5.4.9 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 Cape May County.

2021 Plan Update Changes

- New and updated figures from federal and state agencies are incorporated.
- A new table explaining prior severe winter weather events was added.
- Previous occurrences were updated with events that occurred between 2016 and 2020.
- A vulnerability assessment was conducted for the severe winter weather hazard using a more accurate and updated building inventory.

5.4.9.1 Profile

Hazard Description

A winter storm is a weather event in which the main types of precipitation are snow, sleet, or freezing rain. They can be a combination of heavy snow, blowing snow, and dangerous wind chills. According to the National Severe Storms Laboratory (n.d.), the three basic components needed to make a winter storm include the following:

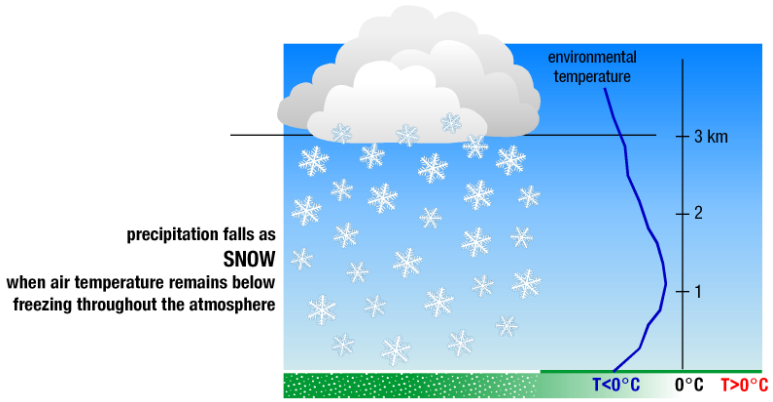
- Below freezing temperatures (cold air) in the clouds and near the ground to make snow and ice.
- Lift, something to raise the moist air to form clouds and cause precipitation, such as warm air colliding with cold air and being forced to rise over the cold dome or air flowing up a mountainside (oliographic lifting).
- Moisture to form clouds and precipitation, such as air blowing across a large lake or the ocean.

Some winter storms can immobilize an entire region, while others might only affect a single community. Winter storms typically are 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 blocked roadways, downed utility lines, and power outages. Cape May County's winter weather events include blizzards, snow storms, Nor'Easters, and ice storms. For details regarding Nor'Easters, refer to Section 5.4.7.

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 °F) and 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 a snow pellet, which then falls to the earth. Snow falls in different forms: snowflakes, snow pellets, or sleet. Snowflakes are clusters of ice crystals that form from a cloud. Figure 5.4.9-1 depicts snow creation.

