5.4.4 Flood

The following section provides the hazard profile (hazard description, location, extent, previous occurrences and losses, probability of future occurrences, and impact of climate change) and vulnerability assessment for the flood hazard in Orleans County.

5.4.4.1 Profile

Hazard Description

Floods are one of the most common natural hazards in the United States. 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] 2007). Most U.S. communities have experienced some type 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 New York State Hazard Mitigation Plan (NYS HMP) (NYS DHSES 2014), flooding is a general and temporary condition of partial or complete inundation on normally dry land from the following:

- Riverine overbank flooding
- Flash floods
- Alluvial fan floods
- Mudflows or debris floods
- Dam- and levee-break floods
- Local draining or high groundwater levels
- Fluctuating lake levels
- Ice jams
- Coastal flooding

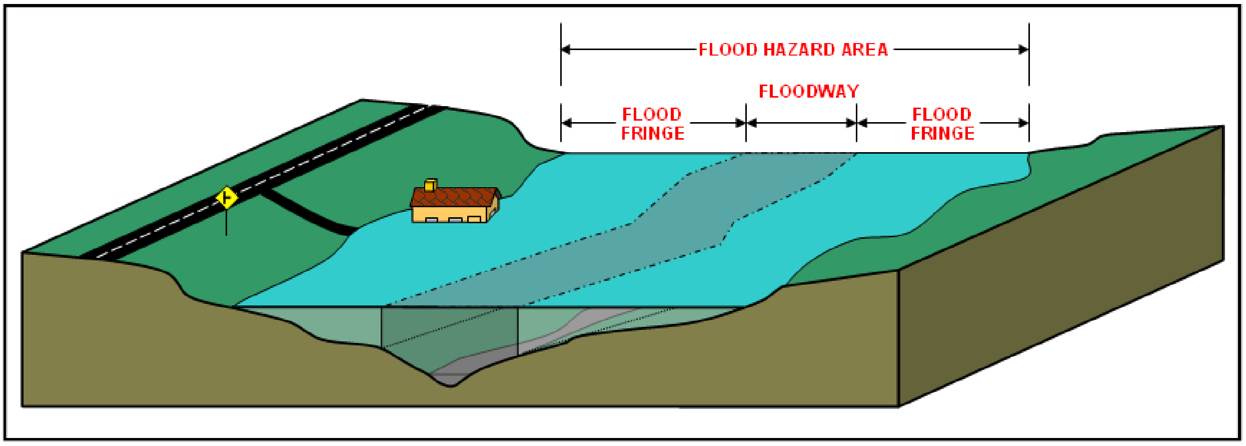
Many floods fall into three categories: riverine, coastal, and shallow (FEMA 2007). Other types of floods may include ice jam floods, alluvial fan floods, dam failure floods, and floods associated with local drainage or high groundwater. For the purpose of this HMP and as deemed appropriate by the Orleans County Steering Committee, riverine, shallow, flash, ice jam, and dam failure flooding are the main flood types of concern for the county. Dam failure floods are described in Section 5.4.1. The other types of floods are further discussed below.

Riverine (Inland) and Flash Flooding

Riverine floods are the most common flood type. They 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, 2007; The Illinois Association for Floodplain and Stormwater Management 2006).

The National Weather Service (NWS) defines a flash flood as "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). Figure 5.4.4-1 depicts the flood hazard area, the flood fringe, and the floodway areas of a floodplain.

Figure 5.4.4-1. Illustration of a Floodplain



Source: New Jersey Department of Environmental Protection (NJDEP) Date Unknown

Coastal (Lacustrine) Flooding

Coastal flooding occurs along the coasts of oceans, bays, estuaries, coastal rivers, and large lakes. For Orleans County, coastal flooding would be a result of the county's proximity to Lake Ontario. Coastal floods involve submersion of land areas along the ocean coast and inland waters caused by levels of seawater (or freshwater in the case of Orleans County) over and above normal tide action. Coastal flooding results from a storm surge causing local sea or lake levels to rise, often resulting in weakened or destroyed coastal structures. Winter snowmelt, hurricanes and tropical storms, severe storms, and Nor'easters cause most coastal flooding in Orleans County.

Coastal flooding poses many of the same problems as riverine flooding, but presents additional problems such as the following: beach erosion; loss or submergence of wetlands and other coastal ecosystems; saltwater intrusion (although this does not apply to Orleans County); high water tables; loss of coastal recreation areas, beaches, protective sand dunes, parks, and open space; and loss of coastal structures (FEMA 2011).

Coastal flooding exerts the following forces:

- *Hydrostatic forces* against a structure are created by standing or slowly moving water. Flooding can cause vertical hydrostatic forces, or flotation. These types of force are the main causes of flood damage.
- *Hydrodynamic forces* on buildings result when coastal floodwaters move at high velocities. These high-velocity flows can destroy solid walls and dislodge buildings with inadequate foundations. High-velocity flows can also move large quantities of sediment and debris, causing additional damage. In coastal areas, high-velocity flows are typically associated with one or more of the following:
    - Storm surge and wave run-up flowing landward through breaks in sand dunes or across low-lying areas
    - Tsunamis
    - Outflow of floodwaters driven into bay or upland areas
    - Strong currents parallel to the shoreline, driven by waves produced from a storm

  - Flows created or exacerbated by presence of manmade or natural obstructions along the shoreline, and by weak points formed by roads and access paths that cross dunes, bridges or canals, channels, or drainage features.

