5.4.9 Severe Winter Storm

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 storm hazard in Chenango County.

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 (2020), 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.

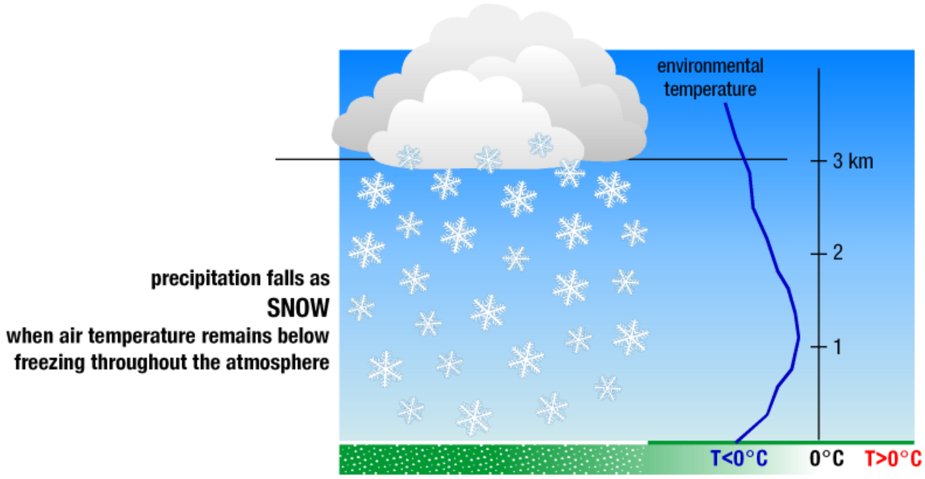
Some winter storms can immobilize an entire region while others might only affect a single community. Winter storms typically are accompanied by low temperatures, high winds, freezing rain or sleet, and heavy snowfall. The aftermath of a winter storm can have an impact on a community or region for days, weeks, or even months; potentially causing cold temperatures, flooding, storm surge, closed and blocked roadways, downed utility lines, and power outages. Chenango County's winter storms include snow storms, blizzards, Nor'Easters, and ice storms. Extreme cold temperatures and wind chills are associated with winter storms.

Figure 5.4.9-1. Snow Accumulation in Downtown Norwich, December 17, 2020

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: sleet, snowflakes, or snow pellets. Snowflakes are clusters of ice crystals that form from a cloud. Figure 5.4.9-2 depicts snow creation.

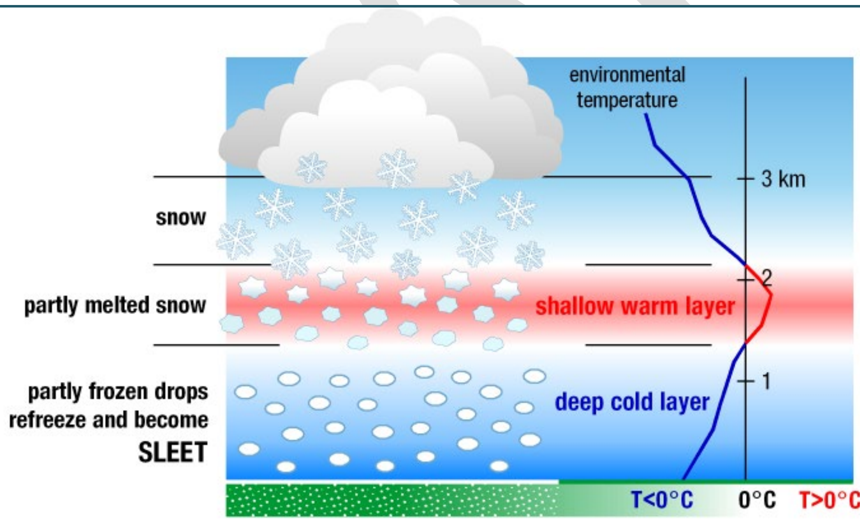
Figure 5.4.9-2. Snow Creation



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. They are usually smaller than 0.30 inches in diameter (NSIDC 2015).

Figure 5.4.9-3. Sleet Creation



Source:NOAA-NSSL 2015

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 (The Weather Channel 2019).

Nor'Easters

A Nor'Easter is a cyclonic storm that moves along the east coast of North America. It is called a Nor'Easter because the damaging winds over coastal areas blow from a northeasterly direction. Nor'Easters can occur any time of the year but are most frequent and strongest between September and April typically moving from southwest to northeast along the Atlantic Coast of the United States (NOAA 2013). In order to be called a Nor'Easter, a storm must have the following conditions, as per the Northeast Regional Climate Center (NRCC):

