. Its center passed just north of the region with the pressure gradient tightening as the center of the storm approached, producing high winds over Northeastern New Jersey during this period.
3/11/2024	High Winds	0	1	0	High winds occurred across the area during the daytime hours of March 11, 2024 with a tight pressure gradient in place as strong low pressure near the coast of northern New England slowly shifted northeast.
08/09/2024	High Winds	0	0	0	The pressure gradient tightened over the region as a cold front associated with the remnants of tropical system Debby approached from the west. This produced strong winds over northeastern New Jersey during the afternoon hours of Aug 9, 2024.

Sources: NCDC 2013; ONJSC Rutgers University 2013; SPC 1998; SPC 2012, NCDC, 2019, NCEI 2025

According to the NOAA National Centers for Environmental Information Storm Events Database, there have been 119 reported thunderstorm wind events in Bergen County from 2010 to the end of May 2019. That said, there were 37 days with a thunderstorm event; the storm events database categories thunderstorm wind events by locality rather than on the county level. **Table 4.9-5 Previous Occurrences of Thunderstorms (Wind and Lightning)** aggregates thunderstorm wind by day and adds reported damage from lightning as reported by the State HMP. Since 2010, thunderstorm winds have caused 6 reported injuries and nearly $860,000 in reported property damage.

Table 4.9-5 Previous Occurrences of Thunderstorms (Wind and Lightning), June 2010-September 2024

Date	Event Type	Deaths	Injuries	Property Damage	Description
6/24/2010	Thunderstorm Wind	0	0	$750.00	A few tree limbs were reported down in Cliffside Park.
7/19/2010	Thunderstorm Wind	0	0	$18,250.00	A lightning strike struck an attached garage on a house along Colonial Road in Emerson. Thunderstorm winds caused downed trees and wires.
7/23/2010	Thunderstorm Wind	0	0	$18,000.00	Severe storms, including an isolated supercell moved southeast into the region. These thunderstorms produced heavy rain and flash flooding and impacted most of Northeast New Jersey. Thunderstorm winds caused downed trees and wires.
7/25/2010	Thunderstorm Wind	0	1	$38,500.00	A person was struck by a falling tree branch and injured. Thunderstorm winds caused downed trees and wires.

Date	Event Type	Deaths	Injuries	Property Damage	Description
8/16/2010	Thunderstorm Wind	0	0	$4,500.00	An approaching cold front triggered isolated severe thunderstorm, which impacted Bergen and Hudson Counties. Thunderstorm winds caused downed trees and wires.
9/22/2010	Thunderstorm Wind	0	0	$10,500.00	Thunderstorm winds caused downed trees and wires.
7/8/2011	Thunderstorm Wind	0	0	$750.00	A tree was reported down on Ripplewood Road in Upper Saddle River.
7/13/2011	Thunderstorm Wind	0	0	$10,000.00	Thunderstorm winds caused downed trees.
8/18/2011	Thunderstorm Wind	0	0	$5,000.00	Multiple trees were downed throughout Upper Saddle River.
8/19/2011	Thunderstorm Wind	0	0	$6,000.00	A passing mid-level disturbance triggered severe thunderstorms that produced large hail, damaging winds and lightning strikes across Bergen, Essex, Hudson, and Passaic Counties. Several homes were reported struck by lightning in the town of Bergenfield. A large wire was reported down on Ridge Road in North Arlington. Several trees were reported down in the town of Oradell.
8/21/2011	Thunderstorm Wind	0	0	$21,500.00	Thunderstorm winds caused downed trees.
9/29/2011	Thunderstorm Wind	0	0	$20,000.00	Thunderstorm winds caused downed trees.
7/18/2012	Thunderstorm Wind	0	0	$0.00	Wires were reported down across Route 17 in Mahwah.
7/26/2012	Thunderstorm Wind	0	0	$4,000.00	A tree fell on a power line on Chestnut Ridge Road, casing an electrical fire that burned for a few hours. A one foot diameter tree was reported down on Pulis Avenue.
9/7/2012	Lightning Strike	-	1	-	A 71-year-old man was injured by lightning at Northern Valley Regional High School.
9/8/2012	Thunderstorm Wind	0	0	$3,500.00	Thunderstorm winds caused downed trees and wires.
9/18/2012	Thunderstorm Wind	0	0	$5,000.00	Multiple trees were reported down on Fairview Avenue, making the road impassable.
5/23/2013	Lightning	-	-	$5,000.00	An approaching pre-frontal trough, ahead of a cold front, triggered thunderstorms over Northeast New Jersey during the afternoon, causing a lightning strike in Bergen County.
7/7/2013	Thunderstorm Wind	0	0	$4,000.00	Tree down on car on Merritt Road. Tree fell into home on Tillman Street. Fire department was called to the scene.
9/12/2013	Thunderstorm Wind; Lightning	0	0	$13,000.00	Multiple wires were reported down at Grenadier Drive and Airmont Avenue, prompting the need to close the road. The State HMP reported $11,000 worth of property damage while NCDC reported $2,000.
10/7/2013	Thunderstorm Wind	0	2	$122,750.00	A tree fell on two people on Summit Street. Thunderstorm winds caused downed trees and wires.
11/1/2013	Thunderstorm Wind	0	0	$2,000.00	A tree was reported down on wires near the Intersection of Lincoln Avenue and Boulevard.
5/10/2014	Thunderstorm Wind	0	0	$0.00	A tree was reported down on a car at the corner of Cliff Street and 7th Street.
6/13/2014	Thunderstorm Wind	0	0	$14,500.00	Thunderstorm winds caused downed trees and wires.
7/2/2014	Lightning	-	-	$1,030,000.00	A weakening approaching cold front triggered a series of strong to severe thunderstorms. Hardest hit was Hunterdon County with multiple municipalities that reported downed trees and wires. There was $1,030,000 of property damage.

Date	Event Type	Deaths	Injuries	Property Damage	Description
7/3/2014	Thunderstorm Wind	0	0	$26,000.00	Thunderstorm winds caused downed trees and wires.
7/8/2014	Thunderstorm Wind	0	0	$9,000.00	Thunderstorm winds caused downed trees.
8/31/2014	Thunderstorm Wind	0	0	$5,000.00	A tree was reported down on a car at the intersection of River Road and Birchwood Drive. One person was trapped in the car, though was unharmed in the event.
7/1/2015	Thunderstorm Wind	0	0	$5,000.00	Thunderstorm winds caused downed trees and wires.
6/5/2016	Thunderstorm Wind	0	0	$5,750.00	Thunderstorm winds caused downed trees.
8/12/2016	Thunderstorm Wind	0	0	$4,000.00	Numerous trees were reported down in Dumont.
5/14/2017	Thunderstorm Wind	0	0	$9,700.00	Thunderstorm winds caused downed trees.
6/19/2017	Thunderstorm Wind	0	0	$13,000.00	Thunderstorm winds caused downed trees.
8/2/2017	Thunderstorm Wind	0	0	$2,500.00	Trees were reported down at the intersection of Martha Road and Parkway Street, just west of Harrington Park.
5/15/2018	Thunderstorm Wind	0	1	$91,000.00	Tree fell and injured a person on intersection of Hickory Street and Willow Street. Thunderstorm winds caused downed trees.
7/3/2018	Thunderstorm Wind	0	0	$8,000.00	Thunderstorm winds caused downed trees.
8/3/2018	Thunderstorm Wind	0	0	$0.00	A tree down on house on Austin Place.
8/7/2018	Thunderstorm Wind	0	0	$3,000.00	Multiple tree limbs and branches down up to three inches in diameter. Also had hail ranging from one quarter to three quarters of an inch in diameter.
10/2/2018	Thunderstorm Wind	0	0	$3,000.00	Medium sized trees uprooted.
5/26/2019	Thunderstorm Wind	0	0	$19,000.00	Thunderstorm winds caused downed trees and wires.
6/29/2019	Thunderstorm Wind	0	0	$11,000.00	A weak upper level disturbance in association with a cold front lead to the development of severe thunderstorms across Northeastern New Jersey.
7/17/2019	Thunderstorm Wind	0	0	$14,000.00	An approaching cold front and mid level shortwave triggered severe thunderstorms that impacted Northeastern New Jersey.
08/7/2019	Thunderstorm Wind	0	0	$6,000.00	A cold front and an upper level disturbance triggered severe thunderstorms and a tornado across the Northeastern New Jersey.
8/18/2019	Thunderstorm Wind	0	0	$1,000.00	A stationary front which eventually moved north as a warm front along with a humid air mass in place triggered strong to severe thunderstorms across Northeastern New Jersey.
10/31/2019	Thunderstorm Wind	0	0	0	An unseasonably humid air mass ahead of an approaching deep mid and upper level trough and cold front triggered a severe thunderstorm that impacted Northeastern New Jersey.
4/21/2020	Thunderstorm Wind	0	0	$11,000.00	A cold front and pre-frontal trough, in association with a mid level disturbance brought strong to severe thunderstorms to Northeastern New Jersey.
7/6/2020	Thunderstorm Wind	0	0	$2,000.00	A slow moving front and an upper level low north of the region triggered severe thunderstorms across Northeastern New Jersey.
7/22/2020	Thunderstorm Wind	0	0	$1,000.00	A hot and humid air mass along with a weak upper level disturbance triggered severe thunderstorms across Northeastern New Jersey.

Date	Event Type	Deaths	Injuries	Property Damage	Description
8/12/2020	Thunderstorm Wind	0	0	$2,000.00	A slow moving cold front in a warm and humid air mass triggered a severe thunderstorm across Northeastern New Jersey.
8/25/2020	Thunderstorm Wind	0	0	$52,000.00	A cold front and an upper level disturbance triggered severe thunderstorms across Northern New Jersey.
11/15/2020	Thunderstorm Wind	0	0	$20,000.00	A strong cold front triggered convective showers and thunderstorms across Northeastern New Jersey.

Sources: NCEI 2025, NCDC 2019

Tornadoes

Since 1950, there have been nine recorded instances of tornadoes touching down in Bergen County (two touchdowns occurred on July 10, 1989). Two of the most destructive tornadoes occurred on July 10, 1989 in Fair Lawn causing approximately five million dollars in damage. These tornadoes were rated F0 on the Fujita Scale.

According to the State HMP, there have been 144 tornado touchdowns in New Jersey from 1950-2012, with at least one in each county. **Table 4.9-6 Historic Tornado Events in Bergen County (1950-May 2019)** lists all historic tornado touchdowns in Bergen County from 1950 to May 2019 (NCDC 2019). For an updated table of the number of historic tornado touchdowns in New Jersey by county, please refer to the State HMP.

Table 4.9-6 Historic Tornado Events in Bergen County (1950-May 2019)

Date	Deaths	Injuries	Property Damage	Description
9/6/1956	0	0	$0	No description provided.
8/7/1962	0	0	$250,000	Confirmed tornado formed south-southwest corner of Borough of Oradell and moved north-northeast at a very rapid rate, terminating eastern sector of Borough of Emerson. A second funnel crossed the Oradell reservoir and joined the main funnel in the vicinity of the Emerson School.
7/15/1970	0	0	$25,000	No description provided.
7/19/1971	0	0	$250,000	No description provided.
7/13/1975	0	0	$250,000	No description provided.
7/10/1989	0	0	$5 million	No description provided.
11/16/1989	0	0	$0	No description provided.
10/7/2013	0	0	$30,000	A passing cold front triggered a line of severe thunderstorms that moved through Northeast New Jersey. The line also spawned a tornado in Bergen County. Based on Doppler Weather Radar data, a storm survey and information from the local media, the National Weather Service has confirmed an EF1 tornado impacted central Bergen County. As a line of severe thunderstorms moved northeast, a portion of the line accelerated and produced a weak tornado as it moved northeast across Bergen County. Both radar and observed damage patterns showed rotation near and at ground levels. This coupled with eyewitness reports of a tornado was the basis for confirming the tornado. The most significant damage occurred in the George Washington Memorial Park Cemetery near the intersection of Paramus and Century Roads and in the Paramus Golf and Ridgewood Country Clubs, where dozens of trees were snapped and/or uprooted.

Source: NCDC, 2019

Probability of Future Occurrences

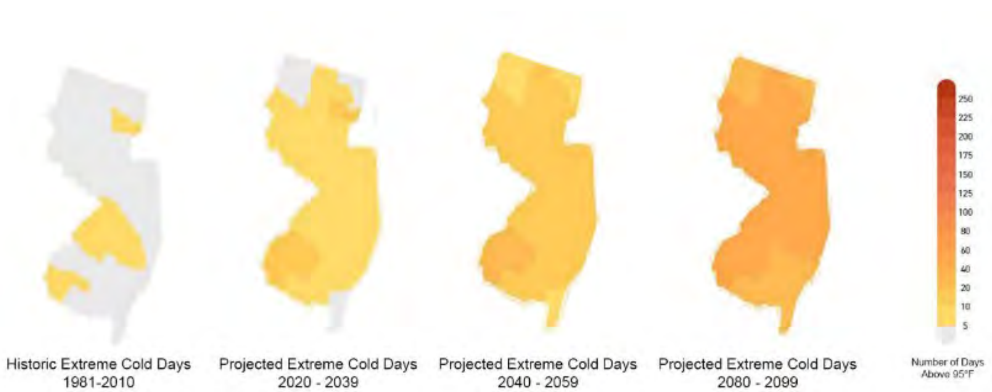
Extreme Temperatures

Summers in New Jersey and Bergen County are becoming hotter, and heat waves are predicted to become longer and more frequent. Now, New Jersey experiences temperatures in the summer that range from 85 to 100 degrees, with occasional temperatures that may reach above 100 degrees Fahrenheit. The probability of Bergen County experiencing extreme heat is very high (see **Figure 4.9-7 Historical and Projected Number of Days Above 95 Degrees**). It is almost certain that there will be a period of extreme heat in Bergen County every summer.

Extreme temperatures are predicted to occur more frequently as part of regular seasons. Specifically, extreme heat may continue to impact New Jersey and, based upon data presented, may increase in the next several decades. Many heat records have been set in the last 10 to 15 years. This trend is predicted to continue.

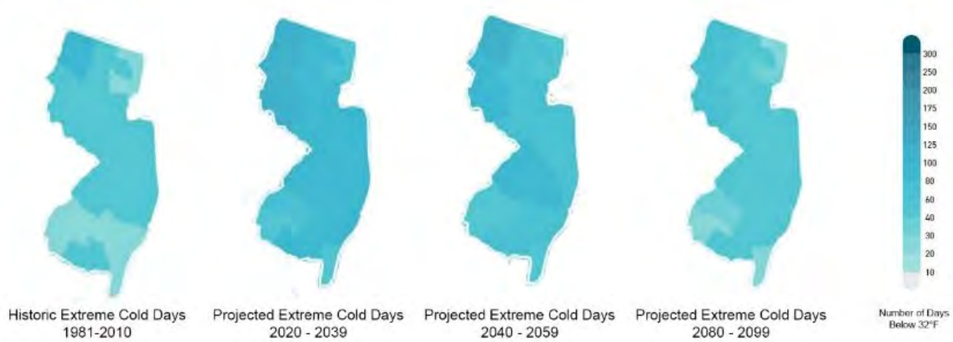
Although the trend in the state is generally towards warmer temperatures, as the climate changes, traditional weather patterns are being disrupted. Climate change is predicted to further alter weather phenomena such as the Polar Vortex which typically keeps polar air in place over the North Pole, leading to events where extremely cold weather patterns can move out of the arctic to lower latitudes such as New Jersey where they may settle. Such an event could expose the State to severe and abnormal cold (Lindsey, 2021). This trend may likely continue.

Figure 4.9-7 Historical and Projected Number of Days Above 95 Degrees



Source: Climate Impact Map, 2018

Figure 4.9-8 Historical and Projected Number of Days Below 32 Degrees



SO

High Wind

High winds result from other extreme weather events, including hurricanes, tropical storms, nor'easters, and thunderstorms, whose probabilities have been discussed elsewhere in this Risk Assessment. High wind events occur annually, and in most cases several times per year across the State.

Lightning
Given regional climate conditions and the expected increase in convective storm activity due to climate change, the probability of lightning events in Bergen County remains high. Most municipalities within the county can expect multiple lightning occurrences each year. While most events will be non-damaging, the potential for injury or infrastructural impact remains, particularly during peak thunderstorm season in late spring through early fall.

Like high windstorms, thunderstorms occur in regular intervals as part of normal weather systems in New Jersey. During the summer months some thunderstorms may be severe and could cause significant damage. Thunderstorms often occur in conjunction with other severe hazards such as hail and damaging winds. Based on historic facts, the probability of a tornado in Bergen County is low.

Tornadoes
Tornadoes occur approximately one to three times per year in New Jersey. Generally, these events will be rather minor and will not cause significant damage.

Potential Effects of Climate Change

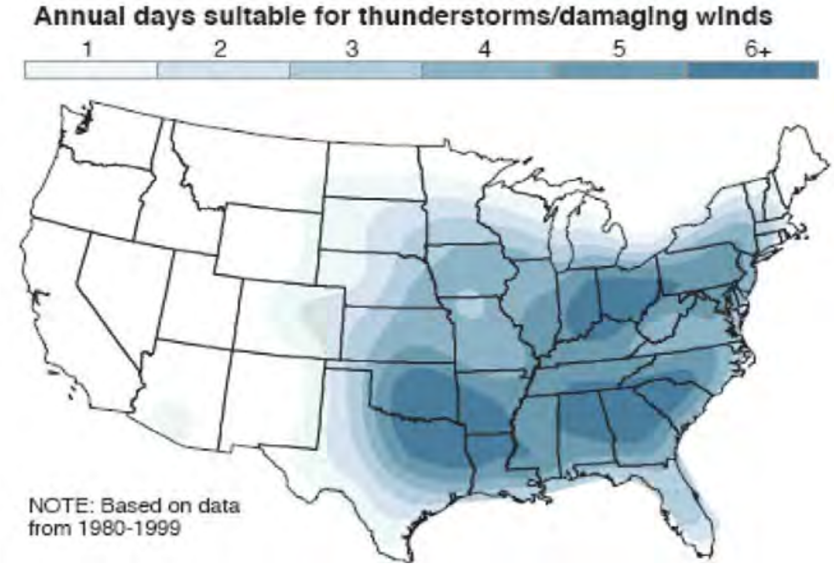
Extreme Temperatures
Climate change projections suggest that both heat waves and sudden cold events will become more frequent and more severe, increasing long-term stress on Bergen County's natural assets and breaking down the resilience of ecosystems already under pressure from development and pollution. Climate change is expected to increase the frequency, duration, and intensity of extreme heat events in Bergen County. Average annual temperatures are expected to rise, resulting in more frequent days above 90° F, and warmer nighttime temperatures, which reduce relief during heatwaves. Vulnerable populations, including the elderly and low-income households, may face greater health risks, while energy systems will experience increased demand. Although extreme cold events may become less frequent overall, sudden and severe cold snaps may still occur, potentially stressing infrastructure and public health systems not equipped for rapid shifts in temperature.

High Wind
Climate models suggest an increased frequency of strong wind events associated with more intense storm systems, including nor'easters and tropical remnants. In Bergen County, this may lead to more frequent damage from high winds, particularly in urban and suburban areas with aging trees and above-ground utility lines. Infrastructure stress, power outages, and debris hazards may become more common as storms grow in intensity and track through the region more frequently due to a changing climate.

Lightning
While lightning is difficult to project with precision, warming atmospheric conditions and increased convective storm activity could lead to a rise in the frequency and intensity of thunderstorms capable of producing lightning in Bergen County. Warmer, more humid air masses provide the instability needed to fuel such storms. As a result, there is a potential for more lightning –related damage to homes, infrastructure, and natural areas, along with an increased risk of wildfire ignition and injury during peak summer months.

National Aeronautics and Space Administration (NASA) scientists suggest that the United States will face more severe thunderstorms in the future, with deadly lightning, damaging hail, and the potential for tornadoes in the event of climate change. A recent study conducted by NASA predicts that smaller storm events like thunderstorms will also be more dangerous due to climate change (NASA 2007). As prepared by the NWS **4.9-9 Annual Days Suitable for Thunderstorms/Damaging Winds** identifies those areas, particularly within the eastern United States, that are more prone to thunderstorms, including New Jersey (NWS 2010).

Figure 4.9-9 Annual Days Suitable for Thunderstorms/Damaging Winds



Source: Borenstein, 2007

Tornadoes

Although tornadoes remain rare in Bergen County, there is growing evidence that warming conditions and increased atmospheric instability may contribute to a northward and eastward expansion of tornado-prone areas of the U.S. New Jersey has already seen an uptick in EF-0 and EF-1 tornado events in recent years. Climate change could increase the frequency of short-lived, low-intensity tornadoes, particularly as a by-product of stronger convective storms, bringing heightened risk and buildings and vulnerable populations in the county.

Vulnerability Assessment

Built Environment, Infrastructure, and Community Lifelines

Severe storms in Bergen County often bring a combination of strong winds, lightning, extreme temperatures, and occasional tornadoes, each posing risks to buildings, infrastructure, and critical services. Above-ground utility systems are particularly vulnerable to high winds and falling trees, frequently resulting in power outages, transportation disruptions, and service interruptions for emergency response, healthcare, and communications. Older structures, particularly those not built to modern wind-resistant codes, may experience roof, siding, or structural damage, while lightning can ignite residential or institutional structure fires, especially in heavily developed suburban neighborhoods. Additionally, prolonged extreme heat events associated with summer storms can overburden cooling systems and increase strain on the electrical grid.

Population and Economy

Severe storms disproportionately affect vulnerable populations, including the elderly, those with pre-existing health conditions, lower-income residents, and people without access to adequate shelter or cooling. Extreme heat can pose life-threatening risks, particularly for individuals without air conditioning, while high winds and tornadoes can result in injuries or fatalities due to falling debris or structural collapse. Economically, severe storms can cause property damage, business closures, and inventory loss, especially for small businesses and flood- or wind-prone commercial corridors. Insurance claims and recovery costs from severe convective storms—including events with straight-line winds and embedded tornadoes—can be substantial, as seen in recent years across multiple Bergen County communities.