- *Waves* can affect coastal buildings via actions of breaking waves, wave run-up, wave reflection and deflection, and wave uplift. Breaking waves cause the most severe damage—often acting against a vertical surface with forces at least 10 times higher than forces created by high winds during a coastal storm.
- *Flood-borne debris* produced by coastal flooding events and storms typically includes decks, steps, ramps, breakaway wall panels, portions of or entire houses, heating oil and propane tanks, cars, boats, decks and pilings from piers, fences, erosion control structures, and many other types of smaller objects. Debris from floods can destroy unreinforced masonry walls, light wood-frame construction, and small-diameter posts and piles (FEMA 2011).

Shallow Flooding

Stormwater flooding is due to local drainage issues and high groundwater levels. Locally, heavy precipitation may produce flooding in areas other than delineated floodplains or along recognizable channels. If local conditions cannot accommodate intense precipitation through a combination of infiltration and surface runoff, water may accumulate and cause flooding problems. During winter and spring, frozen ground and snow accumulations may contribute to inadequate drainage and localized ponding. Flooding issues of this nature generally occur in areas with flat gradients and increase with urbanization, which speeds the accumulation of floodwaters because of impervious areas. Shallow street flooding can occur unless channels have been improved to account for increased flows (FEMA 1997).

High groundwater levels can be a concern and cause problems, even where there is no surface flooding. Basements are susceptible to high groundwater levels. Seasonally high groundwater is common in many areas; elsewhere, high groundwater occurs only after a long period of above-average precipitation (FEMA 1997).

Heavy rainfall that overwhelms a developed area's stormwater infrastructure causing flooding is commonly referred to as urban flooding. Urban flooding can be worsened by aging and inadequate infrastructure and over development of land. The growing number of extreme rainfall events that produce intense precipitation are resulting in increased urban flooding (Center for Disaster Resilience 2016). While riverine and coastal flooding is mapped and studied by FEMA, urban flooding is not.

NOAA defines urban flooding as the flooding of streets, underpasses, low-lying areas, or storm drains. (NOAA 2009). Urban drainage flooding is caused by increased water runoff due to urban development and inadequate drainage systems. Drainage systems are designed to remove surface water from developed areas as quickly as possible to prevent localized flooding on streets and other urban areas. The systems make use of a closed conveyance system that channels water away from an urban area to surrounding streams. This bypasses the natural processes of water filtration through the ground, containment, and evaporation of excess water. Because drainage systems reduce the amount of time the surface water takes to reach surrounding streams, flooding in those streams can occur more quickly and reach greater depths than prior to development in that area (Harris 2008).

Ice Jam Flooding

An ice jam occurs when pieces of floating ice are carried with a stream's current and accumulate behind any obstruction to the stream flow. Obstructions may include river bends, mouths of tributaries, points where the river slope decreases as well as dams and bridges. The water held back by this obstruction can cause flooding upstream, and if the obstruction suddenly breaks, flash flooding can occur as well (NOAA 2011). The formation of ice jams depends on the weather and physical condition of the river and stream channels. They are most likely to occur where the channel slope naturally decreases, in culverts, and along shallows where channels may freeze solid. Ice jams and resulting floods can occur during at different times of the year: fall freeze-up from the formation of frazil ice; mid-winter periods when stream channels freeze solid, forming anchor ice; and spring breakup when rising water levels from snowmelt or rainfall break existing ice cover into pieces that accumulate at bridges or other types of obstructions (NYS DHSES 2014).

There are two main 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 (NYS DHSES 2014).

Ice jams are common in the northeast U.S., and New York is not an exception. 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 DHSES 2014).

The Ice Jam Database, maintained by the Ice Engineering Group at the U.S. Army Corp of Engineers (USACE) Cold Regions Research and Engineering Laboratory (CRREL), currently consists of over 19,000 records from across the United States. According to the USACE-CRREL, Orleans County experienced one historic ice jam event between 1780 and 2018 (USACE 2018). The ice jam took place in 1996 on the Black River in Castorland. Recent non-historic events are further mentioned in the "Previous Occurrences" section of this hazard profile.

Location

Flooding is the primary natural hazard in NYS because combined effects of the State's latitude, topography, climatology, meteorology, water bodies, and waterways uniquely influence potential for flooding. Flooding occurs in every part of the State. Some areas are more flood-prone than others, but no area is exempt, including Orleans County.

Riverine/Flash Flooding

Water drains from the land surface through drainage features that range from rivulets in parking lots to large rivers such as Oak Orchard Creek. The entire area drained by a particular body of water is called a drainage basin or watershed. In Orleans County, there is one major drainage basin, with most of the land in the county located within the Oak Orchard-Twelvemile drainage basin. For details regarding the drainage basin in Orleans County, refer to Section 4 (County Profile) of this plan.