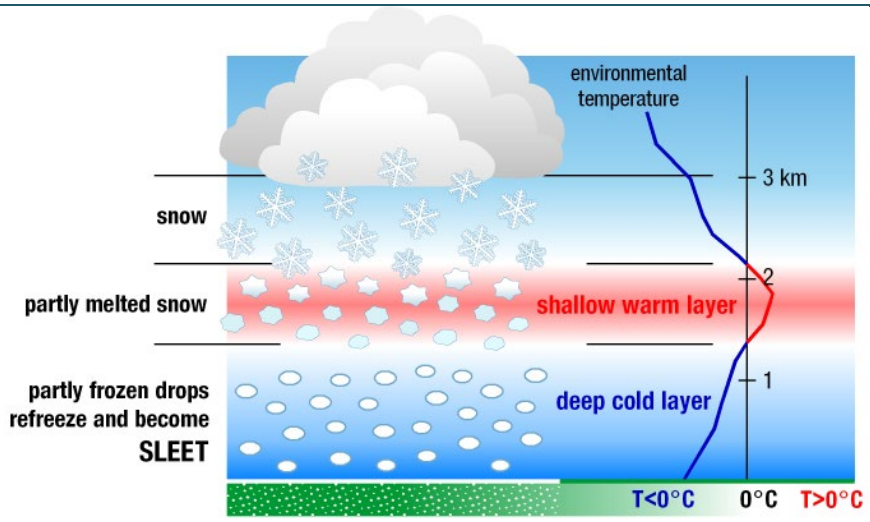
Figure 5.4.9-1. Snow Creation



Source: NOAA-NSSL, 2015

Snow pellets are opaque ice particles in the atmosphere. They form as ice crystals fall through super-cooled cloud droplets, which are below freezing but remain a liquid. The cloud droplets then freeze to the crystals. Sleet is made up of drops of rain that freeze into ice as they fall through colder air layers (see Figure 5.4.9-2). They are usually smaller than 0.30 inches in diameter (NSIDC 2020).

Figure 5.4.9-2. Sleet Creation



Source: NOAA-NSSL 2020

Blizzards

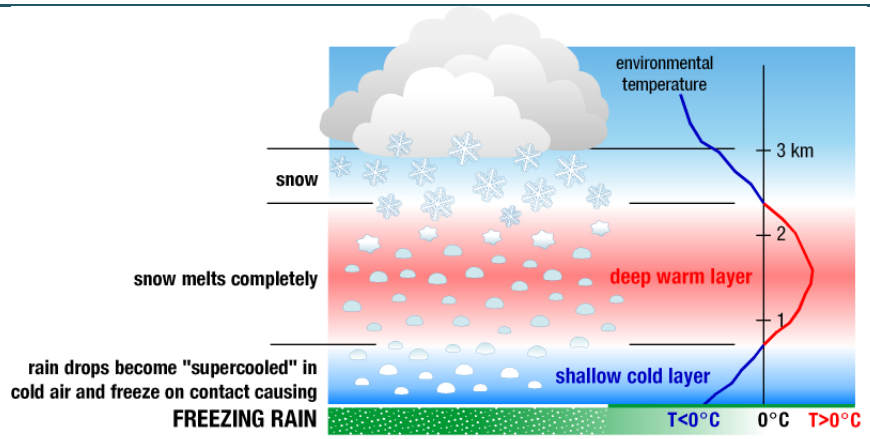
A blizzard is a winter snowstorm with sustained or frequent wind gusts of 35 miles per hour (mph) or more, accompanied by falling or blowing snow reducing visibility to or below 0.25 mile, as the predominant conditions over a 3-hour period. Extremely cold temperatures often are associated with blizzard 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 (Dolce 2018).

Ice Storms

An ice storm describes those events when damaging accumulations of ice are expected during freezing rain situations. Significant ice accumulations typically are accumulations of 0.25-inches or greater (NWS 2013). Heavy accumulations of ice can bring down trees, power lines, utility poles, and communication towers. Ice can disrupt communications and power for days. Even small accumulations of ice can be extremely dangerous to motorists and pedestrians (Dolce 2018).

