5.4.7 Severe Storms

The following section provides the hazard profile and vulnerability assessment for the severe weather hazard in Onondaga County.

5.4.8 Profile

Hazard Description

For this HMP and as deemed appropriated by the Onondaga County Steering and Planning Partnership, the severe storm hazard includes: thunderstorms, lightning, hail, tornadoes, high winds, and hurricanes/tropical storms, which are defined below.

Thunderstorms

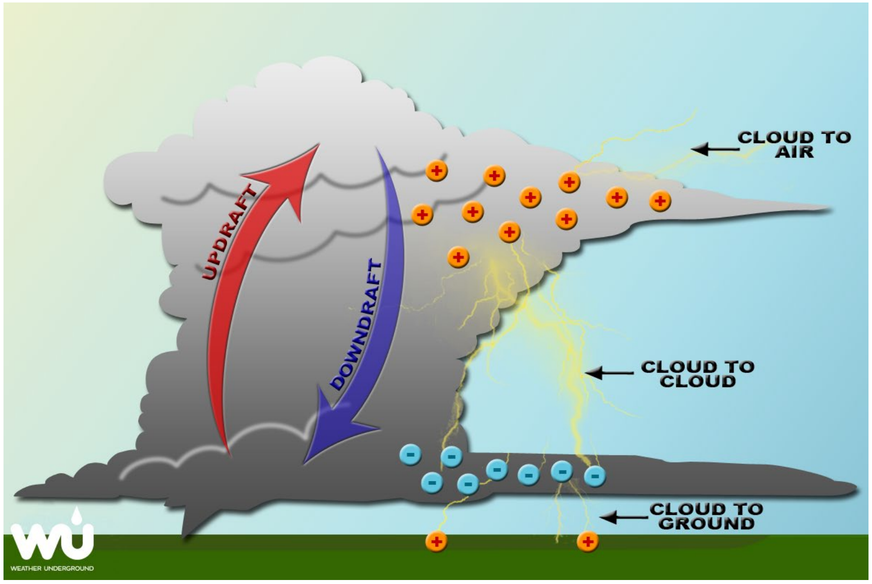
A thunderstorm is a local storm produced by a cumulonimbus cloud and accompanied by lightning and thunder (National Weather Service [NWS] 2009). A thunderstorm forms from a combination of moisture; rapidly rising warm air; and a force capable of lifting air, such as a warm front, cold front, a sea breeze, or a mountain. Thunderstorms form from the equator to as far north as Alaska. Although thunderstorms generally affect a small area when they occur, they have the potential to become dangerous due to their ability to generate tornadoes, hailstorms, strong winds, flash flooding, and lightning.

Thunderstorms can lead to heavy rain induced flooding, landslides, strong winds, and lightning. Roads could become impassable from flooding, downed trees, utility poles, power lines, or a landslide. Downed utility poles can lead to utility losses, such as electricity, phone, and water (from loss of pumping and filtering capabilities). Typical thunderstorms are 15 miles in diameter and last an average of 30 minutes. During the summer, thunderstorms are responsible for most of the rainfall.

Lightning

Lighting is a bright flash of electrical energy produced by a thunderstorm. The resulting clap of thunder is the result of a shock wave created by the rapid heating and cooling of the air in the lightning channel. All thunderstorms produce lightning and are very dangerous. Lightning ranks as one of the top weather killers in the United States, killing approximately 50 people and injuring hundreds each year. Lightning can occur anywhere there is a thunderstorm. Lightning can be cloud to air, cloud to cloud, and cloud to ground. Figure 5.4.7-1 demonstrates the variety of lightning types.

Figure 5.4.7-1. Types of Lightning

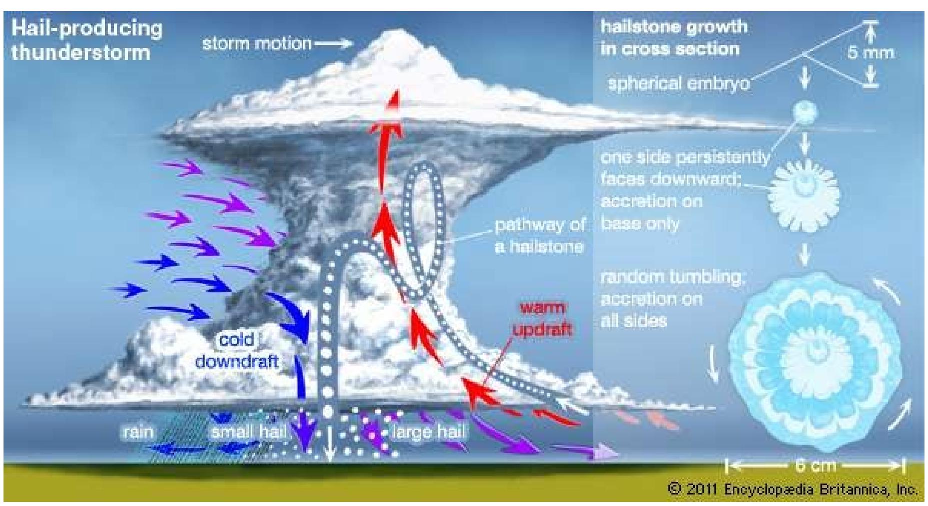


Source: Weather Underground date unknown

Hailstorms

Hail forms inside a thunderstorm or other storms with strong updrafts of warm air and downdrafts of cold water. If a water droplet is picked up by the updrafts, it can be carried well above the freezing level. Water droplets freeze when temperatures reach 32 degrees Fahrenheit (°F) or colder. As the frozen droplet begins to fall, it may thaw as it moves into warmer air toward the bottom of the thunderstorm or, the droplet might be picked up again by another updraft and carried back into the cold air and re-freeze. With each trip above and below the freezing level, the frozen droplet adds another layer of ice. The frozen droplet, with many layers of ice, falls to the ground as hail. Most hail is small and typically less than 2 inches in diameter (NWS 2010). Figure 5.4.7-2 shows how hail is formed within thunderstorms.

Figure 5.4.7-2. Hail Formation in Thunderstorms



Source: Encyclopedia Britannica 2011

High Winds

Wind begins with differences in air pressures and occurs through rough horizontal movement of air caused by uneven heating of the earth's surface. Wind occurs at all scales, from local breezes lasting a few minutes to global winds resulting from solar heating of the earth. High winds are often associated with other severe weather events such as thunderstorms, derechos, tornadoes, nor'easters, hurricanes, and tropical storms (all discussed further in this section).

Tornadoes

A tornado appears as a rotating, funnel-shaped cloud that extends from a thunderstorm to the ground with whirling winds that can reach 250 miles per hour (mph). Damage paths can be greater than 1 mile wide and 50 miles long. Tornadoes typically develop from either a severe thunderstorm or hurricane as cool air rapidly overrides a layer of warm air. Tornadoes typically move at speeds between 30 and 125 mph and can generate combined wind speeds (forward motion and speed of the whirling winds) exceeding 300 mph. The lifespan of a tornado rarely is longer than 30 minutes (FEMA 1997). Tornadoes can occur at any time of the year, with peak seasons at different times for different states (NSSL 2013).

Hurricanes/Tropical Storms

Tropical cyclones (hurricanes) are fueled by a different heat mechanism than other cyclonic windstorms such as Nor'easters and polar lows. The characteristic that separates a tropical storm from another cyclonic system is that at any height in the atmosphere, the center of a tropical storm will be warmer than its surroundings, a phenomenon called "warm core" storm systems (NOAA 2013). Tropical cyclones strengthen when water evaporated from the ocean is released as the saturated air rises, resulting in condensation of water vapor contained in the moist air. Tropical cyclones begin as disturbed areas of weather, often referred to as tropical waves. As the storm organizes, it is designated as a tropical depression.

