4.3.10   NOR'EASTER

The following section provides the hazard profile (hazard description, location, extent, previous occurrences and losses, probability of future occurrences, and impact of climate change) and vulnerability assessment for the Nor'Easter hazard in Sussex County.

2021 HMP UPDATE CHANGES

➢ Previous occurrences were updated with events that occurred between 2015 and 2021.
➢ An updated qualitative vulnerability assessment was conducted.

Profile

Hazard Description

A Nor'Easter is a cyclonic storm that moves along the East Coast of North America. It is called a Nor'Easter because the damaging winds over coastal areas blow from a northeasterly direction. Nor'Easters can occur any time of the year, but are most frequent and strongest between September and April. 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). A Nor'Easter event can cause storm surges, waves, heavy rain, heavy snow, wind, and coastal flooding. Nor'Easters have diameters that can span 1,200 miles, impacting large areas of coastline. The forward speed of a Nor'Easter is usually much slower than a hurricane, so with the slower speed, a Nor'Easter can linger for days and cause tremendous damage to those areas impacted.

In order 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°W 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)

A Nor'Easter event can cause storm surges, waves, heavy rain, heavy snow, wind, and coastal flooding. Nor'Easters have diameters that can span 1,200 miles, impacting large areas of coastline. The forward speed of a Nor'Easter is usually much slower than a hurricane, so with the slower speed, a Nor'Easter can linger for days and cause tremendous damage to those areas impacted. Approximately 20 to 40 Nor'Easters occur in the northeastern United States every year, with at least two considered severe (Storm Solution, 2014). New Jersey can be impacted by 10 to 20 Nor'Easters each year, with approximately five to 10 of those having significant impact on the State. 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.

For the purpose of this HMP, only Nor'Easter events are being further discussed within this hazard profile, due to their significant historical impact on Sussex County. For information flooding related to Nor'Easters, refer to Section 4.3.5 (Flood) and Section 4.3.8 (Hurricane). For information on severe winter storms, refer to Section 4.3.12.

Location

The entire State of New Jersey, including Sussex County, is susceptible to the effects of Nor'Easters; however, coastal communities and other low-lying areas are particularly vulnerable. Nor'Easters usually form off the east coast near the Carolina, and then follow a track northwards along the coast until they blow out to sea. Although Sussex County is bordered to the west by the Delaware River which is considered a coastal boundary in New Jersey, it is well upriver of areas that would experience coastal flooding. The County is exposed to the direct and indirect impacts of a Nor'Easter including rain, snow, and wind.

Extent

The magnitude or severity of a severe winter storm or Nor'Easter 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 (e.g., weekday versus weekend), and time of season.

The extent of a severe winter storm can be classified by meteorological measurements and by evaluating its societal impacts. NOAA's National Climatic Data Center (NCDC) is currently producing 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 1 to 5. It is 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 NCDC has analyzed and assigned RSI values to over 500 storms since 1900 (NOAA-NCDC 2011). Table 4.3.10-1 presents the five RSI ranking categories.

Table 4.3.10-1. RSI 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-NCDC 2011
Note: RSI = Regional Snowfall Index

Previous Occurrences and Losses

FEMA Major Disasters and Emergency Declarations

Between 1954 and 2020, FEMA included the State of New Jersey in seven Nor'Easter-related major disaster (DR) or emergency (EM) declarations classified as one or a combination of the following disaster types: severe storm, high tides, flooding, coastal storm, coastal flooding, or tropical depression. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. Sussex County has been included in two Nor'Easter-related declarations. Table 4.3.10-2 lists FEMA DR and EM declarations for Sussex County.

