4.3.12 SEVERE WINTER WEATHER

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 severe winter weather hazard in Mercer County.

2021 HMP UPDATE CHANGES

- Previous occurrences were updated with events that occurred between 2015 and 2021.
- The vulnerability assessment was updated using that current building stock inventory generated for this plan update.

Profile

Hazard Description

A winter storm is considered a storm with significant snowfall, ice, and/or freezing rain. The quantity of precipitation varies by elevation. Heavy snowfall in non-mountainous areas is four inches or more in a 12-hour period, or six inches or more in a 24-hour period. In mountainous areas, heavy snowfall is considered 12 inches or more in a 12-hour period or 18 inches or more in a 24-hour period. Blizzards are storms with considerable falling and/or blowing snow combined with sustained winds or frequent wind gusts of 35 mph or greater that frequently reduce visibility to less than 0.25 mile for at least three hours.

Some winter storms are large enough to immobilize an entire region while others may only affect a single community. Winter storms are typically accompanied by low temperatures, high winds, freezing rain or sleet, and heavy snowfall. The aftermath of a winter storm can have an impact on a community or region for days, weeks, or even months; potentially causing cold temperatures, flooding, storm surge, closed and/or blocked roadways, downed utility lines, and power outages. In Mercer County, winter storms include blizzards, snowstorms, Nor'Easters, and ice storms. Extreme cold temperatures, wind chills and Nor'Easters are also associated with winter storms; however, based on input from the Planning Committee, these events are further discussed in this Plan in Section 4.3.10 (Nor'Easters) and Section 4.3.11 (Severe Weather).

Heavy Snow

According to the National Snow and Ice Data Center (NSIDC), snow is precipitation in the form of ice crystals. It originates in clouds when temperatures are below the freezing point (32 degrees Fahrenheit [°F]), when water vapor in the atmosphere condenses directly into ice without going through the liquid stage. Once an ice crystal has formed, it absorbs and freezes additional water vapor from the surrounding air, growing into snow crystals or snow pellets, which then fall to the earth. Snow falls in different forms, such as snowflakes, snow pellets, or sleet. Snowflakes are clusters of ice crystals that form from a cloud. Snow pellets are opaque ice particles in the atmosphere. They form as ice crystals fall through super-cooled cloud droplets that are below freezing but remain a liquid. The cloud droplets then freeze to the crystals. A heavy snowstorm is defined as a snowstorm with accumulations of 4 inches or more of snow in a 6-hour period, or 6 inches of snow in a 12-hour period (NWS 2009).

Blizzards

A blizzard is a winter snowstorm with sustained or frequent wind gusts of 35 mph or more, accompanied by falling or blowing snow reducing visibility to or below 0.25 mile. These conditions must be the predominant over a 3-hour period. Extremely cold temperatures are often associated with blizzard conditions but are not a formal part of the definition. The hazard, created by the combination of snow, wind, and low visibility, significantly increases when temperatures are below 20°F. 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. Storm systems powerful enough to cause blizzards usually form when the jet stream dips far to the south, allowing cold air from the north to clash with warm, moister air from the south. Blizzard conditions often develop on the northwest side of an intense storm system. The difference between the lower pressure in the storm and the higher pressure to the west creates a tight pressure gradient, resulting in strong winds and extreme conditions caused by the blowing snow (The Weather Channel 2012).

Sleet

Sleet is made up of drops of rain that freeze into ice as they fall. They are usually smaller than 0.30 inch in diameter (NSIDC 2013). A sleet storm involves significant accumulations of solid pellets, which form from the freezing of raindrops or partially melted snowflakes causing slippery surfaces, posing a hazard to pedestrians and motorists (NWS 2009).

Freezing Rain

Freezing rain occurs when rain falls into areas that are below freezing. In order for this to occur, ground-level temperatures must be colder than temperatures aloft. Freezing rain can also occur when the air temperature is slightly above freezing but the surface that the rain lands upon is still below freezing from prior cold air temperatures (NWS 2009).

An ice storm is an event caused by damaging accumulations of ice during freezing rain events. An ice storm involves significant accumulation of rain or drizzle freezing on objects (trees, power lines, roadways, etc.) as it strikes them, causing slippery surfaces and damage from sheer weight of ice accumulations (NWS 2009). Significant ice accumulations are typically 0.25 inch or greater (National Weather Service [NWS] 2013).