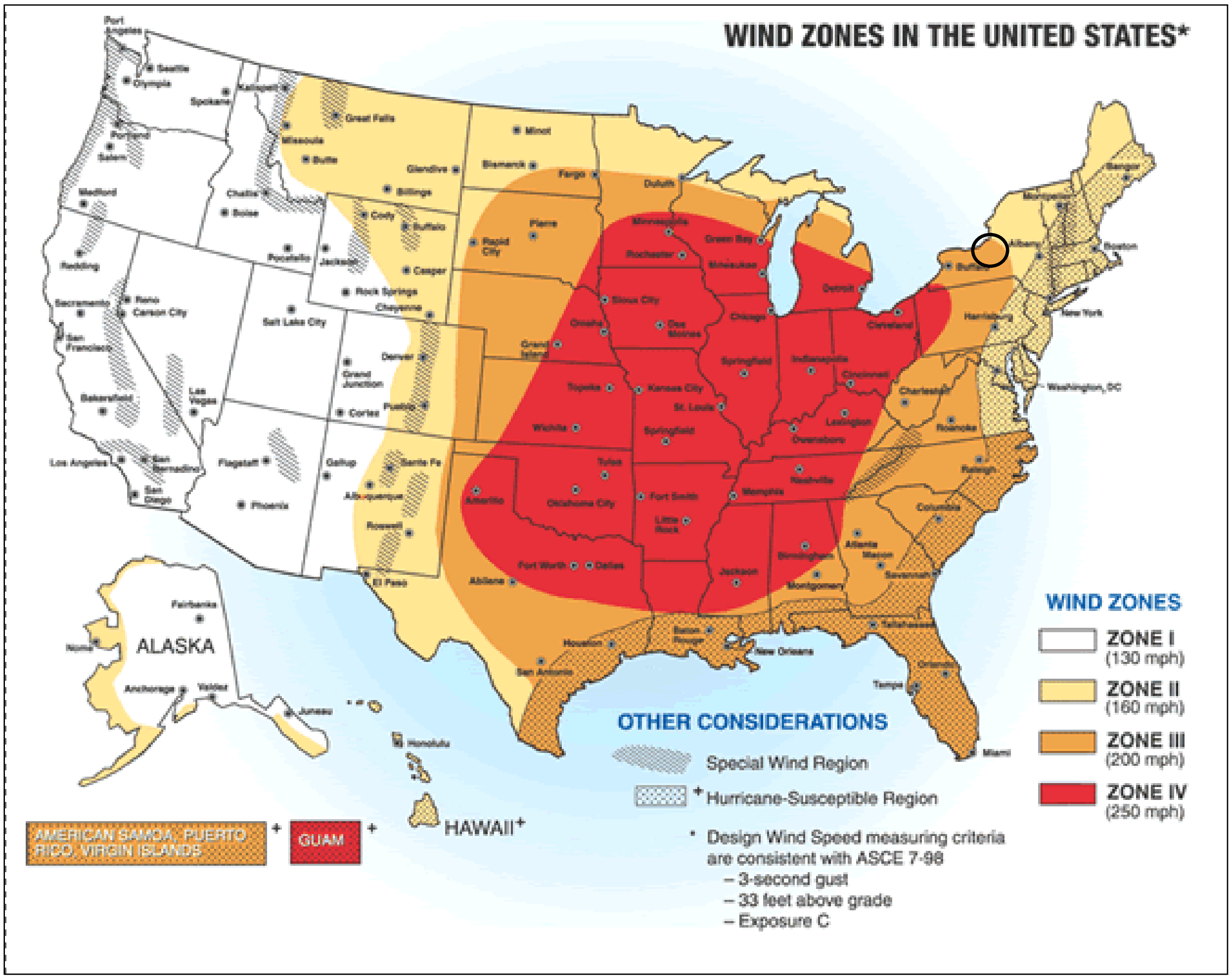
A tropical storm system is characterized by a low-pressure center and numerous thunderstorms that produce strong winds of 39 to 73 mph and heavy rain. A hurricane is a tropical storm that attains hurricane status when its wind speed reaches 74 mph or higher. Tropical systems can develop in the Atlantic between the Lesser Antilles and the African coast, or may develop in the warm tropical waters of the Caribbean and Gulf of Mexico. These storms can move up the Atlantic coast of the United States impacting the eastern seaboard, or move into the United States through the states along the Gulf Coast, bringing wind and rain as far north as New England before moving eastward offshore.

Despite Onondaga being an inland county, coastal storms, such as hurricanes and tropical storms, can impact the county (NYS DHSES 2014). Hurricanes and tropical storms can impact Onondaga County from June to November, the official eastern U.S. hurricane season; however, late July to early October is the most likely period for hurricanes and tropical storms to impact the County due to the cooling of the North Atlantic Ocean waters (NYS DHSES 2014). Although one of the most severe impacts associated with hurricanes is storm surge, due to Onondaga County's location, storm surge is not a concern for the County and has not been detailed in this profile.

Location

All of Onondaga County is exposed to hail, lightning, windstorms, high wind, thunderstorms, tornadoes, hurricanes, tropical storms, and high winds from severe weather events. According to the FEMA Wind Zones of the United States map, Onondaga County is located on the edge of Wind Zone III, where wind speeds can reach up to 200 mph. Figure 5.4.7-3 illustrates wind zones across the United States, which indicates the impacts of the strength and frequency of wind activity per region. The information on the figure is based on 40 years of tornado data and 100 years of hurricane data collected by FEMA.

Figure 5.4.7-3. Wind Zones in the United States



Source: FEMA 2012

Note: The black oval indicates the approximate location of Onondaga County.

Extent

The extent (severity or magnitude) of a severe storm is largely dependent upon the most damaging aspects of each type of severe weather. This section describes the extent of thunderstorms, lighting, hail, windstorms, tornadoes, and hurricanes and tropical storms in Onondaga County. Historical data presented in Table 5.4.7-1 shows the most powerful severe weather records in Onondaga County.

Table 5.4.7-1. Severe Storm Extent in Onondaga County (1950 to 2018)

Extent of Severe Storms in Onondaga County	
Largest Hailstone on Record	2.75 inches
Strongest Tornado on Record	F3
Highest Wind Speed on Record	70 knots (80.5 mph)
Strongest Tropical Storm/Hurricane on Record	Unnamed Tropical Storm(August 1933)

Sources: NHC 2018; NOAA NCEI 2018; SPC 2018

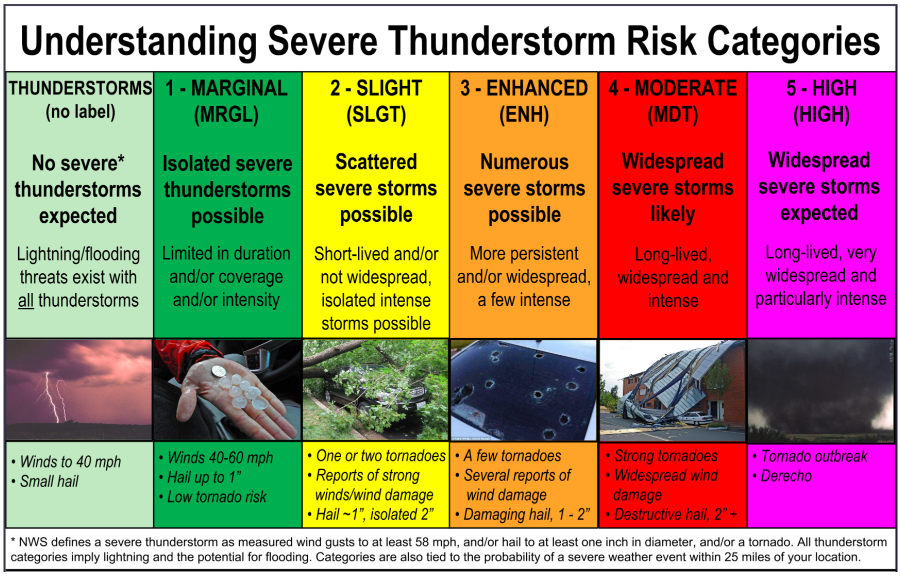
Thunderstorms

Severe thunderstorm watches and warnings are issued by the local NWS office and the Storm Prediction Center (SPC). The NWS and SPC will update the watches and warnings and notify the public when they are no longer in effect. Watches and warnings for tornadoes in New York State are as follows:

- Severe Thunderstorm Warnings are issued when there is evidence based on radar or a reliable spotter report that a thunderstorm is producing, or forecast to produce, wind gusts of 58 mph or greater, structural wind damage, or hail one-inch in diameter or greater. A warning will include where the storm was located, what municipalities will be impacted, and the primary threat associated with the severe thunderstorm warning. After it has been issued, the NWS office will follow up periodically with Severe Weather Statements that contain updated information on the severe thunderstorm and advise the public when the warning is no longer in effect (NWS 2009d, NWS 2010c).
- Severe Thunderstorm Watches are issued by the SPC when conditions are favorable for the development of severe thunderstorms over a larger-scale region for a duration of at least three hours. Tornadoes are not expected in such situations, but isolated tornado development can also occur. Watches are normally issued well in advance of the actual occurrence of severe weather. During the watch, the NWS will keep the public informed on what is happening in the watch area and also advise public when the watch has expired or been cancelled (NWS 2009, NWS 2010).
- Special Weather State for Near Severe Thunderstorms are issued for strong thunderstorms that are below severe levels but still might have some adverse impacts. Usually, they are issued for the threat of wind gusts of 40 to 58 mph or small hail less than one-inch in diameter (NWS 2010).

