5.4.7 Severe Storm

This section provides a profile, and vulnerability assessment for severe storm hazards.

5.4.7.1 Hazard Profile

Hazard profile information is provided in this section, including information on description, extent, location, previous occurrences and losses, the probability of future occurrences, and climate change impacts within Monroe County.

Description

For the purpose of this HMP and as deemed appropriated by Monroe County, the severe storm hazard includes hailstorms, windstorms, lightning, thunderstorms, tornadoes, and hurricanes, which are defined below. Northeasters (or Nor'easters) are a type of extra-tropical cyclone that most frequently occur during winter months; however, Monroe County's location in western New York means that the county is not susceptible to Nor'easters; therefore, they are not profiled in this HMP.

Hail

Hail forms inside a thunderstorm where there are 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°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. However, the droplet may 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 two inches in diameter (NWS 2010).

High Winds

High winds, other than tornadoes, are experienced in all parts of the United States. Areas that experience the highest wind speeds are coastal regions from Texas to Maine, and the Alaskan coast; however, exposed mountain areas experience winds at least as high as those along the coast (FEMA 1997; Robinson 2013). 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 (Ilicak 2005). High winds have the potential to down trees, tree limbs, and power lines, which may lead to widespread power outages, and damage residential and commercial structures throughout Monroe County. High winds are often associated by other severe weather events such as thunderstorms, tornadoes, hurricanes, and tropical storms (all discussed further in this section). The following table provides the descriptions of winds used by the National Weather Service (NWS).

Table 5.4.7-1. 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 2010
mph miles per hour

Tornadoes

Tornadoes are nature's most violent storms and can cause fatalities and devastate neighborhoods in seconds. A tornado appears as a rotating, funnel-shaped cloud that extends from a thunderstorm to the ground with whirling winds that can reach 250 mph. Damage paths can be greater than one mile in width and 50 miles in length. 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 internal winds exceeding 300 mph. The lifespan of a tornado rarely is longer than 30 minutes (FEMA 1997).

Thunderstorms

A thunderstorm is a local storm produced by a cumulonimbus cloud and accompanied by lightning and thunder (NWS 2009d). A thunderstorm forms from a combination of moisture, rapidly rising warm air, and a force capable of lifting air, such as a warm or 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 in generating tornadoes, hailstorms, strong winds, flash flooding, and lightning. The NWS considers a thunderstorm severe if it produces damaging wind gusts of 58 mph or higher, hail 1 inch (quarter size) in diameter or larger, or tornadoes (NWS 2010).

Lightning 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 may be very dangerous. Lightning can damage homes and injure people. In the United States, an average of 300 people are injured, and 80 people are killed by lightning each year. Lightning can occur anywhere there is a thunderstorm.

Thunderstorms can lead to flooding, landslides, strong winds, and lightning. Roads may become impassable from flooding, downed trees or power lines, or a landslide. Downed power lines can lead to loss of utility services, such as water, phone and electricity. Typical thunderstorms are 15 miles in diameter and last an average of 30 minutes. An estimated 100,000 thunderstorms occur each year in the United States, with approximately 10 percent of them classified as severe. During the warm season, thunderstorms are responsible for most of the rainfall.

A hurricane is a tropical storm that attains hurricane status when its wind speed reaches 74 or more miles an hour. Tropical systems may 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 may move up the Atlantic coast of the United States and impact 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 offshore and heading east.

A tropical storm system is characterized by a low-pressure center and numerous thunderstorms that produce strong winds and heavy rain (winds are at a lower speed than hurricane-force winds, thus gaining its status as tropical storm versus a hurricane). Tropical storms 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. They are fueled by a different heat mechanism than other cyclonic windstorms such as Nor'Easters and polar lows. The characteristic that separates tropical storms from other cyclonic systems 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 1999).

The NWS issues hurricane and tropical storm watches and warnings. These watches and warnings are issued or will remain in effect after a tropical storm becomes post-tropical, when such a storm poses a significant threat

to life and property. The NWS allows the National Hurricane Center (NHC) to issue advisories during the post-tropical stage. The following are the definitions of the watches and warnings:

- *Hurricane/Typhoon Warning* is issued when sustained winds of 74 mph or higher are expected somewhere within the specified area in association with a tropical, subtropical, or post-tropical storm. Because hurricane preparedness activities become difficult once winds reach tropical storm force, the warning is issued 36 hours in advance of the anticipated onset of tropical storm force winds (24 hours in the western north Pacific). The warning can remain in effect when dangerously high water or a combination of dangerously high water and waves continue, even though winds may be less than hurricane force.
- *Hurricane Watch* is issued when sustained winds of 74 mph or higher are possible within the specified area in association with a tropical, subtropical, or post-tropical cyclone. Because hurricane preparedness activities become difficult once winds reach tropical storm force, the hurricane watch is issued 48 hours prior to the anticipated onset of tropical storm force winds.
- *Tropical Storm Warning* is issued when sustained winds of 39 to 73 mph are expected somewhere within the specified area within 36 hours (24 hours for the western north Pacific) in association with a tropical, subtropical, or post-tropical storm.
- *Tropical Storm Watch* is issued when sustained winds of 39 to 73 mph are possible within the specified area within 48 hours in association with a tropical, sub-tropical, or post-tropical storm (NWS 2013).

One of the most severe impacts associated with hurricanes is storm surge; however, due to Monroe County's location, storm surge is not a concern for the county and has not been detailed in this profile.

Extent

The extent or severity of a severe storm is largely dependent upon sustained wind speed. In extreme cases, straight-line winds, which are winds that come out of a thunderstorm, can cause wind gusts exceeding 100 mph. These winds are most responsible for hailstorm and thunderstorm wind damage. One type of straight-line wind, the downburst, can cause damage equivalent to a strong tornado (NVRC 2006).

Hail

The severity of hail is measured by duration, hail size, and geographic extent. All of these factors are directly related to thunderstorms, which create hail. There is wide variation in the severity components of hail, with the most significant impact being damage to crops. Hail also has the potential to damage structures and vehicles during hailstorms.

Hail can be produced from many different types of storms; however, hail typically occurs with thunderstorm events, and the size of hail is estimated by comparing it to a known object. Most hail storms are made up of a variety of sizes, and only the very largest hail stones pose serious risk to people, if exposed (NYS DHSES 2014). Table 5.4.7-2 shows the different types of hail and the comparison to real-world objects.

Table 5.4.7-2. Hail Size

Description	Diameter (in inches)
Pea	0.25
Marble or mothball	0.50
Penny or dime	0.75
Nickel	0.88
Quarter	1.00
Half dollar	1.25
Walnut or ping pong ball	1.50
Golf ball	1.75
Hen's egg	2.00
Tennis ball	2.75
Baseball	2.75
Tea cup	3.00
Grapefruit	4.00
Softball	4.50

Source: NYS DHSES, 2014

Lightning

As with hail, lightning can be produced by a wide variety of situations, but it is most often associated with moderate to severe thunderstorms. As noted earlier, lightning is responsible for deaths, injuries, and property damage in all areas of the United States. 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 upon the severity of the strike. Lightning can also spark wildfires or building fires, especially if structures aren't protected by surge protectors on critical electronic, lighting, or information technology systems.

Despite the potential damage associated with lightning, most strikes do not hit anything important (i.e., persons, animals, local assets). Additionally, the majority of people struck by lightning survive, although they may have severe burns and internal damage (as mentioned above). Multiple devices are available to track and monitor the frequency of lightning strikes; however, most jurisdictions only focus on cloud-to-ground lightning that occurs during periods of dry heat or when associated with severe storms.

Windstorms and High Winds

The following table provides the NWS descriptions of winds during wind-producing events.

Table 5.4.7-3. 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

The NWS issues advisories and warnings for winds, which are normally site-specific. High wind advisories, watches, and warnings are issued by the NWS when wind speeds may pose a hazard or may be life threatening. The criterion for each of these varies from state to state. Wind warnings and advisories for New York State are as follows:

- *High Wind Warnings* are issued when sustained winds of 40 mph or greater are forecast for one hour or longer, or wind gusts of 58 mph or greater for any duration
- *Wind Advisories* are issued 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 (NWS 2015).

Thunderstorms

Severe thunderstorm watches and warnings are issued by the local NWS office and NOAA's Storm Prediction Center (SPC). The NWS and SPC will update the watches and warnings and will notify the public when they are no longer in effect. Watches and warnings for thunderstorms in New York 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 is forecast to produce, wind gusts of 58 mph or greater, structural wind damage, and hail 1 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, which contain updated information on the severe thunderstorm and will let the public know when the warning is no longer in effect (NWS 2009; NWS 2010).
- *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 3 hours. Tornadoes are not expected in such situations, but isolated tornado development may 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 let the public know when the watch has expired or been cancelled (NWS 2009; NWS 2010).
- *Special Weather State for Near Severe Thunderstorms* bulletins are issued for strong thunderstorms that are below severe levels, but still may have some adverse impacts. Usually, they are issued for the threat of wind gusts of 40 to 58 mph or small hail less than 1 inch in diameter (NWS 2010).

Tornado

The magnitude or severity of a tornado was originally categorized using the Fujita Scale (F-Scale) or Pearson Fujita Scale introduced in 1971, based on a relationship between the Beaufort Wind Scales (B-Scales) (measure of wind intensity) and the Mach number scale (measure of relative speed). It is used to rate the intensity of a

tornado by examining the damage caused by the tornado after it has passed over a manmade structure (The Tornado Project, Date Unknown). The F-Scale categorizes each tornado by intensity and area and is divided into six categories, F0 (Gale) to F5 (Incredible) (Edwards, 2012). Table 5.4.7-4 explains each of the six F-Scale categories.

Table 5.4.7-4. Fujita Damage Scale

Scale	Wind Estimate (MPH)	Typical Damage
F0	< 73	Light damage. Some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; sign boards damaged.
F1	73-112	Moderate damage. Surfaces peel off roofs; mobile homes pushed off foundations or overturned; moving autos blown off roads.
F2	113-157	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars overturned; large trees snapped or uprooted; light-object missiles generated; cars lifted off the ground.
F3	158-206	Severe damage. Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off the ground and thrown.
F4	207-260	Devastating damage. Well-constructed houses leveled; structures with weak foundations blown some distance, cars thrown, and large missiles generated.
F5	261-318	Incredible damage. Strong frame houses leveled off foundations and swept away; automobile-sized missiles become airborne for over 100 meters (109 yards); trees debarked; incredible phenomena occur.

Source: SPC, 2012

The Enhanced Fujita Scale (EF-Scale) is now the standard used to measure the strength of a tornado. It is used to assign tornadoes a rating based on estimated wind speeds and related damage. When tornado-related damage is surveyed, it is compared to a list of Damage Indicators (DI) and Degree of Damage (DOD), which help better estimate the range of wind speeds produced by the tornado. From that, a rating is assigned, similar to that of the F-Scale, with six categories from EF0 to EF5, representing increasing degrees of damage. The EF-Scale was revised from the original F-Scale to reflect better tornado damage surveys. This new scale considers how most structures are designed (NOAA 2008). Table 5.4.7-5 displays the EF-Scale and each of its six categories.

Table 5.4.7-5. Enhanced Fujita Damage Scale

F-Scale Number	Intensity Phrase	Wind Speed (mph)	Type of Damage Done
EF0	Light tornado	65–85	Light damage. Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.
EF1	Moderate tornado	86-110	Moderate damage. Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	Significant tornado	111-135	Considerable damage. Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.

F-Scale Number	Intensity Phrase	Wind Speed (mph)	Type of Damage Done
EF3	Severe tornado	136-165	Severe damage. Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown some distance.
EF4	Devastating tornado	166-200	Devastating damage. Well-constructed houses and whole frame houses completely leveled; cars thrown; small missiles generated.
EF5	Incredible tornado	>200	Incredible damage. Strong frame houses leveled off foundations and swept away; automobile-sized missiles become airborne for over 100 meters (109 yards); Significant structural deformation occurs to high-rise buildings; incredible phenomena occur.

Source: SPC, Date Unknown

Tornado watches and warnings are issued by the local NWS office. A tornado watch is issued 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 2013; FEMA 2013).

Hurricanes and Tropical Storms

The term used to identify a tropical cyclone based on the strength of its winds. Hurricanes are further categorized. The extent of a hurricane is categorized by the Saffir-Simpson Hurricane Scale. The Saffir-Simpson Hurricane Wind Scale is a 1 to 5 rating based on a hurricane's 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. Category 1 and 2 storms are still dangerous and require preventive measures (NHC, 2015). Table 5.4.7-6 presents this scale, which is used to estimate the potential property damage and flooding expected when a hurricane makes land fall.

