# 5.4.1 FLOOD

This section provides a profile and vulnerability assessment for the flood hazard.

## HAZARD PROFILE

This section provides profile information including description, location, extent, previous occurrences and losses and the probability of future occurrences.

### Description

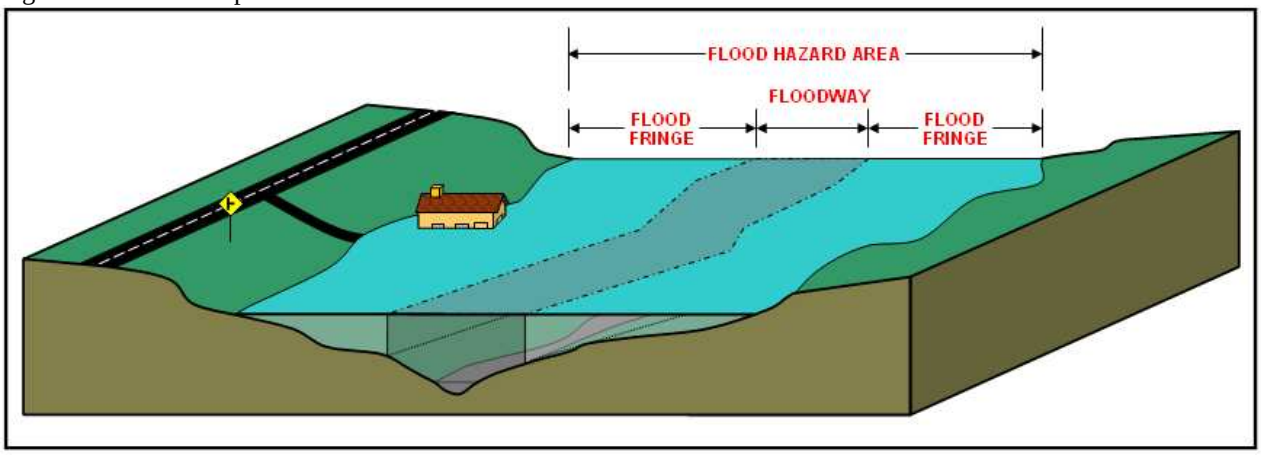
Floods are one of the most common natural hazards in the U.S. They can develop slowly over a period of days or develop quickly, with disastrous effects that can be local (impacting a neighborhood or community) or regional (affecting entire river basins, coastlines and multiple counties or states) (Federal Emergency Management Agency [FEMA], 2010). Most communities in the U.S. have experienced some kind of flooding, after spring rains, heavy thunderstorms, coastal storms, or winter snow thaws (George Washington University, 2001). Floods are the most frequent and costly natural hazards in New York State in terms of human hardship and economic loss, particularly to communities that lie within flood prone areas or flood plains of a major water source. As defined in the NYS HMP, flooding is a general and temporary condition of partial or complete inundation on normally dry land from the following:

- Riverine flooding, including overflow from a river channel, flash floods, alluvial fan floods, dam-break floods and ice jam floods;
- Local drainage or high groundwater levels;
- Fluctuating lake levels;
- Coastal flooding;
- Coastal erosion (Draft NYS HMP, 2011)
- Unusual and rapid accumulation or runoff of surface waters from any source;
- Mudflows (or mudslides);
- Collapse or subsidence of land along the shore of a lake or similar body of water caused by erosion, waves or currents of water exceeding anticipated cyclical levels that result in a flood as defined above (Floodsmart.gov, 2012);
- Sea Level Rise; or
- Climate Change (USEPA, 2012).

A floodplain is defined as the land adjoining the channel of a river, stream, ocean, lake, or other watercourse or water body that becomes inundated with water during a flood. Most often floodplains are referred to as 100-year floodplains. A 100-year floodplain is not the flood that will occur once every 100 years, rather it is the flood that has a one-percent chance of being equaled or exceeded each year. Thus, the 100-year flood could occur more than once in a relatively short period of time. With this term being misleading, FEMA has properly defined it as the one-percent annual chance flood. This one percent annual chance flood is now the standard used by most Federal and State agencies and by the National Flood Insurance Program (NFIP) (FEMA, 2002).

Figure 5.4.1-1 depicts the flood hazard area, the flood fringe, and the floodway areas of a floodplain.

Figure 5.4.1-1. Floodplain




Source: NJDEP, Date Unknown

Many floods fall into three categories: riverine, coastal and shallow (FEMA, 2008). Other types of floods may include ice-jam floods, alluvial fan floods, dam failure floods, and floods associated with local drainage or high groundwater (as indicated in the previous flood definition). For the purpose of this HMP and as deemed appropriate by the County, riverine/flash, dam failure and ice jam flooding are the main flood types of concern for the Planning Area. These types of flood or further discussed below.

Riverine/Flash Floods – Riverine floods are the most common flood type and occur along a channel, and include overbank and flash flooding. Channels are defined, ground features that carry water through and out of a watershed. They may be called rivers, creeks, streams or ditches. When a channel receives too much water, the excess water flows over its banks and inundates low-lying areas (FEMA, 2008; The Illinois Association for Floodplain and Stormwater Management, 2006).

Flash floods are "a rapid and extreme flow of high water into a normally dry area, or a rapid water level rise in a stream or creek above a predetermined flood level, beginning within six hours of the causative event (e.g., intense rainfall, dam failure, ice jam). However, the actual time threshold may vary in different parts of the country. Ongoing flooding can intensify to flash flooding in cases where intense rainfall results in a rapid surge of rising flood waters" (NWS, 2009).

Ice-Jam Floods – An ice jam is an accumulation of ice that acts as a natural dam and restricts flow of a body of water. Ice jams occur when warm temperatures and heavy rains cause rapid snow melt. The melting snow, combined with the heavy rain, causes frozen rivers to swell. The rising water breaks the ice layers into large chunks, which float downstream and often pile up near narrow passages and obstructions (bridges and dams). Ice jams may build up to a thickness great enough to raise the water level and cause flooding (NESEC, Date Unknown; FEMA, 2008).

There are two different types of ice jams: freeze-up and breakup. Freeze-up jams occur in the early to mid-winter when floating ice may slow or stop due to a change in water slope as it reaches an obstruction to movement. Breakup jams occur during periods of thaw, generally in late winter and early spring. The ice cover breakup is usually associated with a rapid increase in runoff and corresponding river discharge due to a heavy rainfall, snowmelt or warmer temperatures (USACE, 2002).

Dam Failure Floods – A dam is an artificial barrier that has the ability to impound water, wastewater, or any liquid-borne material for the purpose of storage or control of water (FEMA, 2010). Dams are man-made structures built across a stream or river that impound water and reduce the flow

downstream (FEMA, 2003). They are built for the purpose of power production, agriculture, water supply, recreation, and flood protection. Dam failure is any malfunction or abnormality outside of the design that adversely affect a dam's primary function of impounding water (FEMA, 2011). Dams can fail for one or a combination of the following reasons:

- Overtopping caused by floods that exceed the capacity of the dam (inadequate spillway capacity);
- Prolonged periods of rainfall and flooding;
- Deliberate acts of sabotage (terrorism);
- Structural failure of materials used in dam construction;
- Movement and/or failure of the foundation supporting the dam;
- Settlement and cracking of concrete or embankment dams;
- Piping and internal erosion of soil in embankment dams;
- Inadequate or negligent operation, maintenance and upkeep;
- Failure of upstream dams on the same waterway; or
- Earthquake (liquefaction / landslides) (FEMA, 2010).

### Extent

In the case of riverine or flash flooding, once a river reaches flood stage, the flood extent or severity categories used by the NWS include minor flooding, moderate flooding, and major flooding. Each category has a definition based on property damage and public threat:

- Minor Flooding - minimal or no property damage, but possibly some public threat or inconvenience.
- Moderate Flooding - some inundation of structures and roads near streams. Some evacuations of people and/or transfer of property to higher elevations are necessary.
- Major Flooding - extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations (NWS, 2011).

The severity of a flood depends not only on the amount of water that accumulates in a period of time, but also on the land's ability to manage this water. One element is the size of rivers and streams in an area; but an equally important factor is the land's absorbency. When it rains, soil acts as a sponge. When the land is saturated or frozen, infiltration into the ground slows and any more water that accumulates must flow as runoff (Harris, 2001).

Flood severity from a dam failure can be measured with a low, medium or high severity, which are further defined as follows:

- Low severity - No buildings are washed off their foundations; structures are exposed to depths of less than 10 feet.
- Medium severity - Homes are destroyed but trees or mangled homes remain for people to seek refuge in or on; structures are exposed to depths of more than 10 feet.
- High severity - Floodwaters sweep the area clean and nothing remains. Locations are flooded by the near instantaneous failure of a concrete dam, or an earthfill dam that turns into "jello" and washes out in seconds rather than minutes or hours. In addition, the flooding caused by the dam

failure sweeps the area clean and little or no evidence of the prior human habitation remains after the floodwater recedes (Graham, 1999).

Two factors which influence the potential severity of a full or partial dam failure include (1) The amount of water impounded; and (2) The density, type, and value of development and infrastructure located downstream (City of Sacramento Development Service Department, 2005).

### Location

Flooding is the primary natural hazard in New York State because the State exhibits a unique blend of climatological and meteorological features that influence the potential for flooding. These factors include topography, elevations, latitude and water bodies and waterways. Flooding is the primary natural hazard in New York State and they occur in every part of the State. Some areas are more flood prone than others, but no area is exempt, including Tioga County. There are over 52,000 miles of river and streams in New York State, and along their banks there are 1,480 communities that are designated as flood prone. It is estimated that 1.5 million people live in these flood-prone areas. Millions more work, travel through or use recreational facilities located in areas subject to flooding. Areas outside recognized and mapped flood hazard zones can also experience flooding (Draft NYS HMP, 2011).

The NYSDEC conducted a vulnerability assessment that depicted how vulnerable a county may be to flood hazards. This was determined by a rating score; each county accumulated points based on the value of each vulnerability indicator. The higher the indication for flood exposure, the more points assigned, resulting in a final rating score. The result of this assessment presented an indication of a county's vulnerability to the flood hazard. Tioga County's rating is 26, out of a possible 35. The rating was based on number of NFIP insurance policies, number of NFIP claims, total amount of NFIP claims, total amount of NFIP policy coverage, number of repetitive flood loss properties, and number of flood disasters (Draft NYS HMP, 2011).

Riverine flooding problems are most severe in the Delaware, Susquehanna, Chemung, Erie-Niagara, Genesse, Allegany, Hudson and Mohawk River Basins (Draft NYS HMP, 2011). Tioga County is part of the Susquehanna River Basin (NYSDEC, Date Unknown).

#### Susquehanna River Basin

The Susquehanna River Basin is the second largest basin east of the Mississippi River. The 444 miles of the Basin drain approximately 27,500 square miles, covering the large portions of New York State, Pennsylvania and Maryland, before emptying into the Chesapeake Bay. In New York State, the Susquehanna River Basin encompasses most of the south-central portion of the State. The Basin drains approximately 4,520 square miles in central New York State. Within the State, the drainage area includes most of Broome, Chenango, Cortland, Otsego and Tioga Counties, portions of Delaware, Madison and Chemung Counties, and small parts of Schuyler, Tompkins, Onondaga, Oneida, Herkimer and Schoharie Counties (NYSDEC, 2009). In Tioga County, the Susquehanna River flows in the southern portion of the County, from the east to the southwest.

The past history of flooding along the Susquehanna River indicates that flooding can occur any time of the year. The majority of the larger floods has occurred in the late winter or early spring and has resulted from a combination of heavy rains and extensive snowmelt. This area is also susceptible to floods due to tropical storms or hurricanes moving up the Atlantic coast in the summer and fall (FEMA FIS, 2009).

#### FEMA Flood Hazard Areas

According to FEMA, flood hazard areas are defined as areas that are shown to be inundated by a flood of a given magnitude on a map. These areas are determined using statistical analyses of records of riverflow, storm tides, and rainfall; information obtained through consultation with the community; floodplain topographic surveys; and hydrologic and hydraulic analyses. Flood hazard areas are delineated on FEMA's Flood Insurance Rate Maps (FIRM), which are official maps of a community on which the Federal Insurance and Mitigation Administration has indicated both the Special Flood Hazard Areas (SFHA) and the risk premium zones applicable to the community. These maps identify the SFHAs; the location of a specific property in relation to the SFHA; the base (100-year) flood elevation (BFE) at a specific site; the magnitude of a flood hazard in a specific area; the undeveloped coastal barriers where flood insurance is not available and locates regulatory floodways and floodplain boundaries (100-year and 500-year floodplain boundaries) (FEMA, 2003; FEMA, 2005; FEMA, 2008).

The land area covered by the floodwaters of the base flood is the SFHA on a FIRM. It is the area where the National Flood Insurance Programs (NFIP) floodplain management regulations must be enforced and the area where the mandatory purchase of flood insurance applies. The SFHA includes Zones A, AO, AH, A1-30, AE, A99, AR, AR/A1-30, AR/AE, AR/AO, AR/AH, AR/A, VO, V1-30, VE, and V. (FEMA, 2007). This regulatory boundary is a convenient tool for assessing vulnerability and risk in flood-prone communities since many communities have maps showing the extent of the base flood and likely depths that will be experienced. The base flood is often referred to as the "100-year" flood designation. The BFE on a FIRM is the elevation of a base flood event, or a flood which has a 1-percent chance of occurring in any given year as defined by the NFIP. The BFE describes the exact elevation of the water that will result from a given discharge level, which is one of the most important factors used in estimating the potential damage to occur in a given area. A structure located within a 100-year floodplain has a 26-percent chance of suffering flood damage during the term of a 30-year mortgage. The 100-year flood is a regulatory standard used by Federal agencies and most states, to administer floodplain management programs. The 100-year flood is used by the NFIP as the basis for insurance requirements nationwide. FIRMs also depict 500-year flood designations, which is a boundary of the flood that has a 0.2-percent chance of being equaled or exceeded in any given year (FEMA, 2005; FEMA, 2003).

**Flood Insurance Study (FIS)**

In addition to FIRM and DFIRMs, FEMA also provides FISs for entire counties and individual jurisdictions. These studies aid in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. They are narrative reports of countywide flood hazards, including descriptions of the flood areas studied and the engineered methods used, principal flood problems, flood protection measures and graphic profiles of the flood sources (FEMA, Date Unknown). A countywide FIS for Tioga County has been completed; however, it is a preliminary document. The 2009 preliminary FIS discussed the principal flood problems in the County. Based on historic data, the Susquehanna River, Apalachin Creek, Owego Creek, East Branch Owego Creek and West Branch Owego Creek are the major sources of flooding problems in the County. Tioga County has experienced notable damage from a number of floods in the past, with the most notable occurring in 1935, 1936, 1940, 1942, 1948, 1964, 1972, 1977, 1979, 2005 and 2006 (FEMA FIS, 2009).