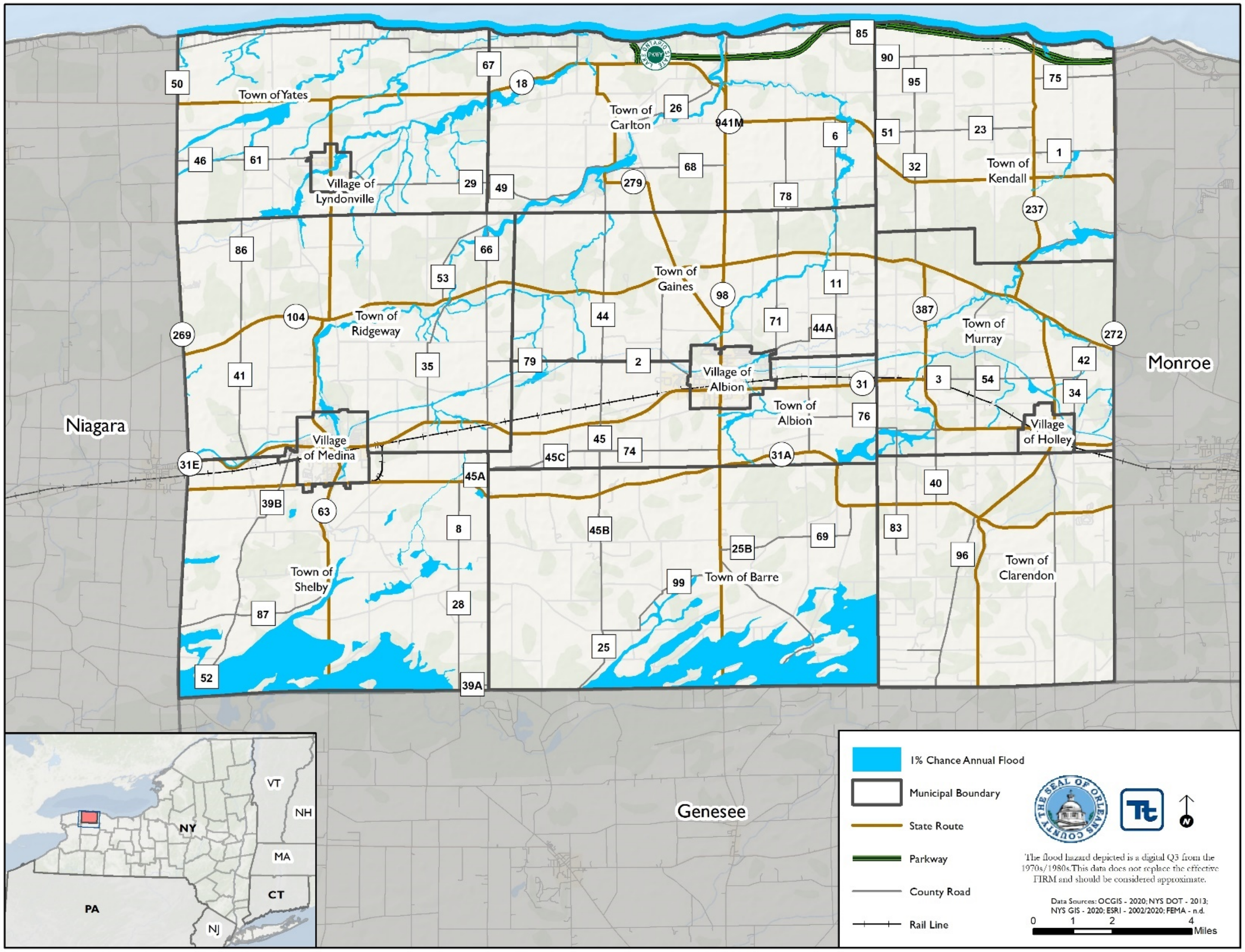
A floodplain is defined as the land adjoining the channel of a river, stream, ocean, lake, or other watercourse or water body that becomes inundated with water during a flood. Most often floodplains are referred to as 100-year floodplains. A 100-year floodplain is not a flood that will occur once every 100 years; rather it is a flood that has a 1 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. Due to this misleading term, FEMA has properly defined it as the 1 percent annual chance flood. The 1 percent annual chance flood is now the standard used by most federal and state agencies and by the National Flood Insurance Program (NFIP) (FEMA 2003). Similarly, the 500-year floodplain will not occur every 500 years but is an event with a 0.2 percent chance of being equaled or exceeded each year. In Orleans County, floodplains line the rivers and streams of the county. The boundaries of the floodplains are altered as a result of changes in land use, the amount of impervious surface, placement of obstructing structures in floodways, changes in precipitation and runoff patterns, improvements in technology for measuring topographic features, and utilization of different hydrologic modeling techniques.

