5.4.7 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 Dutchess County.

5.4.7.1 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/or dangerous wind chills. There are three basic components needed to make a winter storm. Below freezing temperatures (cold air) in the clouds and near the ground are necessary to make snow and ice. Lift, something to raise the moist air to form clouds and cause precipitation, is needed. Examples of this is warm air colliding with cold air and being forced to rise over the cold dome or air flowing up a mountainside. The last thing needed to make a winter storm is moisture to form clouds and precipitation. Air blowing across a body of water, such as a large lake or the ocean (National Severe Storms Laboratory 2014).

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 Dutchess County, winter storms include blizzards, snow storms, Nor'Easters and ice storms. Extreme cold temperatures and wind chills are also associated with winter storms; however, based on input from the Planning Committee, these events are further discussed in this Plan in Section 5.4.4 (Extreme Temperatures).

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), 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 a snow crystals or snow pallet, 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. 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 2013).

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).

Ice Storms

An ice storm describes those events when damaging accumulations of ice are expected during freezing rain situations. Significant ice accumulations are typically accumulations of 0.25-inches or greater (NWS 2013). Heavy accumulations of ice can bring down trees, power lines and 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 2008).

Location

Snow and Blizzards

On average, New York State receives more snowfall than any other states within the United States, with the easternmost and west-central portions of the State most likely to suffer under severe winter storm occurrences than the southern portion. Average snowfall in the State is about 65 inches, but varies greatly in the different regions of the State. Between 1960 and 2012, Dutchess County had a total average snowfall of less than 60 inches.

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. Dutchess County has an average of five to six days with freezing rain.

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, and time of occurrence during the day (e.g., weekday versus weekend), and time of season.

The extent of a severe winter storm can be classified by meteorological measurements and by evaluating its societal impacts. NOAA's National Climatic Data Center (NCDC) is currently producing the Regional Snowfall Index (RSI) for significant snowstorms that impact the eastern two-thirds of the United States. The RSI ranks snowstorm impacts on a scale from 1 to 5. It is based on the spatial extent of the storm, the amount of snowfall, and the interaction of the extent and snowfall totals with population (based on the 2000 Census). The NCDC has analyzed and assigned RSI values to over 500 storms since 1900 (NOAA-NCDC 2011). Table 5.4.7-1 presents the five RSI ranking categories.

Table 5.4.7-1. RSI Ranking Categories

Category	Description	RSI Value
1	Notable	1-3
2	Significant	3-6
3	Major	6-10
4	Crippling	10-18
5	Extreme	18.0+

Source: NOAA-NCDC 2011
Note: RSI = Regional Snowfall Index

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).

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 winter storm watch is issued when severe winter conditions (heavy rain and/or significant ice accumulations) are possible within in the next day or two. A winter storm warning is issued when severe winter conditions are expected (heavy snow seven inches or greater in 12 hours or nine inches or greater in 24 hours; ice storm with ½ inch or more). A winter weather advisory is used when winter conditions (snow, sleet and/or freezing rain/ice) are expected to cause significant inconvenience and may be hazardous (snow and/or sleet with amounts of four to six 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 2015).

Previous Occurrences and Losses

Many sources provided winter storm information regarding previous occurrences and losses associated with winter storm events throughout Dutchess County. With so many sources reviewed for the purpose of this Hazard Mitigation Plan (HMP), loss and impact information for many events could vary depending on the source. Therefore, the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP.

Between 1954 and 2015, FEMA included New York State in 24 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. Dutchess County was included in seven of these declarations.

For this Plan, winter weather events were summarized from 1990 to 2015. Known severe winter storm events, including FEMA disaster declarations, which have impacted Dutchess County are identified in Table 5.4.7-2. For detailed information on damages and impacts to each municipal, refer to Section 9 (jurisdictional annexes). Please note that not all events that have occurred in Dutchess County are included due to the extent of documentation and the fact that not all sources may have been identified or researched. Loss and impact information could vary depending on the source. Therefore, the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP Update.