Figure 5.4.9-3. Freezing Rain Creation



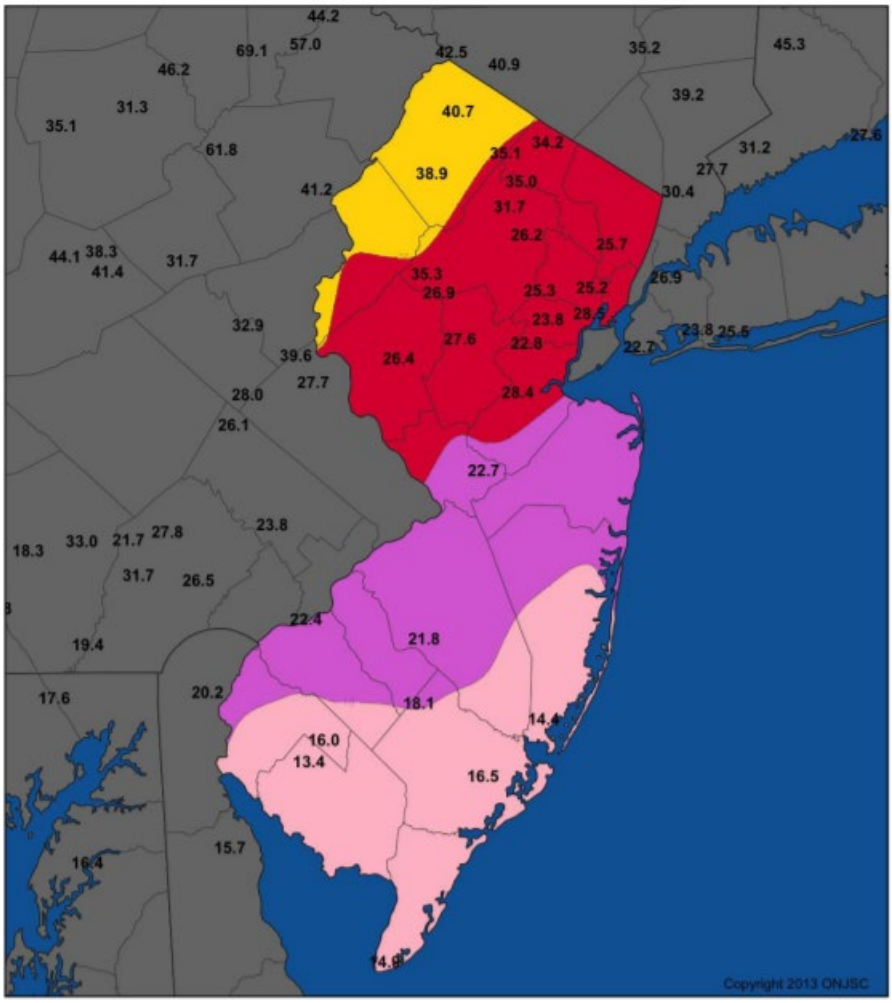
Source: NOAA-NSSL 2020

Location

Snow and Blizzards

Heaviest snowfall from winter storms is typically within a 150-mile wide swath to the northwest of what are generally southwest to northeast moving storms. The trajectory of the snowstorm will determine the location of heaviest snowfalls. Typical seasonal snowfall in New Jersey ranges from 14.9 inches annually in Cape May County to more than 40 inches in Sussex County. However, there is great variability from year to year. For example, the winter of 2019-2020 yielded 0.9 inches of accumulation total in Cape May County. The prior year (2018-2019) saw 10.5 inches of snow fall, whereas the 2017-2018 season saw 19.5 inches. The highest seasonal snowfall on record for the County was during the 2009-2010 season, when 54.2 inches of snow fell. The 2019-2020 season saw among the five lowest seasonal snowfall totals on record (ONJSC 2020). The following map displays normal seasonal snowfall totals between 1981 and 2019.

Figure 5.4.9-4. NJ Normal Seasonal Snowfall Totals (1981-2019)



Ice Storms

Cape May County, like 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.

Extent

The magnitude or severity of a severe winter storm depends on several factors, including snowfall rates, regional climatological susceptibility to snowstorms, snowfall amounts, wind speeds, temperatures, visibility, storm duration, topography, time of occurrence during the day and week (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 2010 Census. The NCDC has analyzed and assigned RSI values to over 500 storms since 1900 (NOAA 2015). Table 5.4.9-1 presents the five RSI ranking categories.

Table 5.4.9-1. 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 2015
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.

The NWS uses winter weather watches, warnings and advisories to ensure that people know what to expect in the coming hours and days. A winter storm watch means that 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 12 to 48 hour notice of the possibility of severe winter weather. A watch is upgraded to a winter storm warning when hazardous winter weather, in the form of heavy snow, heavy freezing rain or heavy sleet, is imminent or occurring. They are usually issued 12 to 24 hours before the event is expected to begin. Winter weather advisories inform people that winter weather conditions are expected to cause significant inconveniences that may be hazardous. The NWS may also issue a blizzard warning when snow and strong winds combine and produce a blinding snow, deep drifts, and wind chill (NWS 2013).

