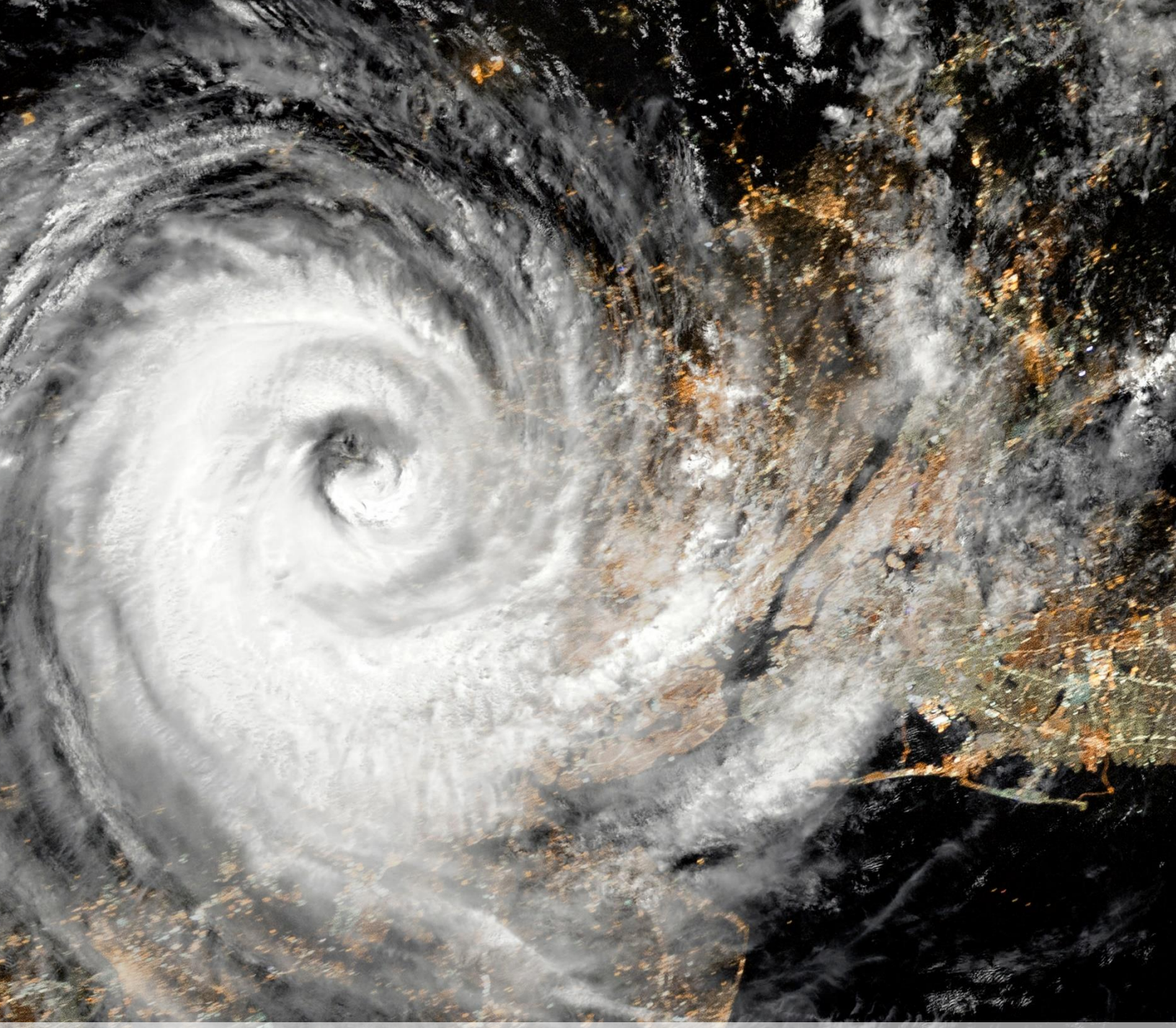


4.9 HURRICANE, NOR'EASTER, & TROPICAL STORM

SECTION 4.9 HURRICANE, NOR'EASTER, TROPICAL STORM

4.9-1 HAZARD OVERVIEW

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, but this profile will focus on the impacts from the winds they produce. Other impacts, such as flooding and severe weather, are covered in the Secondary Hazards section below and in additional hazard profiles.

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.

Secondary Hazards

As mentioned above, these storms result in more than just the high winds that are the focus of this profile. The most prominent secondary hazard associated with these storms is flooding, which may be the result of either heavy precipitation, storm surges, or both. While the winds produced by these storms play a significant role in generating storm surges, the full analysis on them and other precipitation impacts is contained within the Flooding profile in Section 4.7. These storms may also result in severe weather such as tornadoes, thunderstorms, lightning, and blizzards. These hazards are covered in more detail in Sections 4.10 Severe Weather and 4.11 Severe Winter Weather, respectively.

In addition to the secondary natural hazards that may occur because of these storms, power failure is a significant concern as well. Power failures in New Jersey are usually localized and are usually the result of a natural hazard event involving high winds and can exacerbate ongoing emergencies. Power failures lead to the inability to use electric-powered equipment, such as: lighting, heating, ventilation, and air conditioning (HVAC) and necessary equipment; communication equipment (cellular telephones, computers, internet, cable etc.); fire and security systems; small appliances such as refrigerators, sterilizers, etc.; and 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. Additionally, impacts to the power grid can cause traffic and transportation disruptions.

Section 4.9-3 of this profile, Previous Occurrence and Losses, details past impacts from these three types of storms, which includes discussions on how these secondary hazards have contributed to the damage caused. Impacts continuity of operations and business- impacts are discussed in further detail in this section under Lifeline Impacts.

