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 (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).

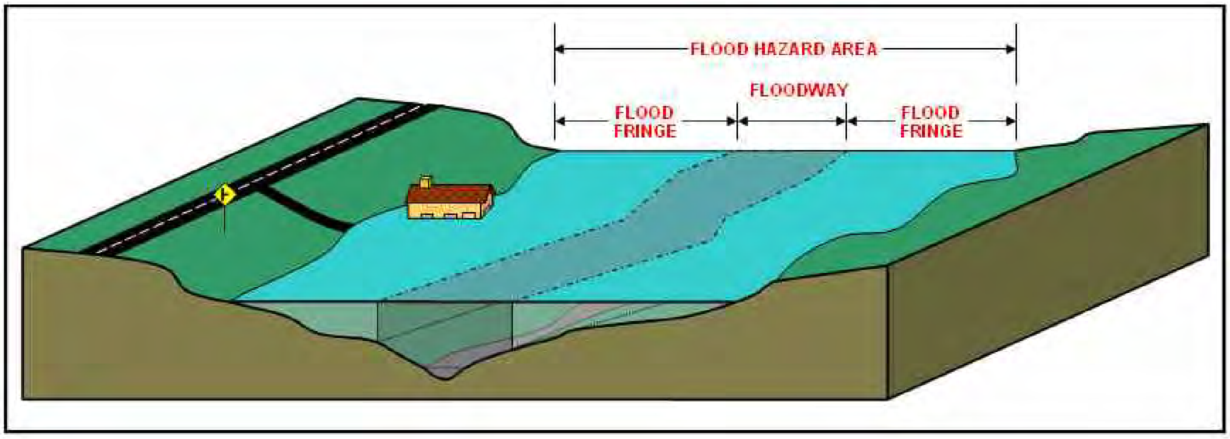
A floodplain is defined as the land adjoining the channel of a river, stream, ocean, lake, or other watercourse or water body that becomes inundated with water during a flood. Most often floodplains are referred to as 100-year floodplains. A 100-year floodplain is not the flood that will occur once every 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,

> One hundred-year floodplains (or 1% annual chance floodplain) can be described as a bag of 100 marbles, with 99 clear marbles and one black marble. Every time a marble is pulled out from the bag, and it is the black marble, it represents a 100-year flood event. The marble is then placed back into the bag and shaken up again before another marble is drawn. It is possible that the black marble can be picked one out of two or three times in a row, demonstrating that a 100-year flood event could occur several times in a row (Interagency Floodplain Management Review Committee, 1994).

2003).

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, 2005). 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.

<u>Riverine/Flash Floods</u> – 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, 2005; FEMA, 2008).

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).

<u>Ice-Jam Floods</u> – 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 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).

The Broome County Planning Committee indicated that ground failure due to saturated soils is also a concern in the County. Historic areas of concern include Route 88 embankment failure between Exits 2 and 3 and Airport Road Exit (Route 71) embankment failure next to Route 17 (Broome County Meeting, 2012).

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 Broome County.

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. Broome County's rating is 28, out of a possible 35. The County's ranking makes it the 6^{th} most vulnerable to the flood hazard in New York State. 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 (NYS HMP 2011).

Riverine flooding problems are most severe in the Delaware, Susquehanna, Chemung, Erie-Niagara, Genesse, Allegany, Hudson and Mohawk River Basins (NYS HMP 2011). Broome County is part of the Delaware and Susquehanna River Basins (NYSDEC, Date Unknown). Please refer to Section 4 (County Profile) for detailed information regarding the river basins and the hydrography/hydrology of the County.

Water Resources

Water resources have shaped settlement patterns in the region well before the inception of Broome County. Native Americans settled along the Susquehanna, Chenango, Tioughnioga, Otselic, and Delaware Rivers, and utilized the resources for food, travel and navigation. After the American Revolution, the land at the confluence of the Susquehanna and Chenango was given to William Bingham, who, along with Joshua Whitney, envisioned a new village at the confluence. The river systems would provide transportation and a corridor for economic development. This land and surrounding area later became Broome County (Broome County Comprehensive Plan, 2012).

With the establishment of the railroad system, the Rivers became less as a means of transportation but still provided a valuable service. Today, Broome County depends on surface water and ground water for drinking water, recreation, industry, and agriculture. Water resources and their natural features provide significant services include: public water supply, groundwater recharge, sediment and erosion control, flood protection, scenic enhancement, recreation, and agricultural productivity (Broome County Comprehensive Plan, 2012).

Development decisions can significantly minimize adverse impacts on water quality from land use practices and development. This is important in areas that have high water resource value including floodplains, stream buffers, wetlands and their buffers, groundwater recharge areas, lake shores, drinking water sources and headwater areas (Broome County Comprehensive Plan, 2012).

Streams

Stream buffers of at least 100 feet are recommended to provide adequate stream protection. Approximately 16.8 square miles of Broome County are encompassed in the zone within 100 feet of major streams. In addition, maintain vegetated buffers around lake shores can help maintain the water quality of these systems (Broome County Comprehensive Plan, 2012).

Aquifers

Approximately 80% of Broome County's water for public use comes from groundwater sources. There are several aquifers located beneath the Susquehanna and Chenango Rivers and their surrounding floodplains. These are referred to as unconsolidated aquifers, characterized as having frequent discharge/recharge with the streams that lie above them. Bedrock aquifers are common in the rural parts of the County, which are hydrologically isolated from large streams and hold water in bedrock fractures (Broome County Comprehensive Plan, 2012).

Aquifers are classified based on importance as a public water supply, productivity, and vulnerability to pollution. Johnson City, Endwell, Endicott and Vestal are all dependent on primary aquifers. There are also a number of principal aquifers which are classified as highly productive; however, used by a lower percentage of the County's population (Broome County Comprehensive Plan, 2012).

All of Broome County that is located within the Susquehanna River watershed is federally designated by the U.S. EPA as a sole source aquifer (Clinton Street-Ballpark Aquifer System). Sole source aquifers supply 50% or more of the area's drinking water. If it is contaminated, it would create a significant hazard to public health and could not be replaced by another water source (Broome County Comprehensive Plan, 2012).

Floodplains

Flooding has historically been a significant threat to properties in Broome County. FEMA updated the floodplain maps of the County and according to these new maps, approximately 26 square miles of the County lie within the Special Flood Hazard Area (SFHA). Approximately 3.7 square miles is located within the 500-year floodplains. This includes several urbanized areas, which makes flooding a primary concern for the County (Broome County Comprehensive Plan, 2012).

Wetlands

Wetlands are periodically or permanently flooded areas that support plant and animal species adapted to live in those conditions. Wetlands include swamps, blogs, marshes and ponds. They function to trap and slowly release surface water, providing natural flood control. Wetlands and their buffers are also important to protect water quality and hydrology. Any development impacting wetlands requires a permit from the state or federal government (Broome County Comprehensive Plan, 2012).

In Broome County, there are approximately 2,190 acres of state designated wetlands. New York State protects all wetlands at least 12.4 acres in size. Smaller wetlands may be protected by the State if deemed locally unusual or important. The U.S. Army Corps of Engineers has the authority to protect wetlands that are larger than one acre. There are approximately 21.25 square miles (13,600 acres) listed on the National Wetland Inventory, protected by the federal government, that includes the Susquehanna, Chenango, and Tioughnioga Rivers, which encompass 3,700 acres (Broome County Comprehensive Plan, 2012).

Management Issues

<u>Flood</u>

Flooding creates a hazard to Broome County's municipalities. The Susquehanna River is one of the most flood-prone regions in the U.S. Higher gradient streams in the lower basin and highly erodible soils result in frequent flash flooding and excessive erosion. Recently, the County has been subject to multiple major flood events, which have received FEMA disaster declarations (June 2006 and September 2011). Flooding due to high river levels is not the only concern in the County, there have also been impacts related to poor drainage and flash flooding, with a significant event occurring November 2006 that received a FEMA disaster declaration as well (Broome County Comprehensive Plan, 2012).

Flooding events have had devastating impacts on the County's communities. This includes displacement of residents and businesses and the endangerment of public health and safety. There are long term impacts that include economic hardships for residents, businesses and local municipalities, damage to local infrastructure and negative impacts on local economies. Environmental impacts include disrupted wastewater treatment for treatment plants and private septic systems, as well as the threat of chemicals and other pollutants washed away from flooded commercial and industrial properties (Broome County Comprehensive Plan, 2012).

There is a significant system of publically-owned flood control structures that are operated and maintained by Broome County. There are also several federally-owned flood control structures located in the City of Binghamton, the Towns of Union and Vestal, and the Villages of Endicott, Johnson City, Lisle, Port Dickinson, and Whitney Point. These structures were built by the U.S. Army Corps of Engineers and maintained by the NYSDEC. Broome County owns and maintains 24 flood control structures that are referred to as watersheds (Broome County Comprehensive Plan, 2012).

The local communities of Broome County have incorporated floodplain ordinances into their local codes. These ensure that development within floodplains are built to acceptable standards, minimizing impacts to the structure or neighboring properties and discourage inappropriate land use in the floodplains. Local communities have also participated in the acquisition of properties substantially damaged during flooding events. Development is prohibited on these properties, removing vulnerable structures and adding in flood mitigation (Broome County Comprehensive Plan, 2012).

<u>Stormwater</u>

Broome County has a history of poor drainage and flash flooding events which exacerbates flooding events due to high river levels. Localized flooding and erosion problems lead to significant damage to infrastructure and properties during less significant events. The leading causes of flooding and erosion include: improperly managed stormwater; rain and snow melt that run off surfaces such as rooftops, paved streets, highways and parking lots. This can lead to property damage, cause road safety hazards, and clog catch basins and culverts with sediment and debris. It addition, stormwater carries materials and pollutants from paved surfaces to the waterways, degrading the quality of drinking water, damaging plant and wildlife habitat, and making water resources unsuitable for consumption, recreation or other uses (Broome County Comprehensive Plan, 2012).

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 (or 1% annual chance event). 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 1% (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 1% (100-year) annual chance 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, 2003; FEMA, 2005).

It is important to recognize, however, that flood events and flood risk is not limited to the NFIP delineated flood hazard areas. In fact, in Broome County, significant flood events have resulted in devastating impacts to structures and infrastructure outside of currently mapped floodplains. Developing and maintaining accurate flood risk maps is an ongoing process involving direct input from the impacted communities and the county, and such mapping will only ever be able to help identify areas of statistically higher risk within the limits of current science and understanding of the myriad of factors (weather, topography, hydrology and hydraulics, development, etc.) that affect flooding the region. See Section 4 (County Profile) for information regarding the SFHA updates within Broome County.

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 Broome County has been completed; however, it is a preliminary document. The FIS states that flooding may occur in Broome County during any season of the year, but it is most likely to occur in the late winter-early spring months when melting snow may combine with intense rainfall to produce increased runoff. During the winter, flooding has been a threat when ice and debris jam in the channel and at the bridges. Summer and fall floods occur due to hurricane and thunderstorm activity (FEMA FIS, 2010).

The following discussion presents flood information as directly provided in the FEMA FIS document(s). The 2010 preliminary FIS discussed the principal flood problems in the County.

- **Village of Deposit** – In the Village, flooding on several streams has caused damage. Butler Brook floods almost each year, causing damage to residential, farm, and commercial properties along the eastern side of the Village. Flooding from Big Hollow has also damaged the school and residential properties. Oquaga Creek can flood residential and commercial properties in the area of Borden Street. The West Branch of the Delaware River floods a relatively small area. Some agricultural flood damage above the Pine Street bridge occurs, as well as some residential and commercial flood damage, between Pine Street and the Conrail embankment (FEMA FIS, 2010).

  Most of the Bone Creek channel is now concrete-lined throughout the Village. In 1929, a flood on the Creek led to the subsequent construction of the concrete lined channel (FEMA FIS, 2010).

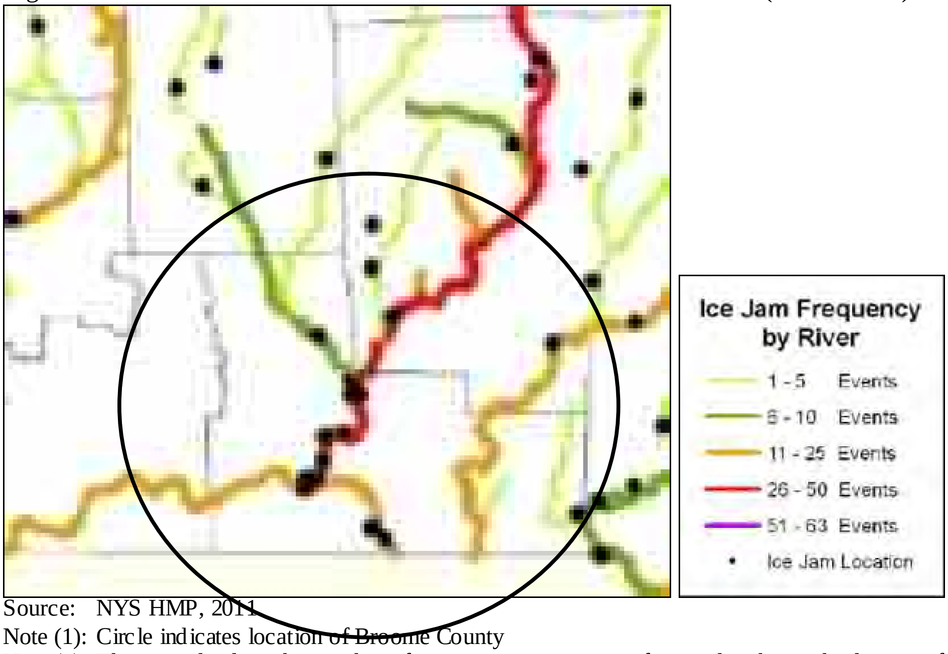
- **Village of Johnson City** – Finch Hollow Creek and Little Choconut Creek are sources of minor flooding in the Village. Flooding on these creeks has basically the same causes as flooding on the Susquehanna River, but with the added effect of backwater from the Susquehanna River (FEMA FIS, 2010).

- **Town of Sanford** – All streams in the Town have caused floodwater damage. The West Branch of the Delaware River floods infrequently; however, when it overflows, it floods a small area throughout the length of the stream, except for a three-mile segment beginning approximately 4,000 feet downstream of the Highway 17 bridge. The most severe flooding along Oquaga Creek occurs in the Hamlet of McClure and at its confluence with Marsh Creek (FEMA FIS, 2010).

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 (NYS HMP 2011). Figure 5.4.1- 2 presents the number of ice jam incidences within the vicinity of Broome County between 1875 and 2007.

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



Source: NYS HMP, 2011
Note (1): Circle indicates location of Broome 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, Broome County experienced 46 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 mis-operation 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 mis-operation 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 4-23 and Figure 4-17 in the County Profile (Section 4) for dams located in Broome County.

The County further notes that there are numerous dams that are below the threshold impoundment size for monitoring by NYSDEC, however such dams still pose significant risk and threat to the region that must be managed to protect public safety.

Additional documentation provided the following information regarding location of flooding in the municipalities of Broome County:

- **Town of Conklin** – The majority of flooding in the Town has occurred from riverine flooding of the Susquehanna River, and to a lesser extent, Snake Creek and Little Snake Creek. The Susquehanna River in the Town is also subject to ice jams and subsequent flooding (Town of Conklin HMP, 2006).
- **Town of Fenton** – There are several flood prone areas within the Town, including most lands along the Chenango River and a large low-lying area between Port Crane and the Page Brook Outlet. There are also 100-year floodplains along Phelps Creek, Page Brook, and Osborne Creek (Town of Fenton Comprehensive Plan, 2007).
- **Town of Triangle** – After the 1935 flood, the U.S. Army Corps of Engineers constructed the Whitney Point Dam on the Otselic River as a unit of the flood control plan for the southern tier of New York State and eastern Pennsylvania communities in the Susquehanna River basin. The Whitney Point Dam forms the Whitney Point Reservoir. The 100-year floodplain within the Town is limited to the area immediately adjacent to the northern and southern portions of the Whitney Point Reservoir. No portions of Page Brook, Ticknor Brook or Halfway Brook are located within the floodplain (Town of Triangle Comprehensive Plan, 2004).
- **Town of Union –** Repetitive loss properties in the Town are located in the Endwell and Fairmount Park areas. These properties are located in 100-year floodplains along the Susquehanna River. The most severe floods in the Town tend to occur in the late winter or early spring. Ice jams cause flooding along the Chenango and Susquehanna Rivers in the Town as well (Town of Union HMP, 2008).