Previous Occurrences and Losses

Numerous sources provided winter storm information regarding previous occurrences and losses associated with winter storm events throughout Cape May County. Loss and impact information for many events could not be determined or may vary. Therefore, the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP.

FEMA Disaster Declarations

Between 1954 and 2020, FEMA declared that the State of New Jersey experienced eight 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. Cape May County was included in six of these declarations. **Table 5.4.9-2** lists FEMA DR and EM declarations that included Cape May County.

Table 5.4.9-2. FEMA Declarations for Severe Winter Weather Events in Cape May County

FEMA Declaration Number	Date(s) of Event	Event Type	Counties Included
DR-528	February 8, 1977	Ice Conditions	Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester, Middlesex, Monmouth, Ocean, and Salem

Table 5.4.9-2. FEMA Declarations for Severe Winter Weather Events in Cape May County

FEMA Declaration Number	Date(s) of Event	Event Type	Counties Included
EM-3106	March 13-17, 1993	Severe Blizzard	All 21 Counties in New Jersey
DR-1088	January 7-12, 1996	Blizzard of '96 (severe snow storm)	All 21 Counties in New Jersey
DR-1206	February 4-8, 1998	Severe Winter Coastal Storm, High Winds, Flooding	Atlantic, Cape May, and Ocean
DR-1889	February 5-6, 2010	Severe Winter Storm and Snowstorm	Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester and Salem
DR-1954	December 26-27, 2010	Severe Winter Storm and Snowstorm	Atlantic, Bergen, Burlington, Cape May, Cumberland, Essex, Hudson, Mercer, Middlesex, Monmouth, Morris, Ocean, Passaic, Somerset, and Union
DR-4264	January 22-24, 2016	Severe Winter Storm and Snowstorm	Atlantic, Bergen, Burlington, Camden, Cape May, Cumberland, Essex, Hudson, Hunterdon, Mercer, Middlesex, Monmouth, Morris, Ocean, Somerset, Union and Warren

Source: FEMA 2020

U.S. Department of Agriculture Disaster Declarations

Between 2016 and 2020, the period for which data was available, Cape May County was not included in any winter weather-related USDA declarations.

Previous Events

For this 2021 Plan update, winter weather events were summarized from 2016 to 2020. For information regarding severe winter weather events prior to 2016, refer to Appendix E (Supplementary Data). For detailed information on damages and impacts to each municipality, refer to Section 9 (jurisdictional annexes).

Table 5.4.9-3. Severe Winter Weather Events in Cape May County, 2016 to 2020

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Event Details*
January 17, 2016	Winter Weather	N/A	No	Southern and Coastal New Jersey were impacted by one to three inches of winter precipitation, resulting in vehicular accidents in some areas.
January 22, 2016	Winter Storm	DR-4264	Yes	A storm impulse from the west coast developed into a nor'easter over the Carolinas, resulting in blizzard conditions to the County. Approximately one foot of snow fell, and wind gusts up to 64 mph were recorded in the County. The storm, known as Jonas, caused widespread power failures and flooding throughout the County.
February 5, 2016	Winter Weather	N/A	No	Shore areas of New Jersey saw heavy, wet snow following a north-moving low pressure system located offshore.
February 15, 2016	Winter Weather	N/A	No	A low pressure system from the Tennessee River Valley brought early snow followed by freezing rain and rain.
March 3, 2016	Winter Storm	N/A	No	Southern New Jersey saw high accumulations of snow resulting from an intensifying low-pressure system off the coast of North Carolina.
April 9, 2016	Winter Weather	N/A	No	Late-season snow brought approximately three inches to the County. The snow was followed by low temperatures, which caused localized plant damage.
December 17, 2016	Winter Weather	N/A	No	Cape May County saw a wintry mix of precipitation, resulting in a small amount of snowfall and ice glaze.