Ecosystems and Natural Assets

Severe storms pose threats to forested areas, urban tree canopies, and riparian ecosystems across Bergen County. High winds and lightning can lead to tree loss, canopy damage, and subsequent increased vulnerability to invasive species and erosion. Urban green spaces and natural drainage areas can be overwhelmed by storm runoff, and sudden temperature shifts can stress local flora and fauna. Lightning also poses a wildfire ignition risk during prolonged dry periods, especially in the county's northern wooded zones such as Mahwah and Oakland. Repeated disturbances from severe storms can degrade ecosystem services that support water quality, biodiversity, and flood mitigation. Estimates of expected annualized losses which have been calculated through FEMA's National Risk Index (NRI) for hazards summarized under Severe Weather (Extreme Temperatures, High Winds, Lightning, Tornado) are reviewed below.

Extreme Temperatures

Table 4.9-7 Expected Annualized Losses from Heat Wave by Jurisdiction shows expected annualized losses for the extreme heat hazard for municipalities within Bergen County. This data was derived from FEMA's NRI. Expected EAL represents the average economic loss in dollars resulting from natural hazards each year. The table includes EAL for buildings as well as total EAL which includes building damage as well as damage to agriculture and population equivalency (the monetized cost of injury and fatality).

Table 4.9-7 Expected Annualized Losses from Heat Wave by Jurisdiction

Municipality	Expected Annual Losses (Building)	Expected Annual Losses (Total)
Allendale Borough	$0.06	$18,956.41
Alpine Borough	$0.04	$5,853.95
Bergenfield Borough	$0.14	$93,876.16
Bogota Borough	$0.04	$29,108.55
Carlstadt Borough	$0.12	$21,166.32
Cliffside Park Borough	$0.11	$85,262.37
Closter Borough	$0.08	$28,547.40
Cresskill Borough	$0.08	$30,410.72
Demarest Borough	$0.05	$16,736.52
Dumont Borough	$0.09	$59,535.84
East Rutherford Borough	$0.10	$33,194.37
Edgewater Borough	$0.08	$47,432.77
Elmwood Park Borough	$0.11	$61,420.14
Emerson Borough	$0.06	$24,149.19
Englewood City	$0.21	$97,297.98
Englewood Cliffs Borough	$0.09	$17,744.89
Fair Lawn Borough	$0.19	$97,275.81
Fairview Borough	$0.06	$49,544.10
Fort Lee Borough	$0.19	$133,504.72
Franklin Lakes Borough	$0.14	$30,675.58
Garfield City	$0.15	$108,471.94
Glen Rock Borough	$0.09	$34,006.35
Hackensack City	$0.31	$152,900.54
Harrington Park Borough	$0.04	$15,748.53
Hasbrouck Heights Borough	$0.07	$40,276.31
Haworth Borough	$0.04	$11,104.65
Hillsdale Borough	$0.08	$33,364.56
Ho-Ho-Kus Borough	$0.04	$11,786.72
Leonia Borough	$0.05	$30,905.63
Little Ferry Borough	$0.06	$36,496.15
Lodi Borough	$0.14	$86,966.91
Lyndhurst Township	$0.14	$77,545.70
Mahwah Township	$0.22	$70,393.75
Maywood Borough	$0.06	$33,483.46
Midland Park Borough	$0.05	$19,415.70
Montvale Borough	$0.10	$27,165.85
Moonachie Borough	$0.07	$10,407.12
New Milford Borough	$0.09	$56,214.09
North Arlington Borough	$0.09	$54,661.72
Northvale Borough	$0.06	$15,810.79

Municipality	Expected Annual Losses (Building)	Expected Annual Losses (Total)
Norwood Borough	$0.05	$18,738.07
Oakland Borough	$0.10	$35,293.58
Old Tappan Borough	$0.07	$19,558.87
Oradell Borough	$0.08	$27,384.80
Palisades Park Borough	$0.09	$67,405.08
Paramus Borough	$0.30	$83,268.47
Park Ridge Borough	$0.08	$29,507.39
Ramsey Borough	$0.12	$40,963.12
Ridgefield Borough	$0.07	$38,204.16
Ridgefield Park Village	$0.07	$43,926.93
Ridgewood Village	$0.19	$71,913.58
River Edge Borough	$0.08	$40,023.95
River Vale Township	$0.08	$32,915.41
Rochelle Park Township	$0.04	$19,312.24
Rockleigh Borough	$0.00	$1,356.19
Rutherford Borough	$0.11	$62,865.22
Saddle Brook Township	$0.10	$44,194.20
Saddle River Borough	$0.01	$888.58
South Hackensack Township	$0.05	$9,335.84
Teaneck Township	$0.29	$137,349.83
Tenafly Borough	$0.14	$51,185.73
Teterboro Borough	$0.07	$7,997.19
Upper Saddle River Borough	$0.09	$23,122.47
Waldwick Borough	$0.06	$27,842.02
Wallington Borough	$0.06	$40,578.76
Washington Township	$0.07	$30,179.88
Westwood Borough	$0.08	$37,476.09
Wood-Ridge Borough	$0.07	$19,426.68
Woodcliff Lake Borough	$0.07	$33,685.95
Wyckoff Township	$0.14	$45,910.52
Bergen County Total	**$93.26**	**$3,050,631.05**

High Winds

Table 4.9-8 Expected Annualized Losses from Strong Winds by Jurisdiction shows expected annualized losses for high wind hazards for municipalities within Bergen County. This data was derived from FEMA's NRI. Expected EAL represents the average economic loss in dollars resulting from natural hazards each year. The table includes EAL for buildings as well as total EAL which includes building damage as well as damage to agriculture and population equivalency (the monetized cost of injury and fatality).

Table 4.9-8 Expected Annualized Losses from Strong Winds by Jurisdiction

Municipality	Expected Annual Losses (Building)	Expected Annual Losses (Total)
Allendale Borough	$5,593.43	$44,577.49
Alpine Borough	$2,610.68	$12,366.07
Bergenfield Borough	$10,832.26	$178,858.35
Bogota Borough	$3,223.73	$55,324.24
Carlstadt Borough	$9,346.91	$47,231.71
Cliffside Park Borough	$9,002.98	$161,671.82
Closter Borough	$6,007.90	$53,180.73
Cresskill Borough	$6,113.74	$58,972.47
Demarest Borough	$3,655.95	$31,065.30
Dumont Borough	$6,626.96	$110,532.39
East Rutherford Borough	$8,265.62	$67,679.11
Edgewater Borough	$6,032.55	$91,267.40
Elmwood Park Borough	$11,600.68	$162,616.85
Emerson Borough	$4,046.98	$43,952.26
Englewood City	$16,275.13	$190,425.24
Englewood Cliffs Borough	$7,104.99	$38,865.91
Fair Lawn Borough	$21,384.13	$265,957.85

Municipality	Expected Annual Losses (Building)	Expected Annual Losses (Total)
Fairview Borough	$5,112.08	$94,443.38
Fort Lee Borough	$14,984.63	$253,940.68
Franklin Lakes Borough	$12,928.05	$77,277.23
Garfield City	$12,137.29	$213,222.40
Glen Rock Borough	$9,896.85	$96,207.96
Hackensack City	$24,681.65	$298,353.53
Harrington Park Borough	$3,201.06	$29,224.60
Hasbrouck Heights Borough	$5,504.09	$77,593.41
Haworth Borough	$2,610.51	$20,960.35
Hillsdale Borough	$5,821.45	$61,510.27
Ho-Ho-Kus Borough	$3,493.65	$27,725.40
Leonia Borough	$4,275.90	$59,592.93
Little Ferry Borough	$4,687.88	$70,011.22
Lodi Borough	$10,695.73	$166,355.16
Lyndhurst Township	$10,479.98	$144,376.72
Mahwah Township	$20,238.73	$164,996.53
Maywood Borough	$4,820.91	$64,751.73
Midland Park Borough	$4,338.23	$44,267.20
Montvale Borough	$7,484.55	$54,152.56
Moonachie Borough	$5,458.14	$24,085.43
New Milford Borough	$7,305.47	$107,743.76
North Arlington Borough	$6,770.49	$104,615.77
Northvale Borough	$4,100.65	$30,227.00
Norwood Borough	$3,958.98	$34,922.63
Oakland Borough	$9,061.65	$81,633.45
Old Tappan Borough	$5,161.43	$37,480.98
Oradell Borough	$5,949.94	$53,228.70
Palisades Park Borough	$7,387.00	$128,033.31
Paramus Borough	$25,518.96	$181,980.73
Park Ridge Borough	$5,901.80	$54,666.08
Ramsey Borough	$11,348.58	$95,590.04
Ridgefield Borough	$5,878.63	$74,257.95
Ridgefield Park Village	$5,811.08	$84,434.52
Ridgewood Village	$17,470.17	$169,193.58
River Edge Borough	$6,162.55	$77,800.05
River Vale Township	$6,101.54	$60,492.42
Rochelle Park Township	$3,046.76	$37,613.96
Rockleigh Borough	$351.74	$2,592.76
Rutherford Borough	$8,867.59	$120,845.35
Saddle Brook Township	$8,604.35	$95,068.65
Saddle River Borough	$614.97	$2,205.39
South Hackensack Township	$4,741.48	$23,938.10
Teaneck Township	$22,781.77	$268,142.69
Tenafly Borough	$11,084.89	$102,699.55
Teterboro Borough	$5,534.72	$19,848.54
Upper Saddle River Borough	$7,812.12	$55,363.78
Waldwick Borough	$5,361.89	$62,619.65
Wallington Borough	$4,311.01	$74,872.34
Washington Township	$5,380.55	$56,347.59
Westwood Borough	$5,997.00	$67,924.30
Wood-Ridge Borough	$5,732.81	$39,712.31
Woodcliff Lake Borough	$5,175.57	$65,469.00
Wyckoff Township	$13,270.87	$108,852.98
Bergen County Total	**$563,134.96**	**$6,238,011.83**

Lightning

Table 4.9-9 Expected Annualized Losses from Lightning by Jurisdiction shows expected annualized losses for lightning hazards for municipalities within Bergen County. This data was derived from FEMA's NRI. Expected EAL represents the average economic loss in dollars resulting from natural hazards each year. The table includes EAL for buildings as well as total EAL which includes building damage as well as damage to agriculture and population equivalency (the monetized cost of injury and fatality).

Table 4.9-9 Expected Annualized Losses from Lightning by Jurisdiction

Municipality	Expected Annual Losses (Building)	Expected Annual Losses (Total)
Allendale Borough	$329.20	$14,122.58
Alpine Borough	$166.26	$3,989.24
Bergenfield Borough	$646.69	$61,740.49
Bogota Borough	$186.98	$18,476.44
Carlstadt Borough	$576.54	$14,352.72
Cliffside Park Borough	$647.28	$67,296.04
Closter Borough	$415.25	$20,235.23
Cresskill Borough	$377.21	$20,389.36
Demarest Borough	$249.82	$11,603.18
Dumont Borough	$422.46	$40,565.48
East Rutherford Borough	$495.25	$21,639.82
Edgewater Borough	$423.85	$36,871.56
Elmwood Park Borough	$587.71	$46,183.10
Emerson Borough	$242.59	$14,728.40
Englewood City	$899.61	$59,382.54
Englewood Cliffs Borough	$401.43	$11,435.48
Fair Lawn Borough	$1,049.47	$74,064.25
Fairview Borough	$341.38	$37,586.56
Fort Lee Borough	$969.36	$93,881.79
Franklin Lakes Borough	$655.92	$20,341.87
Garfield City	$736.87	$75,869.97
Glen Rock Borough	$509.48	$27,491.03
Hackensack City	$1,469.86	$100,181.85
Harrington Park Borough	$214.44	$10,779.84
Hasbrouck Heights Borough	$338.29	$27,229.40
Haworth Borough	$181.39	$8,001.03
Hillsdale Borough	$430.76	$25,229.57
Ho-Ho-Kus Borough	$211.14	$9,016.55
Leonia Borough	$255.33	$20,191.76
Little Ferry Borough	$282.57	$24,210.08
Lodi Borough	$673.79	$60,366.80
Lyndhurst Township	$582.60	$45,404.91
Mahwah Township	$1,041.47	$46,176.94
Maywood Borough	$278.54	$21,369.87
Midland Park Borough	$251.82	$14,329.23
Montvale Borough	$579.80	$22,410.03
Moonachie Borough	$340.85	$7,433.99
New Milford Borough	$436.67	$36,898.02
North Arlington Borough	$382.97	$33,931.93
Northvale Borough	$252.89	$10,298.11
Norwood Borough	$247.49	$12,085.97
Oakland Borough	$438.76	$21,749.06
Old Tappan Borough	$339.79	$13,246.47
Oradell Borough	$368.11	$18,100.51
Palisades Park Borough	$439.39	$44,201.89
Paramus Borough	$1,425.52	$55,535.06
Park Ridge Borough	$463.43	$23,606.42
Ramsey Borough	$641.63	$29,332.70
Ridgefield Borough	$362.07	$26,194.57
Ridgefield Park Village	$332.23	$27,634.39
Ridgewood Village	$1,039.53	$55,773.86
River Edge Borough	$362.10	$25,892.72
River Vale Township	$421.14	$23,094.28
Rochelle Park Township	$173.70	$12,135.26

Municipality	Expected Annual Losses (Building)	Expected Annual Losses (Total)
Rockleigh Borough	$21.69	$883.33
Rutherford Borough	$506.16	$39,327.47
Saddle Brook Township	$502.02	$31,048.57
Saddle River Borough	$37.52	$626.08
South Hackensack Township	$332.48	$8,480.67
Teaneck Township	$1,266.40	$83,910.65
Tenafly Borough	$648.47	$33,431.24
Teterboro Borough	$337.72	$5,634.76
Upper Saddle River Borough	$467.53	$17,619.81
Waldwick Borough	$324.96	$21,425.43
Wallington Borough	$251.83	$25,304.31
Washington Township	$367.63	$21,513.07
Westwood Borough	$363.68	$23,249.65
Wood-Ridge Borough	$448.75	$16,685.89
Woodcliff Lake Borough	$315.66	$22,596.95
Wyckoff Township	$762.64	$34,200.24
Bergen County Total	**$33,545.82**	**$2,090,228.35**

Tornado

Table 4.9-10 Expected Annualized Losses from Tornado by Jurisdiction shows expected annualized losses for tornado hazards for municipalities within Bergen County. This data was derived from FEMA's NRI. Expected EAL represents the average economic loss in dollars resulting from natural hazards each year. The table includes EAL for buildings as well as total EAL which includes building damage as well as damage to agriculture and population equivalency (the monetized cost of injury and fatality).

Table 4.9-10 Expected Annualized Losses from Tornado by Jurisdiction

Municipality	Expected Annual Losses (Building)	Expected Annual Losses (Total)
Allendale Borough	$40,783.66	$68,242.83
Alpine Borough	$20,160.80	$27,488.25
Bergenfield Borough	$70,823.78	$181,136.56
Bogota Borough	$21,076.19	$55,280.06
Carlstadt Borough	$61,117.72	$85,989.10
Cliffside Park Borough	$58,859.99	$159,086.75
Closter Borough	$47,905.05	$83,894.14
Cresskill Borough	$43,168.41	$79,881.56
Demarest Borough	$29,170.92	$50,064.23
Dumont Borough	$46,448.88	$118,060.19
East Rutherford Borough	$54,077.98	$93,082.80
Edgewater Borough	$39,439.76	$95,396.19
Elmwood Park Borough	$79,083.18	$176,485.46
Emerson Borough	$32,271.79	$62,717.97
Englewood City	$106,404.17	$220,733.27
Englewood Cliffs Borough	$46,451.28	$67,302.26
Fair Lawn Borough	$146,008.04	$303,855.07
Fairview Borough	$33,421.93	$92,067.73
Fort Lee Borough	$97,967.06	$254,841.17
Franklin Lakes Borough	$93,877.43	$138,962.21
Garfield City	$80,396.77	$211,898.68
Glen Rock Borough	$67,949.84	$123,644.16
Hackensack City	$161,364.53	$341,029.50
Harrington Park Borough	$25,522.47	$45,375.32
Hasbrouck Heights Borough	$35,984.82	$83,311.30
Haworth Borough	$20,826.86	$34,829.91
Hillsdale Borough	$46,374.25	$88,835.92
Ho-Ho-Kus Borough	$25,497.95	$42,568.14

Municipality	Expected Annual Losses (Building)	Expected Annual Losses (Total)
Leonia Borough	$27,955.12	$64,270.63
Little Ferry Borough	$30,724.60	$73,794.66
Lodi Borough	$69,926.90	$172,116.96
Lyndhurst Township	$68,519.96	$156,422.02
Mahwah Township	$147,696.05	$249,687.70
Maywood Borough	$31,518.35	$70,862.77
Midland Park Borough	$31,622.15	$59,729.44
Montvale Borough	$58,188.93	$93,194.07
Moonachie Borough	$35,684.46	$47,913.24
New Milford Borough	$48,012.28	$114,176.99
North Arlington Borough	$44,271.51	$108,506.79
Northvale Borough	$32,712.72	$52,649.38
Norwood Borough	$31,571.99	$55,195.91
Oakland Borough	$66,153.72	$117,296.14
Old Tappan Borough	$41,176.78	$65,851.51
Oradell Borough	$43,129.31	$76,388.54
Palisades Park Borough	$48,294.99	$127,499.03
Paramus Borough	$173,818.16	$280,167.71
Park Ridge Borough	$47,026.43	$84,219.30
Ramsey Borough	$82,721.83	$142,022.05
Ridgefield Borough	$38,482.25	$83,373.68
Ridgefield Park Village	$37,991.87	$89,607.99
Ridgewood Village	$126,773.16	$232,649.11
River Edge Borough	$40,289.75	$87,319.59
River Vale Township	$48,661.55	$90,165.94
Rochelle Park Township	$19,919.20	$42,612.49
Rockleigh Borough	$2,805.98	$4,516.07
Rutherford Borough	$57,974.84	$131,487.97
Saddle Brook Township	$56,490.32	$113,140.77
Saddle River Borough	$4,020.57	$5,064.68
South Hackensack Township	$34,610.27	$48,149.88
Teaneck Township	$148,943.47	$309,960.53
Tenafly Borough	$72,487.33	$132,642.63
Teterboro Borough	$36,185.12	$45,582.11
Upper Saddle River Borough	$56,943.94	$90,417.03
Waldwick Borough	$39,083.74	$79,389.28
Wallington Borough	$28,184.68	$74,508.03
Washington Township	$42,900.96	$81,785.44
Westwood Borough	$47,814.79	$95,057.93
Wood-Ridge Borough	$44,201.57	$69,559.58
Woodcliff Lake Borough	$33,837.01	$73,419.51
Wyckoff Township	$96,402.40	$163,355.57
Bergen County Total	**$3,908,166.56**	**$7,741,791.40**

4.10 STORM SURGE

Hazard Description

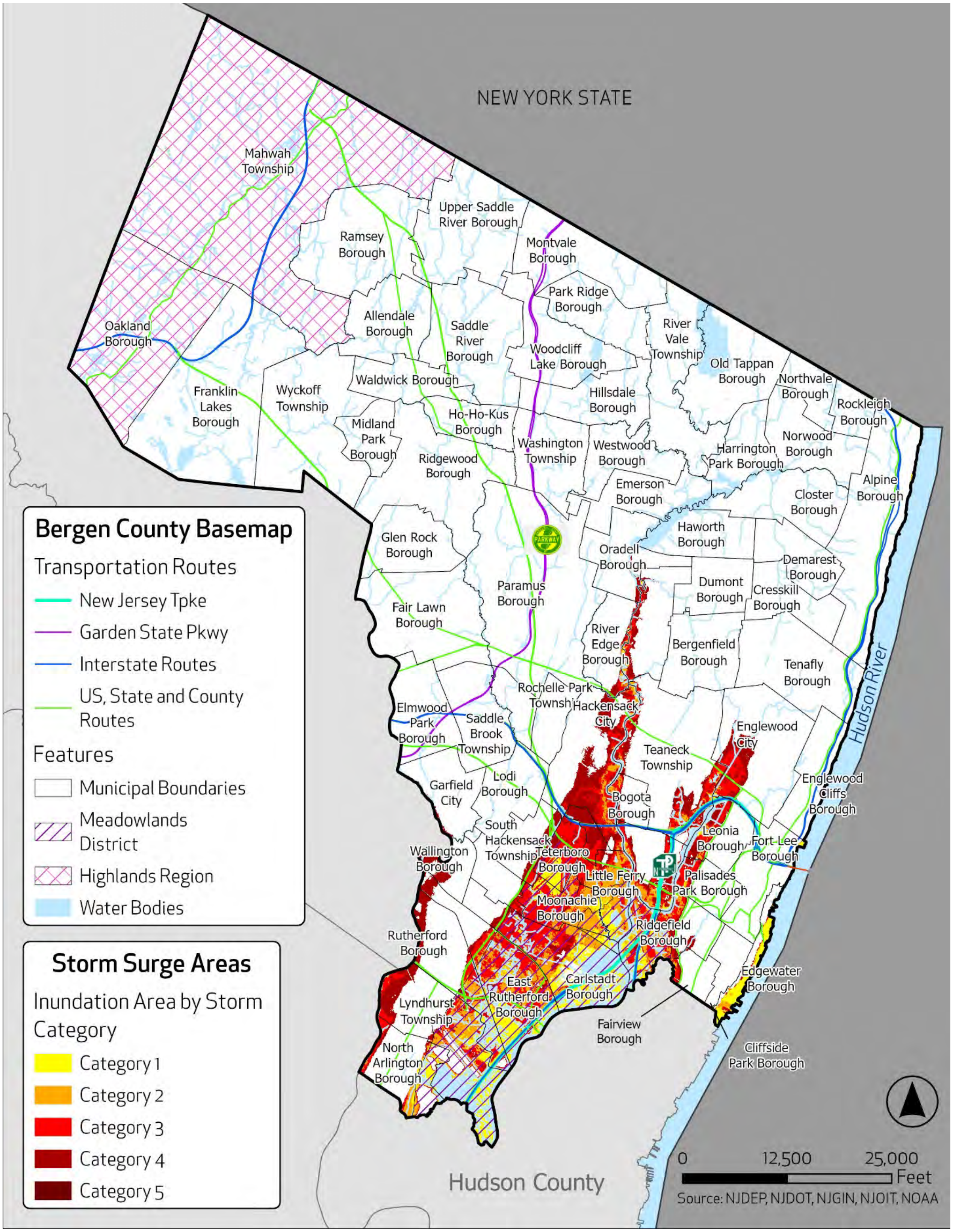
A storm surge is a large dome of water often 50 to 100 miles wide and rising anywhere from four to five feet in a Category 1 hurricane up to more than 30 feet in a Category 5 storm. Storm surge heights and associated waves are also dependent upon the shape of the offshore continental shelf (narrow or wide) and the depth of the ocean bottom (bathymetry). A narrow shelf, or one that drops steeply from the shoreline and subsequently produces deep water close to the shoreline, tends to produce a lower surge but higher and more powerful storm waves. Storm surge arrives ahead of a storm's actual landfall and the more intense the hurricane is, the sooner the surge arrives. Storm surge can be devastating to coastal regions, causing severe beach erosion and property damage along the immediate coast. Further, water rise caused by storm surge can be very rapid, posing a serious threat to those who have not yet evacuated flood-prone areas. Storm surge can be exacerbated if occurring at or near high tide.

