5.1 METHODOLOGY AND TOOLS

A risk assessment is the process of measuring the potential loss of life, personal injury, and economic and property damage resulting from identified hazards. Identifying potential hazards and vulnerable assets allows planning personnel to address and reduce hazard impacts and emergency management personnel to establish early response priorities. Results of the risk assessment are used in subsequent mitigation planning processes, including determining and prioritizing mitigation actions that reduce each jurisdiction's risk to a specified hazard. Past, present, and future conditions must be evaluated to most accurately assess risk for the county and each jurisdiction. The process focuses on the following elements:

- **Hazard Identification**—Use best-available information to determine what types of hazards may affect a jurisdiction.
- **Profile Each Hazard**—Understand each hazard in terms of:
  - Extent—Severity of each hazard
  - Location—Geographic area most affected by the hazard
  - Previous occurrences and losses
- **Assess Vulnerability**
  - Exposure identification—Estimate the total number of assets in the jurisdiction that are likely to experience a hazard event if it occurs by overlaying hazard maps with the asset inventories.
  - Vulnerability identification and loss estimation—Assess the impact of hazard events on the people, property, economy, and lands of the region, including estimates of the cost of potential damage or cost that can be avoided by mitigation.
  - Future changes that may impact vulnerability—Analyze how demographic changes, projected development and climate change impacts can alter current exposure and vulnerability.

The following sections summarize the asset inventories, methodology, and tools used to support the risk assessment process.

5.1.1 Asset Inventories

Cattaraugus County assets were identified to assess potential exposure and loss associated with the hazards of concern. For the HMP update, Cattaraugus County assessed vulnerability of the following types of assets: population, buildings and critical facilities/infrastructure, and the environment. Some assets might be more vulnerable because of their physical characteristics or socioeconomic uses.

Population

As discussed in Section 4, County Profile, research has shown that some populations are at greater risk from hazard events because of decreased resources or physical abilities. The Centers for Disease Control and Prevention (CDC) social vulnerability index was referenced in this hazard mitigation plan to better understand the county's highest areas of risk for its communities. For the purposes of this planning process, vulnerable populations in Cattaraugus County include children, elderly, low-income individuals and families, people with physical or mental disabilities, non-English speakers, and the medically or chemically dependent.

The 2018 American Community Survey 5-Year Population Estimates (2014-2018) were used to estimate exposure and potential impacts to the general population. The 2010 U.S. Census demographic data available in Federal Emergency Management Agency's (FEMA) Hazards U.S. (HAZUS) model v4.2 was used to estimate potential displacement for persons exposed to the 1-percent annual chance flood event and the 500-year mean return period (MRP) hurricane wind event.

Buildings

The general building stock was updated countywide with a custom-building inventory using the 2018 Microsoft building stock inventory data set. The building inventory attributes were updated using parcel tax assessor information provided by Cattaraugus County Geographic Information System (GIS). Attributes provided in the spatial files were used to further define each structure, such as year built, number of stories, basement type, occupancy class, and square footage. The centroid of each building footprint was used to estimate the building location. Structural and content replacement cost values (RCV) were calculated for each building using the available assessor data, the building footprint, and RSMeans 2019 values. A regional location factor for Cattaraugus County was not available in the 2019 RSMeans data set; therefore, the analysis used the best option based on the zip codes within the county, which best fit within the location factors for Buffalo, New York. Therefore, the location factors of 1.06 and 1.09 was applied for non-residential occupancy classes and residential occupancy classes, respectively. Replacement cost value is the current cost of returning an asset to its pre-damaged condition using present-day cost of labor and materials. Total replacement cost value consists of both the structural cost to replace a building and the estimate value of contents of a building. The occupancy classes available in HAZUS v4.2 were condensed into the categories of residential, commercial, industrial, agricultural, religious, governmental, and educational to facilitate analysis and presentation of results. Residential loss estimates addressed both multi-family and single-family dwellings.

Critical Facilities

The critical facility inventory—which includes essential facilities, utilities, transportation features, high potential loss facilities and user-defined facilities as outlined in Section 4—was updated beginning with all GIS data provided by Cattaraugus County GIS and then reviewed by the Planning Committee allowing for municipal input. To protect individual privacy and the security of assets, information is presented in aggregate, without details about specific individual properties or facilities.

New Development

In addition to summarizing the current vulnerability, Cattaraugus County examined recent and anticipated new development that can affect the county's vulnerability to hazards. Identifying these changes and integrating them into the risk assessment ensures they are considered when developing the mitigation strategy to reduce vulnerabilities in the future. An exposure analysis was conducted using anticipated and recent new development provided by each jurisdiction. The development is presented in Section 9, Jurisdictional Annexes, as a table in each annex.