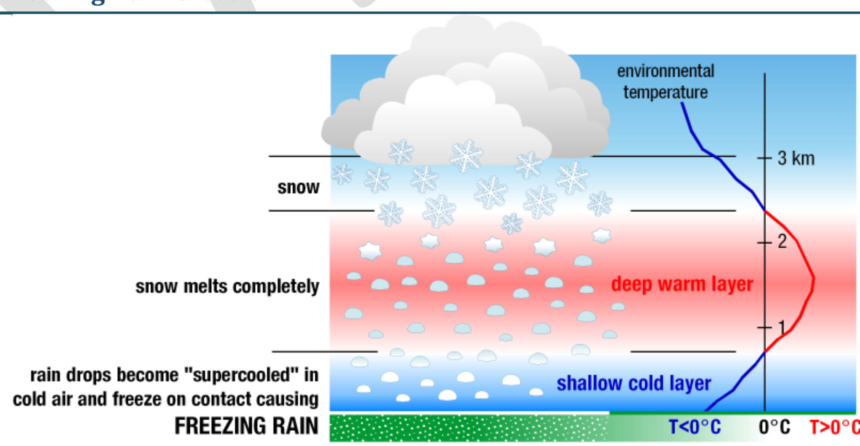
- Must persist for at least a 12-hour period.
- Have a closed circulation.
- Be located within the quadrilateral bounded at 45°N by 65° and 70°W and at 30°N by 85°W and 75°W.
- Show general movement from the south-southwest to the north-northeast.
- Contain wind speeds greater than 23 miles mph.

A Nor'Easter event can cause storm surges, waves, heavy rain, heavy snow, wind, coastal flooding and erosion. Nor'Easters have diameters that can span 1,200 miles, impacting large areas of coastline. The forward speed of a Nor'Easter is usually much slower than a hurricane, so with the slower speed, a Nor'Easter can linger for days and cause tremendous damage to those areas impacted. Approximately 20 to 40 Nor'Easters occur every year, with at least two considered severe (Storm Solution n.d.). The intensity of a Nor'Easter can rival that of a tropical cyclone in that, on occasion, it may flow or stall off the mid-Atlantic coast resulting in prolonged episodes of precipitation, coastal flooding, and high winds.

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 2018). 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 (NWS 2018).

Figure 5.4.9-4. Freezing Rain Creation



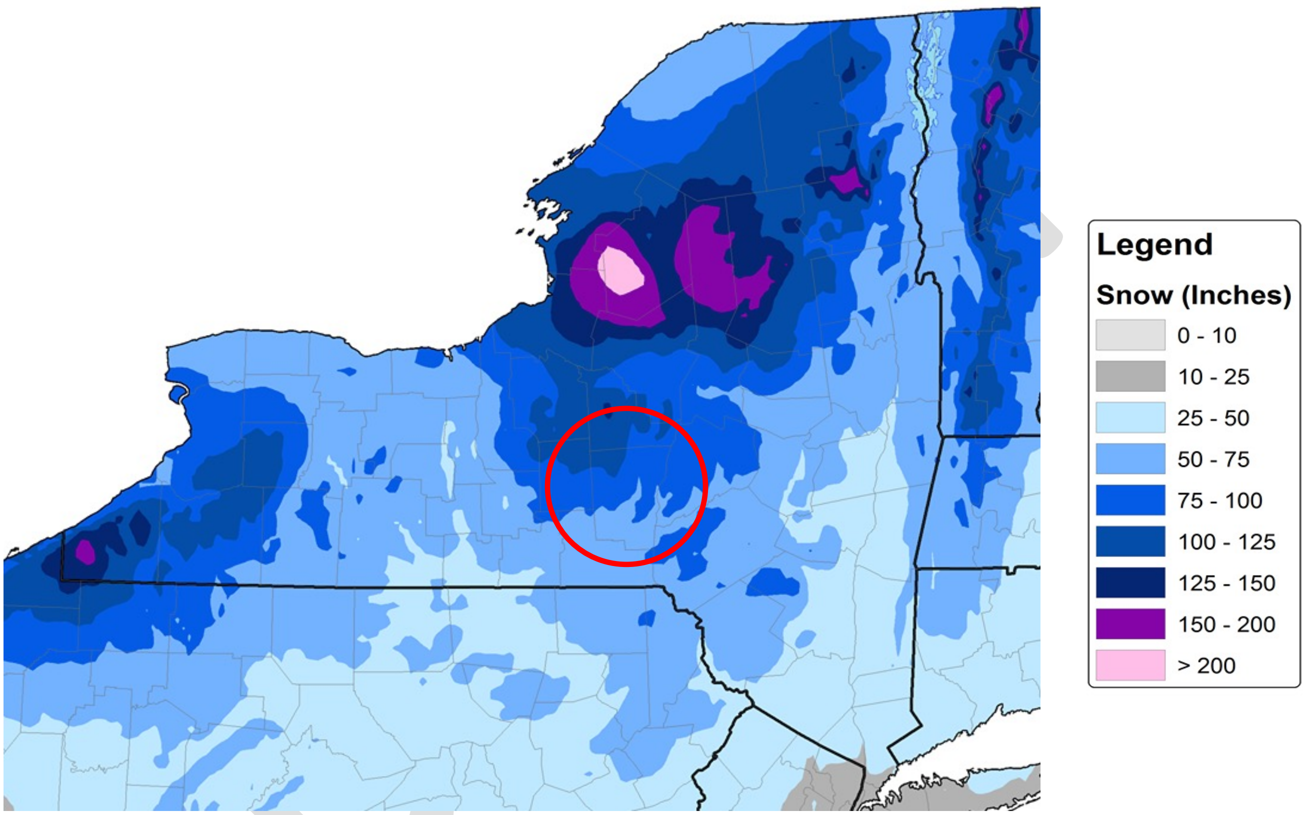
Source: NOAA-NSSL 2015

Location

Snow, Blizzards, and Nor'Easters

Snowfall in New York State is highly variable. The inland regions of the State see an average seasonal amount of 40 inches or more, whereas the coastal regions typically see 25 to 35 inches. More than half of New York State's land area sees more than 70 inches of snow each season (NOAA 2020). According to data from Cornell University, snowfall in Chenango is widely variable, with the southern portion of the County seeing 50 to 75 inches/year and the northwest corner seeing between 100 and 125 inches/year. Nor'Easters typically develop within 100 miles of the East Coast, however their impacts can still be felt in Chenango County, nearly 200 miles inland.