Location

Snow and Blizzards

The trajectory of the storm center—whether it passes close to the New Jersey coast or at a distance—largely determines both the intensity and the duration of the snowfall over the State. Winter storms tend to have the heaviest snowfall within a 150-mile-wide swath to the northwest of what are generally southwest to northeast moving storms. Depending on whether all or a portion of New Jersey falls within this swath, the trajectory determines which portion of the State (or all of the State) receives the heaviest amount of snow. According to the ONJSC, normal seasonal snowfall in Mercer County is approximately 22.7 inches (ONJSC n.d).

Ice Storms

All regions of New Jersey are subject to ice storms. The distribution of ice storms often coincides with general distribution of snow within several zones in the State. A cold rain may be falling over the southern portion of the State, freezing rain over the central region, and snow over the northern counties as a coastal storm moves northeastward offshore. A locality's distance to the passing storm center is often the crucial factor in determining the temperature and type of precipitation during a winter storm. Based on data from 1948–2000, Mercer County can anticipate 2-4 days with freezing rain per year (Changnon & Karl. 2003). Based on data from 1932–2001, the County can anticipate 9-15 total hours of freezing rain per year (Changnon 2004).

Extent

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, time of occurrence during the day (for example, weekday versus weekend), and time of season. While sleet accumulation is measured and tracked in a method similar to snow

events, the extent or severity of freezing rain or an ice storm requires a different and sometimes more challenging process. According to NWS, ice accumulation does not coat the surface of an object evenly, as gravity typically forces rainwater to the underside of an object before it freezes. Wind can also force rainwater downward prior to freezing, resulting in a thicker coating of ice on one side of the object than the other side. Ice mass is then determined by taking the average from the thickest and thinnest portions of ice on the sample used for measurement.

The NOAA NCDC produces 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 Category 1 to 5, which is similar to the Enhanced Fujita scale for tornadoes or the Saffir-Simpson scale for hurricanes. RSI is based on the spatial extent of the storm, the amount of snowfall, and the combination 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-NCEI 2018). Table 4.3.12-1 presents the five RSI ranking categories.

Table 4.3.12-1. 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-NCEI 2018
Note: RSI = Regional Snowfall Index

The NWS operates a widespread network of observing systems such as geostationary satellites, Doppler radars, and automated surface observing systems that feed into the current state-of-the-art numerical computer models to provide a look into what will happen next, ranging from hours to days. The models are then analyzed by NWS meteorologists who then write and disseminate forecasts (NWS 2013). While winter weather is normal during the winter season for Mercer County, the NWS uses winter weather watches, warnings, and advisories to help people anticipate what to expect in the days and hours prior to an approaching storm.

- A ***winter storm watch*** is issued when severe winter conditions (heavy snow, ice, etc.) may affect a certain area, but its occurrence, location, and timing are uncertain. A watch is issued to provide 24 to 72 hours of notice of the possibility of severe winter weather.
- A ***winter storm warning*** is issued when hazardous winter weather, in the form of heavy snow, heavy freezing rain, or heavy sleet, is imminent or occurring. A warning is usually issued 12 to 24 hours before the event is expected to begin.
- A ***winter weather advisory*** is issued when a hazardous winter weather event is occurring, is imminent, or has a greater than 80 percent chance of occurrence. Advisories are used to inform people that winter weather conditions are expected to cause significant inconveniences and that conditions may be hazardous. These conditions may refer to sleet, freezing rain, or ice storms, in addition to snow events. NWS may also issue a ***blizzard warning*** when snow and strong winds combine to produce the potential for blinding snow, deep drifts, and wind chill (NWS n.d.).

Previous Occurrences and Losses

FEMA Disaster Declarations

Between 1954 and 2021, FEMA declared that the State of New Jersey experienced six winter storm-related disasters (DR), or emergencies (EM) classified as one or a combination of the following disaster types: severe winter storm, severe storm, snowstorm, blizzard, and ice conditions. Generally, these disasters cover a wide

region of the State; therefore, they may have impacted many counties. Mercer County was included in three of these declarations.