Table 4.3.10-2. FEMA Declarations for Nor'Easter Events in Sussex County

FEMA Declaration Number	Date(s) of Event	Date Declared	Event Type
DR-1694	April 14-20, 2007	April 26, 2007	Severe Storms and Inland and Coastal Flooding

FEMA Declaration Number	Date(s) of Event	Date Declared	Event Type
DR-4048	October 29, 2011	November 30, 2011	Severe Storm

Source: FEMA 2020; NJ HMP 2019

For this plan update, known Nor'Easter events that have impacted Sussex County between 2015 and 2021 are identified in Table 4.3.10-3. Events identified in the 2016 HMP are included in Appendix E (Risk Assessment Supplement).   For detailed information on damages and impacts to each municipality, refer to Section 9 (Jurisdictional Annexes).

Table 4.3.10-3. Nor'Easter Events in Sussex County, 2015 to 2020

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Location	Description
January 22-24, 2016	Winter Storm	DR-4264	No	Sussex County	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. Snow began falling during the Friday afternoon commute on January 22nd, then continued, heavy at times, Friday night into early Sunday morning. Wind gusts up to 60 MPH produced blizzard conditions as visibilities dropped to one-quarter mile or less in spots. Representative snowfall totals include 16.0 inches in Stockholm (Sussex).
January 24, 2017	Heavy Rain, Nor'Easter	N/A	N/A	Sussex County	Just over 2 inches of rain fell in association with the Nor'easter.
March 14, 2017	Blizzard	N/A	N/A	Sussex County	Low pressure systems across the Ohio Valley and Carolinas phased. This led to a rapidly developing storm which tracked just offshore. Wind and a foot of snow were reported across Sussex County.
March 2, 2018	Winter Storm	N/A	N/A	Sussex County	A heavy, wet snow accumulated to a depth of over 16 inches in the higher elevations of the county, and around 6 inches or so in the valleys. Some snowfall totals include 16.5 inches in Branchville, 14.0 inches in Highland Lakes, 13.5 inches at High Point, 8 inches near Wantage, 7.0 inches in Stockholm, and 2.3 inches near Sussex. A wind gust of 48 MPH was reported at High Point Monument at 1125EST on the 2nd. Blowing and drifting snow made travel hazardous Friday afternoon and evening. Numerous power outages, some lasting over two weeks, were widespread throughout the county due to tree and wire damage. Warming centers were established around the county for affected residents.
March 7, 2018	Winter Storm	DR-4368	No	Sussex County	Narrative A broad area of low pressure extending from the Ohio Valley to the Piedmont of South Carolina consolidated off the Virginia Capes during the early morning of March 7th. This new primary low moved northeast and gradually deepened as it passed east of the Delaware and New Jersey coasts on March 7th. The snow contained large amounts of liquid, making it heavy and wet. This resulted in downed trees, limbs, and wires, leading to numerous power outages across portions of New Jersey, especially where the heaviest snow was reported. Many customers were still without power from the previous

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Location	Description
					storm when this storm struck. Governor Murphy estimated about 350,000 customers state-wide lost power as a result of this second storm. Although all portions of the county experienced significant snowfall from this event, the higher amounts occurred over the central and eastern portions of the county which were closer to the low pressure system. Some reported snowfall totals include: 21.0 inches in Highland Lakes, 17.0 inches in Stockholm, 16.0 inches in Sparta, 15.5 inches in Hardyston Township, 15.0 inches in Vernon, 13.5 inches in Wantage, 12.7 inches in Montague, and 12.0 inches in Newton.
March 21-22, 2018	Winter Storm	N/A	N/A	Sussex County	A complex area of low pressure over the middle Atlantic, which involved several individual centers, slowly consolidated off the Virginia Capes Tuesday morning, March 20th into Wednesday March 21st along a frontal boundary. This primary low, the fourth nor'easter of March, gradually moved northeast Wednesday night, to a position southeast of the 40 North/70 West Benchmark coordinates on Thursday morning. Precipitation began as a wet, heavy snow during the evening hours on March 20th. After a lull during the overnight hours, a drier snow began falling, heavy at times, during the afternoon and evening hours on March 21st. The heaviest snow from this event fell in the southern one-half of the county, with a sharp drop off in the far north. Some snowfall reports include: 10.0 inches in both Stockholm and Byram Township, 9.5 inches in Fredon, 8.5 inches in both Hardyston Township and Newton, 7.0 inches in Ogdensburg, 7.0 inches in Andover, Sparta, and Franklin, 2.5 inches in Vernon Valley, 1.3 inches in Sussex, 1.1 inches in Wantage, and 0.2 inches in Montague.
March 3-4, 2019	Winter Storm	N/A	N/A	Sussex County	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 10, 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. A trained spotter in Highland Lakes reported 8.2 inches of snow.