Table 5.4.7-6. The Saffir-Simpson Scale

Category	Wind Speed (mph)	Storm Surge (feet)	Expected Damage
1	74-95 mph	3 to 5 feet	Very dangerous winds will produce some damage: Homes with well-constructed frames could have damage to roof, shingles, vinyl siding, and gutters. Large tree branches will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110 mph	6 to 8 feet	Extremely dangerous winds will cause extensive damage: Homes with well-constructed frames could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block roads. Near-total power loss is expected with outages that could last from several days to weeks.
3 (major)	111-129 mph	9 to 12 feet	Devastating damage will occur: Homes with well-built frames may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4 (major)	130-156 mph	13 to 18 feet	Catastrophic damage will occur: Homes with well-built frames can sustain severe damage with loss of most of the roof structure and some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5 (major)	>157 mph	19+ feet	Catastrophic damage will occur: A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last

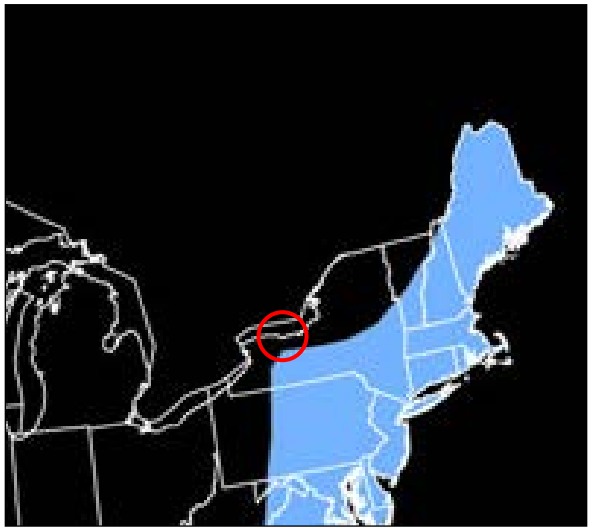
Table 5.4.7-6. The Saffir-Simpson Scale

Category	Wind Speed (mph)	Storm Surge (feet)	Expected Damage
			for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Source: NHC, 2013; NASA 2003
mph = Miles per hour
> = Greater than

Figure 5.4.7-1 illustrates the number of hurricanes expected to occur during a 100-year period. According to this map, portions of New York State (although not including Monroe County) can expect between 20 and 40 hurricanes during a 100-year return period. While Monroe County does not have as high a frequency of hurricanes as other New York counties, it is still important for the county be prepared because responders may need to support other counties impacted by severe hurricanes.

Figure 5.4.7-1. Number of Hurricanes for a 100-year Return Period



Source: USGS, 2005
Note: The number of hurricanes expected to occur during a 100-year MRP based on historical data—light blue area, 20 to 40; dark blue area, 40 to 60; red area, more than 60. Map not to scale.

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). For example, a flood that has a 1 percent chance of being equaled or exceeded in any given year is also referred to as the base flood and has a MRP of 100, which is also known as a 100-year flood. The term 100-year flood can be misleading; it is not the flood that will occur once every 100 years. Rather, it is the flood elevation that has a one-percent chance of being equaled or exceeded each year. Therefore, the 100-year flood could occur more than once in a relatively short period of time or less than one time in 100 years (Dinicola, 2014).

Location

Hail

Hailstorms are most frequent in the southern and central plains states in the United States, where warm moist air off of the Gulf of Mexico and cold dry air from Canada collide, spawning violent thunderstorms. This area of the United States is known as hail alley and lies within the states of Texas, Oklahoma, Colorado, Kansas, Nebraska, and Wyoming. In New York State, hailstorms can occur anywhere within the state independently or during a tornado or thunderstorm event.

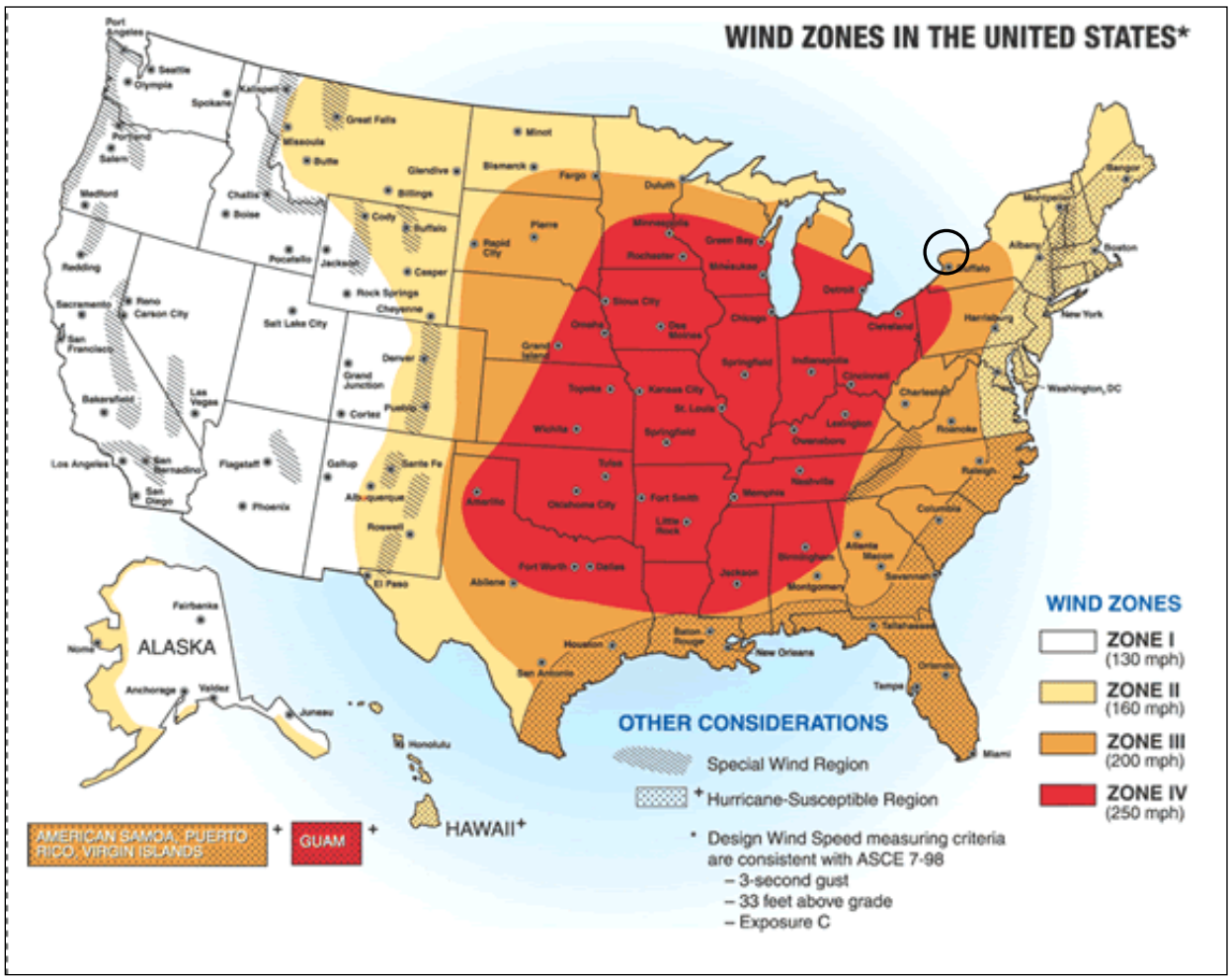
Lightning

Lightning is most often associated with thunderstorms and other severe storms. Although dry lightning strikes can occur without significant precipitation anywhere in the United States, they are more frequently associated with the western portion of the country. The New York City Office of Emergency Management (NYC OEM) notes that the State of New York has a moderate frequency of lightning strikes, with 3.8 strikes occurring per square mile each year. In comparison, Florida experiences 20 strikes per square mile per year, and California experiences two strikes per square mile per year.

Windstorms and High Winds

All of Monroe County is subject to high winds from thunderstorms, hurricanes, tropical storms, tornadoes, and other severe weather events. According to the FEMA Winds Zones of the United States map, Monroe County is located in Wind Zone III, where wind speeds can reach up to 200 mph. The following figure indicates how the frequency and strength of windstorms impacts the United States, and the general location of the most wind activity. This is based on 40 years of tornado data and 100 years of hurricane data collected by FEMA.

Figure 5.4.7-2. Wind Zones in the U.S.



Source: *FEMA, 2012*
Note: *The black circle indicates the approximate location of Monroe County.*

Thunderstorms

Thunderstorms affect relatively small localized areas, rather than large regions such as winter storms and hurricanes (NWS, 2010). Thunderstorms can strike in all regions of the United States; however, they are common in the central and southern states. The atmospheric conditions in these regions of the country are most ideal for generating these powerful storms (NVRC, 2006). It is estimated that as many as 40,000 thunderstorms occur each day world-wide. The southeastern states have the most thunderstorms, with Florida having the highest number (80 to over 100 thunderstorm days each year) (NWS, 2010). According to NOAA, Monroe County experiences between 20 and 40 thunderstorm days each year.

Tornado

Tornadoes have been documented in every state in the United States, and on every continent with the exception of Antarctica. Approximately 1,200 tornadoes occur in the United States each year, with the central portion of the country experiencing the most. Tornadoes can occur at any time of the year, with peak seasons at different times for different states (NSSL 2014). New York State has a definite vulnerability to tornadoes. Since 1952, over 350 tornadoes ranging from F0 to F4 have occurred throughout the state (NYS DHSES 2014). Based on

statistics from 1991 to 2010, New York State has experienced an average of 10 tornadoes annually (NCDC 2013). Monroe County has experienced two tornadoes between 1960 and 2012 (NYS DHSES, 2014).

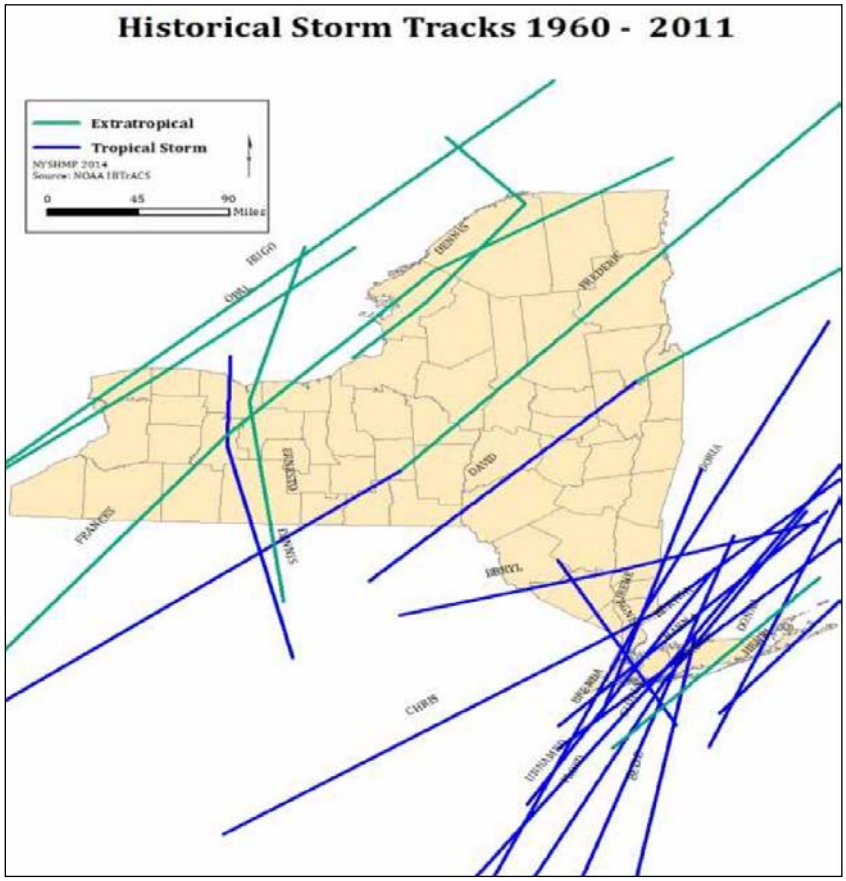
Hurricanes and Tropical Storms

Hurricane risk in the United States extends along the entire east coast, from Maine to Florida, the Gulf Coast, and Hawaii. Hurricane and tropical storms are the two major types of storms that generally impact New York State's marine coastline and adjacent inland areas (NYS DHSES 2014).

Hurricanes and tropical storms can impact New York State 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 New York State due to the cooling of the North Atlantic Ocean waters (NYS DHSES, 2014).

Figure 5.4.7-3, from the 2014 NYS HMP, illustrates the tracks for storms between 1960 and 2011 for the state. The vast majority of these storms have been over the eastern part of the state, specifically in the southeastern corner. This area includes the New York City metropolitan area and the mid- and lower-Hudson Valley areas (NYS DHSES, 2014).

Figure 5.4.7-3. Hurricane Tracks in New York State, 1960 to 2011.



Source: NYS DHSES, 2014

Monroe County is not frequently impacted by hurricanes, tropical storms, or tropical depressions. It occasionally has experienced the direct and indirect landward effects associated with hurricanes and tropical storms in recent history. These storms are based on the Historical Hurricane Tracker, which include recent effects of Hurricane Agnes and Superstorm Sandy. In 2012, Superstorm Sandy caused minor damage and power outages (NCDC

2015) and caused emergency responders in Monroe County to be deployed to more severely impacted counties in New York State, which reduced the county's ability to respond to hazard events until the responders were able to return (Monroe County Hazard Mitigation Planning Committee 2015). Monroe County provided almost 45 firefighters to assist the cleanup and recovery efforts following Superstorm Sandy. Firefighters hailed from nearly a dozen fire departments, including Gates, Brighton, Spencerport, West Webster, and Fairport (Cleare 2012).