Location, Extent and Magnitude

There are many areas in Bergen County subject to potential storm surge inundation. **Figure 4.10-1 Hurricane Storm Surge Inundation Zones in Bergen County** illustrates inundation zones storm surges associated with hurricanes of Category 1 to 4 for Bergen County derived from georeferenced Sea, Lake and Overland Surge from Hurricanes (SLOSH) data produced by NOAA’s National Weather Service . SLOSH is a modeling tool used to estimate storm surge for coastal areas resulting from historical, hypothetical or predicted hurricanes taking into account maximum expected levels for pressure, size, forward speed, track and winds. Therefore, the SLOSH data is best used for defining the potential maximum surge associated with various storm intensities for any particular location. Storm surge arrives prior to a hurricane's landfall, and the greater the hurricane's intensity, the sooner the surge arrives.

As shown in the Figure X, all of the jurisdictions in the county with tidally influenced waters are at high risk to storm surge inundation. While non-coastal areas may not be directly impacted by storm surge inundation, they might experience flooding caused by storm surge and extremely high tides that can affect the drainage of areas further inland.

Figure 4.10-1 Hurricane Storm Surge Inundation Zones in Bergen County



Previous Occurrences and Losses

NOAA's NCEI Storm Events Database was consulted on May 1, 2025. A search of the database for Storm Surge/Tide events in Bergen County from 1950 to 2024 returned zero results. However, a review of the database yields instances of coastal flood, hurricane, tropical depression, tropical storm, or winter storm (nor'easter) that would presumably include instances of storm surge.

Probability of Future Occurrences

According to researchers from Colorado State University, the probability of a named storm making landfall in New Jersey is 28 percent. The probability for Bergen County is not identified specifically but it is probably similar to the probability provided for Hudson and Essex Counties, which is 17 percent.[32] However, the probability is less for events that cause significant storm surge (dependent on storm speed, direction, tides, etc.), as less severe to moderate storm surge events typically associated with nor'easters and less intense coastal storms are more likely to occur, and in the case of nor'easters will last longer and possibly cause more damage than fast-moving hurricanes.

Potential Impacts of Climate Change

The frequency and intensity of coastal storms and severe weather events is expected to increase in the future due to climate change. In the years to come, it is anticipated that Bergen County will observe drastic changes in storm character, intensity, frequency, and storm tracking. Hurricanes are likely to become more intense with rising sea water temperatures.

Additionally, the long-term rise in sea level can be expected to impact the occurrence of significant storm surges and hence future damages from coastal flooding in Bergen County. Rising sea levels over time will shorten the return period (or exceedance interval) and hence increase the frequency of significant storm surge events. To take a hypothetical example, a one-foot rise in sea level over 50 years could result in a storm surge event with a current annual occurrence probability of 2% (a "50-year" event) becoming an event of 10% annual probability (a "10-year" event).

Vulnerability Assessment

Built Environment, Infrastructure, and Community Lifelines

To analyze potential losses from storm surge, FEMA's National Risk Index (NRI) was used. The NRI contains a category for coastal flood which it defines as inundation of normally dry coastal land as a result of high or rising tides or storm surges. **Table 4.10-1** below displays the Expected Annual Losses (EAL) for coastal flood by jurisdiction. EAL is calculated using a multiplicative equation that includes exposure, annualized frequency, and historic loss ratio risk factors. Total losses includes building losses as well as population equivalency losses (the monetized cost of injury and fatality) and agricultural losses.

Table 4.10-1 Annualized Losses for Coastal Flood Hazard by Jurisdiction

Municipality	Expected Annual Losses (Building)	Expected Annual Losses (Total)
Allendale Boro	$-	$-
Alpine Borough	$79,439.21	$79,439.21
Bergenfield Borough	$-	$-
Bogota Borough	$7,740.39	$7,943.99
Carlstadt Borough	$60,805,445.54	$60,833,087.76
Cliffside Park Borough	$-	$-
Closter Borough	$-	$-
Cresskill Borough	$-	$-
Demarest Borough	$-	$-
Dumont Borough	$-	$-

[32] https://tropical.colostate.edu/TC_impact.html

Municipality	Expected Annual Losses (Building)	Expected Annual Losses (Total)
East Rutherford Borough	$5,711,214.02	$5,904,313.72
Edgewater Borough	$1,571,188.79	$1,877,957.07
Elmwood Park Borough	$-	$-
Emerson Borough	$-	$-
Englewood City	$156,012.71	$184,009.69
Englewood Cliffs Borough	$350,481.67	$350,481.67
Fair Lawn Borough	$-	$-
Fairview Borough	$640,668.50	$674,693.13
Fort Lee Borough	$591.73	$591.73
Franklin Lakes Borough	$-	$-
Garfield City	$29,696.03	$37,410.84
Glen Rock Borough	$-	$-
Hackensack City	$388,843.05	$448,418.92
Harrington Park Borough	$-	$-
Hasbrouck Heights Borough	$903,637.36	$912,933.89
Haworth Borough	$-	$-
Hillsdale Borough	$-	$-
Ho-Ho-Kus Borough	$-	$-
Leonia Borough	$5,624.23	$6,529.75
Little Ferry Borough	$23,737,070.49	$29,943,953.83
Lodi Borough	$24,574.58	$27,752.16
Lyndhurst Township	$2,035,655.38	$2,319,505.38
Mahwah Township	$-	$-
Maywood Borough	$-	$-
Midland Park Borough	$-	$-
Montvale Borough	$-	$-
Moonachie Borough	$81,041,153.93	$85,997,120.28
New Milford Borough	$32,291.53	$38,625.93
North Arlington Borough	$417,587.86	$423,289.98
Northvale Borough	$-	$-
Norwood Borough	$-	$-
Oakland Borough	$-	$-
Old Tappan Borough	$-	$-
Oradell Borough	$8,533.80	$8,594.36
Palisades Park Borough	$5,151.19	$5,182.94
Paramus Borough	$396.48	$396.48
Park Ridge Borough	$-	$-
Ramsey Borough	$-	$-
Ridgefield Borough	$1,046,610.08	$1,052,482.20
Ridgefield Park Village	$51,655.29	$61,105.49
Ridgewood Village	$-	$-
River Edge Borough	$17,132.24	$18,739.71
River Vale Township	$-	$-
Rochelle Park Township	$-	$-
Rockleigh Borough	$-	$-
Rutherford Borough	$1,690,773.62	$1,694,563.30
Saddle Brook Township	$-	$-
Saddle River Borough	$-	$-
South Hackensack Township	$1,498,428.18	$1,510,735.62
Teaneck Township	$59,852.02	$62,670.50
Tenafly Borough	$-	$-
Teterboro Borough	$13,485,853.66	$13,596,620.62
Upper Saddle River Borough	$-	$-
Waldwick Borough	$-	$-
Wallington Borough	$67,945.52	$89,714.68
Washington Township	$-	$-
Westwood Borough	$-	$-
Wood-Ridge Borough	$-	$-
Woodcliff Lake Borough	$2,093,881.17	$2,190,766.69
Wyckoff Township	$-	$-

Municipality	Expected Annual Losses (Building)	Expected Annual Losses (Total)
Bergen County Total	**$197,965,133.01**	**$210,359,634.55**

Population and Economy
Impacts to the general public include evacuation and sheltering needs, as well as emergency response for those who shelter in place or are injured during the event. Local economies can be impacted by direct losses like damage to property and infrastructure, as well as indirect impacts like business disruptions and reduced tourism.

Ecosystems and Natural Assets
Storm surge can destroy beaches and shoreline ecosystems, transporting sand inland and burying vegetation. It can also negatively disrupt coastal habitats, especially estuaries and wetlands which perform vital ecosystem functions.

4.11 WAVE ACTION

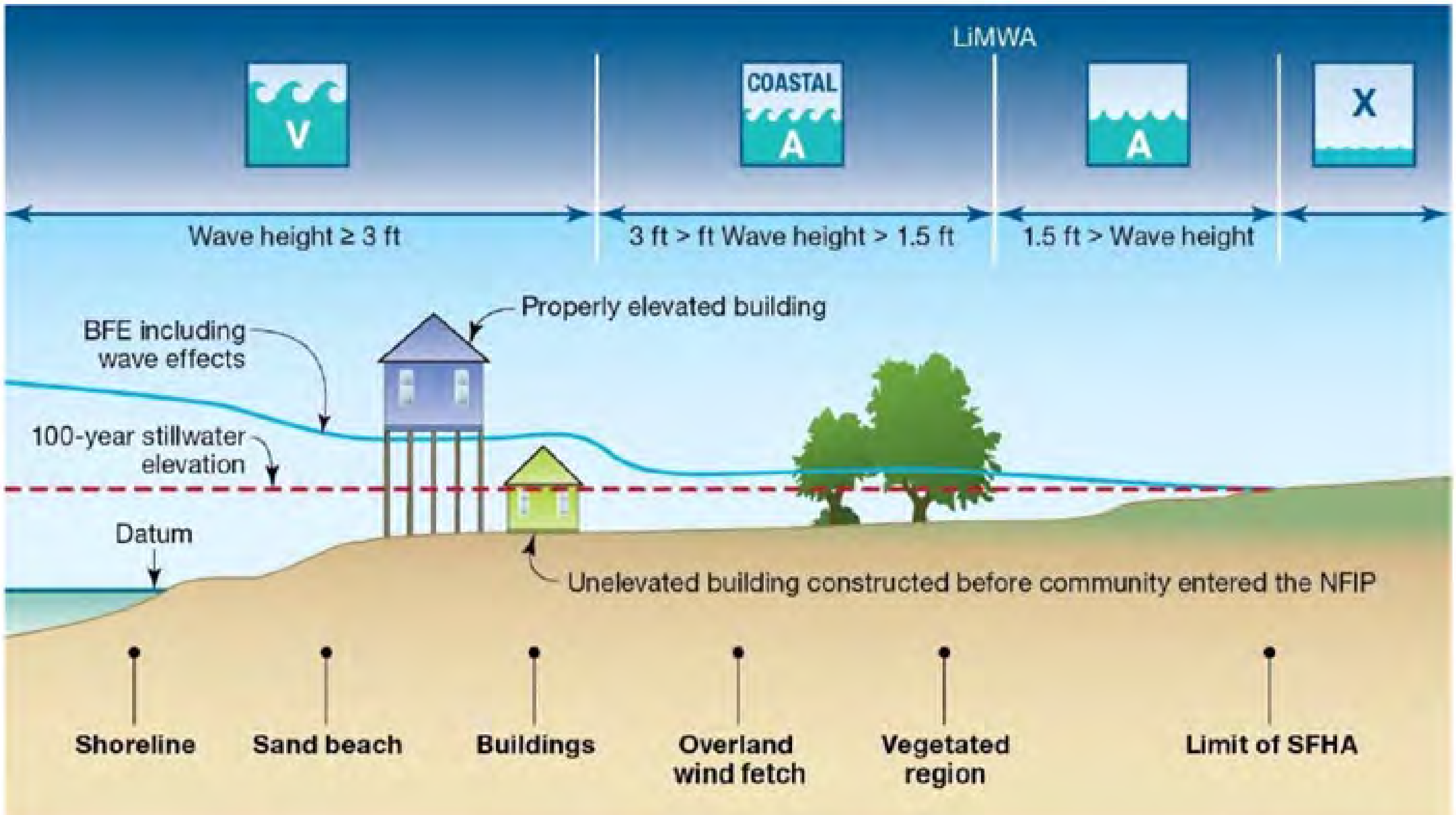
Hazard Description

Wave action is the characteristics and effects of waves that move inland from an ocean, bay, or other large body of water. Large, fast-moving waves can cause extreme erosion and scour and their impact on buildings can cause severe damage. During hurricanes and other high-wind events, storm surge and wind increase the destructiveness of waves and cause them to reach higher elevations and penetrate further inland.

Location, Extent and Magnitude

Location
The area most susceptible to wave action in Bergen County are predominantly located along the immediate shoreline areas of the Hudson River. Additional areas may occasionally experience wave action during extremely large storm events that cause storm surge (addressed separately within this section). **Figure 4.11-1** shows a typical transect illustrating coastal zones and the effects of energy dissipation and regeneration of a wave as it moves inland. Zones include Zone V, the Coastal A-Zone (characterized by Moderate Wave Action (MoWA) where waves can be between 1.5 to 3 feet during a BFE) and Zone A (characterized by Minimal Wave Action (MiWA) where waves are less than 1.5 feet during a BFE) which are separated by the Limit of Wave Action (LiMWA).Wave elevations are decreased by obstructions such as vegetation and rising ground elevation (FEMA, 2011).

Figure 4.11-1 Transect Schematic of Zone V, Coastal A-Zone and Zone A

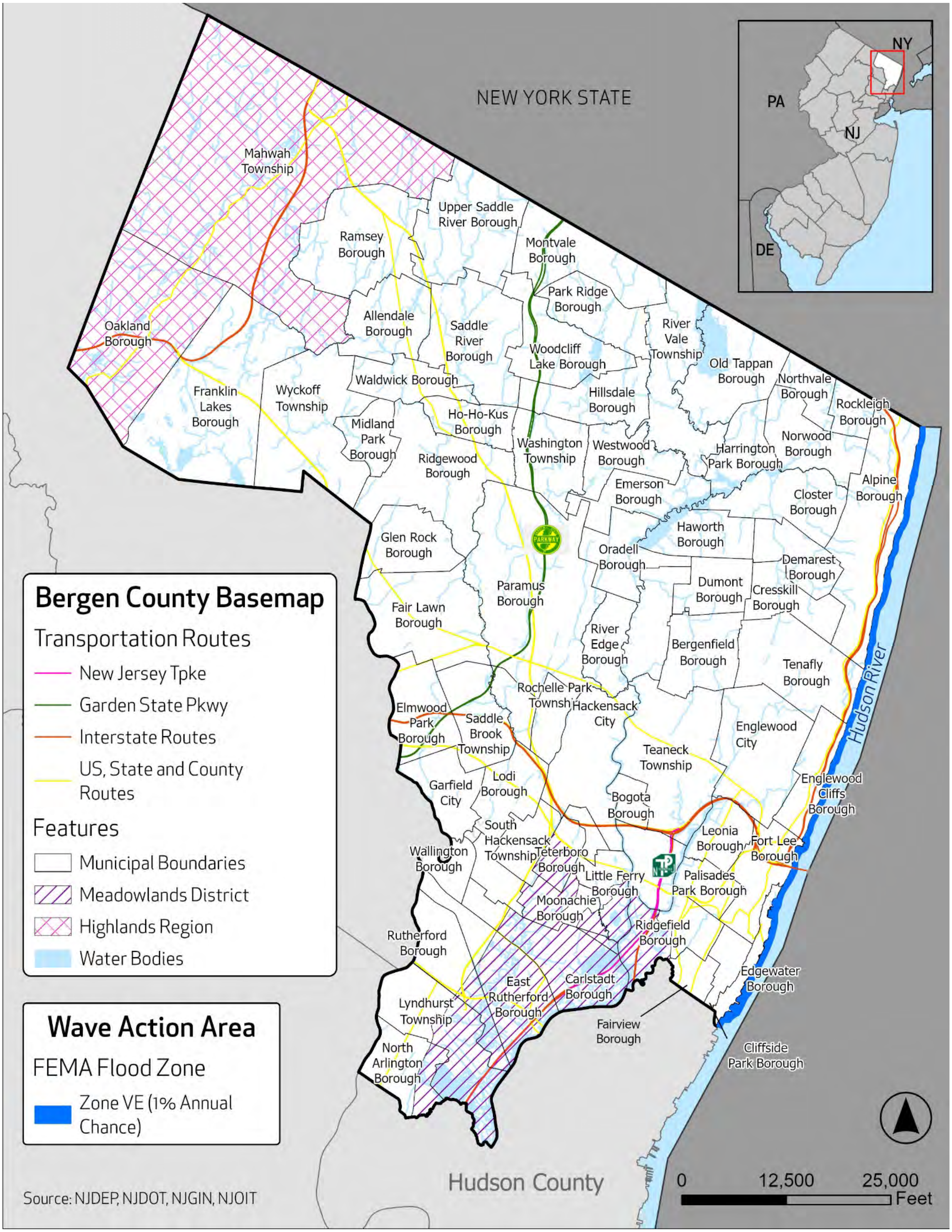


Source: FEMA, 2009

Before reaching Bergen County, wave oscillations are attenuated by the funneling of ocean water through several restrictions and bays, including Upper New York Bay, the Kill Van Kull, and Newark Bay. Updated FIRMs show VE zones in Bergen County. Bergen County, per FEMA's Flood Insurance Rate Maps, did not previously have any labeled Zone V hazard areas, denoting coastal areas with a 1.% or greater chance of flooding, and additional hazard associated with storm waves. As the area had not been designated as having "coastal flood zones with wave action", coastal erosion, though not impossible, was deemed unlikely within Bergen County.

The Preliminary FIRMs now show V zones in Bergen County in the municipalities of Edgewater, Fort Lee, Englewood Cliffs, Alpine and Tenafly, all of which have small slivers of VE along their riverine frontage with the Hudson River. **Figure 4.11-2 Wave Action Areas in Bergen County** illustrates the wave action hazard zones for Bergen County based on FEMA Preliminary and Effective FIRMs.

Figure 4.11-2 Wave Action Areas in Bergen County



A map of all the flood zones can be found in the Flood section of this Risk Assessment.

Magnitude

There is no particular scale that classifies the magnitude or severity of different wave events for different category storms. The extent of flooding associated with a 1% annual probability of occurrence (the base flood or 100-year flood) is used as the regulatory boundary by many agencies and this mapping does include mapping of the V-zone, or the lands that can support breaking waves of three feet or more. This boundary is therefore a convenient tool for assessing the extent of the wave action hazard and risk in flood-prone communities. Higher category storms on the Saffir-Simpson scale would, however, typically have more destructive waves breaking into the built environment at the coastline causing more extensive damages to those susceptible structures

Previous occurrences and Losses

NOAA's NCEI Storm Events Database was consulted on May 1, 2025. A search of the database for High Surf events in Bergen County from 1950 to 2024 returned zero results. However, a review of the database yields instances of hurricane, tropical depression, tropical storm, or winter storm (nor'easter) that would presumably include instances of wave action.

Probability of Future Occurences

Wave action will continue to have a probability of occurrence for the coastal flood hazard zones of Bergen County, and the probability of future occurrences is certain. Less severe wave action events will be more frequent but likely cause less impact (i.e., minor damages, coastal erosion, etc.), while more severe waves associated with less frequent coastal storm events such as hurricanes and nor'easters will cause higher impacts (including property damages) along the shoreline.

Potential Effects of Climate Change

The frequency and intensity of coastal storms and severe weather events which cause wave action hazard is expected to increase in the future due to climate change. It is anticipated that Bergen County will observe changes in storm character, intensity, frequency, and storm tracking. Hurricanes are likely to become more intense with rising sea water temperatures. Coastal erosion rates are likely to increase with sea level rise occurring at faster rates than have been observed over the last century.

Vulnerability Assessment

Built Environment, Infrastructure and Community Lifelines

Given the lack of readily available historical loss data on significant wave action occurrences in Bergen County, it is assumed that while one major event (i.e., hurricane or nor'easter) may result in significant losses due to wave action, annualizing structural losses over a long period of time would most likely yield a negligible annualized loss estimate in each jurisdiction exposed to this hazard. However, it should also be noted that over the long term, anticipated sea level rise will increase the risk of damages/losses to future wave action events.

Population and Economy

The wave action hazard typically has a negligible effect on population. Local economies could be impacted if waterfront businesses or recreation areas are damaged by wave action.

Ecosystems and Natural Assets

Wave action can damage beaches, geologic formations such as cliffs, and wetlands and other coastal ecosystems that are an important natural resource for Bergen County. They help protect the coast from storms and flooding, provide habitat for birds, small mammals, reptiles, amphibians, and insects. Coastal erosion from wave action can impact a variety of natural systems including beaches, wetlands, marshes, and coastal habitats, degrading their natural functions through loss of land, and conversion to open water areas.