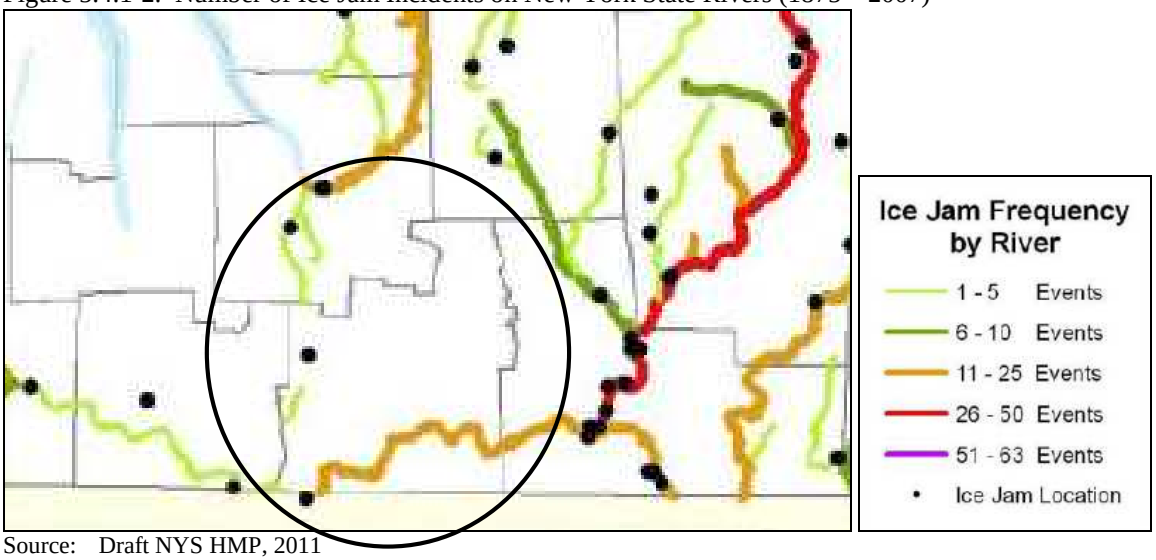
In addition to the sources of flooding noted in the FIS, the County Mitigation Planning committee noted additional flooding sources which include Catatonk Creek, Wappasening Creek, Pipe and Cayuta Creek.

**Ice Jam Hazard Areas**

Ice jams are common in the Northeast U.S. and New York is not an exception. In fact, according to the USACE, New York State ranks second in the U.S. for total number of ice jam events, with over 1,500

incidents documented between 1867 and 2010. Areas of New York State that include characteristics lending to ice jam flooding include the northern counties of the Finger Lakes region and far western New York, the Mohawk Valley of central and eastern New York State and the North Country (Draft NYS HMP, 2011Figure 5.4.1-2 presents the number of ice jam incidences within the vicinity of Tioga County between 1780 and 2010.

Figure 5.4.1-2. Number of Ice Jam Incidents on New York State Rivers (1875 – 2007)




Source: Draft NYS HMP, 2011
Note (1): Circle indicates location of Tioga County
Note (2): This map displays the number of instances a river was referenced as being the location for an ice jam in the USACE Cold Regions Research and Engineering Laboratory (CRREL) database.
Note (3): Multiple instances of ice jams can be associated to a single point location.

The Ice Jam Database, maintained by the Ice Engineering Group at the USACE Cold Regions Research and Engineering Laboratory (CRREL), currently consists of over 18,000 records from across the U.S. According to the USACE-CRREL, Tioga County experienced three historic ice jam events between 1875 and 2011 (Ice Engineering Research Group, 2012). Historical events are further mentioned in the "Previous Occurrences" section of this hazard profile.

**Dam Break Hazard Area**

According to the NYSDEC Division of Water Bureau of Flood Protection and Dam Safety, the hazard classification of a dam is assigned according to the potential impacts of a dam failure pursuant to 6 NYCRR Part 673.3. Dams are classified in terms of potential for downstream damage if the dam were to fail. These hazard classifications are identified and defined below:

- *Low Hazard (Class A)* is a dam located in an area where failure will damage nothing more than isolated buildings, undeveloped lands, or township or county roads and/or will cause no significant economic loss or serious environmental damage. Failure or misoperation would result in no probable loss of human life. Losses are principally limited to the owner's property
- *Intermediate Hazard (Class B)* is a dam located in an area where failure may damage isolated homes, main highways, minor railroads, interrupt the use of relatively important public utilities, and/or will cause significant economic loss or serious environmental damage. Failure or misoperation would result in no probable loss of human life, but can cause economic loss, environment damage, disruption of lifeline facilities, or impact other concerns. Significant hazard

potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

- *High Hazard (Class C)* is a dam located in an area where failure may cause loss of human life, serious damage to homes, industrial or commercial buildings, important public utilities, main highways or railroads and/or will cause extensive economic loss. This is a downstream hazard classification for dams in which more than 6 lives would be in jeopardy and excessive economic loss (urban area including extensive community, industry, agriculture, or outstanding natural resources) would occur as a direct result of dam failure (NYSDEC, Date Unknown).

Refer to Table 4-X and Figure 4-X in the County Profile (Section 4) for dams located in Tioga County.

### Previous Occurrences and Losses

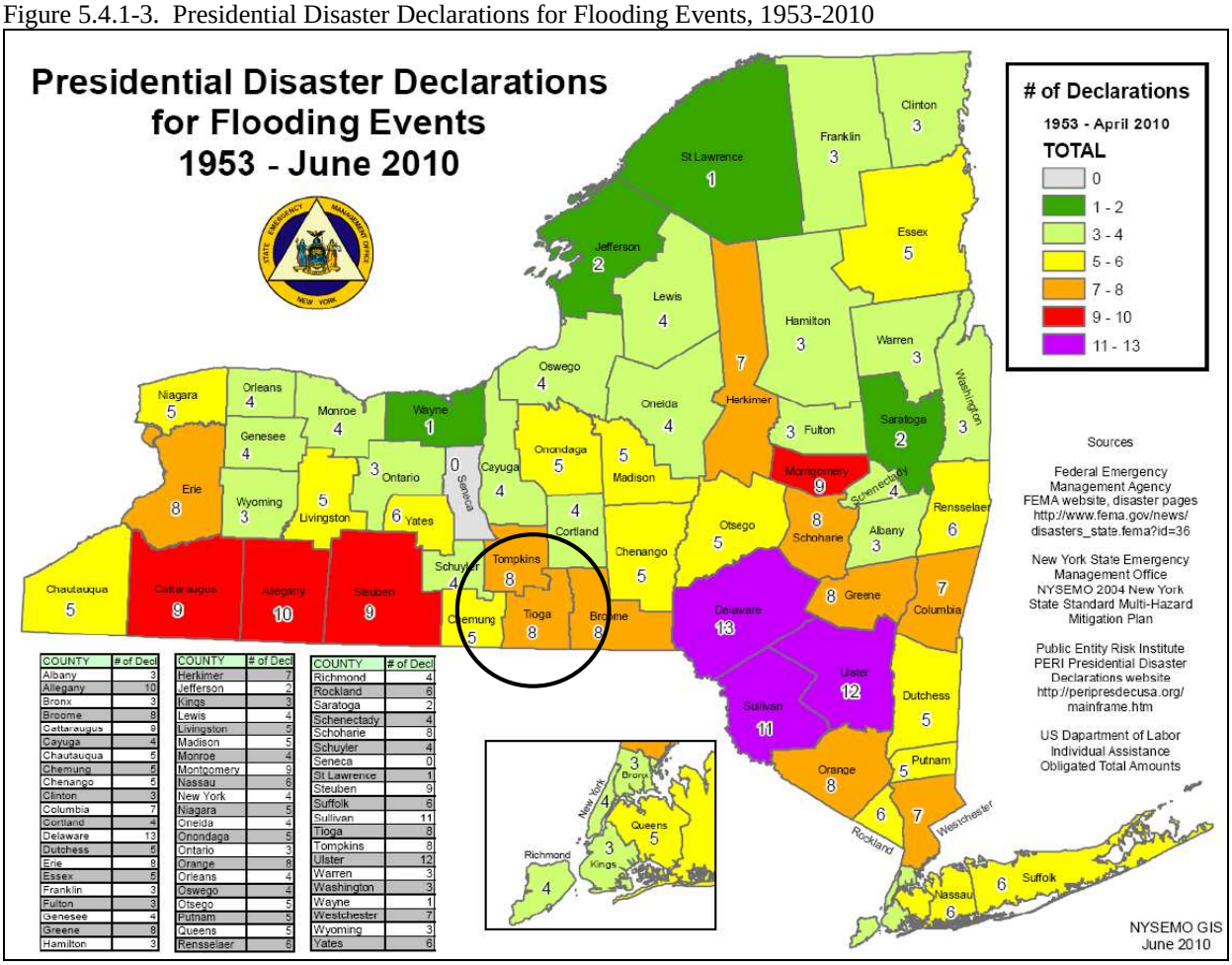
Many sources provided historical information regarding previous occurrences and losses associated with flooding events throughout New York State and Tioga County. With so many sources reviewed for the purpose of this HMP, loss and impact information for many events could vary depending on the source. Therefore, the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP.

According to NOAA's NCDC storm events database, Tioga County experienced 51 flood events between 1950 and April 2012. Total property damages, as a result of these flood events, were estimated at $608.7 million; however, the estimate only includes damages identified in the database and the total may not agree with specific event information presented later in this plan. According to the Hazard Research Lab at the University of South Carolina's Spatial Hazard Events and Losses Database for the U.S. (SHELDUS), between 1960 and 2010, 57 flood events occurred within the County. The database indicated that flood events and losses specifically associated with Tioga County and its municipalities totaled over $119.2 million in property damage and over $818,000 in crop damage. However, these numbers may vary due to the database identifying the location of the hazard event in various forms or throughout multiple counties or regions.

Between 1954 and 2012, FEMA declared that New York State experienced 40 flood-related disasters (DR) or emergencies (EM) classified as one or a combination of the following disaster types: severe storms, coastal storms, flash flooding, heavy rain, tropical storm, hurricane, high winds, ice jam, wave action, high tide 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 other sources indicate that Tioga County has been declared as a disaster area as a result of eight flood events (FEMA, 2011).

Figure 5.4.1-3 shows the FEMA disaster declarations (DR) for flooding events in New York State, from 1953 to June 2010. This figure indicates that Tioga County was included in eight disaster declarations. Since the date of this figure, Tioga County has not been included in any additional FEMA disaster declarations for flooding.

Figure 5.4.1-3. Presidential Disaster Declarations for Flooding Events, 1953-2010




| COUNTY | # of Decl |
|---|---|
| Albany | 3 |
| Allegany | 10 |
| Bronx | 3 |
| Broome | 8 |
| Cattaraugus | 9 |
| Cayuga | 4 |
| Chautauqua | 5 |
| Chemung | 5 |
| Chenango | 5 |
| Clinton | 3 |
| Columbia | 7 |
| Cortland | 4 |
| Delaware | 13 |
| Dutchess | 5 |
| Erie | 8 |
| Essex | 5 |
| Franklin | 3 |
| Fulton | 3 |
| Genesee | 4 |
| Greene | 8 |
| Hamilton | 3 |

| COUNTY | # of Decl |
|---|---|
| Herkimer | 7 |
| Jefferson | 2 |
| Kings | 3 |
| Lewis | 4 |
| Livingston | 5 |
| Madison | 5 |
| Monroe | 4 |
| Montgomery | 9 |
| Nassau | 6 |
| New York | 4 |
| Niagara | 5 |
| Oneida | 4 |
| Onondaga | 5 |
| Ontario | 3 |
| Orange | 8 |
| Orleans | 4 |
| Oswego | 4 |
| Otsego | 5 |
| Putnam | 5 |
| Queens | 5 |
| Rensselaer | 6 |

| COUNTY | # of Decl |
|---|---|
| Richmond | 4 |
| Rockland | 6 |
| Saratoga | 2 |
| Schenectady | 4 |
| Schoharie | 8 |
| Schuyler | 4 |
| Seneca | 0 |
| St Lawrence | 1 |
| Steuben | 9 |
| Suffolk | 6 |
| Sullivan | 11 |
| Tioga | 8 |
| Tompkins | 8 |
| Ulster | 12 |
| Warren | 3 |
| Washington | 3 |
| Wayne | 1 |
| Westchester | 7 |
| Wyoming | 3 |
| Yates | 6 |

Source: Draft NYS HMP, 2011

Note: The black circle indicates the approximate location of Tioga County.

Based on all sources researched, known flooding events that have affected Tioga County and its municipalities are identified in Table 5.4.1-1. With flood documentation for New York State being so extensive, not all sources have been identified or researched. Therefore, Table 5.4.1-1 may not include all events that have occurred throughout the County and region.

Table 5.4.1-1. Flooding Events Between 1950 and 2012

| Dates of Event | Event Type | FEMA Declaration Number | County Designated? | Losses / Impacts | Source(s) |
|---|---|---|---|---|---|
| October 1954 | Hurricane Hazel | | | Heavy rain from Hurricane Hazel caused some minor flooding in the County. | Tioga County HMP |
| August 1955 | Hurricane Diane | | | Heavy rain from Hurricane Diane caused some minor flooding in the County. | Tioga County HMP |
| April 6, 1964 | Flooding | | | Heavy spring runoff caused the Susquehanna River to overflow its banks in the County. | Tioga County HMP |
| June 20-25, 1972 | Hurricane Agnes (flooding) | DR-338 | Yes | The waterways within the County overflowed their banks, causing extensive damage to many municipalities. Homes were flooded, roadways flooded and/or washed out, bridges were damaged/destroyed, streambanks were eroded, and landslides occurred.<br><br>In the Catatonk Creek watershed, the Town and Village of Spencer experienced flooding of 15 homes and commercial structures, road wash-outs, and severe stream bank erosion. The Willseyville Creek and Prospect Creek had severe streambank erosion and road washouts along Prospect Creek. In the Village of Candor, 30 homes and commercial structures flooded, the high school flooded, and two dams in Catatonk Creek were damaged. In the hamlet of Cataonk, 10 homes were flooded. In the Town of Tioga, homes were flooded and there was streambank erosion.<br><br>In the Owego Creek watershed, the hamlet of Berkshire had 10 homes that were flooded, and Glen Road was washed out in several locations. In the Town of Berkshire, Route 38 and secondary roads south of Berkshire hamlet was flooded and there was streambank erosion. Homes, churches and commercial structures were flooded in the Village of Newark Valley. In the Town of Newark Valley, a bridge washed out and there was flooding. Homes were flooded and Park Settlement Road washed out in several locations in the Town of Owego. Homes were flooded in the Village of Owego.<br><br>Towns and Villages along the Susquehanna River experienced over $19M in damages from this event. | FEMA FIS, SHELDUS, Tioga County HMP |

