4.3.13 Winter Storm

This section provides a profile and vulnerability assessment of the winter storm hazard in Fulton County. Winter storms occur, on average, approximately five times each year in Pennsylvania. From November through March, Pennsylvania is exposed to winter storms that move up the Atlantic coast or sweep in from the west. Every county in the Commonwealth is vulnerable to severe winter storms; however, the northern tier, western counties, and mountainous regions tend to experience winter weather more frequently and with greater severity.

Winter storms can produce more damage than any other severe weather event, including tornadoes. Complications caused by winter storms can lead to road closures (especially secondary and farm roads); business losses to commercial centers built in outlying areas because of supply interruption and loss of customers; property losses and roof damages from snow and ice loading and fallen trees; utility interruptions; and loss of water supplies. Flooding can result from winter storm events as well.

Most severe winter storm hazards include heavy snow (snowstorms), blizzards, sleet or freezing rain, ice storms, and mid-Atlantic cyclones locally known as Northeasters or Nor'easters. Because most Nor'easters generally occur during winter weather months, these hazards have also been grouped as a type of severe winter weather storm. Types of severe winter weather events or conditions are further defined as follows:

- **Heavy Snow:** According to the National Weather Service (NWS), heavy snow is generally considered snowfall accumulating to depth of 4 inches or more within 12 hours or less or snowfall accumulating to depth of 6 inches or more within 24 hours or less. A snow squall is an intense but limited-duration period of moderate to heavy snowfall, also known as a snowstorm, accompanied by strong, gusty surface winds and possibly lightning (generally moderate to heavy snow showers) (NWS 2009). Snowstorms are complex phenomena involving heavy snow and winds whose impact can be affected by a great many factors, including a region's climatological susceptibility to snowstorms, snowfall amounts, snowfall rates, wind speeds, temperatures, visibility, storm duration, topography, and occurrence during the course of the day, weekday versus weekend, and time of season (Kocin and Uccellini 2013).

- **Blizzard:** Blizzards are characterized by low temperatures, wind gusts of 35 miles per hour (mph) or more, and falling and/or blowing snow that reduces visibility to 0.25 mile or less for an extended period of time (3 or more hours) (NWS 2009). A severe blizzard is defined as having a wind velocity of 45 mph, temperatures of 10°F or lower, and a high density of blowing snow with visibility frequently measured in feet over an extended period of time.

- **Sleet or Freezing Rain:** Sleet is defined as pellets of ice composed of frozen or mostly frozen raindrops or refrozen, partially melted snowflakes. These pellets of ice usually bounce after hitting the ground or other hard surfaces. Freezing rain is rain that falls as a liquid but freezes into glaze upon contact with the ground. Both types of precipitation, even in small accumulations, can cause significant hazards to a community (NWS 2009).

- **Ice Storm:** An ice storm is described as an occasion when damaging volumes of ice are expected to accumulate during freezing rain situations. Significant accumulations of ice pull down trees and utility lines, resulting in loss of power and means of communication. These accumulations of ice render walking and driving extremely dangerous, and can create extreme hazards to motorists and pedestrians (NWS 2009).

- **Nor'easter:** Nor'easters are macro-scale, extra-tropical storms named for the strong northeasterly winds that blow in from the Atlantic Ocean ahead of the storm and over coastal areas of the northeastern United States and Atlantic Canada. They are also referred to as a type of extra-tropical cyclone (mid-latitude storms, or Great Lake storms). Wind gusts associated with Nor'easters can exceed hurricane

forces in intensity. Unlike tropical cyclones that form in the tropics and have warm cores (including tropical depressions, tropical storms, and hurricanes), Nor'easters contain a cold core of low barometric pressure that forms in the mid-latitudes. Their strongest winds are close to the earth's surface and often extend several hundred miles across. Nor'easters may occur at any time of the year but are more common during fall and winter months (September through April) (NWS 2019).