Figure 5.4.4-2 illustrates the FEMA flood hazard zones in Orleans County. Since FEMA Digital Flood Insurance Rate Maps (DFIRMs) are not available for Orleans County, Orleans County digitized their effective Flood Insurance Rate Maps (FIRMs) to spatially delineate the 1 percent annual chance flood boundaries. As illustrated by this figure, flooding occurs along the rivers, streams, and bodies of water located throughout the county. A large area of 1 percent annual chance event floodplain is located along Oak Orchard Creek, which flows through the center of the county. The 0.2 percent annual chance flood boundaries are not digitized and are not spatially available for use in this plan. The Town of Clarendon does not have spatially delineated 1 percent annual chance flood boundaries available in the spatial layer.

Despite not being included in the available spatial layer, these communities are not free of flood risk. Flooding is still possible along the waterways and water bodies throughout these communities.

Section 9 (Jurisdictional Annexes) provides information regarding specific areas of flooding for each participating municipality in Orleans County.

Figure 5.4.4-2. FEMA Flood Hazard Areas in Orleans County



According to the Flood Insurance Studies for the Town of Barre, there are many areas in the southern portion that are subject to inundation (FEMA FIS 1981). The Town of Carlton has stream flooding in areas along the streams where the banks and terrain abutting the streams are relatively flat and unable to contain the flood levels within the channel (FEMA FIS 1978). The Town of Kendall's stream flooding problems exist because of low banks and flat terrain abutting Sandy Creek and Yanty Creek (FEMA FIS 1977). The Village of Lyndonville occasionally experiences flooding during the spring thaw (FEMA FIS 1981). In the Town of Yates (FEMA FIS 1978), stream flood problems exist due to the low banks and flat terrain in areas along Johnson Creek. The available Flood Insurance Studies for the county noted structural flood protection measures such as dams, seawalls, and stone and concrete revetments along the shoreline.

Coastal (Lacustrine) Flooding

The south shore of Lake Ontario is the only major coastline in the county, and thus the county's only scene of notable lacustrine flooding. Orleans County contains 24 miles of Lake Ontario shoreline, which increases residential risk from erosion and wave action, threatens local infrastructure, compromises sensitive environmental features, and contributes to general flooding events. Moreover, the geography along Lake Ontario increases likelihood of training thunderstorms (i.e., thunderstorms repeatedly moving across the same area), particularly along Lake Breeze Fronts. Most damaging floods from Lake Ontario occur when lake levels are high or during severe storms. Both scenarios create a temporary rise in the lake level and wave run-ups.

Urban Flooding

NOAA defines urban flooding as the flooding of streets, underpasses, low-lying areas, or storm drains. (NOAA 2009). Urban drainage flooding is caused by increased water runoff due to urban development and inadequate drainage systems. Drainage systems are designed to remove surface water from developed areas as quickly as possible to prevent localized flooding on streets and other urban areas. The systems make use of a closed conveyance system that channels water away from an urban area to surrounding streams. These bypasses the natural processes of water filtration through the ground, containment, and evaporation of excess water. Because drainage systems reduce the amount of time the surface water takes to reach surrounding streams, flooding in those streams can occur more quickly and reach greater depths than prior to development in that area (Harris 2008). High groundwater levels can be a concern and cause problems, even where there is no surface flooding. Basements are susceptible to high groundwater levels. Seasonally high groundwater is common in many areas, while elsewhere high groundwater occurs only after a long period of above-average precipitation (FEMA 1997).

Extent

In the case of riverine flood hazard, 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)

Severity of a flood depends not only on the amount of water that accumulates within a period of time, but also on the land's ability to manage this water. Sizes of rivers and streams in an area and infiltration rates are significant factors. During rain events, soil acts as a sponge. When land is saturated or frozen, infiltration rates decrease, and any more water that accumulates must flow as runoff (Harris 2001).

Previous Occurrences and Losses

Between 1954 and 2020, the State of New York was included in 25 flood-related disaster (DR) or emergency (EM) declarations. Orleans County was included in two of these declarations (FEMA 2020).