4.12 WINTER STORMS

Hazard Description

For this plan update, Winter Storms includes winter storms, blizzards, and ice storms. Nor'easters are also a common type of storm that may occur during winter months within Bergen County, however, given the frequency of these types of storms throughout New Jersey, as well as their severe potential impact, nor'easters are considered as a separate hazard and are further discussed in Section 4.7 "Hurricanes, Tropical Storms, and Nor'easters". Extreme cold temperatures and extreme wind chills are also associated with winter storms, however, these hazards are further discussed as part of extreme temperatures within Section 4.9," Severe Weather".

In addition to extremely cold temperatures and wind chills, New Jersey is also highly susceptible to winter storms and winter precipitation, including blizzards and ice storms.

Winter Storms/Winter Weather
According to FEMA's National Risk Index for Natural Hazards (NRI), winter weather events are categorized as winter storms in which the main type of precipitation is snow, sleet, or freezing rain. The quantity of precipitation to be considered 'heavy snowfall' varies by elevation; in Bergen County's non-mountainous landscape, heavy snowfall is considered 4" or more in a 12-hour period, or 6" or more in a 24-hour period.

Some winter storms are large enough to immobilize an entire region, while others may impact a smaller area. Winter storms may be accompanied by low temperatures, high winds, freezing rain or sleet, and heavy snowfall. The aftermath of a winter storm can impact a community or county for days, weeks, or potentially months; causing cold temperatures, flooding, storm surge, blocked roadways, downed utility lines, and persistent power outages.

Blizzards
A blizzard is a winter snowstorm with sustained or frequent wind gusts of 35 mph or higher, accompanied by falling or blowing snow which can reduce visibility to below .25 miles. These winds in combination with low temperatures, heavy snowfall can create dangerous conditions which can immobilize a region, strand commuters, stop the flow of supplies, and disrupt emergency and medical services. A *severe blizzard* is categorized as having temperatures near or below 10°F, winds exceeding 45 mph, and visibility reduced by snow to near zero.

Ice Storms
An ice storm describes damaging accumulations of ice during freezing rain situations. Significant ice accumulation is typically ¼" or greater (NWS, 2013). Heavy accumulations of ice can bring down trees, power lines and utility poles, and communication towers. Ice can disrupt communications and local power grids for days. Even small accumulations of ice can be extremely dangerous to motorists and pedestrians (NWS, 2008).

Location, Extent and Magnitude

Nearly the entire continental United States is susceptible to winter storms, but the degree of exposure typically depends on the normal expected severity of local winter weather, location elevation, and local geography. Although the entire State of New Jersey may be considered at risk for snow and blizzard conditions, higher snow accumulations are prevalent in northern New Jersey, including Bergen County. Lower snow accumulations may present along coastal areas and lower elevation geographies along wetlands and riparian areas. A locality's distance to a winter storm center is a determining factor in gauging impacts of temperature and type of precipitation during winter storm events. Normal seasonal snowfall in Bergen County reaches nearly 26 inches, and all municipalities within the county are equally likely to be impacted by extreme cold and winter storms.

The magnitude or severity of a severe winter storm depends on several factors including a region's climatological susceptibility to snowstorms, snowfall amounts, snowfall rates, wind speeds, temperatures, visibility, storm duration, topography, and time of occurrence during the day (i.e., weekday versus weekend), and time of season.

Storm magnitude can be communicated through NWS alerts. The NWS uses winter weather *watches*, *warnings*, and *advisories* to notify communities of potentially hazardous conditions. A winter storm *watch* means that severe weather conditions (heavy snow, ice) may affect a certain area, but specific occurrence, location, and timing are uncertain. A *watch* is issued to provide 12- to 48-hour notice of the possibility of severe winter weather. A *watch* is upgraded to a winter storm *warning* when hazardous winter weather, in the form of heavy snow, heavy freezing rain, or heavy sleet, is imminent or occurring. *Warnings* are usually issued 12 – 24 hours before the storm is expected to begin in the region. Winter weather *advisories* inform communities that winter weather conditions are expected to cause significant inconvenience that may be hazardous. The NWS may also issue a *blizzard warning* when snow and strong winds combine to produce blinding snow, deep drifts, and notable wind chill (NWS, 2013).

The extent of a severe winter storm can be classified both by meteorological measurements and by evaluating its societal impacts. NOAA's National Centers for Environmental Information (NCEI) produced the Regional Snowfall Index (RSI) for significant snowstorms that impact the eastern two-thirds of the United States. The RSI ranks snowstorm impacts on a scale from one to five, based on the spatial extent of the storm, the amount of snowfall, and the interaction of the extent and snowfall totals with population (based on the 2000 Census). The NCEI has analyzed and assigned RSI values to over 500 storms since 1900 (NOAA, 2011). **Table 4.12-1 Regional Snowfall Index Ranking Categories** presents the five RSI ranking categories.

Table 4.12-1 Regional Snowfall Index Ranking Categories

Category	Description	RSI Value
1	Notable	1-3
2	Significant	3-6
3	Major	6-10
4	Crippling	10-18
5	Extreme	18.0+

Source: NOAA-NCEI, 2011

Previous Occurrences and Losses

Several winter storms have impacted Bergen County in recent years. Two of the most significant storms in Bergen's history were the North American Blizzard of 1996 (January) and the North American Blizzard of 2006 (February). The Blizzard of 1996 was a state-declared emergency which dropped at least 24 inches of snow across the entire state of New Jersey. Roads were shut down during the three-day storm and power outages were reported statewide. Businesses were closed either due to road conditions or because of the resulting loss of power. **Table 4.12-2 Snowfall Amounts for the Northeast** shows a summary of snowfall for the northeast and comparisons to other storms.

Record snowfall amounts are calculated for storms measuring snowfall spanning no more than two days. Another state declared emergency, the Blizzard of 2006, saw record snowfall for New York City at 26.9" recorded at Central Park. In New Jersey, the storm was powerful enough to stop NJ Transit bus service for a day. According to measurements in Newark, New Jersey, just south of Bergen County, 21.0" of snow fell and 16,000 people were left without power. Businesses were closed for most of the day throughout northern New Jersey.

Table 4.12-2 Snowfall Amounts for the Northeast

City	Blizzard of '96 Total (inches)	Record Snowfall Amount	Date of Record Amount	"Storm of the Century" (March 1993)
Philadelphia, PA	30.7	21.3	Feb. 11-12, 1983	12.0
Newark, NJ	27.8	22.6	Feb. 3-4, 1961	12.7
Washington Dulles AP	24.6	22.8	Feb. 10-11, 1983	14.1
Providence, RI	24.0	28.6	Feb. 7-8, 1978	10.2
Elkins, WV	23.4	20.7	Nov. 24-25, 1950	18.8
Baltimore, MD	22.1	22.8	Feb. 11, 1983	11.9
Wilkes-Barre/Scranton, PA	21.0	21.4	Mar. 13-14, 1993	21.4
Charleston, WV	20.5	18.9	Mar. 13-14, 1993	18.9
New York, NY	20.2	26.4	Dec. 26-27, 1947	10.6
Boston, MA	18.2	27.1	Feb. 6-7, 1978	12.8
Hartford, CT	18.2	21.0	Feb. 11-12, 1983	14.8
Washington National AP	17.1	18.7	Feb. 18-19, 1979	6.6
Bridgeport, CT	15.0	17.0	Dec. 19-20, 1948	10.8
Portland, ME	10.2	27.1	Jan. 17-18, 1979	18.6
Pittsburgh, PA	9.6	24.6	Mar. 12-13, 1993	24.6
Williamsport PA	8.6	24.1	Jan. 12-13, 1964	15.9

DATA COMPILED BY THE NORTHEAST REGIONAL CLIMATE CENTER AT CORNELL UNIVERSITY[33].

Table 4.12-3 Snow and Blizzard Events Affecting Bergen County details ice storm, winter storm, and blizzard events that were reported in Bergen County from 2010 through December 31, 2024. In these reported events, there has been one death (January 2016), no injuries, and no property damage reported. This table may not include all incidents[34].

Table 4.12-3 Snow and Blizzard Events Affecting Bergen County

Date of Event	Event Type	Deaths	Injuries	Property Damage	Description
12/26/2010	Blizzard	0	0	0.00K	A rapidly intensifying low-pressure system tracked from off the Southeast US coast on Christmas Day and then past the Mid Atlantic Coast on Sunday December 26th to just east of Long Island by early Monday morning December 27th. This intense low-pressure system spread snowfall into the region Sunday morning, with bands of heavy snow plus embedded thunderstorms and very strong winds affecting the region Sunday afternoon through Sunday night. The powerful blizzard (defined when sustained winds or frequent gusts greater than or equal to 35 mph accompanied by falling and/or blowing snow, frequently reducing visibility to less than 1/4 mile for three hours or more) brought a widespread area of 20 to 30 inches of snow across Northeast New Jersey. The heavy snow was accompanied by area wide winds of 25 to 40 mph and gusts in excess of 60 mph Sunday afternoon into Sunday night, resulting in near whiteout conditions with blowing and drifting snow and making all forms of travel extremely difficult to nearly impossible. As a result, Acting Governor Stephen Sweeney declared a state of emergency during the height of the storm around 8 pm on December 26th. In fact, all three major New York/New Jersey Airports were closed during and for a period after the storm as well as New Jersey Transit bus lines, and several lines of PATH train service were

[33] "Snowfall Summary for the Northeast," Cornell University. http://www.nrcc.cornell.edu/snow_records.html

Date of Event	Event Type	Deaths	Injuries	Property Damage	Description
					suspended Sunday night into Monday morning due to high snow drifts. In addition, 8000 customers lost power during the height of the storm.
2/1/2011	Ice Storm	0	0	0.00K	A complex low-pressure system tracked northeast from the Lower Mississippi River Valley into the Ohio Valley Tuesday, February 1st into Tuesday Night, with a secondary low pressure developing over the Delmarva region and tracking southeast of Long Island on Wednesday February 2nd. With a polar high locked in place over Ontario and Quebec, this slow moving storm system brought a mixture of snow, sleet and freezing rain to the region. A bout of light snow, sleet and freezing rain occurred early Tuesday morning into Tuesday afternoon ahead of an approaching warm front, with a second heavier round of freezing rain and sleet for the region Tuesday Night into early Wednesday afternoon. This later episode caused numerous accidents and road closures. Generally 1 to 3 inches of snow and sleet fell across Northeastern New Jersey during this 2 day storm, with 1/4 to 6/10ths of an inch of additional ice accretion.
10/29/2011	Winter Storm	0	0	0.00K	A historic and unprecedented early-season winter storm impacted the area on Saturday, October 29, with more than one foot of heavy wet snow falling on interior portions of northeast New Jersey. This is the first time a winter storm of this magnitude has ever occurred in October. Late Friday night, October 28, an area of low pressure emerged from the South Carolina coastal plain into the western Atlantic Ocean. The low moved up the coast late Friday night into Saturday morning. The low began to rapidly strengthen late Saturday morning when it was east of the Delmarva coast, and continued to strengthen as it passed south of Long Island Saturday night. Areas just north and west of New York City were just cold enough to support a heavy wet snow. The heaviest snow fell across interior northeast New Jersey, with up to 18 inches of snowfall across higher elevations. Thousands of people across northeast New Jersey lost power during this event as heavy snow accumulated on trees that still had partial to full foliage during mid-autumn. This caused extensive felling of trees and limbs across the region and damage to power lines.
2/8/2013	Winter Storm	0	0	0.00K	Low pressure that formed along the northern Gulf coast by the morning of Thursday, February 7, 2013 moved northeast to near Cape Hatteras by the morning of Friday, February 8, 2013 . The low then rapidly intensified while moving northeast to a position east of Cape Cod by the morning of Saturday, February 9, 2013, producing heavy snowfall and gusty winds across northeast New Jersey on February 8th and 9th. Spotters reported snowfall ranging from 10 inches in Saddle Brook to 16 inches in Woodcliff Lake.
12/14/2013	Winter Storm	0	0	0.00K	An intensifying low pressure system taking shape over the lower Mississippi Valley the morning of Saturday the 14th moved to a position south of Long Island by the morning of the 15th, bringing heavy snow and some freezing rain to parts of Northeast New Jersey. Spotters and the public reported snowfall of 6.3 inches in Mahwah and Oakland, and 6.1 inches in Ramsey. The NJ DOT also reported snowfall of 5.5 inches in Paramus. The snowfall was followed by ice accretion of 1/10 to 1/4 inch.
2/5/2014	Winter Storm	0	0	0.00K	A complex low pressure system moving through the Ohio Valley and Mid Atlantic regions brought a quick burst of moderate to heavy snow, sleet, and freezing rain to Northeast New Jersey the morning of February fifth. Trained spotters, Teterboro Airport, and the public reported widespread 5 to 9 inches snowfall.
2/13/2014	Winter Storm	0	0	0.00K	A low pressure system developed along the northern Gulf Coast on February 12th, and moved to near Cape Hatteras and the Virginia capes by the morning of the 13th. The intensifying low then headed northeast, passing east of Long Island and into the Gulf of Maine early the morning of the 14th, bringing heavy snow and ice to northeast New Jersey. Trained spotters and the public reported widespread snowfall of 11 to 15 inches. Amateur radio also reported freezing rain accretion of 3 tenths of an inch in Fort Lee.
1/23/2016	Winter Storm	1	0	0.00K	Low pressure moving across the deep South on Thursday January 21st and Friday January 22nd intensified and moved off the Mid Atlantic coast on Saturday January

Date of Event	Event Type	Deaths	Injuries	Property Damage	Description
					23rd, bringing heavy snow and strong winds to northeast New Jersey, and blizzard conditions to the urban corridor and some nearby areas. Governor Chris Christie declared a state of emergency for New Jersey on Friday January 22nd. New Jersey Transit stopped running trains, buses and light rail at 2 AM Saturday January 23rd. Bridges and tunnels from New York City into New Jersey were shut down by mid-afternoon Saturday. Travel in and out of airports lagged through Monday January 25th as airlines pre-emptively cut hundreds of flights. More than 1,000 flights out of area airports were cancelled, and Teterboro Airport were shuttered due to whiteout conditions. The public and trained spotters reported snowfall ranging from 15 to 24 inches. Teterboro Airport ASOS reported near blizzard conditions through the day and early evening of Saturday January 23rd.
2/9/2017	Winter Storm	0	0	0.00K	Low pressure developed along a cold front over the Middle Atlantic early Thursday, February 9th. The low rapidly intensified as it moved off the Delmarva coast in the morning and then to the south and east of Long Island late morning into the afternoon. The low brought heavy snow and strong winds to portions of Northeast New Jersey. Numerous flights were cancelled or delayed at Newark Airport. A CoCoRaHS observer reported 9.4 inches of snow in Tenafly. Trained spotters also reported 6 to 8 inches of snowfall.
3/14/2017	Winter Storm	0	0	0.00K	Rapidly deepening low pressure tracked up the eastern seaboard on Tuesday March 14 bringing blizzard conditions to Western Passaic county. Heavy snow and sleet along with strong winds occurred across the rest of Northeast New Jersey. The storm cancelled numerous flights at Newark airport with some mass transit services suspended. Large trees fell onto homes in Bergen County and approximately 4,500 power outages resulted from the strong winds and heavy snow. Trained spotters reported 6 to 13 inches of snow and sleet. A large tree fell on a home in Park Place in Westwood and a large tree fell on a home in Washington Township.
1/4/2018	Winter Storm	0	0	0.00K	The development of the blizzard/winter storm began along the southeast coast on Wednesday January 3, 2018. An amplifying upper-level trough spawned the development of low pressure off the coast of Florida. The low pressure rapidly intensified on Wednesday night through Thursday January 4, 2018, as it moved north-northeast along the coast. The low passed just east of the 40N 70W benchmark Thursday afternoon. The central pressure when the storm developed was around 1004 millibars at 1 pm Wednesday. 24 hours later, the central pressure fell to around 950 mb, approximately a 54 millibar drop. The rapid intensification of the storm led to heavy snow, strong winds, and near-blizzard conditions across portions of Northeast New Jersey. Thousands of flights were cancelled at Newark Airport on January 4, 2018. Homes and businesses lost power and there were numerous accidents on area roadways. Trained spotters and the public reported 6 to 9 inches of snowfall. At 1:30 PM, broadcast media reported a partial roof collapse at a gas station on River Drive in Garfield. Winds gusted to 49 MPH at Teterboro Airport at 5:57 PM.
3/7/2018	Winter Storm	0	0	0.00K	A strong low-pressure system developed along the Middle Atlantic coast during the morning of Wednesday, March 7, 2018. The low tracked along the coast through the early morning hours on Thursday, March 8, 2018. The storm brought heavy wet snow, strong gusty winds, and even some thundersnow across northeast New Jersey. Snowfall rates ranged from 1 to 3 inches per hour at times in the heaviest snow bands. Trained spotters reported 7 to 9 inches of snowfall. Strong winds brought down power lines, which were on fire closing Bergen Boulevard.
11/15/2018	Winter Storm	0	0	0.00K	A wave of low pressure developed along the Middle Atlantic coast during Thursday November 15, 2018. The low was associated with a closed upper level trough across the Midwest. As the trough translated eastward into Friday November 16, 2018, the low pressure moved up the northeast coast. The antecedent air mass ahead of the low was cold and dry for the middle of November with temperatures during the morning and afternoon of November in the upper 20s and low 30s. The

Date of Event	Event Type	Deaths	Injuries	Property Damage	Description
					moisture associated with the trough and low pressure was able to produce moderate to heavy bands of snow as the precipitation began across the entire Tri-State area due to the cold air in place. Once the low drew warmer air from the south, the precipitation gradually changed to a wintry mix and then plain rain, especially for the New York City metro and Long Island. The moderate to heavy wet snowfall significantly impacted the evening rush hour with 1-2 inch per hour snowfall rates. Hundreds of trees, tree limbs, and branches were brought down by the weight of the snow, which caused many power outages. Numerous accidents were reported, and many motorists were stranded on roads until the early morning hours the next day. There were over 1,000 flights cancelled at the New York City metro airports (Kennedy, La Guardia, and Newark). Trained spotters and the public reported 6 to 8 inches of snow.
12/16/2020	Winter Storm	0	0	0.00K	Low pressure developed along the Middle Atlantic coast on Wednesday December 16, 2020. The low deepened as it tracked northward towards Long Island, NY through the night on December 16, 2020. Arctic high pressure situated over southeast Canada provided a cold and dry air mass ahead of the low supporting moderate to locally heavy snowfall throughout much of the storm. The low pressure ultimately tracked from near Atlantic City, NJ to about 50 miles south of Fire Island, NY before sliding offshore Thursday December 17, 2020. The storm significantly impacted travel during the evening commute on Wednesday December 16, 2020, and the morning commute on Thursday December 17, 2020. Many accidents resulted from the snow-covered roads and poor visibilities. Snowfall rates ranged from 1 to 2 inches per hour Wednesday evening. Total snowfall ranged from around 6 to 12 inches with strong wind gusts ranging from 35 to 50 mph. CoCoRaHS measured 8 inches of snow 1 mile southeast of Oakland. Trained spotters, broadcast media, and the public measured 6 to 9 inches of snow. The nearby Teterboro Airport measured a 38 mph at 6:51 am on December 17, 2020.
2/1/2021	Winter Storm	0	0	0.00K	Low pressure developed over the Ohio Valley and Middle Atlantic on Sunday, January 31, 2021. The low then consolidated along the Middle Atlantic coast early on Monday, February 1, 2021 and intensified as it slowly tracked to the north-northeast. The low meandered slowly north as it moved along the northeast and New England coast later on Monday February 1, 2021 through Wednesday, February 3, 2021. The low brought a major winter storm to northeast New Jersey, with the most significant impacts occurring on Monday, February 1, 2021. 3 to 6 inches of snow had already accumulated by the start of the morning commute. Near blizzard conditions then occurred through the rest of the morning into the early afternoon with snowfall rates of 1 to 3 inches per hour. Strong winds combined with these heavy snow rates to produce visibilities one quarter mile or less at times. The heavier bands of snow lifted north across the rest of northeast New Jersey in the afternoon and evening. Lighter snow bands then lingered intermittently through the early morning hours on February 3, 2021. Snowfall totals ranged 15 to 20 inches of snow with some locations receiving around two feet. Winds gusted 40 to 55 mph at times on Monday, February 1, 2021, which caused power outages. Travel was also severely impacted as many flights were cancelled and travel by train was suspended. COVID testing and vaccination sites were closed. Impacts were limited on February 2, 2021 and February 3, 2021 as the snow was largely light. Trained spotters in Franklin Lakes and Ridgewood reported 20.6 and 20.1 inches of snow respectively. Other trained spotters reported 17 to 21 inches of snow. The nearby Newark Liberty International Airport ASOS measured a 41 mph wind gust at 2:51 pm on February 1, 2021.
1/28/2022	Winter Storm	0	0	0.00K	A Nor'easter tracked just east of the benchmark bringing snow and gusty winds. The highest snowfall totals occurred primarily across eastern sections. Wind gusts of 40 mph were reported across eastern parts of Northeastern New Jersey, with higher impacts to the east across New York City, Coastal SE New York, and Eastern Connecticut. Trained spotters reported 6.9 inches in Bergenfield and 6.2 inches in East Rutherford. A COCORAHS report of 6.0 inches came in from North Arlington at

Date of Event	Event Type	Deaths	Injuries	Property Damage	Description
					9:30 am before the snow had tapered off. The cold temperatures and gusty winds also resulted in blowing snow.

Source: NOAA-NCEI, 2024

Exposure and Damage Estimates

Because winter storms often impact large areas and cross jurisdictional boundaries, all existing and future buildings, facilities and populations are considered to be exposed to this hazard and could potentially be impacted.