Figure 5.4.9-5. New York Annual Average Snowfall



Source: Cornell University, NYSkiBlog.com
Note: The red circle indicates the location of Chenango County.

Ice Storms

The Midwest and Northeast United States are prime areas for freezing rain and ice storm events. These events can occur anytime between November and April, with most events occurring during December and January. Based on data from 1948 to 2000, in Chenango County there is an average of six to seven days with freezing rain and an average of 15 to 21 hours of freezing rain per year (Midwest Regional Climate Center [MRCC] 2020).

Extent

The severity or magnitude 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 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. The National Oceanic and Atmospheric Administration's (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 and is based on the spatial extent of the storm, the amount of snowfall, and the interaction of the extent and snowfall totals with population (based on the 2000 Census). The NCDC has analyzed and assigned RSI values to over 500 storms since 1900 (NOAA 2015). Table 5.4.9-1 presents the five RSI ranking categories. Figure 5.4.9-6 depicts the NOAA National Centers for Environmental Information's Regional Snowfall Index.

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 2020
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 2018).

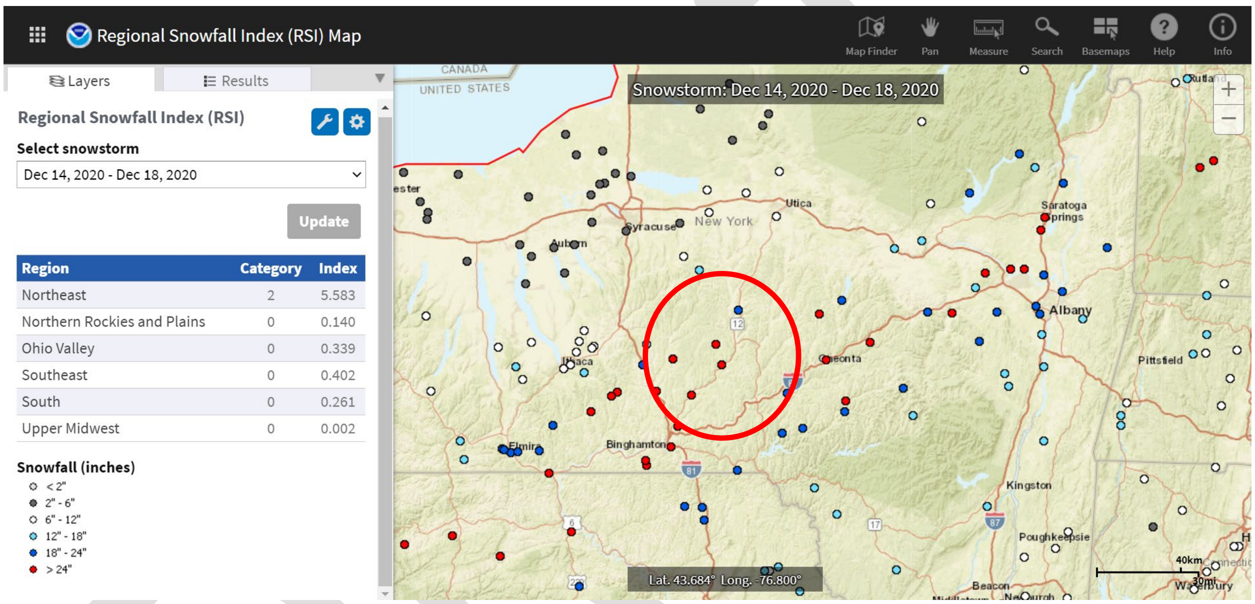
According to the NWS, the magnitude of a severe winter storm can be qualified into five main categories by event type:

- Heavy Snowstorm – Accumulations of 4 inches or more of snow in a 6-hour period, or 6 inches of snow in a 12-hour period.
- Sleet Storm – Significant accumulations of solid pellets that form from the freezing of raindrops or partially melted snowflakes causing slippery surfaces, posing a hazard to pedestrians and motorists.
- Ice Storm – Significant accumulation of rain or drizzle freezing on objects (trees, power lines, roadways) as it strikes them, causing slippery surfaces and damage from sheer weight of ice accumulations.
- Blizzard – Wind velocity of 35 mph or more, temperatures below freezing, considerable blowing snow with visibility frequently below one-quarter mile prevailing over an extended period.
- Severe Blizzard – Wind velocity of 45 mph, temperatures of 10 °F or lower, a high density of blowing snow with visibility frequently measured in feet prevailing over an extended period.