Previous Occurrences and Losses

Many sources provided historical information regarding previous occurrences and losses associated with hurricane events throughout New York State and Monroe County. With so many sources reviewed for the purpose of this 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 Update.

Between 1954 and 2015, FEMA declared that New York State experienced 55 severe storm-related disasters (DR) or emergencies (EM) classified as one or a combination of the following disaster types: severe storm, heavy rain, high wind, hurricane/tropical storm, and tornado. Generally, these disasters cover a wide region of the state; therefore, they may have impacted many counties. However, not all counties were included in the disaster declarations. Of those events, the NYS HMP and FEMA indicate that Monroe County has been included in 10 declarations for severe storm-related events (FEMA 2015).

The United States Department of Agriculture (USDA) crop losses provide another indicator of the severity of previous events. Additionally, crop losses can have a significant impact on the economy by reducing produce sales and purchases. Such impacts may have long-term consequences, particularly if crop yields are low the following years as well. USDA records indicate that Monroe County has experienced crop losses from severe storm events. Details are provided in the table immediately below:

Table 5.4.7-7. USDA Crop Losses from Severe Storms in Monroe County

Year	Crop Type	Cause of Loss	Losses
1990	All Other Crops	Wind/Excess Wind	$ 1,164.00
2001	Fresh Market Sweet Corn	Hail	$ 1,825.00
2002	All Other Crops	Other (Snow-Lightning-Etc.)	$ 41,715.00
2002	All Other Crops	Other (Snow-Lightning-Etc.)	$ 16,287.00
2002	All Other Crops	Other (Snow-Lightning-Etc.)	$ 8,419.00
2002	All Other Crops	Other (Snow-Lightning-Etc.)	$ 1,456.00
2003	All Other Crops	Wind/Excess Wind	$ 1,588.00
2003	All Other Crops	Wind/Excess Wind	$ 240.00
2003	All Other Crops	Wind/Excess Wind	$ 6,410.00
2004	All Other Crops	Hail	$ 85,878.00
2005	All Other Crops	Hail	$ 164,809.00
2005	All Other Crops	Other (Snow-Lightning-Etc.)	$ 1,143.00
2005	All Other Crops	Wind/Excess Wind	$ 10,007.00
2006	All Other Crops	Hail	$ 19,366.00
2006	All Other Crops	Hail	$ 60,729.00
2007	All Other Crops	Hail	$ 4,091.00

Year	Crop Type	Cause of Loss	Losses
2007	All Other Crops	Hail	$ 3,006.00
2008	All Other Crops	Hail	$ 286,205.00
2008	All Other Crops	Hail	$ 129,456.00
2008	All Other Crops	Hail	$ 12,033.00
2008	Cabbage	Hail	$ 16,853.00
2009	All Other Crops	Hail	$ 23,024.00
2009	All Other Crops	Hail	$ 211,171.00
2009	Fresh Market Sweet Corn	Wind/Excess Wind	$ 1,576.00
2010	Green Peas	Other (Snow-Lightning-Etc.)	$ 5,588.00
2010	Green Peas	Other (Snow-Lightning-Etc.)	$ 7,815.00
2011	Apples	Hail	$ 3,081.00
2011	Sweet Corn	Other (Snow-Lightning-Etc.)	$ 25,333.00
2014	Apples	Other (Snow-Lightning-Etc.)	$ 17,701.00

For this 2017 Plan Update, known severe storm events that have impacted Monroe County between 1950 and 2015 are identified in Table 5.4.7-8. Records of these storm events often included impacts in other counties. The NYS HMP indicated that Monroe County has experienced 57 hailstorm events between 1960 and 2012, although only one hailstorm occurred between 2010 and 2012. Those events caused no injuries or deaths, but they did cause over $487,000 in property damage and over $960,000 in crop damage. Although the NYS HMP data only includes data up to 2012, other sources were used to determine whether additional hail events occurred after 2012. These events are also listed in Table 5.4.7-8.

Between 1960 and 2012, the county experienced 204 high wind events, leading to 6 fatalities, 17 injuries, over $28.5 million in property damage, and over $2.2 million in crop damage. Of those 204 events, 23 of them occurred between 2010 and 2012 (no fatalities or injuries, but $853,000 in property damage). The NYS HMP did not profile other types of severe storms or lightning events, and as such, County summary data is not available for these events (NYS DHSES 2014). As with hail events, however, other sources have been utilized to determine hazard events and frequency post-2012. With severe storm documentation for New York State and Monroe County being so extensive, not all sources have been identified or researched. Therefore, Table 5.4.7-8 may not include all events that have occurred in the county.

Table 5.4.7-8. Severe Storm Events in Monroe County

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
June 23, 1972	Tropical Storm Agnes	DR-338	Yes	Not listed.
June 6, 1973	Thunderstorm Wind	N/A	N/A	Unofficially, the Rochester Airport (at the FAA Tower) had a wind gust of 100 mph (Democrat & Chronicle, 2.22.06, 2.12.09).
November 12, 1992	Thunderstorm Wind	N/A	N/A	The County EOC was activated for 13.25 hours for a severe wind storm that knocked out power, and downed trees and power lines (County Office of Emergency Management, Disaster Response File: 1992 Wind Storm).
August 13, 1993	Thunderstorm Wind	N/A	N/A	Thunderstorms developed in a moist flow ahead of a cold front. The thunderstorm winds downed trees and power lines. Hail up to an inch in diameter was reported with the storms. Some structural damage was reported from fallen trees and limbs. Damage was estimated at $4,000.00 for Fairport.
August 28, 1994	Thunderstorm Wind	N/A	N/A	Thunderstorms developed in a moist, southwest flow ahead of a cold front. The thunderstorm winds downed trees and power lines, resulting in power outages scattered across the region, including Webster and Spencerport. Damage was estimated at $4,000.00.
June 26, 1995	Thunderstorm Wind	N/A	N/A	Severe thunderstorms moved across portions of Western and Central New York. The thunderstorm winds downed trees and power lines. Power outages were scattered across the entire area. Damage estimates were $6,000.00 for Pittsford and $10,000.00 for Macedon Center.
July 6, 1995	Thunderstorm Wind	N/A	N/A	Severe thunderstorms moved across the area ahead of a cold front. There were numerous reports of downed trees and wires and power outages. Damage was estimated at $8,000.00 for Penfield.
July 15, 1995	Thunderstorm Wind	N/A	N/A	The County EOC was activated for 3 hours to assist coordination of resource identification and deployment to northern New York State after a “Wind Burst” (County Office of Emergency Management, Disaster Response File: July 1995 North Country Wind Burst).
July 17, 1995	Thunderstorm Wind	N/A	N/A	Thunderstorms with wind caused damage estimated at $4,000.00 for Brockport.
August 3, 1995	Thunderstorm Wind	N/A	N/A	Severe thunderstorms crossed the area resulting in fallen trees and power lines, nearly continuous lightning and record rainfall. In Monroe County, traffic was disrupted by flash flooding caused by over 2 inches of rain in a very short time. Numerous power outages were also reported. Damage was estimated at $25,000.00 for Rochester, $5,000.00 for Henrietta, and $35,000.00 for the county.

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
August 31, 1995	Thunderstorm Wind	N/A	N/A	A fast moving line of severe thunderstorms crossed the region causing widespread damage. There were countless reports of downed trees and power lines, many onto cars and houses. Several SKYWARN observers recorded wind gusts of 60-70 mph as the storms moved through. Damage was estimated at $8,000.00 for Irondequoit.
January 27, 1996	Thunderstorm Wind	N/A	N/A	Deep low pressure over the upper Great Lakes brought strong winds to the area. The high winds downed trees and power lines in Mendon. Damage was estimated at $15,000.00.
March 25, 1996	Thunderstorm Wind	N/A	N/A	Thunderstorms accompanying a cold front produced damaging winds, which downed trees and power lines. Damage was estimated at $20,000.00.
April 20, 1996	Thunderstorm Wind	N/A	N/A	Severe thunderstorms developed in the late afternoon. The thunderstorms dropped large hail across the region. Thunderstorm winds downed trees and power lines. Damage was estimated at $15,000.00 for Hamlin.
May 20, 1996	Thunderstorm Wind	N/A	N/A	A line of severe thunderstorms crossed the area producing damaging winds. The thunderstorm winds downed trees and power lines. In Riga, the winds damaged a large road sign. Damage was estimated at $35,000.00.
June 22, 1996	Thunderstorm Wind	N/A	N/A	Severe thunderstorms produced damaging winds, which downed trees and power lines. Damage was estimated at $8,000 for Irondequoit.
October 30, 1996	Thunderstorm Wind	N/A	N/A	Low pressure moving northeast across Lake Superior brought strong winds to the area. The winds brought down trees, tree limbs, and power lines. In Penfield, two persons were injured when a tree fell on the car they were driving. Winds gusted to 52 mph. Damage was estimated at $25,000.00.
February 22, 1997	Thunderstorm Wind	N/A	N/A	A strong cold front crossed the region during the morning hours. Temperatures dropped 40 to 45 degrees with the passage of the front. The funneling effect of the Great Lakes combined with rapid pressure rises behind the front combined to produce hazardous winds. Trees, power lines, and poles were downed across the entire area. Hundreds of thousands were left without power. Reports of homes and autos damaged by the falling trees and branches were numerous. The strong winds caused structural damage in some locations tearing off roofs and shingles, blowing-out windows, and collapsing walls. Air travel from the Buffalo and Rochester airports was interrupted. A 54-year-old volunteer fireman was killed in Spencerport while responding to an emergency call when a large tree fell on his car, crushing him. His 15-year-old son also riding in the car suffered injuries. Reported gusts included: 61 knots at Rochester. Damage was estimated at $500,000.00.

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
February 27, 1997	Thunderstorm Wind	N/A	N/A	Deep low pressure moved from Indiana to Ontario bringing high winds to the area. The strong winds downed trees and telephone and power lines. Power outages were reported throughout the area. Several cities and towns declared States of Emergency because of the prolonged lack of power. Windows were blown-out of buildings. The strong winds caused structural damage in some locations tearing-off roofs and sidings and collapsing walls. Home and autos were damaged by falling limbs. An electric lineman was injured in Perinton, when he was knocked from a pole by a falling tree. Damage was estimated at $150,000.00.
July 15, 1997	Thunderstorm Wind	N/A	N/A	Strong thunderstorms crossed the region during the afternoon hours. The thunderstorm winds downed trees and power lines. Scattered power outages lasting several hours were reported. In Henrietta, numerous utility poles were downed by the thunderstorm winds leaving nearly 24,000 customers in the Rochester area without power for several hours. Damage was estimated at $75,000.00 for Henrietta.
September 29, 1997	Thunderstorm Wind	N/A	N/A	Severe thunderstorms rolled across the area during the evening hours producing damaging winds estimated at sixty to seventy miles per hour. The winds downed trees and power lines and resulted in thousands being left without power. Damage was estimated at $15,000.00 for Penfield.
March 28, 1998	Thunderstorm Wind	N/A	N/A	A fast moving squall line crossed the area during the afternoon hours. Winds, gusting over 70 mph, downed numerous trees and wires. Power outages were reported throughout the area. Damage was estimated at $40,000.00.
May 31, 1998	Thunderstorm Wind	N/A	N/A	An outbreak of severe storms began across the region during the early morning hours. The storms were particularly dangerous because of their speed moving across the region – sometimes in excess of 60 mph. Most of the damage associated with these storms occurred from a combination of high winds and hail. There were reports of numerous trees and wires down as well as power outages. Tens of thousands were without power. Several flights were delayed or cancelled at the Buffalo and Rochester airports due to the storms. Damage was estimated at $18,000.00 for Gates Center, $17,000.00 for Hamlin, $15,000.00 for Scottsville, and $15,000.00 for Rochester. A person in Henrietta was struck by lightning. A second round of storms for the day moved across the region during the evening hours. Again the thunderstorms produced high winds, large hail and torrential rains. Trees and power lines were downed across western New York. In the Rochester area, the power company reported 30 poles snapped by the winds and 40,000 customers were without power. Lightning throughout the area shattered trees and set a number of fires. At Locust Hill Country Club, the nationally televised Ladies Pro Golf Association tournament was delayed four times by the storms. Damage was estimated at $30,000.00 for Rochester.
June 16, 1998	Thunderstorm Wind	N/A	N/A	Scattered thunderstorms crossed the area during the early evening hours. The thunderstorm winds downed trees and power lines. The heavy rains, which accompanied the thunderstorms, resulted in widespread poor drainage and urban flooding in the Rochester metro area. Damage was estimated at $40,000.00 for Rochester.

