



## 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 Hunterdon County.

### 2021 HMP CHANGES

- New and updated figures from federal and state agencies are incorporated.
- Previous occurrences were updated with events that occurred between 2015 and 2020.

#### 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 Hunterdon 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 5.4.7 (Nor'Easters) and Section 5.4.8 (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 Hunterdon County is approximately 40 to 50 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, Hunterdon County can anticipate 2-4 days with freezing rain per year (Changnon & Karl. 2003). Based on data from 1932–2001, the County can anticipate 12-18 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 National Oceanic and Atmospheric Administration’s (NOAA) National Climatic Data Center (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 5.4.9-1 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 Hunterdon 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 2020, 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. Hunterdon County was included in three of these declarations.

**Table 4.3.12-2. Winter Weather Related Disaster (DR) and Emergency (EM) Declarations 1954-2020**

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-4264	January 22 - 24, 2016	March 14, 2016	Severe Winter Storm and Snowstorm

Source: FEMA 2020

### 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 2015-2020, Hunterdon County was not included in any USDA disaster declarations for winter storm events (USDA 2020, USDA 2020a).

### Severe Winter Weather Events

The National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (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 1/2 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.
- Winter weather is reported in the NOAA-NCEI database when a winter precipitation event causes a death, injury, or a significant impact to commerce or transportation, but does not meet locally/regionally defined warning criteria.

For this 2021 HMP update, winter weather events were summarized from 2015 to 2020. For information regarding severe winter weather events prior to 2015, refer to the Appendix G. 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 Hunterdon County, 2015 to 2020

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Hunterdon County Designated?	Location	Description
January 23-24, 2015	Winter Storm	N/A	N/A	Hunterdon County	<p>A winter storm dropped heavy snow in Northwest New Jersey and a mixture of snow, sleet and freezing rain in the central and southwest part of New Jersey on the evening of the 23rd into the morning of the 24th. Overall less wintry precipitation (a faster switch to rain) occurred progressively farther to the south and southeast in the state. Snowfall averaged 5 to 9 inches in northwest New Jersey; 2 to 5 inches in central New Jersey and less than two inches across southwest New Jersey. No snow fell in southeast New Jersey. Ice accumulations were generally around a trace. The snow caused traveling difficulties as well as postponement of social activities on the 24th. There were over 100 reported accidents in the state. The snow and accidents caused about 2,000 homes and businesses to lose power. New Jersey Transit cross-honored all commuting tickets. The onshore flow from the winter storm also caused minor tidal flooding in southern New Jersey during the morning high tide cycle on the 24th.</p> <p>Precipitation started as snow on the evening of the 23rd from southwest New Jersey northward between 9 p.m. EST and Midnight EST. In Northwest New Jersey, the snow fell at its heaviest during the pre-dawn hours on the 24th and ended between 8 a.m. EST and 10 a.m. EST on the 24th. In the Raritan Valley, snow also fell at its heaviest during the pre-dawn hours on the 24th, but then changed to freezing rain and sleet between 4 a.m. EST and 6 a.m. EST on the 24th. Precipitation in some areas changed to plain rain before ending later that morning. In the central third of New Jersey, a change to rain (with some sleet at the transition time) worked its way to the northwest from coastal areas and occurred between 1 a.m. EST and 5 a.m. EST on the 24th and remained rain until it ended around 8 a.m. EST on the 24th.</p> <p>Representative snowfall included 6.8 inches in Clinton (Hunterdon County).</p>
February 1, 2015	Winter Storm	N/A	N/A	Hunterdon County	<p>A winter storm brought a heavy mixture of snow, some sleet and freezing rain to the Raritan Valley and northwest New Jersey with less of a wintry impact to the rest of central and southwest New Jersey on the first into the second. The storm greatly impacted the morning commute on the 2nd in the northwest part of the state.</p> <p>Precipitation started as snow throughout the northern half and southwest part of New Jersey during the evening of the 1st. Precipitation fell as rain in the southeast part of the state throughout the event. In southwest New Jersey, the snow transitioned briefly to sleet and then rain early on the 2nd. The rain briefly changed to snow before ending in the mid afternoon on the 2nd. In northwest New Jersey including the Passaic Basin, the snow transitioned to a sleet and/or freezing rain mixture during the morning of the 2nd, then changed back to snow by early afternoon and ended during the middle of the afternoon on the 2nd.</p> <p>Speed restrictions were in place on most major roadways in central and northern New Jersey on the 2nd. Speed restrictions were also in place on all of the Delaware River bridges in the Philadelphia Metropolitan area. In northern New Jersey, accidents were reported on Interstates 78 and 80 in Warren and Hunterdon Counties. Many schools in northwest New Jersey</p>