Table 4.3.12-2. Winter Weather Related Disaster (DR) and Emergency (EM) Declarations 1954-2021

Declaration	Event Date	Declaration Date	Event Description
EM-3106	March 13-17, 1993	March 17, 1993	Severe Blizzard
DR-1088	January 7-12, 1996	January 13, 1996	Blizzard of 96 (Severe Snowstorm)
EM-3181	February 16-17, 2003	March 20, 2003	Snow
DR-1954	December 26-27, 2010	February 4, 2011	Severe Winter Storm and Snowstorm
DR-4264	January 22-24, 2016	March 14, 2016	Severe Winter Storm and Snowstorm

Source: FEMA 2021

USDA Declarations

Agriculture-related drought disasters are quite common. The USDA Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. From 2015-2021, Mercer County was not included in any USDA disaster declarations for winter storm events (USDA 2021a, USDA 2021b).

Severe Winter Weather Events

NOAA NCEI Storm Events database records and defines severe winter storm events as follows:

- Blizzard is reported in the NOAA-NCEI database when a winter storm which produces the following conditions for 3 consecutive hours or longer: (1) sustained winds or frequent gusts 30 knots (35 mph) or greater, and (2) falling and/or blowing snow reducing visibility frequently to less than 1/4 mile.
- Heavy snow is reported in the NOAA-NCEI database whenever snow accumulation meets or exceed locally/regionally defined 12 and/or 24-hour warning criteria.
- Ice storm is reported in the NOAA-NCEI database when ice accretion meets or exceed locally/regionally defined warning criteria (typical value is 1/4 or 1/2 inch or more).
- Sleet is reported in the NOAA-NCEI database whenever sleet accumulations meet or exceed locally/regionally defined warning criteria (typical value is ½ inch or more).
- Winter storm is reported in the NOAA-NCEI database whenever a winter weather event has more than one significant hazard (i.e., heavy snow and blowing snow; snow and ice; snow and sleet; sleet and ice; or snow, sleet, and ice) and meets or exceeds locally/regionally defined 12 and/or 24-hour warning criteria for at least one of the precipitation elements.

For this 2021 HMP update, winter weather events were summarized from 2015 to 2021. For information regarding severe winter weather events prior to 2015, refer to the Appendix E. For detailed information on damages and impacts to each municipality, refer to Section 9 (jurisdictional annexes).

Table 4.3.12-3. Severe Winter Weather Events in Mercer County, 2015 to 2021

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Mercer County Designated?	Location	Description
January 22-24, 2016	Blizzard	DR-4264	Yes	Mercer 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. Snow began during the evening hours on the 22nd, then continued, heavy at times through the 23rd before ending early on the 24th. Snowfall totals included 24.0 inches in Hamilton Township, 23.0 inches in Hopewell, 22.5 inches in Princeton, 22.0 inches in Trenton, and 18.5 inches in Ewing.
March 14, 2017	Winter Storm	N/A	N/A	Mercer County	Low pressure systems across the Ohio Valley and Carolinas phased. This led to a rapidly developing storm which tracked just offshore. Wind, coastal flooding, heavy rain, and snow all occurred. Heavy rainfall in Southeast New Jersey ranged from 1-3 inches. Snowfall ranged from 4 to 8 inches across the county, some sleet did mix in as well.
January 4, 2018	Winter Storm	N/A	N/A	Mercer County	An area of low pressure tracked up the east coast interacting with a cold front which led to rapid development of a winter storm across the state. This storm quickly moved out by the 5th. However, snowfall accumulations and gusty winds occurred with the storm. Blizzard conditions occurred along many coastal locations. Top wind gusts were generally around 40 mph across the state but were highest in Ocean County, closer to 60 mph. Snow amounts were highest in southern and coastal New Jersey with over 6 inches, 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. Severe cold continued for the next week leading to many locations going to code blue operations. Snowfall was around 6 inches in the county.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Mercer County Designated?	Location	Description
March 7, 2018	Winter Storm	DR-4368	No	Mercer County	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 storm when this storm struck. Governor Murphy estimated about 350,000 customers state-wide lost power as a result of this second storm. Banding and thundersnow produced pockets of heavier snow around the county. Some reported snowfall totals include: 11.5 inches in Hamilton Township, 11.0 inches in Princeton Junction, 10.5 inches in Hopewell, 10.0 inches in East Windsor Township, 9.0 inches in Yardville, 7.5 inches in Lawrenceville, 7.0 inches in Robbinsville, and 6.1 inches in Ewing.
March 21-22, 2018	Winter Storm	N/A	N/A	Mercer 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. The main winter storm snowfall began in the early morning hours of the 21st and continued into the early morning hours on the 22nd. Some reported snowfall amounts include: 10.2 inches in Hamilton Township, 9.1 inches near Hightstown, 9.0 inches near Washington Crossing, 8.8 inches near Hopewell Township, 7.8 inches in Ewing Township, and 7.3 inches just north of Trenton.
March 3-4, 2019	Winter Storm	N/A	N/A	Mercer 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 Princeton reported 3.4 inches of snow. Higher totals likely occurred in the western half of the county based on nearby reports.