Table 5.4.7-2. Severe Winter Weather Events in Dutchess County, 1990 to 2015

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
March 10-11, 1993	Snow	N/A	N/A	A low pressure system moved from eastern Pennsylvania on the evening of the 10th to off the southern New England Coast on the morning of the 11th. The storm dumped 3 to 6 inches across much of eastern New York with some of the higher amounts being 5.5 inches at Averill Park and Round Lake, 5 inches at Johnstown and Eagle Bridge, and 4.5 inches at Albany and Piseco. Numerous accidents were reported across the area, although most were of the fender-bender variety. The County had $50,000 in property damage.
March 12-15, 1993	Blizzard / Nor'Easter	EM-3107	Yes	This event brought between three and six inches of snow to much of eastern New York State. There were numerous accidents reported across the area. Travel was extremely difficult in the State and a state of emergency was declared across most of eastern and central New York State. Dutchess County had approximately $50,000 in damages from this event.
January 7-9, 1996	Nor'Easter / Heavy Snow	DR-1083	Yes	Heavy snow fell across southeast New York State causing many power outages across the region and several roofs to collapse. Snowfall totals ranged from 15.5 inches in Ulster County to 36 inches in Dutchess County. Dutchess County had approximately $80,000 in property damage.
December 7-8, 1996	Winter Storm	N/A	N/A	This storm brought heavy, wet snow across the Catskills, Taconics and Washington County in New York State. Power outages were widespread due to downed trees and power lines from the heavy snow. In Dutchess and Ulster Counties, approximately 12,000 customers were without power. Dutchess County had approximately $35,000 in property damage.
March 31 – April 1, 1997	Winter Storm	N/A	N/A	This storm brought heavy snow and near freezing temperatures to the area. Snowfall totals in New York State ranged from 10 inches to over 30 inches.
November 17, 2002	Winter Storm / Nor'Easter	N/A	N/A	A strong Nor'Easter developed off of Cape Hatteras and slowly moved north along the Atlantic coast. Across eastern New York State, the storm produced a heavy winter mix of precipitation and totals ranged from one to six inches. The storm also brought strong winds and ice which caused power outages throughout the area. Dutchess County had approximately $25,000 in property damage from this event.
December 25-26, 2002	Nor'Easter / Snowstorm	N/A	N/A	Snow began early on Christmas morning in eastern New York State and western New England. The storm picked up intensity as the day went on and it event was characterized by a band of very heavy snow which produced snowfall rates of up to four and five inches an hour. Snowfall totals in Dutchess County ranged from 8.8 inches in Boston Corners (Town of Northeast) to 14 inches in the Village of Tivoli.
January 3-4, 2003	Nor'Easter / Snowstorm	N/A	N/A	A heavy mix of freezing rain, sleet and snow fell over eastern New York State. Following this event, a coastal storm developed with periods of heavy snow. The weight of the snow combined with the ice, brought down trees and power lines that resulted in power outages to 15,000 customers. Snowfall totals in Dutchess County ranged from 10.5 inches in Stormville (Town of East Fishkill) to 15.8 inches in Poughkeepsie.
December 11-31, 2008	Severe Winter Storm	EM-3299	Yes	A series of severe winter weather events impacted eastern New York State and Dutchess County from December 11th through December 31st. The most significant event in

Table 5.4.7-2. Severe Winter Weather Events in Dutchess County, 1990 to 2015

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
				Dutchess County occurred on December 18th which brought snowfall rates of one to three inches an hour. Snowfall totals ranged from seven inches in the Village of Tivoli to 10.6 inches in Lagrangeville (Town of LaGrange).
December 26-27, 2010	Severe Winter Storm and Snowstorm (Nor'Easter)	DR-1957	Yes	A major Nor'Easter brought significant snow and blizzard conditions to much of the northeast United States. Bands of heavy snow with snowfall rates of one to three inches an hour occurred across the region. Strong, gusty winds were also associated with this storm. Wind gusts across the region ranged from 35 to 45 mph with gusts of 50 to 70 mph reported across southeastern New York State, Connecticut and eastern Massachusetts. Snowfall totals in Dutchess County ranged from nine inches in Salt Point (Town of Poughkeepsie) to 25 inches in Town of Pine Plains.
October 29-30, 2011	Nor'Easter / Snowstorm	N/A	N/A	An early season Nor'Easter brought heavy, wet snow to the south and east of the Capital District. Snowfall rates were as high as two to four inches per hour. Power outages occurred due to downed trees and wires. In Dutchess County, snowfall totals ranged from 4.8 inches in Salt Point (Town of Poughkeepsie) to 21.6 inches in the Village of Millbrook. More than 115,000 homes and businesses were without power in Dutchess and Ulster Counties.
November 7-8, 2012	Nor'Easter	N/A	N/A	An early season Nor'Easter impacted the region a week after Hurricane Sandy struck. Most of the precipitation from the storm fell as snow across the mid-Hudson Valley region. Approximately three to six inches of snow fell in Dutchess County. In addition to the snow, strong and gusty winds of up to 35 mph impacted the County.
November 26-27, 2014	Nor'Easter / Snowstorm	DR-4204	No	An early season winter storm impacted eastern New York State during Thanksgiving. The storm began the morning of the 26th and once the snow began, it increased in intensity, falling at rates at or greater than one inch per hour. Temperatures dropped to or below freezing across the entire region. There were heavy bands of snow occurring in some locations, especially across the Taconics, Mohawk Valley and southeastern Adirondacks. Snowfall totals ranged from six to 12 inches, with up to 15 inches in the southeastern Adirondacks. The weight of the snow caused power outages in the area, especially across the mid-Hudson Valley. There were up to 32,000 customers without power in Dutchess and Ulster Counties. Snowfall totals in Dutchess County ranged from five inches in the Town of Hyde Park to 12 inches in the Town of Pine Plains.