Section 4.3.12: Risk Assessment – Severe Winter Weather

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					were closed on the 2nd. Many schools in central New Jersey had delayed openings on the 2nd. Representative snowfall included 7.5 inches in Lebanon (Hunterdon County).
March 5, 2015	Heavy Snow	N/A	N/A	Hunterdon County	Waves of low pressure that formed along a sinking cold front brought New Jersey heavy snow and the southern half of the state its heaviest snow of the season. Snowfall averaged 4 to 9 inches with the highest amounts in central New Jersey. Less snow fell in Sussex County. The heavy snow prompted Governor Chris Christie to declare a state of emergency and close state offices to non emergency personnel. Nearly all schools and universities in the state were closed on the 5th. Many were also closed the next day. The snow also caused hazardous travel and hundreds of accidents, including a fatal one in Somerset County. New Jersey Transit cross-honored transit tickets on the 5th and 6th. Precipitation with this event started as rain on the 4th. As colder air moved in from the north and precipitation intensity increased, the rain changed to all snow in northwest New Jersey between Midnight EST and 3 a.m. EST on the 5th. The precipitation changeover included sleet in southeast New Jersey. The snow fell heavy at times in the central and southern part of the state from the late morning into the mid afternoon on the 5th. The snow ended during the late morning of the 15th in Sussex County. In the rest of the state it ended from northwest to southeast between 6 p.m. EST and 10 p.m. EST on the 5th. The impact from the winter storm continued into the 6th. Many schools were closed. The PARCC school tests had to be rescheduled. Dozens of accidents occurred on the Garden State Parkway in Monmouth County. One hour drives were taking three hours. Representative snowfall included 6.8 inches in Lambertville (Hunterdon County).
January 22-24, 2016	Blizzard	DR-4264	Yes	Hunterdon 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. Some representative snowfall totals include 29.6 inches in Whitehouse (Hunterdon). New Jersey Governor Chris Christie declared a State of Emergency on Friday, January 22nd for the duration of the event. Schools and many businesses recessed early on Friday afternoon in anticipation of the storm. On March 15, 2016, President Obama declared the following counties federal disaster areas: Atlantic, Burlington, Camden, Cape May, Cumberland, Hunterdon, Mercer, Middlesex, Monmouth, Morris, Ocean, Somerset, and Warren, in addition to Bergen, Essex, Hudson, and Union counties. Snow began during the evening hours on the 22nd, then continued, heavy at times through the 23rd before ending early