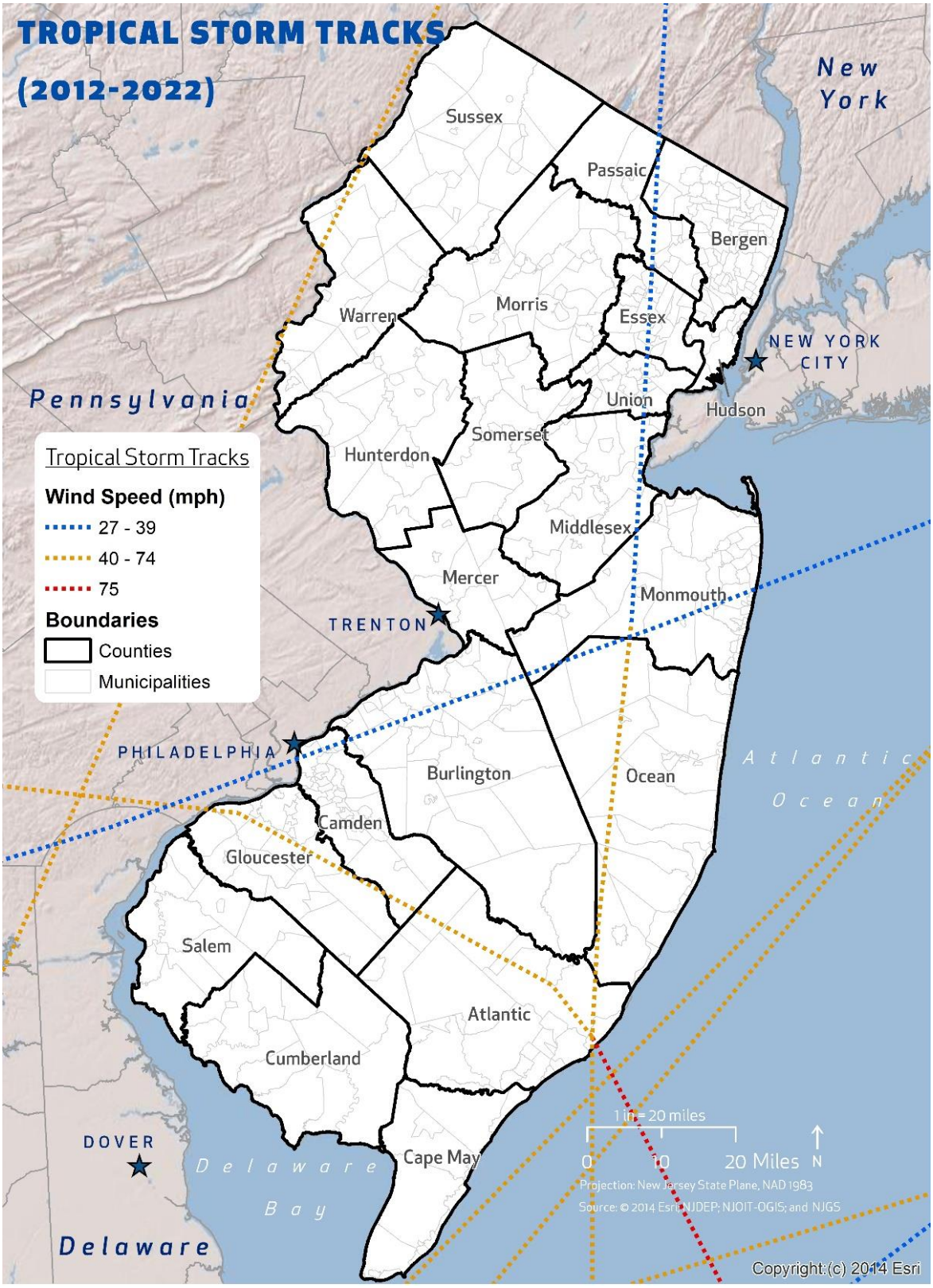
4.9-2 LOCATION, EXTENT, AND MAGNITUDE

Location

Historical data shows that a number of hurricanes, tropical storms, and nor'easters have impacted New Jersey. Hurricanes and tropical storms often impact the state as remnants of a larger storm hitting the Gulf or Atlantic coast hundreds of miles south of New Jersey but maintaining sufficient wind and precipitation to cause substantial damage. Almost all hurricanes and tropical storms in the Atlantic basin, which includes the Gulf of Mexico and Caribbean Sea, form between June 1 and November 30. This is known as "Hurricane Season." Typically, August and September are peak months for hurricane development. Tropical cyclones affect New Jersey the most during the month of September, though the State has experienced tropical cyclones throughout the hurricane season, excluding November. Because of peak warmth in water temperatures in September, storms usually affect New Jersey during this time (Bucholz and Savadove, 1993). Nor'easters can occur any time of the year but are most frequent and strongest between September and April.

The entire State of New Jersey is susceptible to the effects of these storms, depending on the storm's track. However, coastal communities and other low-lying areas of the State are particularly vulnerable. As development and re-development increase, even less-intense storms may lead to costly storm damage. Most of the damage following these storms often results from residual wind damage, as was demonstrated during recent storms. Figure 4.9-1 below tracks tropical storms between 2012 -2022.

Figure 4.9-1 Tropical Storm Tracks



Extent and Magnitude

Hurricanes and Tropical Storms

Hurricanes have greater wind speeds than tropical storms, as stated above, and therefore the extent of potential damage is greater. Tropical storms have wind speeds of between 39 and 73 miles per hour (mph); anything less is a tropical depression, anything more is a hurricane. Wind speeds like these can cause minor or moderate damage, including breaking tree branches and windows and loosening or removing roof shingles and vinyl siding. The potential for major structural damage begins to occur when you reach hurricane-force winds. While any tropical cyclone with wind speeds greater than 73 mph is considered a hurricane, hurricanes are further categorized according to their wind speed using the Saffir-Simpson Hurricane Wind Scale, shown below in Table 4.9-1 below. Categories 3 through 5 are considered major hurricanes.

High wind speeds occur in a narrow ring usually extending 20 to 30 miles from the wall of the eye of a hurricane. Some hurricanes spawn tornadoes that contribute to the damage delivered by hurricanes. Tornadoes are discussed in their own profile in Section 4.10: Severe Weather. Winds to the east of the storm track typically cause more damage. New Jersey is typically to the west of the storm track (NJOEM, 2011).

Table 4.9-1 Saffir-Simpson Hurricane Wind Speed Scale with Potential Damages

Category	Wind Speeds (miles per hour)	Potential Damages
1	74 to 95 mph	Very dangerous winds will produce some damage, as frame homes can experience major damage that involves the damage or loss of the roof covering, the removal of porch coverings and awnings, damaged siding, and broken windows. Older mobile homes could be destroyed, while newer ones may experience similar damage to frame homes. Trees may be uprooted, and their branches snapped. Damage to power lines and poles may cause power outages.
2	96 to 110 mph	Extremely dangerous winds will cause extensive damage. There is a substantial risk of injury or death to people, livestock, and pets due to flying and falling debris. Frame homes may experience major roof and siding damage along with broken windows. Older mobile homes will likely be destroyed, while newer ones may experience significant damage. Trees will be uprooted, and their branches snapped. Near-total power loss is expected.
3	111 to 129 mph	Devastating damage will occur. There is a high risk of injury or death to people, livestock, and pets. Frame homes may experience complete removal of the roof and/or exterior walls along with broken windows. Older mobile homes will be destroyed while newer ones sustain severe damage similar to frame homes. Complete failure of older metal buildings and unreinforced masonry buildings is possible. Trees will be uprooted and snapped. Electricity and water will be unavailable for several days or weeks.
4	130 to 156 mph	Catastrophic damage will occur. There is a very high risk of injury or death to people, livestock, and pets. Nearly all mobile homes, new or old, will be destroyed. Some frame homes will experience complete collapse, while others experience the loss of the roof structure and some exterior walls. High levels of structural damage to top floors of apartment buildings and a high likelihood of older metal structures and unreinforced masonry buildings. Most trees and power poles will experience damage, with power outages and water shortages potentially lasting weeks to months.
5	157+ mph	Catastrophic damage will occur. People, livestock, and pets are at very high risk of injury or death, even indoors. All mobile homes will likely be destroyed, along with a high percentage of frame homes, industrial buildings, and low-rise apartment buildings. This damage will create even more destructive potential as windborne debris is lofted into the air. Nearly all trees and power poles will be snapped, with power outages and water shortages lasting weeks to months.

Source: National Hurricane Center (NHC), 2022

Figure 4.9-2 and Figure 4.9-3 show the estimated maximum three-second gust wind speeds that can be anticipated in the study area associated with the 100- and 500-year MRP events. These peak wind speed projections were generated using Hazards U.S. Multi-Hazard (HAZUS-MH) model runs. The estimated hurricane track used for the 100- and 500-year event is also shown. The maximum three-second gust wind speeds for the State range from Tropical Storm to Category 3 hurricane speeds for the 100-year MRP event. The maximum three-second gust wind speeds for the State range from Category 1 to Category 3 hurricane speeds for the 500-year MRP event. The associated impacts and losses from these 100-year and 500-year MRP hurricane event model runs are reported in the Vulnerability Assessment presented in Section 4.9-5 Vulnerability Assessment.