  River Road, Argonne Avenue, Scarborough Drive and Chaumont Drive in Endwell are frequently flooded by the Susquehanna River. When the Susquehanna River reaches a flood stage of 20 to 21 feet, basement flooding occurs on the south side of Argonne Avenue. With more severe flooding at flood stage of 22 to 23 feet, flooding occurs at the Kent Avenue Trailer Park (now defunct) and the lower end of Davis Avenue, Shady Drive, Verdun Avenue, Davis Avenue and Fairmont Avenue. At a flood stage of 25 to 26 feet, the mobile home park is flooded with four feet of water. Houses along Kent Avenue, Shady Drive, Verdun Avenue, Davis Avenue and Fairmont Avenue are also flooded (Town of Union HMP, 2008).

  The Fairmont Park area is subject to the backwater effect from the Susquehanna River along existing water conveyance paths and Gray Creek (Town of Union HMP, 2008).

  Patterson Creek has been subject to flash floods. A dam was constructed on the Creek above Struble Road to provide flood control and flash floods have not occurred since the construction of this dam (Town of Union HMP, 2008).

Nanticoke Creek affects areas in the western part of the Town, including the Route 26, West Corners area, Glendale Drive, and West Endicott. These areas are also subject to the backwater effect of the Susquehanna River. A series of dams were constructed along Nanticoke Creek, including East Branch, Ketchumville Branch, and Bradley Creek, that provide flood control for Nanticoke Creek (Town of Union HMP, 2008).

Little Choconut Creek runs south through Choconut Center into the Village of Johnson City, emptying the Susquehanna River. Flash floods occur along this Creek. Ice jams are also an issue (Town of Union HMP, 2008).

The Westover area is impacted by the backwater effect from the Little Choconut Creek and high water from the Susquehanna River. The area is protected by a system of levees, floodwalls, and closures located on the east, west, and south sides of the Westover area (Town of Union HMP, 2008).

Previous Occurrences and Losses

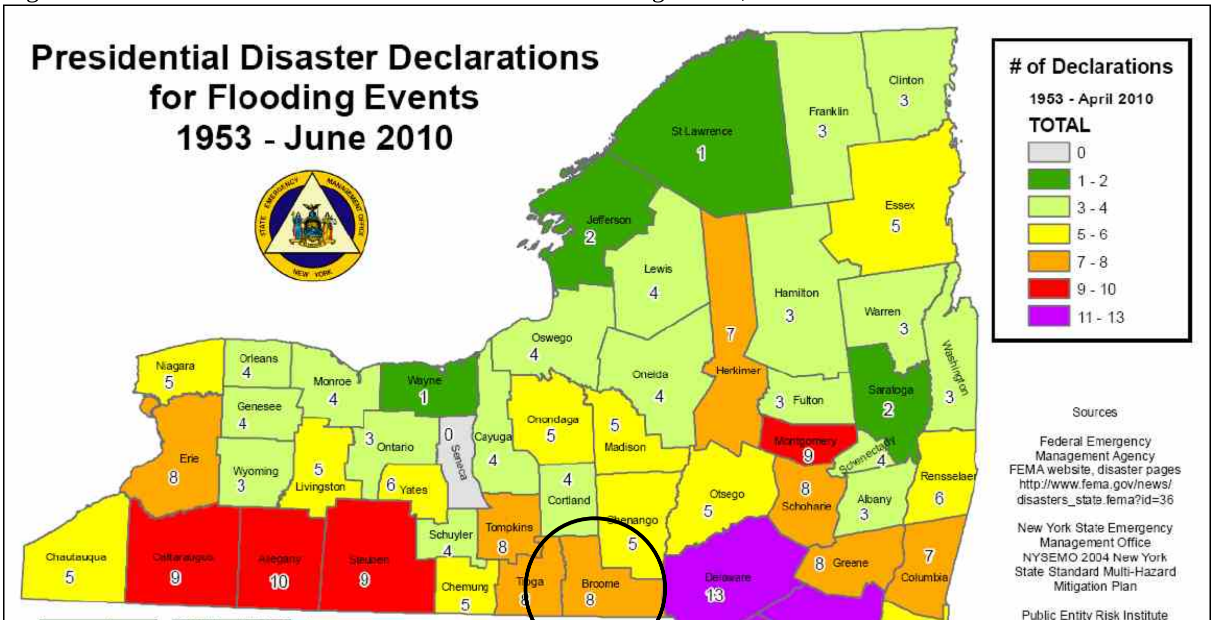
Many sources provided historical information regarding previous occurrences and losses associated with flooding events throughout New York State and Broome County. With so many sources reviewed for the purpose of this HMP, loss and impact information for many events could vary depending on the source. 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, Broome County experienced 132 flood events between April 30, 1950 and August 31, 2012. Total property damages, as a result of these flood events, were estimated at over $1.07 billion. This total may also include damages to other counties. 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, 92 flood events occurred within the County. The database indicated that flood events and losses specifically associated with Broome County and its municipalities totaled over $305.5 million in property damage and over $1.05 million 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 38 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 Broome County has been declared as a disaster area as a result of nine flood events (FEMA, 2012).

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 Broome County was included in eight disaster declarations. Since the date of this figure, Broome County has been included in one additional FEMA disaster declaration 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: NYS HMP 2011
Note: The black circle indicates the approximate location of Broome County.

Based on all sources researched, known flooding events that have affected Broome 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 1903 and 2012

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
1903	Flood	N/A	N/A	The West Branch of the Delaware River overflowed its banks, sending floodwaters through the center of the Village of Deposit. This was one of the largest floods on record.	FEMA FIS
April 8, 1935	Flooding	N/A	N/A	On this date, a 24-hour flood event caused the Dudley Creek and the Tioughnioga, Otselic, and Chenango Rivers to flood. This caused damage to the City of Binghamton, Towns of Lisle and Chenango and the Village of Whitney Point. Four people drowned during this event and six were reported missing or presumed drowned.	Broome County HMP
July 8, 1935	Flooding	N/A	N/A	Flash flooding of the Chenango River caused $1.6 M in damages to the City of Binghamton. The flood event of the Chenango River caused the water level in Chenango Township Chenango Fork Station to rise to 20.3 feet, resulting in serious flooding at Port Crane, Chenango Bridge and Broad Acres.	Broome County HMP
March 18, 1936	Flooding	N/A	N/A	Flash flooding of the Susquehanna River closed bridges in the City of Binghamton, which divided the City into four, disconnected sections. Flooding of the Chenango River at the Washington Street Station caused water to rise to a record high (22 feet), resulting in some evacuation; stop logs being erected at Chamberlain Creek, Conrail Railroad, and Exchange Street Bridge; and many road closures. Vestal Station had record highs during this flood event (up to 30.5 feet).	Broome County HMP
July 3, 1970	Severe Storms and Flooding	DR-290	Yes	The County had approximately $250 K in property damage and $25 K in crop damage. In the Village of Deposit, the flooding damaged over 50 homes and commercial buildings.	FEMA, FEMA FIS, SHELDUS
June 20-25, 1972	Flooding, Severe Storm and TSTM	N/A	N/A	The County had over $1.6 M in property and crop damages from this event.	SHELDUS
March 17-19, 1973	Flooding, Severe Storm and TSTM	N/A	N/A	The County had approximately $200 K in property damages from this event.	SHELDUS
July 11, 1976	Flash Flood	N/A	N/A	This flash flood event resulted from intense rainfall over the Nanticoke Creek watershed and caused $900 K in damage. Approximately 30 homes in the Town of Nanticoke were severely damaged. Both the East Branch and West Branch of the Nanticoke Creeks crested within one hour of the start of the rainfall. Several roads, including State Route 26 at several locations and Pendall Hill Road were overtopped and impassable. The Leekville Road and Dunham Hill Road bridges over the East Branch were washed out. Erosion undermined	FEMA FIS

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
				trailers at the Green Valley Trailer Park in Glen Aubrey.	
December 12, 1983	Flood	N/A	N/A	A flood event on the Susquehanna River included 5.10 inches of rain in 28 hours; over 100 homes and 64 trailers/mobile homes were inundated. The County had over $227 K in property damage from this event.	SHELDUS, Broome County HMP
March 14, 1986	Flooding	N/A	N/A	The County had approximately $1 M in property damage.	SHELDUS
July 31, 1986	Flooding	N/A	N/A	The County had approximately $50 K in property damage.	SHELDUS
August 6, 1986	Flooding	N/A	N/A	The County had approximately $50 K in property damage.	SHELDUS
April 4, 1987	Flooding	N/A	N/A	The County had over $2 M in property damage and over $200 K in crop damage.	SHELDUS
March 29 – April 5, 1993	Flooding	N/A	N/A	The County had approximately $1 M in property damage. In the Town of Union, on April 2, the Susquehanna River crested at a flood stage of 25.6 feet. Argone Avenue and adjacent streets were flooded. Residents were evacuated.	SHELDUS, Town of Union HMP
April 10-14, 1993	Flooding	N/A	N/A	The County had approximately $500 K in property damage. In the Town of Union, on April 11, the Susquehanna River crested at a flood stage of 26.3 feet.	SHELDUS, Town of Union HMP
March 10-11, 1994	Flash Flood	N/A	N/A	Flash flooding of Occanum Creek along Main and Grove Streets occurred in Windsor.	Broome County HMP
March 24-26, 1994	Ice Jam Flooding	N/A	N/A	An ice jam along the Susquehanna River at the Town of Conklin resulted in flooding along River Road.	Broome County HMP
January 19-20, 1996	Severe Storms and Flooding	DR-1095 (IA and PA)	Yes	The City of Binghamton experienced $35 M in damages. In the Town of Chenango, the flood event caused widespread flooding and extensive damage to dozens of town roads. In the Town of Sanford, the event resulted in $296,405.91 in roadway losses within the Town. Many roads were washed out as a result of the flooding. In the Town of Union, the Susquehanna River crested at a flood stage of 27.25 feet (January 19) and 24.6 feet (January 20). A 30-inch snowpack melted within a 48-hour	FEMA, SHELDUS, Broome County HMP, Town of Union HMP

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
				period with two to three inches of rain causing creeks and small streams to overflow. River Road and Argonne Avenue in the Town of Union (hamlet of Endwell) were evacuated. Nanticoke Drive at Bradley Creek Road in Union Center was flooded. Overall, the County had approximately $7.9 M in property damage.	
June 30, 1998	Flash Flood	N/A	N/A	A flash flood event near Chenango Bride on Hiner Park Creek caused the creek to flood its banks and several basement homes were flooded. The County had approximately $10 K in property damage.	SHELDUS, Broome County HMP
July 8, 1998	Flooding	N/A	N/A	The County had approximately $75 K in property damage.	SHELDUS
May 10, 2000	Flooding	N/A	N/A	Flooding occurred throughout the Town of Chenango and resulted in minor roadside erosion damages.	Broome County HMP
April 4, 2000	Flooding	N/A	N/A	A flood event washed out numerous town roads, including Water Street and Dorman, Hand, Dimmock Hill, and Mix Roads. The recovery time for this event was at least four days and the damage included hill road washouts, clogged ditches, and erosion.	Broome County HMP
July 29, 2000	Flooding	N/A	N/A	Flooding impacted the eastern portion of the Town of Chenango. Washouts occurred on hill roads. Barricades and flashing lights were placed on Mix and East Hill Roads until all the washouts could be repaired. Large rocks and mud were present in the roadways. East Hill, Oak Hill, and Mix Roads had to be closed as a result of flooding.	Broome County HMP
May 28, 2002	Flooding	N/A	N/A	The County had approximately $100 K in property damage.	SHELDUS
June 14, 2003	Flooding	N/A	N/A	The County had approximately $100 K in property damage.	SHELDUS
June 16, 2004	Flooding and TSTMs	N/A	N/A	Severe TSTMs and flooding affected the northern part of the Town of Chenango, affecting the hamlet of Castle Creek. Castle Creek flooding and damage occurred to several homes, the Civic Association, and area ball fields.	Broome County HMP
March 4, 2004	Flooding	N/A	N/A	A huge raft of ice broke free on the Chenango River, upstream from Chenango Bridge. That bridge is located a few miles upstream of the merger of the Chenango and Susquehanna Rivers in the City of Binghamton. The ice first jammed against a	SHELDUS, Broome County HMP

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
				railroad bridge and then, the Route 12A Bridge that crosses the river. The jam almost completely blocked the flow of the Chenango River, causing water to back up behind the Route 12A Bridge. This flooded an ice skating rink, a golf course, a parking lot, and an office building which houses a pub, a senator's office, and a financial institution. The NWS in Binghamton issued a Flash Flood Warning to alert residents along the river of the rapid rises that this and other potential ice jams could cause when the ice eventually breaks free and flows downstream. The County had approximately $50K in property damage.	
August 13, 2004	Severe Storm and Flooding	DR-1564	Yes	Remnants of Tropical Storm Bonnie brought heavy rain to the area. This event resulted in roads and bridges being closed in the Town of Windsor, creeks flooding, State Highway 17 being closed between Exit 79 and 80, and a rescue of a woman from a submerged vehicle. In the Town of Sanford, the event resulted in $52,359.85 in roadway losses within the Town.	FEMA, NOAA-NCDC, Broome County HMP
August 30-31, 2004	Flooding	N/A	N/A	The County had approximately $1 M in property damage.	SHELDUS
September 18-19, 2004	Flood (remnants of Hurricane Ivan)	DR-1565	Yes	Remnants of Hurricane Ivan and a slow-moving cold front produced heavy rainfall throughout the Susquehanna River Basin. Rainfall totals ranged between 1.5 inches in the northwest region and over nine inches in the West Branch of the Susquehanna Subbasin. The southern tier of New York State, from Elmira to Binghamton, received four to five inches of rain and areas north of that measured three to four inches. In Broome County, at least 100 homes suffered damaged with 1,000 or more receiving moderate damage. Flooding and evacuations forced over 1,000 people from their homes. Damages were estimated at more than $2 M. In the Town of Sanford, $43,355 in property damage and $30 K in public infrastructure damage was reported. In the Town of Conklin, flooding along Carlin Creek washed out and destroyed a bridge on Karic Road and a culvert on Kethum Road. Eight streets were inundated with water and closed for several days. In the Town of Sanford, flooding resulted in $180,972.47 in roadway losses within the Town. Overall, the County had approximately $14.5 M in property damage.	NWS, FEMA, SHELDUS, SRBC, Broome County HMP

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
November 28, 2004	Flash Flooding	N/A	N/A	Flash flooding occurred throughout the County. Emergency personnel were called in to uncover catch basins and unplug sluice pipes. The County had approximately $50 K in property damage.	SHELDUS, Broome County HMP
April 1-3, 2005	Severe Storms and Flooding	DR-1589 (IA and PA)	Yes	A combination of heavy rainfall and snow melt produced the worst river flooding in almost 70 years across portions of the Upper Susquehanna, Delaware, and Chenango River Basins of Central NY, including Broome County and Northeast Pennsylvania. The flood crest summary indicates that the Chenango Forks River Gauge Station along Chenango River crested at a maximum of 14.34 feet; the Windsor River Gauge Station along Susquehanna River crested at a maximum of 19.07 feet; the Conklin River Gauge Station Along the Susquehanna River crested at a maximum of 18.08 feet; and the Vestal River Gauge Station along the Susquehanna River crested at a maximum of 28.87 feet during this flood event. Overall, Broome County experienced two flood-related fatalities, the evacuation of over 100 people and $3 to $4 M in estimated damages. In the Town of Chenango, approximately two to three inches of rain fell and caused one of the worst floods in 70 years. The Town experienced approximately $45,249.94 in property damages. In the Town of Conklin, flooding of the Susquehanna River led to the closure of NYS Route 7 (Conklin Road) and twelve streets. The streets were re-opened after the water subsided and highway crews cleaned mud and debris from the roadways. In the Town of Sanford, $78,464 in property damage and $52,642 in public infrastructure damage occurred. $164,474.59 in roadway losses within the Town. Primary damage occurred along Reservoir, Terry, Smith, Huggins and Perry Roads. In the Village of Port Dickinson, the flooding caused the Village to suffer heavy losses (approximately $22,000). Most of the damage was to the village park. Some basements flooded and minor street damage also occurred. Village park damage included fence and picnic bench damage, baseball dirt erosion, and material under playground equipment being swept away.	FEMA, NOAA-NCDC, SHELDUS, NWS, Broome County HMP
June 26-29, 2006	Severe Storm and Flooding	DR-1650 (IA and PA)	Yes	This event affected Broome, Chenango, Delaware, Herkimer, Montgomery, Oneida, Orange, Otsego, Schoharie, Sullivan,	FEMA, NOAA-NCDC, SHELDUS,