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) might affect a certain area, but its occurrence, location, and timing are uncertain.
- A winter storm watch is issued when severe winter conditions (heavy rain or significant ice accumulations) are possible within in the next 24 to 72 hours.
- A winter storm warning is issued when severe winter conditions are expected (heavy snow 7 inches or greater in 12 hours or 9 inches or greater in 24 hours; ice storm with ½ inch or more).
- A winter weather advisory is used when winter conditions (i.e., snow, sleet, freezing rain, ice) are expected to cause significant inconvenience and could be hazardous (e.g., snow or sleet of 4–6 inches, freezing rain and drizzle in any accretion of ice on roads but less than ½ inch).
- A blizzard warning is issued when snow and strong winds will combine to produce a blinding snow, visibility near zero/whiteouts, and deep snow drifts (NWS 2018).

Figure 5.4.9-6 NOAA NCEI Regional Snowfall Index



Note: The red circle indicates the approximate location of Chenango County

Previous Occurrences and Losses

Many sources have provided historical information regarding previous occurrences and losses associated with severe winter storm events in Chenango County. According to the NOAA-NCEI storm events database, Chenango County has experienced 90 winter weather events between 1996 and 2020, including 55 heavy snow events, 10 ice storms, 4 lake effect snowstorms, 20 winter storms, and 2 winter weather events. Table 5.4.9-2 and Table 5.4.9-3 summarize these statistics, as well as the annual average number of events and the percent chance of these individual severe winter storm hazards occurring in Chenango County in future years (NOAA NCEI 2020).

Table 5.4.9-2. Severe Winter Events 1996-April 2020

Hazard Type	Number of Occurrences Between 1950 and 2020	Total Fatalities	Total Injuries	Total Property Damage ($)	Total Crop Damage ($)
Blizzard	0	0	0	$0	$0
Heavy Snow	55	0	0	$527,000	$0
Ice Storm	10	0	0	$2,115,000	$0

Hazard Type	Number of Occurrences Between 1950 and 2020	Total Fatalities	Total Injuries	Total Property Damage ($)	Total Crop Damage ($)
Lake Effect Snow	4	0	0	$0	$0
Sleet	0	0	0	$0	$0
Winter Storm	20	0	0	$0	$0
Winter Weather	2	0	0	$0	$0
Total	**91**	**0**	**0**	**$2.64 million**	**$0**

Source: NOAA-NCEI 2020
Note: NOAA-NCEI database includes winter-related events starting in 1996. Events that occurred prior to 1996 are not included in the table.

FEMA Disaster Declarations

Between 1954 and April 2020, FEMA included New York State in 28 winter storm-related major disaster (DR) or emergency (EM) declarations classified as one or a combination of the following disaster types: severe winter storm, snowstorm, snow, ice storm, winter storm, blizzard, and flooding. Generally, these disasters cover a wide region of the state; therefore, they may have impacted many counties. Chenango County was included in six of these declarations.

Table 5.4.9-3 FEMA Major Disasters and Emergency Declarations in Chenango County

Disaster Number	Event Date	Declaration Date	Incident Type	Title
EM-3107	March 13 – March 17, 1993	3/17/1993	Snow	Severe Blizzard
EM-3173	December 25 – January 4, 2002	2/25/2003	Snow	Snowstorms
EM-3184	February 17 – February 18, 2003	3/27/2003	Snow	Snow
DR-1467	April 3 – April 5, 2003	5/12/2003	Severe Ice Storm	Ice Storm
EM-3299	December 11 – December 31, 2008	12/18/2008	Severe Storm(s)	Severe Winter Storm
DR-4322	March 14 – March 15, 2017	7/12/2017	Snow	Severe Winter Storm and Snowstorms

Source: FEMA 2020
DR Major Disaster Declaration (FEMA)
EM Emergency Declaration (FEMA)
FEMA Federal Emergency Management Agency

USDA Declarations

Between 2012 and 2020, Chenango County was included in the following winter-related USDA disaster designations:

Table 5.4.9-4. USDA Designations in Chenango County, 2012-2020

Designation Number	Event Date	Declaration Date	Incident Type	Description
S3249	March 1, 2012	June 5, 2012	Frost, Freeze	Frosts and Freezes
S3746	February 1 – April 30, 2014	September 24, 2014	Frost, Freeze	Freeze
S4903	April 1 – June 1, 2020	January 15, 2021	Frost, Freeze	Freeze and Frost

Source: USDA 2020

Previous Events

Table 5.4.9-5 identifies the known severe winter storm events that impacted Chenango County between 2013 and April 2020. For events prior to 2013, please refer to Appendix E (Supplementary Data). For detailed information on damages and impacts to each municipality, refer to Section 9 (Jurisdictional Annexes).

Table 5.4.9-5. Severe Winter Weather Events in Chenango County, 2013 to December 2020