Source: NOAA-NCDC 2021; NJOEM 2019; NWS 2021; FEMA 2021
DR Disaster Declaration

FEMA	*Federal Emergency Management Agency*
N/A	*Not Applicable*
NCDC	*National Climatic Data Center*
NOAA	*National Oceanic and Atmospheric Administration*
NWS	*National Weather Service*

Probability of Future Occurrences

Severe winter weather is a common occurrence each winter season in New Jersey. The majority of the State will receive at least one measurable snow event during the 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. Generally, counties in the northern region experience more snow events than those in the southern region. It is estimated that Mercer County will continue to experience the direct and indirect impacts of severe winter weather events annually that many induce secondary hazards such as: structural damage (snow and ice load), wind damage, impact to life safety, disruption of traffic, loss of productivity, economic impact, loss of ability to evacuate, taxing first-responder capabilities, service disruption (power, water, etc.), and communication disruption.

According to the Storm Events Database, Mercer County has been impacted by 62 severe winter storm events between 1950 and 2021 (Table 4.3.12-4). While no events resulted in crop damage, $3.1 million in property damages and 1 death were reported.

Table 4.3.12-4. Probability of Future Occurrence of Severe Winter Weather Events

Hazard Type	Number of Occurrences Between 1950 and 2021	Annual Number of Events (average)	Recurrence Interval* (in years)	Probability of Event Occurring in Any Given Year	Percent Chance of Occurring in Any Given Year
Blizzard	2	0.03	36.00	0.03	2.8
Heavy Snow	28	0.39	2.57	0.39	38.9
Ice Storm	0	0.00	0.00	0.00	0.00
Sleet	3	0.04	24.00	0.04	4.2
Winter Storm	29	0.41	2.48	0.40	40.3
Total	**62**	**0.87**	**1.16**	**0.86**	**86.1**

Source: NOAA-NCEI 2021

In Section 4.4, the identified hazards of concern for Mercer 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 severe winter weather in the County is considered 'frequent'. The ranking of the severe winter weather hazard for individual municipalities is presented in the jurisdictional annexes.

Climate Change Impacts

Climate change includes major changes in temperature, precipitation, or wind patterns, which occur over several decades or longer. 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). Thus, New Jersey can expect to experience an average annual temperature that is warmer than any to date (low emissions scenario) and future temperatures could be as much as 10° F (5.6° C) warmer (high emissions scenario) (Runkle et al. 2017). New Jersey can also expect that by the middle of the 21st century, 70 percent of summers will be hotter than the warmest summer experienced to date (Runkle et al. 2017). The increase in temperatures is expected to be felt more during the winter months (December, January, and February), resulting in less intense cold waves, fewer sub-freezing days, and less snow accumulation.

As temperatures increase, Earth's atmosphere can hold more water vapor which leads to a greater potential for precipitation. Currently, New Jersey receives an average of 46 inches of precipitation each year (Office of the New Jersey State Climatologist 2020). 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 percent increase. By 2050, annual precipitation in New Jersey could increase by 4 percent to 11 percent (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).

4.3.13 VULNERABILITY ASSESSMENT

All of Mercer County is vulnerable to severe winter storm events. The following subsections discuss Mercer County's vulnerability, in a qualitative nature, to the severe winter weather hazard.