Sources: NYSDEC, NWS, NYS DHSES, NOAA-NCDC, FEMA

DR Major Disaster Declaration (FEMA)
FEMA Federal Emergency Management Agency
Mph Miles Per Hour
NCDC National Climatic Data Center
NOAA National Oceanic and Atmospheric Administration
NYSDEC New York State Department of Environmental Conservation
NYSDHSES New York State Division of Homeland Security and Emergency Services
N/A Not Applicable

Probability of Future Occurrences

Winter storm hazards in New York State are virtually guaranteed yearly since the State is located at relatively high latitudes resulting in winter temperatures that range between 0°F and 32 °F for a good deal of the fall through early spring season (late October until mid-April). In addition, the State is exposed to large quantities of moisture from both the Great Lakes and the Atlantic Ocean. While it is almost certain that a number of significant winter storms will occur during the winter and fall season, what is not easily determined is how many such storms will occur during that time frame (NYS DHSES 2014).

The New York State HMP includes a similar ranking process for hazards that affect the State. Based on historical records and input from the Planning Committee, the probability of at least one winter snow storm of emergency declaration proportions, occurring during any given calendar year is virtually certain in the State. Based on historical snow related disaster declaration occurrences, New York State can expect a snow storm of disaster declaration proportions, on average, once every three to five years. Similarly, for ice storms, based on historical disaster declarations, it is expected that on average, ice storms of disaster proportions will occur once every seven to 10 years within the State (NYS DHSES 2014). It is estimated that Dutchess County will continue to experience direct and indirect impacts of severe winter storms annually.

In Section 5.3, the identified hazards of concern for Dutchess 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 storms in the County is considered 'frequent' (event that occurs within 25 years, as presented in Table 5.3-3).

Climate Change Impacts

New York State averages 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 is more than 165 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.

Climate change is beginning to affect both people and resources in New York State, and these impacts are projected to continue growing. Impacts related to increasing temperatures and sea level rise are already being felt 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 (New York State Energy Research and Development Authority [NYSERDA] 2011).

Each region in New York State, as defined by ClimAID, has attributes that will be affected by climate change. Dutchess County is part of Region 5, East Hudson and Mohawk River Valleys. Some of the issues in this region, affected by climate change, include: more frequent heat waves and above 90°F days, more heat-related deaths, increased frequency of heavy precipitation and flooding, decline in air quality, etc. (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° F to 3.4° F by the 2020s, 4.1° F to 6.8° F by the 2050s, and 5.3° F to 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).

Regional precipitation across New York State is projected to increase by approximately one to eight-percent by the 2020s, three to 12-percent by the 2050s, and four to 15-percent by the 2080s. By the end of the century, the greatest increases in precipitation are projected to be in the northern areas of the State (NYSERDA 2014).

In Region 5, it is estimated that temperatures will increase by 3.5ºF to 7.1ºF by the 2050s and 4.1ºF to 11.4ºF by the 2080s (baseline of 47.6ºF). Precipitation totals will increase between 2 and 15% by the 2050s and 3 to 17% by the 2080s (baseline of 38.6 inches). Table 5.4.6-3 displays the projected seasonal precipitation change for the East Hudson and Mohawk River Valleys ClimAID Region (NYSERDA 2011).

Table 5.4.7-3. Projected Seasonal Precipitation Change in Region 5, 2050s (% change)

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

Source: NYSERDA 2011

It is uncertain how climate change will impact winter storms. Based on historical data, it is expected that the following will occur at least once per 100 years:

- Up to eight inches of rain fall in the rain band near the coast over a 36-hour period
- Up to four inches of freezing rain in the ice band near central New York State, of which between one and two inches of accumulated ice, 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 (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 (NYSDEC Date Unknown). Overall winter temperatures in New York State are almost five degrees warmer than in 1970 (NYSDEC Date Unknown). The State has seen 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 to 50% 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).