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
June 25, 1998	Thunderstorm Wind	N/A	N/A	Thunderstorms, accompanied by almost continuous lightning, torrential rains, damaging winds, and pea to marble-sized hail swept across the area. Over 15,000 were without power when thunderstorm winds downed power lines and poles. Damage was estimated at $10,000.00 for Webster.
August 24, 1998	Thunderstorm Wind	N/A	N/A	Thunderstorms moved across the southern Lake Ontario counties during the early morning hours. The thunderstorms produced damaging winds, which downed trees and power lines. Several thousand customers were left without power for several hours. Winds were estimated in some areas at 60-70 mph. Damage was estimated at $50,000.00 for Greece.
September 6-7, 1998	Thunderstorm Wind	N/A	N/A	Several thunderstorms moved onshore over northeast Niagara County shortly before midnight. The line of storms quickly moved across Orleans, Monroe, Wayne, Ontario and northern Cayuga counties. Across the area the damage path was nearly 100 miles long and 5 to 10 miles wide. Winds were estimated between 80 and 100 mph throughout the 2-hour event. Along the entire path, damage and debris all laid in an easterly direction consistent with the damage from straight-line winds. Most of the damage consisted of downed trees and limbs. The falling trees and limbs in-turn downed power and telephone lines and resulted in damage to buildings and automobiles. Power outages, some lasting nearly a week, were widespread across parts of Orleans, Monroe and Wayne counties. Hundreds of thousands of customers were without power. The strong winds themselves also resulted in structural damage to homes, barns and buildings along the path including some in Brockport and Bushnell's Basin among other locations. Several aircraft were damaged at the Rochester Airport where wind gusts were measured at 89 mph. States of Emergency were declared throughout Monroe and Wayne counties and sections of Orleans County. Monroe, Wayne, and Cayuga counties were declared federal disaster areas. The strong winds severely damaged apple crops and trees from Niagara across Orleans and Monroe through Wayne counties. Damage was estimated at $20 million for the Rochester Airport, $350,000.00 for Brockport, $1.2 million for Pittsford, and $2 million in crop damages. This storm, known locally as the "1998 Labor Day Windstorm," was later classified by the National Weather Service as a derecho. Its associated straight line winds were predominant on a path that followed the Erie Canal and NYS Route 31, from Orleans County stretching almost to Albany. The County EOC was open for 113.75 hours. The Presidential Disaster Declaration on September 22, 1998 for seven counties identified this storm as FEMA-1244-DR-NY. Reimbursement to all counties for public assistance was $36.1M. Of that amount, Monroe County communities received $4M (County Office of Emergency Management, Disaster Response File: 1998 Labor Day Windstorm).

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
November 10, 1998	Thunderstorm Wind	N/A	N/A	Low pressure over the central plains moved across the Great Lakes and brought high winds to western New York and the North Country. The strong winds, gusting to 62 mph, brought down tree limbs and power lines across the region. Several windows were blown-in. In East Rochester, several buildings were damaged as walls were blown-in. One cinderblock wall was over 30 feet high and 100 feet long. Thousands were without power as outages were scattered across the area. Power outages were reported in Victor and Rochester as well as other cities and towns in the region. Damage was estimated at $150,000.00.
July 3, 1999	Thunderstorm Wind	N/A	N/A	Several thunderstorms crossed the region during the late afternoon hours. The thunderstorms produced heavy downpours, up to three inches in some spots, strong winds and large hail. The heavy downpours resulted in localized poor drainage flooding. The strong winds downed trees and power lines throughout the region. Structural damage was also reported. Greece reportedly had $25,000.00 in damage.
July 24, 1999	Thunderstorm Wind	N/A	N/A	Severe thunderstorms developed across the counties along the south shore of Lake Ontario. The thunderstorms produced downpours and strong winds. The damaging winds downed trees and power lines with scattered outages reported. Greece reportedly had $15,000.00 in damage.
July 31, 1999	Thunderstorm Wind	N/A	N/A	Violent thunderstorms ripped across western New York and the Finger Lakes Region during the evening hours. The strong thunderstorms downed trees and power lines and left hundreds of thousands without power. Several roads were blocked by fallen debris. Several of the falling trees caused damage to houses and automobiles. In Monroe County, at the Freeman Park in Mumford four people at a company picnic were injured when high winds picked up a tent and dragged it through the crowd. They were treated and released from an area hospital.
August 4, 1999	Thunderstorm Wind	N/A	N/A	Severe thunderstorms crossed the Finger Lakes during the late afternoon hours. The thunderstorms produced damaging winds, which downed trees and power lines. Damage was estimated at $8,000.00 for Rochester.
October 13, 1999	Thunderstorm Wind	N/A	N/A	A strong cold front crossed the area. The thunderstorms that accompanied the front produced damaging winds and large hail. The winds downed trees and power lines. About 10,000 customers lost their power. Falling trees damaged houses in Webster among other areas. Damages in Webster were estimated at $35,000.00.
November 2, 1999	Thunderstorm Wind	N/A	N/A	An intense storm, which moved from the eastern Gulf of Mexico to New Western New York, brought high winds to the region. Trees and lines were downed and power outages were scattered throughout the area. In Rochester, an overhead highway sign was blown into the path of a minivan. A 41-year-old male driver died, while his wife and daughter were not injured in the accident. Damage was estimated at $100,000.00.
January 4, 2000	High Wind	N/A	N/A	Strong winds accompanied the passage of a cold front across the area during the late morning and early afternoon hours. Trees and power lines were downed by the winds. In Rochester, a smokestack was blown over. Gusts of 55 mph at Rochester were recorded. Power outages were scattered throughout the area. Damage was estimated at $50,000.00.

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
March 9, 2000	Thunderstorm Wind	N/A	N/A	Spring thunderstorms rolled-in off Lake Ontario during the afternoon hours. The storms produced 3/4 inch hail and damaging winds that downed trees and power lines. Damage was estimated at $25,000.00.
May 12, 2000	Thunderstorm Wind	N/A	N/A	Thunderstorms rolled across the Niagara Peninsula and then along the Lake Ontario shore counties. Only small hail was reported with the storms, however the storms produced hurricane-force winds. The high winds buffeted the area taking down trees and power lines. Various communities reported power outages of 12 hours or more. In Irondequoit, Kings Highway and Bayview Road caved-in as a result of erosion. Damages in Gates Center were estimated at $35,000.00.
May 24, 2000	Thunderstorm Wind	N/A	N/A	Thunderstorms roared across the Genesee Valley and the Finger Lakes Region during the late morning and early afternoon hours. In addition to producing hail up to one inch in diameter, the thunderstorms produced damaging winds. Damage was estimated at $8,000.00 for Henrietta.
August 1, 2000	Thunderstorm Wind	N/A	N/A	Thunderstorms developed along lake breezes during the afternoon hour. The thunderstorm winds downed trees and power lines. In addition to producing hail up to an inch and a quarter in diameter, the thunderstorms produced torrential rains, which resulted in localized poor drainage flooding. Damage was estimated at $25,000.00 for Brockport.
December 12, 2000	Thunderstorm Wind	N/A	N/A	Deep low pressure over Ohio tracked northeast across the region. The strong pressure gradient on the back side of the low combined with rapid pressure rises resulted in very strong northwest winds across the region. The damaging winds downed trees and lines throughout the area. Specific reports of damage were received from Spencerport along with many other areas outside of Monroe County. Nearly 100,000 customers were without power across the region. Flights on the morning of the 12th were either delayed or cancelled at both the Buffalo Niagara International Airport and the Rochester Airport. Damage was estimated at $200,000.00.
February 10, 2001	Thunderstorm Wind	N/A	N/A	Deep low pressure over the western Great Lakes moved across Ontario to Quebec and dragged a cold front across the area. Sustained winds of 20 to 30 mph were reported across the area with recorded gusts up to 76 mph. The strong winds downed trees and utility lines throughout the 14-county area. Several hundred thousand customers were without power. Roads were blocked by downed trees. There were numerous reports of property damage from the winds, mostly from trees falling on buildings and cars. Specifically, this was reported from Pittsford and Honeoye Falls along with many other areas outside of Monroe County. In Fairport, a winter carnival had to be cancelled because the high winds tore apart a large tent erected for the carnival. Damage was estimated at $300,000.00.
February 25, 2001	Thunderstorm Wind	N/A	N/A	Deep low pressure over the northern Great Lakes moved northeast to Quebec and pulled a strong cold front across the area. The strong winds that accompanied the system downed trees and power lines. Sustained winds of 51 mph were reported at the Rochester Airport. Damage was estimated at $100,000.00.

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
May 27, 2001	Thunderstorm Wind	N/A	N/A	Thunderstorms crossed the area during the afternoon hours producing hail up to ¾ inch in Gates Center and damaging winds estimated to 68 mph. Trees and power lines were downed by the strong winds in western Monroe County. Damage was estimated at $5,000.00 in Gates Center and $20,000.00 in Rochester.
July 1, 2001	Thunderstorm Wind	N/A	N/A	Thunderstorms ahead of a cold front crossed the western Finger Lakes Region and Eastern Lake Ontario counties during the morning hours. The storms produced damaging winds, which downed trees and power lines across the area. Damage was estimated at $10,000.00 in Webster.
July 10, 2001	Thunderstorm Wind	N/A	N/A	Strong thunderstorms moved across parts of the Finger Lakes Region during the late evening hours. The storms downed trees and power lines in Chili. Damage was estimated in Chili Center at $10,000.00.
February 1, 2002	Thunderstorm Wind	N/A	N/A	An intensifying storm moved across the Great Lakes and lifted northeast to the St. Lawrence Valley. Very strong winds behind the low blasted the region with wind gusts exceeding 55 mph. Trees and power lines were downed by the strong winds. Hundreds of thousands were without power…some for several days. Fallen trees and limbs littered the area and closed roads. Numerous reports of damage to homes and automobiles were received from throughout the area. Driving bans and States of Emergency were declared in several counties. Numerous school districts were forced to close on the first and several remained closed through the beginning of the following week. In Monroe County, two injuries resulted from the high winds. A man was briefly hospitalized after gusts blew apart the trailer he was working in at the Greater Rochester Airport. Also in Rochester, a woman was blown from the sidewalk into the street where she was hit by an oncoming car. Damage was estimated at $750,000.00.
March 3, 2002	Thunderstorm Wind	N/A	N/A	Low pressure over Indiana deepened as it moved northeast. Trees and power lines were downed. Damage was estimated at $100,000.00.
March 9, 2002	Thunderstorm Wind	N/A	N/A	Low pressure over Wisconsin deepened as it moved across Lake Superior and into northern Ontario. Strong winds accompanied and followed the passage of a cold front. The damaging winds affected the entire area, downing trees and power lines and causing some structural damage. Nearly 100,000 customers completely lost power with thousands of others experiencing brief power outages. In Rochester, a roof was blown-off a building supply store. In Mendon, a two-story, 100-year old barn was pushed over. Damage was estimated in Webster at $50,000 and overall at $500,000.00.
April 28, 2002	Thunderstorm Wind	N/A	N/A	Thunderstorms developed across the eastern Great Lakes Region during the afternoon hours. The thunderstorm's downburst winds ripped down trees and power lines. Scattered power outages were reported. Several structures and automobiles were damaged by falling trees. Wind damage was estimated at $10,000.00 in Henrietta.