Probability of Future Occurrences

Severe winter weather is a common occurrence in northern New Jersey. It is highly likely that northern New Jersey, including Bergen County, will see winter weather events and winter storms in the future. Historically, most of the state receives at least one measurable snow event during winter months. The months of January, February, March, April, October, November, and December are typically when a vast majority of New Jersey has been observed to receive measurable snow. FEMA's National Risk Index has calculated the expected number of ice storm and winter weather events per year –this annualized frequency represents the average number of recorded hazard events per year over the period of record (67.1 years for ice storms, 16.9 years for winter storms). This calculation does not account for possible changes in future occurrences due to climate change. According to FEMA's NRI, Bergen County may expect **.95 Ice Storm Events** per year, **and 3.97 Winter Weather Events** per year (NRI, FEMA, NJSHJMP, 2024).

Potential Effects of Climate Change

Providing projections of future climate change for a specific region is challenging. Shorter term projections are more closely tied to existing trends making longer term projections even more challenging. The further out a prediction reaches the more subject to changing dynamics it becomes.

In terms of snowfall and ice storms, there is a lack of quantitative data to predict how future climate change will affect this hazard. It is likely that the number of winter weather events may decrease, and the winter weather season may shorten; however, it is also possible that the intensity of winter storms may increase. The exact effect on winter weather is still highly uncertain (Sustainable Jersey Climate Change Adaptation Task Force, 2013).

Since 1895, New Jersey's annual temperature has increased by 3.5°F, a trend projected to continue with average annual temperatures in New Jersey expected to increase by 34.1°F to 5.7°F by 2050 (NJDEP, 2020). The general warming trend in the state is expected to be felt more during the winter months, and result in fewer sub-freezing days, and less snow accumulation (NJDEP, 2020). While overall snowfall in Bergen County may decrease slightly over time due to rising average temperatures, winter storms are expected to become more intense and disruptive when conditions locally do support snow and ice. Climate change research indicates global patterns of increasing surface temperatures, reductions in Arctic Sea ice, and greater prevalence of high-pressure blocking patterns over the North Atlantic which creates conditions that are conducive to the formation of slow-moving winter storm development. Warmer atmospheric moisture may produce heavier, wetter snow that leads to greater damage to roofs, trees, and utility lines throughout the county. Additionally, freeze-thaw cycles may increase, contributing to infrastructure degradation, road hazards, and localized flooding, especially following rapid snowmelt events.

Vulnerability Assessment

Built Environment, Infrastructure, and Community Lifelines

Winter storms pose a moderate to high risk to the built environment and critical infrastructure in Bergen County. While individual storms may not result in long-term structural losses, repeated impacts from snow accumulation, ice formation, and freezing temperatures can deteriorate building materials, especially roofs, gutters, and unreinforced masonry in older structures. Areas with dense residential and commercial development—such as Hackensack, Teaneck, and Fort Lee—are particularly susceptible to service disruptions and increased maintenance costs due to snow removal and ice control.

The most significant impacts of winter storms fall on infrastructure systems and community lifelines. Prolonged or intense snow and ice events can disrupt road networks, especially local and county roadways that may not be cleared as quickly as state or federal routes. Downed tree limbs and ice accumulation on power lines frequently cause utility outages. Mass transit—including NJ Transit commuter lines and buses—can experience delays or cancellations, particularly affecting commuters in municipalities like Ridgewood, Paramus, and Rutherford.

Emergency services, healthcare access, and delivery of goods and services are also affected during severe winter weather events. Vulnerable jurisdictions with limited road access or topographical challenges, such as the hilly areas of Alpine or Mahwah, may face greater risk of temporary isolation during extreme events.

Population and Economy

Winter storms generally have limited direct mortality or injury risk, but indirect effects—such as traffic accidents, slips and falls, or exposure to extreme cold—can pose significant public health threats, particularly to the elderly, medically dependent individuals, and those without adequate heating or shelter.

Economically, winter storms cause episodic losses due to business closures, disrupted transportation, and emergency response costs. Retail and service industries are particularly vulnerable to lost revenue during extended storm periods. Municipal budgets also bear recurring expenses for snow removal, overtime for emergency crews, and infrastructure repairs. Prolonged power outages can interrupt commercial operations, especially for small businesses and industries reliant on continuous service.

Populations most vulnerable to winter storm impacts include:

- Seniors, particularly those living alone.
- Low-income households with limited ability to afford heating or insulation upgrades.
- Residents of mobile homes or substandard housing.
- Non-English-speaking populations who may not receive emergency updates effectively.
- Commuters and workers dependent on mass transit for employment access.

Ecosystems and Natural Assets

While winter storms may not pose long-term destructive effects on ecosystems compared to other hazards, heavy snow and ice can still damage natural assets in Bergen County. Tree limbs are frequently broken under snow and ice loads, altering forest composition, especially in county parks and wooded preserves such as the Palisades Interstate Park and Ramapo Valley County Reservation.

Freezing temperatures and prolonged snow cover can impact wildlife, particularly species with limited mobility or access to food during storm events. Salt and chemical runoff from roads and sidewalks used for de-icing can degrade water quality in nearby rivers, lakes, and wetlands—affecting habitats and sensitive aquatic species. Streambanks may also erode more rapidly from fluctuating freeze-thaw cycles, altering hydrology and increasing sedimentation downstream.

Municipalities near ecologically sensitive areas (e.g., wetlands in the Meadowlands or reservoir lands in North Jersey) must balance snow management with environmental protection to reduce cumulative impacts on local ecosystems.

4.13 WILDFIRE

Hazard Description

A wildfire is an unplanned, unwanted fire burning in a natural area, such as a forest, grassland, or prairie. Although wildfires can start from lightning or other natural causes, most are ignited by human activity, either accidentally or intentionally. Wildfires generally start and grow depending on a combination of 3 factors: fuel, topography, and weather. Dry plant debris like leaves and branches, steep slopes which allow flames to climb uphill, and any of a variety of weather conditions that may start or spread a fire including strong winds, thunderstorms, or dry, drought like conditions. Wildfire can damage natural resources, destroy structures, and threaten human lives and safety (FEMA, 2023).

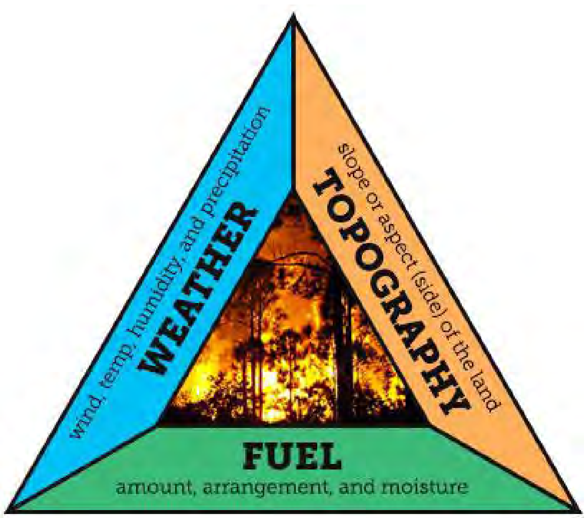
High population within northern New Jersey and Bergen County has created land use pressures in which more people are moving from urban areas to build homes in more rural areas. A potentially explosive combination is created when hazardous wildland fuels interface home development, and an increased risk of human-cased ignition come together under extreme fire weather conditions. Although wildfires can occur at any time during the year, most destructive fires in New Jersey occur during the spring (March through May), and wildfire season typically culminates in early May, corresponding with the driest live fuel moisture periods of the year.

Though the spring months are the most severe, summer and fall may also experience wildfires in Bergen County. Drought, snowpack, and local weather conditions can influence the length of the fire season. The early and late shoulders of the fire season usually are associated with human-caused fires while lightning-related fires are more common in the peak season of June through August. These weather conditions provide optimal conditions for the rapid spread of wildfires.

Fire Ecology and Wildfire Behavior

The “wildfire behavior triangle” illustrates how three primary factors influence wildfire behavior: fuel, topography, and weather. For example, drier and warmer weather combined with dense fuel loads and steeper slopes will cause more hazardous fires than light fuel sources on flat ground. Climate change is also considered a potential influence on wildfire, which is discussed later in this profile.

Figure 4.13-1 Wildfire Behavior Triangle



Location, Extent, and Magnitude

The New Jersey Forest Fire Service (NJFFS) published wildfire hazard assessment for much of the State and has published maps of wildfire hazard areas in Bergen County. NJFFS defines wildfire as hazard plus risk; the hazard is what burns and risk is what causes the fire. **Figure 4.13-1 Fuel Hazard in Bergen County** and **Figure 4.13-2 Fire Risk in Bergen County** illustrate both the hazard and the risk for Bergen County.

There are two distinguishable types of WUI: Interface and Intermix. The difference between the two types is based on density of housing.[2] Housing density has a significant effect on the spread of WUI fires, with higher density housing enabling fire to spread more easily.[4,6]

Interface: WUI occurs in areas where high-density development is next to undeveloped wildland. The population in these areas is greater than or equal to 250 people per square mile, and human structures are directly next to wildland. The housing density is greater than or equal to 3 structures per acre.[2]

Intermix: WUI exists in areas between lower-density housing and adjacent undeveloped wildland. In these regions, the population density is between 28 and 250 people per square mile. Physical structures are spread throughout an area of wildland, with a housing density of greater than or equal to 1 structure per 30 acres.[2]

Bergen County has a relatively low probability of being affected by wildfires, as indicated by **Table 4.13-1 Wildfire Fuel Hazard Areas in Bergen County**. The Ramapo Mountain State Forest in Mahwah and Palisades Interstate Park in Fort Lee, Englewood Cliffs, Tenafly and Alpine are considered to be moderate wildfire hazards and the Meadowlands marsh grasses and old landfills are deemed to be a high hazard area. The remainder of the County is developed, lowering the risk of wildfires with wildland interfacing. A great deal of landfill closure work has been taking place in the New Jersey Meadowlands, further reducing the potential for future wildfires in Bergen County.

Table 4.13-1 Wildfire Fuel Hazard Areas in Bergen County

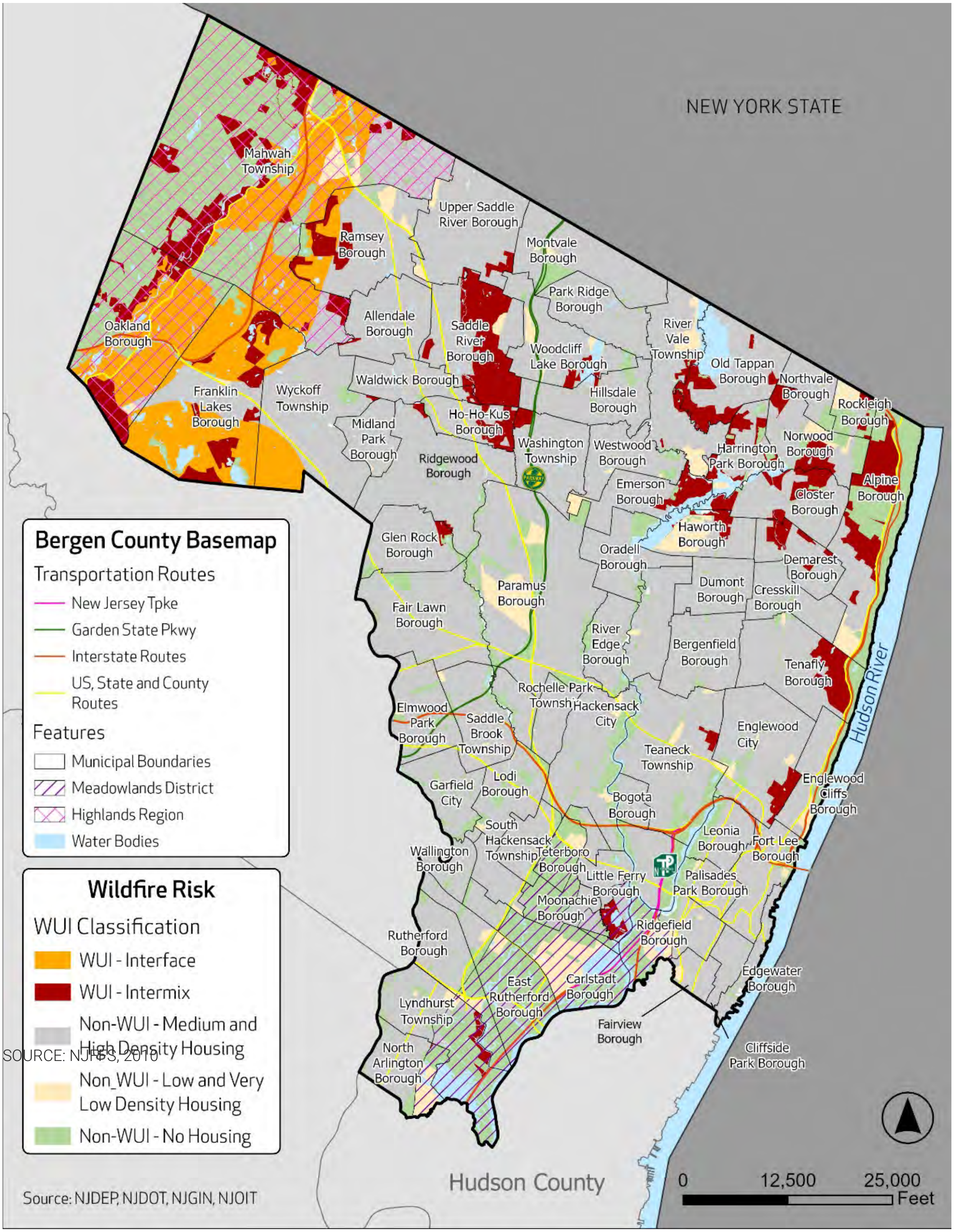
Jurisdiction	Total Land Area (sq. mi.)	Total Land Area of Wildfire Hazard Area (sq. mi.)	Total Land Area in Moderate and Low Areas (sq. mi.)	% of Total Land Area in Moderate and Low Areas	Total Land in Extreme, Very High, and High Areas (sq. mi.)	% of Total Land Area in Extreme, Very High, and High Areas
Allendale Borough	3.12	1.17	1.15	37%	0.02	1%
Alpine Borough	6.40	5.86	5.80	91%	0.06	1%
Bergenfield Borough	2.91	0.45	0.45	16%	0.00	0%
Bogota Borough	0.80	0.08	0.08	9%	0.00	0%
Carlstadt Borough	4.20	1.78	0.45	11%	1.32	31%
Cliffside Park Borough	0.96	0.04	0.04	4%	0.00	0%
Closter Borough	3.30	1.01	0.94	29%	0.06	2%
Cresskill Borough	2.07	0.40	0.39	19%	0.01	1%
Demarest Borough	2.08	0.91	0.90	43%	0.00	0%
Dumont Borough	1.96	0.16	0.16	8%	0.00	0%
East Rutherford Borough	4.05	2.02	0.92	23%	1.10	27%
Edgewater Borough	0.97	0.23	0.21	22%	0.02	2%
Elmwood Park Borough	2.74	0.32	0.32	12%	0.01	0%
Emerson Borough	2.42	0.94	0.83	34%	0.11	5%
Englewood City	4.95	1.43	1.42	29%	0.01	0%
Englewood Cliffs Borough	2.08	0.67	0.67	32%	0.00	0%
Fair Lawn Borough	5.22	0.67	0.65	12%	0.02	0%
Fairview Borough	0.84	0.19	0.19	23%	0.00	0%
Fort Lee Borough	2.51	0.40	0.38	15%	0.02	1%

Jurisdiction	Total Land Area (sq. mi.)	Total Land Area of Wildfire Hazard Area (sq. mi.)	Total Land Area in Moderate and Low Areas (sq. mi.)	% of Total Land Area in Moderate and Low Areas	Total Land in Extreme, Very High, and High Areas (sq. mi.)	% of Total Land Area in Extreme, Very High, and High Areas
Franklin Lakes Borough	9.88	6.72	6.57	67%	0.14	1%
Garfield City	2.19	0.17	0.16	7%	0.01	0%
Glen Rock Borough	2.72	0.39	0.39	14%	0.00	0%
Hackensack City	4.34	0.51	0.47	11%	0.04	1%
Harrington Park Borough	2.06	0.69	0.62	30%	0.07	3%
Hasbrouck Heights Borough	1.53	0.13	0.11	7%	0.01	1%
Haworth Borough	2.35	1.02	0.97	41%	0.05	2%
Hillsdale Borough	2.93	0.62	0.60	20%	0.02	1%
Ho-Ho-Kus Borough	1.75	0.91	0.90	51%	0.02	1%
Leonia Borough	1.63	0.42	0.30	19%	0.12	7%
Little Ferry Borough	1.67	0.31	0.28	17%	0.04	2%
Lodi Borough	2.29	0.23	0.17	7%	0.06	2%
Lyndhurst Township	4.97	1.60	0.71	14%	0.89	18%
Mahwah Township	25.88	18.72	18.12	70%	0.60	2%
Maywood Borough	1.29	0.09	0.08	6%	0.01	1%
Midland Park Borough	1.58	0.12	0.12	8%	0.00	0%
Montvale Borough	4.03	1.21	1.17	29%	0.04	1%
Moonachie Borough	1.74	0.55	0.50	29%	0.05	3%
New Milford Borough	2.32	0.26	0.25	11%	0.01	0%
North Arlington Borough	2.53	0.71	0.55	22%	0.16	6%
Northvale Borough	1.26	0.15	0.14	11%	0.01	1%
Norwood Borough	2.80	1.36	1.33	47%	0.03	1%
Oakland Borough	8.77	4.72	4.48	51%	0.25	3%
Old Tappan Borough	4.16	1.61	1.56	37%	0.05	1%
Oradell Borough	2.56	0.72	0.68	27%	0.04	2%
Palisades Park Borough	1.28	0.24	0.18	14%	0.06	4%
Paramus Borough	10.50	2.77	2.69	26%	0.08	1%
Park Ridge Borough	2.63	0.52	0.50	19%	0.01	0%
Ramsey Borough	5.57	1.83	1.75	31%	0.08	1%
Ridgefield Borough	2.85	1.01	0.63	22%	0.39	14%
Ridgefield Park Village	1.92	0.38	0.25	13%	0.14	7%
Ridgewood Village	5.80	0.94	0.93	16%	0.01	0%
River Edge Borough	1.88	0.32	0.31	17%	0.01	1%
River Vale Township	4.31	1.56	1.51	35%	0.05	1%
Rochelle Park Township	1.03	0.17	0.17	16%	0.00	0%
Rockleigh Borough	1.01	0.75	0.75	74%	0.00	0%
Rutherford Borough	2.89	0.68	0.21	7%	0.48	17%
Saddle Brook Township	2.75	0.51	0.48	18%	0.03	1%
Saddle River Borough	4.96	4.39	4.35	88%	0.04	1%
South Hackensack Township	0.74	0.11	0.06	8%	0.05	6%
Teaneck Township	6.24	1.23	1.06	17%	0.17	3%
Tenafly Borough	4.56	1.81	1.81	40%	0.00	0%
Teterboro Borough	1.12	0.10	0.08	7%	0.01	1%
Upper Saddle River Borough	5.27	1.53	1.49	28%	0.04	1%
Waldwick Borough	2.07	0.31	0.30	15%	0.01	0%

Jurisdiction	Total Land Area (sq. mi.)	Total Land Area of Wildfire Hazard Area (sq. mi.)	Total Land Area in Moderate and Low Areas (sq. mi.)	% of Total Land Area in Moderate and Low Areas	Total Land in Extreme, Very High, and High Areas (sq. mi.)	% of Total Land Area in Extreme, Very High, and High Areas
Wallington Borough	1.05	0.10	0.09	9%	0.01	1%
Washington Township	3.00	0.77	0.76	25%	0.01	0%
Westwood Borough	2.30	0.45	0.43	18%	0.03	1%
Woodcliff Lake Borough	3.55	0.82	0.76	22%	0.06	2%
Wood-Ridge Borough	1.11	0.10	0.08	7%	0.02	2%
Wyckoff Township	6.65	1.26	1.22	18%	0.05	1%
Bergen County Total	239.83	87.34	80.03	33%	7.31	3%

Source: NJDEP

Figure 4.13-2 Wildfire Urban Interface Risk in Bergen County



SOURCE: NJFFS, 2010

The magnitude or severity of wildfires depends on weather and human activity. NJFFS uses two indices to measure and monitor dryness of forest fuels and the possibility of fire ignitions becoming wildfires. The State HMP notes that these indices include the National Fire Danger Rating System's Buildup Index, and the Keetch-Byram Drought Index. Both are used for fire preparedness planning, which includes the following: campfire and burning restrictions, fire patrol assignments, staffing of fire lookout towers, and readiness status for both observation and firefighting aircraft.

The Buildup Index (BUI) is a number that reflects the combined cumulative effects of daily drying and precipitation in fuels with a 10-day time lag constant. The BUI can represent three to four inches of compacted litter or can represent up to six inches or more of loose litter.[35]

The Keetch-Byram Drought Index (KBDI) is a drought index designed for fire potential assessment as defined by the United States Department of Agriculture Forest Service. It is a number representing the net effect of evapotranspiration and precipitation in producing cumulative moisture deficiency in deep duff and upper soil layers. The index increases each day without rain and decreases when it rains. The scale ranges from zero (no moisture deficit) to 800 (maximum drought possible). The Florida Forest Service states that the range of the index is determined by assuming that 8 inches of moisture in a saturated soil is readily available to the vegetation. For different soil types, the depth of soil required to hold eight inches of moisture varies. A prolonged drought influences fire intensity, largely because more fuel is available for combustion. The drying of organic material in the soil can lead to increased difficulty in fire suppression.

There are also many other scales and fire weather indices that evaluate wildfire *potential* on any given day considering factors such as daily weather and vegetation condition information, fuel moisture, fuel hazard, moisture content in the lower atmosphere, etc.