Figure 4.9-2 Wind Speeds for the 100-Year Mean Return Period Event

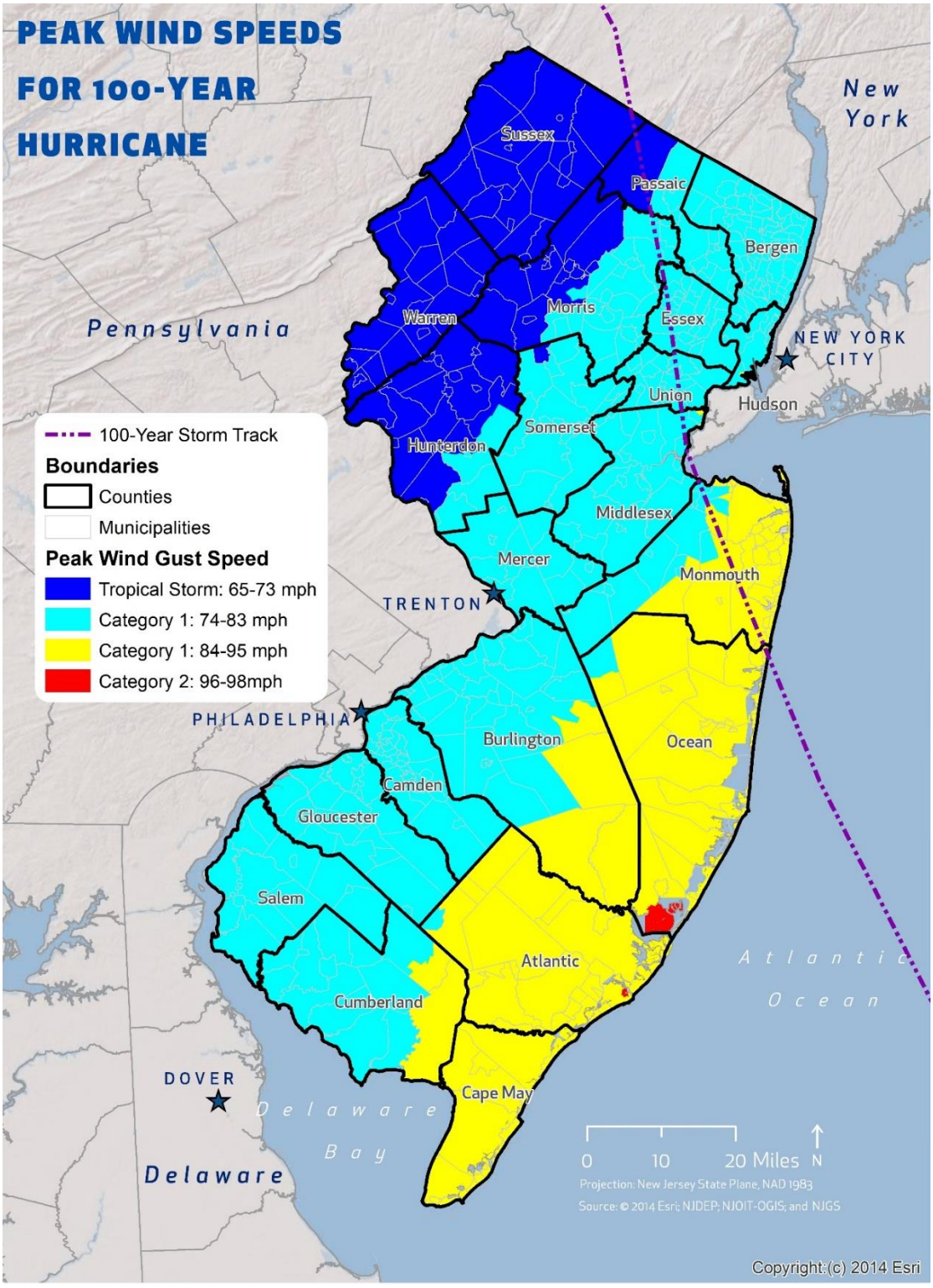
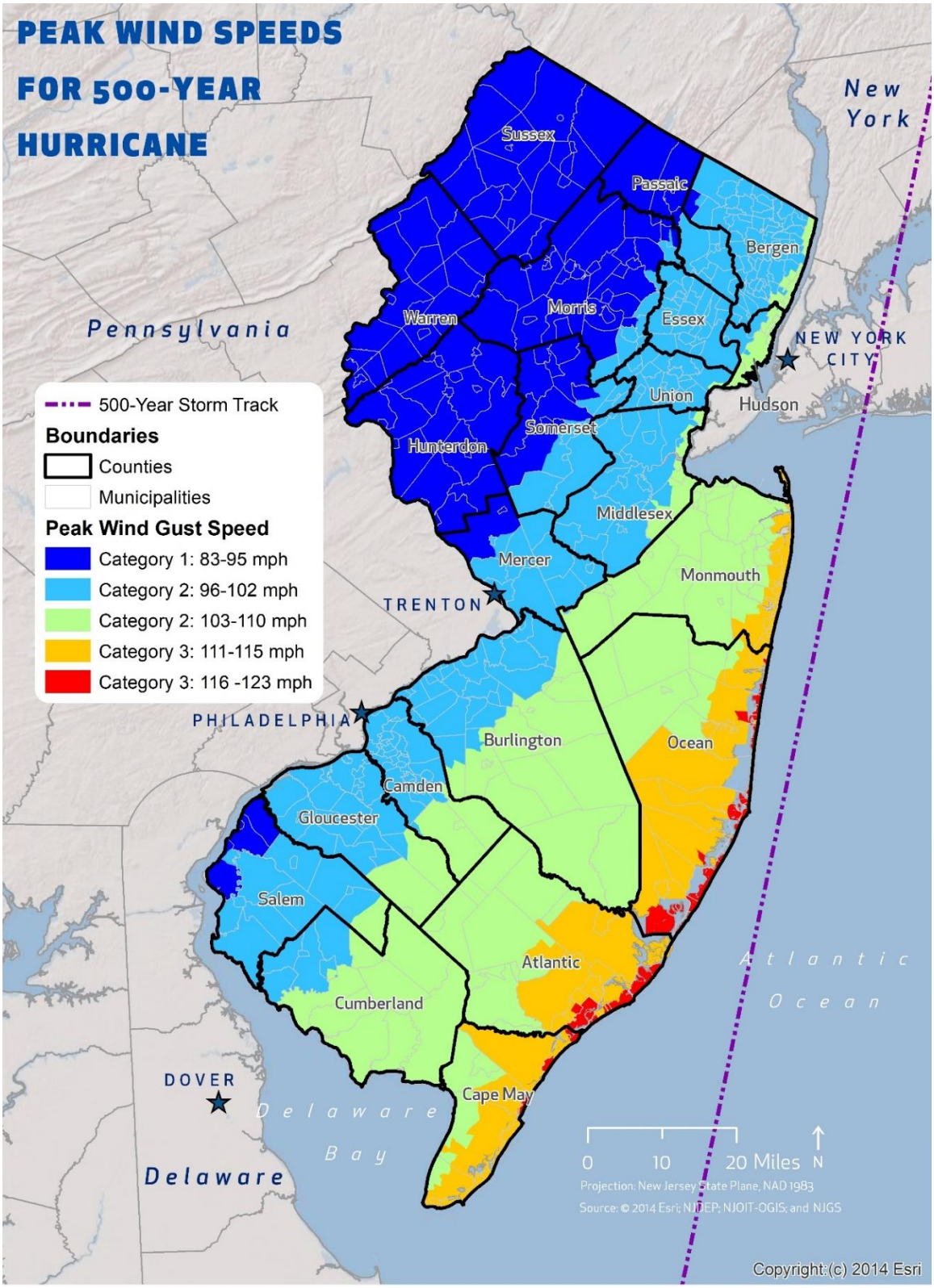


Figure 4.9-3 Wind Speeds for the 500-Year Mean Return Period Event



Nor'easter

Nor'easters must have wind speeds greater than 23 mph to be considered as such. According to the National Park Service, nor'easter's winds typically range from 23 to 45 mph (NPS, 2023). Previous nor'easters in New Jersey have recorded wind gusts of up to 90 mph (Kachmar, 2018). There is currently no scale or system that categorized nor'easters directly on their wind speeds, which is the focus of this profile.