| Dates of Event | Event Type | FEMA Declaration Number | County Designated? | Losses / Impacts | Source(s) |
|---|---|---|---|---|---|
| March 17-19, 1973 | Flood | N/A | N/A | Heavy rain and flooding caused over $227K in property damage to Tioga County. | SHELDUS |
| September 25-27, 1975 | Severe Storms, Heavy Rain, Landslides, Flooding | DR-487 | Yes | | FEMA |
| July 11-12, 1976 | Severe Storms and Flooding | DR-515 | Yes | | FEMA |
| March 14, 1985 | Flood | N/A | N/A | Flooding caused approximately $1M in property damage and $1K in crop damage to Tioga County. | SHELDUS |
| March 29-31, 1993 | Flood | N/A | N/A | Flooding caused approximately $550K in property damage to Tioga County. | NOAA-NCDC |
| April 1-5, 1993 | Flood | N/A | N/A | Flooding caused approximately $500K in property damage to Tioga County. | SHELDUS, NOAA-NCDC |
| April 10-15, 1993 | Flood | N/A | N/A | Flooding caused approximately $5M in property damage to Tioga County. | SHELDUS, NOAA-NCDC |
| February 22, 1994 | Flash Flood | N/A | N/A | An ice jam along the Chemung River caused water to back up in the Village of Waverly. The County had approximately $50 K in property damage. | NOAA-NCDC |
| August 18, 1994 | Flash Flood (Remnants of Tropical Storm Beryl) | N/A | N/A | Tropical Storm Beryl caused severe damage to the Villages of Waverly and Newark Valley. In Waverly, the village hall was flooded, along with several businesses on Broad Street. In the Village of Newark Valley, water from a small stream flooded Main Street and several homes. Flooding caused approximately $500K in property damage to Tioga County. There was one reported fatality in the County. | SHELDUS, NOAA-NCDC |
| January 19-20, 1996 | Flash Flood | DR-1095 | Yes | This was a flash flood event caused by melting snow and rains which affected all of Tioga County. Damages from this flood event exceeded $7.8M in 12 municipalities and included over $5M in damage to public infrastructure. | SHELDUS, NOAA-NCDC, FEMA, Tioga County HMP |
| December 1-2, 1996 | Flash Flood | N/A | N/A | Flooding caused approximately $20K in property damage to Tioga County. | NOAA-NCDC |
| December 13, 1996 | Flash Flood | N/A | N/A | A slow moving storm system brought heavy rains and small stream flooding to most of Tioga County. The most notable flooding occurred along the West Branch of the Owego Creek | NOAA-NCDC |

| Dates of Event | Event Type | FEMA Declaration Number | County Designated? | Losses / Impacts | Source(s) |
|---|---|---|---|---|---|
| | | | | where roadways were closed due to standing water. The flooding caused $20K in property damage to the County. | |
| July 8, 1998 | Severe Storms and Flooding (flash floods) | DR-1233 | Yes | A batch of TSTMs produced excessive rainfall, with amounts between two and four inches in many areas of the County. The Catatonk Creek, Hoyt Creek and Bliven Creek caused the most significant problems. In the Town of Owego, the bridge that crosses the intersection of Owego and Catatonk Creeks at Route 96 and 38 was closed due to water levels topping the bottom of the bridge. Six bridges were washed out in the Towns of Spencer and Candor. Many roads were closed and water had to be pumped out of the first floor of homes in the Town of Spencer, near Owl Creek. Tioga County had approximately $2.9 M in damages. | NOAA-NCDC, FEMA, Tioga County HMP |
| May 10-11, 2000 | Flash Flood | DR-1355 | Yes | Tioga County had $1.25 M in property damages. | NOAA-NCDC |
| March 2004 | Flood | N/A | N/A | Tioga County had $40 K in property damages. | NYS HMP |
| July 7, 2004 | Flash Flood | N/A | N/A | The Town of Spencer had $150 K in property damages. | NYS HMP, NOAA-NCDC |
| September 16-18, 2004 | Remnants of Hurricane Ivan | DR-1565 | Yes | Heavy rain in the area caused flash flooding. Rainfall totals ranged between two and six inches. Many creeks and streams went out of their banks; the Susquehanna River flooded. The County had approximately $1M in property damage. | NOAA-NCDC |
| March 28, 2005 | Flash Flood | N/A | N/A | In the Town of Owego, State Route 96 was closed due to flooding of the Owego Creek. Several other roads were closed in the hamlets of Berkshire and Tioga Center. One road in the Town of Berkshire was closed due to a mudslide. Overall, the County had approximately $70K in property damage. | NYS HMP, NOAA-NCDC |
| April 2-4, 2005 | Flood | DR-1589 | Yes | Overall, New York State had $66.21 M in damages. All towns and villages in Tioga County were affected by flash flooding. Between one and four inches of rain fell, causing creeks and streams to overflow their banks. Many roads, bridges and buildings were damaged from this event in the County. Tioga County had approximately $500K in property damage. | NYS HMP, NOAA-NCDC, FEMA |
| June 10, 2005 | Flash Flood | N/A | N/A | Slow moving TSTMs brought heavy rain to the County, which caused flash flooding. Roads were flooded and closed in the Towns of Barton, Nichols and Waverly. The County had approximately $20K in property damage. | NYS HMP, NOAA-NCDC |

| Dates of Event | Event Type | FEMA Declaration Number | County Designated? | Losses / Impacts | Source(s) |
|---|---|---|---|---|---|
| October 25, 2005 | Flood | N/A | N/A | The Town of Waverly had $20 K in property damages from a flooding event. | NYS HMP |
| November 30 – December 1, 2005 | Flood | N/A | N/A | The Town of Waverly had $25 K in property damages from a flooding event. | NYS HMP |
| January 18, 2006 | Flood | N/A | N/A | Heavy rainfall caused minor flooding in Tioga County. The Town of Barton had $10 K in property damages from a flooding event. | NYS HMP, NOAA-NCDC |
| June 26-30, 2006 | Tropical Storm Ernesto | DR-1650 | Yes | Flood caused widespread damage throughout the Susquehanna River Basin. Overall, New York State had $246.33 M in damages.<br><br>Tropical moisture entered into south-central New York State, bringing heavy rain and TSTMs to many areas in upstate New York. Total rainfall for this three-day event was up to six inches in Tioga County. Almost every stream and creek overflowed its banks. Flash flooding occurred in the Town of Owego and the Village of Waverly. Numerous roads, bridges, businesses and homes were flooded. A total of 5,000 homes were affected, with 500 homes damaged and 10 destroyed. Hardest hit areas were Tioga, Campville, Owego, Nichols, Barton and Apalachin. The County declared a state of emergency. The Susquehanna at Owego rose above its flood stage of 30 feet. The County had over $105M in property damage. | FEMA FIS, NYS HMP, NOAA-NCDC |
| November 16-17, 2006 | Flash Flood | DR-1670 | Yes | A line of TSTMs produced 45 to 74 mph winds across central NYS. This area experienced heavy rainfall, with amounts of 1.5 to four inches within three hours that caused significant flash flooding. Overall, New York State had $32.59 M in damages.<br><br>In Tioga County, many roads were washed out in the Towns of Owego, Apalachin, and Nichols. The County had approximately $35 K in property damages. | NYS HMP, NOAA-NCDC |
| March 15-16, 2007 | Riverine Flood | N/A | N/A | Heavy rainfall and melting snow caused many rivers and creeks to exceed their flood stages. Rainfall totals in the Susquehanna River Basin ranged between 0.75 inches to 1.5 inches. The Susquehanna River at Conklin crested just above its moderate flood stage of 13 feet. Twenty homes, one business and five roads were flooded. An ice jam was associated with this flood event. | NYS HMP, NOAA-NCDC |

| Dates of Event | Event Type | FEMA Declaration Number | County Designated? | Losses / Impacts | Source(s) |
|---|---|---|---|---|---|
| | | | | In Tioga County, the Town of Barton experienced minor flooding on the Susquehanna River at Waverly/Sayre. The River crested at 14.2 feet, 3.2 feet over the flood state of 11 feet. Over an inch of rain, along with snowmelt, caused minor flooding in the Town. The Town had approximately $5 K in property damage. | |
| March 25-30, 2007 | Riverine Flood | N/A | N/A | Rainfall totals of one-half to one inch, along with warm temperatures and snowmelt, minor flooding occurred along a few rivers. River levels were close to or slightly above flood stage along the Susquehanna River from the Town of Waverly east through the City of Binghamton.<br><br>In Tioga County, the Town of Barton experienced minor flooding on the Susquehanna River. The River at Waverly/Sayre crested at 11.1 feet. | NOAA-NCDC |
| September 30 – October 1, 2010 | Flash Flooding (Remnants of Tropical Storm Nicole) | N/A | N/A | Remnants of Tropical Storm Nicole brought between three to six inches of rain across central NYS. The rain caused flash floods and minor flooding along the main stem rivers.<br><br>In Tioga County, the heavy rain caused flash flooding in the Town of Newark Valley. The most serious flooding occurred where water and debris flowed downhill across Rock Street to Irishtown Road. Both roads were closed. Water continued across Route 38 in the Village of Newark Valley. Homes flooded along Mill and Clinton Streets. The Owego Creek flooded the Trout Pounds recreation area. Flash flooding occurred along Route 388 in the Town of Newark Valley due to a mudslide. In the Village of Owego, several roads were flooded. Overall, the County had approximately $75 K in property damage. | NOAA-NCDC |
| April 27-28, 2011 | Flash Flooding | DR-1993 | Yes | A severe weather outbreak brought heavy rain, flash floods and tornadoes to central New York State. In Tioga County, major flash flooding occurred in several areas of the County, especially along State Route 38 corridor. In the Town of Newark Valley, the storms impacted 50 homes, washed out roads and caused road closures. In the Town of Owego, damages included roads, five major stream crossings, ditches, culverts and road closures. The County had approximately $3 M in property damages. | NOAA-NCDC, FEMA |
| September 7-12, 2011 | Flooding (Tropical Storm Lee) | DR-4031 | Yes | The remnants of Tropical Storm Lee moved into the Appalachians, bringing between six and 12 inches over most of the Susquehanna River Basin. The heavy rain caused record | NOAA-NCDC |

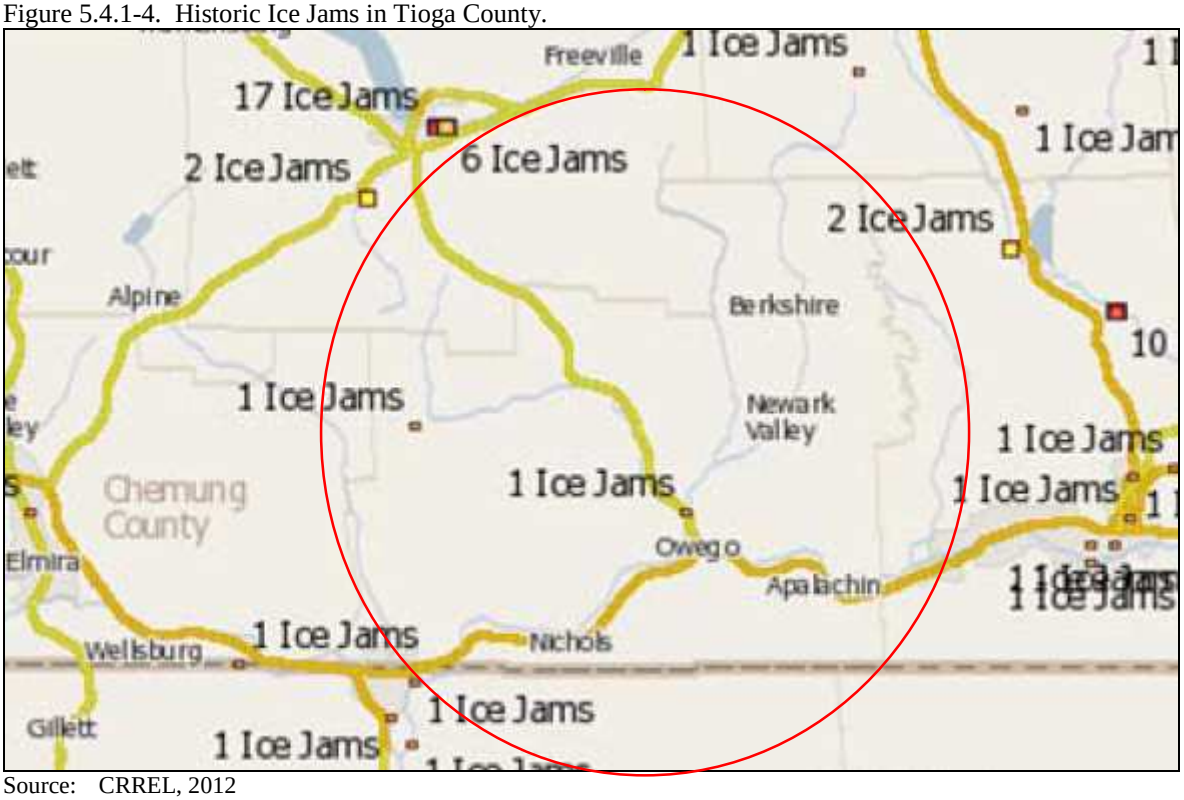
| Dates of Event | Event Type | FEMA Declaration Number | County Designated? | Losses / Impacts | Source(s) |
|---|---|---|---|---|---|
| | | | | breaking flooding on small streams, creeks and the River. The River crested from one to four feet higher than the previous record crests from June 2006.<br><br>In Tioga County, record flooding occurred along the Susquehanna River near the Town of Waverly where it crested at 26.67 feet. In the Town of Owego, the River crested at 39.62 feet. The County had over $477 M in property damages. | |

Note (1): 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 increased U.S. Inflation Rates.

| | |
|---|---|
| Cfs | Cubic feet per second |
| DR | Federal Disaster Declaration |
| EM | Federal Emergency Declaration |
| FEMA | Federal Emergency Management Agency |
| FSA | Farm Service Agency |
| HMP | Hazard Mitigation Plan |
| IA | Individual Assistance |
| K | Thousand ($) |
| M | Million ($) |
| N/A | Not applicable |
| NCDC | National Climate Data Center |
| NOAA | National Oceanic Atmospheric Administration |
| NWS | National Weather Service |
| NYS | New York State |
| PA | Public Assistance |
| SHELDUS | Spatial Hazard Events and Losses Database for the U.S. |
| TSTM | Thunderstorm |

According to the CRREL database, ice jams have historically formed at various points along Dean Creek, Owego Creek and the Susquehanna River (Ice Engineering Research Group, 2012). Locations of historical ice jam events are indicated in Figure 5.4.1-4 below.

Figure 5.4.1-4. Historic Ice Jams in Tioga County.




Source: CRREL, 2012
Note: Tioga County has experiend three ice jams between 1780 and 2012.

Based on review of the CRREL Database, Table 5.4.1-2 lists the ice jam events that have occurred in Tioga County between 1780 and 2012. Information regarding losses associated with these reported ice jams was limited.

Table 5.4.1-2. Ice Jam Events in Tioga County between 1900 and 2011

| Event Date | River / Location | Description | Source(s) |
|---|---|---|---|
| January 22, 1959 | Town of Spencer / Dean Creek | Gage height of 4.80 feet; affected by backwater from ice. Discharge 290 cfs. | CRREL |
| January 19, 1996 | Town of Owego / Owego Creek | Maximum gage height of 11.66 feet due to an ice jam at USGS gaging station near the Town of Owego. | CREEL |
| March 6, 2007 | Village of Waverly / Susquehanna River | Due to an ice jam, the stage of the Susquehanna River at Waverly was fluctuating between eight and 10 feet. The ice jam released as a result of heavy rain and snowmelt. | CRREL |

Source: CRREL, 2012
Note: Although many events were reported for Tioga County, information pertaining to every event was not easily ascertainable; therefore this table may not represent all ice jams in the County.