Section 4.3.12: Risk Assessment – Severe Winter Weather

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					on the 24th. Some snowfall totals included 29.6 inches in Whitehouse, 29.0 inches in Califon, 28.3 inches in Flemington, 27.0 inches in Clinton, 24.0 inches in Lebanon, and 21.6 inches in Flemington Junction.
February 9, 2017	Winter Storm	N/A	N/A	Hunterdon County	A strong cold front moved through the region with a temperature drop from the 50's and 60's all the way down close to freezing. Low pressure developed along the front with precipitation northwest of the boundary. The precipitation changed to snow across most of the state. Northern locations had all snow with higher totals. Further south the precipitation was mainly rain for an extended period resulting in much lower accumulations. Gusty winds also occurred as the low departed the region. Some higher snowfall amounts include 7.0 inches in Ringoes, and 6.0 inches in Whitehouse Station.
March 14, 2017	Winter Storm	N/A	N/A	Hunterdon County	Low pressure systems across the Ohio Valley and Carolinas phased. This led to a rapidly developing storm which tracked just offshore. Wind, heavy rain and snow all occurred. Snowfall ranged from 6 to 18 inches across the county.
March 17-18, 2017	Winter Storm	N/A	N/A	Hunterdon County	Snow began during the late afternoon hours on Saturday, February 16th, then ended during the very early morning hours on Sunday, February 17th. Given the bulk of this snow fell on a Saturday evening, and the fact that antecedent ground temperatures were above freezing, societal impact from this event was minimal. Some representative snowfall totals include: 8.8 inches in Lebanon, 8.5 inches in Califon, 6.5 inches in Ringoes, 6.0 inches in Glen Gardner, and 4.7 inches in Flemington.
March 7, 2018	Winter Storm	DR-4368	No	Hunterdon County	<p>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.</p> <p>Precipitation gradually overspread the region during the overnight hours of March 6th to the 7th. To the east of the NJ Turnpike/Interstate 95, precipitation began as rain or a mix of rain and snow. Further west, precipitation fell mainly as snow. During the daylight hours of the 7th, precipitation to the east of the NJ Turnpike/Interstate 95 turned over to snow, as colder air worked in from the north and west.</p> <p>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. Governor Phil Murphy declared a state of emergency which went into effect at 8 PM Tuesday March 6th. There were numerous reports of lightning associated with the precipitation in New Jersey, mainly southeast of the Turnpike. This included thunderstorms with heavy rainfall closer to the coast, and thunder with heavy snowfall further inland.</p>



Section 4.3.12: Risk Assessment – Severe Winter Weather

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Hunterdon County Designated?	Location	Description
					Although all portions of the county experienced significant snowfall from this event, the higher amounts (around one and one half feet) occurred in the central and northern portions of the county where banding and thundersnow occurred. Some reported snowfall totals include: 17.5 inches in Flemington, 15.5 inches near Stockton, 14.5 inches in Kingwood, 12.7 inches in Wertsville, 12.0 inches in Ringoes, 11.2 inches in Whitehouse, 9.0 inches in Whitehouse Station, 8.5 inches in Lebanon, 8.0 inches in Readington, 7.0 inches near Annandale, and 6.0 inches in East Amwell Township.
March 21-22, 2018	Winter Storm	N/A	N/A	Hunterdon County	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. Banding provided the mechanism for snowfall totals exceeding one foot in some locations. Some reported snowfall amounts include: 14.0 inches in Byram, 13.1 inches in Stockton, 11.5 inches in Alpha, 11.3 inches in Hampton, 11.0 inches in Frenchtown, 10.4 inches in Hampton, 9.7 inches in Flemington, 9.3 inches in Cloverhill, 9.1 inches in Lebanon, 9.0 inches in Annandale, 9.0 inches in White House Station, 8.6 inches in Readington Township, 8.2 inches in Three Bridges, 8.1 inches in High Bridge, 8.0 inches in Clinton Township, and 6.7 inches in Wertsville.
November 15-16, 2018	Winter Storm	N/A	N/A	Hunterdon County	An early season Winter Storm occurred with totals ranging from 10.0 in Bethlehem Township to 5.0 2 miles S of Clinton Township.
February 12-13, 2019	Winter Storm	N/A	N/A	Hunterdon County	This event was the second part of a multi-day storm that impacted the region with light snow changing to a wintry mix and then to rain. Snow and ice totals were less across Delmarva than other locations farther north and west. Trained spotters reported 2.2 of snow in Lebanon and 0.03 of ice in Readington Twp.
March 3-4, 2019	Winter Storm	N/A	N/A	Hunterdon 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 report was received from Byram of 7.0 inches of snow.
December 1-3, 2019	Winter Storm	N/A	N/A	Hunterdon County	A complex, long duration winter storm impacted parts of the mid-Atlantic over the first three days of December. Impacts from the storm came mainly in two phases. Initially, weakening low pressure moved into the Midwest and Great Lakes region on December 1, bringing a widespread area of overrunning precipitation to the mid-Atlantic. Cold air in place ahead of the precipitation led to heavy mixed precipitation in interior areas, with most though not all areas eventually seeing a gradual change to rain. On December 2nd, developing secondary low pressure brought additional precipitation to the region, which took the form of rain changing to snow. The rapidly strengthening secondary low finally pulled away from the area during the early hours of December 3rd.



Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Hunterdon County Designated?	Location	Description
					A mix of snow, sleet, and freezing rain occurred. 4.8 inches of snow were measured near Pittstown, and a trained spotter in Readington Twp measured 0.10 inches of glaze ice.
December 16-17, 2019	Winter Storm	N/A	N/A	Hunterdon County	Low pressure developed along a stationary boundary over the Southeast US on December 16. The low pressure tracked into the Appalachians before beginning to develop near the southern New Jersey coast early on December 17. This brought widespread precipitation to the mid-Atlantic. Surface temperatures were initially cold enough for frozen precipitation in some areas, but a surge of low level warm air caused most of the frozen precipitation to fall as sleet and freezing rain, with most areas eventually seeing a change to all rain. In some places, impacts due to icing were significant. Up to 0.25 inch of radial ice accretion was measured in Lebanon. Dozens of reports of downed trees and power lines were received from throughout the county.

Source: NOAA-NCEI 2020; NJOEM 2019; NWS 2020; FEMA 2020  
 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 measureable 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 Hunterdon 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, Hunterdon County has been impacted by 37 severe winter storm events between 1950 and 2020 (Table 5.4.9-4). No events resulted in injuries, deaths, or crop damage. \$1.6M in property damages occurred.

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

Hazard Type	Number of Occurrences Between 1950 and 2020	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	35.50	0.03	2.82%
Heavy Snow	31	0.44	2.29	0.44	43.66%
Ice Storm	2	0.03	35.50	0.03	2.82%





Hazard Type	Number of Occurrences Between 1950 and 2020	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
Sleet	4	0.06	17.75	0.06	5.63%
Winter Storm	45	0.64	1.58	0.63	63.38%
Total	84	1.20	0.85	1.18	100%

Note: Not all events that have occurred in Hunterdon County are included due to the extent of documentation and the fact that not all sources have been identified or researched.

Source: NOAA-NCEI 2020

In Section 5.3, the identified hazards of concern for Hunterdon 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’ (likely to occur within 25 years, as presented in Table 5.3-3).

### 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).

### Vulnerability Assessment

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

### Impact on Life, Health and Safety

The entire population of Hunterdon County (125,051 people) is exposed to severe winter storm events (American Community Survey 2018). 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 (ACS) 5-Year estimate, there are 21,457 persons over 65 years old that reside in the County that are considered vulnerable to severe winter weather. In addition, severe winter storm events can reduce the ability of these populations to access emergency services.



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 Hunterdon County, the jurisdiction with the highest concentration of population below the poverty level is the Borough of Flemington (22.7-percent of total population in the Borough). Refer to Section 4 (County Profile) that displays the densities of low-income populations in Hunterdon County.

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. Heavy accumulations of ice can bring down trees and power lines, disabling electric power and communications for days or weeks. Heavy snow can immobilize a region and paralyze a city, shutting down all air and rail transportation and disrupting medical and emergency services. Storms near the coast can cause coastal flooding and beach erosion as well as sink ships at sea. The economic impact of winter weather each year is huge, with costs for snow removal, damage and loss of business in the millions (NOAA 2017).

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. This allows planners and emergency managers to select a range of potential economic impact based on an estimate of the percent of damage to the general building stock. Table 5.4.11-1 below summarizes the estimated loss based on 1-, 5-, and 10-percent losses. 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

Table with 6 columns: Jurisdiction, 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. Rows include Alexandria (Twp), Bethlehem (Twp), Bloomsbury (B), Califon (B), Clinton (T), Clinton (Twp), Delaware (Twp), East Amwell (Twp), Flemington (B), and Franklin (Twp).