Figure 5.4.7-4 presents the severe thunderstorm risk categories, as provided by the SPC.

Figure 5.4.7-4. Severe Thunderstorm Risk Categories.



Source: NOAA SPC 2017

Lightning

Lightning is most often associated with moderate to severe thunderstorms. The severity of lightning refers to the frequency of lightning strikes during a storm. The New York City Office of Emergency Management notes that lightning strikes occur with moderate frequency in the State of New York, with 3.8 strikes occurring per square mile each year. Multiple devices are available to track and monitor the frequency of lightning (NYSDHSES 2014).

Hailstorms

The severity of a hailstorm is measured by duration, hail size, and geographic extent. Most hail stones from hail storms are made up of variety of sizes. Only the very largest hail stones pose serious risk to people, if exposed (NYS DHSES 2014). The size of hail is estimated by comparing it to a known object. Table 5.4.7-2 describes the different sizes of hail as compared to real-world objects and lists approximate measurements.

Table 5.4.7-2. Hail Size

Size	Diameter (inches)	Diameter (millimeter)
Pea	0.25 inch	6.35 mm
Marble/mothball	0.50 inch	12.7 mm
Dime/Penny	0.75 inch	19.05 mm
Nickel	0.875 inch	22.23 mm
Quarter	1.0 inch	25.4 mm
Ping-Pong Ball	1.5 inches	38.1 mm
Golf Ball	1.75 inches	44.45 mm
Tennis Ball	2.5 inches	63.5 mm
Baseball	2.75 inches	69.85 mm
Tea Cup	3.0 inches	76.2 mm
Grapefruit	4.0 inches	101.6 mm
Softball	4.5 inches	114.3 mm

Source: NOAA 2012, NYS DHSES 2014

The Tornado and Storm Research Organization (TORRO) Hailstorm Intensity Scale (H0 to H10) relates typical damage and hail sizes.

Table 5.4.7-3. TORRO Hailstorm Intensity Scale

TORRO Hailstorm Intensity Scale	Intensity Category	Typical Hail Diameter (mm)	Typical Damage Impacts
H0	Hard Hail	5	No damage
H1	Potentially Damaging	5-15	Slight general damage to plants, crops
H2	Significant	10-20	Significant damage to fruit, crops, vegetation
H3	Severe	20-30	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
H4	Severe	25-40	Widespread glass damage, vehicle bodywork damage
H5	Destructive	30-50	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
H6	Destructive	40-60	Bodywork of grounded aircraft dented, brick walls pitted
H7	Destructive	50-75	Severe roof damage, risk of serious injuries
H8	Destructive	60-90	(Severest recorded in the British Isles) Severe damage to aircraft bodywork
H9	Super Hailstorms	75-100	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open
H10	Super Hailstorms	>100	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open

Source: TORRO 2018

Windstorms

The following table provides the descriptions of winds and their associated sustained wind speed used by the NWS during wind-producing events.

Table 5.4.7-4. NWS Wind Descriptions

Descriptive Term	Sustained Wind Speed (mph)
Strong, dangerous, or damaging	≥40
Very windy	30-40
Windy	20-30
Breezy, brisk, or blustery	15-25
None	5-15 or 10-20
Light or light and variable wind	0-5

Source: NWS 2015

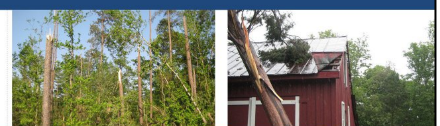
The NWS issues advisories and warnings for winds. Issuance is normally site-specific. High wind advisories, watches, and warnings are products issued by the NWS when wind speeds can pose a hazard or are life threatening. The criterion for each of these varies from state to state. According to the NWS (2018), wind warnings and advisories for New York State are as follows:

- *High Wind Warnings* are issued when sustained wind speeds of 40 mph or greater lasting for one hour or longer or for winds of 58 mph or greater for any duration or widespread damage are possible.
- *Wind Advisories* are issues when sustained winds of 30 to 39 mph are forecast for one hour or longer, or wind gusts of 46 to 57 mph for any duration.

Tornadoes

The magnitude or severity of a tornado is categorized using the Enhanced Fujita Tornado Intensity Scale (EF Scale). This is the scale now used exclusively for determining tornado ratings by comparing wind speed and actual damage. Figure 5.4.7-5 illustrates the relationship between EF ratings, wind speed, and expected tornado damage.

Figure 5.4.7-5. Enhanced Fujita Tornado Intensity Scale Ratings, Wind Speeds, and Expected Damage

EF Rating	Wind Speeds	Expected Damage	
EF-0	65-85 mph	'Minor' damage: shingles blown off or parts of a roof peeled off, damage to gutters/siding, branches broken off trees, shallow rooted trees toppled.	
EF-1	86-110 mph	'Moderate' damage: more significant roof damage, windows broken, exterior doors damaged or lost, mobile homes overturned or badly damaged.	
EF-2	111-135 mph	'Considerable' damage: roofs torn off well constructed homes, homes shifted off their foundation, mobile homes completely destroyed, large trees snapped or uprooted, cars can be tossed.	
EF-3	136-165 mph	'Severe' damage: entire stories of well constructed homes destroyed, significant damage done to large buildings, homes with weak foundations can be blown away, trees begin to lose their bark.	
EF-4	166-200 mph	'Extreme' damage: Well constructed homes are leveled, cars are thrown significant distances, top story exterior walls of masonry buildings would likely collapse.	
EF-5	> 200 mph	'Massive/incredible' damage: Well constructed homes are swept away, steel-reinforced concrete structures are critically damaged, high-rise buildings sustain severe structural damage, trees are usually completely debarked, stripped of branches and snapped.	

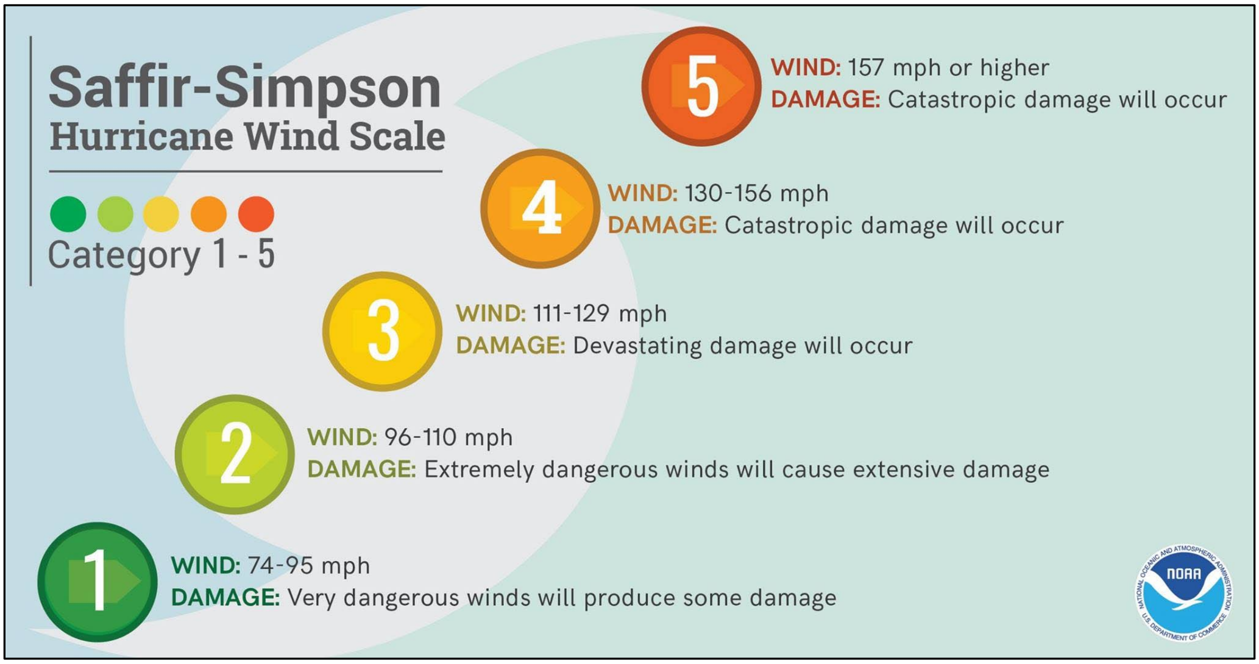
Source: NWS 2018

Tornado watches and warning are issued by the local NWS office. A tornado watch is released when tornadoes are possible in an area. A tornado warning means a tornado has been sighted or indicated by weather radar. The current average lead time for tornado warnings is 13 minutes. Occasionally, tornadoes develop so rapidly, that little, if any, advance warning is possible (NOAA 2011).