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
				Tioga, and Ulster Counties. It resulted in federal funding to state and eligible local governments and certain non-profit organizations on a cost-sharing basis for debris removal and emergency protective measures, including direct federal assistance. $227 M was approved or obligated for assistance to families and individuals, as well as public entities who suffered damage from this event. Various repairs, improvements and equipment replacements have been underway to improve the poor conditions throughout those counties affected by the floods, including Broome County. A $220,000 project to repair and improve Endicott School damages in Broome County (total damage is near $2 million) was approved in April 2007. A $98,000 project to repair and improve the Town of Kirkwood Sewer Station was also approved in April 2007. The NYSDOH assessed the impacts on the victims who were evacuated from nursing homes and hospitals, including issues such as medication and life support for the 165 displaced residents of a nursing home in Vestal and 80 patients at the Lady of Lourdes Hospital in Binghamton, NY. Additionally, several state parks and historic sites in the central region, including Broome County, were closed to the public. Flood damage included roads and beaches, water system closures and/or damage and overflow of sewage treatment plants. In Broome County, record setting river levels occurred along Susquehanna and Chenango Rivers. The Susquehanna River at Vestal exceeded its 18-foot flood stage by more than 15 feet (approx. 31 feet.), breaking the previous records by 2.5 feet. A shortage in the supply of clean water occurred. Thousands of residents were without electricity and/or gas service (approximately 16,000 electric and 1,500 gas customers of NYS Electric and Gas Corp. (NYSEG) were impacted). Broome County infrastructure was significantly impacted. Highways, roads, streets and bridges were water-covered, washed out, or closed. Municipal water and sewage treatment facilities were also impacted and/or shut-down. Boil-water advisories were issued in the Towns of Windsor and Vestal because pumps were shutting down, resulting in a loss of pressure and increasing the chance of contaminated water. Water and waste water treatment plants were also shut down in the Village of Endicott and Johnson City. Hospitals were forced to evacuate	Broome County HMP

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
				patients or reduce services. Lourdes Hospital joined a mandatory evacuation of the City of Binghamton's low-lying areas, sending about 90 patients to Wilson Memorial and Binghamton General Hospitals. Multiple rescues of residents were made by ground, boat and helicopter. Two men were swept downstream in Kirkwood and were rescued by emergency volunteers. Evacuation Shelters were opened, including the Binghamton University Events Center, which housed over 1,000 evacuees. Tri-Cities Airport was completely inundated with flood waters. Twenty families along the Chenango River were evacuated in the Town of Chenango. The Union-Endicott High School's Ty Cobb Stadium was water-covered in the Village of Endicott. Many sections of the high school also experienced flooding. Many campgrounds and mobile home parks were damaged (including, the Pine Crest Campgrounds in the Town of Windsor). Residential homes were removed from their foundations or experienced explosions as a result of cascading impacts of the flood. A home along the Susquehanna River in the Town of Conklin was dragged off its foundation near Schnurbush Park. Also, a house along the Susquehanna River exploded in the Town of Conklin, which created additional damage to homes surrounding the explosion. The Boys and Girls Club in Endicott was completely surrounded by flood water.	
November 16-17, 2006	Severe Storm and Flooding	DR-1670	Yes	A line of thunderstorms produced 45 to 74 mph winds across a large part of central New York State. Additionally, the squall line spawned an F1 tornado north of the Town of Elmira. Areas from Oswego and Binghamton, north and east through Ithaca, Cortland and Norwich, to Oneida County in the western Mohawk Valley and the northern Catskills saw the brunt of the heavy rainfall from this slow moving line of storms. Between 1.5 inches and four inches of rain fell in just three hours, causing significant flash flooding over many of these areas. Many hillsides and creeks turned into raging torrents, causing mudslides and debris flows that cascaded into more populated valley areas. The flash flooding evolved into a minor to moderate river flood event mainly on the Susquehanna River and its tributaries in New York. This disaster resulted in the federal approval of more than $19.1 M in New York State. In Broome County, flooding along the Vestal Parkway occurred in the Town of Vestal. The rain caused the Susquehanna River	FEMA, NOAA-NCDC, SHELDUS, Broome County HMP

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
				to exceed its 18 foot flood stage and crested at 21.76 feet. In the Town of Union, multiple houses flooded and a road collapsed. In the City of Binghamton, three feet of water accumulated on Vestal Avenue. Minor flooding was observed along the Susquehanna River at Washington Street. In the Village of Endicott", numerous roads flooded. In the Town of Port Crane, a mudslide occurred on Interstate 88 and resulted in a multi-injury car accident. In the Chenango Forks area of the Town of Chenango, the Chenango River crested at 10.89 feet and minor flooding was observed. In the Town of Conklin, the Susquehanna River crested at 11.55 feet. Overall, the County experienced approximately $250 K in property damage.	
March 15-16, 2007	Flood	N/A	N/A	A widespread rainfall melted snowpack, causing many rivers and creeks to exceed their flood stages. In the Susquehanna and Chemung River Basins and the Finger Lakes, rainfall ranged between 0.75 and 1.5 inches. The Susquehanna River in the Town of Conklin reported significant flood damage. It crested at 10 feet. Twenty homes, one business and five roads were flooded. An ice jam was associated with this flooding. In Broome County, minor flooding occurred along the Susquehanna River in the Town of Vestal and it crested at 19.1 feet. In the Town of Conklin, the Susquehanna River crested at 13.2 feet. Overall, the County had approximately $255 K in property damage.	NOAA-NCDC
January 25, 2010	Flash Flood	N/A	N/A	Mild temperatures combined with rain caused flash flooding in isolated areas. In Tracy Creek, heavy rains caused flooding along Tracy Creek Road as well as parts of the Vestal Parkway. Several homes were flooded in the Vestal Center area. In the Twin Orchard area of the Town of Vestal, several roads were flooded. The Interstate 81 South to Route 17 West ramp was partially closed due to a landslide off Prospect Mountain. In the Town of Maine, Route 26 was flooded. Overall, the County had approximately $130 K in property damage.	NOAA-NCDC, SHELDUS
September 30, 2010	Flash Flood (Remnants of Tropical Storm Nicole)	N/A	N/A	Remnants of Tropical Storm Nicole brought between three and six inches of rain across central New York State. In Broome County, several areas in the western part of the County experienced problems due to flash flooding. The Village of Endicott, the Endwell area of the Town of Union, and the Town of Maine reported several roads flooded, washouts and basement flooding. Several vehicles were stranded due to high	NOAA-NCDC

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
				water at road intersections and in parking lots. The County had approximately $50 K in property damage.	
April 26 – May 8, 2011	Severe Storm, Flooding, Straight-Line Winds	DR-1993	Yes	A significant severe weather outbreak developed across central New York State as a storm system moved east from the Great Lakes. First, showers and TSTMs developed early in the evening on the 27th, as an upper level disturbance approached the region. Two of the more significant storms included one supercell that produced a tornado in Steuben County caused tree and structural damage across Steuben, Chemung and Schuyler counties. Elsewhere across central New York, storms caused scattered wind damage and heavy rain. Broome County experienced significant flash flooding, especially along the Route 26 corridor. Route 26 was closed between the hamlet of Glen Aubrey and the Village of Whitney Point, with 18 houses cut off by flood waters. Nanticoke Creek in the Town of Maine flooded many homes, with water up to the first floor of some homes. About 150 people were evacuated and two shelters were set up. The County experienced approximately $4 M in property damages.	FEMA, NOAA-NCDC
August 27-28, 2011	Hurricane Irene	EM-3328/DR-4020	No	Hurricane Irene brought heavy rains and high winds from northeast Pennsylvania to the Catskill Mountains of New York. Rainfall totaled from two to five inches over most of northeast Pennsylvania and in the Susquehanna Region of central New York. Between four and eight inches of rain fell in the western Catskills with portions of Wyoming and northern Susquehanna Counties in northeast Pennsylvania and southern Broome County in New York receiving six to eight inches of rain. In addition to the heavy rains, high winds from the storm knocked down numerous trees and power-lines across Broome, Delaware, Sullivan and Otsego Counties in New York. During the height of the storm, over 40,000 residences were without power. In some cases, power was not restored for one week. In Broome County, heavy rains in the Town of Conklin (hamlet of Conklin Forks) caused flooding along Pierce Creek Road. In the Town of Conklin, the Susquehanna River at Conklin crested at 16.34 feet. Many roads were flooded in the Town of Kirkwood area and several roads and one bridge were closed due to flash flooding. In the Town of Vestal, major flash flooding occurred along the Choconut Creek and many roads were	FEMA, NOAA-NCDC

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
				flooded. In Vestal Center, West Hill and Juneberry Roads were closed due to water over bridges. In Stella, numerous roads were closed due to water over bridges. Overall, the County experienced approximately $375 K in property damage.	
September 7-8, 2011	Remnants of Tropical Storm Lee	EM-3341/DR-4031	Yes	Remnants of Tropical Storm Lee brought between six and 12 inches of rain over most of the upper Susquehanna River Basin. The heavy rain caused massive, record breaking flooding on small streams, creeks, and the Susquehanna River and its larger tributaries. In Broome County, the main branch of the Susquehanna River from the City of Binghamton to the Towns of Vestal, Owego, and Waverly crested from one to four feet higher than the previous record set in June 2006. In the Town of Conklin, the Susquehanna River crested at 23.94 feet. Catastrophic flooding occurred in Binghamton, Town of Vestal, Village of Endicott, the Endwell section of the Town of Union, and Chenango Valley areas. Numerous roads, bridges, and homes were severely damaged. Deep ponding of water occurred below underpasses. In the Town of Endicott, flooding occurred along the Nanticoke Creek in the hamlet of West Corners. Numerous roads, homes, and bridges were severely damaged. In the Town of Chenango, the river crested at 14.93 feet at Chenango Forks. Overall, the County had approximately $502.8 M in property damage.	FEMA, NOAA-NCDC

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.

DR	Federal Disaster Declaration
EM	Federal Emergency Declaration
FEMA	Federal Emergency Management Agency
FSA	Farm Service Agency
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
PA	Public Assistance
SHELDUS	Spatial Hazard Events and Losses Database for the U.S.
SRBC	Susquehanna River Basin Commission

Agriculture-related flood disasters are quite common. One-half to two-thirds of the counties in the U.S. have been designated as disaster areas in each of the past several years. The Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency loans (EM) to producers suffering losses in those counties and in counties that are contiguous to a designated county. Table 5.4.1- 2 summarizes the USDA disaster designations for flood-related events.

Table 5.4.1- 2. USDA Disaster Designations

Incidence Period	Event Type	USDA Declaration Number	County Designated?*	Losses / Impacts	Source(s)
5/11/2006	Flood	S2412	Yes	Production losses were attributed to excessive rain, flooding, flash flooding, and hail	USDA
November 16 to 17, 2006	Flood	M1670	Yes	Production and physical losses were attributed to severe storms and flooding	USDA
May 3, 2008	Flood	S2794	Yes	Production losses were attributed to excessive rain, hail, high wind, flooding, flash flooding, and lighting	USDA
June 1 to August 25, 2009	Flood	S2894	Yes	Production losses were attributed to excessive rain, flooding, flash flooding, hail, and high winds	USDA
April 26 to May 8, 2011	Flood	M1993, Amendment 1	Yes	Physical losses were attributed to severe storms, flooding, and tornadoes.	USDA
August 27 to September 15, 2011	Flood	S3203	Yes	Production and physical losses were attributed to flooding, flash flooding, and severe weather during Hurricane Irene	USDA
September 4 to 14, 2011 (S3207) September 7, 2011 and continuing (M4031)	Flood	S3207 M4031	Yes	Production and physical losses were attributed to flooding, flash flooding, and severe weather during and remnants of Tropical Storm Lee	USDA
October 28 to 31, 2012	Hurricane	S3442	No	Production and physical losses were attributed to Hurricane Sandy	USDA

Source: USDA, 2012

*Disaster event occurred within the county.

M	Presidential Major Disaster Declaration
N	Administrative Physical Loss Notification
S	Secretarial National Disaster Determination
USDA	United States Department of Agriculture

According to the CRREL database, ice jams have historically formed at various points along the Chenango River, Oquaga Creek, Susquehanna River and the Tioughnioga River (Ice Engineering Research Group, 2011). Locations of historical ice jam events are indicated in Figure 5.4.1- 4 below.

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

Source: CRREL, 2012

Based on review of the CRREL Database, Table 5.4.1-3 lists the ice jam events that have occurred in Broome County between 1900 and 2012. Information regarding losses associated with these reported ice jams was limited.

Table 5.4.1-3. Ice Jam Events in Broome County between 1900 and 2012

Date	River / Location	Description	Source(s)
March 24, 1904	Susquehanna River at Binghamton	No reference and/or no damage reported.	CRREL
February 21, 1918	Susquehanna River at Conklin	No reference and/or no damage reported.	CRREL
February 26, 1918	Chenango River at Chenango Forks	No reference and/or no damage reported.	CRREL
March 13, 1920	Chenango River at Chenango Forks	No reference and/or no damage reported.	CRREL
March 13, 1920	Susquehanna River at Conklin	No reference and/or no damage reported.	CRREL
February 24, 1922	Chenango River at Chenango Forks	Maximum annual gage height of 11.82 feet, affected by backwater from ice, reported at USGS gage Chenango River near Chenango Forks.	CRREL
March 24, 1926	Chenango River at Chenango Forks	Maximum annual gage height of 13.54 feet, affected by backwater from ice, reported at USGS gage Chenango River near Chenango Forks. Additional ice-affected gage height of 10.71 feet, reported on March 25, 1926. Discharge about 19,900 cfs.	CRREL
March 4, 1934	Chenango River at Chenango Forks	Maximum annual gage height of 10.50 feet, affected by backwater from ice, reported at USGS gage Tioughnioga River at Itaska.	CRREL
March 4, 1934	Tioughnioga River at Itaska	Maximum annual gage height of 10.50 feet, affected by backwater from ice, reported at USGS gage Tioughnioga River at Itaska, on March 4, 1934.	CRREL
February 20, 1939	Tioughnioga River at Itaska	Maximum annual gage height of 12.16 feet, affected by backwater from ice, reported at USGS gage Tioughnioga River at Itaska, on February 20, 1939. Discharge 15,300 cfs.	CRREL
March 31, 1940	Tioughnioga River at Itaska	Maximum annual gage height of 10.63 feet, affected by backwater from ice, reported at USGS Tioughnioga River at Itaska, on March 31, 1940. Additional ice-affected gage height of 9.63 feet, reported on April 1, 1940. Discharge 15,000 cfs.	CRREL
February 25, 1943	Susquehanna River at Conklin	Gage height of 15.26 feet, affected by backwater from ice, reported at USGS gage Susquehanna River at Conklin, on February 25, 1943. Discharge 27,500 cfs. Bankfull stage 17 ft.	CRREL
March 17, 1944	Tioughnioga River at Itaska	Maximum annual gage height of 9.05 feet, affected by backwater from ice, reported at USGS gage Tioughnioga River at Itaska, on March 17, 1944. Discharge 12,500 cfs.	CRREL
March 18, 1944	Susquehanna River at Conklin	USGS reported a gage height of 15 ft and a discharge of 30,000 cfs on March 18, 1944 on the Susquehanna River at Conklin, NY due to backwater from ice.	CRREL
January 3, 1945	Susquehanna River at Binghamton	Weather Bureau reports ice jam upstream from gage Susquehanna River at Binghamton on January 3 through 17, 1945. Maximum stage 6.8 ft January 3, minimum stage 3.1 ft January 17. Ice jams reported both upstream and downstream from gage on January 18 through	CRREL