### National Flood Insurance Program

The U.S. Congress established the NFIP with the passage of the National Flood Insurance Act of 1968 (FEMA's 2002 *National Flood Insurance Program (NFIP): Program Description*). The NFIP is a Federal program enabling property owners in participating communities to purchase insurance as a protection against flood losses in exchange for State and community floodplain management regulations that reduce future flood damages. As stated in the NYS HMP, the NFIP collects and stores a vast quantity of information on insured structures, including the number and location of flood insurance policies, number of claims per insured property, dollar value of each claim and aggregate value of claims, repetitive flood loss properties, etc. NFIP data presents a strong indication of the location of flood events among other indicators (NYSDPC, 2008).

There are three components to NFIP: flood insurance, floodplain management and flood hazard mapping. Nearly 20,000 communities across the U.S. and its territories participate in the NFIP by adopting and enforcing floodplain management ordinances to reduce future flood damage. In exchange, the NFIP makes federally backed flood insurance available to homeowners, renters, and business owners in these communities. Community participation in the NFIP is voluntary. Flood insurance is designed to provide an alternative to disaster assistance to reduce the escalating costs of repairing damage to buildings and their contents caused by floods. Flood damage is reduced by nearly $1 billion a year through communities implementing sound floodplain management requirements and property owners purchasing of flood insurance. Additionally, buildings constructed in compliance with NFIP building standards suffer approximately 80 percent less damage annually than those not built in compliance (FEMA, 2008).

NFIP data for Tioga County is presented further in Table 5.4.1-13 in the Vulnerability Assessment section of this profile.

As an additional component of NFIP, the CRS is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. As a result, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from the community actions meeting the three goals of the CRS: (1) reduce flood losses; (2) facilitate accurate insurance rating; and (3) promote the awareness of flood insurance (FEMA, 2007). According to FEMA, none of the jurisdictions within the County participate in the CRS; therefore specific repetitive loss areas other than those identified by FEMA are not available for Tioga County (FEMA, 2011).

### Probability of Future Events

Given the history of flood events that have impacted Tioga County, it is apparent that future flooding of varying degrees will occur. The fact that the elements required for flooding exist and that major flooding has occurred throughout the county in the past suggests that many people and properties are at risk from the flood hazard in the future.

In addition to riverine flooding, ice jams frequently occur in New York State, and Tioga County is no exception. According to the New York State HMP, New York State is ranked as the second highest state with the highest number of ice jam events compared to the remainder of the U.S. (NYSHMP, 2011 – need proper reference). Please refer to the Vulnerability Assessment for a complete discussion of vulnerable population, facilities, utilities and infrastructure in Tioga County.

It is estimated that Tioga County will continue to experience direct and indirect impacts of floods annually. Table 5.4.1-3 summarizes the occurrences of flood events and their annual occurrence (on average).

Table 5.4.1-3. Occurrences of Flood Events in Tioga County, 1950 - 2011

| Event Type | Total Number of Occurrences | Annual Number of Events (average) |
|---|---|---|
| Flash Flood | 28 | 2.2 |
| Flood | 15 | 0.2 |
| **Total:** | **43** | **1.4** |

Source: NOAA-NCDC, 2011
Note: On average, Tioga County experiences 1.4 flood events each year.

In Section 5.3, the identified hazards of concern for Tioga County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for flood in the County is considered 'Frequent' (likely to occur within 25 years, as presented in Table 5.3-6).

**The Role of Global Climate Change on Future Probability**

Climate change is beginning to affect both people and resources in New York State, and these impacts are projected to continue growing. Impacts related to increasing temperatures and sea level rise are already being felt in the State. ClimAID: the Integrated Assessment for Effective Climate Change in New York State (ClimAID) was undertaken to provide decision-makers with information on the State's vulnerability to climate change and to facilitate the development of adaptation strategies informed by both local experience and scientific knowledge (New York State Energy Research and Development Authority [NYSERDA], 2011).

Each region in New York State, as defined by ClimAID, has attributes that will be affected by climate change. Tioga County is part of Region 3, Southern Tier. Some of the issues in this region, affected by climate change, include: dairy dominates the agricultural economy and milk production losses are projected, Susquehanna River flooding increases, and this region is one of the first parts of the State hti by invasive insects, weeds and other pests moving north (NYSERDA, 2011).

Temperatures are expected to increase throughout the state, by 1.5 to 3ºF by the 2020s, 3.5 to 5.5ºF by the 2050s and 4.5 to 8.5ºF by the 2080s. The lower ends of these ranges are for lower greenhouse gas emissions scenarios and the higher ends for higher emissions scenarios. Annual average precipitation is projected to increase by up to five-percent by the 2020s, up to 10-percent by the 2050s and up to 15-percent by the 2080s. During the winter months is when this 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. Table 5.4.1-4 displays the projected seasonal precipitation change for the Southern Tier ClimAID Region (NYSERDA, 2011).

Table 5.4.1-4. Projected Seasonal Precipitation Change in Region 3, 2050s (% change)

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

Source: NYSERDA, 2011

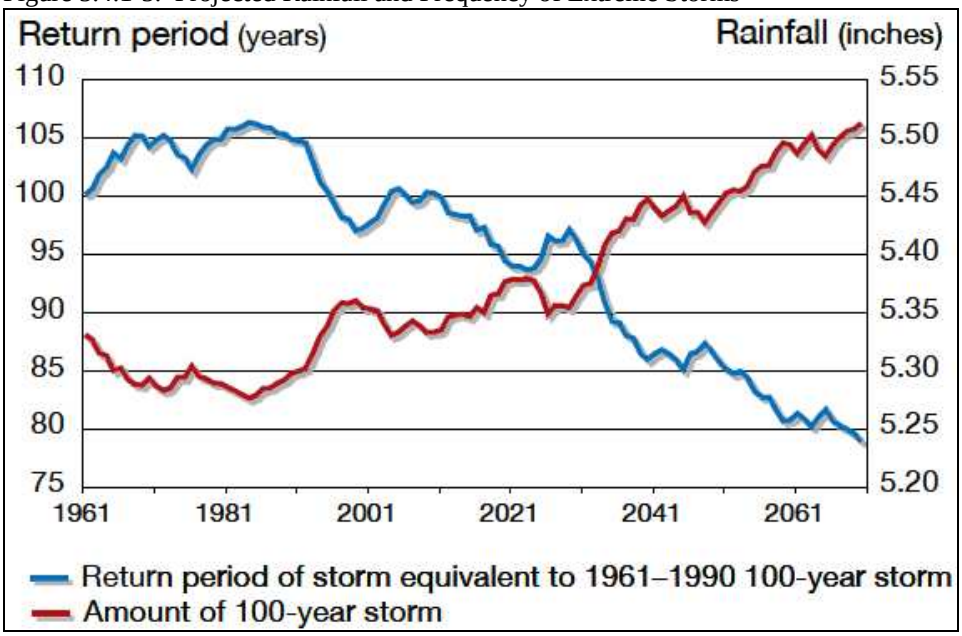
The projected increase in precipitation is expected to fall in heavy downpours and less in light rains. The increase in heavy downpours has the potential to affect drinking water; heighten the risk of riverine flooding; flood key rail lines, roadways and transportation hugs; and increase delays and hazards related to extreme weather events (NYSERDA, 2011).

Increasing air temperatures intensify the water cycle by increasing evaporation and precipitation. This can cause an increase in rain totals during events with longer dry periods in between those events. These changes can have a variety of effects on the State's water resources (NYSERDA, 2011).

Over the past 50 years, heavy downpours have increased and this trend is projected to continue. This can cause an increase in 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 (NYSERDA, 2011).

Figure 5.4.1-5 displays the project rainfall and frequency of extreme storms in New York State. The amount of rain fall in a 100-year event is projected to increase, while the number of years between such storms (return period) is projected to decrease. Rainstorms will become more severe and more frequent (NYSERDA, 2011).

Figure 5.4.1-5. Projected Rainfall and Frequency of Extreme Storms




Source: NYSERDA, 2011

Total precipitation amounts have slightly increased in the Northeast U.S., by approximately 3.3 inches over the last 100 years. There has also been an increase in the number of two-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 (DeGaetano et al [Cornell University], 2010).

## VULNERABILITY ASSESSMENT

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. For the flood hazard, areas identified as hazard areas include the 100- and 500-year floodplains. The following text evaluates and estimates the potential impact of flooding in Tioga County including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact, including: (1) impact on life, safety and health, (2) general building stock, (3) critical facilities and infrastructure, (4) economy and (5) future growth and development
- Further data collections that will assist understanding of this hazard over time
- Overall vulnerability conclusion

### Overview of Vulnerability

All types of flooding can cause widespread damage throughout rural and urban areas, including but not limited to: water-related damage to the interior and exterior of buildings; destruction of electrical and other expensive and difficult-to-replace equipment; injury and loss of life; proliferation of disease vectors; disruption of utilities, including water, sewer, electricity, communications networks and facilities; loss of agricultural crops and livestock; placement of stress on emergency response and healthcare facilities and personnel; loss of productivity; and displacement of persons from homes and places of employment (Foster, Date Unknown).

The flood hazard is a concern for Tioga County. To assess vulnerability, potential losses were calculated for the County for riverine flooding for 100-year and 500-year MRP flood events. Historic loss data associated with ice jam events and dam failures is limited. Flooding, impacts and losses associated with ice jam and dam failure events are similar to flash flooding events. The flood hazard exposure and loss estimate analysis is presented below.

### Data and Methodology

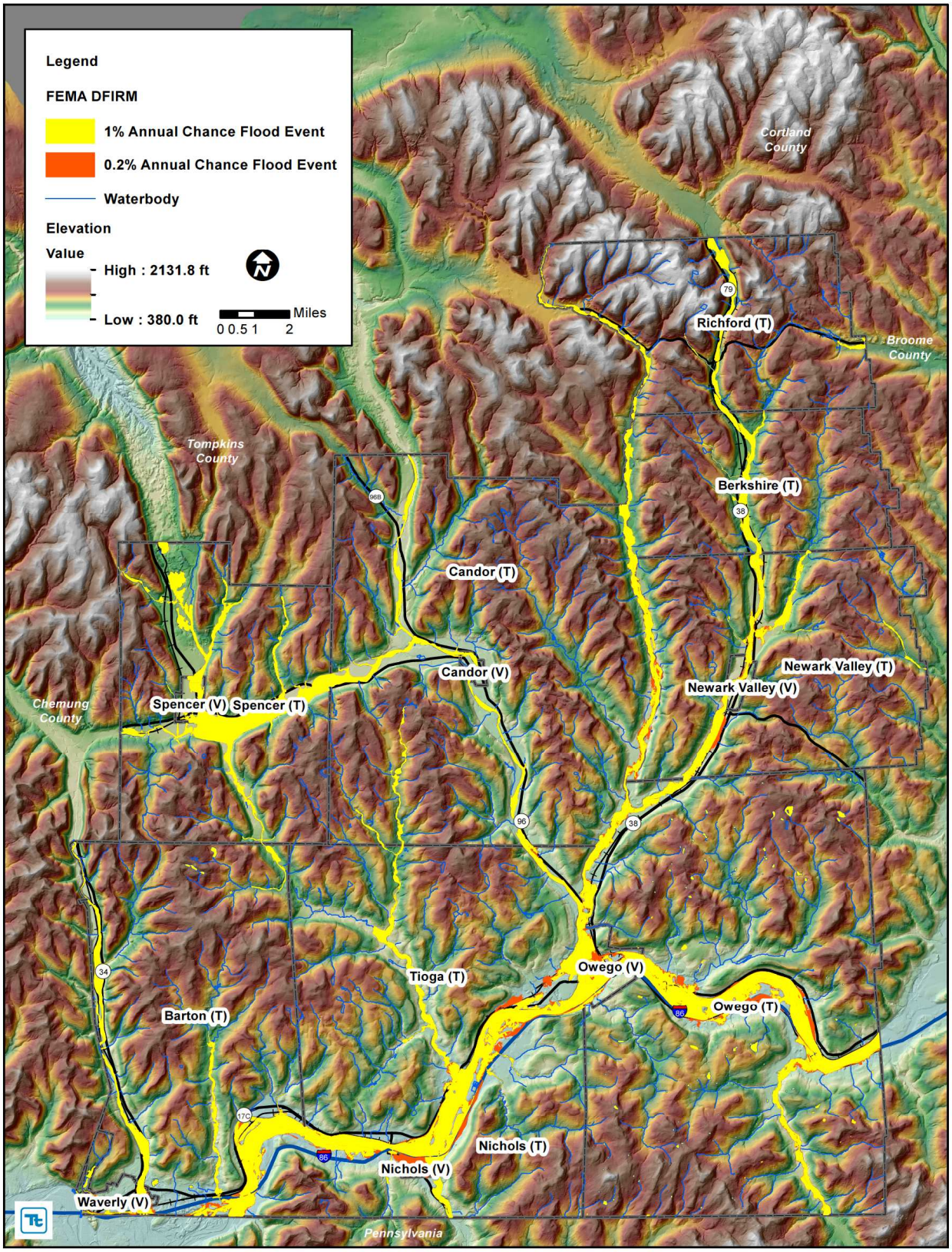
The 100- and 500-year MRP flood events were examined to evaluate the County's vulnerability to the flood hazard. These MRP flood events are generally those considered by planners and evaluated under federal programs such as the NFIP.

A modified Level 1 HAZUS-MH analysis was performed to analyze the risk and vulnerability to Tioga County. The model uses 2000 U.S. Census data at the block level and default general building stock data (RSMeans 2006), which has a level of accuracy acceptable for planning purposes. Where possible, the HAZUS-MH default data was enhanced using local GIS data from the county, state and federal sources and updated 2010 U.S. Census data was used for the exposure analysis.

The hydrology and hydraulics for the selected river reaches in the County was run in HAZUS and the flood-depth grid and flood boundary for the specified return periods (100- and 500-year mean return period [MRP]) were generated. At the time the flood analysis was conducted for this Plan, the Tioga County DFIRMs were still considered preliminary. The final effective DFIRM date is April 17, 2012 (FEMA, 2012). These preliminary DFIRMs were used as part of Tioga County's flood vulnerability assessment. To estimate exposure, the preliminary DFIRM flood boundaries were used. HAZUS-MH 2.0 calculated the estimated damages to the general building stock and critical facilities based on the

depth grid generated and the default HAZUS damage functions in the flood model. Figure 5.4.1-6 illustrates Tioga County's DFIRM boundaries used for this vulnerability assessment.

Figure 5.4.1-6. FEMA DFIRM Flood Boundaries for Tioga County




Source: FEMA preliminary DFIRMs from Tioga County (2012)

### Impact on Life, Health and Safety

The impact of flooding on life, health and safety is dependent upon several factors including the severity of the event and whether or not adequate warning time is provided to residents. Exposure represents the population living in or near floodplain areas that could be impacted should a flood event occur. Additionally, exposure should not be limited to only those who reside in a defined hazard zone, but everyone who may be affected by the effects of a hazard event (e.g., people are at risk while traveling in flooded areas, or their access to emergency services is compromised during an event). The degree of that impact will vary and is not measurable.