Source: NOAA NCEI 2020, NJ HMP 2019, SHELDUS

Probability of Future Occurrences

Sussex County will continue to experience the direct and indirect impacts of Nor'Easters. Secondary hazards may include flooding, extreme wind, erosion, infrastructure deterioration or failure, utility failures, power outages, water quality and supply concerns, and transportation delays, accidents, and inconveniences.

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

In Section 4.4, the identified hazards of concern for Sussex County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for nor'easter in the county is considered 'frequent' (100 percent annual probability; a hazard event may occur multiple times per year, as presented in Table 4.4-1). The ranking of the nor'easter hazard for individual municipalities is presented in the jurisdictional annexes.

Climate Change Impacts

Due to the increase in greenhouse gas concentrations since the end of the 1890s, New Jersey has experienced a 3.5° F (1.9° C) increase in the State's average temperature (Office of the New Jersey State Climatologist 2020), which is faster than the rest of the Northeast region (2° F [1.1° C]) (Melillo et al. 2014) and the world (1.5° F [0.8° C]) (IPCC 2014). This warming trend is expected to continue. By 2050, temperatures in New Jersey are expected to increase by 4.1 to 5.7° F (2.3° C to 3.2° C) (Horton et al. 2015).

Since the end of the twentieth century, New Jersey has experienced slight increases in the amount of precipitation it receives each year, and over the last 10 years there has been a 7.9% increase. By 2050, annual precipitation in New Jersey could increase by 4% to 11% (Horton et al. 2015). By the end of this century, heavy precipitation events are projected to occur two to five times more often (Walsh et al. 2014) and with more intensity (Huang et al. 2017) than in the last century. New Jersey will experience more intense rain events, less snow, and more rainfalls (Fan et al. 2014, Demaria et al. 2016, Runkle et al. 2017).

Climate change may result in changes to the frequency of coastal storms. A warmer atmosphere means storms have the potential to be more intense (Guilbert et al. 2015) and occur more often (Coumou and Rahmstorf 2012, Marquardt Collow et al. 2016, Broccoli et al. 2020). In New Jersey, extreme storms typically include coastal nor'easters, snowstorms, spring and summer thunderstorms, tropical storms, and on rare occasions hurricanes. Most of these events occur in the warmer months between April and October, with nor'easters occurring between September and April. Over the last 50 years, in New Jersey, storms that resulted in extreme rain increased by 71% (Walsh et al. 2014) which is a faster rate than anywhere else in the United States (Huang et al. 2017).

Some climatologists believe that climate change may play a role in the frequency and intensity of Nor'Easters. Two ingredients are needed to produce strong Nor'Easters and intense snowfall: (1) temperatures which are just below freezing, and (2) massive moisture coming from the Gulf of Mexico. When temperatures are far below freezing, snow is less likely. As temperatures increase in the winter months, they will be closer to freezing rather than frigidly cold. Climate change is expected to produce more moisture, thus increasing the likelihood that these two ingredients (temperatures just below freezing and intense moisture) will cause more intense snow events.

Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable to the identified hazard. For the Nor'Easter hazard, all of Sussex County has been identified as potentially exposed or vulnerable. Therefore, all assets in the County (population, structures, critical facilities and lifelines), as described in Section 3, are vulnerable to a Nor'Easter.