Date	River / Location	Description	Source(s)
		January 16. Peak stage during this period 5.0 ft on January 27. Ice jam downstream from gage only on February 17 through 23. Peak stage during this period 4.9 ft on February 23. Ice jam upstream from gage only on February 25 through March 3. Maximum stage during this period, 8.7 ft February 28, minimum stage, 6.8 ft March 3. Gage datum 821.49 ft MSL, flood stage 14 ft.	
January 4, 1945	Chenango River at Binghamton	Weather Bureau reports ice jam upstream from gage Chenango River at Binghamton on January 4 through March 4, 1945. Peak stage 15.4 ft at 2200 hours on March 4, 1945.	CRREL
February 27, 1945	Tioughnioga River at Itaska	Maximum annual gage height of 10.34 feet, affected by backwater from ice, reported at USGS gage Tioughnioga River at Itaska, on February 27, 1945.	CRREL
March 3, 1945	Chenango River at Chenango Forks	Maximum annual gage height of 13.29 feet, affected by backwater from ice, reported at USGS gage Chenango River near Chenango Forks, on March 3, 1945.	CRREL
March 4, 1945	Susquehanna River at Conklin	Gage height of 13.76 feet, affected by backwater from ice, reported at USGS gage Susquehanna River at Conklin, on March 4, 1945. Discharge 24,900 cfs. Bankfull stage 17 ft.	CRREL
March 16, 1948	Tioughnioga River at Itaska	Maximum annual gage height of 9.67 feet, affected by backwater from ice, reported at USGS gage Tioughnioga River at Itaska, on March 16, 1948.	CRREL
January 28, 1954	Chenango River at Chenango Forks	Maximum annual gage height of 9.02 feet, affected by backwater from ice, reported at USGS gage Chenango River near Chenango Forks, on January 28, 1954.	CRREL
February 11, 1955	Oquaga Creek at Deposit	Gage height of 5.70 feet, affected by backwater from ice, reported at USGS gage Oquaga Creek at Deposit, on February 11, 1955.	CRREL
February 28, 1955	Tioughnioga River at Itaska	Maximum annual gage height of 8.98 feet, affected by backwater from ice, reported at USGS gage Tioughnioga River at Itaska, on February 28, 1955.	CRREL
January 22, 1957	Oquaga Creek at Deposit	Maximum annual gage height of 6.25 feet, affected by backwater from ice, reported at USGS gage Oquaga Creek at Deposit, on January 22, 1957.	CRREL
January 24, 1957	Tioughnioga River at Itaska	Maximum annual gage height of 11.38 feet, affected by backwater from ice, reported at USGS gage Tioughnioga River at Itaska, on January 24, 1957.	CRREL
January 22, 1959	Chenango River at Chenango Forks	Maximum annual gage height of 11.32 feet, affected by backwater from ice, reported at USGS gage Chenango River near Chenango Forks, on January 22, 1959. Discharge about 20,000 cfs.	CRREL
January 29, 1959	Tioughnioga River at Itaska	Maximum annual gage height of 10.39 feet, affected by backwater from ice, reported at USGS gage Tioughnioga River at Itaska, on January 29, 1959. Additional ice-affected gage height of 9.66 feet, reported on January 29, 1959.	CRREL

Date	River / Location	Description	Source(s)
March 19, 1963	Tioughnioga River at Itaska	The maximum annual gage height of 11.39 ft was recorded on the Tioughnioga River at Itaska, NY, which was caused by an ice jam. The associated discharge was 3,750 cfs.	CRREL
January 25, 1979	Susquehanna River at Conklin	The USGS reported backwater from ice on the Susquehanna River at Conklin. The water discharge was 17,000 cubic feet per second, gage height was 15.70 ft.	CRREL
February 26, 1979	Susquehanna River at Conklin	The USGS reported an ice jam on the Susquehanna River at Conklin, NY. The water discharge was 14,000 cubic feet per second, gage height was 11.04 ft.	CRREL
March 28, 1992	Susquehanna River at Conklin	An ice jam caused the river to back up just above Conklin, NY. Flooding was reported around the Alta Road area. Flood stage at 11.0 ft. and observed stage at 11.9 ft. - at 11 ft. Riverside Yards started to flood.	CRREL
February 22, 1994	Susquehanna River at Conklin	An ice jam on the Susquehanna River in the vicinity of Kirkwood caused rapid rises on the river in Conklin and Kirkwood. The river rose over 1.5 feet. The ice jam on the Kirkwood-Conklin bridge broke up but a lot of ice was still in the river.	CRREL
March 23, 1994	Susquehanna River at Conklin	An ice jam developed on the Susquehanna River in the Town of Conklin. Minor flooding was reported near River Boulevard.	CRREL
January 19, 1996	Susquehanna River at Conklin	NWS reported an ice jam on the Susquehanna River near Conklin, NY causing river levels to rise. Rising water levels resulted in flooding of fields and yards.	CRREL
January 19, 1996	Tioughnioga River at Itaska	No reference and/or no damage reported.	CRREL
January 19, 1996	Tioughnioga River at Itaska	No reference and/or no damage reported.	CRREL
January 20, 1996	Susquehanna River at Windsor	Maximum gage height of 21.22ft due to an ice jam at USGS gaging station 01502731 Susquehanna River at Windsor, NY. The average daily discharge was 40,000cfs.	CRREL
January 31, 1997	Chenango River at Chenango Forks	Minor backwater has been reported as a result of one minor ice jam located on the Chenango River below the confluence of the Tioughnioga River. Water continues to flow through the jam.	CRREL
March 3, 2004	Chenango River at Chenango Forks	NWS reported that some ice movement and jamming was causing backwater near the Chenango Forks stream gage. The flood stage there is 10 feet and the stage at 200 PM was 9.8 feet, with minor flooding beginning at 10 feet.	CRREL
March 4, 2004	Chenango River at Chenango Bridge	The NWS reported a large ice jam on the Chenango River in Chenango Bridge, NY on March 4, 2004. The ice jam was reported just west of the Route 12A Bridge and was causing flooding to low lying areas on the north side of the river. Two businesses were evacuated. The water raised high enough to flood the Chenango Commons Golf Course and Polar Cap Ice Rink. The ice moved out by late afternoon,	CRREL

Date	River / Location	Description	Source(s)
		March 4th, relieving the region of ice jam flooding.	
January 27, 2005	Chenango River at Dickinson/Binghamton	The NWS reported that freeze-up ice accumulations on the Chenango River from the Binghamton City line up through Chenango Bridge to Port Crane was restricting flow on the river and causing backwater effect. These effects were visible at the USGS gage Chenango River near Chenango Forks some 3.5 miles upstream from Port Crane. The NWS predicted that minor flooding might occur - that is, water might rise briefly out of bank, causing basement flooding, but not life threatening.	CRREL
March 15, 2007	Susquehanna River at Corbettsville	The NWS in Binghamton NY issued a Flood Statement for the Susquehanna River in Broome County, NY and Susquehanna County, PA. Heavy rain and melting snow caused several area rivers to flood, and river ice to move and form a significant jam at Corbettsville NY. The stage was 13.0 feet; flood stage is 11.0 feet. Minor flooding was occurring and moderate flooding was forecast, with an anticipated crest Friday morning at 13.0-13.5 feet. The river level at the jam, located just upstream from the USGS gage #01503000 at Conklin NY, was reported to be about 5 feet higher, which was causing significant flooding from Corbettsville to Great Bend, PA. Several residences in the immediate river flood plain in NY had been evacuated due to the flooding. At 4 PM Friday, the stage at Conklin was 12.9 feet, with the river forecast to fall below flood stage late Saturday afternoon. At 8 PM Saturday, the stage was 10.9 feet, cancelling the flood warning. The ice jam was still in place, however, which could cause fluctuations in the water level, and some localized flooding in the flood plain near the river.	CRREL
February 12, 2009	Chenango River at Chenango	No reference and/or no damage reported.	CRREL
February 12, 2009	Chenango River at Chenango	No reference and/or no damage reported.	CRREL
February 12, 2009	Susquehanna River at Conklin	Flooding occurred along the Susquehanna River, in the vicinity of Route 11, due to an ice jam, requiring the evacuation of at least one home. Warm temperatures and rain over the previous days, prompted runoff into the river, resulting in river ice running and jamming. The hydrograph of USGS gage at Conklin NY, #01503000, indicates that the stage rose to about 11.6 feet, above the flood stage of 11.0 ft.	CRREL
March 7, 2011	Susquehanna River at Windsor	Heavy rain prompted river runs across northern New England, with numerous ice jams across the region. The Susquehanna River jammed causing the stage at Windsor NY to be just above the 17.0 ft flood stage, at 17.2 ft. At a stage of 17.0 ft, minor flooding begins in the Windsor area affecting low lying and agricultural areas. The stage had	CRREL

Date	River / Location	Description	Source(s)
		risen to 18.3 ft with minor flooding occurring and moderate flooding forecast.	

Source: CRREL, 2012
Note: Although many events were reported for Broome 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 Broome County is presented further in Table 5.4.1-11 in the Vulnerability Assessment section of this profile.

As an additional component of NFIP, the Community Rating System (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, 2012).

Probability of Future Events

Given the history of flood events that have impacted Broome 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.

It is estimated that Broome County will continue to experience direct and indirect impacts of floods annually. Table 5.4.1-4 summarizes the occurrences of winter storm events and their annual occurrence (on average).

Table 5.4.1-4. Occurrences of Flood Events in Broome County, 1956 - 2011

Event Type	Total Number of Occurrences	Annual Number of Events (average)
Flash Flood	67	1.2
Urban Flood	4	0.07
Flood	61	1.1

Event Type	Total Number of Occurrences	Annual Number of Events (average)
Total:	**132**	**2.4**

Source: NOAA-NCDC, 2011
Note: On average, Broome County experiences 2.4 flood events each year.

In Section 5.3, the identified hazards of concern for Broome 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. Broome County is part of Region 3, Southern Tier. Some of the issues in this region, affected by climate change, include: dairy dominates agricultural economy, milk production losses projected, Susquehanna River flooding increases and Region 3 was one of the first areas of New York State hit 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 to 5.5ºF by the 2050s and 4 to 9ºF 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 5.4.1-5 displays the projected seasonal precipitation change for the Southern Tier ClimAID Region (NYSERDA, 2011).

Table 5.4.1-5. Projected Seasonal Precipitation Change in Region 3, 2050s (% change)

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

Source: NYSERDA, 2011

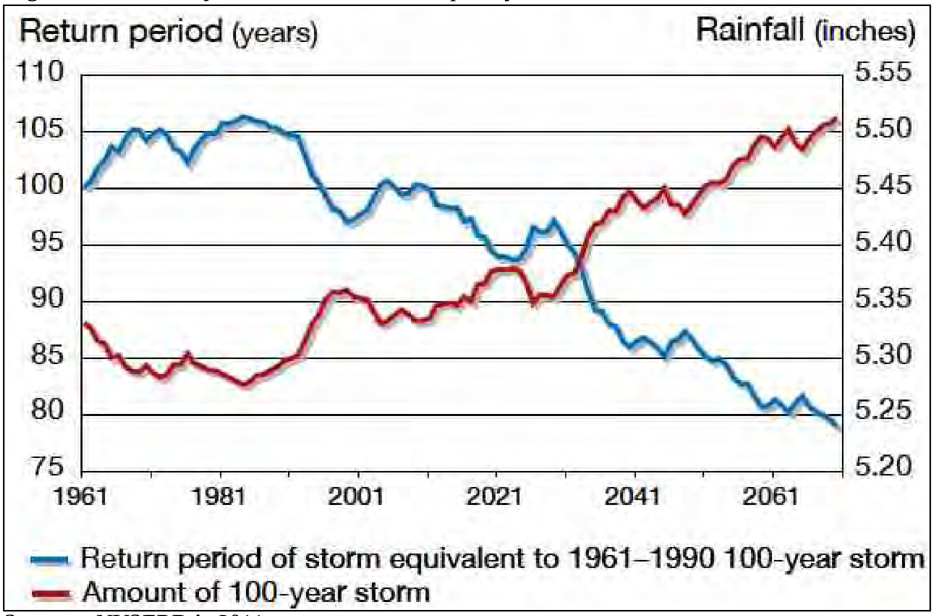
The projected increase in precipitation is expected to fall in heavy downpours and less in light rains. The increase in heavy downpours has the potential to affect drinking water; heighten the risk of riverine flooding; flood key rail lines, roadways and transportation hugs; and increase delays and hazards 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 1% annual chance (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).

Broome County Early Demonstration Project

This project includes Flood Risk MAP products for Broome County communities that include: the City of Binghamton, the Towns of Union and Vestal, and the Villages of Johnson City and Endicott. The desired outcomes of this project is to improve the community risk understanding, especially after the levee de-accreditation, through the usage of Risk MAP projects; and to engage the community in specific areas of mitigation interest, focusing in the area that the City of Binghamton has planned for urban development. According to the preliminary maps and re-studied flooding sources, this area is now part of the Special Flood Hazard Area (SFHA). The Susquehanna and Chenango Rivers are identified as flooding sources in this study.

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 1% and 0.2% (100- and 500-year) floodplains. The following text evaluates and estimates the potential impact of flooding in Broome County including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on: (1) life, safety and health, (2) general building stock, (3) critical facilities and infrastructure, (4) economy and (5) future growth and development
- Effect of climate change on vulnerability
- Change of vulnerability as compared to that presented in the 2007 Broome County Hazard Mitigation Plan
- Further data collections that will assist understanding of this hazard over time

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 including riverine, dam failure, ice jams, and flash flooding, is a major concern for Broome County. To assess vulnerability, potential losses were calculated for the County for riverine flooding for 1% and 0.2% annual chance flood events. Historic loss data associated with ice jam events and dam failures is limited and as such impacts and losses are examined in light of historical information available and are treated similar to flash flood events. The Broome County flood hazard exposure and loss estimate analysis is presented below.

Data and Methodology

The 1- and 0.2-percent annual chance flood events were examined to evaluate Broome County's risk and vulnerability to the flood hazard. These flood events are generally those considered by planners and evaluated under federal programs such as the NFIP.

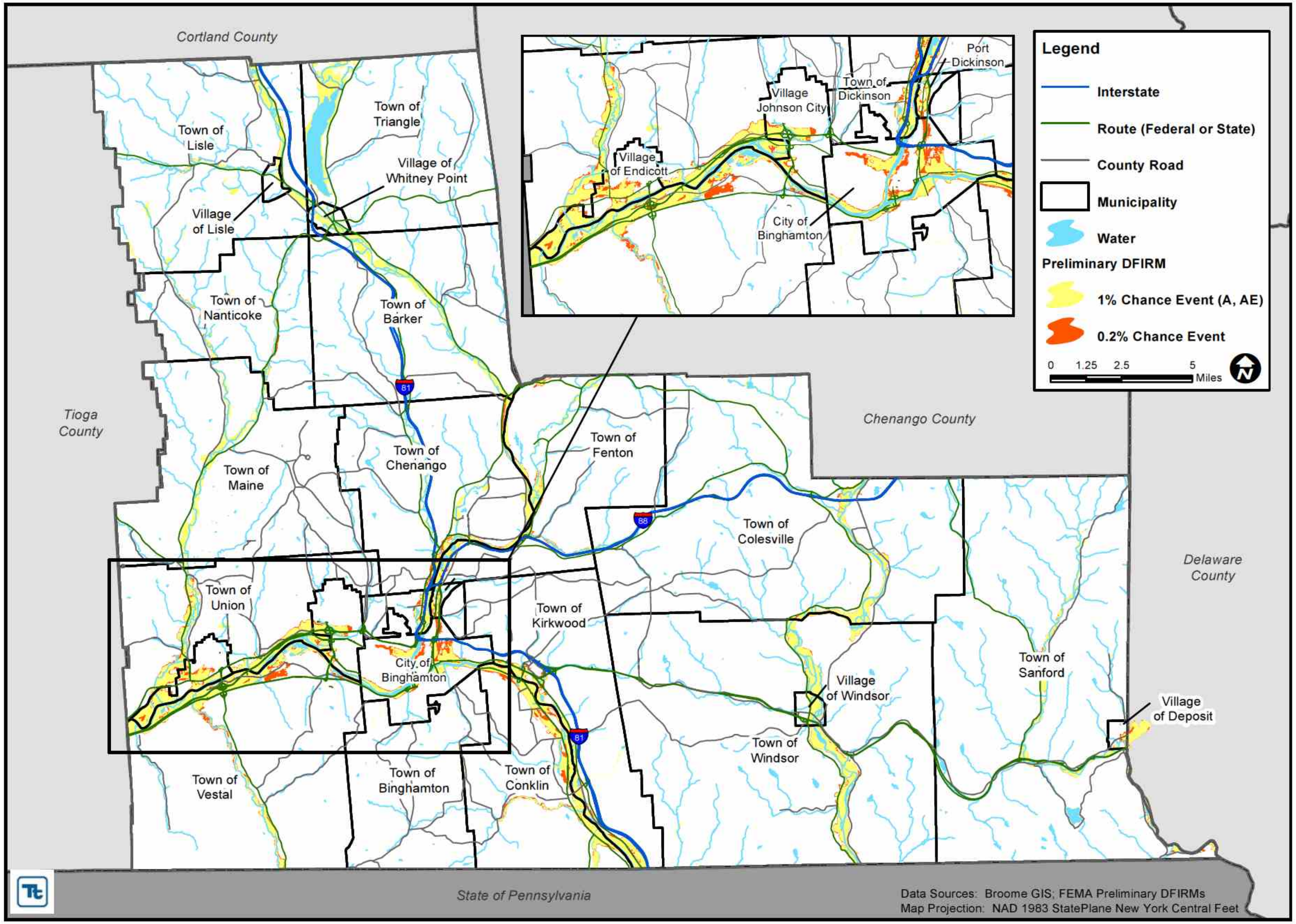
The HAZUS-MH version 2.1 riverine flood model was used to estimate Broome County's estimated potential losses. HAZUS-MH applies engineering and scientific risk calculations that have been developed by hazard and information technology experts to provide defensible damage and loss estimates. These methodologies are accepted by FEMA and provide a consistent framework for assessing risk across a variety of hazards. The GIS framework also supports the evaluation of hazards and assessment of inventory and loss estimates for these hazards. HAZUS-MH can serve as a basis to quantify risk and to allocate limited resources for prioritization of mitigation projects. Refer to the Methodology section of this Plan for further details on HAZUS-MH.