To estimate the population exposed to the 100- and 500-year flood events, the FEMA DFIRM floodplain boundaries were overlaid upon the 2010 Census population data in GIS (U.S. Census 2010). Census blocks do not follow the boundaries of the floodplain. The Census blocks with their centroid in the flood boundaries were used to calculate the estimated population exposed to this hazard. Using this approach, it is estimated that 6,107 people are within the 100-year floodplain or 11.3% of the total County population and 7,276 people are within the 500-year floodplain (13.5% of the total County population of 53,954 people). Table 5.4.1-5 lists the estimated population located within the 100- and 500-year flood zones by municipality.

Table 5.4.1-5. Estimated Tioga County Population Vulnerable to the 100-Year and 500-Year MRP Flood Hazard

| Municipality | Population in 100- Year Flood Boundary | Percent Population (Census 2010) | Population in 500-Year Flood Boundary | Percent Population (Census 2010) |
|---|---|---|---|---|
| Barton (T) | 440 | 9.6% | 452 | 9.8% |
| Berkshire (T) | 118 | 7.5% | 118 | 7.5% |
| Candor (T) | 238 | 5.3% | 253 | 5.6% |
| Candor (V) | 111 | 13.0% | 111 | 13.0% |
| Newark Valley (T) | 331 | 10.1% | 372 | 11.4% |
| Newark Valley (V) | 95 | 9.5% | 120 | 12.1% |
| Nichols (T) | 212 | 11.0% | 251 | 13.0% |
| Nichols (V) | 0 | 0.0% | 357 | 69.7% |
| Owego (T) | 980 | 5.6% | 1,148 | 6.5% |
| Owego (V) | 1,974 | 50.7% | 2,334 | 59.9% |
| Richford (T) | 99 | 6.0% | 99 | 6.0% |
| Spencer (T) | 386 | 15.9% | 386 | 15.9% |
| Spencer (V) | 328 | 43.2% | 328 | 43.2% |
| Tioga (T) | 583 | 12.0% | 645 | 13.2% |
| Waverly (V) | 212 | 4.8% | 302 | 6.8% |
| **Tioga County** | **6,107** | **11.3%** | **7,276** | **13.5%** |

Source: Census, 2010; FEMA, 2011
Note: T = Town; V = Village; % = percent

Of the population exposed, the most vulnerable include the economically disadvantaged and the population over the age of 65. Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions to evacuate based on the net economic impact to their family. The population over the age of 65 is also more vulnerable because they are more likely to seek or need medical attention which may not be available to due isolation during a flood event and they may have more difficulty evacuating.

HAZUS-MH 2.0 estimates the potential sheltering needs as a result of a 100- and 500-year MRP flood events. For the 100-year event, HAZUS-MH 2.0 estimates 4,877 people will be displaced and 1,994 people will seek short-term sheltering, representing 9.4% and 3.9% of the County population, respectively. For the 500-year event, HAZUS-MH 2.0 estimates 5,333 people will be displaced and 2,322 people will seek short-term sheltering, representing 9.9% and 4.3% of the County population, respectively. Refer to Table 5.4.1-6.

The total number of injuries and casualties resulting from flooding is generally limited based on advance weather forecasting, blockades and warnings. Therefore, injuries and deaths generally are not anticipated if proper warning and precautions are in place. Ongoing mitigation efforts should help to avoid the most likely cause of injury, which results from persons trying to cross flooded roadways or channels during a flood.

Table 5.4.1-6 Estimated Tioga County Population Displaced or Seeking Short-Term Shelter from the 100-Year and 500-Year MRP Events

| Municipality | 100 Year | | | | 500 Year | | | |
|---|---|---|---|---|---|---|---|---|
| | Displaced Persons | Percent Displaced | Persons Seeking Short-Term Sheltering | Percent Seeking Shelter | Displaced Persons | Percent Displaced | Persons Seeking Short-Term Sheltering | Percent Seeking Shelter |
| Barton (T) | 460 | 10.0% | 158 | 3.4% | 519 | 11.3% | 191 | 4.2% |
| Berkshire (T) | 206 | 13.0% | 45 | 2.8% | 236 | 14.9% | 57 | 3.6% |
| Candor (T) | 658 | 14.5% | 202 | 4.5% | 692 | 15.3% | 235 | 4.9% |
| Candor (V) | 247 | 29.0% | 161 | 18.9% | 320 | 37.6% | 223 | 26.2% |
| Newark Valley (T) | 236 | 7.2% | 41 | 1.3% | 256 | 7.8% | 57 | 1.7% |
| Newark Valley (V) | 119 | 12.0% | 40 | 4.0% | 146 | 14.7% | 54 | 5.4% |
| Nichols (T) | 268 | 13.9% | 117 | 6.1% | 338 | 17.5% | 154 | 8.0% |
| Nichols (V) | 28 | 5.5% | 4 | 0.8% | 42 | 8.2% | 10 | 2.0% |
| Owego (T) | 779 | 4.4% | 323 | 1.8% | 780 | 4.4% | 331 | 1.9% |
| Owego (V) | 439 | 11.3% | 361 | 9.3% | 488 | 12.5% | 419 | 10.8% |
| Richford (T) | 175 | 10.6% | 30 | 1.8% | 189 | 11.5% | 33 | 2.0% |
| Spencer (T) | 328 | 13.5% | 123 | 5.1% | 343 | 14.1% | 126 | 5.2% |
| Spencer (V) | 201 | 26.4% | 75 | 9.9% | 222 | 29.2% | 87 | 11.4% |
| Tioga (T) | 524 | 10.8% | 213 | 4.4% | 578 | 11.9% | 245 | 5.0% |
| Waverly (V) | 209 | 4.7% | 101 | 2.3% | 184 | 4.1% | 100 | 2.3% |
| **Tioga County** | **4877** | **9.0%** | **1994** | **3.7%** | **5333** | **9.9%** | **2322** | **4.3%** |

Source: HAZUS-MH 2.0 (Census 2000)
Note: T = Town; V = Village; % = percent

### Impact on General Building Stock

After considering the population exposed to the flood hazard, developed land, the HAZUS-MH 2.0 default value of general building stock exposed to, and damaged by, the 100- and 500-year MRP flood events was evaluated. Exposure in the flood zone includes those buildings located in the flood zone. Potential damage is the modeled loss that could occur to the exposed inventory, including structural and content value.

To provide a general estimate of number of properties and structural/content replacement value exposure, the preliminary FEMA DFIRM flood boundaries, the parcel GIS and assessment files from Tioga County and HAZUS-MH 2.0 general building stock inventory were used. The FEMA preliminary DFIRM 100- and 500-year flood zones were overlaid upon the County parcel layer provided for each municipality. The polygons that intersect the 100- and 500-year flood zones were totaled for each municipality to approximate the number of properties and assessed values (total, building and land) located in the flood zone. Although it is unknown where on each parcel/property a structure may/may not be located, a portion of each property is within the flood zone and is inundated by flood waters.

The HAZUS-MH 2.0 Census blocks that intersect the FEMA preliminary DFIRM flood zones were also used to estimate the building replacement cost value exposed to this hazard (Table 5.4.1-7).

In summary, there are approximately 32 and 35 square miles of land in Tioga County located in the preliminary DFIRM 100-year and 500-year floodplains, respectively. Nearly four miles (or 6-percent) of this land is developed land and located within the 100-year preliminary DFIRM flood zone and approximately 25 miles (or nearly 7-percent) of this land is developed and located within the 500-year preliminary DFIRM flood zone and thus exposed to the flood hazard (FEMA, 2012; USGS, 2011). Refer to Table 5.4.1-8 below.

There are greater than 5,000 parcels and greater than $527 Million in total assessed value (building and land) exposed to the 100-year flood. In addition, there are an estimated 5,875 properties and nearly $575 Million in total assessed value exposed to the 500-year flood. For more detailed information per municipality, please refer to Tables 5.4.1-9 and 5.4.1-10 below.

According to the HAZUS Census block analysis (blocks that intersect the flood zones), there is approximately $3.2 billion of building/contents exposed to the 100-year flood in Tioga County. This represents approximately 60-percent of the County's total general building stock replacement value inventory (approximately $5.3 billion; see Section 4). For the 500-year event, it is estimated there is nearly $3.4 billion of buildings/contents exposed in Tioga County or approximately 64-percent (Table 5.4.1-11).

HAZUS-MH 2.0 estimates the potential damage to the general building stock inventory associated with the 100-year flood is approximately $110 million or 2.1-percent of the County's general building stock inventory. For the 500-year event, the HAZUS-MH 2.0 potential damage estimate is approximately $140 million (structure and contents) or 2.6-percent of the County's general building stock inventory. HAZUS-MH damage assessments for Tioga County are displayed in Table 5.4.1-12.

Table 5.4.1-7. Land Use (2006) in the 100- and 500-year FEMA Preliminary DFIRM Flood Boundaries

| Land Use | Total Area (sq. mi.) | 100-Year | | 500-Year | |
|---|---|---|---|---|---|
| | | Area (sq. mi.) | Percent of Total Area | Area (sq. mi.) | Percent of Total Area |
| Barren | 0.45 | 0.09 | 20.0% | 0.11 | 24.4% |
| Developed | 28.66 | 3.77 | 13.2% | 5.03 | 17.6% |
| Farmland | 151.75 | 13.14 | 8.7% | 14.23 | 9.4% |
| Forested | 327.98 | 8.69 | 2.6% | 9.44 | 2.9% |
| Open Water | 4.39 | 3.43 | 78.1% | 3.47 | 79.0% |
| Wetlands | 9.19 | 2.71 | 29.5% | 2.79 | 30.4% |
| **Total** | **522.42** | **31.83** | **6.1%** | **35.07** | **6.7%** |

Source: FEMA, 2012; USGS, 2011 (2006 National Land Cover Database)
Note: sq. mi. = square miles

Table 5.4.1-8. Area Located in the 100- and 500-year FEMA Preliminary DFIRM Flood Boundaries

| Municipality | Total Area (sq. mi.) | Area Exposed (sq. miles) | | Percent of Total Area | |
|---|---|---|---|---|---|
| | | 100 Year | 500 Year | 100 Year | 500 Year |
| Barton (T) | 57.5 | 2.85 | 3.03 | 5.0% | 5.3% |
| Berkshire (T) | 30.5 | 1.32 | 1.32 | 4.3% | 4.3% |
| Candor (T) | 94.5 | 3.00 | 3.13 | 3.2% | 3.3% |
| Candor (V) | 0.5 | 0.09 | 0.09 | 18.0% | 18.0% |
| Newark Valley (T) | 49.6 | 2.08 | 2.37 | 4.2% | 4.8% |
| Newark Valley (V) | 1.0 | 0.18 | 0.20 | 18.0% | 20.0% |
| Nichols (T) | 34.0 | 4.05 | 4.65 | 11.9% | 13.7% |
| Nichols (V) | 0.6 | 0.10 | 0.40 | 16.7% | 66.7% |
| Owego (T) | 102.9 | 6.04 | 7.25 | 5.9% | 7.0% |
| Owego (V) | 2.8 | 1.32 | 1.55 | 47.1% | 55.4% |
| Richford (T) | 37.8 | 1.22 | 1.22 | 3.2% | 3.2% |
| Spencer (T) | 48.2 | 3.96 | 3.96 | 8.2% | 8.2% |
| Spencer (V) | 1.1 | 0.44 | 0.44 | 40.0% | 40.0% |
| Tioga (T) | 59.3 | 4.57 | 5.01 | 7.7% | 8.4% |
| Waverly (V) | 2.2 | 0.31 | 0.42 | 14.1% | 19.1% |
| **Tioga County** | **522.5** | **31.53** | **35.04** | **6.0%** | **6.7%** |

Source: FEMA, 2012; Tioga County GIS 2012
Notes:
sq.mi. = square miles; T = Town; V = Village

Table 5.4.1-9. Estimated Assessed Value (Building and Land) Located in the 100- and 500-Year MRP Flood Boundaries

| Municipality | Number of Properties | | 100-Year | | | 500-Year | | |
|---|---|---|---|---|---|---|---|---|
| | 100-Year | 500-Year | Land AV | Building AV | Total AV | Land AV | Building AV | Total AV |
| Barton (T) | 349 | 361 | $9,799,700 | $14,677,523 | $24,477,223 | $9,972,000 | $15,200,023 | $25,172,023 |
| Berkshire (T) | 195 | 195 | $6,935,650 | $8,623,800 | $15,559,450 | $6,935,650 | $8,623,800 | $15,559,450 |
| Candor (T) | 379 | 391 | $723,075 | $2,013,780 | $2,736,855 | $733,435 | $2,058,780 | $2,792,215 |
| Candor (V) | 66 | 66 | $59,400 | $2,586,440 | $2,645,840 | $59,400 | $2,586,440 | $2,645,840 |
| Newark Valley (T) | 275 | 290 | $4,698,980 | $17,863,620 | $22,562,600 | $4,838,130 | $18,780,120 | $23,618,250 |
| Newark Valley (V) | 110 | 131 | $1,213,410 | $4,890,200 | $6,103,610 | $1,373,410 | $5,381,700 | $6,755,110 |
| Nichols (T) | 311 | 330 | $2,199,684 | $26,377,229 | $28,576,913 | $2,271,934 | $26,815,429 | $29,087,363 |
| Nichols (V) | 7 | 236 | $17,500 | $25,000 | $42,500 | $519,495 | $4,707,483 | $5,226,978 |
| Owego (T) | 946 | 1,078 | $35,961,949 | $190,514,257 | $226,476,206 | $38,701,449 | $199,381,257 | $238,082,706 |
| Owego (V) | 999 | 1,252 | $15,670,298 | $128,011,959 | $143,682,257 | $19,258,998 | $145,651,659 | $164,910,657 |
| Richford (T) | 140 | 140 | $5,763,300 | $4,559,123 | $10,322,423 | $5,763,300 | $4,559,123 | $10,322,423 |
| Spencer (T) | 403 | 403 | $2,155,825 | $5,382,452 | $7,538,277 | $2,155,825 | $5,382,452 | $7,538,277 |
| Spencer (V) | 214 | 214 | $360,490 | $6,851,483 | $7,211,973 | $360,490 | $6,851,483 | $7,211,973 |
| Tioga (T) | 433 | 480 | $672,373 | $5,729,125 | $6,401,498 | $803,023 | $6,091,015 | $6,894,038 |
| Waverly (V) | 239 | 308 | $4,092,500 | $18,913,529 | $23,006,029 | $5,228,400 | $23,944,929 | $29,173,329 |
| **Tioga County** | **5,066** | **5,875** | **$90,324,134** | **$437,019,520** | **$527,343,654** | **$98,974,939** | **$476,015,693** | **$574,990,632** |

Source: Tioga County

Notes:

1. This analysis was conducted using the preliminary DFIRM for Tioga County.
2. T = Town; V = Village

Table 5.4.1-10. Estimated HAZUS General Building Stock Replacement Value (Structure and Contents) Located in the 100- and 500-Year MRP Flood Boundaries

| Municipality | Total Buildings (All Occupancy Classes) | | | | Residential Buildings | | Commercial Buildings | | Industrial Buildings | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 100 Year | % Total | 500 Year | % Total | 100 Year | 500 Year | 100 Year | 500 Year | 100 Year | 500 Year |
| Barton (T) | $191,092,000 | 47.1 | $197,700,000 | 48.78 | $153,423,000 | $159,837,000 | $13,892,000 | $14,086,000 | $15,105,000 | $15,105,000 |
| Berkshire (T) | $81,892,000 | 69.9 | $81,892,000 | 69.92 | $65,128,000 | $65,128,000 | $7,467,000 | $7,467,000 | $2,057,000 | $2,057,000 |
| Candor (T) | $194,877,000 | 55.3 | $196,601,000 | 55.81 | $153,768,000 | $154,506,000 | $21,236,000 | $22,222,000 | $7,579,000 | $7,579,000 |
| Candor (V) | $38,397,000 | 38.8 | $38,397,000 | 38.83 | $29,763,000 | $29,763,000 | $3,270,000 | $3,270,000 | $930,000 | $930,000 |
| Newark Valley (T) | $136,195,000 | 58.0 | $137,125,000 | 58.38 | $105,841,000 | $106,345,000 | $18,229,000 | $18,497,000 | $1,839,000 | $1,997,000 |
| Newark Valley (V) | $82,335,000 | 72.7 | $89,143,000 | 78.69 | $61,563,000 | $66,409,000 | $10,492,000 | $10,912,000 | $1,196,000 | $1,196,000 |
| Nichols (T) | $113,682,000 | 65.9 | $117,305,000 | 67.96 | $93,155,000 | $96,354,000 | $14,090,000 | $14,514,000 | $1,661,000 | $1,661,000 |
| Nichols (V) | $15,122,000 | 20.5 | $73,886,000 | 100.00 | $10,066,000 | $41,756,000 | $3,556,000 | $11,102,000 | $122,000 | $2,534,000 |
| Owego (T) | $1,215,670,000 | 65.6 | $1,252,995,000 | 67.57 | $862,351,000 | $891,215,000 | $144,143,000 | $151,333,000 | $157,207,000 | $157,674,000 |
| Owego (V) | $484,747,000 | 86.6 | $507,688,000 | 90.71 | $256,132,000 | $265,931,000 | $140,035,000 | $152,451,000 | $38,506,000 | $38,506,000 |
| Richford (T) | $43,505,000 | 55.7 | $43,505,000 | 55.67 | $27,634,000 | $27,634,000 | $5,897,000 | $5,897,000 | $3,677,000 | $3,677,000 |
| Spencer (T) | $160,830,000 | 82.6 | $160,830,000 | 82.57 | $125,686,000 | $125,686,000 | $16,893,000 | $16,893,000 | $8,189,000 | $8,189,000 |
| Spencer (V) | $74,358,000 | 82.4 | $74,358,000 | 82.37 | $42,838,000 | $42,838,000 | $22,274,000 | $22,274,000 | $2,076,000 | $2,076,000 |
| Tioga (T) | $201,510,000 | 48.3 | $213,464,000 | 51.19 | $138,970,000 | $147,944,000 | $34,758,000 | $36,972,000 | $6,257,000 | $6,525,000 |
| Waverly (V) | $191,757,000 | 35.0 | $228,938,000 | 41.78 | $71,646,000 | $91,657,000 | $25,045,000 | $32,637,000 | $85,286,000 | $91,602,000 |
| **Tioga County** | **$3,225,969,000** | **60.7** | **$3,413,827,000** | **64.29** | **$2,197,964,000** | **$2,313,003,000** | **$481,277,000** | **$520,527,000** | **$331,687,000** | **$341,308,000** |

Source: HAZUS-MH 2.0

Notes:

1. Values represent replacement values (RV) for building structure and contents.
2. The general building stock valuations provided in HAZUS-MH 2.0 are Replacement Cost Value from RSMeans as of 2006.

Table 5.4.1-11. Estimated General Building Stock Replacement Value (Structure and Contents) Located in the 100- and 500-Year MRP Flood Boundaries

| Municipality | Agricultural Buildings | | Religious Buildings | | Government Buildings | | Educational Buildings | |
|---|---|---|---|---|---|---|---|---|
| | 100 Year | 500 Year | 100 Year | 500 Year | 100 Year | 500 Year | 100 Year | 500 Year |
| Barton (T) | $916,000 | $916,000 | $2,024,000 | $2,024,000 | $5,732,000 | $5,732,000 | $0 | $0 |
| Berkshire (T) | $1,812,000 | $1,812,000 | $2,282,000 | $2,282,000 | $1,738,000 | $1,738,000 | $1,408,000 | $1,408,000 |
| Candor (T) | $6,918,000 | $6,918,000 | $4,900,000 | $4,900,000 | $0 | $0 | $476,000 | $476,000 |
| Candor (V) | $696,000 | $696,000 | $0 | $0 | $782,000 | $782,000 | $2,956,000 | $2,956,000 |
| Newark Valley (T) | $2,504,000 | $2,504,000 | $4,718,000 | $4,718,000 | $0 | $0 | $3,064,000 | $3,064,000 |
| Newark Valley (V) | $0 | $138,000 | $4,362,000 | $4,362,000 | $578,000 | $578,000 | $4,144,000 | $5,548,000 |
| Nichols (T) | $1,818,000 | $1,818,000 | $2,958,000 | $2,958,000 | $0 | $0 | $0 | $0 |
| Nichols (V) | $0 | $482,000 | $882,000 | $5,020,000 | $0 | $10,834,000 | $496,000 | $2,158,000 |
| Owego (T) | $10,348,000 | $10,348,000 | $19,056,000 | $19,860,000 | $10,479,000 | $10,479,000 | $12,086,000 | $12,086,000 |
| Owego (V) | $756,000 | $756,000 | $22,872,000 | $23,598,000 | $14,836,000 | $14,836,000 | $11,610,000 | $11,610,000 |
| Richford (T) | $868,000 | $868,000 | $226,000 | $226,000 | $5,075,000 | $5,075,000 | $128,000 | $128,000 |
| Spencer (T) | $5,150,000 | $5,150,000 | $726,000 | $726,000 | $0 | $0 | $4,186,000 | $4,186,000 |
| Spencer (V) | $0 | $0 | $2,904,000 | $2,904,000 | $1,158,000 | $1,158,000 | $3,108,000 | $3,108,000 |
| Tioga (T) | $1,152,000 | $1,650,000 | $2,282,000 | $2,282,000 | $5,317,000 | $5,317,000 | $12,774,000 | $12,774,000 |
| Waverly (V) | $228,000 | $484,000 | $6,770,000 | $9,646,000 | $0 | $130,000 | $2,782,000 | $2,782,000 |
| **Tioga County** | **$33,166,000** | **$34,540,000** | **$76,962,000** | **$85,506,000** | **$45,695,000** | **$56,659,000** | **$59,218,000** | **$62,284,000** |

Source: HAZUS-MH 2.0

Notes:

1. Values represent replacement values (RV) for building structure and contents.
2. The general building stock valuations provided in HAZUS-MH 2.0 are Replacement Cost Value from RSMeans as of 2006.

Table 5.4.1-12. Estimated Potential General Building Stock Loss (Structure and Contents) by the 100-Year and 500-Year MRP Flood Events

| Municipality | Total Buildings (All Occupancies) | | Percentage of Total Building Value | | Residential Buildings | | Commercial Buildings | | Industrial Buildings | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 100 Year | 500 Year | 100 Year | 500 Year | 100 Year | 500 Year | 100 Year | 500 Year | 100 Year | 500 Year |
| Barton (T) | $9,205,000 | $11,445,000 | 2.3 | 2.8 | $5,817,000 | $7,192,000 | $1,500,000 | $1,809,000 | $540,000 | $628,000 |
| Berkshire (T) | $2,397,000 | $2,982,000 | 2.0 | 2.5 | $1,764,000 | $2,201,000 | $290,000 | $357,000 | $180,000 | $224,000 |
| Candor (T) | $12,406,000 | $20,505,000 | 3.5 | 5.8 | $8,062,000 | $9,456,000 | $2,129,000 | $2,397,000 | $816,000 | $1,012,000 |
| Candor (V) | $3,631,000 | $12,129,000 | 3.7 | 12.3 | $3,631,000 | $4,936,000 | $1,041,000 | $1,865,000 | $323,000 | $484,000 |
| Newark Valley (T) | $3,903,000 | $4,741,000 | 1.7 | 2.0 | $2,516,000 | $3,141,000 | $746,000 | $845,000 | $81,000 | $92,000 |
| Newark Valley (V) | $3,590,000 | $4,709,000 | 3.2 | 4.2 | $1,962,000 | $2,554,000 | $693,000 | $966,000 | $118,000 | $152,000 |
| Nichols (T) | $6,326,000 | $10,225,000 | 3.7 | 5.9 | $4,735,000 | $7,780,000 | $673,000 | $1,179,000 | $153,000 | $227,000 |
| Nichols (V) | $999,000 | $1,156,000 | 1.4 | 1.6 | $231,000 | $334,000 | $563,000 | $553,000 | $13,000 | $14,000 |
| Owego (T) | $23,808,000 | $27,694,000 | 1.3 | 1.5 | $12,069,000 | $13,490,000 | $6,689,000 | $7,629,000 | $2,964,000 | $4,052,000 |
| Owego (V) | $12,581,000 | $15,405,000 | 2.2 | 2.8 | $5,287,000 | $6,330,000 | $3,174,000 | $3,788,000 | $2,837,000 | $3,685,000 |
| Richford (T) | $2,029,000 | $2,732,000 | 2.6 | 3.5 | $1,468,000 | $1,893,000 | $466,000 | $717,000 | $19,000 | $22,000 |
| Spencer (T) | $3,008,000 | $3,766,000 | 1.5 | 1.9 | $1,769,000 | $2,343,000 | $427,000 | $472,000 | $317,000 | $402,000 |
| Spencer (V) | $2,887,000 | $3,690,000 | 3.2 | 4.1 | $928,000 | $1,398,000 | $1,312,000 | $1,523,000 | $154,000 | $183,000 |
| Tioga (T) | $12,676,000 | $14,561,000 | 3.0 | 3.5 | $8,828,000 | $10,306,000 | $2,641,000 | $3,028,000 | $711,000 | $770,000 |
| Waverly (V) | $6,427,000 | $4,333,000 | 1.2 | 0.8 | $2,352,000 | $2,350,000 | $1,755,000 | $1,449,000 | $1,804,000 | $196,000 |
| **Tioga County** | **$109,712,000** | **$140,073,000** | **2.1** | **2.6** | **$61,419,000** | **$75,704,000** | **$24,099,000** | **$28,577,000** | **$11,030,000** | **$12,143,000** |

Source: HAZUS-MH 2.0

Notes:

1. Values represent replacement values (RV) for building structure and contents.
2. The general building stock valuations provided in HAZUS-MH 2.0 are Replacement Cost Value from RSMeans as of 2006.

Table 5.4.1-12 Potential Estimated General Building Stock Loss (Structure and Contents) by the 100-Year and 500-Year MRP Flood Events (Continued)

| Municipality | Agriculture Buildings | | Religious Buildings | | Government Buildings[3] | | Education Buildings | |
|---|---|---|---|---|---|---|---|---|
| | 100 Year | 500 Year | 100 Year | 500 Year | 100 Year | 500 Year | 100 Year | 500 Year |
| Barton (T) | $390,000 | $478,000 | $413,000 | $401,000 | $545,000 | $937,000 | $0 | $0 |
| Berkshire (T) | $13,000 | $14,000 | $31,000 | $40,000 | $81,000 | $105,000 | $38,000 | $41,000 |
| Candor (T) | $309,000 | $382,000 | $1,090,000 | $7,257,000 | $0 | $0 | $0 | $1,000 |
| Candor (V) | $250,000 | $311,000 | $261,000 | $1,298,000 | $211,000 | $324,000 | $1,753,000 | $2,911,000 |
| Newark Valley (T) | $307,000 | $365,000 | $253,000 | $297,000 | $0 | $0 | $0 | $1,000 |
| Newark Valley (V) | $0 | $0 | $621,000 | $822,000 | $59,000 | $55,000 | $137,000 | $160,000 |
| Nichols (T) | $105,000 | $243,000 | $514,000 | $653,000 | $146,000 | $143,000 | $0 | $0 |
| Nichols (V) | $0 | $0 | $88,000 | $144,000 | $4,000 | $5,000 | $100,000 | $106,000 |
| Owego (T) | $319,000 | $400,000 | $764,000 | $912,000 | $657,000 | $815,000 | $346,000 | $396,000 |
| Owego (V) | $0 | $0 | $414,000 | $488,000 | $0 | $0 | $869,000 | $1,114,000 |
| Richford (T) | $64,000 | $85,000 | $0 | $0 | $12,000 | $15,000 | $0 | $0 |
| Spencer (T) | $167,000 | $217,000 | $17,000 | $21,000 | $0 | $0 | $311,000 | $311,000 |
| Spencer (V) | $0 | $0 | $240,000 | $293,000 | $106,000 | $122,000 | $147,000 | $171,000 |
| Tioga (T) | $107,000 | $129,000 | $328,000 | $259,000 | $4,000 | $3,000 | $57,000 | $66,000 |
| Waverly (V) | $70,000 | $90,000 | $425,000 | $218,000 | $0 | $0 | $21,000 | $30,000 |
| **Tioga County** | **$2,101,000** | **$2,714,000** | **$5,459,000** | **$13,103,000** | **$1,825,000** | **$2,524,000** | **$3,779,000** | **$5,308,000** |

Source: HAZUS-MH 2.0

Notes:

1. Values represent replacement values (RV) for building structure and contents.
2. The general building stock valuations provided in HAZUS-MH 2.0 are Replacement Cost Value from RSMeans as of 2006.
3. Potential estimated damages are based on the default HAZUS-MH 2.0 general building stock inventory at the Census-block level. Local input indicates that some values may be underestimated by HAZUS, specifically for the occupancy classes with zero ($0) damages noted.

In addition to total building stock modeling, individual data available on flood policies, claims, RLP and severe RLP (SRLs) were analyzed. FEMA Region 2 provided a list of residential properties with NFIP policies, past claims and multiple claims (RLPs). According to the metadata provided: "The NFIP Repetitive Loss File contains losses reported from individuals who have flood insurance through the Federal Government. A property is considered a repetitive loss property when there are two or more losses reported which were paid more than $1,000 for each loss. The two losses must be within 10 years of each other & be as least 10 days apart. Only losses from (*sic* since) 1/1/1978 that are closed are considered."

Severe RLPs (SRL) were then examined in Tioga County. According to section 1361A of the National Flood Insurance Act, as amended (NFIA), 42 U.S.C. 4102a, an SRL property is defined as a residential property that is covered under an NFIP flood insurance policy and:

- Has at least four NFIP claim payments (including building and contents) over $5,000 each, and the cumulative amount of such claims payments exceeds $20,000; or
- For which at least two separate claims payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building.
- For both of the above, at least two of the referenced claims must have occurred within any 10-year period, and must be greater than 10 days apart.

Table 5.4.1-13 and Figure 5.4.1-7 summarize the NFIP policies, claims and repetitive loss statistics for Tioga County. According to FEMA, there are 19 2-4 family residential RL properties; 20 non-residential RL properties; 197 single-family residential RL properties and three condominium RL properties in the County. Of the 23 SRL properties in Tioga County, all 21 are residential (FEMA Region 2, 2011). This information is current as of January 31, 2012.