Table 5.4.9-3. Severe Winter Weather Events in Cape May County, 2016 to 2020

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Event Details*
January 5, 2017	Winter Weather	N/A	No	The region received snowfall resulting from a clipper system combining with a northeast-moving low pressure system.
January 7, 2017	Winter Storm	N/A	No	Cape May County saw approximately eight inches of snow resulting from a strengthening low-pressure system located off the coast.
February 9, 2017	Winter Weather	N/A	No	Rain and minor slow accumulations were experienced in the region, followed by gusty winds following a strong cold front.
December 8, 2017	Winter Weather	N/A	No	Approximately three inches of snow were recorded in the coastal and southwestern sections of New Jersey following a low pressure system moving up the coast. Some mixed precipitation was recorded.
January 4, 2018	Blizzard	N/A	No	Blizzard conditions – with winds up to 40 mph – were experienced in Cape May County, resulting in a State of Emergency. The blizzard was followed by protracted cold conditions, leading to Code Blue operations and the closure of the Cape May Lewes Ferry.
March 7, 2018	Winter Weather	N/A	No	A low pressure system deepened as it passed east of the New Jersey Shore, causing mixed precipitation and then predominantly snow. A number of downed trees were recorded resulting from wet, heavy snow. Smaller amounts of precipitation were recorded in Cape May County.
March 21, 2018	Winter Storm	N/A	No	Cape May County saw minor coastal flooding and mixed precipitation following a complex area of low pressure moving into the region. Snow developed in Cape May County relatively later, resulting in only three inches of snow, which was wet and heavy in character.
December 5, 2018	Winter Weather	N/A	No	Localized snowfall was recorded due to a Norlun Trough, resulting in up to four inches of snow, with higher totals recorded in the northern portion of the Country.
January 12, 2019	Winter Weather	N/A	No	Cape May County was struck by a weekend winter storm, yielding approximately 4.7 inches of snow.
February 1, 2019	Winter Weather	N/A	No	Cape May County experienced light snow during an Arctic airmass outbreak.
February 10, 2019	Winter Weather	N/A	No	Light snow was recorded in the southern mid-Atlantic region, which was followed by the second part of the storm that brought wintry mix and rain.
February 20, 2019	Winter Weather	N/A	No	Mixed precipitation amounting to several inches of snow and freezing rain was recorded in the region following a complex area of low pressure.
March 1, 2019	Winter Weather	N/A	No	Two to four inches fell over a three-hour period during a brief but intense winter weather event.

Sources: FEMA 2020; NOAA-NCEI 2020; SPC 2020; NJOSC 2020
** Many sources were consulted to provide an update of previous occurrences and losses; event details and loss/impact information may vary and has been summarized in the above table*
DR Major Disaster Declaration (FEMA)
FEMA Federal Emergency Management Agency
Mph Miles per Hour
NCEI National Centers for Environmental Information
NJOSC New Jersey State Climatologist
NOAA National Oceanic and Atmospheric Administration
N/A Not Applicable

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 Cape May 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.

Table 5.4.9-4 summarizes data regarding the probability of occurrences of severe winter weather events in Cape May County based on the historic record. To calculate the probability, the NOAA-NCEI database was queried for all winter weather-related events in Cape May County. Table 5.4.9-4 shows the number of occurrences and the percent chance of the event occurring in any given year. The information used to calculate the probability of occurrences is based solely on NOAA-NCEI storm events database results.

Table 5.4.9-4. Probability of Future Occurrence of Severe Winter Weather Events

Hazard Type	Number of Occurrences Between 1950 and 2020	% Chance of Occurring in Any Given Year
Blizzard	3	4.2
Ice Storm	0	0
Heavy Snow	23	33
Winter Storm	20	28.5
Winter Weather	82	100%
Total	**128**	**100%**

Source: NOAA-NCEI 2020
Note: Disaster occurrences include federally declared disasters since the 1950 Federal Disaster Relief Act, and selected storm events since 1950. Due to limitations in data, not all severe winter weather events occurring between 1950 and 1996 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated.