Hurricanes and Tropical Storms

The extent of a hurricane or tropical storm is commonly categorized in accordance with the Saffir-Simpson Hurricane Wind Scale, which assigns a designation of tropical storm for storms with sustained wind speeds below 74 mph and a hurricane category rating of 1-to-5 based on a hurricane's increasing sustained wind speed. This scale estimates potential property damage. Hurricanes reaching Category 3 and higher are considered *major hurricanes* because of their potential for significant loss of life and damage. Tropical storms and Category 1 and 2 hurricanes are dangerous and require preventative measures (NOAA 2013). Figure 5.4.7-6 presents this scale, which is used to estimate the potential property damage and flooding expected when a hurricane makes landfall.

Figure 5.4.7-6. The Saffir-Simpson Hurricane Wind Scale

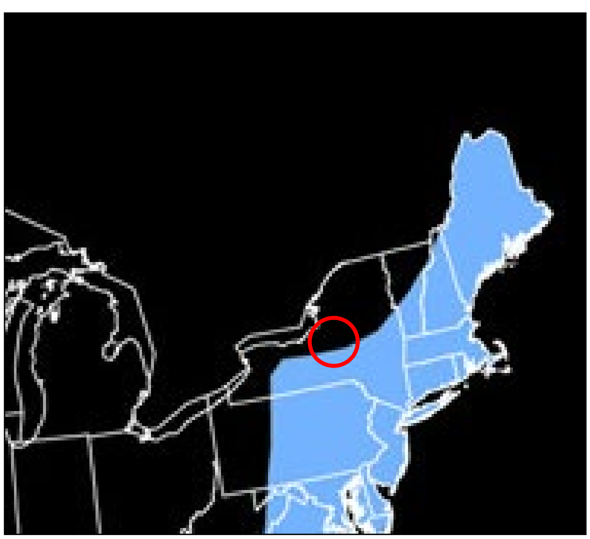


Source: Disaster Preparedness Portal 2017

Mean Return Period

In evaluating the potential for hazard events of a given magnitude, a mean return period (MRP) is often used. The MRP provides an estimate of the magnitude of an event that may occur within any given year based on past recorded events. MRP is the average period of time, in years, between occurrences of a particular hazard event, equal to the inverse of the annual frequency of exceedance (Dinicola 2009). Figure 5.4.7-7 shows the number of hurricanes expected for the 100-year mean return period in the northeast region. Onondaga County is on the edge of the area that could expect 20 hurricanes in a 100-year period.

Figure 5.4.7-7. Number of Hurricanes for a 100-year Mean Return Period



Notes:
Red circle indicates Onondaga County's approximate location within the region.

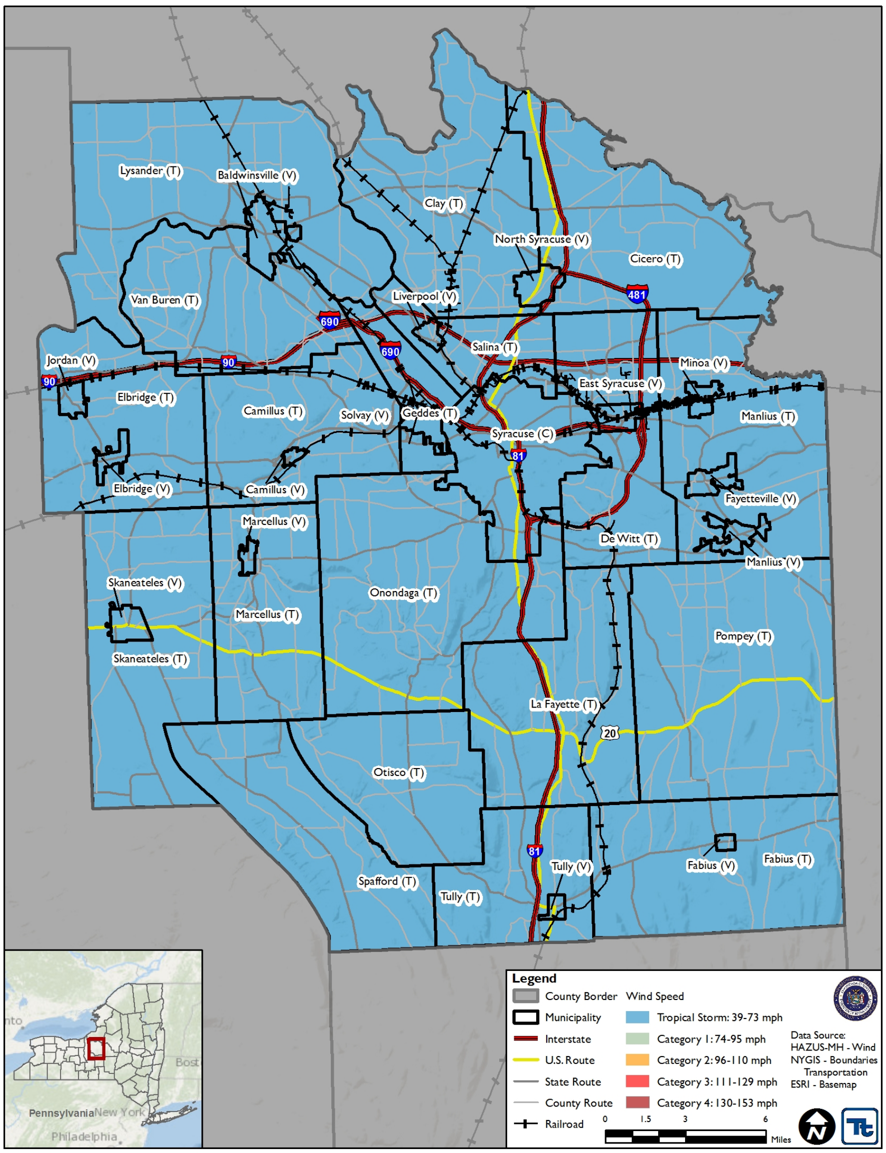
The light blue area is expected to experience 20 to 40 hurricanes during a 100-year mean return period based on historical data.:

Source: U.S. Geological Survey (USGS) 2005

Peak hurricane wind speed projections were estimated using HAZUS-MH v4.2 for probabilistic MRP hurricane events. HAZUS-MH v4.2 did not generate the hurricane track for the 100- and 500-year probabilistic events. HAZUS-MH v4.2 estimated the maximum 3-second gust wind speeds for Onondaga County to be below 39 mph for the 100-year MRP event and not strong enough to be considered a tropical storm; due to low wind speeds, the 100-year MRP event is not strong enough for HAZUS-MH to calculate damages and impacts. The estimated maximum 3-second gust wind speeds for Onondaga County ranges from 46 to 55 mph for the 500-year MRP event (tropical storm). The associated impacts and losses from these 100-year and 500-year MRP hurricane event model runs are reported in the Vulnerability Assessment (Section 5.4.7.2).

Figure 5.4.7-8 shows the estimated maximum 3-second gust wind speeds that can be anticipated in the study area associated with the 500-year MRP event.

Figure 5.4.7-8. Wind Speeds for the 500-Year Mean Return Period Event



Source: HAZUS-MH 4.2

Previous Occurrences and Losses

Table 5.4.7-5 documents the total number of severe storm events that have occurred between 1950 and 2018; based on the NOAA-NCEI database and National Hurricane Center records.