The location of the properties with policies, claims and repetitive and severe repetitive flooding were geocoded by FEMA with the understanding that there are varying tolerances between how closely the longitude and latitude coordinates correspond to the location of the property address, or that the indication of some locations are more accurate than others. This data is more current than the properties reported in the New York State HMP and may explain any difference in property count between the two sources.

Table 5.4.1-13. NFIP Policies, Claims and Repetitive Loss Statistics

| Municipality | # Policies (1) | # Claims (Losses) (1) | Total Loss Payments (2) | # Rep. Loss Prop. (1) | # Severe Rep. Loss Prop. (1) | # Polices in 100-year Boundary (3) | # Polices in 500-Boundary (3) | # Policies Outside the 500-year Flood Hazard (3) |
|---|---|---|---|---|---|---|---|---|
| Barton (T) | 36 | 74 | $1,188,893 | 1 | 0 | 20 | 20 | 16 |
| Berkshire (T) | 8 | 3 | $13,937 | 0 | 0 | 4 | 4 | 4 |
| Candor (T) | 30 | 25 | $141,953 | 1 | 0 | 1 | 1 | 29 |
| Candor (V) | 11 | 10 | $63,406 | 0 | 0 | 3 | 3 | 8 |
| Newark Valley (T) | 20 | 13 | $183,483 | 1 | 0 | 5 | 7 | 13 |
| Newark Valley (V) | 10 | 11 | $184,232 | 1 | 0 | 5 | 5 | 5 |
| Nichols (T) | 65 | 92 | $2,667,766 | 18 | 0 | 47 | 50 | 15 |
| Nichols (V) | 5 | 4 | $28,512 | 0 | 0 | 0 | 6 | -1 |
| Owego (T) | 252 | 432 | $20,362,141 | 66 | 11 | 148 | 171 | 81 |
| Owego (V) | 470 | 694 | $23,928,133 | 136 | 7 | 370 | 453 | 17 |
| Richford (T) | 3 | 4 | $1,731 | 0 | 0 | 0 | 0 | 3 |
| Spencer (T) | 31 | 28 | $500,141 | 1 | 0 | 25 | 25 | 6 |
| Spencer (V) | 3 | 3 | $6,036 | 0 | 0 | 2 | 2 | 1 |
| Tioga (T) | 42 | 124 | $3,252,315 | 14 | 5 | 30 | 31 | 11 |
| Waverly (V) | 39 | 22 | $94,744 | 0 | 0 | 31 | 32 | 7 |
| **Tioga County** | **1,025** | **1,539** | **$52,617,423** | **239** | **23** | **691** | **810** | **215** |

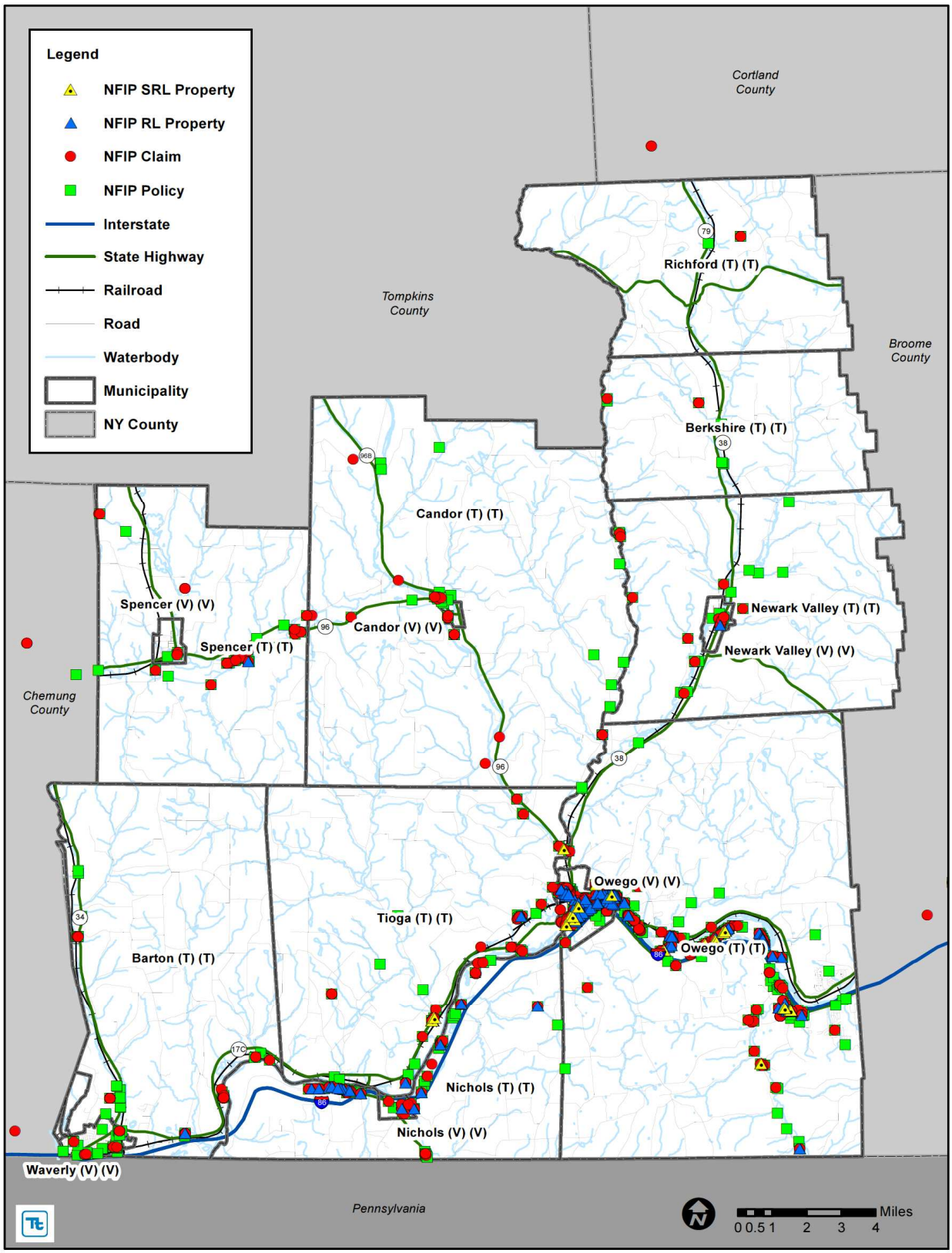
Source:

(1) Policies, claims, repetitive loss and severe repetitive loss statistics provided by FEMA Region 2, in April 2012 using the "Comm_Name". These statistics are current as of January 31, 2012. Please note the total number of repetitive loss properties includes the severe repetitive loss properties.

(2) Total building and content losses from the claims file provided by FEMA Region 2 (current as of January 31, 2012).

(3) The policy locations used are based on the latitude and longitude provided by FEMA Region 2.

Figure 5.4.1-7. NFIP Polices, Claims, Repetitive Loss and Severe Repetitive Loss Properties in Tioga County

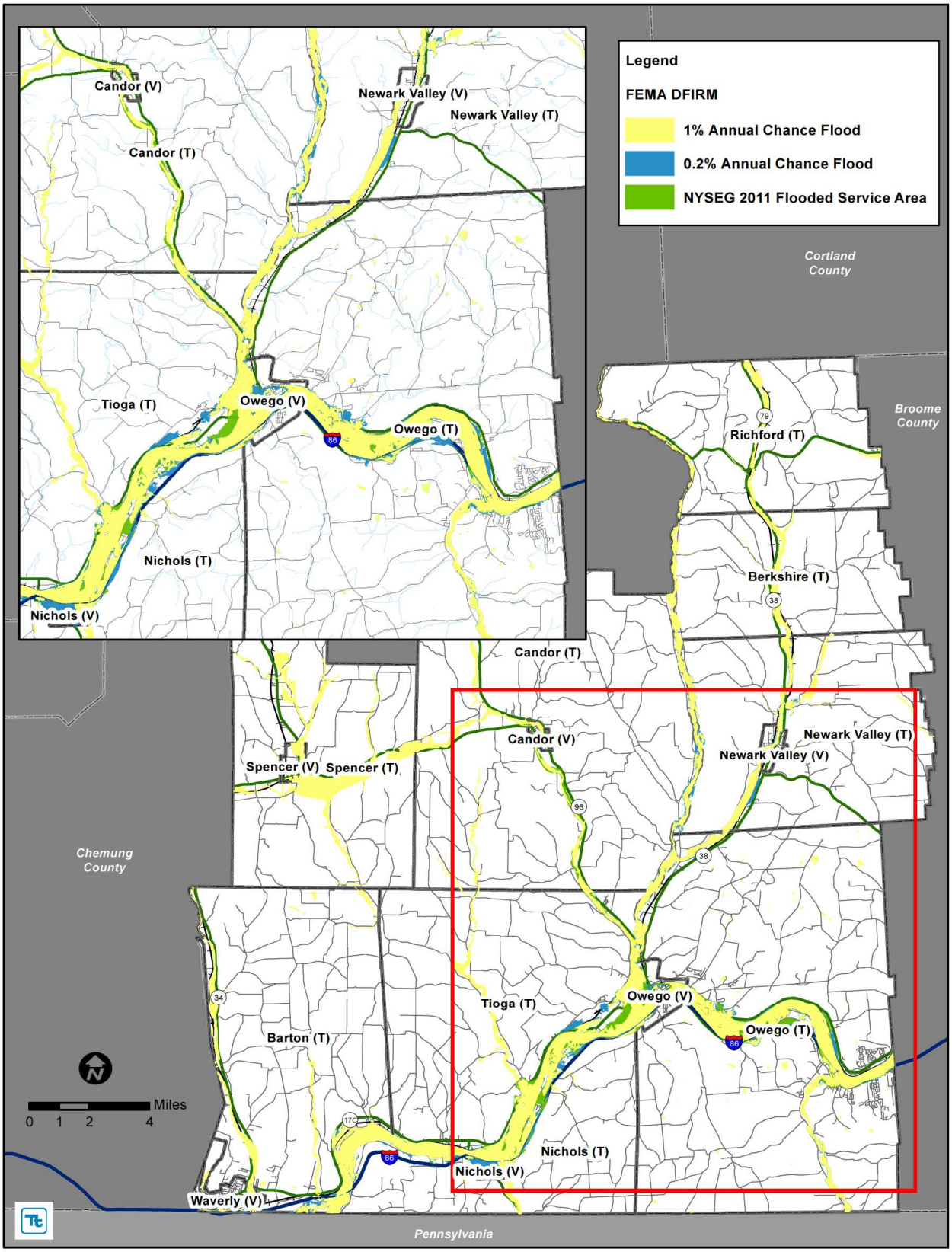



Source: FEMA Region 2, 2012

As discussed in the Previous Occurences and Losses subsection, Tioga County experienced extensive damages as a result of the September 2011 flood event. NYSEG, a gas and electric company that services Tioga County, mapped the flood inundation in their service area as a result of the September 2011 event (Figure 5.4.1-8). The flood inundation area exceeded the 100- and 500-year flood boundaries in some areas, specifically along the Susquehanna River in the Town of Tioga just southwest of the Village of Owego.

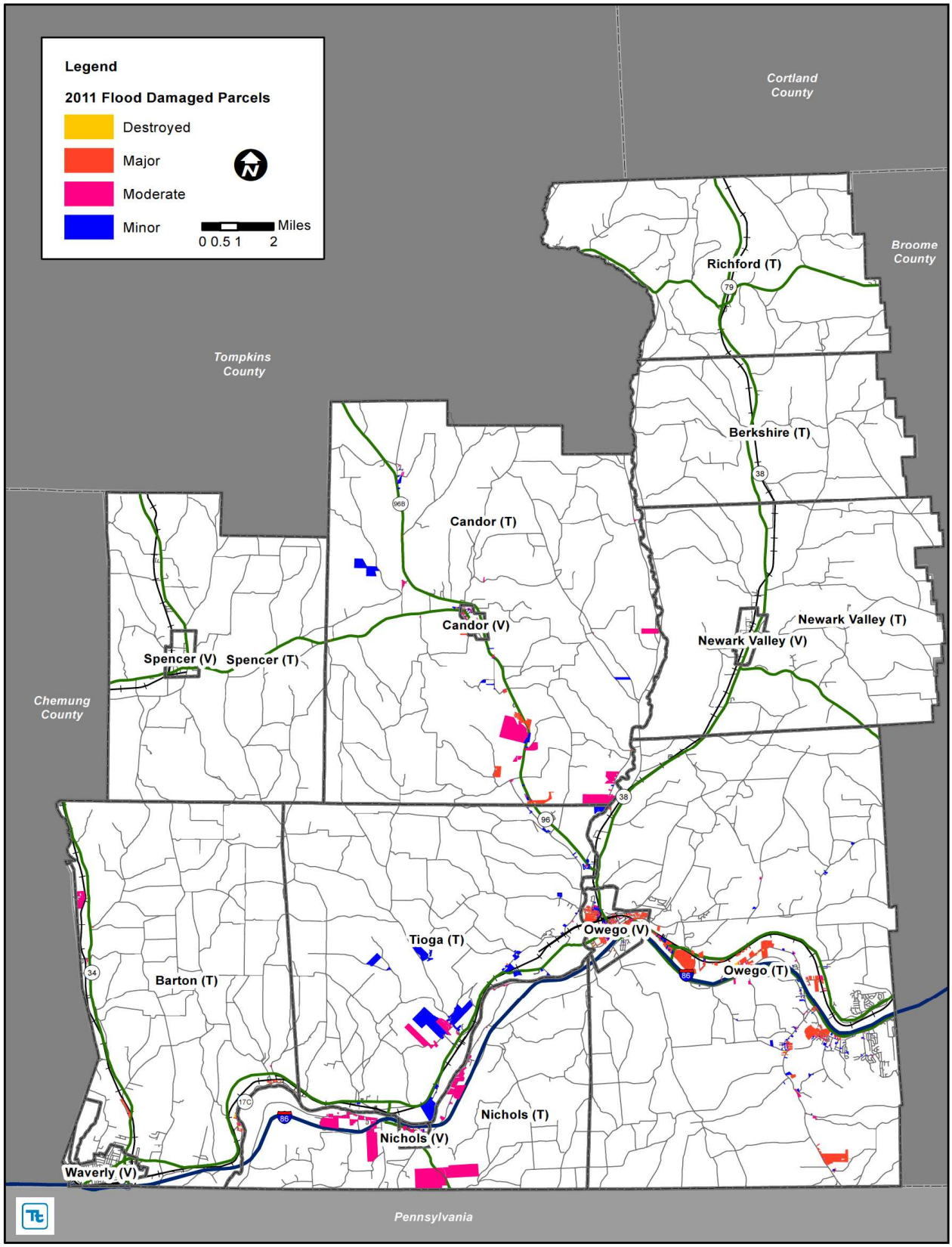
Tioga County and municipal officials collected information on parcels that experienced damages as a result of the 2011 flood event. This data was then categorized base upon percent damage (minor, moderate, major and destroyed). In total, the data estimates there is greater than $125 Million in damages. This data is approximate as there may have been more properties affected than the data shows. Refer to Figure 5.4.1-9 below and the detailed maps in the jurisdiction annexes in Section 9 of this Plan.