4.9-3 PREVIOUS OCCURRENCES AND LOSSES

FEMA Disaster Declarations

Between 1954 and 2023, FEMA declared that the State of New Jersey experienced eighteen tropical cyclone disasters (DR) or emergencies (EM) classified as one or a combination of the following disaster types: hurricane, tropical storm, severe storms, flooding, tropical depression, severe winter storm, snowstorm, and nor'easter. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. However, not all counties were included in the disaster declarations as determined by FEMA (FEMA, 2013).

Based on all sources researched, known hurricane, tropical storm, and nor'easter events that have affected New Jersey and were declared a FEMA disaster are identified in Table 4.9-2. This table lists information concerning the FEMA disaster declarations for the 9 disasters that have occurred since 2010.

Table 4.9-2 FEMA Hurricane, Tropical Storm, and Nor'Easter-Related Disaster Declarations

Disaster Number	Disaster Type	Incident Period	Atlantic	Bergen	Burlington	Camden	Cape May	Cumberland	Essex	Gloucester	Hudson	Hunterdon	Mercer	Middlesex	Monmouth	Morris	Ocean	Passaic	Salem	Somerset	Sussex	Union	Warren	Impacted Number of Counties
DR-4021	Hurricane Irene	8/27/2011 – 9/5/2011	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	21
DR-4039	Remnants of Tropical Storm Lee	9/28/2011 - 10/6/2011										X	X					X			X		X	5
DR-4048	Severe Storm	10/29/2011		X			X		X			X		X		X		X		X	X	X	X	11
DR-4086	Superstorm Sandy	10/26/2012 – 11/8/2012	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	21
DR-4264	Severe Winter Storm and Snowstorm	3/14/2016	X	X	X	X	X	X	X		X	X	X	X	X	X	X			X		X	X	17
DR-4368	Severe Winter Storm and Snowstorm	3/6-3/7/2018		X	X				X							X		X		X				6
DR-4574	Tropical Storm Isaias	8/4/2020	X	X	X		X	X	X	X					X	X			X		X			11
DR-4597	Severe Winter	1/31-2/2/2021					X									X	X				X		X	5

Disaster Number	Disaster Type	Incident Period	Atlantic	Bergen	Burlington	Camden	Cape May	Cumberland	Essex	Gloucester	Hudson	Hunterdon	Mercer	Middlesex	Monmouth	Morris	Ocean	Passaic	Salem	Somerset	Sussex	Union	Warren	Impacted Number of Counties
	Storm and Snowstorm																							
DR-4614 EM-3451	Remnants of Hurricane Ida	9/1-9/3/2021	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	21

Source: FEMA, 2023

Historical Events Summary

Table 4.9-3 summarizes significant historical hurricanes, tropical storms, and nor'easters events since 2010.

Table 4.9-3 Significant Historical Hurricanes, Tropical Storms, and Nor'easters Events since 2010

Date(s) of Event	Event Type	Counties Affected	Description
3/13/2010 to 3/16/2010	Nor'easter	Atlantic, Bergen, Burlington, Camden, Cape May, Gloucester, Hunterdon, Mercer, Middlesex, Monmouth, Morris, Ocean, Passaic, Salem, Somerset, Sussex, Union, Warren	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 State had over $85 million in property damage from this event.
9/3/2010 to 9/4/2010	Hurricane Earl	Statewide	A maximum wind gust of 65 mph was reported in Cape May (Cape May County). High surf and rip tides were also reported. The storm caused two fatalities in New Jersey, both because of the rough surf from Earl.
8/27/2011 to 8/28/2011	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.
9/7/2011 to 9/10/2011	Remnants of Tropical	Burlington, Camden, Cape May, Atlantic,	Remnants of Tropical Storm Lee brought three to eight inches of rain to many parts of New Jersey. The heavy rain caused flooding, mainly in west and northwest New Jersey.

Date(s) of Event	Event Type	Counties Affected	Description
	Storm Lee	Ocean	Most of the damage was reported along the Delaware River, where two homes were destroyed, 24 suffered major damage, 249 suffered minor damage, and 28 others were affected. Many roads were closed throughout the State because of flooding. Freshwater surge caused moderate tidal flooding along sections of the Delaware River. The State had approximately $11.5 million in damage.
10/29/2011	Nor'easter	Statewide	A nor'easter knocked out power to more than three million homes and businesses across the Northeast on Sunday in large part because leaves still on the trees caught more snow, overloading branches that snapped and wreaked havoc. Close to 2 feet of snow fell in some areas.
10/26/2012 to 11/8/2012	Superstorm Sandy	Statewide	Hurricane 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 Mantaloking (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. Hurricane Sandy caused approximately $30 billion in damages in New Jersey and caused 12 deaths in the State.
11/7/2012	Nor'easter	Statewide	A strong Nor'easter caused high winds along the coast, heavy snow in east central New Jersey, 10-foot waves along the ocean front and minor tidal flooding along the ocean front with the overnight high tide on November 7. It caused setbacks with restoration efforts near and along coastal areas caused by post tropical storm Sandy, particularly in Monmouth and Ocean Counties. It also forced some coastal area evacuations again. Elsewhere across the state, winds were lighter, but accumulating snows occurred in most areas. Snowfall averaged one to five inches in most of the state, but reached six to 12 inches in Middlesex, Monmouth and Ocean Counties. The least snow fell in Hunterdon and coastal Cape May Counties.
3/6/2013	Winter Storm / Nor'easter	Coastal Counties	A slow-moving winter storm arrived in New Jersey with strong winds that knocked out power to thousands of homes and businesses Wednesday, ahead of an expected snowfall of two to four inches. But the real problem was expected to be winds, which could gust up to 60 mph. A 58-mph reading was reported in Ocean City.
6/1/2013	Tropical Storm Andrea	Statewide	The storm caused heavy rains that knocked out power and flooded streets. Maximum sustained winds were 45 mphs.
8/28/2014	Hurricane Cristobal	Off the coast	While the storm passed well offshore of the state, it generated strong waves and rip currents that killed two people in Sandy Hook.
11/26/2014	Winter Storm / Nor'easter	Sussex, Warren, Morris, Hunterdon, Mercer, Middlesex, Somerset	A winter storm on the 26th, the day before Thanksgiving Day, dropped heavy snow over parts of northwest New Jersey and caused power outages as well as additional traveling difficulties. Governor Chris Christie declared a state of emergency. About 23,000 homes and businesses lost power, mainly in Jersey Central Power and Light's service area in the northwest part of the state. In addition to wintry precipitation inland, the onshore flow around the Nor'easter caused minor tidal flooding along the Atlantic coast from Ocean County southward as well as in lower Delaware Bay during the daytime high tide cycle on the 26th.
12/9/2014 to 12/11/2014	Nor'easter	Sussex, Hunterdon, Cape May, Morris, Middlesex,	A strong Nor'easter caused strong winds as well as minor to moderate tidal flooding in Upper Delaware Bay and around Raritan Bay and moderate tidal flooding in Lower Delaware Bay and Atlantic Coastal New Jersey on the 9th. The Nor'easter also caused