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
May 29, 2002	Thunderstorm Wind	N/A	N/A	Thunderstorms developed in warm, moist, unstable air during the afternoon and evening hours downing trees and power lines. Up to 5,000 homes were without power at the peak of the storm. Damage was estimated at $25,000.00 for the Rochester Airport.
May 31, 2002	Thunderstorm Wind	N/A	N/A	Thunderstorms moved across the region ahead of a cold front. The thunderstorms produced damaging winds and hail up to ¾ inch in diameter. The winds downed trees and power lines and scattered power outages were reported. A home suffered damage in Bushnell's Basin. Damage was estimated at $50,000.00 in Bushnell's Basin.
June 26, 2002	Thunderstorm Wind	N/A	N/A	Thunderstorms developed in a warm, moist, unstable flow during the late morning and afternoon hours. Eight thousand customers lost power in the Rochester metro area. Damage was estimated at $35,000.00 in Rochester, and $30,000.00 in Irondequoit.
June 27, 2002	Thunderstorm Wind	N/A	N/A	Thunderstorms developed ahead of an approaching cold front. The thunderstorms produced damaging winds which gusted to near 70 mph. Damages consisted mainly of downed trees and power lines, although some structural damage occurred. Damage was estimated in Greece at $20,000.00.
May 11, 2003	Strong Winds	N/A	N/A	Spencerport had straight-line winds (60-70 mph) with a localized microburst. A microburst is defined as a, "Highly localized downburst of air released from within a thunderstorm. Winds associated with microbursts can exceed 150 mph. That is equal to the force of an F-2 tornado" (Glenn Johnson, Meteorologist, Democrat & Chronicle, 5-14-03).
April 18, 2004	Hail	N/A	N/A	Spencerport: 0.88 inches; Fairport: 0.88 inches
May 14, 2004	Thunderstorm Wind	N/A	N/A	In Greece, trees fell down on a house, E50 KT; Rochester had trees down, E50KT
May 20, 2004	Lightning	N/A	N/A	An electrical storm followed by a heavy downpour rolled into the Rochester area shortly after 8:00 p.m." Lightning struck the First Presbyterian Church in the Village of Pittsford. About 30 people were attending choir practice. Everyone was safely evacuated, but there was major damage to the structure (Democrat & Chronicle, 5.21.04, 5.22.04).
May 22, 2004	Thunderstorm Wind	N/A	N/A	Spencerport had numerous trees down, E50KT

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
May 23, 2004	Thunderstorm Wind	N/A	N/A	Henrietta's Memorial Day Parade was canceled due to thunderstorms. "Frontier officials say recent storms have knocked out telephone service for an estimated 1,100 business and residential customers across the Rochester region. The company has no official estimate for when most customers will regain service (some maybe 3 days)" (Democrat & Chronicle, 5.24.04, 5.25.04). Thunderstorms on the 23rd and 24th, "...delivered as much as 2 to 4 inches of rain over most of western New York. On the 24th, the National Weather Service issued two severe thunderstorm warnings for Monroe County within six hours' time. With the ground being saturated, any rainfall will create the potential for significant additional flooding" (Democrat & Chronicle, 5.25.04).
May 24, 2004	Thunderstorm Wind	N/A	N/A	In Webster, power lines were down, E55KT Durand-Eastman Park closed portions of the park due to standing water. Pine Brook Elementary School in Greece had the day off because a lightning strike cut power. Rochester firefighters pumped 72 basements. RG&E reported outages for 6,700 customers (Democrat & Chronicle, 5.25.04). The Rush Fire Department canceled their routine water rescue training because of unsafe conditions on Honeoye Creek. They were subsequently called to rescue four people who were rafting in the creek near the bridge on NYS Route 15A. One person was trapped in the creek. "Two of the rescuers and the person trapped were brought to shore by ropes" during the rescue (Democrat & Chronicle, 5.26.04).
July 20, 2004	Hail	N/A	N/A	Pittsford: 0.75 inches
August 29, 2004	Thunderstorm Wind	N/A	N/A	Henrietta Power Lines Down, E50KT; Brighton Large Tree Down, E50KT
June 13, 2005	Thunderstorm Wind	N/A	N/A	Mendon Trees Down, EG50KTS; Clarkson Trees/Limbs down, EG50KTS
July 14, 2005	Thunderstorm Wind	N/A	N/A	Rochester ASOS, MG56KTS; Rochester Tree limbs/chimney down, EG55KTS; Spencerport Wires and Trees down, EG50KTS Thunderstorms that ripped through parts of Monroe County, are to blame for power outages, localized flooding, at least one house fire and one minor incident of a person struck by lightning. The woman struck was shocked by lightning that traveled through the home's telephone line. The National Weather Service, Buffalo Office said strong storms blew through western Monroe County between 7:30 and 8:30 p.m. They reported indications of rainfall greater than 3 inches an hour, which is the whole monthly average rainfall in about an hour. The rain caused numerous flooded basements and some flooded roadways. The power outages affected about 5,700 RG&E customers" (Democrat & Chronicle, 7.15.05).

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
July 26, 2005	Thunderstorm Wind	N/A	N/A	Honeyoe Falls Trees Down, EG50KTS Violent Thunderstorms…toppled trees and power lines in Honeoye Falls. Emergency Services and DPW crews cleared debris from roadways and attended occupants of a car who were trapped when a falling tree struck their vehicle. Local damage was reported on TV13 newscast the following morning" (The Sentinel, 8.4.05). "Peak gusts of 37 mph were recorded at the Airport. The winds downed tree limbs and power lines. A man was struck by lightning in his home when it traveled through electric wiring in his house" (Democrat & Chronicle, 7.27.05).
August 29-October 1, 2005	Hurricane Katrina Evacuation	EM-3262	Yes	Not listed.
September 29, 2005	Thunderstorm Wind	N/A	N/A	Brockport Trees/Wires down, EG50KTS The winds were strong enough to cause damage to trees, homes and scattered power outages to more than 5,600 RG&E customers. A wind gust of 45 mph was registered at the Rochester Airport. .The strong winds accompanied by thunderstorms were leading a cold front into New York" (Democrat & Chronicle, 9.30.05, 10.2.05, The Sentinel, 10.6.05).
November 6, 2005	Thunderstorm Wind	N/A	N/A	Hamlin Wires Down, EG50KTS Supercell thunderstorms raced across the area at 60 mph. Supercells are capable of producing tornadoes, large hail, and dangerous bursts of wind or flash flooding, as well as significant lightening. …The separation between updraft and downdraft leads to longer storm life, helping the storm maintain itself for several hours. 4,000 RG&E customers lost power. Most of the problems were from tree limbs on power lines. The peak wind gust at the Airport was 47 mph" (Democrat & Chronicle, 11.8.05). "WHAM-TV13 was knocked off the air for about half an hour, until 6:35 p.m., by transmitter problems" (Democrat & Chronicle, 11.7.05).
November 9, 2005	Hail	N/A	N/A	Henrietta: 0.75 inches Heavy rains, lightening and hail tore through the Rochester area causing strange weather. Four people on the Wesleyan College Campus were treated for non-life-threatening injuries when lightning struck nearby. Multiple accidents, multiple alarm calls and some flooding the low areas were reported to the 911 Center. About 500 RG&E customers lost power (Democrat & Chronicle, 11.10.05).
February 17, 2006	High Wind	N/A	N/A	Greater Rochester International Airport (ROC) ASOS – MG67KT The area had an official wind gust of 77 mph; this is second on the all-time list" (Democrat & Chronicle, 2.12.09).

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
April 13, 2006	Hail	N/A	N/A	Greece: 1.00 inches
May 13, 2006	Hail	N/A	N/A	Rochester: 1.0 inches
June 28, 2006	Thunderstorm Wind	N/A	N/A	Webster Trees Down, Garage door blown in, EG53KT
June 28, 2006	Hail	N/A	N/A	Penfield: 1.5 inches; Henrietta: 1.50 inches
July 10, 2006	Thunderstorm Wind	N/A	N/A	Webster Trees down, on shed, EG52KT
July 29, 2006	Thunderstorm Wind	N/A	N/A	Lockport Trees down, EG50KT
August 2, 2006	Thunderstorm Wind	N/A	N/A	Hilton Power Lines down, EG50KT
October 29, 2006	High Winds	N/A	N/A	Winds ranged from 25 to 35 mph, with gusts above 40 mph coming off Lake Ontario. Drivers were warned to use caution on roadways and bridges. At its peak, more than 4,500 customers were without power. The NWS, Buffalo Office, issued a wind advisory until 6:00 p.m. There were no cancellations or delays at the Rochester Airport. The high winds caused tree branches to fall on homes and take down power lines" (Democrat & Chronicle, 10.30.06).
December 1, 2006	High Wind	N/A	N/A	ROC EG50KT The NWS, Buffalo Office, reported a wind gust of more than 40mph at the Airport. RG&E had about 3,600 customers without power. Several flights were cancelled at the Airport (Democrat & Chronicle, 12.2.06). The high winds produced a seiche on Lake Ontario. "Water is pushed from one end of the lake and piles-up on the opposite side. Seiches can cause changes in water level of several feet before diminishing over time" (Democrat & Chronicle, 12.3.06).

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
June 8, 2007	Thunderstorm Wind	N/A	N/A	Henrietta Trees/wires down, EG50KT Strong winds, frequent lightening and briefly heavy rain caused scattered power outages. Fallen tree limbs were reported throughout the area. A house was struck by lightning but no injuries were reported. About 8,000 RG&E customers lost power" (Democrat & Chronicle, 6.9.07).
June 19, 2007	Thunderstorm Wind	N/A	N/A	Rochester Trees down, 1 dead, 1 injured; Rochester Trees down, EG50KT; Brockport Trees/wires down, EG50KT A man on an ATV was killed near Riverside Cemetery when a treetop snapped and landed on him during a fast-moving heavy thunderstorm that brought wind gusts of more than 60 mph." In the city, a 500-pound street vendor cart was lifted by the wind and slammed into a car. The fire service responded to calls for people trapped in their cars from falling trees, and DPW crews responded to remove trees that blocked streets. Multiple reports of trees on houses, into houses and obstructing building access were received at the 911 Center. More than 11,500 RG&E customers lost power, and some traffic signals were dark as a result (Democrat & Chronicle, 6.20.07, 6.21.07).
June 21, 2007	Hail	N/A	N/A	Penfield: 1 inch; Honeoye Falls: 0.75 inches
August 16, 2007	Thunderstorm Wind	N/A	N/A	Scottsville Wires down, EG50KT
September 11, 2007	Thunderstorm Wind	N/A	N/A	Mendon Trees/Wires down; tree on home, EG55KT
January 9, 2008	High Wind	N/A	N/A	Brighton Trees Down, EG74MPH
January 9, 2008	Thunderstorm Wind	N/A	N/A	ROC ASOS MG75MPH The winds gusted to hurricane force at 75 mph, downing trees and causing power outages. This is the fourth-highest recorded gust in Rochester history (Democrat & Chronicle, 2.4.08, 2.16.08).
January 30, 2008	High Wind	N/A	N/A	ROC ASOS MG60MPH The peak wind speed was 63 mph, again downing trees and causing power outages (Democrat & Chronicle, 1.31.08, 2.4.08).

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
April 26, 2008	Hail	N/A	N/A	Rochester: 1 inch
June 5, 2008	Thunderstorm Wind	N/A	N/A	Rochester Roof blown off building, EG50KT
June 10, 2008	Hail	N/A	N/A	Honeoye Falls: 0.75 inches
June 10, 2008	Thunderstorm Wind	N/A	N/A	Pittsford Trees and wires down, EG50KT
June 13, 2008	Thunderstorm Wind	N/A	N/A	Greece Wires down, EG50KT
June 16, 2008	Hail	N/A	N/A	Chili Center: 0.88 inches; 3S Penfield: 0.75 inches; Fairport: 0.75 inches; 2SE Fairport: 0.88 inches; Fairport: 0.75 inches; 3S Fairport; 0.75 inches; 2S Brockport: 0.75 inches
June 29, 2008	Thunderstorm Wind	N/A	N/A	Hamlin Trees down, EG50KT
July 16, 2008	Hail	N/A	N/A	Brockport: 0.75 inch
July 23, 2008	Hail	N/A	N/A	Henrietta: 1 inch
July 23, 2008	Thunderstorm Wind	N/A	N/A	1NW Honeoye Falls Trees down, EG50KT; Gates Trees down, EG50KT
February 12, 2009	High Wind	N/A	N/A	Brighton EG60MPH
June 2009	Thunderstorm Wind, Hail	N/A	N/A	The last week of June featured thunderstorms that produced localized flooding and damaging hail, which was reported up to 1.75 inches in diameter" (Democrat & Chronicle, 7.2.09).

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
June 26, 2009	Hail	N/A	N/A	Greece: 1 inch; N. Brockport 0.75 inches; 5SW Brockport: 1.5 inches; Brockport: 0.75 inches; Rochester: 1 inch
July 25, 2009	Tornado	N/A	N/A	Hilton F0 1755-1805
July 25, 2009	Thunderstorm Wind	N/A	N/A	Brockport Trees/wires down; Churchville Trees/wires down; West Webster Tree on house; Irondequoit – Power transformers down; Rochester – Trees down in city
July 26, 2009	Thunderstorm Wind	N/A	N/A	Rochester –Lyell Road Trees down
August 22, 2009	Hail	N/A	N/A	2W Spencerport: 0.75 inches
September 28, 2009	Thunderstorm Wind	N/A	N/A	Brockport Trees/wires down; Hilton Trees/wires Railroad/Underwood; 4NW Rochester Trees down West Ridge Rd
May 8, 2010	High Wind	N/A	N/A	Deep low pressure passed over western New York with its trailing cold front rapidly sweeping east across the region. Winds increased within a few hours of the approaching front to gust speeds of 60 to 65 mph. Tens of thousands were left without power. There were reports of vehicles and/or buildings damaged by falling trees in: Niagara Falls, Ransomville, Rochester, Olean, and Perry just to name a few. The high winds were blamed for several delayed flights at both Buffalo and Rochester airports. “14,000 customers lost power due to winds that took down trees and power lines.” Two-tenths of an inch of snow fell in Charlotte and a trace was measured at the Airport on Sunday morning (Mother’s Day). A freeze warning was in effect the morning of May 10th as the cold front that brought the high winds made its way across the region (Democrat & Chronicle, 5.8.10, 5.10.10).