Table 5.4.4-1. Flood Events in Orleans County, 2010 to 2020

Dates of Event	Location	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts
May 1, 2013	Orleans County	Flood	N/A	No	Excessive rain and related flooding, high wind, and hail resulting in a USDA declaration.
May1-July 14, 2015	Orleans County	Excessive Rain	N/A	No	Excessive rain, hail, and high winds damaged crops throughout the county resulting in a USDA declaration.
April 1, 2017	Orleans County	Excessive Rain	N/A	Yes	Excessive rain caused crop damage to farms in Orleans County resulting in a USDA declaration.
May 2, 2017-November 1, 2017	New York	Flood	DR-4348	Yes	More than twice the normal amount of water accumulated on Lake Ontario. Flooding began in early May and continued into early Fall. Thousands of homes and buildings were affected by flood waters. Sanitary sewer systems in lakeside communities were affected. In late May, the Governor imposed 5 mph speed limit within 600 feet of Lake Ontario and St. Lawrence River shore. The shoreline counties of Lake Ontario and the St. Lawrence River sustained enough damage to qualify for both a New York State and Federal Disaster Declaration. By the end of summer, damage estimates included $9 Million in Orleans County.
May 17-31, 2019	Orleans	Flood	N/A	N/A	Excessive runoff into the Ottawa River Basin in Canada restricted the outlet of Lake Ontario. This combined with above-normal precipitation into the Lake Ontario Basin, record levels on the Great Lakes above Lake Ontario, and higher than normal flows into the lake from the Niagara River pushed the lake to well above normal levels. Throughout May, the levels quickly approached those reached in 2017. The levels continued to increase through the end of the month, rising to near 5.5 feet above low water datum by May 31.
June 1-30, 2019	Orleans County	Flood	N/A	N/A	Excessive runoff into the Ottawa River Basin in Canada restricted the outlet of Lake Ontario. This combined with above-normal precipitation into the Lake Ontario Basin, record levels on the Great Lakes above Lake Ontario, and higher than normal flows into the lake from the Niagara River pushed the lake to well above normal levels. Throughout June, new records were broken as the lake pushed to nearly 6 feet above low water datum and eclipsed the levels set in 2017. The lake peaked on June 10.

Dates of Event	Location	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts
July 1-31, 2019	Orleans County	Flood	N/A	N/A	Excessive runoff into the Ottawa River Basin in Canada restricted the outlet of Lake Ontario. This combined with above-normal precipitation into the Lake Ontario Basin, record levels on the Great Lakes above Lake Ontario, and higher than normal flows into the lake from the Niagara River pushed the lake to well above normal levels. Throughout July, water levels began to slowly recede; however, after starting the month about 5.5 feet above low water datum, the lake only fell to just below 5 feet above low water datum over the entirety of the month.
August 1-24, 2019	Orleans County	Flood	N/A	N/A	Excessive runoff into the Ottawa River Basin in Canada through the early half of the summer restricted the outlet of Lake Ontario. This combined with above-normal precipitation into the Lake Ontario Basin, record levels on the Great Lakes above Lake Ontario, and higher than normal flows into the lake from the Niagara River pushed the lake to well above normal levels. Throughout August, while ongoing precipitation gradually started to seasonally decrease, and outgoing flows through the Moses Saunders Dam increased, it took the majority of the month before the lake finally decreased below 4 feet above low water datum and flooding along the lakeshore finally subsided.
July 27, 2020	Orleans County	Flash Flood	N/A	N/A	Ditches were overflowing and running across roads. In 3.5 hours, 5.10 inches of rainfall was reported. Flash flooding closed roads, and a travel ban was instituted for Medina due to impassible roads.

Sources: FEMA 2020; NOAA-NCEI 2020 USDA Disaster Declarations 2020
Cfs Cubic feet per second
FEMA Federal Emergency Management Agency
HMP Hazard Mitigation Plan
Mph Miles per hour
NCEI National Centers for Environmental Information
NOAA National Oceanic and Atmospheric Administration
NYS New York State
N/A Not applicable
SPC Storm Prediction Center
USDA U.S. Department of Agriculture

Probability of Future Occurrences

Based on the historic and more recent flood events in Orleans County, it is clear that the county has a high probability of flooding for the future. 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 Orleans County will continue to experience direct and indirect impacts of flooding events annually that may induce secondary hazards such as coastal erosion, storm surge in coastal areas, infrastructure deterioration or failure, utility failures, power outages, water quality and supply concerns, and transportation delays, accidents, and inconveniences.

As defined by FEMA, geographic areas within the 1 percent annual chance flood area in Orleans County are estimated to have a 1 percent chance of flooding in any given year. A structure located within a 1 percent annual chance flood area has a 26 percent chance of suffering flood damage during the term of a 30-year mortgage. Geographic areas in Orleans County located within the 0.2 percent annual chance flood area boundary are estimated to have a 0.2 percent chance of being flooded in any given year (FEMA, 2003).

In Section 5.3, the identified hazards of concern for Orleans 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 flooding in the county is considered 'frequent' (hazard event is likely to occur within 25 years).

Table 5.4.4-2. Probability of Occurrence of Severe Storm Events in Orleans County

Hazard Type	Number of Occurrences Between 1950 and 2020	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	% chance of occurrence in any given year
Coastal Flood	7	0.10	10.00	10.0
Flash Flood	8	0.12	8.75	11.43
Flood	6	0.09	11.67	8.57
Storm Surge/Tide	0	0.00	0.00	0.00
Total	**21**	**0.30**	**3.33**	**100**

Source: NOAA NCEI 2020

In Section 5.3, the identified hazards of concern for Orleans 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'.

It is anticipated Orleans County will continue to experience direct and indirect impacts of flooding events annually that may induce secondary hazards such as erosion, storm surge in coastal areas, infrastructure deterioration or failure, utility failures, power outages, water quality and supply concerns, and transportation delays, accidents, and inconveniences.