Date(s) of Event	Event Type	Counties Affected	Description
		Monmouth, Ocean, Somerset, Warren	minor to moderate beach erosion. Peak wind gusts averaged 45 to 55 mph along coastal New Jersey and knocked down weak trees, tree limbs and power lines. Tidal flooding affected all of the coastal counties in New Jersey.
1/26/2015 to 1/27/2015	Nor'easter	Essex, Union, Hudson, Bergen	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.
10/28/2015	Hurricane Patricia	Northeast New Jersey	Inches of heavy rain and winds caused downed tree limbs, power outages and flooding throughout the state.
1/22/2016 to 1/24/2016	Nor'easter	Camden, Cumberland, Atlantic, Cape May, Gloucester, Salem, Burlington, Hunterdon, Middlesex, Morris, Somerset, Monmouth, Ocean, Sussex, Warren	An impulse from the west coast traversed the midsection of the country, then developed into a low-pressure system as it tracked across the Gulf states before intensifying along the Carolina coast into a major Nor'easter, producing record snowfall in parts of New Jersey on January 23rd. It then moved out to sea after passing by the mid-Atlantic coast early on January 24th.
1/4/2018	Nor'easter	Statewide	An area of low pressure tracked up the east coast interacting with a cold front which lead to rapid development of a winter storm across the state. Blizzard conditions occurred along many coastal locations. Top wind gusts were generally around 40 mph across the state and southern and coastal New Jersey dealt with over six inches of snow. Totals were only a few inches further northwest. A state of Emergency was declared during the height of the storm. Several hundred vehicles were stranded, and hundreds of thousands were without power at some point.
3/1/2018 to 3/3/2018	Nor'easter	Statewide	Sussex County in the northern part of the state reported 10 inches (25 cm) of snow. At the Jersey Shore, the storm caused minor flooding and road closures during the high tide on the morning of March 2. Two local roads in Absecon were closed from flooding and there was flooding on U.S. Route 40 leading into Atlantic City. Flooding also caused lane closures along portions of Route 35 in Brick and Belmar while floodwaters covered roads in Neptune and Highlands. Some flights were cancelled at Newark Liberty International Airport. Atlantic City Electric reported 29,111 customers without power and PSE&G reported tens of thousands of customers without power. New Jersey Transit cancelled some service.
3/7/2018	Nor'easter	Statewide	Two to three feet of snow fell from New Jersey to New England. At least one person died from the storm. This was the second of three Nor'easters to hit the east coast in a two-week span. The third Nor'easter on 3/13 did not significantly impact New Jersey.
3/20/2018 to 3/22/2018	Nor'easter	Statewide	A complex area of low pressure over the middle Atlantic, which involved several individual centers, slowly consolidated off the Virginia Capes. As this precipitation moved northward into a colder air mass, snow and sleet developed across southern New Jersey., Snowfall amounts varied from less than 3 inches in portions of northern Sussex County and Cape May County, with a general 6 to 12 inches elsewhere, with the exception of portions of Monmouth, Ocean, and Burlington Counties, where some areas received 12 to 15 inches.
11/15/2018	Nor'easter	Essex, Bergen, Hudson, Hunterdon, Morris, Passaic, Somerset, Sussex, Union, Warren	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 to 3/4/2019	Nor'easter	Statewide	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

Date(s) of Event	Event Type	Counties Affected	Description
			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.
8/4/2020	Tropical Storm Isaias	Statewide	Tropical Storm Isaias brought high winds, heavy rain, several tornadoes, and coastal flooding to the mid-Atlantic region, becoming the most impactful tropical cyclone to impact most of the region since Sandy in 2012.
12/16/2020 to 12/17/2020	Nor'easter	Statewide	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 to 2/3/2021	Nor'easter	Statewide	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 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.
8/22/2021 to 8/23/2021	Hurricane Henri	Statewide	On August 22, 2021, and lasting into the early mornings of August 23, 2021, remnants of Hurricane Henri impacted the state with heavy rainfall, totaling nearly 10 inches. The storm prompted evacuations, road closures, and water rescues throughout the State.
8/31/2021	Remnants of Hurricane Ida	Statewide	One of the deadliest and most impactful storms since Superstorm Sandy, the remnants of Hurricane Ida caused intense rainfall, severe flooding and flash flooding, multiple tornadoes that included the first EF-3 tornado in 30 years for New Jersey, 30 deaths, and prompted nearly $1 billion in federal relief funds. Rainfall totals reached nearly 10 inches in Bergen, Hunterdon, Mercer, and Somerset Counties. Over 200 abandoned vehicles were removed from roads in just Franklin Township in Somerset County.
1/3/2022	Nor'easter	Statewide	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'easter-type 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	Nor'easter	Statewide	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: NCEI 2023, NJ State HMP 2011; ONJSC 2013

Power Outages

Power failures in New Jersey are usually localized and are usually the result of a natural hazard event involving high winds or ice storms which result from hurricanes, tropical storms, and nor'easters. 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. Table 4.9-4 summarizes recent power failures from Hurricanes, Nor'easters, and Tropical Storms.

Table 4.9-4 Power Outages In New Jersey Due to Hurricanes, Nor'easters, and Tropical Storms Since 2010

Date of Event	Event	Population Impacted
8/28/2011	Tropical Storm Irene	930,000 electrical customers out at peak
10/29/2012	Superstorm Sandy	2.7 million electrical customers out at peak
3/2/2018	Nor'easter	230,000 electrical customers out at peak
3/7/2018	Nor'easter	342,000 electrical customers out at peak
3/21/2018	Nor'easter	87,000 electrical customers out at peak
8/4/2020	Tropical Storm Isaias	1.3 million out at peak
9/1/2021	Remnants of Ida	88,500 electrical customers out at peak

Source: NJBPU 2023

Power failure is particularly problematic or 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 2016 – 2021 American Community Survey, 484,941 homes across New Jersey are heated with electricity. This represents 15.8% of the total homes in the State. The number of homes heated with electricity per county are listed in Table 4.9-5.

Table 4.9-5 Number of Homes Heated with Electric-Powered Heat

County	Number of Homes	Homes Heated with Electricity	Percentage of Homes Heated with Electricity
Atlantic	105,277	16,596	15.8%
Bergen	348,674	45,360	13.0%
Burlington	172,400	32,230	18.7%
Camden	196,939	33,321	16.9%
Cape May	41,971	8,344	19.9%
Cumberland	51,873	5,563	10.7%
Essex	307,613	45,965	14.9%
Gloucester	109,290	10,850	9.9%
Hudson	282,832	67,621	23.9%
Hunterdon	48,975	4,661	9.5%
Mercer	137,114	22,453	16.4%
Middlesex	299,455	41,215	13.8%
Monmouth	245,569	30,627	12.5%
Morris	187,430	20,946	11.2%
Ocean	237,729	35,426	14.9%
Passaic	176,203	15,697	8.9%
Salem	24,753	3,617	14.6%
Somerset	125,363	13,258	10.6%
Sussex	55,401	8,104	14.6%
Union	198,506	18,223	9.2%
Warren	43,789	4,865	11.1%
Total	**3,397,156**	**484,941**	**15.8%**

Source: ACS 2016-2021

Aside from the importance of power to heat homes, power is vital to maintain out-of-hospital lifesaving systems for patients such as oxygen concentrators and ventilation machines. Across the State thousands of individuals rely on power to sustain