Jurisdiction	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
Frenchtown (B)	598	\$488,631,192	\$4,886,311.92	\$24,431,559.61	\$48,863,119.22
Glen Gardner (B)	810	\$342,984,639	\$3,429,846.39	\$17,149,231.95	\$34,298,463.90
Hampton (B)	624	\$313,409,859	\$3,134,098.59	\$15,670,492.96	\$31,340,985.92
High Bridge (B)	1,528	\$828,154,125	\$8,281,541.25	\$41,407,706.23	\$82,815,412.45
Holland (Twp)	2,924	\$1,768,993,941	\$17,689,939.41	\$88,449,697.07	\$176,899,394.14
Kingwood (Twp)	2,780	\$1,712,064,139	\$17,120,641.39	\$85,603,206.93	\$171,206,413.85
Lambertville (C)	1,940	\$1,166,961,549	\$11,669,615.49	\$58,348,077.46	\$116,696,154.93
Lebanon (B)	671	\$530,649,358	\$5,306,493.58	\$26,532,467.92	\$53,064,935.84
Lebanon (Twp)	3,446	\$2,373,828,013	\$23,738,280.13	\$118,691,400.66	\$237,382,801.31
Milford (B)	573	\$527,153,351	\$5,271,533.51	\$26,357,667.53	\$52,715,335.05
Raritan (Twp)	9,712	\$8,605,785,368	\$86,057,853.68	\$430,289,268.38	\$860,578,536.76
Readington (Twp)	7,953	\$5,837,409,694	\$58,374,096.94	\$291,870,484.68	\$583,740,969.36
Stockton (B)	288	\$219,304,144	\$2,193,041.44	\$10,965,207.21	\$21,930,414.41
Tewksbury (Twp)	3,278	\$2,842,570,106	\$28,425,701.06	\$142,128,505.28	\$284,257,010.55
Union (Twp)	2,563	\$1,836,082,381	\$18,360,823.81	\$91,804,119.05	\$183,608,238.09
West Amwell (Twp)	1,810	\$1,186,083,476	\$11,860,834.76	\$59,304,173.80	\$118,608,347.59
<b>Hunterdon County (Total)</b>	<b>63,773</b>	<b>\$46,364,210,456</b>	<b>\$463,642,104.56</b>	<b>\$2,318,210,522.81</b>	<b>\$4,636,421,045.61</b>

Source: Hunterdon County GIS 2020; RS Means 2020

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 the 1-percent annual chance flood. Please refer to the Hurricane hazard (Section 4.3.8) and Severe Weather hazard (Section 4.3.11) profiles for losses resulting from wind.

### 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 critical facility 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. Impacts on the economy also include commuter difficulties into or out of the area for work or school. The loss of power and closure of roads prevent commuters from traveling within the County. During the 2019-2020 winter season, the State of New Jersey Department of Transportation has 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 Changes That May Impact Vulnerability

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

Areas targeted for future growth and development have been identified across Hunterdon County (refer to Sections 4 and 9). 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

Hunterdon County has experienced a decrease in population of approximately 2.5-percent between 2010 and 2018. According to the American Community Survey 5-year population estimates, in 2018 Hunterdon County had a population of 125,051. Even though the population has decreased, any changes in the density of population can create issues for local residents during evacuation of a severe winter storm event. Furthermore, if the density or number of persons over 65 increases in the County, more persons will be vulnerability to severe winter weather events. Refer to Section 4 (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 extreme events such as 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 (NSSL 2020, NOAA 2017).

Both northern and southern New Jersey have become wetter over the past century. However, the total seasonal snowfall for Hunterdon County has varied since the last hazard mitigation plan (i.e., 2015/2016) and this updated plan for 2018/2019 (Rutgers University 2020). 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.

#### **Vulnerability Change Since the 2016 HMP**

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Overall, the County's exposure and vulnerability have not changed, and the entire County will continue to be exposed and vulnerable to severe winter storm events.