The HAZUS-MH flood model is designed for three levels of analysis. A Level 1 analysis is the simplest type of analysis based on default data provided with the software. A Level 2 analysis provides a more tailored, accurate result using building attributes provided by the County. A Level 2 HAZUS-MH riverine flood analysis was performed for Broome County. For this update, the default general building stock in HAZUS-MH was updated and replaced with a custom inventory at the structure and aggregate level. The building inventory generated by FEMA and described in the *Flood Risk Report* (February 2011) for the City of Binghamton, Village of Endicott, Village of Johnson City, Town of Union, and Town of Vestal was used. Tetra Tech updated the replacement cost values (structure and contents) using RSMeans 2011 data. The inventory for the remainder of the County was developed using parcels and 911 address points. The updated building inventory (76,634 buildings) was incorporated into the HAZUS-MH flood model as individual buildings. Examining risk at the individual building level versus running the model and reporting results at the aggregate level (Census block level as per the analysis provided in the original Broome 2007 Hazard Mitigation Plan) provides more accurate potential loss estimates. An updated critical facility inventory was used in place of the HAZUS-MH defaults for essential facilities and utilities.

Broome County's Flood Insurance Rate Maps (FIRMs) are currently being updated and the latest versions are considered preliminary. Their preliminary Digital FIRMS (DFIRMs), considered the best available data, were used for analysis. A 3-meter Digital Elevation Model (DEM) and the preliminary DFIRM database, both provided by the County, were used to develop the estimated 1-percent and 0.2-percent annual chance depth grids. The depth grids were integrated into HAZUS-MH and the model was run to estimate potential losses.

The HAZUS-MH model uses 2000 U.S. Census demographic data. This data was not updated for this analysis due to technical availability; however, the 2010 U.S. Census data was used to estimate population exposure to provide the best available output. In addition, to estimate exposure, the preliminary DFIRM flood boundaries were used. HAZUS-MH 2.1 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 the FEMA DFIRM flood boundaries used for this vulnerability assessment.

Figure 5.4.1-6. Broome County DFIRM 1-Percent and 0.2-Percent Flood Zones



Source: Broome County GIS; FEMA, 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 strictly measurable.

To estimate the population exposed to the 1-percent and 0.2-percent annual chance 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 that 'intersect' in the flood boundaries were used to calculate the estimated population exposed to this hazard. Table 5.4.1-6 lists the estimated population located within the 1-percent and 0.2-percent flood zones by municipality.

Table 5.4.1-6. Estimated Broome County Population Vulnerable to the 1-Percent and 0.2-Percent Flood Hazards (2010 Census)

Municipality	Total Population	Population in SFHA (1% Flood Boundary)	Percent Population in 1% Flood Boundary	Population in 0.2% Flood Boundary	Percent Population in 0.2% Flood Boundary
Barker (T)	2,732	702	25.7	702	25.7
Binghamton (C)	47,376	11,387	24.0	15,043	31.8
Binghamton (T)	4,942	1,431	29.0	1,431	29.0
Chenango (T)	11,252	3,233	28.7	3,584	31.9
Colesville (T)	5,232	2,131	40.7	2,131	40.7
Conklin (T)	5,441	3,387	62.2	3,847	70.7
Deposit (V)*	819	480	58.6	583	71.2
Dickinson (T)	3,637	1,175	32.3	1,281	35.2
Endicott (V)	13,392	4,861	36.3	5,068	37.8
Fenton (T)	6,674	2,371	35.5	2,629	39.4
Johnson City (V)	15,174	2,521	16.6	3,096	20.4
Kirkwood (T)	5,857	2,724	46.5	2,828	48.3
Lisle (T)	2,431	1,378	56.7	1,378	56.7
Lisle (V)	320	149	46.6	149	46.6
Maine (T)	5,377	1,544	28.7	1,544	28.7
Nanticoke (T)	1,672	1,044	62.4	1,044	62.4
Port Dickinson (V)	1,641	1,051	64.0	1,242	75.7
Sanford (T)*	1,588	839	52.8	839	52.8
Triangle (T)	1,982	581	29.3	581	29.3
Union (T)	27,780	9,569	34.4	10,047	36.2
Vestal (T)	28,043	7,876	28.1	8,255	29.4
Whitney Point (V)	964	588	61.0	588	61.0
Windsor (T)	5,358	2,488	46.4	2,597	48.5
Windsor (V)	916	479	52.3	499	54.5
Broome County	**200,600**	**63,989**	**31.9**	**70,986**	**35.4**

Source: FEMA, 2012; U.S. Census, 2012
Notes: SFHA = Special Flood Hazard Area; *The Town of Sanford population includes the area within the Broome County boundary excluding the Village of Deposit. The U.S. Census 2010 Village of Deposit population of 1,663

includes the area within both Broome and Delaware Counties. The 2010 population of the Village that is located only in Broome County is 819.

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 due to isolation during a flood event and they may have more difficulty evacuating.

Using 2000 U.S. Census data, HAZUS-MH 2.1 estimates the potential sheltering needs as a result of a 1-percent flood event. For the 1-percent flood event, HAZUS-MH 2.1 estimates 20,615 people will be displaced and 16,840 people will seek short-term sheltering, representing approximately 10% and 8% of the Broome County population, respectively. For the 0.2-percent flood event, HAZUS-MH 2.1 estimates 27,232 people will be displaced and 22,909 people will seek short-term sheltering, representing approximately 13.5% and 11% of the Broome County population, respectively. These statistics, by municipality, are presented in Table 5.4.1-7.

Table 5.4.1-7. Estimated Population Displaced or Seeking Short-Term Shelter from the 1% and 0.2% Annual Chance Flood Events

Municipality	Total Population (2010 U.S. Census)	1% Event		0.2% Event	
		Displaced Persons	Persons Seeking Short-Term Sheltering	Displaced Persons	Persons Seeking Short-Term Sheltering
Barker (T)	2,732	160	78	170	85
Binghamton (C)	47,376	5,448	4,879	7,982	7,198
Binghamton (T)	4,942	17	0	25	1
Chenango (T)	11,252	727	539	940	709
Colesville (T)	5,232	347	159	380	174
Conklin (T)	5,441	1,723	1,501	2,149	1,877
Deposit (V)	819	186	128	251	191
Dickinson (T)	3,637	184	105	305	200
Endicott (V)	13,392	2,254	2,079	3,303	3,141
Fenton (T)	6,674	317	170	410	232
Johnson City (V)	15,174	631	466	1,101	864
Kirkwood (T)	5,857	467	277	547	357
Lisle (T)	2,431	156	23	163	25
Lisle (V)	320	87	54	87	54
Maine (T)	5,377	451	325	451	325
Nanticoke (T)	1,672	108	26	151	53
Port Dickinson (V)	1,641	410	355	624	557
Sanford (T)	1,588	95	6	103	6
Triangle (T)	1,982	104	41	104	41
Union (T)	27,780	3,194	2,614	3,752	3,159
Vestal (T)	28,043	2,817	2,584	3,479	3,214
Whitney Point (V)	964	322	255	322	255
Windsor (T)	5,358	260	95	275	108

Municipality	Total Population (2010 U.S. Census)	1% Event		0.2% Event	
		Displaced Persons	Persons Seeking Short-Term Sheltering	Displaced Persons	Persons Seeking Short-Term Sheltering
Windsor (V)	916	150	81	158	83
Broome County	**200,600**	**20,615**	**16,840**	**27,232**	**22,909**

Source: HAZUS-MH 2.1
Note: The population displaced and seeking shelter was calculated using the 2000 U.S. Census data (HAZUS-MH 2.1 default demographic data). This data is considered appropriate given only the slight increase in population between 2000 and 2010 (less than one-percent increase).

The total number of injuries and casualties resulting from typical riverine 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. Mitigation action items addressing this issue are included in Section 9 (Mitigation Strategies) of this plan.

All population in a dam failure inundation zone is considered exposed and vulnerable. Similar to riverine flooding, of the population exposed to dam failure and flash flooding, the most vulnerable include the economically disadvantaged and the population over the age of 65.

There is often limited warning time for dam failure and flash flooding. These events are frequently associated with other natural hazard events such as earthquakes, landslides or severe weather, which limits their predictability and compounds the hazard. Populations without adequate warning of the event are highly vulnerable to this hazard. Ongoing mitigation efforts including dissemination and early warning systems are noted in Section 9 (Mitigation Strategies) of this plan should help to avoid the most likely cause of injury, which results from persons trying to cross flooded roadways or channels during a flood.

Impact on General Building Stock

After considering the population exposed and vulnerable to the flood hazard, the built environment 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.

The total land area located in the 1-percent and 0.2-percent annual chance flood zones created for this planning effort was calculated using preliminary DFIRM boundaries as noted earlier in this section. Refer to Table 5.4.1-8 below. To provide a general estimate of number of structures, parcels, and structural/content replacement value exposure, the flood boundaries (1- and 0.2-percent annual chance flood zones) were overlaid upon the County's parcel and the updated building stock inventory point shapefiles. The parcels that intersect the 1-percent and/or 0.2-percent annual chance flood zones were totaled for each municipality. The total number of buildings with their centroid located in the 1-percent and 0.2-percent flood boundaries was also determined and the estimated building stock replacement value (structure and contents) was listed as well. Refer to Table 5.4.1-9 and Table 5.4.1-10 below for exposure estimates for Broome County.

Table 5.4.1-8. Area Located in the 1-Percent and 0.2-Percent Annual Chance Flood Boundaries

Municipality	Total Area (sq. mi.)	1% Flood Hazard Area		0.2% Flood Hazard Area	
		Area Exposed (sq. mi.)	% of Total	Area Exposed (sq. mi.)	% of Total
Barker (T)	41.9	1.79	4.3	1.8	4.3
Binghamton (C)	11.1	2.09	18.8	2.7	24.3
Binghamton (T)	25.2	0.06	0.2	0.06	0.2
Chenango (T)	34.3	1.85	5.4	2.09	6.1
Colesville (T)	79.4	2.29	2.9	2.4	3.0
Conklin (T)	24.8	2.88	11.6	3.39	13.7
Deposit (V)	0.7	0.11	15.7	0.14	20.0
Dickinson (T)	4.3	0.51	11.9	0.59	13.7
Endicott (V)	3.4	1.39	40.9	1.6	47.1
Fenton (T)	33.2	2	6.0	2.18	6.6
Johnson City (V)	4.6	0.57	12.4	0.69	15.0
Kirkwood (T)	31.2	2.01	6.4	2.22	7.1
Lisle (T)	46.4	2.07	4.5	2.12	4.6
Lisle (V)	0.9	0.14	15.6	0.14	15.6
Maine (T)	45.3	1.67	3.7	1.67	3.7
Nanticoke (T)	24.2	0.74	3.1	0.87	3.6
Port Dickinson (V)	0.6	0.18	30.0	0.24	40.0
Sanford (T)	90.6	2.2	2.4	2.3	2.5
Triangle (T)	38.8	3.4	8.8	3.4	8.8
Union (T)	28.2	2.95	10.5	3.23	11.5
Vestal (T)	52.6	3.59	6.8	4.2	8.0
Whitney Point (V)	1.1	0.41	37.3	0.41	37.3
Windsor (T)	91.6	3.61	3.9	3.76	4.1
Windsor (V)	1.1	0.43	39.1	0.45	40.9
Broome County	**715.7**	**38.94**	**5.4**	**42.65**	**6.0**

Source: Tetra Tech, 2012
Note: sq.mi. = Square miles; % = Percent

Table 5.4.1-9. Estimated General Building Stock Exposure to the 1-Percent and 0.2-Percent Annual Chance Flood Events

Municipality	Total Number of Buildings	Total RCV	1% Flood Boundary				0.2% Flood Boundary			
			Number of Buildings	% of Total	RCV	% of Total	Number of Buildings	% of Total	RCV	% of Total
Barker (T)	1,196	$422,310,650	50	4.2	$47,880,233	11.3	57	4.8	$85,257,911	20.2
Binghamton (C)	14,834	$9,330,180,522	1,656	11.2	$1,631,039,145	17.5	2,421	16.3	$2,250,319,760	24.1
Binghamton (T)	2,079	$897,461,816	3	0.1	$1,372,886	0.2	3	0.1	$1,372,886	0.2
Chenango (T)	4,673	$2,004,173,606	132	2.8	$89,031,744	4.4	241	5.2	$208,145,481	10.4
Colesville (T)	2,246	$1,057,825,224	121	5.4	$91,247,303	8.6	153	6.8	$99,780,623	9.4
Conklin (T)	2,359	$1,236,873,907	594	25.2	$420,466,228	34.0	788	33.4	$568,949,648	46.0
Deposit (V)	386	$381,987,296	80	20.7	$103,445,365	27.1	130	33.7	$185,086,612	48.5
Dickinson (T)	1,229	$817,874,908	11	0.9	$43,399,628	5.3	50	4.1	$123,670,593	15.1
Endicott (V)	4,381	$2,731,141,684	660	15.1	$518,003,192	19.0	1,032	23.6	$724,763,580	26.5
Fenton (T)	2,662	$2,921,471,363	63	2.4	$73,778,731	2.5	95	3.6	$137,813,882	4.7
Johnson City (V)	5,297	$2,961,493,139	271	5.1	$255,790,029	8.6	542	10.2	$334,608,515	11.3
Kirkwood (T)	2,285	$1,621,707,183	170	7.4	$214,967,979	13.3	246	10.8	$331,980,863	20.5
Lisle (T)	1,000	$435,269,043	25	2.5	$15,279,907	3.5	29	2.9	$17,401,014	4.0
Lisle (V)	135	$56,077,223	36	26.7	$21,931,021	39.1	36	26.7	$21,931,021	39.1
Maine (T)	2,100	$1,361,394,964	36	1.7	$23,146,877	1.7	36	1.7	$23,146,877	1.7
Nanticoke (T)	627	$442,171,051	8	1.3	$3,462,533	0.8	32	5.1	$9,365,198	2.1
Port Dickinson (V)	610	$217,167,023	54	8.9	$17,571,169	8.1	141	23.1	$41,075,261	18.9
Sanford (T)	1,428	$929,723,104	20	1.4	$3,013,584	0.3	43	3.0	$6,744,851	0.7
Triangle (T)	880	$472,882,289	1	0.1	$280,659	0.1	1	0.1	$280,659	0.1
Union (T)	11,239	$5,379,154,660	1,101	9.8	$545,281,586	10.1	1,420	12.6	$692,838,694	12.9
Vestal (T)	8,617	$4,673,973,750	871	10.1	$470,406,400	10.1	1,248	14.5	$647,577,960	13.9
Whitney Point (V)	411	$726,200,417	105	25.5	$119,145,473	16.4	105	25.5	$119,145,473	16.4
Windsor (T)	2,615	$1,171,187,529	108	4.1	$16,499,814	1.4	124	4.7	$19,162,165	1.6
Windsor (V)	345	$224,529,123	21	6.1	$52,171,793	23.2	32	9.3	$59,022,589	26.3
Broome County	**73,634**	**$42,474,231,474**	**6,197**	**8.4**	**$4,778,613,278**	**11.3**	**9,005**	**12.2**	**$6,709,442,117**	**15.8**