Impact on Life, Health and Safety

The impact of a Nor'Easter on life, health and safety is dependent upon several factors including the severity of the event and whether or not adequate warning time was provided to residents. Typically, a Nor'Easter has a longer duration (potentially lasting days) than a hurricane or tropical storm event, which normally pass through an area in a matter of hours. It is assumed that the entire County's population (i.e., 142,298 total persons, American Community Survey 2018) could be exposed to this hazard (wind and rain/snow) and secondary impacts discussed earlier associated with a Nor'Easter. Further, residents may be displaced or require temporary to long-term sheltering. Refer to Section 4.3.10 (Hurricanes and Tropical Storms) which displays the peak gust wind speeds of the 100- and 500-year mean return period probabilistic wind events modeled in Hazus v4.2.

Impact on General Building Stock

The entire County's building stock is exposed to the wind and/or rain/snow from the Nor'Easter hazard. Sussex County is estimated to have 72,021 buildings, with a replacement cost value (structure and content) of approximately $60.0 billion. Refer to Section 4.3.5 (Flood), Section 4.3.8 (Hurricane and Tropical Storms), Section 4.3.11 (Severe Weather), and Section 4.3.12 (Severe Winter Weather) for more information about the wind, rain, and snow hazard impacts to the building stock in Sussex County.

Impact on Critical Facilities and Lifelines

All of Sussex County's critical facilities are exposed to the wind and/or rain/snow from the Nor'Easter hazard. Sussex County is estimated to have 596 critical facilities, all of which are considered lifelines. Refer to Section 4.3.5 (Flood), Section 4.3.8 (Hurricane and Tropical Storm), Section 4.3.11 (Severe Weather), and Section 4.3.12 (Severe Winter Weather) for more information about the wind, rain, and snow hazard impacts to the critical facilities in Sussex County.

Impact on the Economy

Nor'Easter events can greatly impact the economy, including loss of business function, damage to inventory (utility outages), relocation costs, wage loss, and rental loss due to the repair/replacement of buildings. Damages to buildings can impact a community's economy and tax base. In addition, damages to buildings and critical infrastructure, as well as road closures, can delay emergency response services during these events. Refer to Section 4.3.5 (Flood), Section 4.3.8 (Hurricane), Section 4.3.11 (Severe Weather), and Section 4.3.12 (Severe Winter Weather) for more information about the wind, rain, and snow hazard impacts to the economy in Sussex County.

Future Changes That May Impact Vulnerability

Understanding future changes that affect vulnerability can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. Several factors are examined in this section to assess hazard vulnerability.

Projected Development

As discussed and illustrated in Section 3 (County Profile), areas targeted for future growth and development have been identified across the County. Any areas of growth could be potentially impacted by a Nor'Easter event if structures do not consider current mitigation measures against flooding, rain, wind, and snow. Therefore, it is the intention of the County and all participating municipalities to discourage development in vulnerable areas or to encourage higher regulatory standards at the local level.

Projected Changes in Population

According to the 2018 5-year population estimates from the American Community Survey, the population of Sussex County (i.e., 142,298 persons) has decreased by approximately 4.7-percent since 2010. Even though the population has decreased, any changes in the density of population can impact the number of persons exposed to Nor'Easter events. Refer to Section 3 (County Profile) for more information about population trends in the County.

Climate Change

Climate is defined not simply as average temperature and precipitation but also by the type, frequency and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of events like hurricanes. While predicting changes to the prevalence or intensity of Nor'Easter events and their affects under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society and the environment (EPA 2020).

Change of Vulnerability Since the 2016 HMP

Overall, the County's vulnerability has not changed; the entire County continues to be exposed and potentially vulnerable to the Nor'Easter hazard. Hazards that relate to Nor'Easter events (i.e., flood, hurricane, severe weather, and severe winter weather) use an updated building stock and critical facility data to assess the County's risk to flood, wind, rain, and snow. The building inventory was updated using RS Means 2020 values, which is more current and reflects replacement cost versus the building stock improvement values reported in the 2016 HMP. Further, the 2018 5-year population estimates from the ACS were used to evaluate the population exposed to the flood, hurricane, severe weather, and severe winter weather hazards of concern.