In Section 5.3, the identified hazards of concern for Cape May 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 Partnership, the probability of occurrence for severe winter weather in the County is considered 'frequent' (100% chance occurring each year, occurring multiple times a year).

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% 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% 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).

5.4.9.2 Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. For the severe winter weather hazard, all of Cape May County has been identified as the hazard area. Therefore, all assets in the County (population, structures, critical facilities and lifelines), as described in the County Profile (Section 4), are vulnerable to a winter weather event.

Impact on Life, Health and Safety

The entire population of Cape May County (93,705 people) is exposed to severe winter weather events (U.S. Census, 2018). 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. 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 (NSSL 2020).

The homeless and elderly are considered most susceptible to this hazard. The elderly are considered 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. According to the 2018 American Community Survey 5-Year population estimate, there are 23,572 persons over 65 years old that reside in the County that are considered vulnerable to severe winter weather. In addition, severe winter weather can reduce the ability of these populations to access emergency services.

Additionally, the homeless and residents below the poverty level may not have access to housing or their housing could be less able to withstand cold temperatures (e.g., homes with poor insulation and heating supply). Residents with low incomes might not have access to housing or their housing can be less able to withstand cold temperatures (e.g., homes with poor insulation and heating supply). In Cape May County, the Borough of Woodbine has the highest population below the poverty level (i.e., 690 persons). Refer to Section 4 (County Profile) that displays the distribution of low-income populations in Cape May County.

Impact on General Building Stock

The entire general building stock inventory is exposed and vulnerable to the severe winter weather hazard. In general, structural impacts include damage to roofs and building frames, rather than building content. Table 5.4.9-5 presents the total exposure value for general building stock for each participating municipality.

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 5.4.9-5 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 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 weather events vary greatly.

Table 5.4.9-5. General Building Stock Exposure and Estimated Losses from Severe Winter Weather Events

Jurisdiction	Number of Buildings	Total Replacement Cost Value (RCV)	1-Percent of Total Replacement Cost Value	5-Percent of Total Replacement Cost Value	10-Percent of Total Replacement Cost Value
Avalon Borough	5,867	$8,232,959,879	$82,329,599	$411,647,994	$823,295,988
Cape May City	4,234	$5,153,049,612	$51,530,496	$257,652,481	$515,304,961
Cape May Point Borough	785	$663,183,164	$6,631,832	$33,159,158	$66,318,316
Dennis Township	7,301	$3,813,425,173	$38,134,252	$190,671,259	$381,342,517
Lower Township	19,597	$9,950,232,225	$99,502,322	$497,511,611	$995,023,223
Middle Township	18,197	$11,557,342,752	$115,573,428	$577,867,138	$1,155,734,275
North Wildwood City	4,729	$4,423,365,953	$44,233,660	$221,168,298	$442,336,595
Ocean City	18,172	$17,100,920,036	$171,009,200	$855,046,002	$1,710,092,004
Sea Isle City	6,712	$7,663,928,227	$76,639,282	$383,196,411	$766,392,823
Stone Harbor Borough	3,836	$3,291,756,871	$32,917,569	$164,587,844	$329,175,687
Upper Township	9,627	$6,506,171,365	$65,061,714	$325,308,568	$650,617,137
West Cape May Borough	1,623	$1,178,516,373	$11,785,164	$58,925,819	$117,851,637
West Wildwood Borough	805	$459,103,094	$4,591,031	$22,955,155	$45,910,309
Wildwood City	3,679	$4,379,038,844	$43,790,388	$218,951,942	$437,903,884
Wildwood Crest Borough	5,410	$4,552,156,876	$45,521,569	$227,607,844	$455,215,688
Woodbine Borough	1,416	$1,335,589,432	$13,355,894	$66,779,472	$133,558,943
Cape May County (Total)	**111,990**	**$90,260,739,877**	**$902,607,399**	**$4,513,036,994**	**$9,026,073,988**