Impact on Life, Health and Safety

According to the NOAA National Severe Storms Laboratory (NSSL); every year, winter weather indirectly and deceptively kills hundreds of people in the U.S., primarily from automobile accidents, overexertion, and exposure (NSSL 2020). Winter storms are often accompanied by strong winds creating blizzard conditions with blinding wind-driven snow, drifting snow and extreme cold temperatures and dangerous wind chill. They are considered deceptive killers because most deaths and other impacts or losses are indirectly related to the storm. People can die in traffic accidents on icy roads, heart attacks while shoveling snow, or of hypothermia from prolonged exposure to cold (NOAA 2017).

The entire population of Mercer County (367,922 people) is exposed to severe winter storm events (U.S. Census, 2019). Snow accumulation and frozen/slippery road surfaces increase the frequency and impact of traffic accidents for the general population, resulting in personal injuries. The elderly are considered most susceptible to this hazard due to their increased risk of injuries and death from falls and overexertion and/or hypothermia from attempts to clear snow and ice. In addition, severe winter storm events can reduce the ability of these populations to access emergency services.

Residents with low incomes may not have access to housing or their housing may be less able to withstand cold temperatures (e.g., homes with poor insulation and heating supply). According to the 2019 ACS 5-Year estimates, Mercer County has 54,941 elderly residents and 40,980 persons with low-income. Refer to Section 3 (County Profile) for population statistics for each participating municipality.

Impact on General Building Stock

The entire general building stock inventory is exposed and vulnerable to the severe winter storm hazard. In general, structural impacts include damage to roofs and building frames, rather than building content. Current modeling tools are not available to estimate specific losses for this hazard. As an alternate approach, this plan considers percentage damages that could result from severe winter storm conditions. Table 4.3.12-5 below summarizes percent damages that could result from severe winter storm conditions for the Planning Area's total general building stock. Given professional knowledge and the currently available information, the potential loss for this hazard is many times considered to be overestimated because of varying factors (building structure type, age, load distribution, building codes in place, etc.). Therefore, the following information should be used as estimates only for planning purposes with the knowledge that the associated losses for severe winter storm events vary greatly.

Table 4.3.12-5 General Building Stock Exposure and Estimated Losses from Severe Winter Storm Events

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value	1-Percent of Total Replacement Cost Value	5-Percent of Total Replacement Cost Value	10-Percent of Total Replacement Cost Value
East Windsor (Twp)	5,439	$7,712,408,240	$77,124,082	$385,620,412	$771,240,824
Ewing (Twp)	12,054	$18,161,858,212	$181,618,582	$908,092,911	$1,816,185,821
Hamilton (Twp)	29,515	$30,878,928,699	$308,789,287	$1,543,946,435	$3,087,892,870
Hightstown (B)	1,624	$1,867,544,787	$18,675,448	$93,377,239	$186,754,479
Hopewell (B)	844	$850,167,003	$8,501,670	$42,508,350	$85,016,700
Hopewell (Twp)	7,719	$11,709,101,176	$117,091,012	$585,455,059	$1,170,910,118
Lawrence (Twp)	9,027	$14,232,035,476	$142,320,355	$711,601,774	$1,423,203,548
Pennington (B)	953	$1,009,760,468	$10,097,605	$50,488,023	$100,976,047
Princeton	7,527	$12,608,393,758	$126,083,938	$630,419,688	$1,260,839,376
Robbinsville (Twp)	4,162	$7,167,631,183	$71,676,312	$358,381,559	$716,763,118
Trenton (C)	17,152	$36,604,311,832	$366,043,118	$1,830,215,592	$3,660,431,183
West Windsor (Twp)	7,563	$13,179,360,332	$131,793,603	$658,968,017	$1,317,936,033
Mercer County (Total)	**103,579**	**$155,981,501,165**	**$1,559,815,012**	**$7,799,075,058**	**$15,598,150,117**

Source: Mercer County GIS 2020; RS Means 2021
Values represent estimated replacement cost.

A specific area that is vulnerable to the severe winter storm hazard is the floodplain. Severe winter storms can cause flooding through blockage of streams or through snow melt. At-risk residential infrastructures are presented in the flood hazard profile (Section 4.3.5). Generally, losses resulting from flooding associated with severe winter storms should be less than that associated with a 100-year flood. Please refer to the Severe Weather (Section 4.3.11) profile for losses resulting from high winds which may also accompany severe winter weather.