Table 5.4.7-5. Severe Storm Events 1950-2018

Hazard Type	Number of Occurrences Between 1950 and 2018	Total Fatalities	Total Injuries	Total Property Damage ($)	Total Crop Damage ($)
Funnel Cloud	1	0	0	$0	$0
Hail	78	0	3	$135,000	$15,000
Heavy Rain	3	0	0	$0	$0
High Wind	19	0	1	$555,000	$0
Hurricane*	0	0	0	$0	$0
Lightning	17	1	7	$342,000	$0
Strong Wind	2	0	0	$10,000	$0
Thunderstorm Wind	160	5	21	$94.165 million	$0
Tornado	8	0	5	$5.288 million	$0
Tropical Depression*	0	0	0	$0	$0
Tropical Storm*	0	0	0	$0	$0
Total	**288**	**6**	**37**	**$100.495 million**	**$15,000**

Source: NOAA-NCEI 2018; NHC 2018
** Number of events were collected from NHC and includes events that occurred within 65 nautical miles of Onondaga County.*

Between 1954 and 2018, New York State was included in 43 FEMA declared severe storm-related major disaster declarations (DR) or emergencies (EM) classified as one or a combination of the following hazards: coastal storm, high tides, heavy rain, flooding, hurricane, ice storm, severe storms, thunderstorms, tornadoes, tropical storm, straight-line winds, and landslides. Generally, disasters cover a wide region of the state; therefore, many counties could have experienced various types of impacts. Of those declarations, Onondaga County was included in 10 declarations (FEMA 2018). Table 5.4.7-6 lists FEMA DR and EM declarations for Onondaga County.

Table 5.4.7-6. Severe Storm-Related FEMA Declarations for Onondaga County, 1954 to 2017

FEMA Declaration Number	Date(s) of Event	Incident Type	Event Title
DR-338	June 23, 1972	Flood	Tropical Storm Agnes
DR-447	July 23, 1974	Flood	Severe Storms and Flooding
DR-487	October 2, 1975	Flood	Storms, Rains, Landslides and Flooding
DR-1095	January 19-30, 1996	Flood	Severe Storms and Flooding
DR-1244	September 7, 1998	Severe Storm(s)	Severe Weather
DR-1335	May 3-August 12, 2000	Severe Storm(s)	Severe Storms and Flooding
DR-1534	May 13-June 17, 2004	Severe Storm(s)	Severe Storms and Flooding
DR-1564	August 13-September 16, 2004	Severe Storm(s)	Severe Storms and Flooding
DR-1993	April 26-May 8, 2011	Flood	Severe Storms, Flooding, Tornadoes, and Straight-Line Winds
EM-3351	October 27-November 8, 2012	Hurricane	Hurricane Sandy

Source: FEMA 2018

The USDA is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. There have been three USDA agricultural disasters since 2012 attributed to severe weather:

- S3593 – 2013 Excessive rain, moisture, humidity; hail; wind, high winds.
- S3747 – 2014 Excessive rain, moisture, humidity; hail; wind, high winds.
- S3885 – 2015 Excessive rain, high winds, hail, lightning, and tornado

The NOAA NCEI Storm Events database records severe storm events. For this HMP update, known severe storm events that have impacted Onondaga County between 2011 and 2018 are identified in Table 5.4.7-7. For events prior to 2012, refer to Appendix E (Supplementary Data). For detailed information on damages and impacts to each municipality, refer to Section 9 (Jurisdictional Annexes).

Table 5.4.7-7. Severe Storm Events in Onondaga County, 2011 to 2017

Dates of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Event Details
February 18, 2011 - February 19, 2011	High Wind	N/A	N/A	High winds occurred across the region with gusts between 50 and 60 mph. Numerous trees were blown down and many customers were without power. $50,000 in property damages were reported.
April 26, 2011	Severe Storms, Flooding, Tornadoes, and straight line winds	DR-1993	Yes	Severe weather developed, and in addition to reports of severe wind damage and hail, plenty of wind shear in the vicinity of the warm front allowed for a few super-cell thunderstorms and tornadoes to develop. In addition, areas of heavy rain caused significant flash flooding in several locations of central New York. The storms affected parts of the Village of Baldwinsville, Town of Camillus, Village of East Syracuse, Town of Elbridge, Village of Liverpool, Town of Manlius, Town of Marcellus, Village of North Syracuse, Town of Skaneateles, and Village of Solvay. $9,015,000 in property damages were reported.
August 10, 2011	Thunderstorm Wind	N/A	N/A	Showers and thunderstorms associated with a cold front moved across upstate New York during the afternoon. A few storms became severe, producing large hail and damaging winds. In Lewiston Manor, multiple trees and wires were blown down on Hier Avenue. In the Town of Manlius, a tree fell on a house on Verbeck Drive. Lewiston Manor reported $4K in property damages. The Town of Manlius reported $3K in property damages.
January 17, 2012 - January 18, 2012	High Wind	N/A	N/A	High winds in Onondaga County, along and behind a gusty cold front, caused numerous downed trees in Syracuse, as well as minor structural damage to a few homes. Thousands of customers lost power in Seneca Knolls, the Town of Clay, the Town of Marcellus, Peru, Village of Jordan, and Town of Camillus. Syracuse Hancock Airport measured a 62 mph wind gust. $50,000 in property damages were reported.
July 23, 2012	Thunderstorm Wind	N/A	N/A	During the afternoon of July 23rd, an upper level disturbance moved east toward central New York from southern Ontario, Canada. Daytime heating and instability combined with favorable wind parameters in the atmosphere to produce severe thunderstorms. Many reports were received of wind damage and very large hail.

Dates of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Event Details
				In Brewerton, trees were blown down at Route 11 and Miller Road. Brewerton reported $2K in property damages. The Town of Cicero reported $3K in property damages from trees being blown down. The Town of Van Buren reported $2K in property damages from trees being blown down.
October 27, 2012	Hurricane Sandy	EM-3351	Yes	Remnants of Hurricane Sandy brought gusty winds to parts of Onondaga County. A wind advisory was put in place by the NWS for central New York State, including Onondaga County. The strongest wind gusts were reported at the Hancock International Airport when sustained winds of 26 mph and gusts of up to 40 mph were recorded. Approximately 0.5 inches of rain fell at the airport. Power outages were reported in parts of Onondaga County.
May 21, 2013	Thunderstorm Wind	N/A	N/A	A warm front lingered across central New York State during the late afternoon and early evening hours of May 21st, 2013. This front resulted in a broken line of storms that produced hail, along with wind damage. In the Village of Liverpool, a large tree was blown down onto a car. The Village of Liverpool reported $5K in property damages. In the Town of Skaneateles, a power pole and wires were blown down. The Town of Skaneateles reported $2K in property damages. Trees were blown down across southern portion of the city of Syracuse and across northern sections of the Town of LaFayette. Lewiston Manor reported $15K in property damages. In Nedrow, a tree was blown down onto a house. Nedrow reported $10K in property damages.
June 17, 2013	Thunderstorm Wind and Hail	N/A	N/A	A cold front dropping into the Great Lakes resulted in scattered severe thunderstorms developing in unstable airmass across central New York. Large branch was blown down on car and garage. The storms affected parts of the Town of Clay, the Village of Liverpool, and the Village of North Syracuse. $10,000 in property damages were reported.
June 17, 2014	Thunderstorm Wind	N/A	N/A	A surface warm front lifted north through New York state on Tuesday, June 17th. This brought unstable air into the region and numerous severe thunderstorms developed during the afternoon and evening hours. A tree was blown down on the top of two cars. The storms affected parts of the Village of East Syracuse and the Town of Marcellus. $20,000 in property damages were reported.
July 8, 2014	Thunderstorm Wind	N/A	N/A	A confirmed microburst produced 65 to 75 MPH winds which downed large branches. Some evergreen trees were snapped and trees were uprooted. The storms affected parts of the Town of Camillus, Village of East Syracuse, Town of Manlius, and Village of Solvay. $105,000 in property damages were reported.
July 31, 2014	Lightning	N/A	N/A	Lightning struck a house and caused a structural fire that was confined to the attic in South Bay, the Town of Cicero. $10,000 in property damages were reported.
October 3, 2014	Flash Flood	N/A	N/A	Significant urban flash flooding was occurring. Hiawatha Boulevard was flooded, and the on-ramp to Interstate 690 was impassable. Roads were closed due to water rushing across them near the Lourdes camp. There were numerous roads in the region with water over them. Many roads were