4.3.13.1 Location and Extent

Winter storms are regional events, most of which impact a large area of the entire Commonwealth. In many cases, surrounding states and even the northeast region of the United States are affected by a single winter storm incident.

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 (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. National Oceanic and Atmospheric Administration (NOAA)'s National Centers for Environmental Information (NCEI) is currently producing the Regional Snowfall Index (RSI) for significant snowstorms that affect the eastern two-thirds of the United States. The RSI ranks snowstorm impacts on a scale from 1 to 5. The index is based on spatial extent of the storm, amount of snowfall, and interaction of the extent and snowfall totals with population (based on the 2000 U.S. Census). NCEI has analyzed and assigned RSI values to over 500 storms since 1900 (NCEI 2011). Table 4.3.13-1 lists the five RSI ranking categories.

Table 4.3.13-1. RSI Ranking Categories

Category	Description	Regional Snowfall Index (RSI)
1	Notable	1-3
2	Significant	3-6
3	Major	6-10
4	Crippling	10-18
5	Extreme	18.0+

Source: NCEI 2011

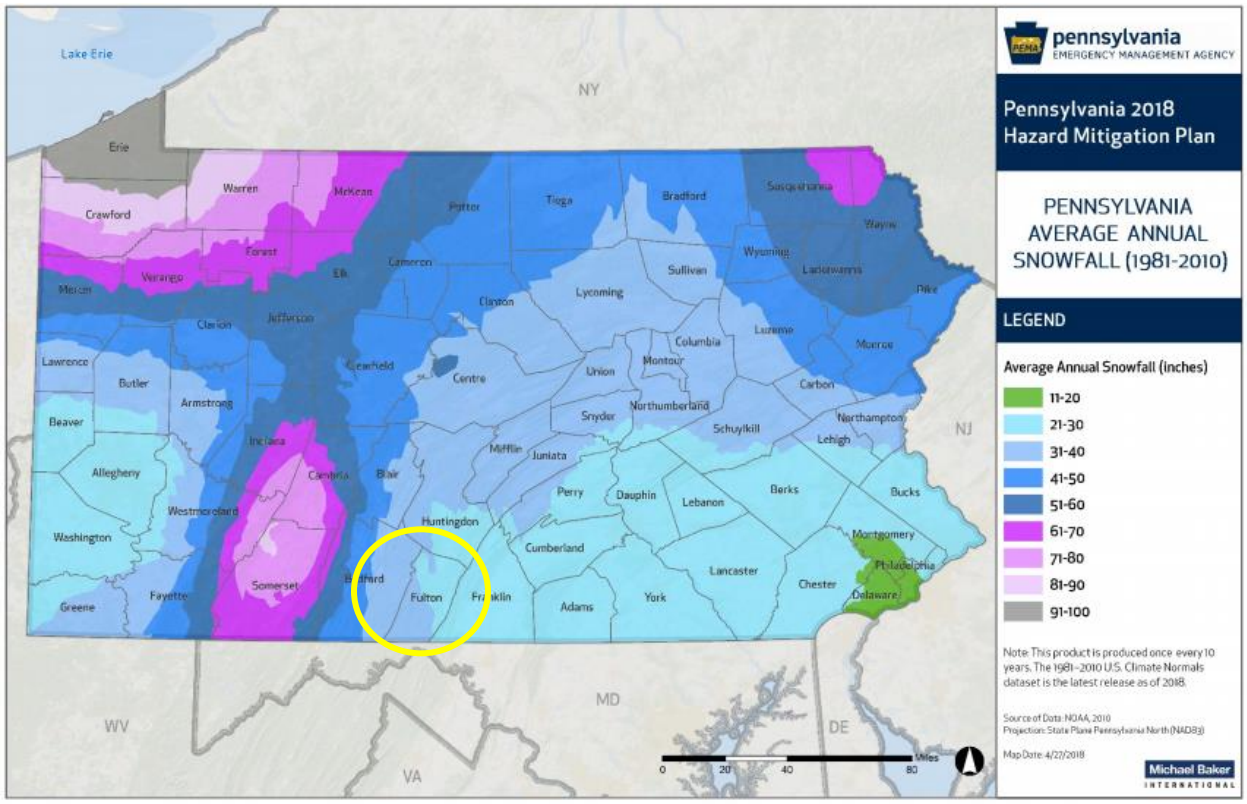
4.3.13.2 Range in Magnitude

A winter storm can adversely affect roadways, utilities, and businesses and can cause loss of life, frostbite, and freezing conditions. These storms typically fall into one of the following categories, defined in the previous section:

- Heavy snow
- Sleet or freezing rain
- Ice storm
- Blizzard
- Nor'easter

All of Fulton County is susceptible to winter storms. Based on annual snowfall averages according to the 2018 State Hazard Mitigation Plan (HMP) (Figure 4.3.13-1), snowfall accumulation during the winter season in Fulton County ranges from 21 to 40 inches.

Figure 4.3.13-1. Pennsylvania Average Annual Snowfall



Source: Pennsylvania Emergency Management Agency (PEMA) 2018
Note: The yellow oval surrounds Fulton County.

The January 1996 snowstorm has been referred to as the "storm of the century," but the worst-case scenario of a winter storm in Fulton County occurred in January 1994. Specific snowfall totals for that storm were not available, but snowfall in the southwest portions of Pennsylvania exceeded 30 inches in 1 day. The Pennsylvania Turnpike (I-76) as well as I-70 (a major north-south highway in Fulton County) were closed or shut down because of the snow. The storm brought with it strong winds and sleet/freezing rains. Numerous storm-related power outages were reported, and as many as 600,000 residents throughout Pennsylvania were without electricity, in some cases for several days at a time. The storm caused 185 injuries and approximately $5 million in damages across the State.

4.3.13.3 Past Occurrence

Many sources provided historical information regarding previous occurrences and losses associated with winter storm events throughout the Commonwealth of Pennsylvania and Fulton County. With so many sources reviewed for the purpose of this plan, loss and impact information for many events varied depending on the source. Therefore, accuracy of monetary figures discussed is based only on available information identified during research for this plan. Monetary figures may also have been calculated for the region as a whole, based on entire storm damage, and include damage from other counties.

Between 1954 and 2017, the Federal Emergency Management Agency (FEMA) declared that the Commonwealth of Pennsylvania experienced eight winter storm-related disasters (DR) or emergencies (EM) classified as one or a combination of the following disaster types: severe winter storms, snowstorms, blizzards, winter storms, severe storms, and snowfalls. Generally, these disasters covered a wide region of the Commonwealth, and therefore may have impacted many counties. However, not all counties were included in

the disaster declarations. PEMA and other sources indicate that Fulton County has been declared as a disaster area as a result of six of the declarations for winter storm events (FEMA 2019).

According to the NOAA-NCEI storm events database, Fulton County experienced 53 winter storm events between January 07, 1996 and February 20, 2019. Based on all sources researched, known winter storm events that have affected Fulton County are listed in Table 4.3.13-2. Because winter storm documentation for the Commonwealth of Pennsylvania is so extensive, not all sources have been identified or researched. Therefore, Table 4.3.13-2 may not include all events that have occurred throughout Fulton County.