Previous Occurrences and Losses

The New Jersey State HMP outlines the history of wildfire events in New Jersey but includes only events that are considered “major” (burning a total of greater than 100 acres) or “significant” wildfires. Of those major wildfires listed throughout the state, none affected Bergen County, and the county has no reported wildfire events impacting burned acreage or causing injury or death. According to the NOAA NCEI Events Database, no events of wildfire have been reported since records began in 1950.

Probability of Future Occurrences

The likelihood of wildfires is difficult to predict in a probabilistic manner. The probability of future wildfires depends on local weather conditions; outdoor activities like camping, burning debris, and construction; and the degree of cooperation with fire prevention measures. Although Bergen County’s fire risk has historically been low, given the numerous factors that can impact wildfire potential, the likelihood of a fire event starting and sustaining itself should be gauged by professional fire managers daily.

[35] North Carolina Forest Service. 2009. “What is the Buildup Index.” May 15. On-Line Address: http://www.ncforestservice.gov/fire_control/pdf/technotes/FDTN03.pdf

Potential Effects of Climate Change

Fire is determined by climate variability, local topography, and human intervention. Hot, dry spells create the highest fire risk. Increased temperatures may intensify wildfire danger by warming and drying out vegetation. When climate alters fuel loads and fuel moisture, this changes the forest susceptibility to wildfires. Climate changes also may increase winds that spread fires. Faster fires are harder to contain and thus are more likely to expand into residential neighborhoods[36].

Although Bergen County is not considered a high-risk wildfire region, climate change could increase the frequency and severity of brush fires and urban-interface fires, particularly in the northern wooded communities of Bergen including Mahwah and Oakland. Warmer temperatures, longer dry periods, and changes in vegetation patterns may contribute to more favorable wildfire conditions. Even small-scale fires can pose threats to homes, air-quality, and ecosystems, especially during prolonged summer heat and drought conditions.

Vulnerability Assessment

Built Environment, Infrastructure, and Community Lifelines

Wildfire risk in Bergen County is generally low to moderate, with higher vulnerability concentrated in the northwestern and northern municipalities where forested areas, open space, and the wildland-urban interface are more prominent. Communities such as Mahwah, Oakland, Ramsey, Franklin Lakes, and Upper Saddle River include residential development near forest preserves, county parks, and steep wooded slopes which can serve as fuel for fires, especially during dry seasons or periods of drought.

Although large, destructive wildfires are rare in the county, the built environment in these edge communities is vulnerable to brush fires, particularly in areas where homes are built into wooded areas without adequate defensible space or fire-resistant construction. Roofing materials, wooden decks, and fencing can provide ignition points even in small-scale fire events.

Infrastructure impacts from wildfire in Bergen County are typically localized but may include disruption to power lines, road closures, and telecommunication interruptions. Narrow or winding roads in hillier communities can impede emergency access or evacuation efforts during a fire. Firefighting access may be limited in more remote areas of Bergen County parks or preserved lands, placing additional strain on local emergency services during dry and windy conditions.

Table 4.13-2 Expected Annualized Losses from Wildfire by Jurisdiction shows expected annualized losses for the wildfire hazard for municipalities within Bergen County. This data was derived from FEMA's NRI. Expected EAL represents the average economic loss in dollars resulting from natural hazards each year. The table includes EAL for buildings as well as total EAL which includes building damage as well as damage to agriculture and population equivalency (the monetized cost of injury and fatality).

Table 4.13-2 Expected Annualized Losses from Wildfire by Jurisdiction

Municipality	Expected Annual Losses (Building)	Expected Annual Losses (Total)
Allendale Borough	$0.00	$0.00
Alpine Borough	$1.23	$1.24
Bergenfield Borough	$348.90	$356.13
Bogota Borough	$97.41	$99.82
Carlstadt Borough	$1,676.28	$1,676.39
Cliffside Park Borough	$171.21	$174.82
Closter Borough	$305.94	$308.56
Cresskill Borough	$73.00	$73.44
Demarest Borough	$0.00	$0.00
Dumont Borough	$373.16	$381.82

[36] Michael Baker International. 2019. State of New Jersey 2019 All-Hazards Mitigation Plan

Municipality	Expected Annual Losses (Building)	Expected Annual Losses (Total)
East Rutherford Borough	$581.35	$581.35
Edgewater Borough	$142.36	$144.71
Elmwood Park Borough	$0.00	$0.00
Emerson Borough	$77.02	$78.90
Englewood City	$145.98	$147.95
Englewood Cliffs Borough	$110.67	$111.22
Fair Lawn Borough	$258.30	$263.97
Fairview Borough	$0.00	$0.00
Fort Lee Borough	$361.22	$370.40
Franklin Lakes Borough	$0.00	$0.00
Garfield City	$0.00	$0.00
Glen Rock Borough	$0.00	$0.00
Hackensack City	$89.97	$90.55
Harrington Park Borough	$0.00	$0.00
Hasbrouck Heights Borough	$0.00	$0.00
Haworth Borough	$0.00	$0.00
Hillsdale Borough	$239.04	$242.93
Ho-Ho-Kus Borough	$66.92	$67.28
Leonia Borough	$386.35	$392.22
Little Ferry Borough	$179.01	$182.34
Lodi Borough	$0.00	$0.00
Lyndhurst Township	$3,976.03	$4,002.91
Mahwah Township	$184.49	$186.04
Maywood Borough	$106.61	$108.30
Midland Park Borough	$0.00	$0.00
Montvale Borough	$107.01	$108.55
Moonachie Borough	$65.33	$65.33
New Milford Borough	$384.34	$392.60
North Arlington Borough	$133.76	$135.93
Northvale Borough	$186.59	$189.31
Norwood Borough	$2.91	$2.95
Oakland Borough	$66.40	$66.69
Old Tappan Borough	$31.22	$31.47
Oradell Borough	$119.56	$121.48
Palisades Park Borough	$134.77	$137.07
Paramus Borough	$534.97	$539.21
Park Ridge Borough	$0.00	$0.00
Ramsey Borough	$50.82	$51.32
Ridgefield Borough	$0.00	$0.00
Ridgefield Park Village	$0.00	$0.00
Ridgewood Village	$258.85	$261.55
River Edge Borough	$423.35	$428.41
River Vale Township	$125.61	$127.18
Rochelle Park Township	$73.15	$74.83
Rockleigh Borough	$16.01	$16.24
Rutherford Borough	$169.80	$172.34
Saddle Brook Township	$0.00	$0.00
Saddle River Borough	$0.00	$0.00
South Hackensack Township	$41.14	$41.32
Teaneck Township	$402.21	$407.50
Tenafly Borough	$491.27	$496.18
Teterboro Borough	$0.00	$0.00
Upper Saddle River Borough	$105.78	$106.30
Waldwick Borough	$78.18	$79.73
Wallington Borough	$0.00	$0.00
Washington Township	$0.00	$0.00
Westwood Borough	$186.45	$189.71
Wood-Ridge Borough	$336.39	$337.84
Woodcliff Lake Borough	$130.48	$132.84
Wyckoff Township	$95.04	$95.49

Municipality	Expected Annual Losses (Building)	Expected Annual Losses (Total)
Bergen County Total	**$14,704.57**	**$14,854.65**

Population and Economy
Population vulnerability to wildfire in Bergen County is largely concentrated in suburban and rural areas near wooded landscapes. Residents in communities such as Mahwah, Saddle River, and Oakland are at higher risk due to proximity to forested lands and a higher prevalence of single-family homes on larger, vegetated lots. While population density in these areas is relatively low, the spread-out development pattern increases exposure and complicates evacuation or emergency response during fire events.

Vulnerable groups include:

- Elderly residents or those with limited mobility living in more isolated or less accessible properties.
- Homeowners without adequate fire protection measures or insurance coverage.

Those living in structures with flammable building materials or landscaping that does not meet fire-safe guidelines. The economic impact of wildfires in Bergen County is generally limited to localized damage and emergency response costs, but even small-scale fires can result in property loss, temporary displacement, and costly fire-suppression efforts. Recreation-based economic activity in county parks or nature centers, such as Campgaw Mountain Reservation or Ramapo Valley County Reservation, may be disrupted by fire incidents or smoke-related closures. Repeated events could also reduce real estate values in high-risk zones over time.

Ecosystems and natural Assets
Wildfire can have both damaging and regenerative effects on Bergen County's ecosystems, depending on fire severity and frequency. Natural areas such as the Ramapo Mountains, Palisades Forest, and portions of the Highlands Region contain fire-adapted ecosystems, but intense or unplanned fires can result in habitat loss, tree mortality, and disruption of ecological succession.

Brush fires and forest fires may threaten biodiversity in Bergen by threatening nesting areas, wildlife corridors, and understory vegetation. Invasive species can gain a foothold in recently burned areas, altering habitat composition and resilience. Post-fire erosion is a concern on steep slopes in Bergen County and can increase sedimentation into waterways and degrade water quality, a particular concern in watersheds which provide public drinking water.

Additionally, increased development pressure along the wildland-urban interface (see **Figure 4.13-22**) can fragment ecosystems and limit the natural role of low-intensity fires in maintaining ecological balance, while also increasing human-caused ignition sourced such as outdoor burns and downed utility lines.

HUMAN-MADE HAZARDS

4.14 CYBER ATTACK

Hazard Description

Cyber terrorism is the use of existing computers and information, particularly over the Internet, to cause physical or financial harm or a severe disruption of infrastructure service. Transportation, public safety, and utility services are all critical, and are highly dependent on information technology. The motive behind such disruptions can be driven by religious, political, or other objectives.

Location, Extent and magnitude

Cyber threats to critical infrastructures can be posed by anyone with the capability, technology, opportunity, and intent to do harm. Potential threats can be foreign or domestic, internal or external, State-sponsored or a single rogue element. Terrorists, insiders, disgruntled employees, and hackers are included in this profile. The fact that most of the nation's vital services are delivered by private companies creates a significant challenge in assigning the responsibility for protecting our critical infrastructures from cyber-attacks. Across Bergen County, countless systems rely on computers for day-to-day operations including but not limited to traffic signals, power plants, HVAC systems, as well as systems responsible for ensuing Bergen County's local governments can operate. While these are just a few examples of critical systems vulnerable to cyber-attacks, it should be noted that an attack could cripple not only the operations of Bergen County's systems but also the economy.

The magnitude of extent of an incident will vary greatly based on the extent and duration of the impact. Additionally, the extent will vary based upon which specific system is affected by an attack, the warning time, and ability to preempt an attack.

Previous Occurrences and Losses

Cyber terrorism is an emerging hazard that can impact the County's computer infrastructure and the systems and services that are provided to the public. Across the United States, concerns over cyber terrorism are growing; former FBI director Louis Freeh warns that cyber-terrorism could have a crippling effect in the United States (ANI, 2013).

In 2016, New Jersey began releasing annual statistics on cyber breaches for the first time. The information released details breaches that involve unauthorized access to personal information, such as a name, social security number, driver's license number, bank account, etc. The State police had 28,145 data breaches reported to them in 2024, up from 26,951 in 2023. In addition, during 2024, 105 public and private organizations in New Jersey were victims of ransomware attacks.

Table 4.14-1 Recent Cyber Attacks on Bergen County Municipalities lists some of the recent cyber-attacks that have affected Bergen County municipalities.

Table 4.14-1 Recent Cyber Attacks on Bergen County Municipalities

Date(s) of Event	Event Type	Description
12/23/2018	Virus	Computer virus infected Oakland Borough administrative systems.
Jan-19	Ransomware	Elmwood Park targeted in a cyberattack that infiltrated municipal government computer system. Attack temporarily shut down portions of borough network. Forensic team is investigating the matter.
Jan-19	Cyber-attack	Fair Lawn experienced a cyber attack.
2/1/2019	Fraud	The Borough of Palisades Park lost $460,000 as a result of a fraudulent wire transfer at Mariner's Bank. It's believed the theft is related to a hacking attack on the borough's computer systems, not a bank breach. The borough received a $200,000 advancement on its insurance claim.
2021	Ransomware	Little Ferry Borough experienced a ransomware cyber-attack. The borough ended up paying the ransom as they felt they didn't have a choice.

Source: northjersey.com

Probability of Future Occurrences

Security experts describe the threat of cyber terrorism as eminent and highly likely to occur in any given year in New Jersey. As illustrated by the Freeh comments, cyber terrorism is expected to have a significant impact on the United States and New Jersey. The level of success of an attack and the subsequent damage it can create will vary greatly. Intrusion detection systems log thousands of attempts in a single month.

Vulnerability Assessment

A cyber-attack can have potentially severe consequences. The following are potential impacts.

Table 4.14-2 Cyber Attack Impact Summary

Consideration	Description
General Public	No direct loss of life is expected from an attack. Indirect injuries or deaths may result from secondary effects to critical life-sustaining resources such as energy and water.
Response Personnel	No direct affects to the health and safety of response personnel are expected; however, critical response systems may be affected.
Property, Facilities and Infrastructure	Effects can range from annoyance to complete shutdown of critical infrastructures caused by infiltration of supervisory control and data acquisition (SCADA) systems. Secondary effects could disturb public welfare and property by denying services or providing false readings.
Economic	Because of the heavy reliance on the electronic transfer of economic and commercial information, the economy could be affected by communication difficulties.
Environment	Generally, cyber terrorism has no direct effect on the environment; however, the environment may be affected should a release of a hazardous material occur because of critical infrastructure failure.
Continuity of Operations	Severe effects to continuity of operations could result if a cyber-attack reached critical operational systems or systems that were needed to carry out the operation.
Reputation of the Entity	If exposed vulnerabilities were known and not reduced or eliminated before the attack, the entity would suffer major damage to their reputation for not taking action before the incident.
Delivery of Services	Cyber-attacks may affect delivery of services if the system was infiltrated and directed to malfunction by self-destructing or overloading.
Regulatory and Contractual Operations	Cyber-attacks would have no significant effect on regulatory or contractual obligations, other than the possible elimination of electronic records, which would affect both.

A cyber terrorism attack can occur with relatively little or no warning. The New Jersey Office of Homeland and Preparedness is charged with gathering intelligence and monitoring cyber-terrorism threats affecting the State. At the Federal level, numerous agencies (such as FBI and CIA) are working collaboratively to thwart cyber-terrorism attacks. The warning time depends upon the ability of these agencies to recognize that a threat exists and their ability to stop the attack. Even with these agencies on task to monitor cyber threats, a cyberattack can occur with no warning.

Because virtually all critical systems are reliant upon computer systems, the secondary hazards that could result from a cyber-terrorism attack could be devastating. For example, many of New Jersey's roadway systems rely on sophisticated traffic control systems that prevent gridlock and accidents daily. Without these systems, the risk of not only auto accidents increases, but also hazardous materials in-transit incidents. Additionally, a cyber-attack on a nuclear power plant could have devastating consequences should the plant suffer an intentional catastrophic failure. A cyber-attack could also completely incapacitate the communications infrastructure not only in New Jersey but across the United States, leading to disturbing secondary consequences and hazards. Because the power grid is also largely controlled by computer systems, a widespread power outage is also a possibility. A failure of the power grid would impact individuals reliant on power such as those with medical needs. The number of critical systems reliant on computer systems are numerous, thus disruption of one or more of the systems would cause severe secondary-cascading hazards.

Exposure and Damages

For the purposes of this Plan, the entire population of New Jersey is considered exposed to the effects of a cyber-terrorism attack. Because it is difficult to predict the particular target of cyber terrorism, assessing vulnerability to the hazard is also difficult. All populations who directly use a computer or those receiving services from automated systems are vulnerable to cyber terrorism. Although all individuals in New Jersey are vulnerable to an attack, certain types of attacks would impact specific segments of the population.

If the cyber-attack targeted the State's power or utility grid, individuals with medical needs would be impacted the greatest. These populations are most vulnerable because many of the life-saving systems they rely on require power. Also, if an attack occurred during months of extreme hot or cold weather, New Jersey's elderly population (those 65 years of age and older) would be vulnerable to the effects of the lack of climate control. These individuals would require shelter or admission to a hospital. Other populations vulnerable to the secondary effects of cyber terrorism are young children.

If a cyber-attack targeted a facility storing or manufacturing hazardous materials, individuals living adjacent to these facilities would be vulnerable to the secondary effects, should the attack successfully cause a critical failure at that facility. Individuals living within 10 miles of a nuclear power plant would be vulnerable should an attack occur at that caused a failure at a facility.

While these examples illustrate the vulnerability of specific populations to cyber-attacks, it is important to reiterate that because of the reliance on computerized systems, the entire population of New Jersey is vulnerable to cyber terrorism.

The County seat, the City of Hackensack, is particularly vulnerable due to the concentration of County buildings there. The sensitive data housed on the computer networks in County and municipal buildings are highly vulnerable to this hazard.

A significant portion of Bergen County's economy is exposed to the effects of cyber-terrorist attacks. Cyber-crimes against banks and other financial institutions can cost many hundreds of millions of dollars every year. Cyber theft of intellectual property and business-confidential information can cost developed economies billions of dollars—how many billions is an open question. These losses could be considered simply the cost of doing business, or they could be a major new risk for companies and nations as these illicit acquisitions damage global economic competitiveness and undermine technological advantage (McAfee, 2013).

The cost of malicious cyber activity involves more than the loss of financial assets or intellectual property. Cyber-crimes can cause damage to a company's brand and reputation, consumer losses from fraud, the opportunity costs of service disruption and "cleaning up" after cyber incidents, and the cost of increased spending on cybersecurity (McAfee, 2013).

In the United States, the costs of cyber terrorism is estimated somewhere between $24 billion and $120 billion annually. These costs represent approximately 0.2% to 0.8% of the total GDP in the United States (McAfee, 2013).

Critical facilities are vulnerable to cyber-terrorism attacks based on the significance of the facilities, and the potential to interrupt critical systems in the County. As previously mentioned, many critical facilities are reliant upon computer networks to monitor and control critical functions. An example is nuclear power plants, which rely on sophisticated networks to prevent catastrophic failure. A cyber-terrorist attack could result in catastrophic failure of one of these facilities. Likewise, the power grid is reliant upon computer systems to distribute power to the County. An attack could disrupt power to millions of New Jersey residents. These are just two examples of how critical facilities are vulnerable to cyber-terrorism attacks. Given the importance of critical facilities to daily living activities, these facilities are highly vulnerable to cyber-terrorism attacks.

4.15 PANDEMIC

Hazard Description

A pandemic is a global outbreak of disease. Pandemics happen when a new virus emerges to infect people and can spread between people sustainably. Because there is little to no pre-existing immunity against the new virus, it spreads worldwide. Conversely, an epidemic is much more limited in effect and impact and is usually restricted to one locale (U.S. Centers for Disease Control and Prevention [CDC], 2020).

In New Jersey, a municipality in which a pandemic occurs bears the first and primary responsibility to control the epidemic. Pandemics that remain uncontrolled warrant local mutual aid from neighboring municipal and/or County and State resources. If the epidemic remains beyond the capabilities of local law enforcement agencies alone, limited State Police assistance may be requested. If the restoration of public health is beyond local, County, and State abilities, the Governor may declare a state of emergency calling on Federal and worldwide support.

This section discusses some of the most severe global disease outbreaks that affected New Jersey within the last 100 years.

Coronavirus

Three versions of the coronavirus have affected New Jersey in the last two decades; Severe Acute Respiratory Syndrome (SARS-CoV), Middle East Respiratory Syndrome (MERS-CoV), and “SARS-CoV-2” also named Coronavirus Disease 2019 (COVID-19). Coronaviruses are a large family of viruses that are common in people and many different species of animals, including camels, cattle, cats, and bats. Animal coronaviruses can infect people and then spread between people, which is how SARS, MERS, and COVID-19 originated (CDC, 2020).

SARS was first reported in Asia in February 2003 and spread to more than two dozen countries in North America, South America, Europe, and Asia before the SARS global outbreak of 2003 was contained. SARS causes mild to moderate upper respiratory tract illness in humans, including the common cold. No single medicine can effectively treat SARS. Different types of treatment regimens have been used for people who are severely ill and hospitalized including antibiotics, antivirals and steroids. Currently, there is no known SARS transmission anywhere in the world (CDC, 2020).

MERS was first reported in Saudi Arabia in September 2012, however after further investigation, the first known cases of MERS occurred in Jordan in April 2012. Most MERS patients developed severe respiratory illness with symptoms of fever, cough and shortness of breath. About 3 or 4 out of every 10 patients reported with MERS have died (CDC, 2020).

Coronavirus disease 2019, also known as COVID-19, is a very contagious disease caused by the virus SARS-CoV-2. When a person infected with COVID-19 breathes, droplets and very small particles that contain the virus can spread and infect other around them. COVID-19 can also spread through droplets and particles that land on people’s eyes, nose, or mouth or when people touch contaminated surfaces. Once infected, people may first notice symptoms 2-14 days after being exposed to the virus. People infected with COVID-19 most commonly experience respiratory cold- and flu-like symptoms, although the disease may affect other parts of the body (CDC, 2023a).

Foodborne Disease Outbreaks

Food-borne illness is caused by consuming contaminated foods or beverages. Many different disease-causing microbes or pathogens can contaminate foods, so there are many different types of food-borne illnesses. Food-borne illness, caused by a variety of bacteria, viruses, and parasites, can be caused by consuming improperly prepared food items, poor hygiene among food handlers, or contamination in food processing facilities or farms. (NJDOH, 2020).

Mumps

Mumps is a contagious disease that is caused by a virus. It typically starts with a few days of fever, headache, muscle aches, tiredness, and loss of appetite (CDC, 2020).

Norovirus

Norovirus is a very contagious virus that spreads easily and causes vomiting and diarrhea in people. People with norovirus illness can shed billions of norovirus particles however only a few virus particles can make other people sick. The norovirus is not related to Influenza. (CDC, 2020).

Influenza

Influenza, known as the flu, comes in four type of viruses: A, B, C and D. Human influenza A and B viruses cause seasonal epidemics of disease (known as the flu season) almost every winter in the United States. Influenza A viruses are the only influenza viruses known to cause flu pandemics. Pandemics happen when new (novel) influenza A viruses emerge which are able to infect people easily and spread from person to person in an efficient and sustained way (CDC, 2020).