Dates of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Event Details
				impassable, in both the Town of Marcellus and Town of Otisco. $135,000 in property damages were reported.
June 12, 2015	Thunderstorm Wind and Hail	N/A	N/A	A severe thunderstorm developed over the area and produced half dollar sized hail. The storm caused $20,000 in property damages in the Town of Tully. $20,000 in property damages were reported.
June 30, 2015	Flash Flood	N/A	N/A	An unseasonably strong storm system tapping into above normal moisture sources across the Great Lakes and Northeast triggered multiple heavy rain producing thunderstorms across the region. Localized torrential rainfall in central New York caused serious urban flash flooding in the City of Syracuse, NY metropolitan area. $3,500,000 in property damages were reported.
July 1, 2015	Flash Flood	N/A	N/A	An unseasonably strong storm system, tapping into above normal moisture sources across the Great Lakes and Northeast, triggered multiple heavy rain producing thunderstorms across the region. It affected the Town of DeWitt and the Town of Salina causing $520,000 in property damages.
July 8, 2015	Flash Flood	N/A	N/A	Torrential rain producing thunderstorms moved slowly through the Finger Lakes region to the Upper Mohawk Valley. Extreme rainfall rates produced rain amounts in excess of 2 inches within 45 to 90 minutes. This led to areas of serious street and small stream flooding in central New York. Flooding affected parts of Clairmont Farms and Long Branch Manor. $5,015,000 in property damages were reported.
July 13, 2016	Thunderstorm Wind	N/A	N/A	A thunderstorm moved across the region and became severe. This thunderstorm resulted in several trees and wires being knocked over. The damage resulted in U.S. Route 20 being closed for a period of time. The storm affected parts of the Town of Marcellus and Town of Skaneateles. $25,000 in property damages were reported.
August 13, 2016	Thunderstorm Wind	N/A	N/A	A thunderstorm moved across the region and became severe. This thunderstorm resulted in trees being knocked over. The storm affected parts of the Town of LaFayette, Town of Marcellus, Village of Minoa, Town of Pompey, and the Town of Spafford. $130,000 in property damages were reported.
August 16, 2016	Thunderstorm Wind	N/A	N/A	A thunderstorm moved across the region and became severe. This thunderstorm resulted in a tree a being knocked which landed on a building causing damage in City of Syracuse and Town of Clay. $10,000 in property damages were reported.
May 18, 2017	Thunderstorm Wind and Hail	N/A	N/A	A severe thunderstorm developed over the area and produced golf ball sized hail affecting parts of the Town of Cicero and Town of Tully. $25,000 in property damages were reported.
May 30, 2017	Thunderstorm Wind	N/A	N/A	A thunderstorm moved across the region and became severe. This thunderstorm produced severe winds and uprooted numerous trees in Woodlawn Cemetery. Gravestones were damaged by this storm in the City of Syracuse. Trees fell on two homes in the Village Liverpool. $35,000 in property damages were reported
July 1, 2017	Flash Flood	N/A	N/A	A tropical moisture laden air mass produced numerous showers and thunderstorms which traveled repeatedly over

Dates of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Event Details
				the same areas of the Finger Lakes Region and Upper Mohawk Valley. Widespread flash flooding of most creeks and urbanized areas occurred throughout the towns of LaFayette, Onondaga, and Tully. $5,367,000 in property damages were reported.
July 24, 2017	Thunderstorm Wind	N/A	N/A	A thunderstorm moved across the region and became severe. This thunderstorm produced severe winds and knocked over multiple trees and power wires in the Village of East Syracuse and City of Syracuse. $45,000 in property damages were reported.
October 15, 2017	Thunderstorm Wind	N/A	N/A	A line of thunderstorms produced damaging wind gusts which knocked down trees and wires. A large tree was blown down onto a house in the Village of Baldwinsville and took out trees and wires in the Town of Lysander.
August 22, 2017	Thunderstorm Wind	N/A	N/A	A thunderstorm moved across the region and became severe. This thunderstorm produced severe winds and knocked over trees and wires throughout the Village of Baldwinsville, Town of Clay, Village of Liverpool, Village of North Syracuse, and City of Syracuse.

Source(s): FEMA 2018; NOAA-NCDC 2018; NWS 2018; NYS HMP 2014
FEMA Federal Emergency Management Agency
HMP Hazard Mitigation Plan
NCDC National Climatic Data Center
NOAA National Oceanic and Atmospheric Administration
NWS National Weather Service
NYS New York State

Climate Change Impacts

Onondaga County is located in the Tug Hill Plateau ClimAID Region. It is estimated that Tug Hill Plateau temperatures will increase by 4.4ºF to 6.4ºF by the 2050s and 5.9ºF to 10.0ºF by the 2080s (baseline of 45.4ºF, mid-range projection). Precipitation totals will increase between 4 and 10% by the 2050s and 6 to 12% by the 2080s (baseline of 42.6 inches, mid-range projection). Table 5.4.7-8 provides the projected seasonal precipitation changes for the Tug Hill Plateau ClimAID Region (NYSERDA 2014).

Table 5.4.7-8. Projected Seasonal Precipitation Change in Region 6, 2050s (% change)

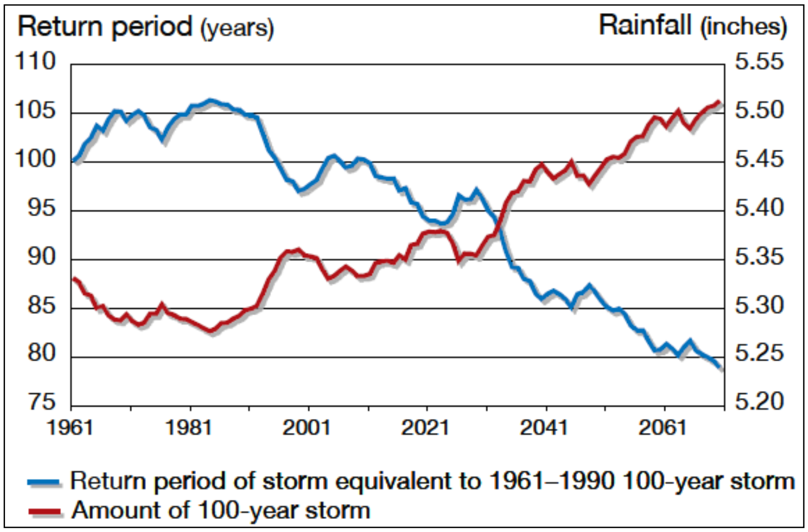
Winter	Spring	Summer	Fall
+5 to +15	0 to +10	-5 to +10	-5 to +10

Source: NYSERDA 2011

The projected increase in precipitation is expected to fall in heavy downpours and less in light rains. Downpours are very likely to increase in frequency and intensity, a change that has the potential to affect drinking water; heighten the risk of riverine flooding; flood key rail lines, roadways and transportation hubs; and increase delays and hazards related to extreme weather events (NYSERDA 2011). Less frequent rainfall during the summer months can impact the ability of water supply systems to provide water. Increasing water temperatures in rivers and streams will affect aquatic health and reduce the capacity of streams to assimilate effluent wastewater treatment plants and industrial discharges (NYSERDA 2011).

Figure 5.4.7-9 displays the projected rainfall and frequency of extreme storms in New York State. The amount of rain fall in a 100-year event is projected to increase, while the number of years between such storms (return period) is projected to decrease. Rainstorms will become more severe and more frequent (NYSERDA 2011).

Figure 5.4.7-9. Projected Rainfall and Frequency of Extreme Storms



Source: NYSERDA 2011

Probability of Future Occurrences

According to the NOAA NCEI Storm Events Database and the National Hurricane Center Historical (NHC) Hurricane Tracks mapping tool, Onondaga County experienced 288 severe storm events between 1950 and 2018. Table 5.4.7-9 summarizes data regarding the probability of occurrences of severe storm events in Onondaga County based on the historic record. The information used to calculate the probability of occurrences is based solely on NOAA-NCEI storm events database results.

Table 5.4.7-9. Probability of Future Occurrence of Severe Storm Events

Hazard Type	Number of Occurrences Between 1950 and 2015	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	% chance of occurrence in any given year
Funnel Cloud	1	0.01	69.00	0.01	1.45
Hail	78	1.15	0.88	1.13	100
Heavy Rain	3	0.04	23.00	0.04	4.35
High Wind	19	0.28	3.63	0.28	27.54
Hurricane*	0	0	0	0	0
Lightning	17	0.25	4.06	0.25	24.64
Strong Wind	2	0.03	34.50	0.03	2.90
Thunderstorm Wind	160	2.35	0.43	2.32	100
Tornado	8	0.12	8.63	0.12	11.59
Tropical Depression*	0	0	0	0	0
Tropical Storm*	0	0	0	0	0
TOTAL	288	4.24	0.24	4.17	100

Source: NOAA-NCEI 2018; NHC 2018
* *Number of events were collected from NHC and includes events that occurred within 65 nautical miles of Onondaga County.*

In Section 5.3, the identified hazards of concern for Onondaga 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 Steering Committee, the probability of occurrence for severe storms in the county is considered *frequent* (event that has 100% annual probability; a hazard event may occur multiple times per year, as presented in Table 5.3-2 in Section 5.3 [Hazard Ranking])

5.4.9 Vulnerability Assessment

Wind-related vulnerability data was generated using a HAZUS-MH analysis for the severe storm hazard. A probabilistic assessment was conducted for the 100- and 500-year MRPs to analyze the severe storm hazard and provide a range of loss estimates. The other severe storm hazards profiled above were assessed qualitatively.