Source: Broome County, 2012; Tetra Tech, 2012
Notes: % = Percent; RCV = Replacement cost value

Table 5.4.1-10. Estimated General Building Stock Potential Loss to the 1-Percent and 0.2-Percent Annual Chance Flood Events

Municipality	Total Number of Buildings	Total RCV	1% Flood Boundary				0.2% Flood Boundary			
			Number of Buildings	% of Total	RCV	% of Total	Number of Buildings	% of Total	RCV	% of Total
Barker (T)	1,196	$422,310,650	47	3.9	$18,760,813	4.4	55	4.6	$23,844,454	5.6
Binghamton (C)	14,834	$9,330,180,522	1,657	11.2	$477,331,705	5.1	2,425	16.3	$711,963,340	7.6
Binghamton (T)	2,079	$897,461,816	3	0.1	$625,259	0.1	3	0.1	$734,087	0.1
Chenango (T)	4,673	$2,004,173,606	132	2.8	$11,068,335	0.6	241	5.2	$26,994,492	1.3
Colesville (T)	2,246	$1,057,825,224	121	5.4	$41,448,400	3.9	151	6.7	$49,146,098	4.6
Conklin (T)	2,359	$1,236,873,907	594	25.2	$132,174,429	10.7	788	33.4	$198,922,577	16.1
Deposit (V)	386	$381,987,296	81	21.0	$3,655,848	1.0	130	33.7	$40,093,593	10.5
Dickinson (T)	1,229	$817,874,908	11	0.9	$2,686,026	0.3	50	4.1	$8,853,981	1.1
Endicott (V)	4,381	$2,731,141,684	658	15.0	$129,070,399	4.7	1,028	23.5	$197,367,306	7.2
Fenton (T)	2,662	$2,921,471,363	61	2.3	$23,239,595	0.8	93	3.5	$35,273,337	1.2
Johnson City (V)	5,297	$2,961,493,139	271	5.1	$75,118,689	2.5	539	10.2	$114,765,562	3.9
Kirkwood (T)	2,285	$1,621,707,183	169	7.4	$37,838,338	2.3	246	10.8	$66,749,437	4.1
Lisle (T)	1,000	$435,269,043	26	2.6	$2,064,310	0.5	29	2.9	$4,123,265	0.9
Lisle (V)	135	$56,077,223	36	26.7	$2,780,289	5.0	36	26.7	$5,803,668	10.3
Maine (T)	2,100	$1,361,394,964	36	1.7	$7,856,552	0.6	36	1.7	$11,537,424	0.8
Nanticoke (T)	627	$442,171,051	8	1.3	$351,287	0.1	31	4.9	$1,448,551	0.3
Port Dickinson (V)	610	$217,167,023	56	9.2	$2,535,286	1.2	141	23.1	$6,224,071	2.9
Sanford (T)	1,428	$929,723,104	21	1.5	$178,359	0.0	40	2.8	$428,101	0.0
Triangle (T)	880	$472,882,289	1	0.1	$28,066	0.0	1	0.1	$43,970	0.0
Union (T)	11,239	$5,379,154,660	1,101	9.8	$144,629,835	2.7	1,416	12.6	$221,094,540	4.1
Vestal (T)	8,617	$4,673,973,750	875	10.2	$184,649,136	4.0	1,247	14.5	$243,799,365	5.2
Whitney Point (V)	411	$726,200,417	106	25.8	$38,645,641	5.3	106	25.8	$51,369,993	7.1
Windsor (T)	2,615	$1,171,187,529	108	4.1	$4,815,176	0.4	123	4.7	$6,232,937	0.5
Windsor (V)	345	$224,529,123	20	5.8	$14,380,283	6.4	33	9.6	$21,612,716	9.6
Broome County	**73,634**	**$42,474,231,474**	**6,199**	**8.4**	**$1,355,932,058**	**3.2**	**8,988**	**12.2**	**$2,048,426,867**	**4.8**

Source: Broome County, 2012; Tetra Tech, 2012
Notes: % = Percent; RCV = Replacement cost value

In addition to total building stock modeling, individual data available on flood policies, claims, Repetitive Loss Properties (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 (*sic* National Flood Insurance Program) 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."

SRLs were then examined for the 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 5.4.1-11 and Figure 5.4.1-7 summarize the NFIP policies, claims and repetitive loss statistics for Broome County. According to FEMA, the following summarizes the occupancy classes of the 318 repetitive loss properties in Broome County: 232 single-family residences; 20 two-to-four family residences; five condominiums; 23 other residential buildings; and 38 non-residential buildings (FEMA Region 2, 2012). This information is current as of May 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.

Figure 5.4.1-7 indicates the repetitive loss areas within the County. Information regarding the locations of the NFIP policies and claims is cataloged at the County.

Table 5.4.1-11. 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)	# Policies in the 1% Flood Boundary (3)	# Policies in the 0.2% Flood Boundary (3)	# Policies Outside the Combined 1% and 0.2% Flood Boundaries Hazard Areas (3)
Barker (T)	14	5	$50,073	0	0	3	0	11
Binghamton (C)	469	263	$15,987,572	38	2	246	44	179
Binghamton (T)	16	16	$924,106	1	0	1	0	15
Chenango (T)	147	81	$1,993,754	6	0	47	17	83
Colesville (T)	55	64	$1,663,581	10	0	13	1	41
Conklin (T)	347	678	$30,439,615	77	17	230	57	60
Deposit (V)	129	105	$2,793,681	13	0	109	7	13
Dickinson (T)	40	25	$1,052,647	6	0	15	7	18
Endicott (V)	120	86	$3,292,194	12	7	74	22	24
Fenton (T)	40	35	$496,624	6	0	8	6	26
Johnson City (V)	322	187	$14,415,601	23	1	157	51	114
Kirkwood (T)	83	196	$7,107,908	11	3	40	14	29
Lisle (T)	11	3	$11,826	0	0	0	0	11
Lisle (V)	4	1	$7,958	0	0	1	0	3
Maine (T)	30	21	$634,263	0	0	11	0	19
Nanticoke (T)	8	2	$54,735	1	0	0	1	7
Port Dickinson (V)	24	13	$363,306	0	0	8	12	4
Sanford (T)	40	13	$179,767	1	0	3	2	35
Triangle (T)	0	0	$0	0	0	0	0	0
Union (T)	493	476	$22,028,465	60	23	274	53	166
Vestal (T)	578	412	$23,254,448	47	4	344	74	160
Whitney Point (V)	11	3	$36,457	0	0	2	2	7
Windsor (T)	42	46	$1,252,712	5	0	5	0	37
Windsor (V)	17	10	$113,624	1	0	1	0	16
Broome County	**3,040**	**2,741**	**$128,154,915**	**318**	**57**	**626**	**370**	**2,044**

Source: FEMA Region 2, 2012

(1) Policies, claims, repetitive loss and severe repetitive loss statistics provided by FEMA Region 2, and are current as of May 31, 2012.

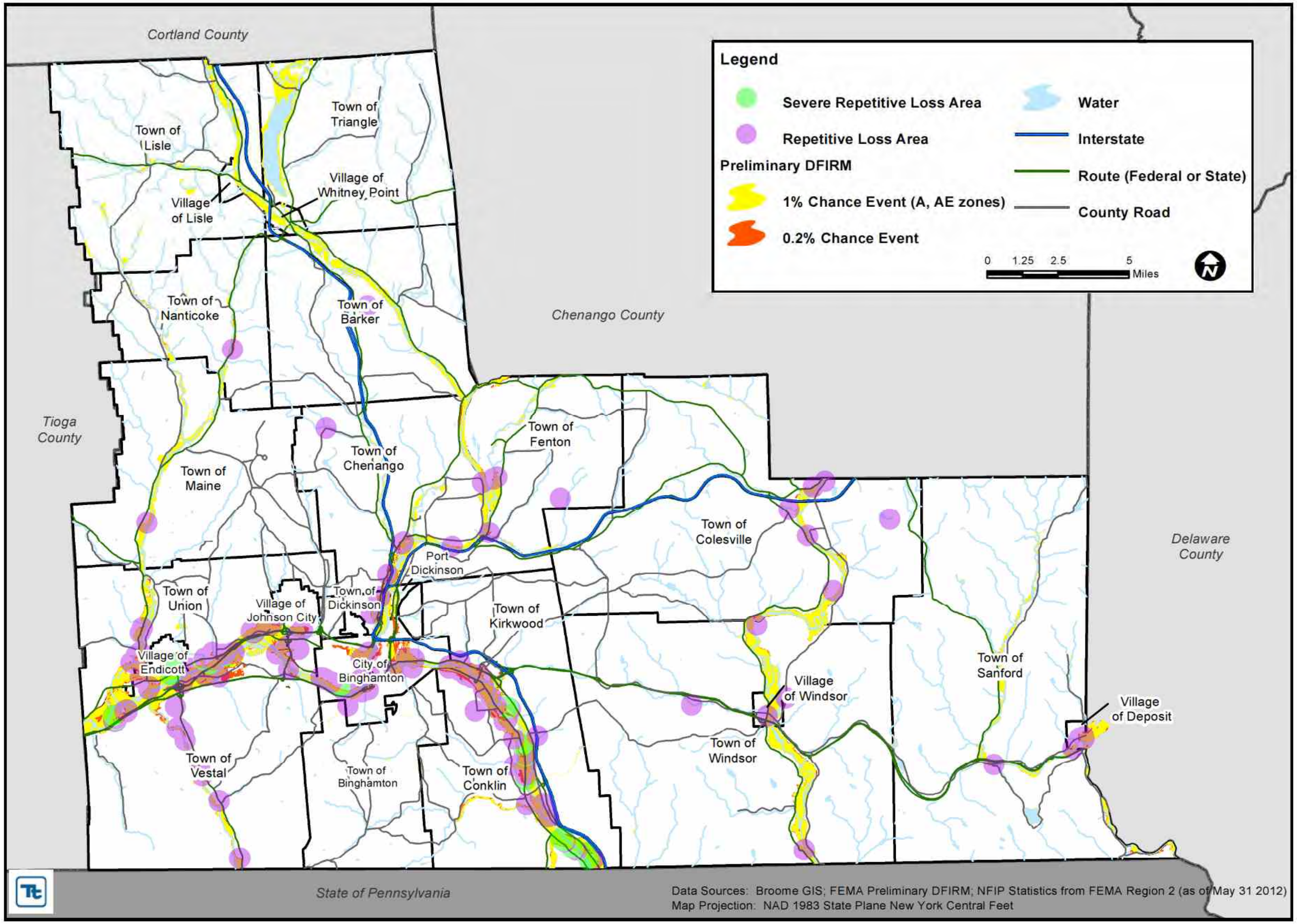
Please note the total number of repetitive loss properties includes the severe repetitive loss properties. The number of claims represents the number of claims closed by May 31, 2012.

(2) Total building and content losses from the claims file provided by FEMA Region 2.

(3) The policies inside and outside of the flood zones is based on the latitude and longitude provided by FEMA Region 2 in the policy file.

FEMA noted that where there is more than one entry for a property, there may be more than one policy in force or more than one GIS possibility.

Figure 5.4.1-7. NFIP Repetitive Loss Areas



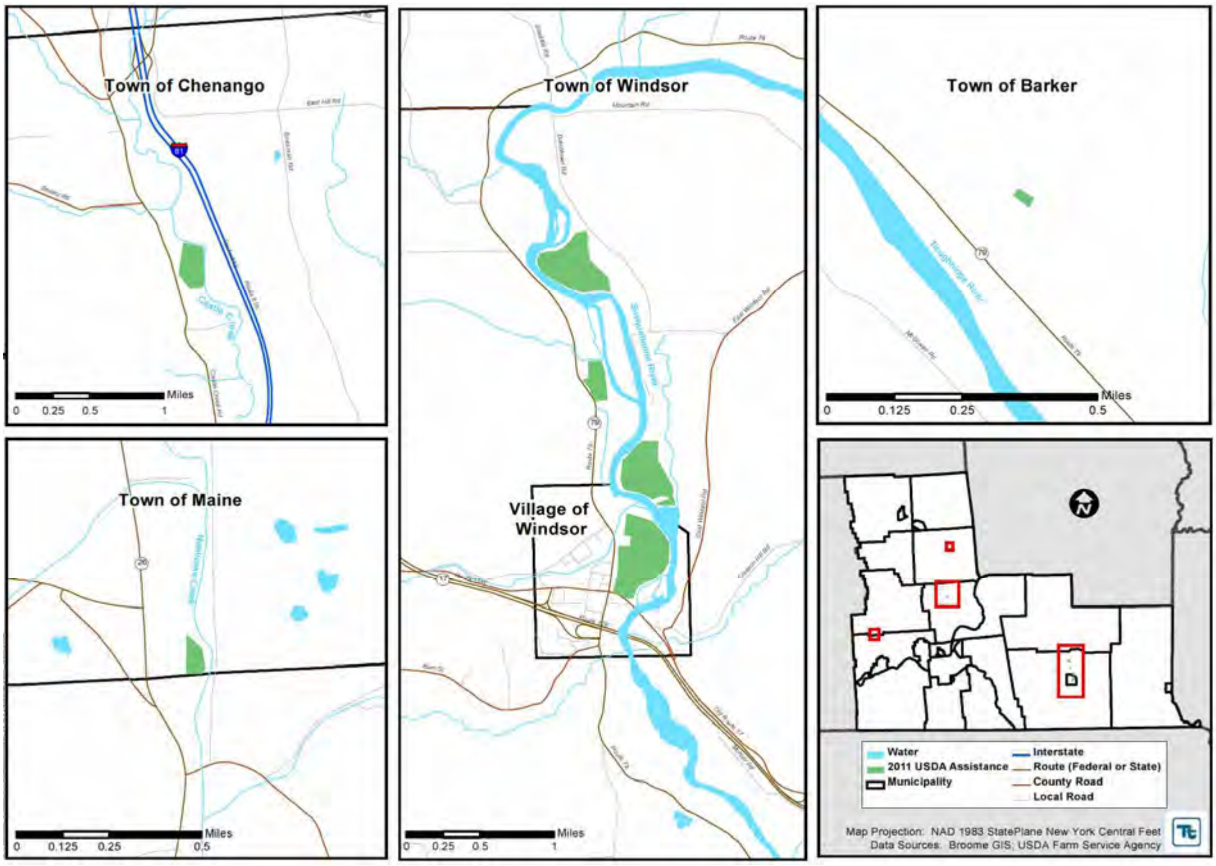
Source: Broome County GIS; FEMA Region 2, 2012

As discussed in the Previous Occurrences and Losses subsection, Broome County experienced extensive damages as a result of the September 2011 flood event. NYSEG, a gas and electric company that services Broome County, mapped the flood inundation in their service area as a result of the September 2011 event (Figure 5.4.1-9). The flood inundation area exceeded the 100- and 500-year flood boundaries in some areas, specifically along the Susquehanna River and its tributaries in the Villages of Endicott and Johnson City, Towns of Chenango, Fenton and Union and City of Binghamton.

According to USDA Farm Service Agency (FSA), the County Executive Director, in conjunction with the partnering agencies and FSA County Committee, analyzes and files loss reports on behalf of agricultural produces after USDA disaster declarations. In addition, FSA provides low-interest emergency loans if needed and administers the Emergency Conservation Program (ECP). Specific monetary losses associated with the USDA disasters could not be disclosed; however, Table 5.4.1-4 in the Previous Occurrences and Losses section summarizes these disasters and when crop losses were experienced in Broome County (USDA, 2012).