West Nile Virus

West Nile Virus is the leading cause of mosquito-borne disease in the continental United States. There are no vaccines to prevent or medications to treat the virus in people. Fortunately, most people infected do not feel sick. About 1 in 5 people who are infected develop a fever and other symptoms. About 1 out of 150 infected people develop a serious, sometimes fatal, illness (CDC, 2020).

Zika Virus

Zika Virus disease is caused by the Zika virus, which is spread to people primarily through the bite of an infected mosquito. The illness is usually mild with symptoms lasting up to a week, and many people do not have symptoms or will have only mild symptoms. However, Zika virus infection during pregnancy can cause a serious birth defect called microcephaly and other severe brain defects (CDC, 2020).

Location and Extent

Compared to epidemics which occur in a smaller geographic area, pandemics affect larger areas and populations. The exact location and extent of a pandemic depends on how easily the illness is spread, the mode of transmission, and the amount of contact between infected and uninfected individuals, Pandemics can occur anywhere including Bergen County. Bergen County may be more vulnerable to pandemic than other areas in the country due to geographic and demographic factors such as the comparatively dense population. Additional factors such as vaccination rates influence the ability of the illness to spread.

Location, Extent and Magnitude

The severity of a pandemic or infectious disease threat in New Jersey will range significantly depending on the aggressiveness of the virus in question and the ease of transmission. Pandemics around the nation have the potential to affect New Jersey's populated areas.

The CDC and Prevention Community Strategy for Pandemic Influenza Mitigation guidance introduced a Pandemic Severity Index (PSI), which uses the case fatality ratio as the critical driver for categorizing the severity of a pandemic. The index is designed to estimate the severity of a pandemic on a population to allow better forecasting of the impact of a pandemic, and to enable recommendations on the use of mitigation interventions that are matched to the severity of influenza pandemic.

The severity and length of the next pandemic cannot be predicted; however, experts expect that its effect on the United States could be severe. Based on previous pandemics and without medications or vaccines available, it is estimated that a severe pandemic could cause almost 2 million deaths in the United States, more than nine million hospitalizations, and more than 90 million people ill (NJDOH, 2012). Pandemics are assigned to one of five discrete categories of increasing severity (Category 1 to Category 5) (NJDOH, 2017).

Pandemics are inevitable and arrive with very little warning. Air travel could hasten the spread of a new virus and decrease the time available for implementing interventions. Outbreaks are expected to occur simultaneously throughout much of the United States, preventing shifts in human and material resources. Warning time for any pandemic will depend on the origin of the virus and the amount of time needed to identify the virus.

In Bergen County, approximately 91.0% of children in Childcare, Pre-K, Kindergarten, and Grade 6 were immunized during the 2023-2024 school year, on par with the average of 91.9%. This number is down from 94.9% during the 2022-2023 school year, following a general decreasing trend since the last plan update (Annual Immunization Status Reports, Communicable Disease Service, New Jersey Department of Health). Of the approximately 9% of non-immunized children, approximately 3.9% claimed a Religious Exemption, up from 3.2% during the 2022-2023 school year. Only 0.2% of enrolled children claimed a medical exemption during the 2023-2024 school year (Annual Immunization Status Reports, Communicable Disease Service, New Jersey Department of Health).

Previous Occurrences and Losses

Table 4.15 - 1 Previous Pandemic Occurrences provides details on pandemic events that have impacted New Jersey.

Table 4.15-1 Previous Pandemic Occurrences

Date(s) of Event	Event Type	Area Affected	Description
1918-1919	1918 “Spanish” Influenza Pandemic	Statewide	The influenza pandemic of 1918-1919 caused between 20 and 40 million deaths, more than World War I. This pandemic has been cited as the most devastating pandemic in recorded history. More people died of influenza in a single year than in the four years of the Black Death Bubonic Plague from 1347 to 1351. By September 27, 1918, the State health officer announced that the disease “was unusually prevalent” throughout New Jersey. The State was reporting that 2,000 cases had been reported in the preceding three days. On October 10, State officials formally banned all public gatherings. By October 15, officials had reported 88,256 cases of influenza. By the October 22, State authorities estimated that there were at least 149,540 cases, with 4,398 deaths being officially reported. On October 22, the pandemic peaked in New Jersey. On that day, there were 7,449 new cases and 366 deaths. The situation slowly improved after the third week of October.
1999-2002	West Nile Virus Outbreak	Statewide	WNV was identified in New York City in 1999, and spread rapidly across the United States, with human disease documented in 39 states and the District of Columbia. In 2002, WNV spread westward and activity was reported in all but six states (Arizona, Utah, Nevada, Oregon, Alaska, and Hawaii) and triggered the largest human arboviral encephalitis epidemic in U.S. history. From June 10 to December 31, 2002, there were 4,156 cases of WNV (including 284 deaths) reported in 39 states and the District of Columbia.
2002-2003	SARS coronavirus (SARS-CoV)	Statewide	SARS coronavirus (SARS-CoV) – virus identified in 2003. SARS-CoV is thought to be an animal virus from an as-yet-uncertain animal reservoir, perhaps bats, that spread to other animals (civet cats) and first infected humans in the Guangdong province of southern China in 2002. SARS affected 26 countries and resulted in more than 8,000 cases in 2003. Since then, a small number of cases have occurred as a result of laboratory accidents or, possibly, through animal-to-human transmission (WHO, 2020)
04/15/2009	Global H1N1 Pandemic	Statewide	The first novel H1N1 patient in the United States was confirmed April 15, 2009. The second patient was confirmed on April 17, 2009. On April 22, the CDC activated its Emergency Operations Center to better coordinate the public health response. On April 26, 2009, the U.S. government declared a public health emergency and began actively and aggressively implementing the country’s pandemic response plan. By June 19, 2009, all 50 states in the United States reported novel H1N1 infection. On June 11, 2009, the WHO signaled that a global pandemic of H1N1 was underway by raising the worldwide pandemic alert level to Phase 6. At the time, more than 70 countries had reported cases of novel influenza A (H1N1) infection. In total there were 18,306 lab-confirmed deaths as a result of H1N1 worldwide. In the United States between April 2009 and August 2009 there were 9,079 cases that required

Date(s) of Event	Event Type	Area Affected	Description
			hospitalization and 593 deaths. In New Jersey, cases were widespread in July 2009, with 1,414 confirmed cases and 15 deaths.
January – 2/1/2011	Escherichia coli O157:H7	N/A	Between January 10 and February 15, 2011, a total of 14 persons were infected with the outbreak strain of Escherichia coli O157:H7 were reported in five states, including two reports in New Jersey. Three of the 14 were hospitalized; no deaths occurred. The outbreak was associated with Lebanon bologna.
February – September 2011	Salmonella Heidelberg	N/A	Between February 27 and September 13, 2011, a total of 136 persons infected with the outbreak strain of Salmonella Heidelberg were reported from 34 states, including one report in New Jersey. Ill persons ranged in age from less than one year old to 90years old. Thirty-seven people were hospitalized; one death was reported.
April – November 2011	Salmonella Heidelberg	N/A	Between April 1 and November 17, 2011, a total of 190 illnesses occurred due to Salmonella Heidelberg that was linked to kosher broiled chicken livers. Sixty-two of those illnesses were reported in New Jersey. Ill person's ages ranged from less than 1 year old to 97 years old. Thirty of the infected people were hospitalized.
8/1/2011	Salmonella Enteritidis	N/A	A total of 43 individuals infected with the outbreak strain of Salmonella Enteritidis were reported from five states, including two cases in New Jersey. Ill persons ranged in age from less than one year old to 94 years old. Two patients were hospitalized; no deaths occurred. The outbreak was linked to Turkish pine nuts purchased from bulk bins at Wegmans grocery stores.
January – June 2012	Salmonella Infantis	N/A	Between January 4 and June 26, 2012, a total of 49 individuals (human) were infected with the outbreak strain of Salmonella Infantis linked to multiple brands of dry dog food produced by Diamond Pet Foods produced at a facility in Gaston, South Carolina. Ten people were hospitalized; there were no deaths. Twenty states reported an outbreak, including two cases in New Jersey. Ill persons ranged in age from less than 1 year old to 82 years old.
January – July 2012	Salmonella Bareilly and Salmonella Nchanga	N/A	Between January 1 and July 7, 2012, a total of 425 individuals were infected with the outbreak strain of Salmonella Bareillyand Salmonella Nchanga. Twenty-eight states reported outbreaks, included 46 cases in New Jersey. The outbreaks were associated with an imported frozen raw yellowfin tuna product, known as Nakaochi Scrape, from Moon Marine USA Corporation. Ill persons ages ranged from less than 1 year old to 86 years old.
March-September 2012	Salmonella Infantis, *Salmonella* Newport, and *Salmonella* Lille	N/A	Between March 1 and September 24, 2012, a total of 195 individuals were infected with the outbreak strain of Salmonella Infantis, Salmonella Newport, and Salmonella Lille. Twenty-seven states reported an outbreak, including five cases in New Jersey. The outbreak was linked to chicks, ducklings, and other live poultry from Mt. Healthy Hatchery in Ohio. Ill persons ranged in age from less than 1 year old to 100 years old.
March-October 2012	Listeria monocytogenes Outbreak	N/A	Between March 28 and October 6, 2012, a total of 22 individuals were infected with the outbreak strain of Listeria monocytogenes. Ricotta salata cheese was the likely source of this outbreak. Thirteen states reported an outbreak, including three cases in New Jersey. Twenty of the persons infected were hospitalized, nine were related to pregnancy, and three were diagnosed in newborns. The others ranged from 30 years old to 87 years old.
June-September 2012	Salmonella Bredeney	N/A	Between June 14 and September 21, 2012, a total of 42 individuals were infected with the outbreak strain of Salmonella Bredeney. The outbreak was linked to Trader Joe's Valencia Peanut Butter. Twenty states reported an outbreak, including two cases in New Jersey. Ill persons ranged in age from less than 1 year old to 79 years old, with a median age of 7 years old.
July-September 2012	Salmonella Braenderup, *Salmonella* Typhimurium and Newport	N/A	Between July 3 and September 1, 2012, a total of 127 individuals were infected with the outbreak of Salmonella Braenderup linked to mangoes originating from Agricola Daniella of Sinaloa, Mexico. Fifteen states reported an outbreak, including one case in New Jersey. Ill persons ranged in age from less than 1 year old to 86 years old. Between July 6 and September 16, 2012, a total of 261 individuals were infected with the outbreak of Salmonella Typhimurium and Newport linked to cantaloupe originating from Chamberlain Farms Produce in Owensville, Indiana. Twenty-four states reported an outbreak, including two cases in New Jersey. Ill persons ranged from less than one year old to 100 years old.

Date(s) of Event	Event Type	Area Affected	Description
2012	West Nile Virus Outbreak	Statewide	During the summer-fall months of 2012, the worst WNV outbreak in the United States occurred. As of December 11, 2012, 48 states reported WNV infections in people, birds, or mosquitoes. A total of 5,387 cases of WNV in people, including 243 deaths, have been reported to CDC. Of these, 2,734 (51%) were classified as neuroinvasive disease (such as meningitis or encephalitis) and 2,653 (49%) were classified as non-neuroinvasive disease. In New Jersey, there were 46 positive test results.
2012	Middle East Respiratory Syndrome (MERS)	Statewide	Health officials first reported the disease in Saudi Arabia in September 2012. Through retrospective (backward-looking) investigations, they later identified that the first known cases of MERS occurred in Jordan in April 2012. So far, all cases of MERS have been linked through travel to, or residence in, countries in and near the Arabian Peninsula. The largest known outbreak of MERS outside the Arabian Peninsula occurred in the Republic of Korea in 2015. The outbreak was associated with a traveler returning from the Arabian Peninsula (CDC, 2020).
July-October 2016	Zika Outbreak	Statewide	In August 2016 the number of Zika cases reported in New Jersey reached over 100. Two counties - Bergen and Passaic - accounted for more than a third of the cases statewide.
2019 Measles Outbreak	2019 Pacific Northwest measles outbreak	Statewide	The New Jersey Department of Health (NJDOH) and local health officials identified 33 cases of measles (30 confirmed cases in Ocean County and 3 connected cases in a Passaic County household) in an outbreak investigation lasting from October 2018 to January 2019.
January 2020- May 2023	Coronavirus Disease 2019 (COVID-19)	Statewide	The first confirmed case of COVID-19 in the U.S. was in Washington State on January 21, 2020; the first confirmed case in New Jersey was reported on March 4, 2020. From March 2020 to August 24, 2023, there have been 2,588,728 confirmed cases of COVID-19 in New Jersey. During that period, 172,973 people have been hospitalized with confirmed cases and 36,242 have died in deaths associated with COVID-19.

Sources: Billings 1997; DHHS 2013; CDC 2008; CDC 2009; WHO 2010; CDC 2011; Laday, 2012; Jaslow, 2012; Rochabrun, 2012; Rochabrun, Nj.com, 2016; 2012; CD C, 2018, CDC 2023a

Table 4.15-2 Communicable Disease Incidence in Bergen County depicts the number of Reportable Diseases along with the Number of Cases by Year from 2021-2023, as reported by the New Jersey Department of Health (NJDOH). Campylobacteriosis (food-borne disease), Chronic Hepatitis C, COVID-19, Influenza-Type A, Influenza-Type B, Lyme Disease, Non-Typhoid Salmonellosis (food-borne disease), Shiga Toxin-Producing E.Coli (STEC) - Non O157:H7 (food-borne disease), and Shigellosis (food-borne disease) had a number of cases in the triple- and quadruple-digits. The table and chart depict counts of communicable diseases in Bergen County through the years of 2021-2023.

Table 4.15-2 Communicable Disease Incidence in Bergen County, 2022-2023

Reportable Disease	2021	2022	2023	3-Year Total
Alpha-Gal Syndrome	0	2	3	5
Amoebiasis	16	5	9	30
Babesiosis	7	10	23	40
Botulism - Infant	2	1	1	4
Campylobacteriosis	210	269	329	808
Chikungunya	1	0	0	1
Creutzfeldt-Jakob Disease	1	0	0	1
Creutzfeldt-Jakob Disease – Sporadic	1	0	0	1
Cryptosporidiosis	15	32	36	83
Cholera – Non O1/O139	1	0	0	1
Cyclosporiasis	9	22	11	42
Dengue Fever- Dengue	0	2	8	10

Reportable Disease	2021	2022	2023	3-Year Total
Ehrlichiosis/Anaplasmosis Anaplasma Phagocytophilum (Previously HGE)	12	6	10	28
Ehrlichiosis/Anaplasmosis - Ehrlichia Chaffeensis (Previously HME)	4	1	1	6
Foodborne Intoications- Scombroid	0	1	0	1
Giardiasis	34	42	52	128
Haemophilus Influenzae	8	13	15	36
Hepatitis A	6	1	8	15
Hepatitus B – Acute	0	1	3	4
Hepatitis B - Chronic	51	52	34	137
Hepatitis C - Acute	8	3	3	14
Hepatitis C - Chronic	348	295	129	772
Influenza, Human Isolates - Type 2009 H1N1	1	257	501	759
Influenza, Human Isolates - Type A (Subtyping Not Done)	453	5544	2366	8363
Influenza, Human Isolates - Type A H3	113	1712	118	1943
Influenza, Human Isolates - Type B	20	91	669	780
Legionellosis	22	22	21	65
Listeriosis	6	6	11	23
Lyme Disease	270	424	499	1193
Malaria	3	3	9	15
Meningococcal Disease (Neisseria Meningitidis)	0	1	2	3
Mpox	0	71	4	75
Multisystem Inflammatory Syndrome (MIS)	0	6	0	6
Novel Coronavirus-2019 NCOV	119,125	139,531	33,256	291,912
Pertussis	17	33	51	101
Q Fever - Acute	1	0	0	1
Q Fever – Chronic	0	1	0	1
Salmonellosis - Non-Typhoid	127	140	157	424
Salmonellosis- Paratyphoid Fever	0	0	1	1
Shiga Toxin-Producing E.Coli (STEC)	0	64	85	149
Shiga Toxin-Producing E.Coli (STEC) - Non O157:H7	5	0	0	5
Shiga Toxin-Producing E.Coli (STEC) - O157:H7	1	3	2	6
Shigellosis	31	81	49	161
Streptococcus Agalactiae (GBS)	2	2	3	7
Streptococcus Pneumoniae	9	38	43	90
Streptococcus Pyogenes (GAS) - With Toxic Shock Syndrome	0	0	2	2
Streptococcus Pyogenes (GAS) - Without Toxic Shock Syndrome	13	13	39	65
Typhoid Fever	2	3	3	8
Vancomycin-Intermediate Staphylococcus Aureus (VISA)	0	1	0	1
Varicella	7	18	13	38
Vibrio Infections (Other Than V.Cholerae Spp.)	14	15	17	46
West Nile Virus (WNV)	4	3	4	11
Yersiniosis	6	2	2	10
Totals	120,987	148,843	38,602	308,432

SOURCE: COMMUNICABLE DISEASE REPORTING AND SURVEILLANCE SYSTEM, NEW JERSEY DEPARTMENT OF HEALTH, 2025

Probability of Future Occurrences

It is difficult to predict when the next pandemic will occur and how severe it will be because viruses are always changing. The United States and other countries are constantly preparing to respond to pandemic. The Department of Health and Human Services and others are developing supplies of vaccines and medicines. Severity of the threat of pandemic is likely to increase. Factors, such as expanded rapid travel and evolution of resistance to medical treatments, are already changing the ways pathogens infect people, plants, and animals.

In Bergem County, the probability for a future pandemic event is dependent on several factors. One factor that influences the spread of disease is population density. Populations that live close to one another are more likely to spread diseases. As population density increases in the State, so too will the probability of a pandemic event occurring. As seen in the COVID-19 pandemic, the State advised people to practice social distancing of at least six feet from other people to minimize the spread of the virus.

As previously shown, Bergen Count saw an increase in unvaccinated school age children from the 2022-2023 school year to the 2023-2024 school year. Bergen County should be advised that a growing unvaccinated community could decrease the County's herd immunity and increase the probability of an outbreak should this trend continue.

Potential Effects of Climate Change

Climate change has the potential to increase the probability of pandemic occurring. While the relationship between climate change and increase in virus susceptibility is difficult to predict with certainty, there are scientific linkages between the two. As warm habitats that host insects such as mosquitoes increase, more of the population becomes exposed to potential virus threats (The Washington Post, 2017). The notion that rising temperatures will increase the number of mosquitoes that can transmit diseases such as West Nile Virus and Zika among humans (rather than just shift their range) has been the subject of debate over the past decade. Milder winters can also lead to increasing tick populations and increase in risk of contracting Lyme disease. Some believe that climate change may affect the spread of disease, while others are not convinced. However, many researchers point out that climate is not the only force at work in increasing the spread of infectious diseases into the future.

Vulnerability Assessment

Bergen County's entire population is vulnerable to the effects of a pandemic. Areas with higher population density are more prone to being exposed to a virus. Additionally, vulnerable populations such as the young and elderly are considered higher risk. The most significant impact on critical facilities would be the increase in hospitalization and emergency room visits that would take place as a result of the outbreak. This would create a greater demand on these critical facilities, their staff, and resources. CDC's model estimates an increase of more than 25% in the demand for hospitalization and intensive care unit services, even in a 'moderate pandemic' (United States Department of Health and Human Services, 2005). In addition to higher demand of critical facility use, it could be anticipated that there would be fewer employees available to run facilities. Employees who are unable to come to work would result in a loss of service, impacting the function of critical facilities. In addition to life and safety, a pandemic would have a significant impact on the economy in Bergen County. There is the potential for shutdowns and social distancing requirements such as those experienced during the COVID-19 pandemic which could harm local businesses and lead to an increase in unemployment, especially in the services sector of the economy.

4.16 POWER FAILURE

Hazard Description

Power failure is defined as any interruption or loss of electrical service caused by disruption of power transmission caused by accident, sabotage, natural hazards, or equipment failure (also referred to as a loss of power or power outage). A significant power failure is defined as any incident of a long duration which would require the involvement of the local and/or State emergency management organizations to coordinate provision of food, water, heating, cooling, and shelter.

Location, Extent and Magnitude

Power failures in New Jersey are usually localized and are usually the result of a natural hazard event involving high winds or ice storms. New Jersey's power systems are overseen by the State of New Jersey Board of Public Utilities. Under New Jersey law, consumers can shop for electric suppliers through a variety of third-party vendors. While the supply portion of energy is open to competition, the delivery of electricity is limited geographically to the following service providers: Atlantic City Electric, Jersey Central Power and Light (JCP&L), Orange and Rockland, and Public Service Electric and Gas (PSE&G). In Bergen County, PSE&G is responsible for maintaining power for most residents, although many communities in the northern part of the county are provided power by Orange and Rockland. Power systems across the State are supported by a vast network of delivery systems, which bridge the gap between supplier and customer.

Power failure is particularly problematic for homes that are heated with electricity. Widespread power outages during the winter months can directly impact vulnerable populations such as the elderly and medically frail. According to the 2023 American Community Survey 5-year estimates, 32,281 homes across Bergen County are heated with electricity. This represents roughly 12.9% of the total homes in the County (US Census, 2024). Almost all homes depend on electricity for cooling, through use of air conditioning and fans. Power failure can present a problem when it occurs in tandem with a heatwave.

Aside from the importance of power to heat and cool homes, power is vital to maintain out-of-hospital lifesaving systems for patients such as oxygen concentrators and ventilation machines. Without power, these individuals will require shelter at a medical-needs shelter or admission to a hospital.

Power failures can range in duration from a few minutes to multiple days and also in the extent of impacts, from minor loss of communication systems at a facility to catastrophic loss of lifelines such as water and electricity. Utility interruptions usually occur because of, or in combination with, other emergency or disaster incidents, such as severe weather and flooding, and can exacerbate such emergencies.