The HAZUS-MH hurricane model estimates hurricane related wind impacts for various mean return periods. The mean return periods are probabilistic estimates based on the predicted hurricane event that would occur. Wind from other severe weather events, including windstorms and thunderstorms can be far greater than those of the predicted hurricane events, as was seen with the Labor Day storm (1998) and can result in greater impacts.

Impact on Life, Health and Safety

The impact of a severe storm on life, health, and safety is dependent upon several factors including the severity of the event and whether adequate warning time was provided to residents. The entire population of Onondaga County (468,050 people) is assumed to be exposed to this hazard (U.S. Census 2016 ACS 5-Year Population Estimate).

Lightning can be responsible for deaths, injuries, and property damage. Lightning-based deaths and injuries typically involve heart damage, inflated lungs, or brain damage, as well as loss of consciousness, amnesia, paralysis, and burns, depending on the severity of the strike. Additionally, most people struck by lightning survive, although they may have severe burns and internal damage. People located outdoors (e.g.,, recreational activities and farming) are considered most vulnerable to hailstorms, thunderstorms, and tornadoes because there is little to no warning and shelter might not be available. Moving to a lower risk location will decrease a person's vulnerability.

As a result of severe storm events, residents can be displaced or require temporary to long-term sheltering. In addition, downed trees, damaged buildings and debris carried by high winds from hurricanes, tropical storms, or tornadoes can lead to injury or loss of life. Socially vulnerable populations are most susceptible, based on a number of factors, including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. HAZUS-MH v4.2 currently estimates that no residents will be displaced or require temporary shelter due to either a 100-year or a 500-year MRP event.

Economically disadvantaged populations are more vulnerable because they often evaluate evacuation needs and make decisions based on the economic impact to their family. The population over the age of 65 (71,770 people) is also vulnerable and may physically have difficulty evacuating and are more likely to seek or need medical attention, which may not be available due to isolation during a storm event (U.S. Census 2016 ACS 5-Year Population Estimate). Section 4 (County Profile) provides the statistics for these populations for Onondaga County.

Impact on General Building Stock

Damage to buildings depends on several factors, including wind speed, storm duration, path of the storm track or tornado, and distance from the tornado funnel. Depending on the size of the hail and severity of the storm, the county could see damage from hail impacting structures. Lightning can spark wildfires or building fires, especially if structures are not protected by surge protectors on critical electronic, lighting, or information technology systems. While damage to the building stock is possible as a result of lightning and hail, they are difficult to estimate and would not have as wide of an impact as a high wind or tornado event.

Building construction plays a major role in the extent of damage resulting from a severe storm event. Due to differences in construction, residential structures generally are more susceptible to wind damage than commercial and industrial structures. Wood and masonry buildings, in general, regardless of their occupancy class, tend to experience more damage than concrete or steel buildings. High-rise buildings are also very vulnerable structures. Mobile homes are the most vulnerable to damage, even if tied down, and offer little protection to people inside.

The U.S. Census Bureau defines manufactured homes as "movable dwellings, 8 feet or wider and 40 feet or more long, designed to be towed on its own chassis, with transportation gear integral to the unit when it leaves the factory, and without need of a permanent foundation" (U.S. Census, 2010). Manufactured homes include multi-wides and expandable manufactured homes but exclude travel trailers, motor homes, and modular housing. Due to their lightweight and often unanchored design, manufactured housing is extremely vulnerable to high winds and will generally sustain the most damage.

Table 5.4.7-10 displays the number of manufactured housing units per municipality in Onondaga County. Total counts were obtained from the custom general building stock. The manufactured housing occupancy class was determined using the property class descriptions from the Onondaga County tax assessor data. As noted below, the Town of Clay has the greatest number of manufactured homes, followed closely by the Town of Elbridge.

Table 5.4.7-10. Manufactured Housing Units per Municipality in Onondaga County

Municipality	Number of Manufactured Homes		Municipality	Number of Manufactured Homes
Camillus (T)	6		Marcellus (T)	41
Cicero (T)	42		Onondaga (T)	11
Clay (T)	468		Otisco (T)	170
De Witt (T)	199		Pompey (T)	42
Elbridge (T)	380		Salina (T)	55
Fabius (T)	6		Skaneateles (T)	23
Geddes (T)	31		Spafford (T)	89
La Fayette (T)	155		Tully (T)	2
Lysander (T)	31		Tully (V)	1
Manlius (T)	98		Van Buren (T)	125
			Onondaga County	**1,975**

Source: Syracuse-Onondaga County Planning Agency
(C) - City
(T) – Town
(V) – Village

The entire county's general building stock is exposed to the severe storm wind hazard (greater than $71 billion in structural replacement cost). Expected building damage was estimated by HAZUS-MH v4.2 at the following wind damage categories: no damage/very minor damage, minor damage, moderate damage, severe damage, and total destruction. Table E-7 in Appendix E (Supplementary Data) summarizes the definition of the damage categories.

As noted earlier in the profile, HAZUS-MH v4.2 estimates the 100-year MRP peak gust wind speeds for Onondaga County to be less than 39 mph and estimates $0 in structure damage. Although damage to buildings was not estimated by the wind model, damage could still occur at these wind speeds.

HAZUS-MH v4.2 estimates approximately $25,000 of damage to the general building stock (less than 1 percent of the county's total building inventory) as a result of the 500-year MRP event's tropical storm peak gust wind speeds (49 to 55 mph). Residential buildings account for 100-percent of the total damage. Table 5.4.7-11 summarizes the building damage (structure only) estimated for the 500-year MRP hurricane wind event by municipality. Total dollar damage reflects the overall impact to buildings at an aggregate level.

Table 5.4.7-11. Estimated Annualized Loss and Building Value (Structure Only) Damaged by the 500-Year MRP Hurricane Wind Events

Municipality	Total Replacement Cost Value (Structure Only)	Estimated Total Damages*		Percent of Total Building Replacement Value	
		Annualized Loss	500-Year	Annualized Loss	500-Year
Village of Baldwinsville	$928,446,807	$224	$0	<1%	0%
Town of Camillus	$3,052,036,657	$947	$0	<1%	0%
Village of Camillus	$114,031,114	$29	$0	<1%	0%
Town of Cicero	$4,266,651,090	$1,202	$0	<1%	0%
Town of Clay	$8,137,341,185	$2,119	$0	<1%	0%
Town of DeWitt	$6,404,939,359	$1,484	$1,993	<1%	< 1%
Village of East Syracuse	$514,055,432	$90	$0	<1%	0%
Town of Elbridge	$729,399,165	$254	$0	<1%	0%
Village of Elbridge	$148,857,976	$58	$0	<1%	0%
Town of Fabius	$490,481,134	$188	$1,804	<1%	< 1%
Village of Fabius	$60,048,901	$40	$0	<1%	0%
Village of Fayetteville	$664,528,666	$278	$0	<1%	0%
Town of Geddes	$2,350,056,049	$562	$0	<1%	0%
Village of Jordan	$194,311,561	$58	$0	<1%	0%
Town of Lafayette	$856,191,594	$367	$2,486	<1%	< 1%
Village of Liverpool	$356,505,810	$117	$0	<1%	0%
Town of Lysander	$3,452,247,706	$1,184	$0	<1%	0%
Town of Manlius	$3,735,064,686	$1,690	$8,939	<1%	< 1%
Village of Manlius	$763,326,145	$288	$0	<1%	0%
Town of Marcellus	$968,785,581	$371	$405	<1%	< 1%
Village of Marcellus	$264,320,392	$64	$0	<1%	0%
Village of Minoa	$425,337,257	$145	$0	<1%	< 1%
Village of North Syracuse	$826,812,636	$247	$0	<1%	0%
Town of Onondaga	$3,681,301,149	$1,360	$1,749	<1%	< 1%
Onondaga Nation Reservation	$121,429,137	$49	$0	<1%	0%
Town of Otisco	$643,807,877	$287	$848	<1%	< 1%
Town of Pompey	$1,594,497,578	$920	$4,080	<1%	< 1%
Town of Salina	$4,973,963,168	$1,328	$0	<1%	0%
Town of Skaneateles	$1,430,527,029	$759	$0	<1%	0%
Village of Skaneateles	$530,891,718	$209	$0	<1%	0%
Village of Solvay	$884,983,486	$217	$0	<1%	0%
Town of Spafford	$521,398,251	$334	$1,948	<1%	< 1%
City of Syracuse	$15,038,897,586	$3,278	$702	<1%	< 1%
Town of Tully	$528,007,157	$224	$233	<1%	< 1%