Climate Change Impacts

Climate change is beginning to affect both people and resources in New York State, and these impacts are projected to continue growing. 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, contains attributes that will be affected by climate change. Orleans County is part of Region 1, Western New York, Great Lakes Plain. In Region 1, it is estimated that temperatures will increase by 3.0 ºF to 5.5 ºF by the 2050s and 4.5 ºF to 8.5 ºF by the 2080s (baseline of 48.0 ºF, mid-range projection). Precipitation totals will increase between 0 and 10% by the 2050s and 0 to 15% by the 2080s (baseline of 37.0 inches, mid-range projection). Table 5.4.4-3 displays the projected seasonal precipitation change for the Western New York, Great Lakes Plain ClimAID Region (NYSERDA 2014).

Table 5.4.4-3. Projected Seasonal Precipitation Change in Region 1, 2050s (% change)

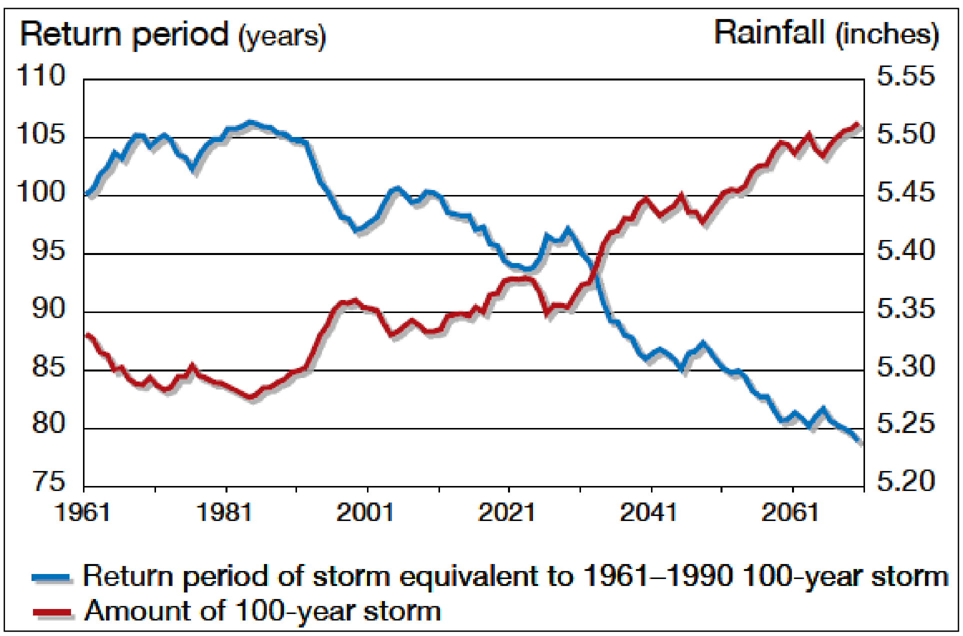
Winter	Spring	Summer	Fall
+5 to +15	0 to +10	-5 to +10	-5 to +10

Source: NYSERDA 2011

The projected increase in precipitation is expected to fall in heavy downpours and less in light rains. The increase in heavy downpours has the potential to affect drinking water; heighten the risk of riverine flooding; flood key rail lines, roadways, and transportation hubs; and increase delays and hazards related to extreme weather events (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). Figure 5.4.4-3 displays the project rainfall and frequency of extreme storms in New York State. The amount of rainfall in a 100-year event is projected to increase, while the number of years between such storms (return period) is projected to decrease. Rainstorms will become more severe and more frequent (NYSERDA 2011).

Figure 5.4.4-3. Projected Rainfall and Frequency of Extreme Storms



Source: NYSERDA 2011

5.4.4.2 Vulnerability Assessment

To assess Orleans County's risk to the flood hazard, a spatial analysis was conducted using the best available spatially delineated flood hazard areas. The 1 percent annual chance flood event was examined to determine the assets located in the hazard areas and to estimate potential loss using the FEMA HAZUS-MH v4.2 riverine model. These results are summarized below. Refer to Section 5.1 (Methodology) for additional details on the methodology used to assess flood risk.

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 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. However, exposure is not limited to persons who reside in a defined hazard zone, but includes all individuals 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.

Based on the spatial analysis, there are an estimated 597 people living in the 1 percent annual chance flood event hazard area. Residents may be displaced due to their homes flooding, requiring them to seek temporary shelter with friends and family or in emergency shelters. The Village of Lyndonville has the greatest percentage of its population located in the 1 percent annual chance flood event hazard area; approximately 9.9 percent. The Town of Carlton has the greatest number of residents located in the 1 percent annual chance flood event hazard area; approximately 176 persons. For this project, the potential population exposed is used as a guide for planning purposes.