Power failures often result from damage to or electrical hazards within an electric power system. System components include power generation plants, substations, circuits, switches, transformers, power lines, and power poles. Due to the varied nature of power outage causes ranging from vehicle accidents to severe weather, utility interruptions can happen at any time.

Power disruption can lead to significant consequences, including service disruption, disruption to infrastructure operations, and loss of heat or cooling that can cause further disturbance or injury.

Previous Occurrences and Losses

Bergen County has experienced several widespread power outage incidents. These incidents have been caused by both natural and non-natural hazards. Recent and significant power outages are summarized in **Table 4.24-1 Historical Power Loss Events**. It is worth noting that power failure incidents occur frequently, often on smaller scales associated with high winds, ice storms, and power grid issues. Data was not readily available on the frequency of smaller power outages across the State.

Table 4.16-1 Historical Power Loss Events

Date(s) of Event	Event Type	Description
11/9/1965	Northeast Blackout of 1965	The Northeast Blackout of 1965 was a significant disruption in the supply of electricity, affecting parts of Ontario in Canada and Connecticut, Massachusetts, New Hampshire, Rhode Island, Vermont, New York, and New Jersey in the United States. Over 30 million people and 80,000 square miles (207,000 square kilometers) were left without electricity for up to 12 hours. The cause of the failure was human error that happened days before the blackout.
7/14/1977	New York City Blackout 1977	On July 14, 1977, lightning hit two Con Edison transmission lines north of New York City, tripping relays that soon shut down power plants in the New York metropolitan area. Parts of the City were dark for more than 25 hours, and there was widespread looting.
9/27/1985	Hurricane Gloria	The storm knocked out power and forced people to be evacuated from homes along the Jersey Shore. Gloria downed thousands of trees and caused extensive power outages across the State.
7/16/1999	Tropical Storm Floyd	Wind gusts rarely exceeded 50 mph, but all the flooding rains made it easier for trees to be knocked over. The strongest winds occurred during the evening and blew down transformers, wires, tree limbs and several trees throughout the County.
8/14/2003 – 8/16/2003	Northeast Blackout of 2003	The In August of 2003, the largest blackout in North America occurred, affecting 50 million people at an estimated cost of $4 - $10 billion. The proximate cause was a software bug which rendered operators unaware of the need to redistribute load after overloaded transmission lines drooped into foliage, cascading a local blackout into the collapse of much of the Northeast regional electricity distribution system. Most parts of New Jersey were without power for four to eight hours.
3/14/2010	Severe Windstorm	A severe windstorm knocked out power to hundreds of thousands of customers primarily in southwestern Connecticut as well as parts of Westchester County and Long Island, in New York State, and New Jersey. The outage lasted as long as six days for some customers in the hardest-hit communities.
8/23/2011	Earthquake	There were minor scattered power outages reported throughout the State.
08/27/2011 – 08/28/11	Hurricane Irene	Hurricane Irene caused a power outage to over five million customers throughout the mid-Atlantic and northeast regions of the United States. Approximately 1.9 million New Jersey residents were without power as a result of this storm.
10/28/2011 – 10/30/2011	2011 Halloween Nor'easter	The 2011 Halloween Nor'easter started as a large low-pressure area that produced unusually early snowfall across the northeastern United States. Snow fell on trees that were often still in leaf, adding extra weight. Trees and branches that bowed under the weight of the snow caused considerable damage, particularly to power lines. In New Jersey, 700,000 customers were without power as a result of the storm.
10/29/2012	Superstorm Sandy	One of the most significant power failure incidents in New Jersey occurred as a result of Superstorm Sandy in 2012. In total, the incident caused approximately 2.5 million power customers across the State to lose power for an extended period of time, forcing many shelters to remain open several weeks (United States Department of Energy, 2012). Power crews from across the country converged in the region to assist with power restoration efforts. Restoration efforts were hampered by the extent of the outages, and the sheer number of customers without power. For example, approximately 90% of JCP&L's customers were without power following the storm (Rose, 2012). In many cases it took weeks to fully restore power to the entire State.
11/7/2012	Winter Storm Athena	A winter storm left thousands across the east coast of the United States without power, adding to the blackouts after Superstorm Sandy. An estimated 60,000 people lost electricity as the Nor'easter moved through New Jersey, New York, and Connecticut. As of December 3, 2012, all customers who were able to receive electricity had power restored due to Superstorm Sandy and the subsequent Nor'easter.
1/31/2013	High Wind	Strong to high winds occurred across New Jersey from the middle of the evening on the 30th into the early afternoon of the 31st in New Jersey. Peak wind gusts reached between 45 mph and 65 mph and downed weak trees, tree limbs and power lines and caused power outages. Approximately 20,000 homes and businesses lost power. The wind damage was exacerbated by isolated severe thunderstorms that moved through the central part of the State during the early morning on the 31st. PSE&G reported about 11,000 outages across New Jersey, 3,400 of them in Burlington County. Power was expected to be fully restored later in the day on the 31st.
2/8/2013 – 2/9/2013	Winter Weather	Scattered power outages were reported, mainly in the northern portion of the State, with service restored by Saturday afternoon.
2/2/2015	Strong Wind	Strong, gusty northwest winds occurred in the wake of a departing and intensifying low pressure system during the late afternoon into the middle of the evening on the 2nd in New Jersey. Peak wind gusts average around 50 mph and knocked down weak trees, tree limbs and wires. Scattered power outages occurred.

Date(s) of Event	Event Type	Description
7/22/19	Severe Weather	A heat wave gave way to powerful thunderstorms with 60-70 mph winds leaving more than 45% of the County without electricity. Heaviest hit areas were Wall, Howell, and Freehold Townships.
8/4/2020	Tropical Storm Isaias	Isaias knocked out power for more than 2 million customers across New York, New Jersey, and Connecticut after barreling through the region on August 4th. Bergen County had 102,392 outages at its worst, affecting both PSE&G and Orange and Rockland utilities. Teaneck and Mahwah were among the most impacted municipalities. Orange & Rockland, Orange and Rockland said in a release that storm damage from Isaias ranked second only to Superstorm Sandy.
11/30/2022	Heavy Rain	A transformer fire left almost 5,000 Teaneck residents without power during a downpour. Power took over 24 hours to return, with police stating PSE&G discovered "extensive damage" to its infrastructure that was "much worse than originally thought.”

Source: NJSHMP 2024, Northjersey.com 2024

Probability of Future Occurrences

While the probability of future power failure incidents in Bergen County is difficult to predict, the historic record indicates that significant power failures have occurred as a result of high winds, lightning, winter weather, and technological failures. As shown in the table above, it can be anticipated that multiple power outage events caused by natural hazards can happen in a year. It is more difficult to predict the probability of power outages caused by technical error. The potential for another major power failure that disrupts power for many Bergen County residents is always possible yet are expected to occur less frequently than smaller incidents.

Potential Effects of Climate Change

Future changes in climate may also impact the frequency and probability of future power failure occurrences. . Due to climate changes, the frequency of some severe weather events is projected to increase which could impact the power supply. Extreme temperatures, for example, are becoming more common occurrences due to climate change, place a burden on existing conveyance systems as electrical usage increases during more extreme hot weather event. Wind and rain from hurricanes and tropical storms, which are expected to increase in intensity, frequency and duration, can cause downed power lines leading to outages.

Vulnerability Assessment

Regional or widespread power outages are the most severe type of power failures. The severity of power failures can be linked to severe weather events, such as winter storms and hurricanes. Power failures lead to the inability to use electric-powered equipment, such as lighting; HVAC and necessary equipment; communication equipment (telephones, computers, etc.); fire and security systems; small appliances such as refrigerators, sterilizers, etc.; and life dependent medical equipment. This all can lead to food spoilage, loss of heating and cooling, basement flooding due to sump pump failure, and loss of water due to well pump failure.

Widespread power outages can occur without warning or as a result of a natural disaster. Generally warning times will be short in the case of technological failure, such as a fire at a sub-station, traffic accident, human error or terrorist attack. In cases where a power failure is caused by natural hazards, greater warning time is possible. For example, high wind events such as tornados and hurricanes often cause widespread power failure and are often forecasted before they affect a community. Additionally, severe winter weather conditions such as ice storms, blizzards, and snowstorms often cause power failure. Incidents such as these often have plenty of warning time, thus power response crews can stage resources to prepare for power failure.

All critical facilities and infrastructure are exposed and vulnerable to a power failure event. Bergen County may potentially experience losses because of an interruption of critical services. Further increased costs such as providing shelters, and costs related to cooling and heating centers may be incurred. Extended power outages will require officials to shelter victims who require heat and power for activities of daily living.

Critical facilities rely on power to conduct daily activities that support Bergen County residents. Of particular concern are those facilities that rely on power to conduct life-saving operations, such as fire, police, and emergency medical services, which may be unable to respond to calls if their stations are not operational. Also important are 9-1-1 communications systems that rely on power to transmit emergency calls to first responders. Without a consistent power source, responders may be unable to charge equipment or operate critical systems, such as computer networks or communications devices. Response efforts could be hampered by the traffic delays caused by inoperable signals. Although many of these facilities typically have backup power, a prolonged power failure would pose challenges related to refueling backup systems. Also, backup power systems may malfunction if they are not regularly maintained, forcing the closure of the facility.

All critical facilities and infrastructure without backup power systems or islanding capabilities with distributed generation are exposed to power failure events. It is imperative that facilities that protect life and property and support emergency response, government, sheltering functions and recovery efforts remain operational during times of need. Examples of critical infrastructure includes sewer and stormwater pump stations, water treatment plants, traffic signals, and communication towers.

During power failure events, water purification systems may not be functioning. Further, populations on private wells will not have access to potable water. Many power outage events are caused by storm events that can lead to flooding. Without electricity, residents would be unable to pump water from their basements potentially causing structural and content damage to their homes.

Power failures can cause secondary hazards. One potential secondary hazard is chemical accidents that occur after power is restored to industrial facilities. Power interruptions at chemical handling plants are of particular concern because of the potential for a chemical spill during restart (EPA, 2001). Chemical spills in turn can have significant health and environmental impacts. Another secondary hazard that can result from power failure is a loss of communications capability by first responders, which may in turn have negative impacts on public safety. Backup systems such as amateur radio operators may be required during disaster to augment communications capabilities. Power outages can also lead to instances of civil disturbance, including looting. Wastewater and potable water utility interruption may occur as a result of a power failure. These critical utilities are essential to community continuity and recovery. Their interruption of service may have cascading economic and environmental impacts.

Power failure can have vast secondary impacts on the health of the community. During periods of extreme heat or extreme cold, vulnerable populations such as the elderly and medically frail can be affected and are susceptible to hypothermia or heat stroke. Additionally, power failure can lead to food spoilage, which has negative impacts on public health. Individuals with medical needs are vulnerable to power failures, because medical equipment such as oxygen concentrators requires electricity to operate. Individuals powering their homes with generators are subjected to carbon monoxide poisoning if proper ventilation procedures are not followed. Improperly connected portable generators are capable of ‘back feeding’ power lines which may cause injury or death to utility works attempting to restore power and may damage house wiring and/or generators (NJDCA, 2012).

Power failure may also lead to an increase in traffic accidents. Traffic accidents may increase because of the lack of traffic control devices such as stoplights and railroad crossing advisory signals. Power outages lasting a long duration will force law enforcement officials to man traffic control points to prevent accidents.

As discussed, power interruptions can cause economic impacts stemming from lost income, spoiled food and other goods, costs to the owners/operators of the utility facilities, and costs to government and community service groups. A prolonged power failure in Bergen County could impact the County's economy. New Jersey hosts the busiest commuter rail network in the country, which operates primarily on electricity. Disruption in the rail network would mean that thousands of workers would not be able to travel to their jobs. For example, the 2003 Northeast Blackout cost states in the northeast an estimated $4 to $10 billion in losses collectively. A widespread power failure in New Jersey could have a similar effect on the State. Other factors include New Jersey's chemical industry and pharmaceutical industry, which rely heavily on power for manufacturing purposes.

4.17 TERRORISM

Hazard Description

Terrorism is the use of force or violence against persons or property with the intent to intimidate or coerce. Acts of terrorism include threats of terrorism; assassinations; kidnappings; hijackings; bomb scares and explosive attacks; cyber-attacks (computer-based attacks); and the use of chemical, biological, nuclear, and radiological weapons (FEMA, 2009). Various types of terrorism are discussed in the sections below.

Armed Attacks and Assassinations

Armed attacks include raids and ambushes. Assassinations are the killing of a selected victim, usually by bombings or small arms. Drive-by shootings is a common technique employed by unsophisticated or loosely organized terrorist groups. Historically, terrorists have assassinated specific individuals for psychological effect.

Arson and Firebombing

Incendiary devices are inexpensive and easy to hide. Arson and fire-bombings are easily conducted by terrorist groups that may not be as well organized, equipped, or trained as a major terrorist organization. An act of arson or firebombing against a utility, hotel, government building, or industrial center portrays an image to the public that the ruling government is incapable of maintaining order.

Bioterrorism

Bioterrorism refers to the intentional release of toxic biological agents to harm and terrorize civilians, in the name of a political or other cause. The United States Centers for Disease Control and Prevention (CDC) has classified the viruses, bacteria, and toxins that could be used in an attack. Category A Biological Diseases are those most likely to do the most damage. They include:

- Anthrax (Bacillus anthracis)
- Botulism (Clostridium botulinum toxin)
- The Plague (Yersinia pestis)
- Smallpox (Variola major)
- Tularemia (Francisella tularensis)
- Hemorrahagic fever, due to Ebola Virus or Marburg Virus

Explosive Attacks

Explosive Attack can be defined as an attack in which a bomb and or destructive device is used to destroy, incapacitate, harass, or distract. These devises are used by criminals, vandals, terrorists, suicide bombers and insurgents. Explosive devices used in an explosive attack can come in many forms ranging from a pipe bomb to a sophisticated device capable of causing massive damage and loss of life (The National Academies and Homeland Security).

Bombings are the most common type of terrorist act. Typically, improvised explosive devices are inexpensive and easy to make. Modern devices are smaller and harder to detect and contain very destructive capabilities. An example of bombing occurred on August 7, 1998, when two American embassies in Africa were bombed. The bombings claimed the lives of over 200 people, including 12 innocent American citizens, and injured over 5,000 civilians. Terrorists such as those responsible for this bombing can use materials that are readily available to the average consumer to construct a bomb.

Cyber Terrorism

Cyber terrorists use information technology to attack civilians and draw attention to the terrorists' cause. This may mean that they use information technology, such as computer systems or telecommunications, as a tool to orchestrate a traditional attack. More often, cyber terrorism refers to an attack on information technology itself in a way that would radically disrupt networked services. For example, cyber terrorists could disable networked emergency systems or hack into networks housing critical financial information. A full discussion of cyber terrorism is presented in Section 4.16 Cyber Attack.

Ecoterrorism

Ecoterrorism is a recently coined term describing violence in the interests of environmentalism. In general, environmental extremists sabotage property to inflict economic damage on industries, businesses, or persons perceived as harming animals or the natural environment. Targets of ecoterrorist attacks have included fur companies, logging companies, and animal research laboratories.

Hijackings and Skyjackings

Hijacking is the seizure by force of a surface vehicle, its passengers, and/or its cargo. Skyjacking is the taking of an aircraft, which creates a mobile, hostage barricade situation; provides terrorists with hostages from many nations; and draws heavy media attention. Skyjacking also provides mobility for the terrorists to relocate the aircraft to a country that supports their cause and provides them with a human shield, making retaliation difficult.

Kidnappings and Hostage-Takings

Terrorists use kidnapping and hostage-taking to establish a bargaining position and to elicit publicity. Kidnapping is one of the most difficult acts for a terrorist group to accomplish, but, if a kidnapping is successful, it can gain terrorists money, release of jailed comrades, and publicity for an extended period. Hostage-taking involves the seizure of a facility or location and the taking of hostages present in that facility. Unlike a kidnapping, hostage-taking provokes a confrontation with authorities. It forces authorities to either make dramatic decisions or to comply with the terrorist's demands. It is overt and designed to attract and hold media attention. The terrorists' intended target is the audience affected by the hostage's confinement, not the hostage.

Nuclear Terrorism

Nuclear terrorism refers to a number of different ways nuclear materials might be exploited as a terrorist tactic. These include attacking nuclear facilities, purchasing nuclear weapons, or building nuclear weapons or otherwise finding ways to disperse radioactive materials.

Nuclear attack can be defined as an attack in which nuclear weaponry is used to inflict crippling damage on a place and the people living there. Nuclear weapons are weapons of mass destruction, which means they can produce far ranging destruction in very short timeframe, while also having lasting impacts (Birks and Sherry, 1986).

Location, Extent and magnitude

Terrorist attacks can occur anywhere. However, the State of New Jersey is a particularly attractive target of a potential terrorist activity because of its dense population and location relative to major urban areas. The State also houses the busiest commuter rail system in the United States, as well as the headquarters of major corporations in economically vital sectors such as the financial and pharmaceutical industries.

Additional targets in Bergen County include the County's critical infrastructure such as utilities, roadways, bridges, tunnels, hospitals, schools, civic centers, and other high-profile venues. The link between New Jersey Transit and New York City also makes this transportation system a target for terrorists. Locations with a high population density will be attractive targets for terror attacks.

Any acts of terrorism can occur anywhere at any time of day. The National Terrorism Advisory System (NTAS) communicates information about terrorist threats by providing detailed information to the public, government agencies, first responders, airports and other transportation hubs, and the private sector. When there is a threat, an NTAS Alert will be announced by the Secretary of Homeland Security and will be shared with the public. It may include specific information about the nature of the threat, including the geographic region, mode of transportation, or critical infrastructure potentially affected, as well as steps that individuals and communities can take to protect themselves and help prevent, mitigate or respond to the threat. The alert indicates whether the threat is elevated or imminent. Elevated threats are when there is no specific information about the timing or location. Imminent threats are when it is believed the threat is impending or very soon. The alerts will be posted online and released to the news media for distribution. The United States Department of Homeland Security (USDHS) will also distribute alerts through its social media channels (USDHS, 2013).

In New Jersey, the NJOEM, New Jersey Office of Homeland Security and Preparedness (OHSP), and the Regional Operations Intelligence Center (ROIC) have introduced NJ Alert, a mass text and email emergency notification system. During an emergency, NJ Alert assists these agencies in delivering emergency messages to the public through their handheld devices or computers, in addition to the Emergency Alert Systems and Amber Alert (NJEOM, 2009).

Previous Occurrences and Losses

The most significant terrorist incident to occur in the United States occurred adjacent to New Jersey in Lower Manhattan, New York, when an extreme terrorist group hijacked two commercial airplanes and flew them into the Towers 1 and 2 of the World Trade Center. Additionally, a simultaneous attack occurred in the Washington D.C. area where a plane was crashed into the Pentagon. New Jersey was directly affected as many of the victims and evacuees were ferried across the Hudson River to New Jersey. The incident required a joint response between regional entities and affected New Jersey significantly.

More recently, several municipalities reported cyber terrorism activity within their municipal networks. Among the incidents, a local school district was targeted in 2022, resulting in closure and disruption to the final exam schedule. The county has worked closely with the towns to increase capabilities and address vulnerabilities to future attacks.

Probability of Future Occurrences

While the potential for future terrorism incidents in Bergen County is difficult to predict, the combination of past incidents and potential terrorist targets make a terrorism incident possible. Efforts from local, State, and Federal officials must be coordinated to prevent future terrorist incidents from occurring. However, despite the best efforts of these entities, the reality is that a terrorist attack may occur in Bergen County or the surrounding areas.

Vulnerability Assessment

The effect of a terrorism event can vary depending on the type of attack and the magnitude of the event or events. A terrorism event can cause public fear regarding the use of mass transportation or leaving their homes in the event of a biological or nuclear attack. Communication systems, both public and private, can fail because of an overwhelming amount of usage or damage to its infrastructure. Healthcare facilities can become quickly inundated and must be prepared to triage injured patients, handle mass casualties, and conduct decontamination operations.

There is often very little if any warning time that a terrorist attack is about to occur. It is possible, however, to thwart terrorist attacks through aggressive intelligence monitoring and monitoring of individuals who exhibit radical tendencies. Some terrorist attacks may show warning signs that an incident may occur, such as a suspicious package left unattended. Local, State, and Federal officials as well as the general public are responsible for recognizing the warning signs of terrorism incidents and for taking appropriate actions to mitigate against possible attacks. In New Jersey, the coordination, direction, and control of all law enforcement personnel and resources fall under the purview of the Attorney General. Additionally, the New Jersey Office of Homeland Security and Preparedness administers, coordinates, leads, and supervises New Jersey’s counter-terrorism efforts.

The secondary hazards resulting from a terrorist attack depend on the size and scope of the incident. Some possible secondary hazards include widespread utility failure, health effects such as epidemics or pandemics, flooding (if a dam was destroyed), and environmental contamination. Additionally, the disruption an attack may cause to the State’s government facilities.

Depending on the type and location of an act of terrorism, it can impact the environment and result in loss of life for humans and animals. A radiological device or an improvised nuclear device would have a long-term impact that could cost billions of dollars to remediate. Additionally, an attack on waste treatment, natural gas, petroleum, or chemical facilities could also have long term environmental impacts.

The direct cost of the attacks on September 11, 2001 has been estimated at somewhat over $20 billion. Paul Krugman cites a property loss estimate by the Comptroller of the City of New York of $21.8 billion, which he has said is about 0.2 % of the GDP for one year (Krugman, 2004). Similarly, the Organization for Economic Cooperation and Development (OECD) estimated that the attack cost the private sector $14 billion and the Federal government $0.7 billion, while clean-up was estimated at $11 billion. These numbers are equal to about one- quarter of one-percent of the United States annual GDP—approximately the same result arrived at by Krugman (Johnston and Nedelscu, 2004).