Table 4.3.13-2. Major Winter Storm Events in Fulton County between 1993 and 2019

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
3/13-17/1993	Severe Snow Fall and Winter Storm	EM-3105	Y	Eligible for Public Assistance
1/6-12/1996	Blizzard	DR-1085	Y	Eligible for Public Assistance
1/7/1996	Blizzard	N/A	N/A	On January 7, more than 2 feet of snow fell across much of the lower Susquehanna Valley with 12 to 18 inches falling across the central mountains from Johnstown and State College east to Wilkes-Barre. The storm was appropriately termed the Blizzard of '96. Snow began falling during the morning of January 7 and continued into the early morning of January 8. Transportation and commerce came to a halt as the cities of south central Pennsylvania were buried under the heavy snow. The storm had a major impact on commerce across south central Pennsylvania.
3/4/2001	Heavy Snow	N/A	N/A	$150,000 in property damage. Statewide.
1/6/2002	Heavy Snow	N/A	N/A	Central Pennsylvania.
10/29/2002	Ice Storm	N/A	N/A	$1 million in property damage. Multiple counties.
2/2003	Severe Winter Storm	N/A	Y	Governor's Proclamation of Disaster Emergency, Governor Edward G. Rendell; Pres-EM
2/14-19/2003	Snow Storm	EM-3180	Y	Eligible for Public Assistance
2/13/2007	Winter Storm	N/A	N/A	A major winter storm, the first of the season, struck central Pennsylvania from the early morning hours of February 13 through the afternoon hours of February 14, 2007. In Fulton County, a mix of sleet and freezing rain fell in addition to 6 to 7 inches of snow.
2/1/2008	Winter Storm	N/A	N/A	Fulton County emergency management reported over 0.25 inch of ice from freezing rain and sleet.
2/5-11/2010	Severe Winter Storms and Snow Storms	DR-1898	Y	Eligible for Public Assistance
12/14/2013	Winter Storm	N/A	N/A	Light snow started in the morning and became heavy at times through the afternoon and evening. Snow changed to sleet and then freezing rain/drizzle with a glaze of ice, topping storm total snow accumulations between 3 and 6 inches. The mixed wintry precipitation adversely impacted travel, especially along the Pennsylvania Turnpike and I-70 corridors.
3/19/2015	Heavy Snow	N/A	N/A	Snowfall amounts of 6 inches were reported across the county.

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
1/22/2016	Winter Storm	DR-4267	N/A	Heavy snowfall amounts of 18 to 30 inches were observed across the county.
2/15/2016	Winter Storm	N/A	N/A	Light snow developed the afternoon of February 15 before quickly changing over to freezing rain. A quarter of an inch or more of ice accumulation was observed across the county.
3/13/2017	Winter Storm	N/A	N/A	A winter storm produced 7-12 inches of snow across Fulton County.
2/07/2018	Winter Storm	N/A	N/A	A winter storm produced snow, sleet, and 0.25 to 0.40 inches of freezing rain across Fulton County.
3/20/2018	Winter Storm	N/A	N/A	A winter storm produced 8-14 inches of snow in a 24-hour period across Fulton County.
11/15/2018	Winter Storm	N/A	N/A	A winter storm produced 6 to 11 inches of snow and sleet across Fulton County on November 15-16, 2018.
2/11/2019	Winter Storm	N/A	N/A	A Winter Storm produced 2 to 4 inches of snow and sleet, and greater than 0.25 of freezing rain across Fulton County from February 11-12, 2019.
2/20/2019	Winter Storm	N/A	N/A	A Winter Storm produced 6 to 8 inches of snow and sleet followed by greater than 0.25 of freezing rain across Fulton County on February 20-21, 2019.

Source: PEMA 2018; NCEI 2019.

Notes:

Monetary figures within this table were U.S. Dollar (USD) figures calculated during or within the approximate time of the event. If such an event would occur in the present day, many monetary losses earlier than 2017 would be considerably higher in USDs as a result of increased U.S. Inflation Rates.

DR Federal Disaster Declaration
FEMA Federal Emergency Management Agency
N/A Not applicable/available
NCDC National Climate Data Center
NOAA National Oceanic Atmospheric Administration

4.3.13.4 Future Occurrence

Apparently, given the history of winter storm events that have impacted Fulton County, future winter storm events of varying degrees will occur, and thus many people and properties are at risk from the winter storm hazard in the future.

Based on available historical data, future occurrences of winter storm events are considered *highly likely*, according to Risk Factor Methodology probability criteria (further discussed in Section 4.4).