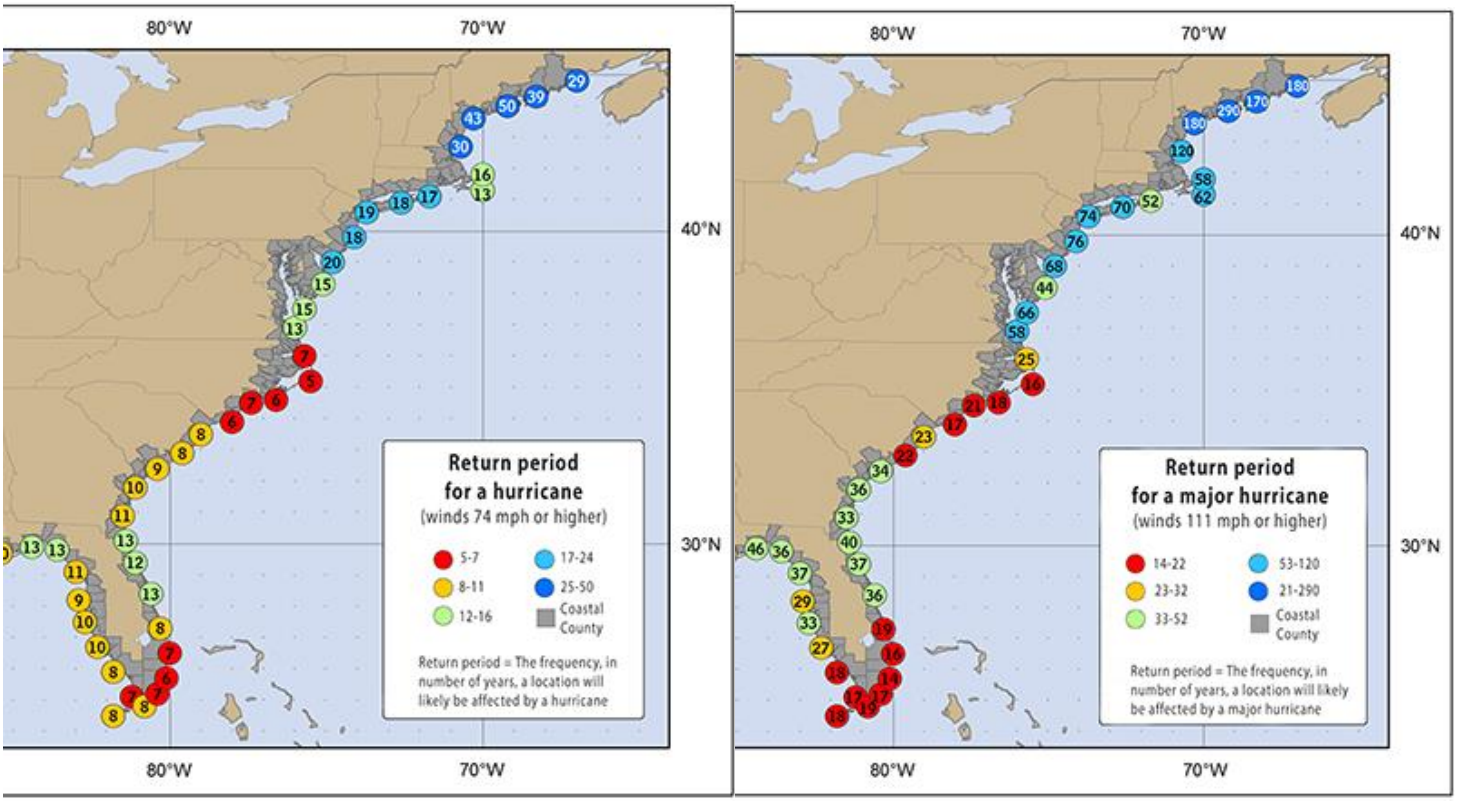
their health. Without power, these individuals will require shelter at a medical-needs shelter or admission to a hospital. Although systems are in place to locate these individuals during disasters, such as New Jersey's Register Ready system, the number of individuals who require these services across the State is unknown and is difficult to track at the state level.

4.9-4 PROBABILITY OF FUTURE OCCURRENCE FOR A CATEGORY 3 OR HIGHER

Tropical Storms and Hurricanes

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 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 were not included in this 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 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. This analysis is modeled for hurricanes in Figure 4.9-4 below.

Figure 4.9-4 Atlantic Basin Hurricane Return Periods (All Hurricanes on the left, Major Hurricanes on the right)



Source: NOAA, 2018

Nor'easters

As with any weather phenomenon, it is nearly impossible to assign probabilities to nor'easters, except over the long-term. 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

Climate change is expected to affect the probability and severity of coastal storms in the state of New Jersey. Sea level rise and warming ocean temperatures are projected to result in more frequent and damaging storm events and contribute significantly to additional hazards such as flooding and coastal erosion. For more in-depth discussion of the potential effects of climate change on these hazards refer to Sections 4.2: Coastal Erosion and 4.7: Flooding.

Tropical storms are fueled by heat energy in the ocean. As sea temperatures increase so will the energy in a storm system, increasing the potential for more intense tropical storms especially those of the Category 4 and 5. The number of Category 3, 4, and 5 North Atlantic hurricanes has increased since 1951, most likely due to higher sea surface temperatures occurring in the region in the Atlantic Ocean where hurricanes form (NJDEP, 2020).

Coastal Storms are resulting in heavier precipitation. Over the last 50 years, in New Jersey, storms that resulted in extreme rain increased by 71%, which is a faster rate than anywhere else in the United States (NJDEP, 2020). Sea level rise will affect the height of storm surge during events. Under current scenarios there is a 50% chance that sea-level rise will meet or exceed an additional 1.4 feet and a 17% chance it will exceed 2.1 feet by 2050. Those levels increase to 3.3 and 5.1 feet by the end of the century (NJDEP, 2020).When combined, sea level rise affected storm surge and precipitation from coastal storms pose a severe flooding risk to coastal communities.

Besides temperature increase and sea level rise, there are additional changes in the climate that could occur which would increase the potential for more intense hurricanes. One such change relates to vertical wind shear, which is the magnitude and directional difference between winds in the lowest region of Earth's atmosphere, the troposphere. Greenhouse gas forcing has the potential to reduce vertical wind shear along the East Coast of the United States, a natural protective barrier from hurricanes making landfall, thereby providing favorable conditions for more intense hurricanes (NJDEP, 2020).

4.9-5 VULNERABILITY ASSESSMENT

Vulnerable Jurisdictions

As a coastal state, coastal storms have impacted every county in the state. Almost all counties in the state identify coastal storms as hazards of concern in their HMPs. In addition to the rankings created by the counties, the table below includes the Hazard Risk Rating data from FEMA's National Risk Index for Natural Hazards. The ratings are relative to other jurisdictions and based on an equation that accounts for expected annual loss, social vulnerability, and community resilience. Organization of hazards does not align perfectly between the NRI and County HMPs or among the counties themselves. For example, some counties separate nor'easters from hurricanes and tropical storms as a hazard of concern while some group them together.

Table 4.9-6 Hurricane, Nor'easter, and Tropical Storm Risk Rankings

County	Hurricanes and Tropical Storms		Nor'easters
	NRI Hazard Risk Rating	Ranking by County HMP	Ranking by County HMP
Atlantic	Relatively Moderate	High	Medium
Bergen	Relatively Moderate	Profiled, Not Ranked	Profiled, Not Ranked
Burlington	Relatively Moderate	High	High
Camden	Relatively Moderate	High	High
Cape May	Relatively Moderate	High	High
Cumberland	Relatively Moderate	Not Profiled	Not Profiled
Essex	Relatively Moderate	High	High
Gloucester	Relatively Moderate	Medium	Medium
Hudson	Relatively Moderate	High	High
Hunterdon	Relatively Low	High	High
Mercer	Relatively Moderate	High	High
Middlesex	Relatively Moderate	High	High
Monmouth	Relatively High	High	High
Morris	Relatively Moderate	High	High
Ocean	Relatively Moderate	High	High

County	Hurricanes and Tropical Storms		Nor'easters
	NRI Hazard Risk Rating	Ranking by County HMP	Ranking by County HMP
Passaic	Relatively Moderate	High	High
Salem	Relatively Low	Not Profiled	Not Profiled
Somerset	Relatively Moderate	High	High
Sussex	Relatively Low	High	High
Union	Relatively Moderate	High	High
Warren	Relatively Low	High	High

Source: FEMA NRI (accessed June 2023), County Hazard Mitigation Plans (accessed June 2023)

Built Environment

Hurricanes

Table 4.9-7 shows estimated potential annual losses (EAL) for hurricane by county in New Jersey. Total building EAL was derived from FEMA's National Risk Index for Natural Hazards while EAL for state owned assets was calculated using Replacement Cost Value for state owned facilities per county derived from LBAM data and Expected Annual Loss Rate for Buildings by county provided by the NRI. Hurricanes are the only hazard in this chapter included in the NRI.