Municipality	Total Replacement Cost Value (Structure Only)	Estimated Total Damages*		Percent of Total Building Replacement Value	
		Annualized Loss	500-Year	Annualized Loss	500-Year
Village of Tully	$181,454,356	$57	$8	<1%	< 1%
Town of Van Buren	$1,993,563,705	$584	$0	<1%	0%
Onondaga County	**$71,828,499,104**	**$21,615**	**$25,195**	**<1%**	**< 1%**

Source: HAZUS-MH 4.2
**The Total Damages column represents the sum of damages for all occupancy classes (residential, commercial, industrial, agricultural, educational, religious and government) based on estimated replacement cost value.*

Impact on Critical Facilities

Utility infrastructure could suffer damage from high winds associated with falling tree limbs or other debris, resulting in the loss of power or other utility service. Loss of service can impact residents, critical facilities, and business operations alike. Interruptions in heating or cooling utilities can affect populations such the young and elderly, who are particularly vulnerable to temperature-related health impacts. Loss of power can impact other public utilities, including potable water and wastewater treatment and communications. In addition to public water services, property owners with private wells may not have access to potable water either until power is restored. Lack of power to emergency facilities, including police, fire, EMS, and hospitals, will inhibit a community's ability to effectively respond to an event and maintain the safety of its citizens.

HAZUS-MH v4.2 estimates the probability that critical facilities (such as medical facilities, fire and emergency medical services, police, emergency operations centers [EOC], schools, and user-defined facilities such as shelters and municipal buildings) may sustain damage as a result of 100-year and 500-year MRP wind-only events. Additionally, HAZUS-MH v4.2 estimates the loss of use for each facility in number of days. HAZUS-MH v4.2 estimates there is a 0 percent chance that critical facilities in Onondaga County will experience at least minor damage; and continuity of operations at these facilities will not be interrupted (no loss of use is estimated) as a result of the 100- or 500-year MRP events with the exception of medical facilities. HAZUS-MH v4.2 estimate there is less than a 1 percent chance that medical facilities may experience moderate to severe damage as a result of the 500-year MRP event.

At this time, HAZUS-MH v4.2 does not estimate losses to transportation lifelines and utilities as part of the wind model. Transportation lifelines, including roadways, rail lines, and bridges, are not considered particularly vulnerable to the wind hazard; they are more vulnerable to cascading effects such as flooding and falling debris, which could block corridors until the hazard is removed. Impacts to transportation lifelines affect both short-term (for example, evacuation activities) and long-term (for example, day-to-day commuting) transportation needs.

Impact on Economy

Severe storms also impact the economy; impacts include loss of business function, damage to inventory, relocation costs, wage loss, and rental loss due to the repair or replacement of buildings. HAZUS-MH v4.2 estimates the total economic loss associated with each probabilistic event (direct building losses and business interruption losses). Business interruption losses include losses associated with the inability to operate a business because of the wind damage sustained during a storm or the temporary living expenses for those displaced from their home because of an event.

For the 100- and 500-year MRP hurricane wind event, HAZUS-MH v4.2 does not estimate any inventory loss to businesses and reports approximately $1,400 in business interruption costs for the 500-year MRP event. Direct building losses are the estimated costs to repair or replace the damage caused to a building, is reported in the "Impact on General Building Stock" section above.

Debris management can be costly and impact the local economy. HAZUS-MH v4.2 estimates the amount of debris that may be produced a result of the 100- and 500-year MRP hurricane wind events. HAZUS-MH v4.2 estimates that no debris will be generated as a result of the 100-year MRP hurricane wind events. Because the estimated debris production does not include flooding, this is likely a low estimate and could be higher if multiple impacts occur. According to the HAZUS-MH Hurricane User Manual, estimates of weight and volume of eligible tree debris consist of downed trees that would likely be collected and disposed at public expense. Refer to the User Manual for additional details regarding these estimates. Table 5.4.7-12 summarizes debris production estimates for 500-year MRP hurricane wind events.

Table 5.4.7-12. Debris Production for the 500-Year Mean Return Period Hurricane Wind Events

Debris Type	Quantity		Debris Type	Quantity
Brick and Wood	0 tons		Trees	362 tons
Concrete and Steel	0 tons		Eligible Tree Volume	347 cubic yards

Source: HAZUS-MH v4.2

Future Changes that May Impact Vulnerability

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

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

Projected Development

Any areas of growth could be potentially impacted by the severe storm hazard because the entire county is exposed and vulnerable; however, due to increased standards and codes, new development may be less vulnerable to the severe storm hazard compared with the aging building stock in the county.

Projected Changes in Population

According to population projections from the Cornell Program on Applied Demographics, Onondaga County will experience a slight population decrease through 2040 (less than 10,000 people in total by 2040). Population change is not expected to have a measurable effect on the overall vulnerability of the county's population over time. As discussed in *Long Range Transportation Plan 2050: Moving Towards a Greater Syracuse*, the population of Syracuse has decreased as the other municipalities in the county have seen an increase (Syracuse Metropolitan Transportation Council, 2015). Those moving to from areas of lower vulnerability to higher will increase their vulnerability, though not in a dramatic fashion. Section 4.4.2 (Population Trends) in the County Profile provides additional discussion on population trends.

Climate Change

The entire State of New York is projected to experience an increase in the frequency and severity of extreme storms and rainfall. Major clusters of summertime thunderstorms in North America will grow larger, more intense, and more frequent later this century in a changing climate, unleashing far more rain and posing a greater threat of flooding across wide areas (UCAR 2017). Section 5.4.4 (Flood) provides a discussion related to the impact of climate change due to increases in rainfall. An increase in storms will produce more wind events and may increase tornado activity. Additionally, an increase in temperature will provide more energy to produce storms that generate tornadoes (Climate Central 2016). With an increased likelihood of strong winds and tornado events, all of the county's assets will experience additional risk for losses as a result of extreme wind events.

Changes in Vulnerability Since the 2013 HMP

Onondaga County and its municipalities continue to be vulnerable to severe storms. However, there are several differences between the loss estimates between this HMP update and the results in the 2013 HMP. For the 2013 plan, the HAZUS-MH MR3 hurricane model was run, while for this HMP update HAZUS-MH v4.2 was used. The HAZUS-MH v4.2 model estimated greater losses than the previous HAZUS-MH MR3 model; the 2013 plan utilized the default general building stock inventory in HAZUS-MH MR3 (2006 RS Means valuations). Both versions of HAZUS-MH estimated no losses as a result of the 100-year event. For the 500-year MRP event, HAZUS-MH v4.2 estimated approximately $25,000 in structural losses, while HAZUS-MH MR3 estimated less than $500 in structural losses. The differences in losses are due to changes in the loss parameters between HAZUS-MH versions and use of a custom general building stock inventory with replacement cost values based on 2018 RS Means valuations. These changes to the HAZUS-MH Hurricane model were implemented in HAZUS v2.2 released in 2015, and include: updated surface roughness coefficients based on the National Land Cover Dataset 2011 Land Use-Land Cover and tree canopy layers, updated tree coverage data using the 2013 U.S. Forest Service Forest Inventory Analysis Database and 2013 U.S. Census TIGER data, and updated probabilistic hurricane wind speeds based on more current and longer records of climatology data.

Overall, the vulnerability assessment presented in this update uses a more accurate and updated building inventory, which provides more accurate estimated exposure and potential losses for Onondaga County.

Identified Issues

Important issues associated with severe storm events in Onondaga County include the following:

- Older building stock in Onondaga County could be more vulnerable to severe storm events, such as windstorms, as they may have been built to low or no code standards.
- Many critical facilities do not have a source of backup power; during power outages, these facilities may not function properly or provide the necessary needs to the county.
- The impacts of drought and invasive species may lead to dead or dying trees. These trees are more susceptible to falling during severe storm events. This can cause power outages, closed roadways, and damage to buildings and property.
- Not all municipalities have a debris management plan in place. Debris from downed trees must be addressed as it can impact the severity of severe storm events, requires coordination efforts, and may require additional funding.
- Above ground power lines may be impacted by high winds and secondary impacts of fallen debris.
- Climate change may increase impact and severity of events in the future.