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Event Details*
December 14, 2013	Winter Storm	N/A	N/A	Between eight and eleven inches of snow fell across Chenango County after a low pressure system intensified as it headed towards the northeast, producing high snowfalls across the upper Susquehanna River.
January 1-3, 2014	Winter Storm	N/A	N/A	Up to 13 inches of snow fell in Chenango and nearby counties owing to a stalled frontal boundary.
February 5, 2014	Winter Storm	N/A	N/A	The Southern Tier region of New York received the highest snowfall (up to 15 inches in Bainbridge) owing to an intense snow band that moved through the region.
February 13, 2014	Winter Storm	N/A	N/A	Chenango County saw five to nine inches of snow in a storm that brought eight to eighteen inches of snow to the region.
November 26, 2014	Winter Storm	N/A	N/A	Thirteen inches of snow fell in Coventry and the rest of the County saw between eight and thirteen inches from a storm system causing localized snow to the Susquehanna, western Catskills, and Southern Tier region.
December 9-11, 2014	Winter Storm	N/A	N/A	Chenango County experienced the high end of estimated snowfall totals from a storm that deposited up to two feet of snow in the County.
February 1-2, 2015	Heavy Snow	N/A	N/A	Up to a foot of snow was seen in Chenango County from a widespread evening storm passing through the region.
November 19-22, 2016	Lake-Effect Snow	N/A	N/A	A strong lake-effect snowstorm brought two feet of snow to the higher elevations of the County and much of the Southern Tier region.
February 12, 2017	Heavy Snow	N/A	N/A	Sherburne saw the highest snowfall totals from a winter storm that brought heavy snow to central and north-central New York.
March 14-15, 2017	Heavy Snow	DR-4322	Yes	A record-breaking winter storm traveling northeast along the coast brought major snow to the region, with one and two-day records broken in many locations. Chenango County received between two and three feet of snow.
February 4, 2018	Heavy Snow	N/A	N/A	Chenango County saw between six and nine inches of snow from a snow storm impacting central New York.
February 7, 2018	Heavy Snow	N/A	N/A	Chenango County received between six and nine inches of snow from a snowstorm passing through the region.
March 2, 2018	Heavy Snow	N/A	N/A	Between one and two feet of snow fell in Chenango County during a storm that brought near-blizzard conditions to the region.
November 15-16, 2018	Heavy Snow	N/A	N/A	Up to a foot of snow fell in the County during a winter storm that brought a mix of precipitation.
January 19-20, 2019	Heavy Snow	N/A	N/A	Chenango County received between eight and fifteen inches of snow as well as ice from a winter storm impacting the region.
December 1-2, 2019	Heavy Snow	N/A	N/A	The County received between eight and thirteen inches of snow from a mixed precipitation, two-part storm event that moved through central New York.
December 16-17, 2020	Heavy Snow, Nor'easter	TBD	TBD	A Nor'easter moved slowly up the US eastern coastline on the afternoon of December 16, 2020 through December 17, 2020. The storm system produced very heavy snowfall across parts of central New York and northeast PA. Snowfall levels in Chenango County ranged from 19 inches in Smyrna, to 35 inches in Oxford and Norwich.

Sources: FEMA 2020; NOAA-NCEI 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*
NOAA	*National Oceanic and Atmospheric Administration*
N/A	*Not Applicable*

Climate Change Projections

On average, New York State receives more than 40 inches of snow each year. Snowfall varies regionally based on topography and the proximity to large lakes and the Atlantic Ocean. Maximum snowfall can exceed 175 inches in parts of the Adirondacks and Tug Hill Plateau, as well as in the westernmost parts of the state. The warming influence of the Atlantic Ocean keeps snow in the New York City and Long Island areas below 36 inches each year (NYSERDA 2014).

Climate change is affecting both people and resources in New York State. These impacts are projected to increase. The impacts related to increasing temperatures and sea level rise are already causing complications in the state. *ClimAID: The Integrated Assessment for Effective Climate Change in New York State (ClimAID)* was undertaken to provide decision-makers with information on the state's vulnerability to climate change and to facilitate the development of adaptation strategies informed by both local experience and scientific knowledge (NYSERDA 2011).

Temperatures in New York State are warming, with an average rate of warming over the past century of 0.25° F per decade. Average annual temperatures are projected to increase across New York State by 2–3.4 °F by the 2020s, 4.1–6.8 °F by the 2050s, and 5.3–10.1 °F by the 2080s. By the end of the century, the greatest warming is projected to be in the northern section of the state (NYSERDA 2014).

Each region in New York State, as defined by ClimAID, has attributes that will be affected by climate change. Chenango County is part of Region 3 (Southern Tier) where temperatures are estimated to increase by 4.4–6.3 ºF by the 2050s and 5.7–9.9 ºF by the 2080s (baseline of 47.5 ºF, middle range projection). Precipitation totals are estimated to increase between 4–10 percent by the 2050s and 6–14 percent by the 2080s (baseline of 35.0 inches, middle range projection). Table 5.4.9-6 displays the projected seasonal precipitation change for Southern Tier ClimAID Region (NYSERDA 2014).

Table 5.4.9-6. Projected Seasonal Precipitation Change in Region 3, 2050s (% change)

Winter	Spring	Summer	Fall
+5 to +15	0 to +15	-10 to +10	-5 to +10

Source:NYSERDA 2011

New York State is already experiencing the effects of climate change during the winter season. Winter snow cover is decreasing, and spring comes, on average, about a week earlier than it did a few years ago. Nighttime temperatures are measurably warmer, even during the colder months. Overall winter temperatures in New York State are almost 5 degrees warmer than in 1970 (NYSERDA 2011; NYSDEC, n.d.). The state has experienced a decrease in the number of cold winter days (below 32 °F) and can expect to see a decrease in snow cover by as much as 25–50 percent by end of the next century. The lack of snow cover may jeopardize opportunities for skiing, snowmobiling, and other types of winter recreation; and natural ecosystems will be affected by the changing snow cover (Cornell University College of Agriculture and Life Sciences 2011). As the century progresses, snowfall is likely to become less frequent, with the snow season decreasing in length. It is uncertain if there will be changes in the intensity of snowfall during each storm; however, it is possible that higher temperatures in colder parts of New York State could support higher snowfall totals during snowstorm events (NYSERDA 2014).