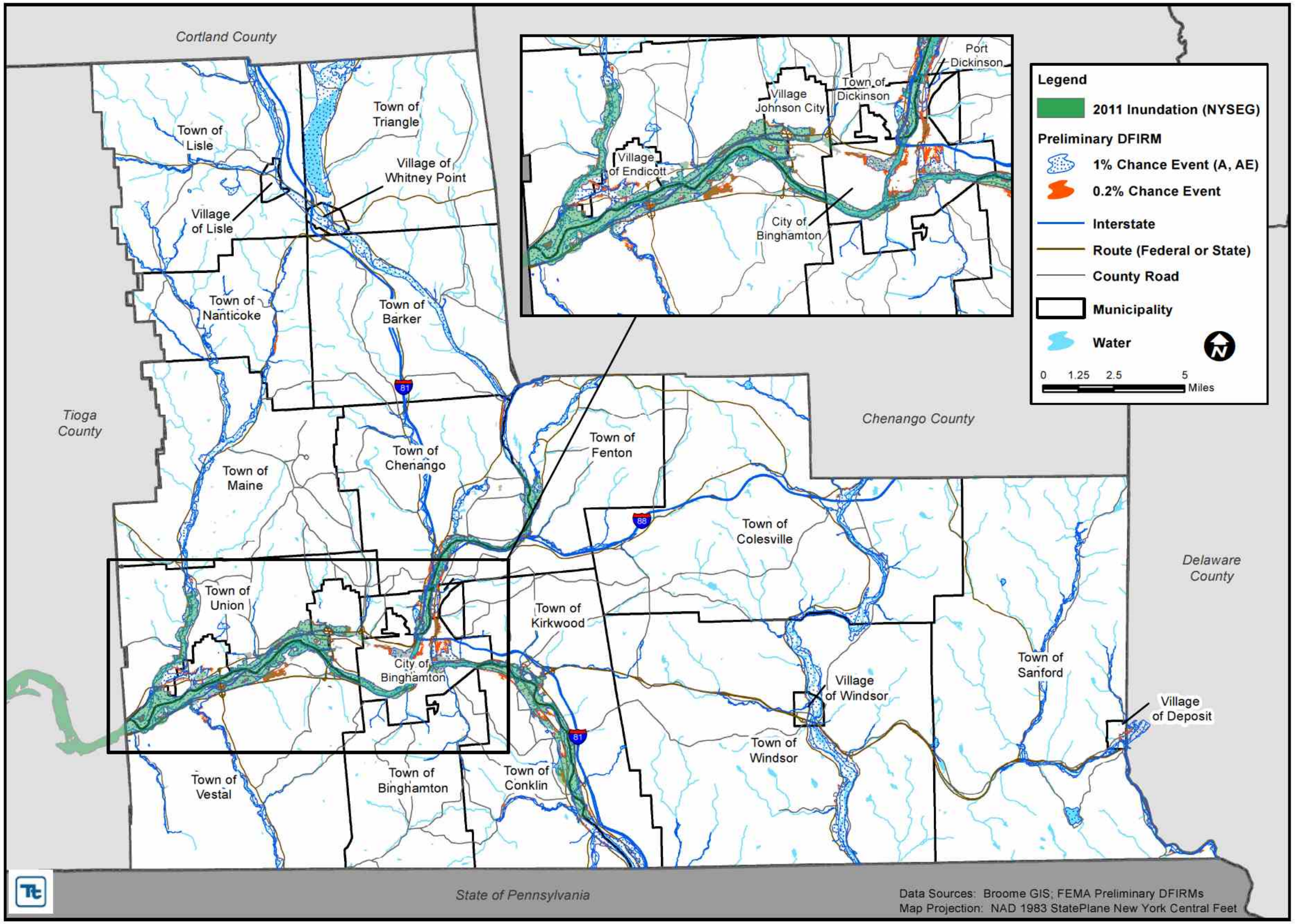
From 2007 to 2012, the only ECP projects cost-shared by the FSA were following the Tropical Storm Lee flooding. These projects consisted of debris removal or erosion filling on crop fields. In addition, USDA has assisted farmers with crop insurance claims or issues. In 2011, losses included over 65-acres of damaged/destroyed corn and vegetables. Refer to Figure 5.4.1-8 for the locations of the ECP projects and where crop losses occurred in the fall of 2011.

Figure 5.4.1-8. 2011 USDA Assistance to Agricultural Producers in Broome County



Source: USDA, 2012

Figure 5.4.1-9. Flood Inundation in the NYSEG Service Area from the 2011 Flood Event



Source: Broome County GIS

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. Table 5.4.1-12 lists the critical facilities and utilities located in the FEMA flood zones and the percent damage HAZUS-MH 2.1 estimates to the facility as a result of the 1% and 0.2% 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. Actions addressing shared services agreements are included in Section 9 (Mitigation Strategies) of this plan.

Table 5.4.1-12. Critical Facilities Located in the 1-Percent and 0.2-Percent Annual Chance Flood Boundaries and Estimated Potential Damage

Name	Municipality	Type	Exposure		Potential Loss from 1% Flood Event			Potential Loss from 0.2% Flood Event		
			1% Event	0.2% Event	Percent Structure Damage	Percent Content Damage	Days to 100-Percent(2)	Percent Structure Damage	Percent Content Damage	Days to 100-Percent(2)
Chenango Forks	Barker (T)	Fire Station		X	-	-	-	0.0	0.0	NA
Our Lady of Lourdes Hospital	Binghamton (C)	Medical		X	-	-	-	0.0	0.0	NA
City of Binghamton Headquarter	Binghamton (C)	Fire Station		X	-	-	-	1.9	2.2	480
City of Binghamton Engine 4	Binghamton (C)	Fire Station	X	X	10.2	24.4	480	12.7	58.7	630
City Training Center/Mechanics Facility	Binghamton (C)	Fire Station	X	X	24.5	98.8	720	34.2	100.0	720
Macarthur School	Binghamton (C)	School	X	X	6.2	33.8	480	9.0	59.8	480
East MS	Binghamton (C)	School	X	X	1.1	5.9	480	7.4	41.3	480
American Legion Post 1645	Binghamton (C)	Poll	X	X	0.0	0.0	NA	5.8	37.4	NA
Binghamton City Hall	Binghamton (C)	Historic		X	-	-	NA	0.0	0.0	NA
Catholic Charities	Binghamton (C)	Poll	X	X	10.5	66.4	NA	14.0	86.5	NA
Community Center	Binghamton (C)	Poll	X	X	0.0	0.0	480	7.9	57.9	NA
Ross Park Carousel	Binghamton (C)	Historic	X	X	0.0	0.0	NA	6.7	46.0	NA
South Washington St Parabolic Bridge	Binghamton (C)	Historic	X	X	80.3	100.0	NA	88.3	100.0	NA
Southview Post Office	Binghamton (C)	Post Office		X	-	-	NA	1.6	9.6	NA
DOT Facility Govt. Plaza	Binghamton (C)	DOT		X	-	-	NA	0.0	0.0	NA
DOT Facility Frederick St.	Binghamton (C)	DOT	X	X	5.4	4.9	NA	32.5	38.0	NA
BC Veterans Memorial Arena	Binghamton (C)	Shelter		X	-	-	NA	0.0	0.0	NA
SUSQUEHANNA RIVER INTAKE	Binghamton (C)	Potable Water	X	X	40.0	-	NA	40.0	-	NA
Kattelville Athletic	Chenango (T)	Poll		X	-	-	NA	3.2	19.3	NA
NORTHGATE WELL	Chenango (T)	Potable Water	X	X	1.7	-	NA	12.0	-	NA
PENNVIEW WELL	Chenango (T)	Potable Water	X	X	0.9	-	NA	4.6	-	NA
ROUTE 12A WELL	Chenango (T)	Potable Water	X	X	40.0	-	NA	40.0	-	NA
Northgate WWTP	Chenango (T)	WWTF		X	-	-	NA	1.8	-	NA

Name	Municipality	Type	Exposure		Potential Loss from 1% Flood Event			Potential Loss from 0.2% Flood Event		
			1% Event	0.2% Event	Percent Structure Damage	Percent Content Damage	Days to 100-Percent(2)	Percent Structure Damage	Percent Content Damage	Days to 100-Percent(2)
Nineveh Post Office	Colesville (T)	Post Office	X	X	6.5	44.0	480	13.5	78.3	NA
Nineveh Public Library	Colesville (T)	Library	X	X	0.0	0.0	NA	4.7	28.3	NA
Ouaquaga Lenticular Truss Bridge	Colesville (T)	Historic	X	X	25.1	100.0	NA	35.6	100.0	NA
WELL #1	Colesville (T)	Potable Water	X	X	0.5		NA	3.6		NA
Conklin Station 1	Conklin (T)	Fire Station		X			480	4.8	5.5	480
Conklin Community Center	Conklin (T)	Poll	X	X	12.2	71.5	NA	14.0	88.8	NA
Conklin Town Hall	Conklin (T)	Poll		X			NA	0.0	0.0	NA
Town of Conklin Highway Garage	Conklin (T)	Public Works		X			NA	2.8	2.5	NA
Susquehanna Valley High School	Conklin (T)	Shelter		X			NA	0.0	0.0	NA
CREEK BRIAR PATCH WELL (#2)	Conklin (T)	Potable Water	X	X	3.8		NA	24.2		NA
CREEK ROAD WELL (#3)	Conklin (T)	Potable Water	X	X	7.9		NA	32.8		NA
WELL #5	Conklin (T)	Potable Water	X	X	40.0		NA	40.0		NA
WELL #6	Conklin (T)	Potable Water	X	X	40.0		NA	40.0		NA
WELL #1	Conklin (T)	Potable Water		X			NA	0.0		NA
Deposit Fire (1)	Deposit (V)	Fire Station		X			NA	NA	NA	NA
Deposit Ambulance (1)	Deposit (V)	Ambulance		X			NA	NA	NA	NA
Village of Deposit Police	Deposit (V)	Police	X	X	9.3	17.0	480	12.3	56.4	630
Deposit Free Library	Deposit (V)	Library	X	X	0.0	0.0	NA	15.6	100.0	NA
Deposit Post Office	Deposit (V)	Post Office	X	X	0.0	0.0	NA	18.9	100.0	NA
Deposit Village Hall	Deposit (V)	Municipal Hall	X	X	1.0	5.8	NA	11.2	68.7	NA
Sanford Town Hall	Deposit (V)	Poll	X	X	0.0	0.0	NA	16.4	100.0	NA
State Theater	Deposit (V)	Historic	X	X	0.0	0.0	NA	9.8	64.4	NA
WELL #1	Deposit (V)	Potable Water	X	X	2.5		NA	17.5		NA
WELL #2	Deposit (V)	Potable Water	X	X	1.3		NA	3.0		NA

Name	Municipality	Type	Exposure		Potential Loss from 1% Flood Event			Potential Loss from 0.2% Flood Event		
			1% Event	0.2% Event	Percent Structure Damage	Percent Content Damage	Days to 100-Percent(2)	Percent Structure Damage	Percent Content Damage	Days to 100-Percent(2)
WELL #4	Deposit (V)	Potable Water	X	X	3.4		NA	15.2		NA
WELL #5	Deposit (V)	Potable Water	X	X	3.0	-	NA	12.9	-	NA
Village of Deposit WWTP	Deposit (V)	WWTF		X	-	-	NA	26.1	-	NA
Sheriff's Office	Dickinson (T)	Police		X	-	-	-	0.0	0.0	NA
Sunrise Terrace Community Center	Dickinson (T)	Poll		X	-	-	-	0.0	0.0	NA
Nimmonsburg United Methodist Church	Dickinson (T)	Shelter	X	X	6.5	27.1	-	11.8	38.6	-
Union Volunteer ES	Endicott (V)	Ambulance	X	X	5.8	6.7	480	11.8	51.8	480
JENNIE F. SNAPP MS	Endicott (V)	School	X	X	9.3	65.2	630	11.6	70.6	630
Central Methodist Church	Endicott (V)	Poll	X	X	7.1	50.4	NA	13.7	80.3	NA
Endicott Square Deal Arch	Endicott (V)	Historic	X	X	11.0	68.0	NA	14.0	87.2	NA
Union Presbyterian Church Education Bldg	Endicott (V)	Poll	X	X	9.9	64.6	NA	14.0	85.6	NA
Central United Methodist Church	Endicott (V)	Shelter	X	X	3.6	13.5	NA	6.3	26.2	NA
Holy Nativity Lutheran Church	Endicott (V)	Shelter	X	X	6.9	28.8	NA	12.4	39.9	NA
WELL #28	Endicott (V)	Potable Water	X	X	40.0	-	NA	40.0	-	NA
WELL #32, RANNEY	Endicott (V)	Potable Water	X	X	28.5	-	NA	40.0	-	NA
WELL #5	Endicott (V)	Potable Water	X	X	40.0	-	NA	40.0	-	NA
Village of Endicott WWTP	Endicott (V)	WWTF		X	-	-	NA	27.1	-	NA
DOT Facility Rte 369	Fenton (T)	DOT		X	-	-	NA	0.0	0.0	NA
WELL #6, BURNS STREET	Johnson City (V)	Potable Water		X	-	-	NA	1.4	-	NA
WELL #7, NORTH BROAD ST.	Johnson City (V)	Potable Water		X	-	-	NA	2.4	-	NA
Five Mile Point Station 1	Kirkwood (T)	Fire Station	X	X	8.0	12.2	480	11.3	43.9	480
Kirkwood Post Office	Kirkwood (T)	Post Office		X	-	-	NA	0.0	0.0	NA
Kirkwood Town Hall	Kirkwood (T)	Poll		X	-	-	NA	0.0	0.0	NA
Town of Kirkwood Highway Garage	Kirkwood (T)	Public Works	X	X	34.5	42.0	NA	45.4	57.8	NA

Name	Municipality	Type	Exposure		Potential Loss from 1% Flood Event			Potential Loss from 0.2% Flood Event		
			1% Event	0.2% Event	Percent Structure Damage	Percent Content Damage	Days to 100-Percent(2)	Percent Structure Damage	Percent Content Damage	Days to 100-Percent(2)
WELL #1, MIDDLE WELL	Kirkwood (T)	Potable Water	X	X	40.0	-	NA	40.0	-	NA
WELL #2, SOUTH WELL	Kirkwood (T)	Potable Water	X	X	2.9	-	-	19.3	-	NA
WELL #3, NORTH WELL	Kirkwood (T)	Potable Water	X	X	40.0	-	-	40.0	-	NA
Killawog Post Office	Lisle (T)	Post Office	X	X	3.5	21.2	-	11.5	69.6	NA
WELL #1	Lisle (T)	Potable Water	X	X	23.7		-	40.0	-	NA
Lisle Free Library	Lisle (V)	Library	X	X	3.5	21.2	-	11.6	69.7	NA
Lisle Post Office	Lisle (V)	Post Office	X	X	0.0	0.0	-	7.7	56.5	NA
SOUTH WELL #1	Maine (T)	Potable Water	X	X	3.4	-	-	22.2	-	NA
Glen Aubrey	Nanticoke (T)	Fire Station	X	X	4.5	5.2	480	10.7	31.7	480
NYS Police Endwell Barracks	Union (T)	Police	X	X	0.0	0.0	NA	5.0	5.7	480
Johnson City YMCA	Union (T)	Poll	X	X	3.4	20.2	-	11.4	69.1	NA
Washingtonian Hall	Union (T)	Historic	X	X	4.6	27.4	-	13.5	78.3	NA
West Endicott Park Carousel	Union (T)	Historic	X	X	14.7	96.6	-	20.9	100.0	NA
WELL #2, SOUTH OF PLANT	Union (T)	Potable Water		X	-	-	-	31.2	-	NA
WELL #3, NORTH OF PLANT	Union (T)	Potable Water		X	-	-	-	11.4	-	NA
WELL #5, FIFTH STREET	Union (T)	Potable Water	X	X	9.0	-	-	34.0	-	NA
Vestal Company 1	Vestal (T)	Fire Station	X	X	21.7	94.0	630	29.2	100.0	720
Vestal Volunteer ES	Vestal (T)	Ambulance	X	X	27.8	100.0	720	39.3	100.0	720
Drovers Inn	Vestal (T)	Historic	X	X	14.3	93.1	-	17.8	100.0	NA
Rounds House	Vestal (T)	Historic	X	X	14.7	97.4	-	18.9	100.0	NA
Vestal Center Methodist Church	Vestal (T)	Poll	X	X	0.0	0.0	-	0.0	0.0	NA
Grace Episcopal Church	Whitney Point (V)	Historic	X	X	3.0	17.8	-	11.0	67.9	NA
Mary Wilcox Memorial Library	Whitney Point (V)	Library	X	X	5.0	30.1	-	13.0	74.0	NA
Triangle Town Hall	Whitney Point (V)	Poll	X	X	7.6	54.8	-	13.9	81.8	NA

Name	Municipality	Type	Exposure		Potential Loss from 1% Flood Event			Potential Loss from 0.2% Flood Event		
			1% Event	0.2% Event	Percent Structure Damage	Percent Content Damage	Days to 100-Percent(2)	Percent Structure Damage	Percent Content Damage	Days to 100-Percent(2)
Whitney Point Post Office	Whitney Point (V)	Post Office	X	X	3.8	22.6	-	11.8	70.3	NA
WELL PW-1	Whitney Point (V)	Potable Water	X	X	29.3	-	-	40.0	-	NA
WELL PW-2	Whitney Point (V)	Potable Water	X	X	27.1	-	-	40.0	-	NA
WELL PW-3	Whitney Point (V)	Potable Water	X	X	23.4	-	-	40.0	-	NA
WELL #1, BEHIND GARAGE	Windsor (V)	Potable Water	X	X	5.0	-	-	29.9	-	NA
WELL #2, ACROSS CREEK	Windsor (V)	Potable Water	X	X	1.8	-	-	13.1	-	NA

Source: HAZUS-MH 2.1

Note: C = City; NA = Not available; T = Town; V = Village

- = No loss calculated by HAZUS-MH 2.1

X = Facility located within the DFIRM boundary.