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

5.4.7.2 Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. For the severe winter storm hazard, all of Dutchess 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 storm. The following text evaluates and estimates the potential impact of the severe winter storm hazard on the County including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on: (1) life, health and safety of residents, (2) general building stock, (3) critical facilities, (4) economy, and (5) future growth and development
- Change of vulnerability as compared to that presented in the 2006 Dutchess County Hazard Mitigation Plan and 2010 Eastern Dutchess All-Hazard Mitigation Plan
- Effect of climate change on vulnerability
- Further data collections that will assist understanding this hazard over time

Overview of Vulnerability

Severe winter storms are of significant concern to the County because of the frequency and magnitude of these events in the region, the direct and indirect costs associated with these events, delays caused by the storms, and impacts on the people and facilities of the region related to snow and ice removal, health problems, cascade effects such as utility failure (power outages) and traffic accidents, and stress on community resources.

Data and Methodology

Updated population and general building stock data were used to support an evaluation of assets exposed to this hazard and the potential impacts associated with this hazard. Additionally, as available economic losses were provided by the Planning Committee to support this vulnerability assessment.

Impact on Life, Health and Safety

According to the NOAA National Severe Storms Laboratory (NSSL); every year, winter weather indirectly and deceptively kills hundreds of people in the U.S., primarily from automobile accidents, overexertion and exposure. 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 (NSSL, 2006).

Heavy snow can immobilize a region and paralyze a city, 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 may be isolated for days, and unprotected livestock may be lost. In the mountains, heavy snow can lead to avalanches. The cost of snow removal, repairing damages, and loss of business can have large economic impacts on cities and towns (NSSL, 2006).

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, 2006).

For the purposes of this HMP, the entire population of Dutchess County (297,488 people) is exposed to severe winter storm events (U.S. Census, 2010). Snow accumulation and frozen/slippery road surfaces increase the frequency and impact of traffic accidents for the general population, resulting in personal injuries. Refer to Section 4 (County Profile) for population statistics for each participating municipality.

The elderly are considered most susceptible to this hazard due to their increased risk of injuries and death from falls and overexertion and/or hypothermia from attempts to clear snow and ice. In addition, severe winter storm events can reduce the ability of these populations to access emergency services. Residents with low incomes may not have access to housing or their housing may be less able to withstand cold temperatures (e.g., homes with poor insulation and heating supply).

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. Table 5.4.7-3 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 5.4.7-3 below summarizes percent damages that could result from severe winter storm conditions for the Planning Area's total general building stock. Given professional knowledge and the currently available information, the potential loss for this hazard is many times considered to be overestimated because of varying factors (building structure type, age, load distribution, building codes in place, etc.). Therefore, the following information should be used as estimates only for planning purposes with the knowledge that the associated losses for severe winter storm events vary greatly.

Table 5.4.7-4. General Building Stock Exposure and Estimated Losses from Severe Winter Storm Events

Municipality	Total (All Occupancies)	1% Damage Loss Estimate	5% Damage Loss Estimate	10% Damage Loss Estimate
Amenia (T)	$1,173,643,243	$11,736,432	$58,682,162	$117,364,324
Beacon (C)	$2,064,232,682	$20,642,327	$103,211,634	$206,423,268
Beekman (T)	$2,449,459,966	$24,494,600	$122,472,998	$244,945,997
Clinton (T)	$1,341,651,069	$13,416,511	$67,082,553	$134,165,107
Dover (T)	$1,677,602,978	$16,776,030	$83,880,149	$167,760,298
East Fishkill (T)	$6,390,057,444	$63,900,574	$319,502,872	$639,005,744
Fishkill (T)	$3,949,240,855	$39,492,409	$197,462,043	$394,924,086
Fishkill (V)	$402,859,104	$4,028,591	$20,142,955	$40,285,910
Hyde Park (T)	$3,781,227,152	$37,812,272	$189,061,358	$378,122,715
LaGrange (T)	$3,728,775,229	$37,287,752	$186,438,761	$372,877,523
Milan (T)	$791,142,073	$7,911,421	$39,557,104	$79,114,207
Millbrook (V)	$430,362,334	$4,303,623	$21,518,117	$43,036,233
Millerton (V)	$200,740,766	$2,007,408	$10,037,038	$20,074,077
Northeast (T)	$872,302,173	$8,723,022	$43,615,109	$87,230,217
Pawling (T)	$1,629,501,263	$16,295,013	$81,475,063	$162,950,126
Pawling (V)	$462,892,825	$4,628,928	$23,144,641	$46,289,283
Pine Plains (T)	$800,637,873	$8,006,379	$40,031,894	$80,063,787

Table 5.4.7-4. General Building Stock Exposure and Estimated Losses from Severe Winter Storm Events