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

Probability of Future Occurrences

Table 5.4.9-7 summarizes data regarding the probability of occurrences of severe winter storm events in Chenango County based on the historic record. Heavy snow events are the most common in Chenango County, followed by winter storms. The information used to calculate the probability of occurrences is based solely on NOAA-NCEI storm events database results.

Table 5.4.9-7. Probability of Future Occurrence of Severe Winter Weather Events in Chenango County

Hazard Type	Number of Occurrences Between 1954 and 2020	% Chance of Occurring in Any Given Year
Blizzard	0	N/A
Heavy Snow	55	82.1%
Ice Storm	10	14.9%
Lake Effect Snow	4	5.9%
Sleet	0	N/A
Winter Storm	20	29.8%
Winter Weather	2	3.0%
TOTAL	**91**	100%

Source: NOAA-NCEI 2020

Note: Disaster occurrences include federally declared disasters since the 1950 Federal Disaster Relief Act (Public Law 81-875), and selected winter storm events since 1996. Due to limitations in data, not all winter storm events occurring between 1954 and 1996 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated.

Based on historical data from NYSERDA (2011), it is expected that the following will occur at least once per 100 years:

- Up to four inches of freezing rain in the ice band near central New York State of which between 1–2 inches of accumulated ice will occur over a 24-hour period.
- Up to two feet of accumulated snow in the snow band in northern and western New York State over a 48-hour period.

Based on geography, location, past event history, and climate projections, Chenango County will continue to experience winter storm events. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings; refer to Section 5.3 (Hazard Ranking) for additional information on the hazard ranking methodology and probability criteria. The probability of occurrence for severe winter storms in the county is considered *frequent* (event has a 100 percent annual probability and might occur multiple times in the same year).

5.4.9.2 Vulnerability Assessment

All of Chenango County is exposed to the severe winter storm hazard. The following summarizes the estimated potential impacts of severe winter storm events on the county.

Impact on Life, Health and Safety

For the purposes of this HMP, the entire population of Chenango County (48,348) is exposed to severe winter storm events (U.S. Census 2018 ACS 5-Year Population Estimate). The homeless and elderly are considered most susceptible to this hazard; the homeless due to their lack of shelter and the elderly due to their increased risk of injuries and death from falls and overexertion or hypothermia from attempts to clear snow and ice.

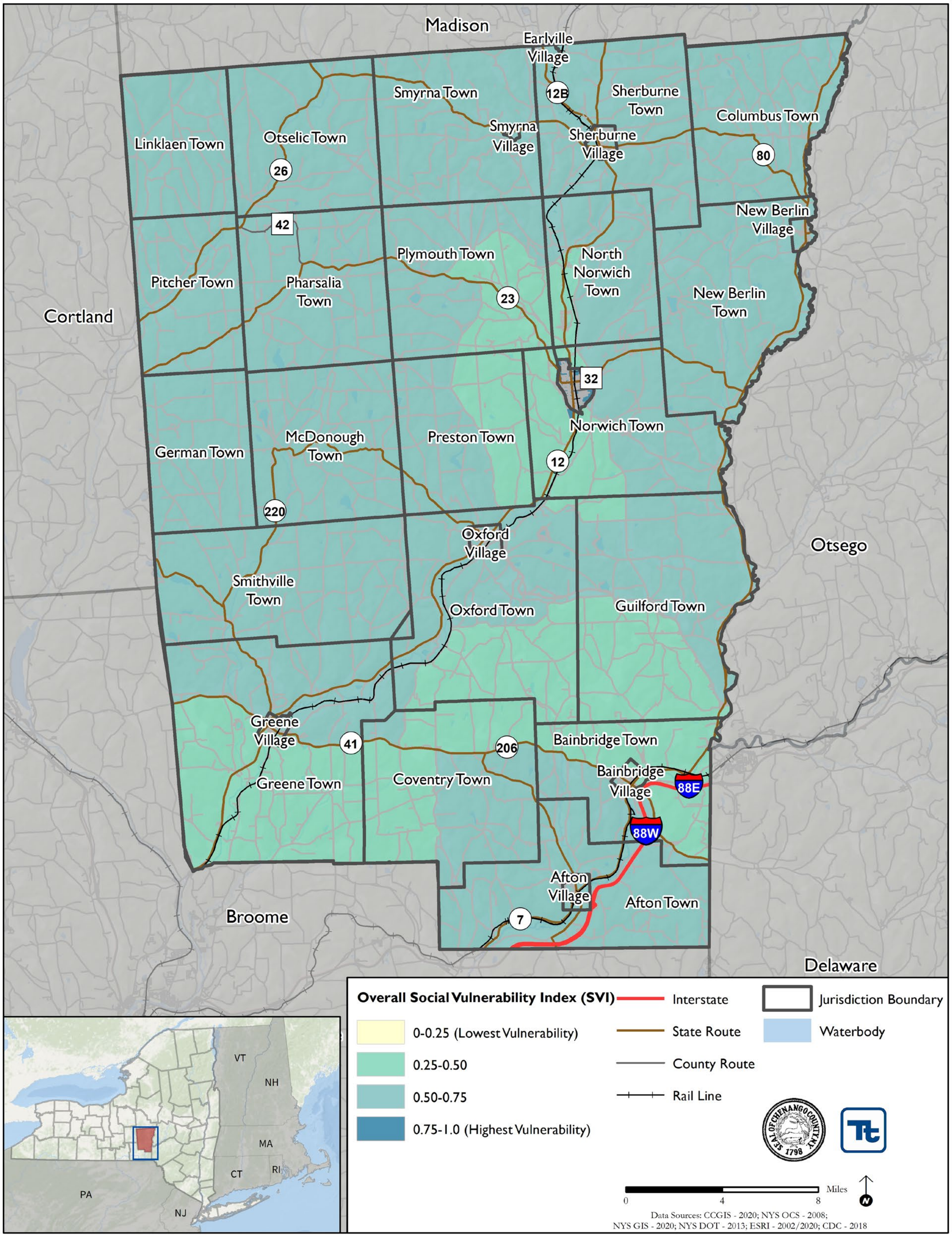
Figure 5.4.9-7. Snow accumulation reached 28 inches at a home in Smithville, December 17, 2020