Impact on Critical Facilities and Lifelines

Full functionality of critical facilities such as police, fire and medical facilities is essential for response during and after a severe winter storm event. These structures are largely constructed of concrete and masonry; therefore, they should only suffer minimal structural damage from severe winter storm events. Because power interruption can occur, backup power is recommended. Infrastructure at risk for this hazard includes roadways that could be damaged due to the application of salt and intermittent freezing and warming conditions that can damage roads over time. Severe snowfall requires the clearing roadways and alerting citizens to dangerous conditions; following the winter season, resources for road maintenance and repair are required.

Heavy snow can immobilize a region and paralyze a city, stranding commuters, stopping the flow of supplies, and disrupting emergency and medical services. Heavy accumulations of ice can bring down trees, electrical wires, telephone poles and lines, and communication towers. Communications and power can be disrupted for days while utility companies work to repair the extensive damage. Even small accumulations of ice may cause extreme hazards to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces (NSSL 2020).

Impact on Economy

The cost of snow and ice removal and repair of roads from the freeze/thaw process can drain local financial resources. Another impact on the economy includes impacts on commuting into, or out of, the area for work or

school. The loss of power and closure of roads prevents the commuter population traveling to work within and outside of the County. During the 2019-2020 winter season, the State of New Jersey Department of Transportation budgeted winter maintenance expenditures at $36.9 million, which includes costs for salt (124,911 tons), liquid calcium chloride (247,424 gallons), and brine (270,820 gallons) (NJDOT 2020).

Impact on the Environment

Severe winter weather can have a major impact on the environment. Not only does winter weather create changes in natural processes, the residual impacts of a community's methods to maintain its infrastructure through winter weather maintenance may also have an impact on the environment. For example, an excess amount of snowfall and earlier warming periods may affect natural processes such as flow within water resources. Rain-on-snow events can also exacerbate runoff rates with warming winter weather. Consequentially, these flow rates and excess volumes of water can erode banks, tear apart habitat along the banks and coastline, and disrupt terrestrial plants and animals.

Furthermore, chemically based winter maintenance practices have its own effect on the natural environment. Melting snow and ice that carry deicing chemicals onto vegetation and into soils can contaminate the local waterways. Elevated salt levels may hinder vegetation from absorbing nutrients, slowing plant growth (UMass Extension 2020).

Future Growth and Development

Understanding future changes that impact vulnerability in the County can assist in planning for future development and ensure that appropriate mitigation, planning, and preparedness measures are in place. The County considered the following factors to examine potential conditions that can affect hazard vulnerability:

- Potential or projected development.
- Projected changes in population.
- Other identified conditions as relevant and appropriate, including the impacts of climate change.

Projected Development

As discussed in Sections 3 and 9, areas targeted for future growth and development have been identified across Mercer County. Any areas of growth could be potentially impacted by the severe winter storm hazard because the entire planning area is exposed and vulnerable. However, due to increased standards and codes, new development may be less vulnerable to the severe winter weather hazard compared with the aging building stock in the County.

Projected Changes in Population

From 2010 to 2019, Mercer County has experienced a 2.3% increase in population over the age of 65; from 12.6 to 14.9%. Residents over the age of 65 may be more vulnerable to severe winter storm events as previously discussed. Refer to Section 3 (County Profile), which includes a discussion on population trends for 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 extremes such winter storms. While predicting changes of winter storm events 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 (U.S. Environmental Protection Agency [EPA], 2020).

Both northern and southern New Jersey have become wetter over the past century. In terms of long-term changes in snowfall and ice storms in New Jersey, 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.

An increase in the frequency and severity of severe winter storms could result in an increase of snow loads on the County's building stock and infrastructure, putting each building at risk to structural damage. More frequent and severe events also will result in increased resources spent to prepare for and clean-up after an event. However, as winter temperatures continue to rise, climate projections indicate the increase in precipitation is likely to occur during the winter months as rain. Increased rain on snowpack or frozen or saturated soils can lead to increased flooding and related impacts on the County's assets.

Change of Vulnerability

The entire County remains exposed and vulnerable to severe winter storm events.