Table 4.9-7 Estimated Potential Annual Losses for Hurricane

County	Total Buildings	State-Owned Assets
Atlantic	$27,578,013.25	$188,317.77
Bergen	$43,783,482.31	$39,305.72
Burlington	$22,641,916.93	$145,506.09
Camden	$17,045,627.75	$84,002.75
Cape May	$19,542,503.90	$58,820.82
Cumberland	$11,752,482.32	$252,372.93
Essex	$19,669,767.81	$125,497.04
Gloucester	$11,117,329.84	$19,613.63
Hudson	$18,447,094.68	$61,877.09
Hunterdon	$4,465,490.56	$29,150.07
Mercer	$20,166,889.55	$668,631.50
Middlesex	$37,459,743.63	$123,216.51
Monmouth	$52,116,586.03	$149,037.07
Morris	$20,322,247.56	$63,420.87
Ocean	$41,942,644.68	$120,286.44
Passaic	$12,994,716.44	$38,542.91
Salem	$2,683,902.50	$13,264.20
Somerset	$16,934,467.25	$43,549.39
Sussex	$3,404,618.23	$9,276.40
Union	$14,136,286.26	$25,067.77
Warren	$2,691,292.76	$7,477.95

Source: FEMA NRI, LBAM

Wind Analysis from Hurricane and Tropical Storm

The HAZUS-MH wind model was used to run probabilistic scenarios for the State to examine the estimated wind speeds, annualized losses, and losses associated with the wind-only 100- and 500-year mean return period (MRP) events. Figure 4.9-2 and Figure 4.9-3 presented earlier in this section illustrate the wind speeds associated with the 100- and 500-year MRP events.

Because of differences in building construction, residential structures are generally more susceptible to wind damage than commercial and industrial structures. Wood and masonry buildings in general, regardless of their occupancy class, tend to experience more damage than concrete or steel buildings. HAZUS determines the general building stock wind-only impacts from hurricane/tropical storm events for the 100- and 500-year probabilistic events. Table 4.9-8 below summarizes the estimated damages (structure only) from wind from these events. Total dollar damage reflects the overall impact to buildings of all occupancy classes.

As a result of a 100-year probabilistic wind event, HAZUS-MH estimates the State will experience greater than $7 billion in building damage. For the 500-year probabilistic wind event, HAZUS-MH estimates the State may experience $26 billion in building damage. Please note these damage estimates account for damage as a result of the wind only and impacts will be much greater when factoring in storm surge inundation, debris, sheltering, and other losses; some of which are discussed further below.

Table 4.9-8 Estimated Building Damage – Wind Analysis Only

County	Annualized Loss	100 - Year Event	500 - Year Event
Atlantic	$26,331,000	$253,358,000	$678,759,000
Bergen	$25,522,000	$919,385,000	$4,005,299,000
Burlington	$14,076,000	$326,503,000	$53,649,000
Camden	$13,427,000	$396,340,000	$7,224,000
Cape May	$19,867,000	$115,421,000	$174,781,000
Cumberland	$5,992,000	$79,002,000	$3,445,000
Essex	$15,821,000	$691,775,000	$1,098,611,000
Gloucester	$17,837,000	$208,617,000	$1,349,000
Hudson	$17,837,000	$590,792,000	$3,066,722,000
Hunterdon	$2,478,000	$180,774,000	$992,000
Mercer	$9,538,000	$242,045,000	$59,264,000
Middlesex	$22,068,000	$552,502,000	$792,079,000
Monmouth	$41,687,000	$423,937,000	$8,881,633,000
Morris	$8,084,000	$557,030,000	$117,112,000
Ocean	$43,222,000	$249,475,000	$6,052,930,000
Passaic	$8,084,000	$356,528,000	$550,331,000
Salem	$2,170,000	$37,543,000	$141,000
Somerset	$7,886,000	$395,166,000	$70,880,000
Sussex	$1,293,000	$86,505,000	$3,391,000
Union	$11,093,000	$427,825,000	$586,338,000
Warren	$1,019,000	$80,475,000	$0
Total	**$305,411,000**	**$7,170,999,000**	**$26,204,931,000**

Note: This takes into consideration the cost of the structural damage due to an event.

Source: HAZUS-MH v. 6.0

Lifeline Impacts

FEMA created the eight Community Lifelines to contextualize information from incidents, communicate impacts in plain language, and promote a more unified effort across a community that focuses on stabilizes these lifelines during response. More information on these lifelines can be found in Section 4.1: Risk Assessment Overview. Table 4.9-9 showcases the most likely lifelines to be impacted by hurricane, nor'easter, or tropical storm, including a short description of anticipated impacts.

Table 4.9-9 Lifelines Most Likely Impacted by Hurricane, Nor'easter, or Tropical Storm

Lifeline Categories	Notable Impacts
Safety and Security	Community safety may be threatened due to potential direct harm from coastal storm impacts and compounding effects on administration of services. Transportation infrastructure issues may directly impact the abilities of law enforcement, fire service, search and rescue, and other government services.
Food, Hydration, Shelter	Coastal storms can cause damage to shelter structures, while the food supply chain may be disrupted due to impacts on agricultural production and transportation infrastructure. Access to food and water may be impacted
Health and Medical	Potential Impacts to the Health and Medical lifeline consist of damage to medical structures and transportation infrastructure. Medical facilities can be impacted due to direct damage to structures from coastal storms or by secondary impacts such as effects on the power grid. Patient movement and medical supply chains can be impacted by damage to transportation infrastructure and dangerous conditions on roadways.
Energy	Coastal storms have the potential to cause direct damage to energy infrastructure and its ability to provide power to the grid due to high winds and storm surge, causing potential for large scale disruption.
Communications	The Communications lifeline can be impacted directly by damage to communication infrastructure as well as damage to the grid. Wi-Fi and cellular data infrastructure can be crippled in such cases leaving many without access to communication lifelines and emergency response personnel and the public with little capacity to exchange information vital for coordinating response action.
Transportation	Transportation lifelines can be threatened by hurricanes, nor'easters, and tropical storms. Direct damage to roads, bridges, and other forms of infrastructure can occur from this hazard. In the case of ordered evacuation mass delays and traffic can occur on roadways impeding movement. Damage to the Transportation lifeline has cascading effects among other lifelines which depend on movement of people or goods.
Hazardous Materials	Hazardous Materials facilities could be impacted by power disruptions due to effects to energy infrastructure. Transport of hazardous materials can be impacted by transportation infrastructure issues and dangerous road conditions including the potential for spills or releases. Flooding damage to facilities can transport hazardous materials throughout floodwaters.
Water Systems	Hurricanes, nor'easters and tropical storms have the potential to threaten the Water Systems lifeline by disrupting drinking water and wastewater utilities. Potential impacts include damage of facilities or contamination of drinking water.