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
July 21, 2010	Thunderstorm Wind	N/A	N/A	Thunderstorms developed ahead of an approaching cold front. The thunderstorms produced large hail and damaging winds. Hail up to an inch and three-quarters was reported in Ontario, Wayne and Jefferson counties. The thunderstorm winds downed trees and power lines in the City of Rochester and Town of Brighton. Utility companies reported thousands without power. Just before 1:00 p.m., a Thunderstorm produced downpours, quarter-sized hail and damaging winds up to 60 MPH in Monroe County. About 3,000 RG&E customers, including Highland Hospital were without power for hours. Wind also knocked down trees, branches and power lines. Worst hit were Perinton, Pittsford, Chili, Henrietta, Rochester, and Irondequoit. NWS Buffalo reported a total of 1.88 inches of rain fell at the Airport by 5:00 p.m., breaking the record of 1.77 inches for the day set in 1919" (Democrat & Chronicle, 7.22.10). The National Weather Service, Buffalo Office issued a Severe Thunderstorm Warning and a Flood Warning in Monroe County related to this storm (NWS Bulletins, 7.21.10).
August 19, 2010	Thunderstorm Wind	N/A	N/A	Thunderstorms developed ahead of an approaching cold front during the late afternoon hours. In Monroe County, the thunderstorms produced strong winds that downed trees and power lines. At the Long Pond Shores apartment complex in Greece, a large tree fell on part of the building. Fallen limbs were scattered along Lakeshore Road in Irondequoit. Electric Utilities reported about 150 homes without power in Irondequoit and Webster.
September 13, 2010	Hail	N/A	N/A	A cold front crossed western New York during the early afternoon hours. Thunderstorms which accompanied the front produced hail up to one inch in diameter near Brighton and Greece.
April 28, 2011	High Wind	DR-1993	No	Following the passage of a strong cold front, strong synoptic winds developed across western New York. The strong winds downed trees and power lines. Specific measured wind gusts included 62 mph at Rochester Airport.
May 29, 2011	Thunderstorm Wind	N/A	N/A	A slow moving cold front crossed the region during the late evening and early overnight hours. The thunderstorms produced wind gusts measured to 65 mph. Numerous localities across the region report trees and power lines downed.
August 13, 2011	Thunderstorms and Hail	N/A	N/A	Thunderstorms that moved across the area produced winds gusting to 60 mph. The winds downed trees and power lines in Ontario and Marion (Wayne County) and in the Village of Fairport (Monroe County). Hail up to three quarter inch in diameter fell in Greece, Monroe County.
August 28, 2011	Hurricane Irene	EM-3328 / DR-4020	Yes / No	Hurricane Irene tracked northeast along the Atlantic Coast and brought gusty winds to the eastern sections of the area. Measured winds gusted to 40 to 45 mph. Normally winds of this magnitude are not strong enough to cause damage however the ground was west and the north to northeast flow opposite of the prevailing direction for the region. Trees are anchored for the prevailing direction and are susceptible to even marginally strong winds from the opposite direction. Downed trees and lines were reported in the Town of Greece and the City of Rochester. Utilities reported several thousand customers without power.

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
January 17, 2012	Thunderstorm Wind	N/A	N/A	Low pressure moved across southern Ontario and pulled a strong cold front across the region during the evening hours. Thunderstorms which accompanied the front produced wind gusts up to around 70 mph. The strong winds downed trees and power lines and poles. Power outages were scattered throughout the region with utilities reporting several thousand without power at its worse.
January 17, 2012	High Wind	N/A	N/A	Strong winds developed across the entire area in the wake of a strong cold front and associated with a deep low pressure center that moved across southern Ontario. Winds gusts to around 70 mph and remained quite strong all night. The strongest winds occurred along the Lake Erie shoreline to the Chautauqua Ridge and the Lake Ontario shoreline from Henderson Bay to the St. Lawrence River. Throughout the region, the strong winds downed trees and power lines. Several autos were reported damaged by falling trees. Several reports of downed signs and minor structure damage were also received. Some school districts in the area either cancelled classes or delayed start as a result of wind damage. Utilities reported tens of thousands without power at the peak of the storm. Specific gusts included: 72 mph at Rochester.
February 24, 2012	High Wind	N/A	N/A	Low pressure over the Ohio Valley deepened as it lifted northeast across the Great Lakes then down the St. Lawrence Valley. The low brought strong winds to the region. Trees and power lines were downed. Scattered power outages were reported. Measured gusts included: 53 mph at Rochester Airport.
March 3, 2012	High Wind	N/A	N/A	Deep low pressure moved from the Midwest across Lake Huron into Quebec. Southeast winds gusting to 55 mph quickly shifted to southwest and increased to 30 to 40 mph with gusts nearing 70 mph. The strong winds downed trees and power lines. A few autos were reported damaged by falling trees. Several reports of downed signs and structural damage to roofs and awnings were also received. Some school districts in the area either cancelled classes or delayed start as a result of wind damage. Utilities reported several tens of thousands without power at the peak of the storm. Specific gusts included 66 mph at Rochester Airport and 59 mph at Irondequoit.
May 29, 2012	Hail	N/A	N/A	A strong cold front crossed the region bringing an end to oppressive heat and humidity. The front however was accompanied by severe thunderstorms which produced hail up to one-and-three-quarter inches in diameter and damaging winds that downed trees and power lines. Utilities reported tens of thousands without power scattered throughout the region. Only minor structural damage was reported, mainly broken windows and ripped off shingles. Several automobiles were damaged by falling trees and limbs.
July 31, 2012	Thunderstorm Wind	N/A	N/A	While a slow moving cold front eased south across southern Ontario, a 30-mile wide band of showers and thunderstorms developed over Western New York. Initially the thunderstorms produced heavy rains. The thunderstorms continued to strengthen as they moved into the southern tier and eastern Lake Ontario Region. Reports of downed trees and wires were scattered throughout the region. Falling trees damaged homes in Savannah and Fairport. Hail, up to three-quarter inch in diameter, was reported with the storms.

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
August 5, 2012	Thunderstorm Wind	N/A	N/A	Showers and thunderstorms developed in a warm, moist atmosphere ahead of an approaching cold front. Wind gusts were measured to 60 mph. The thunderstorm winds downed trees and power lines throughout the region. In many areas, downed trees blocked roads and highways.
September 7, 2012	Thunderstorm Wind	N/A	N/A	Thunderstorms developed in unseasonably warm and muggy conditions across the Genesee Valley, away from the stabilizing effects of the Great Lakes. The thunderstorm winds downed trees and power lines in the Towns of Brighton and Webster.
October 29, 2012	High Wind	EM-3351	Yes	Remnants of Hurricane Sandy brought strong winds and heavy rains to western and north central New York. Rainfall amounts of two to five inches were measured across the area with some area creeks reaching the top of banks. The high winds downed trees and power lines throughout the region. Wind gusts were measured to 60 mph. Tree damage was greater than usual with such wind speeds because of saturated ground and northeast winds - opposite of the normal prevailing southwest direction. Utilities reported tens of thousands of customers without power across the entire region. Specific measured gusts included: 60 mph at Irondequoit Bay. In addition to the remnants of Superstorm Sandy (i.e., high winds and heavy rains) causing road closures and power outages across the County, the hurricane also activated the County's mutual aid agreement. Monroe County provided almost 45 firefighters to assist the cleanup and recovery efforts following Superstorm Sandy. Firefighters hailed from nearly a dozen fire departments, including Gates, Brighton, Spencerport, West Webster, and Fairport (Cleare 2012). Monroe County reported costs of $127,375.03, and non-county costs of $755,799.35.
January 20, 2013	High Wind	N/A	N/A	A deepening storm system moved across the Upper Great lakes. The system brought strong, damaging winds to the entire region late Saturday night into Sunday (20th-21st). Trees, power poles and wires were brought down by the winds. Numerous roads were blocked by fallen trees, wires and debris. Some structural damage was also reported. Utilities reported tens of thousands without power for a time. Specific measured gusts included 59 mph at the Rochester Airport.
January 31, 2013	High Wind	N/A	N/A	Low pressure moved across the lower Great Lakes bringing a strong cold front across the region. In the wake of the front, strong westerly winds overspread the area. The wind downed trees and power lines. Utilities reported scattered outages across the region. Specific wind gusts recorded included 59 mph at the Rochester Airport.
May 15, 2013	Hail	N/A	N/A	An isolated thunderstorm moved on-shore from Lake Ontario and crossed Orleans and Monroe counties. The thunderstorm produced hail which reached 1 inch in diameter near Albion. At peak, the hail covered the ground.

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
May 21, 2013	Hail	N/A	N/A	Thunderstorms developed along various boundaries within a warm and moist air mass over the region. Storms first developed across the Finger Lakes midday along the Lake Ontario lake breeze and then in the midafternoon along the Lake Erie lake breeze boundary as it pushed inland across the Southern Tier. The strongest storms produced 1- to 2-inch hailstones. Specific hail reports were received from Stanley, Geneva, Newark, Walworth, Marion, and Brockport. In several of those locations, automobiles were damaged by the hail stones.
June 1, 2013	Thunderstorm Wind	N/A	N/A	Two distinct lines of thunderstorms developed ahead of a weak boundary during the late afternoon and became more organized toward evening. One line developed across the Genesee Valley and the other across the eastern Lake Ontario Region. In some areas, scattered power outages were reported as the falling limbs and trees brought down power lines. In Rochester, lighting struck a house igniting a fire and damaging the chimney.
June 1, 2013	Lightning	N/A	N/A	Law enforcement reported that house was damaged by a lightning strike. This event is associated with the thunderstorm event on the same day.
June 17, 2013	Hail	N/A	N/A	A weak cold front crossing the region was accompanied by showers and thunderstorms. The thunderstorms produced hail up to 3/4 inch in diameter.
July 3, 2013	Thunderstorms and Hail	DR-4129	No	Thunderstorms developed over the northern Finger Lakes along a lake breeze in a warm humid air mass. The thunderstorms produce damaging winds which downed trees and power lines in Fairport and Pittsford. Between one-and-one-half and two-and-one half inches of rain was measured across parts of Monroe and Wayne Counties. This amount of rain in a very short time resulted in flooding in the City of Rochester. Several city streets were inundated, included Amsterdam Road and Monroe Avenue. Monroe County OEM had costs related to food (for EOC representatives - $2,575.29) and water (for shelters - $596.38) for a total of $3,171.67.
July 18, 2013	Thunderstorm Wind	N/A	N/A	Scattered thunderstorms developed during the afternoon hours. An isolated thunderstorm over Monroe County produced damaging winds which downed trees and power lines in the Town of Greece.
July 19, 2013	Tornado	N/A	N/A	A thunderstorm moving across Lake Ontario spawned a waterspout just north of Hilton, New York. The waterspout, caught on amateur video, came onshore and moved across a small section of Braddock Point before moving back out over water in Braddock Bay. Onshore, the tornado downed several large trees. A home on Ontario Boulevard and several automobiles were damaged by the falling trees. The overall path length was approximated at less than a mile however the exact location of formation and dissipation over the water was unknown. Over land, the tornado path length was about a quarter of a mile, width was about ten yards, and it was ranked an EF0. Winds were estimated at 65 mph.

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
August 2, 2013	Hail	N/A	N/A	Showers and thunderstorms accompanied the passage of a short wave trough across the area. The thunderstorms produced hail up to one-inch in diameter. Hail was reported in Kent, Greece, and Clarence.
November 1, 2013	High Wind	N/A	N/A	Deep low pressure lifted across the Great Lakes region. The system brought strong winds to much of the region on Friday, November 1st. Winds gusted as high as 62 mph. The strong winds downed trees and power lines throughout the region. Power outages were in the tens of thousands. In addition to minor structural damage to homes and building, a number of houses and automobiles were damaged by falling trees and limbs. Reports of damage were received from Rochester. Specific measured wind gusts included 56 mph at Rochester Airport.
November 18, 2013	High Wind	N/A	N/A	Rapidly deepening low pressure tracked from the Upper Great Lakes to James Bay and brought strong winds to the entire region. The winds, gusting as high as 68 mph, brought down trees and power lines throughout the region with numerous reports of damage from downed trees. Power outages were in the tens of thousands. Specific measure wind gusts included 63 mph at Rochester Airport.
January 6, 2014	High Wind	N/A	N/A	A sharp cold front crossed the region during the overnight/early morning hours. For a brief period in the wake of the front winds increased across the region. The winds gusted as high as 60 miles per hour. Downed trees and power lines were reported from Chili Center.
May 3, 2014	Hail	N/A	N/A	A thunderstorm crossing Monroe County produced 3/4 inch hail in Rochester and Irondequoit.
June 17, 2014	Thunderstorm Wind	N/A	N/A	Scattered showers and thunderstorms developed in a warm, humid air mass during the afternoon hours. These were followed by a large area of showers and thunderstorms associated with low pressure moving across the Great Lakes into southern Ontario and then Quebec. Several of the thunderstorms produced strong, damaging winds. Damage was mainly reported as downed trees and wires however there were some reports of structural and other damage. The thunderstorms also produced hail up to 1-1/4 inch.
August 1, 2014	Hail	N/A	N/A	Thunderstorms developed in a moderately unstable air mass along the lake breeze boundary that extended across the lower Genesee Valley and Western Finger Lakes. The thunderstorms produced damaging winds that downed trees and wires in Greece and Newark. Also, 1 -inch hail was reported in Rochester and 3/4- -inch hail covered the ground in Newark. The heavy rains that fell resulted in urban flooding. Storm sewers were not able to keep up in the intense rainfall with streets closed in Newark and Greece.
August 1, 2014	Thunderstorm Wind	N/A	N/A	This event is associated with the hail event on the same day. Associated damage listed above.