5.1.2 Methodology

To address the requirements of the DMA 2000 and better understand potential vulnerability and losses associated with hazards of concern, Cattaraugus County used standardized tools combined with local, state, and federal data and expertise to conduct the risk assessment. The following three levels of analysis were used depending on the data available for each hazard:

1. **Historic Occurrences and Qualitative Analysis**—This analysis includes an examination of historic impacts to understand potential impacts of future events of similar size. In addition, potential impacts and losses are discussed qualitatively using best-available data and professional judgement.
2. **Exposure Assessment**—This analysis involves overlaying available spatial hazard layers, or hazards with defined extent and locations, with assets in GIS to determine which assets are located in the impact area of the hazard. The analysis highlights which assets might be affected by the hazard. If the center of each asset is located in the hazard area, it is deemed exposed and potentially vulnerable to the hazard.

3. **Loss estimation**—The FEMA HAZUS modeling software was used to estimate potential losses for the following hazards: flood, earthquake, and severe storm (wind). In addition, an examination of historic impacts and an exposure assessment was conducted for these spatially-delineated hazards.

Table 5.1-1 summarizes the analysis factors considered for the Cattaraugus County risk assessment.

Table 5.1-1. Summary of Risk Assessment Analyses

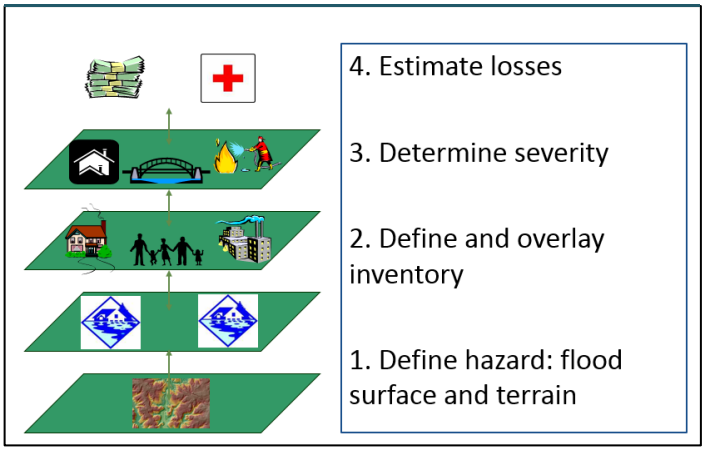
Hazard	Data Analyzed			
	Population	General Building Stock	Critical Facilities	New Development
Flood	E, H	E, H	E, H	E
Landslide	E	E	E	E
Severe Storm	H	H	H	Q
Severe Winter Storm	Q	Q	Q	Q
Utility Failure	Q	Q	Q	Q
Wildfire	E	E	E	E

Notes: E = Exposure analysis; H = HAZUS analysis; Q = Qualitative analysis

Hazards U.S. – Multi-Hazard (HAZUS)

In 1997, FEMA developed a standardized model for estimating losses caused by earthquakes, known as Hazards U.S. or HAZUS. HAZUS was developed in response to the need for more effective national-, state-, and community-level planning and for identification of areas that face the highest risk and potential for loss. HAZUS was expanded into a multi-hazard methodology with new models for estimating potential losses from wind (hurricanes) and flood (riverine and coastal) hazards. HAZUS is a GIS-based software tool that applies engineering and scientific risk calculations, which 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.

Figure 5.1-1. HAZUS – How it works



HAZUS uses GIS technology to produce damage reports, detailed maps, and analytical reports that estimate a community's direct physical damage to building stock, critical facilities, transportation systems, and utility systems. To generate this information, HAZUS uses default HAZUS provided data for inventory, vulnerability, and hazards. These default data can be supplemented with local data to provide a more refined analysis. Damage reports can include induced damage (inundation, fire, threats posed by hazardous materials and debris) and direct economic and social losses (casualties, shelter requirements, economic impact) depending on the hazard and available local data. HAZUS's open data architecture can be used to manage community GIS data in a central location. The use of this software also promotes consistency of data output now and in the future and standardization of data collection and storage. More information on HAZUS is available at http://www.fema.gov/Hazus.

In general, probabilistic analyses were performed to develop expected and estimated distribution of losses (MRP losses) for the flood, wind, and seismic hazards. The probabilistic model generates estimated damages and losses for specified return periods (e.g., 100- and 500-year). For annualized losses, HAZUS calculates the maximum potential annual dollar loss resulting from various return periods averaged on a per year basis. The model sums all HAZUS-supplied return periods (e.g., 10, 50, 100, 200, 500) multiplied by the return period probability (as a weighted calculation) to calculate the estimated cost of a hazard each year. Table 5.1-2 displays the various levels of analyses that can be conducted using the HAZUS software.