Table 5.4.4-4 Estimated Population Exposed to the 1 percent Annual Chance Flood Event Hazard Area

Jurisdiction	Population (American Community Survey 5-Year 2014 - 2018)	Population in 1 percent Annual Chance Flood Event Hazard Area	
		Number of Persons Exposed	Percent of Total
Albion (T)	4,328	0	0.0%
Albion (V)	5,439	6	0.1%
Barre (T)	1,851	49	2.6%
Carlton (T)	2,880	176	6.1%
Clarendon (T)	3,514	0	0.0%
Gaines (T)	1,710	6	0.4%
Holley (V)	1,743	0	0.0%
Kendall (T)	2,626	53	2.0%
Lyndonville (V)	724	72	9.9%
Medina (V)	5,839	16	0.3%
Murray (T)	3,003	66	2.2%
Ridgeway (T)	3,090	15	0.5%
Shelby (T)	2,645	32	1.2%
Yates (T)	1,783	106	5.9%
Orleans County (Total)	**41,175**	**597**	**1.4%**

Sources: FEMA Q3 Data 1970/1980; American Community Survey 2018 (ACS 2014-2018)
Notes: Flood hazard area is depicted by FEMA Q3 data from 1970/1980. This data does not replace any effective DFIRM data for the County. T= Town, V= Village

Research has shown that some populations, while they may not have more hazard exposure, may experience exacerbated impacts and prolonged recovery if/when impacted. This is due to many factors, including their physical and financial ability to react or respond during a hazard. Of the population exposed, the most vulnerable include the economically disadvantaged and the population over age 65. Economically disadvantaged populations may be more vulnerable because they are likely to evaluate their risk and make decisions to evacuate based on net economic impacts on their families. The population over age 65 is also more vulnerable because they are more likely to seek or need medical attention that may not be available due to isolation during a flood event, and they may have more difficulty evacuating. Within Orleans County, there are approximately 6,994 people over the age of 65 and 5,499 people below the poverty level (American Community Survey 2018).

The Centers for Disease Control and Prevention (CDC) 2016 Social Vulnerability Index (SVI) ranks U.S. Census tracts on socioeconomic status, household composition and disability, minority status and language, and housing and transportation. Orleans County's overall score is 0.5839, indicating that its communities have moderate to high social vulnerability (CDC 2016). This score indicates that some county residents may not have enough resources to respond to flood events.

Using 2010 U.S. Census data, HAZUS-MH v4.2 estimates the potential sheltering needs as a result of a 1 percent annual chance flood event. For the 1 percent flood event, HAZUS-MH v4.2 estimates 1,105 households will be displaced, and six people will seek short-term sheltering. These statistics, by jurisdiction, are presented in Table 5.4.4-5. The estimated displaced population and number of persons seeking short-term sheltering differs from the number of persons exposed to the 1 percent annual chance flood because the displaced population numbers take into consideration that not all residents will be significantly impacted enough to be displaced or to require short-term sheltering during a flood event.

Table 5.4.4-5 Estimated Population Displaced or Seeking Short-Term Shelter from the 1 percent Annual Chance Flood Event Hazard Area

Jurisdiction	Population (American Community Survey 5-Year 2014 - 2018)	1 percent Annual Chance Event	
		Displaced Population	Persons Seeking Short-Term Sheltering
Albion (T)	4,328	19	0
Albion (V)	5,439	110	0
Barre (T)	1,851	109	1
Carlton (T)	2,880	142	0
Clarendon (T)	3,514	0	0
Gaines (T)	1,710	20	0
Holley (V)	1,743	16	0
Kendall (T)	2,626	81	0
Lyndonville (V)	724	76	1
Medina (V)	5,839	94	0
Murray (T)	3,003	89	0
Ridgeway (T)	3,090	76	0
Shelby (T)	2,645	189	4
Yates (T)	1,783	84	0
Orleans County (Total)	**41,175**	**1,105**	**6**

Sources: HAZUS v4.2; FEMA Q3 Data 1970/1980; American Community Survey 2018 (ACS 2014-2018)
Note: Flood hazard area is depicted by FEMA Q3 data from 1970/1980. This data does not replace any effective DFIRM data for the county.
T = Town; V = Village;
**HAZUS v4.2 uses 2010 Census data for displacement estimates. These numbers may be underestimated compared to the American Community Survey 2018 5-year estimates data.*

Total number of injuries and casualties resulting from typical riverine and tidal flooding are generally limited based on advance weather forecasting, blockades, and warnings. Injuries and deaths generally are not anticipated if proper warning and precautions occur. In contrast, warning time for flash flooding is limited. 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.

Cascading impacts of flooding and dam failure inundation may also include exposure to pathogens such as mold. After flood events, excess moisture and standing water contribute to the growth of mold in buildings. Mold may present a health risk to building occupants, especially those with already compromised immune systems such as infants, children, the elderly, and pregnant women. The degree of impact will vary and is not strictly measurable. Mold spores can grow in as short a period as 24-48 hours in wet and damaged areas of buildings that have not been properly cleaned. Very small mold spores can easily be inhaled, creating the potential for allergic reactions, asthma episodes, and other respiratory problems. Buildings should be properly cleaned and dried out to safely prevent mold growth (CDC 2015).