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
January 4, 2015	High Wind	N/A	N/A	Deepening low pressure tracked from western Lake Erie across far southern Ontario to Quebec dragging a cold front across the region. Strong winds increased to near 60 mph about 2 to 3 hours after the cold front passage. The strong winds downed trees and wires across western New York. Scattered power outages resulted. Some specific damage locations included St. Paul Boulevard in the Town of Irondequoit.

Sources: *NOAA-NCDC, 2015; FEMA, 2015; NWS 2011; Beaver County 2011*
Note: *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, monetary losses would be considerably higher in USDs as a result of inflation.*

ASOS *Automated Surface Observing System*
E *East*
EG *Estimated Gusts*
FAA *Federal Aviation Administration*
KT/KTS *Knot(s)*
mph *miles per hour*
ROC *Greater Rochester International Airport*
S *South*
SE *Southeast*
W *West*

Probability of Future Events

Predicting future severe storm events in a constantly changing climate has proven to be a difficult task. Predicting extremes in New York State is difficult because the region's geographic location is positioned roughly halfway between the equator and the North Pole, and it is exposed to both cold and dry airstreams from the south. The interaction between these opposing air masses often leads to turbulent weather across the region (Keim, 1997).

It is estimated that Monroe County will continue to experience direct and indirect impacts of severe storms annually. These storms may induce secondary hazards such as flooding, infrastructure deterioration or failure, utility failures, power outages, water quality and supply concerns, transportation delays, accidents, and inconveniences.

Table 5.4.7-9 provides the probability of occurrences of severe storm events. Based on historic occurrences, thunderstorm events are the most common in Monroe County, followed by hail events. However, the information used to calculate the probability of occurrences is only based on using NOAA-NCDC storm events database results.

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

Hazard Type	Number of Occurrences Between 1950 and 2015	Probability	Average Number of Events Per Year
Hail	43	67.7%	0.66
Hurricane / Tropical Storm	0	0%	0
Wind	41	62.2%	0.63
Thunderstorm	122	185%	1.88
Lightning	8	12.1%	0.12
Total	**214**	**324.7%**	**3.29**

Source: NOAA-NCDC 2015
Note: Probability was calculated using the available data provided in the NOAA-NCDC storm events database.

In Section 5.3, the identified hazards of concern for Monroe County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for ranking hazards. Based on historical records and input from the Planning Committee, the probability of occurrence for severe storms in the county is considered frequent (likely to occur more than once every 25 years, as presented in Table 5.3-3).

Climate Change Impacts

Climate change is beginning to affect both people and resources in New York State, and these impacts are projected to continue to grow. Impacts related to increasing temperatures and rising sea levels are already being felt throughout the state. The Integrated Assessment for Effective Climate Change in New York State (ClimAID) was tasked 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. Monroe County is part of Region 1, Western New York, Great Lakes Plain. Some of the issues in this region affected by climate change include: this region has the highest agricultural revenue in the state; relatively low rainfall, increased summer drought risk; high-value crops could need irrigation; improved condition for grapes projected (NYSERDA, 2011).

Temperatures are expected to increase throughout the state, by 2.0 to 3.4ºF by the 2020s, 4.1 to 6.8ºF by the 2050s and 5.3-10.1ºF by the 2080s. The lower ends of these ranges are for lower greenhouse gas emissions scenarios and the higher ends for higher emissions scenarios. This could lead to an increase of about a month to the growing season, more intense summers, and milder winters.

Annual average precipitation is projected to increase by up to 1 to 8 percent by the 2020s, by 3 to 12 percent by the 2050s and 4 to 15 percent by the 2080s. During the winter months, additional precipitation will most likely occur, in the form of rain, and with the possibility of slightly reduced precipitation projected for the late summer and early fall. Northern parts of the State of New York are expected to see the greatest increases in precipitation (NYSERDA, 2014).

The projected increase in precipitation is expected to occur by heavy downpours and less through light rains. The increase in heavy downpours 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. Increasing air temperatures intensify the water cycle by increasing evaporation and precipitation, which can cause an increase in rain totals during storm events, with longer dry periods in between those events. These changes can have a variety of effects on the state's water resources.

Over the past 50 years, heavy downpours have increased and this trend is projected to continue, contributing to localized flash flooding in urban areas and hilly regions. Flooding has the potential to increase pollutants in the water supply and inundate wastewater treatment plants and other vulnerable facilities located within floodplains. Less frequent rainfall during the summer months may impact the ability of water supply systems. Increasing water temperatures in rivers and streams will affect aquatic health and reduce the capacity of streams to assimilate effluent wastewater treatment plants.

Total precipitation amounts have slightly increased in the northeastern states by approximately 3.3 inches over the last 100 years. There has also been an increase in the number of 2-inch rainfall events over a 48-hour period since the 1950s (a 67 percent increase). The number and intensity of extreme precipitation events are increasing in New York State as well. More rain heightens the danger of localized flash flooding, streambank erosion, and storm damage (Cornell University College of Agriculture and Life Sciences, 2011).

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 severe storms, the entire county is considered vulnerable. Therefore, all assets (population, structures, critical facilities and lifelines), as described in Section 4, are vulnerable. The following sections evaluate and estimate the potential impact of severe storms including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on: (1) life, safety and health 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 2011 Monroe County Hazard Mitigation Plan
- Effect of climate change on vulnerability
- Further data collections that will assist understanding of this hazard over time

Overview of Vulnerability

The high winds and air speeds of a hurricane or any severe storm often result in power outages, disruptions to transportation corridors and equipment, loss of workplace access, significant property damage, injuries and loss of life, and the need to shelter and care for individuals impacted by the events. A large amount of damage can be inflicted by trees, branches, and other objects that fall onto power lines, buildings, roads, vehicles, and, in some cases, people. The risk assessment for severe storms evaluates available data for a range of storms included in this hazard category.

Due to the large geographic area that covers with both coastal and inland locations, the loss associated with hurricanes can vary (see flooding discussion in Section 5.4.10, Flood). Secondary flooding associated with the torrential downpours during hurricanes and tropical storms is also a concern in Monroe County.

The entire inventory of the county is at risk of being damaged or lost due to impacts from severe wind storms. Certain areas, infrastructure, and types of buildings are at greater risk than others due to proximity to falling hazards and their manner of construction. Potential losses associated with high wind events were calculated for the county for two probabilistic hurricane events, the 100-year and 500-year MRP hurricane events. The impacts on population, existing structures, critical facilities and the economy are presented below, following a summary of the data and methodology used.

Data and Methodology

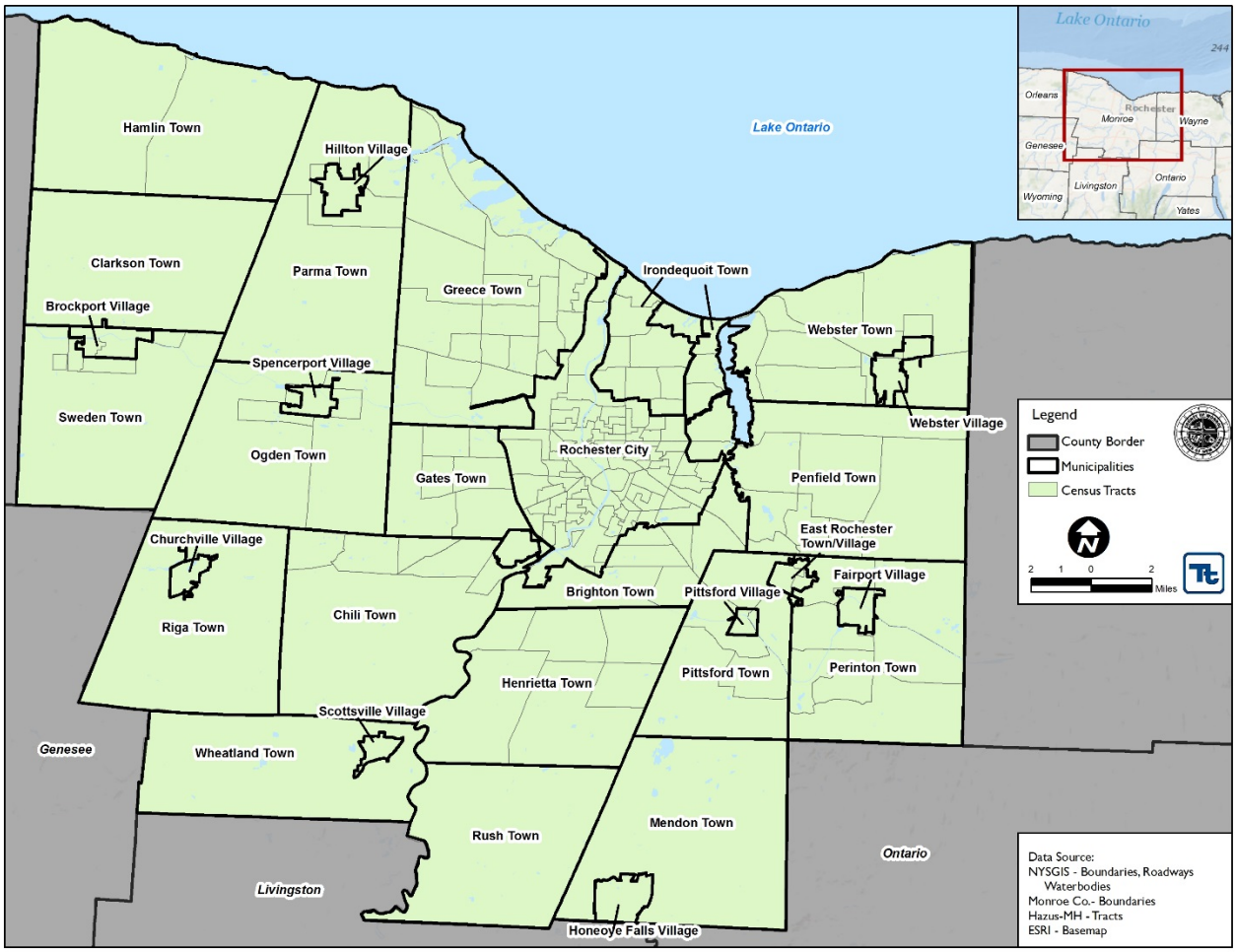
After reviewing historic data, the HAZUS-MH methodology and model were used to analyze the severe storm hazard for Monroe County. Data used to assess this hazard include data available in the HAZUS-MH hurricane model, professional knowledge, information provided by the Steering Committee, and input from the public.

A probabilistic scenario was run for Monroe County for the 100- and 500-year MRPs for the wind/severe storm hazard. The maximum peak gust wind speeds for the 100-year MRP event were less than 39 mph (tropical storm). The results for the 500-year MRP hurricane event are shown in Figure 5.4.7-5, which shows the HAZUS-MH maximum peak gust wind speeds that can be anticipated in the study area associated with the 500-year MRP hurricane event. The estimated hurricane track for the 500-year events is also shown.

HAZUS-MH contains data on historic hurricane events and wind speeds. It also includes surface roughness and vegetation (tree coverage) maps for the area. Surface roughness and vegetation data support the modeling of wind force across various types of land surfaces. Hurricane and inventory data available in HAZUS-MH were used to evaluate potential losses from the 100- and 500-year MRP events (severe wind impacts). Updated critical