According to the 2018 ACS 5-Year Population Estimate, 19.7 percent of the population in Chenango County is 65 and over. In addition, severe winter storm events can reduce the ability of these populations to access emergency services. In Chenango County, the following areas have the highest percentage of elderly population: Village of New Berlin (26.6%), Town of Oxford (23.9%), Village of Greene (20%), Village of Afton (19.1%), and Town of McDonough (18.2%). Refer to Figure 4-5 in Section 4 (County Profile) that displays the densities of populations over 65 in Chenango County.

The homeless and residents with low incomes might 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). Refer to Figure 4-11 in Section 4 (County Profile) that displays the densities of low-income populations in Chenango County. Additionally, homeless populations might not have access to housing or sheltering during a severe winter storm.

According to the Center for Disease Control and Prevention's (CDC) 2016 Social Vulnerability Index, areas within the City of Norwich are the most vulnerable within the County. The average social vulnerability score for Chenango County is 0.5304, indicating moderate to high level of vulnerability. Vulnerable populations throughout the county may be more susceptible to the impacts from severe winter storms. Figure 5.4.9-8 below displays the CDC 2016 Social Vulnerability Index for Chenango County.

Figure 5.4.9-8 CDC's Social Vulnerability Index 2016



Heavy snow can immobilize a region and paralyze a city. A cascading impact of heavy snowstorms seen in the City of Norwich includes the removal of snow by snow plows blocks the middle lanes in the downtown area, covering left turn lanes. This road blockage results in the potential for increased traffic accidents and decreased safety for both pedestrians and drivers. Additional impacts include stranding commuters, stopping the flow of supplies, and disrupting emergency and medical services. Accumulations of snow can collapse buildings and knock down trees and power lines. In rural areas, homes and farms can be isolated for days, and unprotected livestock could be lost. In Chenango County, the towns generally are rural compared with the villages and city. The cost of snow removal, repairing damages, and loss of business can have large economic impacts on cities and towns (NSSL 2006).

Impact on General Building Stock

The entire general building stock inventory in Chenango County is exposed and potentially vulnerable to the severe winter storm hazard; however, properties in poor condition or in particularly vulnerable locations may be at risk to the most damage. 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, the percent damage to structures that could result from severe winter storm conditions is considered. 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 5.4.9-8 summarizes the estimated loss to structures because of 1-, 5-, and 10-percent loss. 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). Therefore, the table's data should be used as estimates only for planning purposes with the knowledge that the associated losses for severe winter storm events vary greatly.

Table 5.4.9-8 General Building Stock Exposure and Estimated Losses from Severe Winter Storm Events

Municipality	Total Replacement Cost Value (RCV)	1-Percent Exposure/Loss	5-Percent Exposure/Loss	10-Percent Exposure/Loss
Afton (T)	$864,699,700	$8,646,997	$43,234,985	$86,469,970
Afton (V)	$1,019,188,804	$10,191,888	$50,959,440	$101,918,880
Bainbridge (T)	$915,529,770	$9,155,298	$45,776,489	$91,552,977
Bainbridge (V)	$584,957,184	$5,849,572	$29,247,859	$58,495,718
Columbus (T)	$862,354,994	$8,623,550	$43,117,750	$86,235,499
Coventry (T)	$703,237,371	$7,032,374	$35,161,869	$70,323,737
Earlville (V)	$87,153,360	$871,534	$4,357,668	$8,715,336
German (T)	$203,106,925	$2,031,069	$10,155,346	$20,310,692
Greene (T)	$1,319,736,091	$13,197,361	$65,986,805	$131,973,609
Greene (V)	$686,754,321	$6,867,543	$34,337,716	$68,675,432
Guilford (T)	$1,010,987,220	$10,109,872	$50,549,361	$101,098,722
Lincklaen (T)	$229,671,722	$2,296,717	$11,483,586	$22,967,172
McDonough (T)	$339,089,552	$3,390,896	$16,954,478	$33,908,955
New Berlin (T)	$778,713,525	$7,787,135	$38,935,676	$77,871,352
New Berlin (V)	$432,605,770	$4,326,058	$21,630,289	$43,260,577
North Norwich (T)	$823,054,726	$8,230,547	$41,152,736	$82,305,473
Norwich (C)	$3,140,959,099	$31,409,591	$157,047,955	$314,095,910
Norwich (T)	$2,080,430,801	$20,804,308	$104,021,540	$208,043,080