Population and Economy

The impact of a hurricane or tropical storm on life, health, and safety depends on several factors, including the severity of the event and whether or not adequate warning time was provided to residents. It is assumed that the entire State's population is exposed to the wind hazard associated with a hurricane or tropical storm event. Of the total State population, economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions based on the major economic impact to their family and may not have funds to evacuate. The population over the age of 65 is also more vulnerable, and they may physically have more difficulty evacuating. The elderly population are considered most vulnerable because they require extra time or outside assistance during evacuations. Also, they are more likely to seek or need medical attention, which may not be available because of isolation during a storm event.

Residents may be displaced or require temporary to long-term sheltering as a result of a hurricane or tropical storm. In addition, downed trees, damaged buildings, and debris carried by high winds can lead to injury or loss of life. Socially vulnerable populations are most susceptible, based on a number of factors including their physical and financial ability to react during a hazard and the location and construction quality of their housing. An analysis was conducted to determine the wind-only impacts from hurricane/tropical storm events for the 100- and 500-year probabilistic events for hurricanes and tropical storms in New Jersey. HAZUS-MH estimates the sheltering needs as a result of the 100- and 500-year wind-only probabilistic events (United States Census, 2000). It should be noted that HAZUS-MH utilizes 2010 Census data, and therefore, the totals will vary slightly. The estimated shelter needs are summarized in Table 4.9-10. All counties, with the exception of Atlantic, Cumberland, Cape May, Salem, and Sussex, have experienced an increase in population growth since the 2010 Census.

Table 4.9-10 Estimated Shelter Needs: Wind Analysis Only (United States Census, 2010)

County	100 - Year Event		500 - Year Event	
	Displaced Households	Short-Term Shelter Needs	Displaced Households	Short-Term Shelter Needs
Atlantic	104	71	619	419
Bergen	167	135	3,425	2,452
Burlington	101	51	7	6
Camden	187	127	0	0
Cape May	15	3	51	17
Cumberland	18	20	0	0
Essex	226	202	760	767
Gloucester	64	40	0	0
Hudson	771	597	7,272	5,678
Hunterdon	13	4	0	0
Mercer	5	2	0	0
Middlesex	176	150	485	430
Monmouth	55	30	11,135	6,333
Morris	52	33	0	0
Ocean	24	12	7,456	4,035
Passaic	97	112	335	422
Salem	0	0	0	0
Somerset	39	23	0	0
Sussex	1	0	0	0
Union	103	130	334	469
Warren	5	5	0	0
Total	**2,223**	**1,747**	**31,879**	**21,028**

Source: HAZUS-MH v. 6.0

In addition to building damages, hurricane/tropical storm events can greatly impact the economy, including loss of business function (e.g., tourism, recreation), damage to inventory, relocation costs, wage loss, and rental loss caused by the repair/replacement of buildings. HAZUS-MH estimates the (wind only) total economic loss associated with each storm scenario (direct building losses and business interruption losses). Direct building losses are the estimated costs to repair or replace the damage caused to the building. This is discussed earlier in this section. Business interruption losses are the losses associated with the inability to operate a business because of the wind damage sustained during the storm or the temporary living expenses for those displaced from their home because of the event. The economic losses generated by HAZUS-MH for each of the probabilistic wind scenarios are summarized in Tables 4.9-11 and 4.9-12.

Table 4.9-11 Estimated Economic Loss for the 100-Year Event – Wind Analysis Only

County	Inventory	Relocation	Rental Income	Wages
Atlantic	$513,000	$8,859,000	$7,560,000	$1,980,000
Bergen	$1,113,000	$29,603,000	$12,576,000	$10,519,000
Burlington	$890,000	$10,446,000	$5,510,000	$2,462,000
Camden	$819,000	$12,696,000	$6,829,000	$3,965,000
Cape May	$74,000	$3,775,000	$2,568,000	$261,000
Cumberland	$530,000	$2,930,000	$1,864,000	$632,000
Essex	$696,000	$28,234,000	$16,317,000	$19,634,000
Gloucester	$818,000	$7,195,000	$3,501,000	$1,926.00

County	Inventory	Relocation	Rental Income	Wages
Hudson	$1,107,000	$32,052 ,000	$24,450,000	$14,874,000
Hunterdon	$2,451,000	$5,095,000	$1,567,000	$595,000
Mercer	$348 ,000	$6,397,000	$2,691,000	$169,000
Middlesex	$1,747,000	$19,643,000	$11,709,000	$4,922,000
Monmouth	$529,000	$12,745,000	$6,178,000	$786,000
Morris	$829,000	$13,538,000	$5,812,000	$1,526,000
Ocean	$85,000	$5,204,000	$2,752,000	$92,000
Passaic	$568,000	$15,401,000	$8,629,000	$6,143,000
Salem	$506,000	$1,204,000	$407,000	-
Somerset	$1,026,000	$9,761,000	$3,893,000	$1,528,000
Sussex	$170,000	$2,413,000	$849,000	$4,000
Union	$844,000	$12,749,000	$8,128,000	$1,462,000
Warren	$1,145,000	$2,601,000	$920,000	$128,000
Total	**$16,808,000**	**$242,540,000**	**$134,709,000**	**$71,683,926**

Source: HAZUS-MH v.6.0

Table 4.9-12 Estimated Economic Loss for the 500-Year Event – Wind Analysis Only

County	Inventory	Relocation	Rental Income	Wages
Atlantic	$3,039,000	$49,050,000	$33,131,000	$21,736,000
Bergen	$20,704,000	$343,762,000	$117,325,000	$76,171,000
Burlington	$56,000	$788,000	$561,000	$85,000
Camden	-	$8,000	$6,000	-
Cape May	$248,000	$7,335,000	$4,807,000	$1,838,000
Cumberland	-	$7,000	$7,000	-
Essex	$3,818,000	$67,585,000	$33,512,000	$50,698,000
Gloucester	-	$1,000	-	-
Hudson	$23,348,000	$294,696,000	$141,530,000	$53,025,000
Hunterdon	-	-	-	-
Mercer	$21,000	$695.,000	$289,000	-
Middlesex	$4,710,000	$39,798,000	$19,548,000	$19,686,000
Monmouth	$84,288,000	$914,007,000	$327,542,000	$218,096,000
Morris	$16,000	$1,028,000	$434,000	-
Ocean	$47,163,000	$674,458,000	$232,725,000	$108,738,000
Passaic	$2,121,000	$31,373,000	$16,186,000	$12,765,000
Salem	-	-	-	-
Somerset	$1,000	$449,000	$179,000	-
Sussex	-	-	-	-
Union	$4,036,000	$29,799,000	$18,145,000	$11,750,000
Warren	-	-	-	-
Total	**$193,568,000**	**$2,454,840,000**	**$945,927,000**	**$574,588,000**

Source: HAZUS-MH v. 6.0

Ecosystems & Natural Assets

Beaches and Dunes

Tropical storm or hurricane events can result in beach erosion and dune destruction from wind-blown sediment or storm surge. Storm surge can drastically reshape the coastal landscape. Vegetative and construction material debris may accumulate on beaches and shorelines. The effects of nor'easters are similar to that of hurricanes and tropical storms. However, because these events tend to be longer in duration their impacts may be greater.

Water Resources

Storm surge that reaches and impacts development or infrastructure may cause the release of hazardous substances such as heating fuel and sewage into the environment which may end up in surface or ground water contaminating potable water supplies.

Freshwater and Coastal Wetlands

Storm surge from high wind events can deposit salt water, sediment, and debris into inland freshwater, coastal, and brackish waters causing major impacts to the wetland's structure and function. The damage to vegetation can alter or destroy specific wildlife habitat, especially where threatened and endangered species are located.