4.3.13.5 Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable within the identified hazard area. Regarding winter storm events, all of Westmoreland County has been identified as the hazard area. Therefore, all assets (population, structures, critical facilities, and lifelines), as described in the County Profile (Section 2), are potentially vulnerable. The following section includes an evaluation and estimation of potential winter storm impacts on Fulton County, including:

- Data and methodology used for the evaluation
- Impacts on life, health, and safety; general building stock; critical facilities; economy; environment; and future growth and development
- Effect of climate change on vulnerability
- Further data collections that will increase understanding of this hazard over time

In Fulton County, winter storms are a concern because of frequency, associated direct and indirect costs, delays caused by the storms, and impacts on people and facilities of the region.

Impact on Life, Health, and Safety

According to the NOAA National Severe Storms Laboratory (NSSL), winter weather indirectly and deceptively kills hundreds of people in the United States every year, 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, extreme cold temperatures, and dangerous wind chill. Winter storms 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, of heart attacks while shoveling snow, or of hypothermia from prolonged exposure to cold.

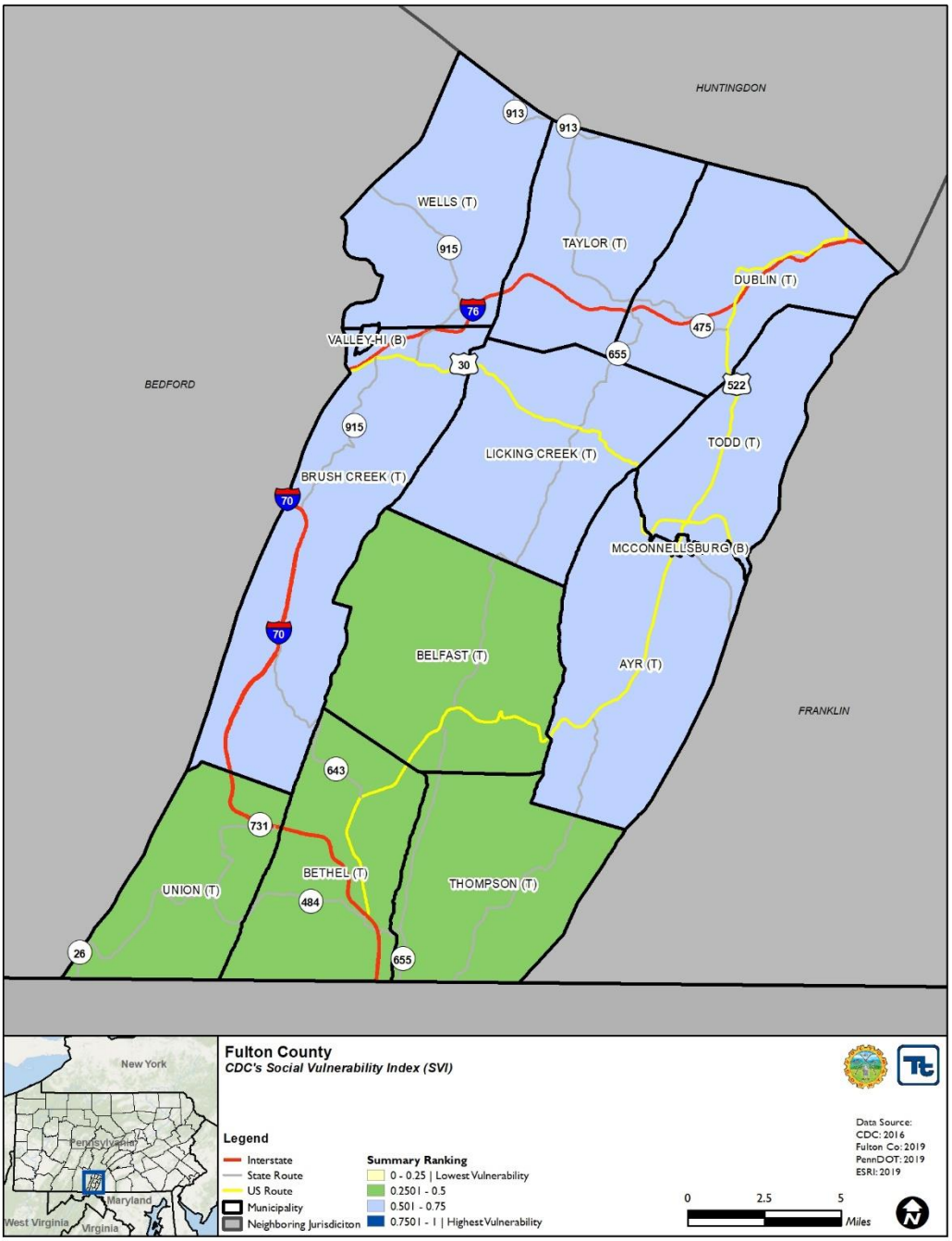
Heavy snow can immobilize a region and paralyze a city, shutting down air and rail transportation, stopping flow of supplies, and disrupting medical and emergency services. Accumulations of snow can collapse buildings and knock down trees and power lines. In rural areas, homes and farms may be isolated for days, and unprotected livestock may be lost. In the mountains, heavy snow can lead to avalanches (NSSL 2015c).