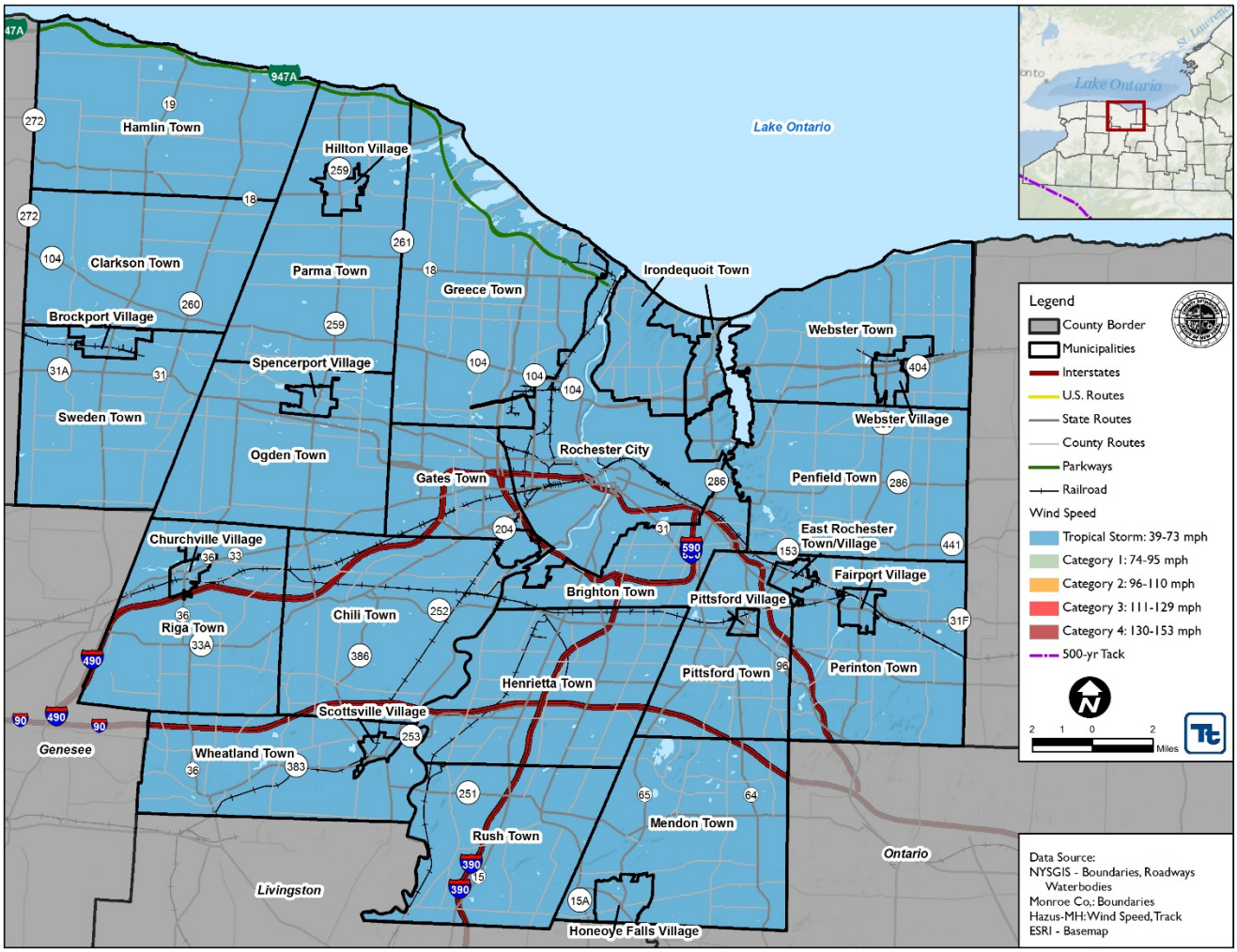
facility inventories and general building stock data were used in this evaluation. The model was run at the tract level for the county. Figure 5.4.7-4 below displays the relationship between the municipalities and census tracts.

Figure 5.4.7-4. Hazus-MH Census Tracts in Monroe County



Source: HAZUS-MH v.2.1

Figure 5.4.7-5. Wind Speeds for the 500-Year Mean Return Period Event



Source: HAZUS-MH v.2.1

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 or not adequate warning time was provided to residents. It is assumed that the entire county's population (U.S. Census 2010 population of 744,344 people) is exposed to this storm hazard.

Residents may be displaced or require temporary to long-term sheltering. In addition, downed trees, damaged buildings and debris carried by high winds 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 currently estimates that no people will be displaced and that no people will require temporary shelter due to either a 100-year or a 500-year MRP event.

Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions based on the major economic impact to their family and may not have funds to evacuate. The population over the age of 65 is also more vulnerable and, physically, they may have more difficulty evacuating. The elderly are considered most vulnerable because they require extra time or outside assistance during

evacuations and are more likely to seek or need medical attention which may not be available due to isolation during a storm event. Section 4 provides for the statistics for these populations.

Impact on General Building Stock

After considering the population exposed to the severe storm hazard, the general building stock replacement value exposed to and damaged by 100- and 500-year MRP events was examined. Wind-only impacts from a severe storm are reported based on the probabilistic hurricane runs in HAZUS-MH. Potential damage is the modeled loss that could occur to the exposed inventory, including damage to structural and content value based on the wind-only impacts associated with a hurricane (using the methodology described in Section 5.1).

It is assumed that the entire county's general building stock is exposed to the severe storm wind hazard (greater than $163 billion structure only). Expected building damage was evaluated by HAZUS across the following wind damage categories: no damage/very minor damage, minor damage, moderate damage, severe damage, and total destruction. Table 5.4.7-10 summarizes the definition of the damage categories.

Table 5.4.7-10. Description of Damage Categories

Qualitative Damage Description	Roof Cover Failure	Window Door Failures	Roof Deck	Missile Impacts on Walls	Roof Structure Failure	Wall Structure Failure
No Damage or Very Minor Damage Little of no visible damage from the outside. No broken windows or failed roof deck. Minimal loss of roof cover, with no or very limited water penetration.	≤ 2%	No	No	No	No	No
Minor Damage Maximum of one broken window, door or garage door. Moderate roof cover loss that can be covered to prevent additional water entering the building. Marks or dents on walls requiring painting or patching for repair.	> 2% and ≤ 15%	One window, door, or garage door failure	No	< 5 Impacts	No	No
Moderate Damage Major roof cover damage, moderate window breakage. Minor roof sheathing failure. Some resulting damage to interior of building from water.	> 15% and ≤ 50%	> the larger of 20% & 3 and ≤ 50%	1 to 3 Panels	Typically 5 to 10 Impacts	No	No
Severe Damage Major window damage or roof sheathing loss. Major roof cover loss. Extensive damage to interior from water.	> 50%	> one and ≤ the larger of 20% & 3	> 3 and ≤ 25%	Typically 10 to 20 Impacts	No	No
Destruction Complete roof failure and/or failure of wall frame. Loss of more than 50% of roof sheathing.	Typically > 50%	> 50%	> 25%	Typically > 20 Impacts	Yes	Yes

Source: HAZUS-MH Hurricane Technical Manual

As noted earlier in the profile, HAZUS-MH estimates the 100-year MRP peak gust wind speeds for Monroe County to be less than 50 mph. For the 100-year MRP event, HAZUS-MH estimates $0 in structure damage.

HAZUS estimates the 500-year MRP peak gust wind speeds for Monroe County to range from 45 to 50 mph. This equates to a tropical storm and to less than $100 in damage to the general building stock (structure only), which is an extremely small percentage of the county's building inventory. The residential buildings are estimated to experience all of the damage. Table 5.4.7-11 summarizes the building value damage (structure only) estimated for the 100- and 500-year MRP wind-only events by occupancy class.

Table 5.4.7-11. Estimated Building Replacement Value (Structure Only) Damaged by the 100-Year and 500-Year Mean Return Period Hurricane-Related Winds for All Occupancy Classes

Municipality	Total RCV (Structure Only)	Estimated Total Damages*		Percent of Total Building Replacement Cost Value	
		100-Year	500-Year	100-Year	500-Year
Brighton (T)	$10,416,071,900	$0	$0	0%	0%
Chili (T)	$4,654,797,764	$0	$0	0%	0%
Clarkson (T) - Brockport (V)	$1,146,909,486	$0	$0	0%	0%
East Rochester (V)	$1,678,415,529	$0	$0	0%	0%
Gates (T)	$5,539,127,603	$0	$0	0%	0%
Greece (T)	$15,563,936,148	$0	$0	0%	0%
Hamlin (T)	$1,109,833,295	$0	$0	0%	0%
Henrietta (T)	$7,658,571,875	$0	$0	0%	0%
Irondequoit (T)	$10,405,402,578	$0	$0	0%	0%
Mendon (T)	$2,498,811,065	$0	$0	0%	0%
Ogden (T) - Spencerport (V)	$3,809,889,108	$0	$0	0%	0%
Parma (T)	$1,503,473,843	$0	$0	0%	0%
Parma (T) - Hilton (V)	$1,143,561,980	$0	$0	0%	0%
Penfield (T)	$8,744,354,755	$0	$0	0%	0%
Perinton (T)	$7,664,227,037	$0	$0	0%	0%
Perinton (T) - Fairport (V)	$4,369,464,987	$0	$0	0%	0%
Pittsford (T)	$3,849,077,058	$0	$0	0%	0%
Pittsford (T) - Pittsford (V)	$2,761,025,115	$0	$0	0%	0%
Pittsford (T) - Pittsford (V) - East Rochester (V)	$2,023,655,794	$0	$0	0%	0%
Riga (T) - Churchville (V)	$1,298,707,681	$0	$0	0%	0%
Rochester (C)	$53,263,742,454	$0	$0	0%	0%
Rush (T)	$879,896,158	$0	$0	0%	0%
Sweden (T)	$687,081,997	$0	$0	0%	0%
Sweden (T) - Brockport (V)	$1,514,606,488	$0	$0	0%	0%
Webster (T)	$5,443,248,370	$0	$0	0%	0%
Webster (T) - Webster (V)	$2,748,836,760	$0	$0	0%	0%
Wheatland (T) - Scottsville (V)	$1,034,831,693	$0	$5	0%	<1%
Monroe County (TOTAL)	**$163,411,558,521**	**$0**	**$5**	**0%**	**<1%**

Source: Monroe County, FEMA 2015

Notes:

% Percent
C City
T Town
V Village

Because of differences in building construction, residential structures are generally 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. The damage counts include

buildings damaged at all severity levels from minor damage to total destruction. Total dollar damage reflects the overall impact to buildings at an aggregate level.

Of the exceeding $163 billion in total residential replacement value (structure) for the entire county, no residential building damage is anticipated for the 100-year event and less than $100 in residential building damage can be anticipated for the 500-year event. Residential building damage accounts for 100 percent of the damage associated with the 500-year wind-only events. Residential structures are the largest component of the Monroe County building inventory.

Impact on Critical Facilities

HAZUS-MH estimates the probability that critical facilities (i.e., medical facilities, fire/EMS, police, 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 estimates the loss of use for each facility in number of days. HAZUS-MH estimates there is a 0 percent chance that critical facilities in Monroe County will experience 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-year or 500-year MRP events.

At this time, HAZUS-MH 2.1 does not estimate losses to transportation lifelines and utilities as part of the hurricane model. Transportation lifelines are not considered particularly vulnerable to the wind hazard; they are more vulnerable to cascading effects such as flooding, falling debris, etc. Impacts to transportation lifelines affect both short-term (e.g., evacuation activities) and long-term (e.g., day-to-day commuting) transportation needs.

Utility structures could suffer damage associated with falling tree limbs or other debris, resulting in the loss of power, which can impact business operations and can impact heating or cooling provision to citizens (including the young and elderly, who are particularly vulnerable to temperature-related health impacts).

Impact on Economy

Severe storms also impact the economy, including: loss of business function (e.g., tourism, recreation), damage to inventory, relocation costs, wage loss, and rental loss due to the repair/replacement of buildings. HAZUS-MH estimates the total economic loss associated with each storm scenario (direct building losses and business interruption losses). Direct building losses are the estimated costs to repair or replace the damage caused to the building. This is reported in the "Impact on General Building Stock" section discussed earlier. Business interruption losses include losses associated with the inability to operate a business because of the wind damage sustained during the storm or the temporary living expenses for those displaced from their home because of the event.

For the 100-year MRP wind event, HAZUS-MH estimates $0 in business interruption losses or inventory losses. For the 500-year MRP wind only event, HAZUS-MH estimates less than $100 in business interruption losses for Monroe County which includes loss of income, relocation costs, rental costs and lost wages. Further HAZUS-MH estimates $0 in loss of inventory.

HAZUS-MH 2.1 also estimates the amount of debris that may be produced a result of the 100- and 500-year MRP wind events. HAZUS-MH 2.1 estimates that there will be no debris generated as a result of the 100- and 500-yr MRP wind events. Because the estimated debris production does not include flooding, this is likely a conservative estimate and may be higher if multiple impacts occur. According to the HAZUS-MH Hurricane User Manual: '*The Eligible Tree Debris columns provide estimates of the weight and volume of downed trees that would likely be collected and disposed at public expense. As discussed in Chapter 12 of the HAZUS-MH Hurricane Model Technical Manual, the eligible tree debris estimates produced by the Hurricane Model tend*

to underestimate reported volumes of debris brought to landfills for a number of events that have occurred over the past several years. This indicates that that there may be other sources of vegetative and non-vegetative debris that are not currently being modeled in HAZUS. For landfill estimation purposes, it is recommended that the HAZUS debris volume estimate be treated as an approximate lower bound. Based on actual reported debris volumes, it is recommended that the HAZUS results be multiplied by three to obtain an approximate upper bound estimate. It is also important to note that the Hurricane Model assumes a bulking factor of 10 cubic yards per ton of tree debris. If the debris is chipped prior to transport or disposal, a bulking factor of 4 is recommended. Thus, for chipped debris, the eligible tree debris volume should be multiplied by 0.4'.

Future Growth and Development

As discussed and illustrated in Section 4, areas targeted for future growth and development have been identified across Monroe County. Any areas of growth could be potentially impacted by the severe storm hazard because the entire county is exposed and vulnerable to the wind hazard associated with severe storms.

Additional Data and Next Steps

Over time, Monroe County will obtain additional data to support the analysis of this hazard. Such data may include additional details on past hazard events and impacts; specific building information, such as type of construction; and details on protective features (for example, hurricane straps). Information on particular buildings or infrastructure age or year built would also be helpful in future analysis of this hazard. Mitigation strategies to reduce vulnerability to severe storms are provided in Section 6 (Volume 1) and Section 9 (Volume II) of this plan.