Please note it is assumed the wells have electrical equipment and openings are three-feet above grade.

(1) The Village of Deposit fire and ambulance facilities are located within the 0.2% flood boundary; however these facilities are located outside of the Broome County boundary and therefore estimated potential losses were not calculated.

(2) HAZUS-MH 2.1 provides a general indication of the maximum restoration time for 100% operations. Clearly, a great deal of effort is needed to quickly restore essential facilities to full functionality; therefore this will be an indication of the maximum downtime (HAZUS-MH 2.1 User Manual).

(3) In some cases, a facility may be located in the DFIRM flood hazard boundary; however HAZUS did not calculate potential loss. This may be because the depth of flooding does not amount to any damages to the structure according to the depth damage function used in HAZUS for that facility type.

Impact on the 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 Broome 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 wash out 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 1-percent flood is approximately $1.3 billion which represents approximately 3-percent of the County's overall total general building stock inventory. The potential damage estimated to the general building stock inventory associated with the 0.2-percent flood is approximately $2 billion, or nearly 5-percent of the Town's total building inventory. These dollar value losses to the County's total building inventory replacement value, in addition to damages to roadways and infrastructure, would greatly impact the local economy.

HAZUS-MH estimates the amount of debris generated from the flood events as a result of 1- and 0.2-percent events. 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 5.4.1-13 summarizes the debris HAZUS-MH 2.1 estimates for these events.

Table 5.4.1-13. Estimated Debris Generated from the 1-Percent and 0.2-Percent Flood Events

Municipality	1% Flood Event				0.2% Flood Event			
	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
Barker (T)	3,607	929	1,635	1,043	7,215	1,153	3,880	2,182
Binghamton (C)	33,944	15,796	9,980	8,168	55,361	23,255	18,199	13,906
Binghamton (T)	8	8	0	0	28	27	0	1
Chenango (T)	6,773	2,298	2,546	1,930	11,655	3,175	4,910	3,570
Colesville (T)	3,565	1,528	1,049	988	5,455	1,971	1,881	1,604
Conklin (T)	35,308	7,964	14,817	12,527	53,161	9,839	23,571	19,751
Deposit (V)	176	175	0	0	1,803	1,227	350	226
Dickinson (T)	2,956	1,377	1,057	522	7,387	1,809	3,734	1,843
Endicott (V)	18,565	6,254	6,580	5,731	36,753	9,785	14,667	12,301
Fenton (T)	10,690	2,898	4,519	3,273	13,820	3,367	5,877	4,577
Johnson City (V)	2,914	1,593	766	554	6,971	3,429	2,064	1,478
Kirkwood (T)	11,940	2,071	5,795	4,073	18,522	2,698	9,263	6,562
Lisle (T)	535	365	75	95	890	513	192	185

Municipality	1% Flood Event				0.2% Flood Event			
	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
Lisle (V)	251	153	52	46	381	216	90	75
Maine (T)	810	635	91	84	1,429	966	258	205
Nanticoke (T)	76	41	13	22	189	93	40	56
Port Dickinson (V)	3,007	1,064	759	1,184	4,657	1,648	1,096	1,914
Sanford (T)	2,586	1,068	959	558	4,429	1,395	1,924	1,109
Triangle (T)	326	120	92	113	624	347	129	148
Union (T)	25,169	8,153	9,424	7,592	40,016	11,430	15,964	12,622
Vestal (T)	52,085	9,475	25,409	17,201	72,789	12,573	35,644	24,573
Whitney Point (V)	6,735	2,233	3,063	1,438	12,150	2,855	6,237	3,057
Windsor (T)	9,585	2,264	4,100	3,220	16,067	2,706	7,504	5,857
Windsor (V)	5,005	945	2,479	1,581	8,566	1,179	4,499	2,887
Broome County	**236,615**	**69,407**	**95,262**	**71,946**	**380,316**	**97,658**	**161,972**	**120,686**

Source: HAZUS-MH 2.1

Effect of Climate Change on Vulnerability

Climate is defined not simply as average temperature and precipitation but also by the type, frequency and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of extremes such as flood events. While predicting changes of flood events under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society and the environment (U.S. Environmental Protection Agency [EPA], 2006).

The 2011 'Responding to Climate Change in New York State' report was prepared for New York State Energy Research and Development Authority to study the potential impacts of global climate change on New York State. According to the synthesis report, heavy rains are increasing and are projected to increase further. Increased frequency and intensity of rainfall may lead to increased flooding and related impacts on water quality, infrastructure, and agriculture in the State as noted earlier in this section (NYSERDA, 2011).

Change of Vulnerability

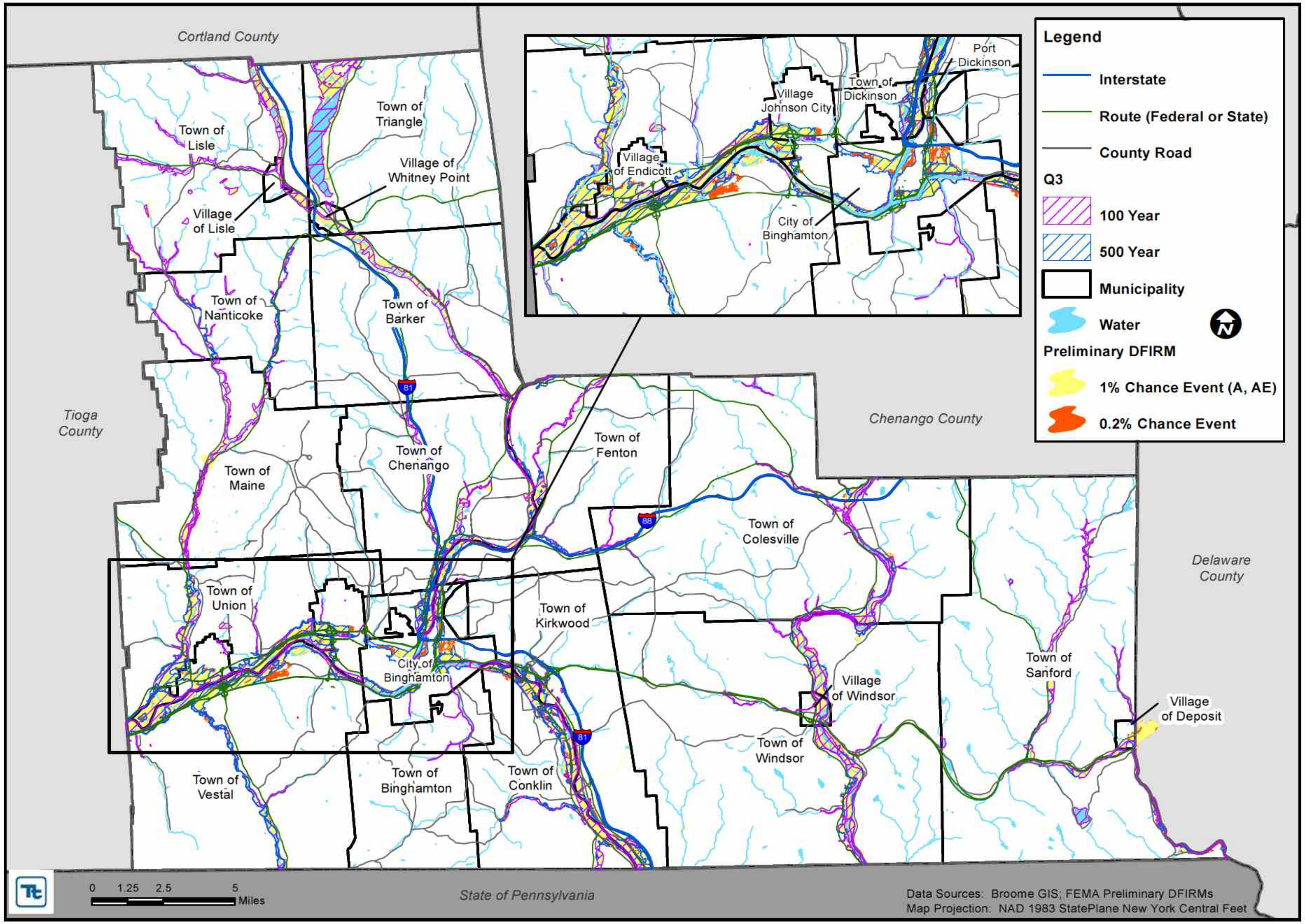
At the time of the original 2007 HMP, the FEMA Q3 flood zone data was identified as the most comprehensive flood polygon data for the study region. U.S. Geologic Survey (USGS) Digital Elevation Model (DEM) data were obtained and used as the base elevation and the hydrology and floodplain delineation was performed in HAZUS-MH. Potential losses estimates were generated at the Census-block level.

For this plan update, Broome County's Flood Insurance Rate Maps (FIRMs) are currently being updated with the best available flood hazard area being the preliminary DFIRMs which were used for this vulnerability assessment. A higher-resolution (3-meter) Digital Elevation Model (DEM) and the preliminary DFIRM database, both provided by the County, were used to develop the estimated 1-percent and 0.2-percent annual chance depth grids. The depth grids were integrated into HAZUS-MH and the model was run to estimate potential losses at the structure level utilizing the custom building inventory developed for this plan update.

Differences in exposure and potential losses estimated from the 2007 HMP and update is mainly due to the difference in flood hazard boundary data, building stock inventory and methodology used for the risk assessment. For example, the 2007 HMP building inventory structural replacement value (based on 2006 RSMeans) is half that of the updated building inventory used for this HMP update (based on 2011 RSMeans).

The county-wide 2007 HMP 1-percent flood event building potential loss estimate (all occupancies, structure and contents) was $232,646,500. As noted, this estimate was generated by a Census block-level analysis. This HMP update estimates potential losses using individual structures and is reported as such in Table 5.4.1-10. However, to compare apples to apples, if 1-percent potential losses were generated at the Census-block level using the updated building inventory, the loss estimate is $2,284,918,000. Figure 5.4.1-10 illustrates the difference between the Q3 hazard areas and the preliminary DFIRM flood hazard boundaries.

Figure 5.4.1-10. Comparison of the Q3 and Preliminary DFIRM Hazard Areas

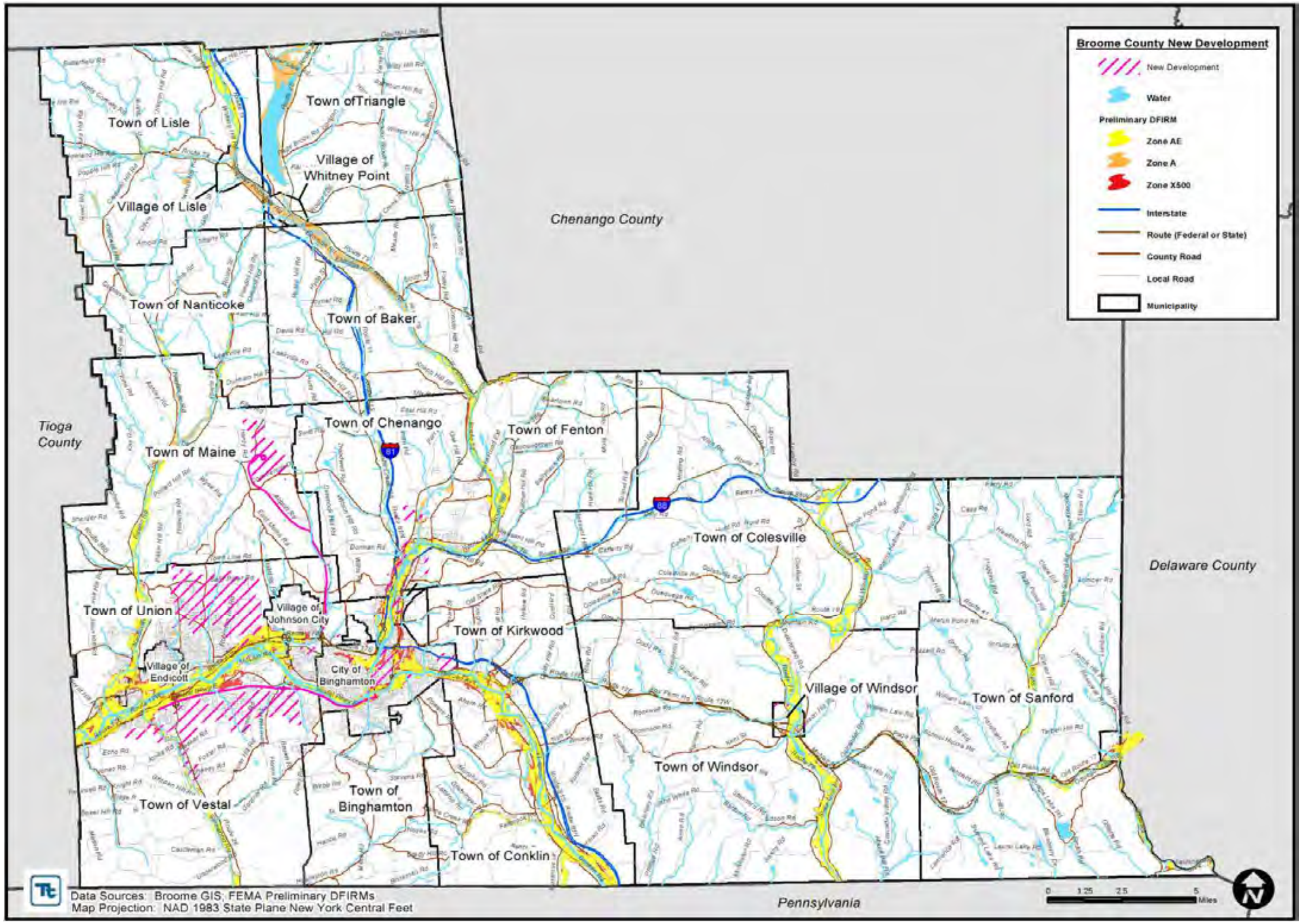


Source: Broome GIS

Future Growth and Development

As discussed in Section 4, 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. Figure 5.4.1-11 illustrates the identified areas of potential new development in relation to the flood boundaries. It is the intention of the County to discourage development in vulnerable areas or to encourage higher regulatory standards on the local level.

Figure 5.4.1-11. Potential New Development and Flood Boundaries



Source: Broome GIS; FEMA Preliminary DFIRMs

Additional Data and Next Steps

A HAZUS-MH riverine flood analysis was conducted for Broome County using the most current and best available data including updated building and critical facility inventories, preliminary DFIRMs and three- meter DEM. For future plan updates, more accurate exposure and loss estimates can be produced by replacing the national default demographic inventory with 2010 U.S. Census data when it becomes available in the HAZUS-MH model. As Assessor databases continue to be updated, the building inventory should also be maintained.

FEMA's Risk Mapping, Assessment, and Planning (Risk MAP) will be providing the flood depth and analysis grids as part of the publicly available DFIRM deliverable for the entire County and multiple return periods. Once these depth grids are available, they can be incorporated into HAZUS and used to recalculate the potential losses to the County's inventory for these recurrence intervals.

Specific mitigation actions addressing improved data collection and further vulnerability analysis is included in Section 9 (Mitigation Strategies) of this plan