Source: Cape May County GIS 2020; RS Mean 2019

A specific area that is vulnerable to the severe winter weather 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 5.4.5). 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 Hurricanes and Tropical Storms (Section 5.4.6) profile and Nor'Easter (Section 5.4.7) profile for losses resulting from high winds which may also accompany severe winter weather.

Impact on Critical Facilities

Full functionality of critical facilities such as police, fire and medical facilities is essential for response during and after a severe winter weather event. These critical facility structures are largely constructed of concrete and masonry; therefore, they should only suffer minimal structural damage from severe winter weather 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 (NSSL 2020).

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.

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 (USGS 2020). 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. Road-salt runoff can cause groundwater salinization, modify the soil structure, and result in loss or reduction in lake turnover. Additionally, road salt can cause changes in the composition of aquatic invertebrate assemblages and pose threats to birds, roadside vegetation, and mammals (Tiwari and Rachlin).

Chemically based winter maintenance practices have its own effect on the natural environment. Melting snow and ice that carry de-icing chemicals onto vegetation and into soils can contaminate the local waterways. Elevated salt levels may hinder vegetation from absorbing nutrients, slowing plant growth.

Cascading Impacts on Other Hazards

Severe winter weather events may exacerbate flooding. As discussed, the freezing and thawing of snow and ice associated with winter weather events can create major flooding issues in the County. Maintaining winter weather hazards through snow and ice removal could minimize the potential risk of flooding during a warming period. Refer to 5.4.5 (Flood) for more information about the flood hazard of concern.

Future Changes That May Impact Vulnerability

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

- Potential or projected development

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

Project Development

As discussed in Sections 4 and 9, areas targeted for future growth and development have been identified across Cape May County. Any areas of growth could be potentially impacted by the severe winter storm hazard because the entire planning area is exposed and vulnerable. Please refer to the specific areas of development indicated in tabular form and/or on the hazard maps included in the jurisdictional annexes in Volume II, Section 9 of this plan.

Projected Changes in Population

Between 2000 and 2010, the County lost nearly five percent of its population. Between 2010 and 2020, the County is expected to have experienced a similar decrease. It is expected that in the next 20 years, population growth will be relatively stagnant (U.S. Census Bureau 2020, SJTPO). Overall, aging infrastructure may result in increased stress on existing infrastructure and related services. Although overall County growth is not expected, individual municipalities that experience increases in population may require utility system upgrades to keep up with utility demands (e.g., water, electric) during winter weather events to prevent increased stresses on these systems. Refer to Section 4 (County Profile) for a detailed discussion on population change in Cape May 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] 2016).

Both northern and southern New Jersey have become wetter over the past century. Northern New Jersey's 1971-2000 precipitation average was over five inches (12%) greater than the average from 1895-1970. Southern New Jersey became two inches (5%) wetter late in the 20th century (Office of New Jersey State Climatologist). Average annual precipitation is projected to increase in the region by 5% by the 2020s and up to 10% by the 2050s. Most of the additional precipitation is expected to come during the winter months (New York City Panel on Climate Change [NPCC] 2009).

In terms of 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 (Sustainable Jersey Climate Change Adaptation Task Force 2013). Future enhancements in climate modeling will provide an improved understanding of how the climate will change and impact the Northeast.

Change of Vulnerability Since 2016 HMP

The entire County continues to be vulnerable to the severe winter weather hazard. The 2010 HMP used default general building stock data from HAZUS-MH MR4. The 2016 HMP update provided damage estimates using an updated custom building stock based on 2015 MODIV tax assessment data. The 2021 updated vulnerability assessment provides a more current and accurate assessment for the County.