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 2015c).

For the purposes of this HMP, the entire population of Fulton County is considered exposed to winter storm events (U.S. Census 2010). The elderly are considered most susceptible to this hazard because of their increased risk of injuries and death from falls and overexertion, and/or hypothermia from exposure while attempting to clear snow and ice. In addition, winter storm events can reduce 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). The County Profile (Section 2) of this HMP provides population statistics regarding each participating municipality and a summary of the more vulnerable populations (over the age of 65 and individuals living below the U.S. Census poverty threshold).

According to the Centers for Disease Control and Prevention's (CDC) 2016 Social Vulnerability Index, populations in Ayr Township, Brush Creek Township, Dublin Township, Licking Creek Township, McConnellsburg Borough, Taylor Township, Todd Township, Valley-Hi Borough, and Wells Township are classified within a higher vulnerability ranking then Belfast Township, Bethel Township, Thompson Township, and Union Township. The vulnerable populations located in these municipalities may be more susceptible to impacts from severe winter storms. Figure 4.3.13-2 below displays the CDC Social Vulnerability Index for Fulton County.

Figure 4.3.13-2. CDC's Social Vulnerability Index 2016



Impact on General Building Stock

The entire general building stock inventory in Fulton County is exposed and vulnerable to the 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 from this hazard. As an alternate approach, this plan considers percentage damages that could result from winter storm conditions. Table 4.3.13-3 summarizes the estimated loss to Fulton County's total general building stock (structure only) as a result of 1-, 5-, and 10-percent loss. 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 4.3.13-3. General Building Stock Exposure (Structure Only) and Estimated Losses from Winter Storm Events in Fulton County

Municipality	Total GBS (Structure Only)	1% of Total	5% of Total	10% of Total
Ayr Township	$203,163,000	$2,031,630	$10,158,150	$20,316,300
Belfast Township	$111,757,000	$1,117,570	$5,587,850	$11,175,700
Bethel Township	$152,457,000	$1,524,570	$7,622,850	$15,245,700
Brush Creek Township	$70,479,000	$704,790	$3,523,950	$7,047,900
Dublin Township	$95,778,000	$957,780	$4,788,900	$9,577,800
Licking Creek Township	$129,459,000	$1,294,590	$6,472,950	$12,945,900
McConnellsburg Borough	$157,058,000	$1,570,580	$7,852,900	$15,705,800
Taylor Township	$87,204,000	$872,040	$4,360,200	$8,720,400
Thompson Township	$101,824,000	$1,018,240	$5,091,200	$10,182,400
Todd Township	$164,001,000	$1,640,010	$8,200,050	$16,400,100
Union Township	$69,402,000	$694,020	$3,470,100	$6,940,200
Valley-Hi Borough	$3,885,000	$38,850	$194,250	$388,500
Wells Township	$37,498,000	$374,980	$1,874,900	$3,749,800
Fulton County	**$1,383,965,000**	**$13,839,650**	**$69,198,250**	**$138,396,500**