Municipality	Total (All Occupancies)	1% Damage Loss Estimate	5% Damage Loss Estimate	10% Damage Loss Estimate
Pleasant Valley (T)	$1,982,280,592	$19,822,806	$99,114,030	$198,228,059
Poughkeepsie (C)	$3,982,167,290	$39,821,673	$199,108,365	$398,216,729
Poughkeepsie (T)	$9,077,634,548	$90,776,345	$453,881,727	$907,763,455
Red Hook (T)	$1,967,030,033	$19,670,300	$98,351,502	$196,703,003
Red Hook (V)	$465,279,056	$4,652,791	$23,263,953	$46,527,906
Rhinebeck (T)	$1,564,600,397	$15,646,004	$78,230,020	$156,460,040
Rhinebeck (V)	$699,038,933	$6,990,389	$34,951,947	$69,903,893
Stanford (T)	$1,361,285,639	$13,612,856	$68,064,282	$136,128,564
Tivoli (V)	$222,466,402	$2,224,664	$11,123,320	$22,246,640
Union Vale (T)	$1,311,718,689	$13,117,187	$65,585,934	$131,171,869
Wappinger (T)	$3,652,165,422	$36,521,654	$182,608,271	$365,216,542
Wappinger Falls (V)	$689,593,231	$6,895,932	$34,479,662	$68,959,323
Washington (T)	$1,392,014,229	$13,920,142	$69,600,711	$139,201,423
Dutchess County (TOTAL)	**$60,513,603,490**	**$605,136,035**	**$3,025,680,175**	**$6,051,360,349**

Source: Dutchess County

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 5.4.5). Generally, losses resulting from flooding associated with severe winter storms should be less than that associated with a 100-year flood. In addition, coastal areas are at high risk during winter storm events that involve high winds. Please refer to the severe storm profile (Section 5.4.6) 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. 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.

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.

Future Growth and Development

As discussed in Sections 4 and 9, 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. Areas targeted for potential future growth and development in the next five (5) years have been identified across the County at the municipal level. Refer to the jurisdictional annexes in Volume II of this HMP.

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

- Removal of snow from roadways
- Removal of dead trees and trim trees/brush from roadways to lessen falling limbs and trees
- Ensure proper road signs are visible and installed properly
- Bury electrical and telephone utility lines to minimize downed lines
- Removal of debris/obstructions in waterways and develop routine inspections/maintenance plans to reduce potential flooding
- Replace substandard roofs of critical facilities to reduce exposure to airborne germs resulting from leakage
- Purchase and install backup generators in evacuation facilities and critical facilities to essential services to residents
- Install cell towers in areas where limited telecommunication is available to increase emergency response and cell phone coverage (NYS DHSES, 2014)

Change of Vulnerability

Overall, the entire County remains vulnerable to coastal storms. A damage estimate was not conducted as part of the 2006 HMP and 2010 Eastern Dutchess AHMP risk assessment. The updated vulnerability assessment provides a more current risk assessment and analysis for the County.

Effect of Climate Change on Vulnerability

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], 2013).

The 2011 'Responding to Climate Change in New York State' report was prepared for New York State Energy Research and Development Authority to study the potential impacts of global climate change on New York State. According to the synthesis report, it is uncertain how climate change will influence extreme winter storm events. Winter temperatures are projected to continue to increase. In general, warmer winters may lead to a decrease in snow cover and an earlier arrival in spring; all of which have numerous cascading effects on the environment and economy. Annual average precipitation is also projected to increase. The increase in precipitation is likely to occur during the winter months as rain, with the possibility of slightly reduced precipitation projected for the late summer and early fall. Increased rain on snowpack may lead to increased flooding and related impacts on water quality, infrastructure, and agriculture in the State. Overall, it is anticipated that winter storms will continue to pass through New York State (NYSERDA, 2011). Future enhancements in climate modeling will provide an improved understanding of how the climate will change and impact the Northeast.

Additional Data and Next Steps

The assessment above identifies vulnerable populations and economic losses associated with this hazard of concern. Historic data on structural losses to general building stock are not adequate to predict specific losses to this inventory; therefore, the percent of damage assumption methodology was applied. This methodology is based on FEMA's How to Series (FEMA 386-2), Understanding Your Risks, Identifying and Estimating Losses (FEMA, 2001) and FEMA's Using HAZUS-MH for Risk Assessment (FEMA 433) (FEMA, 2004). The collection of additional/actual valuation data for general building stock and critical infrastructure losses would further support future estimates of potential exposure and damage for the general building stock inventory. Mitigation strategies addressing early warning, dissemination of hazard information, provisions for snow removal and back-up power are included in Volume II, Section 9 of this plan.