Figure 5.4.1-8. NYSEG Flooded Service Area in 2011




Source: Tioga County, 2012

Figure 5.4.1-9. Damaged Parcels as a Result of the 2011 Flood Event in Tioga County




Source: Tioga County, 2012

### Impact on Critical Facilities

In addition to considering general building stock at risk, the risk of flood to critical facilities, utilities and user-defined facilities was evaluated. HAZUS-MH was used to estimate the flood loss potential to critical facilities exposed to the flood risk. Using depth/damage function curves, HAZUS estimates the percent of damage to the building and contents of critical facilities. Tables 5.4.1-14 and 5.4.1-15 list the critical facilities and utilities located in the FEMA preliminary DFIRM flood zones and the percent damage HAZUS-MH 2.0 estimates to the facility as a result of a 100- and 500-year MRP events.

In cases where short-term functionality is impacted by a hazard, other facilities of neighboring municipalities may need to increase support response functions during a disaster event. Mitigation planning should consider means to reduce impact to critical facilities and ensure sufficient emergency and school services remain when a significant event occurs.

Table 5.4.1-14 Critical Facilities Located in the Preliminary DFIRM Flood Boundaries and Estimated Potential Damage from the 100- and 500-Year MRP Events

| Name | Municipality | Type | Exposure | | Potential Loss | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 100-Year | 500-Year | 100-Year Structure Damage % | 100-Year Content Damage % | 500-Year Structure Damage % | 500-Year Content Damage % |
| Lockwood | Barton (T) | EOC | X | X | 12.16 | 55.78 | 13.66 | 63.28 |
| Lockwood | Barton (T) | Fire | X | X | 12.16 | 55.78 | 13.66 | 63.28 |
| Barton Highway Barn | Barton (T) | UDF | X | X | 12.15 | 49.09 | 12.94 | 65.68 |
| Berkshire Town Hall | Berkshire (T) | UDF | X | X | 0 | 0 | 0 | 0 |
| Weltonville Fire Station | Candor (T) | EOC | X | X | 22.05 | 95.14 | 23.91 | 98.46 |
| Candor Main Station | Candor (T) | EOC | | X | | | 10.11 | 21.9 |
| Weltonville | Candor (T) | Fire | X | X | 22.05 | 95.14 | 23.91 | 98.46 |
| Village of Candor Public Works Garage | Candor (V) | UDF | X | X | 0 | 0 | 0 | 0.34 |
| TBD | Candor (V) | Medical Care | X | X | 7.24 | 3.62 | 24.1 | 18.2 |
| Candor Family Care | Candor (V) | Medical Care | X | X | 9.88 | 4.94 | 24.76 | 19.52 |
| Candor Elementary School | Candor (V) | School | X | X | 6.94 | 37.64 | 8.97 | 52.75 |
| Candor High School | Candor (V) | School | X | X | 9 | 61.98 | 10.23 | 68.46 |
| Candor Main Station | Candor (V) | Fire | | X | | | 10.11 | 21.9 |
| Candor Emergency Squad | Candor (V) | Fire | X | X | 10.16 | 22.89 | 11.95 | 54.1 |
| Village of Newark Valley Hall | Newark Valley (V) | UDF | X | X | 0 | 0 | 0 | 0 |
| Berkshire EMS, Newark Valley | Newark Valley (V) | Fire | X | X | 9.86 | 19.43 | 9 | 16.01 |
| Town of Owego Highway Garage | Owego (T) | UDF | X | X | 4.24 | 15.78 | 6.27 | 21.42 |
| Apalachin Family Care | Owego (T) | Medical Care | | X | | | 0 | 0 |
| Owego-Apalachin Central School | Owego (V) | School | | X | | | 0.19 | 1.01 |
| Owego-Apalachin Central School | Owego (V) | School | X | X | 13.48 | 72.72 | 14.9 | 74.85 |
| Owego Elementary School | Owego (V) | School | X | X | 7.11 | 38.81 | 8.65 | 50.37 |
| Owego Free Academy | Owego (V) | School | | X | | | 2.12 | 11.45 |
| Owego-Apalachin Middle School | Owego (V) | School | | X | | | 2.74 | 14.78 |
| Richford Town Hall | Richford (T) | UDF | X | X | 11.76 | 70.27 | 8.42 | 42.08 |
| Richford Highway Garage | Richford (T) | UDF | | X | | | 0 | 0 |

| Name | Municipality | Type | Exposure | | Potential Loss | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 100-Year | 500-Year | 100-Year Structure Damage % | 100-Year Content Damage % | 500-Year Structure Damage % | 500-Year Content Damage % |
| North Tioga Center for Family Health | Richford (T) | Medical Care | X | X | 20.63 | 11.26 | 10.78 | 5.39 |
| Richford | Richford (T) | Fire | X | X | 27.24 | 100 | 24.77 | 98.88 |
| Spencer Village Hall | Spencer (V) | UDF | X | X | 11.7 | 70.1 | 13.22 | 76 |
| Spencer | Spencer (V) | EOC | X | X | 11.07 | 39.26 | 15.36 | 71.97 |
| Spencer | Spencer (V) | Fire | X | X | 11.07 | 39.26 | 15.36 | 71.97 |
| Tioga County Public Works & Highway Dept. | Tioga (T) | UDF | | X | 6.82 | 22.94 | 11.92 | 45.53 |

Source: FEMA, 2011; HAZUS-MH 2.0

Notes:

(1) 'X' indicates the facility location as provided by Tioga County is located in the preliminary DFIRM flood zone.

(2) HAZUS did not calculate potential loss estimates for some facilities located in the preliminary DFIRM flood zone. This is because either these facilities are located outside of the flood depth grid generated by HAZUS or the depth of flooding does not amount to any damages to the structure or contents according to the depth damage function in HAZUS. The difference between the flood depth grid generated by HAZUS and the preliminary DFIRM flood zones is most likely due to the resolution of the elevation model used (1/3 Arc Second or 10 meters) which differed from the elevation data used to generate the DFIRM itself.

(3) In some cases, HAZUS calculated potential flood loss to structures outside the preliminary FEMA DFIRM. These facilities are located inside the HAZUS flood depth grid.

Table 5.4.1-15. Utilities Located in the Preliminary DFIRM Flood Boundaries and Estimated Potential Damage from the 100- and 500-Year MRP Events

| Name | Municipality | Type | Exposure | | Potential Loss | |
|---|---|---|---|---|---|---|
| | | | 100 Year | 500 Year | 100 Year Damage % | 500 Year Damage % |
| Well 2 | Barton (T) | Potable Water Well | | X | | 0.44 |
| Citizens Telecomm Co | Candor (V) | Comm. Facility | X | X | | |
| Water Pollution Control Plant #2 | Owego (T) | Waste Water Facility | X | X | 4.73 | 14.46 |
| Waste Water Pump Station | Owego (T) | WW Pump Station | X | | | |
| Waste Water Pump Station | Owego (T) | WW Pump Station | X | | | |
| Waste Water Pump Station | Owego (T) | WW Pump Station | X | | | |
| Well 1 | Owego (V) | Potable Water Wells | X | X | 3.62 | 6.38 |
| Well 3 | Owego (V) | Potable Water Wells | X | X | 3.62 | 6.38 |
| Well 4 | Owego (V) | Potable Water Wells | X | X | 3.62 | 6.38 |
| Waste Water Pump Station | Owego (V) | WW Pump Station | X | X | | |
| Well 1 | Spencer (T) | Potable Water Wells | X | X | 8.72 | 16.01 |
| Well 2 | Spencer (T) | Potable Water Wells | X | X | 8.72 | 16.01 |
| Tioga County Highway Department | Tioga (T) | Comm. Facility | X | X | | |
| Well 1 | Tioga (T) | Potable Water Wells | | X | | 0.11 |
| Well 1 | Waverly (V) | Potable Water Wells | X | X | 1.76 | 3.51 |

Source: FEMA, 2012; HAZUS-MH 2.0

Notes:

(1) 'X' indicates the facility location as provided by Tioga County is located in the preliminary DFIRM flood zone.

(2) Loss estimate calculations for electric and communication facilities are not supported in HAZUS-MH 2.0.

(3) HAZUS did not calculate potential loss estimates for some facilities located in the preliminary DFIRM flood zone. This is because either these facilities are located outside of the flood depth grid generated by HAZUS or the depth of flooding does not amount to any damages to the structure or contents according to the depth damage function in HAZUS. The difference between the flood depth grid generated by HAZUS and the preliminary DFIRM flood zones is most likely due to the resolution of the elevation model used (1/3 Arc Second or 10 meters) which differed from the elevation data used to generate the DFIRM itself.

(4) In some cases, HAZUS calculated potential flood loss to structures outside the preliminary FEMA DFIRM. These facilities are located inside the HAZUS flood depth grid.

### Impact on Economy

For impact on economy, estimated losses from a flood event are considered. Losses include but are not limited to general building stock damages, agricultural losses, business interruption, impacts to tourism and tax base to Tioga County. Damages to general building stock can be quantified using HAZUS-MH as discussed above. Other economic components such as loss of facility use, functional downtime and social economic factors are less measurable with a high degree of certainty. For the purposes of this analysis, general building stock damages are discussed further.

Flooding can cause extensive damage to public utilities and disruptions to the delivery of services. Loss of power and communications may occur; and drinking water and wastewater treatment facilities may be temporarily out of operation. Flooded streets and road blocks make it difficult for emergency vehicles to respond to calls for service. Floodwaters can washout sections of roadway and bridges (Foster, Date Unknown).

Direct building losses are the estimated costs to repair or replace the damage caused to the building. The potential damage estimated to the general building stock inventory associated with the 100-year flood is

approximately $110 million. This estimated building damage represents approximately 2.1-percent of the County's overall total general building stock inventory exposed to this hazard. For the 500-year event, the potential damage estimate is approximately $140 million (structure and contents), or 2.6-percent of the total exposed building value. These dollar value losses to the County's total building inventory replacement value, in addition to damages to roadways and infrastructure, would greatly impact Tioga's tax base and the local economy.

When a flood occurs, the agricultural industry is at risk in terms of economic impact and damage (i.e., damaged crop, financial loss to the farmer). In 2007, according to the Census of Agriculture, the market value of all agricultural products sold from Tioga County was greater than $36.7 million with a majority of the value ($712,000 or approximately 2 percent) in grains. As noted in Table 5.4.1-X, approximately 8.7-percent of the farmland in Tioga County is located in the floodplain.

Specific agricultural loss information (monetary losses per agricultural product) was not available at the time this plan was drafted. However, given professional knowledge and historic loss information available, 40-percent and 60-percent loss estimates for crops as a result of major flood events is considered conservative estimates of potential losses for this hazard.

HAZUS-MH estimates the amount of debris generated from the flood events as a result of 100- and 500-year MRPs. The model breaks down debris into three categories: 1) finishes (dry wall, insulation, etc.); 2) structural (wood, brick, etc.) and 3) foundations (concrete slab and block, rebar, etc.). The distinction is made because of the different types of equipment needed to handle the debris. Table 5.4.1-16 summarizes the debris HAZUS-MH 2.0 estimates for each participating municipality.

Table 5.4.1-16 Estimated Tioga County Debris (Tons) Generated from the 100-Year and 500-Year MRP Events

| | 100 Year | | | | 500 Year | | | |
|---|---|---|---|---|---|---|---|---|
| Municipality | Total | Finish | Structure | Foundation | Total | Finish | Structure | Foundation |
| Barton (T) | 2,023 | 629 | 560 | 834 | 2,440 | 718 | 702 | 1,020 |
| Berkshire (T) | 329 | 160 | 79 | 90 | 427 | 193 | 114 | 120 |
| Candor (T) | 1,869 | 652 | 599 | 618 | 2,120 | 751 | 672 | 697 |
| Candor (V) | 1,237 | 388 | 451 | 398 | 1,572 | 538 | 540 | 494 |
| Newark Valley (T) | 505 | 218 | 133 | 154 | 656 | 264 | 187 | 205 |
| Newark Valley (V) | 621 | 167 | 249 | 205 | 871 | 217 | 356 | 298 |
| Nichols (T) | 1,746 | 628 | 472 | 646 | 2,978 | 883 | 948 | 1,147 |
| Nichols (V) | 74 | 47 | 13 | 14 | 114 | 59 | 29 | 26 |
| Owego (T) | 1,858 | 891 | 481 | 486 | 2,351 | 1,059 | 621 | 671 |
| Owego (V) | 1,287 | 864 | 221 | 202 | 1,909 | 1,052 | 442 | 415 |
| Richford (T) | 389 | 146 | 107 | 136 | 504 | 186 | 143 | 175 |
| Spencer (T) | 311 | 166 | 53 | 92 | 393 | 212 | 69 | 112 |
| Spencer (V) | 167 | 100 | 23 | 44 | 226 | 141 | 31 | 54 |
| Tioga (T) | 4,622 | 1,261 | 1,328 | 2,033 | 5,226 | 1,431 | 1,507 | 2,288 |
| Waverly (V) | 550 | 316 | 131 | 103 | 565 | 318 | 135 | 112 |
| **Tioga County** | **17,588** | **6,633** | **4,900** | **6,055** | **22,352** | **8,022** | **6,496** | **7,834** |

Source: HAZUS-MH 2.0

### Effect of Climate Change on Vulnerability

The potential effects of climate change on Tioga County's vulnerability to flooding shall need to be considered as a greater understanding of regional climate change impacts develop.

### Future Growth and Development

As discussed in Sections 4 and 9, areas targeted for future growth and development have been identified across the County. Any areas of growth could be potentially impacted by the flood hazard if located within the identified hazard areas. Please note that because there was very little projected future development, a County-wide figure would not properly illustrate the new development in relation to the preliminary DFIRM boundaries. Please refer to the specific areas of development indicated in tabular form (subsection B) and/or on the hazard maps (subsection I) included in the jurisdictional annexes in Volume II, Section 9 of this plan.

### Additional Data Needs and Next Steps

A HAZUS-MH flood analysis was conducted for Tioga County using the default model data, with the exception of the updated critical facility inventory which included user-defined data. For future plan updates, more accurate exposure and loss estimates can be produced by replacing the national default inventories with more accurate local inventories. Updated demographic and general building stock data would be needed. In the future, FEMA's Risk Mapping, Assessment, and Planning (Risk MAP) will be providing the flood depth and analysis grids as part of the DFIRM deliverable. These depth grids can be incorporated into HAZUS and used to calculate the potential losses to the County inventory. The utilization of the RiskMAP depth grids and the updated general building stock inventory on a structural level will provide more accurate flood loss estimates. To estimate exposure and potential loss due to dam breaks, dam break inundation areas can be digitized for future analysis.

### Overall Vulnerability Assessment

The flood hazard is evaluated as a significant threat, which was ranked overall as a "High" risk by the Planning Committee with a "frequent" probability of occurrence (see Tables 5.3-3 and 5.3-6 in Section 5.3). This hazard can be managed and planned for through the mitigation strategy and specific activities outlined in Volume II Section 9, which build on efforts already undertaken by these communities.