Table 5.1-2. Summary of HAZUS Analysis Levels

HAZUS Analysis Levels	
Level 1	HAZUS-provided hazard and inventory data with minimal outside data collection or mapping.
Level 2	Analysis involves augmenting the HAZUS-provided hazard and inventory data with more recent or detailed data for the study region, referred to as *local data*.
Level 3	Analysis involves adjusting the built-in loss estimation models used for the hazard loss analyses and is typically done in conjunction with the use of local data.

Flood

The 1-percent annual chance flood event was examined to evaluate the county's risk from the flood hazard. This flood event boundary is generally considered by planners and evaluated under federal programs such as the National Flood Insurance Program (NFIP).

The following data were used to evaluate exposure and determine potential future losses for this plan update:

- Q3 data from FEMA for Cattaraugus County dated from the 1970s/1980s
- The 1-percent annual chance flood depth grid generated using the Q3 FEMA data and 1-meter Digital Elevation Model (DEM) from the New York State Geographic Information System Department (NYS GIS)

The resulting depth grid was integrated into ESRI ArcGIS v10.5.1 for an exposure analysis and the HAZUS v4.2 riverine flood model for a loss analysis. This analysis used the Q3 flood boundary, updated general building stock inventory, identified new development, updated critical facility inventory, updated population data using the American Community Survey 5-Year Population Estimates (2014-2018), and the 2010 U.S. Census population data to estimate exposure and losses caused by the 1-percent annual chance flood event. Assets (population, building stock, critical facilities, new development) with their centroid in the floodplain were totaled to estimate the numbers and values exposed to a flooding event. To estimate potential losses, a Level 2 HAZUS v4.2 riverine flood analysis was performed for the 1-percent annual chance flood event. The updated building and critical facility inventories were incorporated into HAZUS. HAZUS calculated the estimated potential losses to the population (sheltering needs) using the 2010 U.S. Census population data and potential damages to the general building stock and critical facility inventories based on the depth grid generated and the default HAZUS damage functions in the flood model.

Landslide

To assess the vulnerability of the county to landslide events and its associated impacts, a quantitative assessment was conducted using ESRI ArcGIS v10.5.1 and a landslide layer that was created using the 2017 DEM from NYS GIS. The ArcGIS slope tool was used to calculate the degrees of the slopes in the DEM. According to the county, areas where slopes are greater than or equal to 25-percent are susceptible to landslide events. Therefore, areas where the slope angles were equal to or greater than 25-percent were converted to degrees (e.g., 25-percent is equal to 14 degrees). Degrees that are equal to or greater than 14 were converted to vectors, which created the final landslide hazard layer. To estimate potential exposure to landslide hazard areas, assets (population,

building stock, critical facilities, new development) with their centroid in the hazard areas were totaled to estimate the numbers and values exposed to the landslide hazard boundary.

Severe Storm

A HAZUS probabilistic analysis was performed to analyze the wind hazard for Cattaraugus County. The probabilistic hurricane model activates a database of thousands of potential storms that have tracks and intensities reflecting the full spectrum of Atlantic hurricanes observed since 1886 and identifies those with tracks associated with Cattaraugus County. HAZUS v4.2 contains data on historic hurricane events and wind speeds. It also includes surface roughness and vegetation (tree coverage) maps for the area. Surface roughness and vegetation data support the modeling of wind force across various types of land surfaces. The 500-year MRP was examined for the wind/severe storm hazard. The analysis used default demographic data provided in the HAZUS model with updated general building and critical facility inventories.

Severe Winter Storm

All of Cattaraugus County is exposed to the winter storm hazard. In general, structural impacts include damage to roofs and building frames, rather than building content. Current modeling tools are not available to estimate specific losses for this hazard. A percentage of the custom-building stock structural replacement cost value was utilized to estimate damages that could result from winter storm conditions (i.e., 1-percent, 5-percent, and 10-percent of total replacement cost value). Given professional knowledge and currently available information, the potential losses for this hazard are considered to be overestimated; hence, providing a conservative estimate for losses associated with winter storm events.

Utility Failure

To assess Cattaraugus County's vulnerability to utility failure and its associated impacts, a qualitative assessment was conducted. Information from U.S. Environmental Protection Agency (EPA), FEMA, and other federal and state resources were referenced to assess the potential impacts to the county's assets from utility failure.

Wildfire

The Wildland-Urban Interface (WUI) obtained through the SILVIS Laboratory, Department of Forest Ecology and Management, University of Wisconsin—Madison, based on the 2010 Census and 2006 National Land Cover Dataset and the Protected Areas Database, was used to delineate the wildfire hazard areas. The WUI area is divided into two categories: intermix and interface. The California Fire Alliance determined that 1.5 miles is the approximate maximum distance that firebrands can be carried from a wildland fire to the roof of a house. Therefore, even structures not within the forest are at risk from wildfire. This buffer distance, along with housing density and vegetation type, were used to define the WUI.