Municipality	Total Replacement Cost Value (RCV)	1-Percent Exposure/Loss	5-Percent Exposure/Loss	10-Percent Exposure/Loss
Otselic (T)	$461,373,250	$4,613,733	$23,068,663	$46,137,325
Oxford (T)	$958,330,880	$9,583,309	$47,916,544	$95,833,088
Oxford (V)	$679,367,779	$6,793,678	$33,968,389	$67,936,778
Pharsalia (T)	$389,863,952	$3,898,640	$19,493,198	$38,986,395
Pitcher (T)	$315,344,531	$3,153,445	$15,767,227	$31,534,453
Plymouth (T)	$510,829,645	$5,108,296	$25,541,482	$51,082,965
Preston (T)	$348,948,426	$3,489,484	$17,447,421	$34,894,843
Sherburne (T)	$1,113,221,738	$11,132,217	$55,661,087	$111,322,174
Sherburne (V)	$768,785,678	$7,687,857	$38,439,284	$76,878,568
Smithville (T)	$690,983,617	$6,909,836	$34,549,181	$69,098,362
Smyrna (T)	$519,858,907	$5,198,589	$25,992,945	$51,985,891
Smyrna (V)	$161,456,951	$1,614,570	$8,072,848	$16,145,695
Chenango County	**$23,000,596,289**	**$230,005,963**	**$1,150,029,814**	**$2,300,059,629**

Sources: Chenango County GIS 2020; RS Means 2019
Notes: T= Town; V= Village; C= City

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 Section 5.4.4 (Flood Hazard Profile). Generally, losses resulting from flooding associated with severe winter storms should be less than that associated with a 1-percent annual chance flood event. In addition, coastal areas are at high risk during winter storm events that involve high winds, as presented in Section 5.4.6 (Severe Storm Profile) for losses resulting from wind.

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 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. Heavy accumulations of ice can bring down trees, electrical wires, telephone poles, utility 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 can cause extreme hazards to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces (NSSL 2006). Because power interruption can occur, backup power is recommended.

Infrastructure at risk for this hazard includes roadways that could be damaged due to salt application 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.

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 within the county. According to the 2020 Chenango County Adopted Budget, County snow removal services including labor, fence materials, ice control, and machinery rentals totals nearly $1.9 million.

Impact on the Environment

> 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.

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 and flash flood events with warming winter weather. Consequentially, these flow rates and excess volumes of water can erode banks, destroying habitats along the riverbanks of the County, and disrupt terrestrial plants and animals.

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 Section 5.4.4 (Flood) for more information about the flood hazard of concern. Additionally, heavy snow pile-up on the sides of streets within the County can disrupt traffic patterns and lead to dangerous road conditions and an increase in traffic incidents.

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

As discussed in Sections 4 (County Profile) and 9 (Jurisdictional Annexes), areas targeted for future growth and development have been identified across the county. Any areas of growth could be potentially impacted by the severe winter storm hazard because the entire planning area is exposed and vulnerable. The ability of new development to withstand severe winter storm impacts lies in sound land use practices and consistent enforcement of codes and regulations for new construction.

Current New York State land use and building codes incorporate standards that address and mitigate snow accumulation. Some local municipalities in the county implemented the following activities to eliminate loss of life and property and infrastructure damages during winter storm events:

- Remove snow from roadways.
- Remove dead trees and trim trees/brush from roadways to lessen falling limbs and trees.
- Bury electrical and telephone utility lines to minimize downed lines.
- Remove debris/obstructions in waterways and develop routine inspections/maintenance plans to reduce potential flooding.
- Purchase and install backup generators in evacuation facilities and critical facilities to essential services to residents.

Projected Changes in Population

In 2018, the Chenango United Way reported that 33 percent of Chenango County households fall under the ALICE category: Asset Limited, Income Restrained, Employed (Meseck 2019). The homeless, as well as the ALICE population is vulnerable to extreme weather events inclusive of storms and extreme temperatures. According to population projections from the Cornell Program on Applied Demographics, Chenango County will experience a continual population decrease through 2040 (an estimated decline of greater than 7,500 people by 2040). This decrease could reduce the overall vulnerability of the county's population over time; however, a closer examination of the age of the population, changes in their geography, and how climate change could alter the winter weather received (rain versus snow) will be important to continue to assess future changes in vulnerability.

Climate Change

As discussed earlier, it is uncertain how climate change will influence extreme winter storm events. With a potential for more frequent lake-effect snow events over the next two decades, the county's assets will be at risk to the impacts of more frequent severe winter storm events. 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 Since 2015 HMP

The Chenango County Comprehensive Plan describes changes in the county's population from the 2000 to the 2010 U.S. Census. Overall, Chenango County has experienced a decrease in population; however, there was an increase in the elderly population and low income population, which are vulnerable to severe winter weather hazards. Further, the county has experienced an increase in population moving to more rural areas (Chenango County 2016). Rural areas could be hit hardest during winter storm events because of geographical remoteness and increased additional winter weather preparedness measures. Overall, the entire county remains vulnerable to severe winter storm events.