Source: HAZUS-MH v4.2

An area especially vulnerable to the winter storm hazard is the floodplain. At-risk building stock and infrastructure in floodplains are presented in the flood hazard profile (Section 4.3.5). Generally, losses from flooding associated with winter storms should be less than those associated with a 1 percent or 0.2 percent flood. Snow and ice melt can cause both riverine and urban flooding. Estimated losses caused by riverine flooding in Fulton County are discussed in Section 4.3.5.

Impact on Critical Facilities

Full functionality of critical facilities such as police, fire, and medical services is essential for response during and after a winter storm event. These critical facility structures are largely constructed of concrete and masonry; therefore, these should undergo only minimal structural damage from severe winter storm events. Because power interruption can occur, backup power is recommended for critical facilities and infrastructure.

Impact on the Economy

Infrastructure at risk from the winter storm hazard includes roadways that could be damaged by application of salt and intermittent freezing and warming conditions that can damage roads over time. Costs of snow and ice removals, as well as repairs of roads undergoing freeze/thaw cycles, can drain local financial resources. Potential secondary impacts from winter storms also impact the local economy, including loss of utilities, interruption of transportation corridors, and loss of business function.

Impact on the Environment

Environmental impacts often include damage to shrubbery and trees due to heavy snow loading, ice build-up, and/or high winds, which can break limbs or even bring down large trees. An indirect effect of winter storms is the treatment of roadway surfaces with salt, chemicals, and other de-icing materials, which can impair adjacent surface and ground waters. Another important secondary impact for winter storms is building or structure collapses; if there is a heavy snowfall or a significant accumulation over time, the weight of the snow may cause building damage or even collapse (PEMA 2018).

Winter storms have a positive environmental impact as well; gradual melting of snow and ice provides excellent groundwater recharge. However, abrupt high temperatures following a heavy snowfall can cause rapid surface water runoff and severe flooding (PEMA 2018).

Future Growth and Development

Areas targeted for potential future growth and development within the next 5 to 10 years have been identified across Fulton County at the municipal level and are further discussed in Section 2.4 of this HMP. Because Fulton County in its entirety has been identified as the hazard area vulnerable to the winter storm hazard, any new development will be exposed to associated risks.

Effect of Climate Change on Vulnerability

Climate is defined not just as average temperature and precipitation, but also by type, frequency, and intensity of weather events. Both globally and at the local level, climate change potentially can alter prevalence and severity of weather extremes such as winter storms. While predicting changes in 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.

The climate of Pennsylvania has changed in several ways. Over the past 100 years, annual average temperatures have been rising across the Commonwealth. Warmer winters have led to decrease in snow cover and earlier arrival of spring. Recent analyses based on the Intergovernmental Panel on Climate Change models suggest a decrease in frequency and an increase in intensity of extra-tropical winter cyclones. However, based on the methodology applied, some models show no significant change in the storm track, whereas others indicate a northward displacement of the storm track in the North Atlantic. For the mid-Atlantic region, there is little indication of a change in storm activity or track over Pennsylvania. An overall increase in winter precipitation is anticipated, with decrease in snow and increase in rain during the winter months. Projections regarding future occurrences of extra-tropical cyclones in Pennsylvania are substantially uncertain. Based on available information and projections, winter storms are anticipated to continue to affect Pennsylvania in the future. Future improvements in modeling smaller-scale climatic processes can be expected and will lead to improved understanding of ways in which changing climate will alter temperature, precipitation, and storm events in Pennsylvania (Shortle and others 2009).

Additional Data and Next Steps

The assessment above identifies vulnerable populations and economic losses associated with the winter storm hazard of concern. Historical 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 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 2015a). Acquisition of additional/actual valuation data regarding general building stock and critical infrastructure losses would further support future estimates of potential exposure of and damage to the general building stock inventory.