Intermix areas have more than one house per 40 acres and have more than 50-percent vegetation.

Interface areas have more than one house per 40 acres, have less than 50-percent vegetation, and are within 1.5 miles of an area over 1,235 acres that is more than 75-percent vegetated (Stewart et al. 2006).

For this risk assessment, the high-, medium-, and low-density interface areas were combined and used as the *Interface* hazard area, and the high-, medium-, and low-density intermix areas were combined and used as the *Intermix* hazard areas.

Asset data (population, building stock, critical facilities, new development) were used to support an evaluation of asset exposure and potential impacts and losses associated with this hazard. To determine the assets exposed to wildfire, the spatial asset inventory was overlaid with the hazard area in GIS. Assets with their centroid located

in the WUI were totaled to estimate the number of assets and their replacement cost value exposed to a wildfire event.

Considerations for Mitigation and Next Steps

The following are listed as considerations for the next plan update to enhance the vulnerability assessment:

- All Hazards
  - Use updated and current demographic data. If 2010 U.S. Census demographic data are the only data available at the U.S. Census Block level during the next plan update, estimate the current population for each Census Block using the American Community Survey 5-Year Estimate population counts at the Census Block group or Census Tract level available at the time of the update.
- Flood
  - Update the general building stock inventory to include attributes regarding first-floor elevation and foundation type (basement, slab on grade) to enhance the inventory and further refine the HAZUS loss estimates.
  - As more current FEMA floodplain data become available (i.e., Digital Flood Insurance Rate Maps), update the exposure analysis and generate a more detailed flood depth grid that can be integrated into the current HAZUS version.
  - Conduct a HAZUS loss analysis for more frequent flood events (e.g., 10- and 50-year flood events).
  - Conduct a repetitive loss area analysis.
- Severe Storm
  - Include attributes regarding hurricane straps and any mitigation measures in the general building stock inventory to enhance loss estimates.
- Severe Winter Storm
  - If available for the region, obtain average snowfall distributions to determine whether various areas in the county have historically received higher snowfalls and might continue to be more susceptible to higher snowfalls and snow loads on the building stock and critical facilities and infrastructure.
- Wildfire
  - Update the general building stock inventory to include attributes such as roofing material or fire detection equipment.

5.1.3 Data Source Summary

Table 5.1-3 summarizes the data sources used for the risk assessment.

Table 5.1-3. Risk Assessment Data Documentation

Data	Source	Date	Format
Population data	American Community Survey 5-Year Estimates	2018	Digital (GIS) format
Building stock data	Cattaraugus County GIS; Microsoft	2020/2018	Digital (GIS) format
Critical facilities	Cattaraugus County GIS	2020	Digital (GIS) format
Q3 Flood Mapping	Cattaraugus County GIS*	1970/1980	Digital (GIS) format
1-Meter Digital Elevation Model (DEM)	NYS GIS	2017	Digital (GIS) format
1-percent Annual Chance Flood Depth Grid	Tetra Tech	2020	Digital (GIS) format
Landslide Hazard Area (Slopes >25%)	Tetra Tech	2020	Digital (GIS) format

Data	Source	Date	Format
Interface/Intermix WUI	University of Wisconsin	2010	Digital (GIS) format
Social Vulnerability Index	Center for Disease Control	2016	Digital (GIS) format

** Note: Q3 Flood Mapping data were received from Cattaraugus County GIS, which was created by FEMA in 1970/1980.*

Limitations

For this risk assessment, the loss estimates, exposure assessments, and hazard-specific vulnerability evaluations rely on the best-available data and methodologies. Uncertainties are inherent in any loss estimation methodology and arise in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from the following:

1) Approximations and simplifications necessary to conduct such a study.
2) Incomplete or dated inventory, demographic, or economic parameter data.
3) The unique nature, geographic extent, and severity of each hazard.
4) Mitigation measures already employed by the participating municipalities.
5) The amount of advance notice residents has to prepare for a specific hazard event.

These factors can result in a range of uncertainty in loss estimates, possibly by a factor of two or more; therefore, potential exposure and loss estimates are approximate. These results do not predict precise results and should be used to understand relative risk. Over the long term to assist in estimating potential losses, Cattaraugus County will collect additional data and update and refine existing inventories.

Potential economic loss is based on the present value of the general building stock using best-available data. The county acknowledges significant impacts can occur to critical facilities and infrastructure as a result of these hazard events, causing great economic loss. However, monetized damage estimates to critical facilities and infrastructure, as well as economic impacts were not quantified and require more detailed loss analyses. In addition, economic impacts to industry, such as tourism and the real-estate market, were not analyzed.