Molds and mildews are not the only public health risk associated with flooding. Floodwaters can be contaminated by pollutants such as sewage, human and animal feces, pesticides, fertilizers, oil, asbestos, and rusting building materials. Common public health risks associated with flood events also include:

- Unsafe food
- Contaminated drinking and washing water and poor sanitation
- Mosquitos and animals
- Carbon monoxide poisoning
- Secondary hazards associated with re-entering/cleaning flooded structures
- Mental stress and fatigue

Current loss estimation models such as HAZUS-MH v4.2 are not equipped to measure public health impacts. The best level of mitigation for these impacts is to be aware that they can occur, educate the public on prevention, and be prepared to deal with these vulnerabilities in responding to flood events.

Impact on General Building Stock

Exposure to the flood hazard includes those buildings located in the flood zone or those that are built downstream in other flood inundation areas such as dam failure inundation areas. Potential damage is the modeled loss that could occur to the exposed inventory measured by the structural and content replacement cost value. There are an estimated 524 buildings located in the 1 percent annual chance flood event hazard area with a value of approximately $279 million of building and contents (based on replacement cost value). This represents approximately 1.7 percent of the county's total general building stock inventory replacement cost value (approximately $15.9 billion). The Town of Carlton has the greatest number of its buildings located in the floodplain; 190 buildings or 7.3 percent of its total building stock. Refer to Table 5.4.4-6 for a summary of 1 percent flood inundation area exposure results by jurisdiction. Table 5.4.4-7 and Table 5.4.4-8 break down the 1 percent annual chance flood event exposure results for residential structures and commercial structures, respectively.

Furthermore, HAZUS-MH v4.2 estimates approximately $12.5 million in building and content damage as a result of the 1 percent annual chance flood event (or 0.1 percent of the total building stock replacement cost value). Of the $12.5 million in potential loss, approximately $8.4 million losses are estimated to occur to residential structures. Refer to Table 5.4.4-9 for the potential losses from the 1 percent annual chance flood event for all occupancies estimated by jurisdiction. Table 5.4.4-10 and Table 5.4.4-11 summarize HAZUS-MH v4.2 estimated damages for residential and commercial occupancy classes, respectively.

Table 5.4.4-6 Estimated General Building Stock Exposure to the 1 percent Annual Chance Flood Event

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Total (All Occupancies) 1 percent Annual Chance Event			
			Number Buildings	Percent Total	Replacement Cost Value (RCV)	Percent Total
Albion (T)	1,144	$1,072,416,436	0	0.0%	$0	0.0%
Albion (V)	2,230	$2,083,615,553	3	0.1%	$1,149,682	0.1%
Barre (T)	1,334	$903,951,870	67	5.0%	$54,158,334	6.0%
Carlton (T)	2,591	$1,347,621,840	190	7.3%	$72,896,400	5.4%
Clarendon (T)	1,965	$907,937,056	0	0.0%	$0	0.0%

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Total (All Occupancies) 1 percent Annual Chance Event			
			Number Buildings	Percent Total	Replacement Cost Value (RCV)	Percent Total
Gaines (T)	1,288	$894,866,214	4	0.3%	$1,033,291	0.1%
Holley (V)	682	$743,620,047	1	0.1%	$461,383	0.1%
Kendall (T)	1,680	$1,031,876,917	36	2.1%	$18,755,262	1.8%
Lyndonville (V)	365	$309,487,559	33	9.0%	$20,316,870	6.6%
Medina (V)	2,373	$2,373,119,133	9	0.4%	$3,906,677	0.2%
Murray (T)	1,735	$910,189,285	39	2.2%	$15,810,899	1.7%
Ridgeway (T)	2,373	$1,520,302,743	10	0.4%	$4,603,775	0.3%
Shelby (T)	1,599	$1,074,700,892	40	2.5%	$50,489,825	4.7%
Yates (T)	1,396	$820,794,015	92	6.6%	$35,796,929	4.4%
Orleans County (Total)	**22,755**	**$15,994,499,560**	**524**	**2.3%**	**$279,379,326**	**1.7%**

Sources: FEMA Q3 Data 1970/1980; Orleans GIS 2020; RS Means 2019
Note: Flood hazard area is depicted by FEMA Q3 data from 1970/1980. This data does not replace any effective DFIRM data for the county.
T = Town; V = Village

Table 5.4.4-7 Estimated General Building Stock Exposure to the 1 percent Annual Chance Flood Event – Residential Occupancy Class

Jurisdiction	Total Number Buildings (Residential Structures Only)	Total Replacement Cost Value (Residential Structures Only)	Residential 1 percent Annual Chance Event			
			Number Buildings	Percent Total	Replacement Cost Value (RCV)	Percent Total
Albion (T)	685	$372,084,522	0	0.0%	$0	0%
Albion (V)	1,935	$1,025,988,498	2	0.1%	$762,693	0.1%
Barre (T)	796	$369,120,544	22	2.8%	$10,093,882	2.7%
Carlton (T)	1,577	$739,940,226	100	6.3%	$39,686,764	5.4%
Clarendon (T)	1,456	$567,780,003	0	0.0%	$0	0.0%
Gaines (T)	749	$452,846,444	4	0.5%	$1,033,291	0.2%
Holley (V)	564	$400,288,547	0	0.0%	$0	0.0%
Kendall (T)	1,119	$549,435,024	24	2.1%	$10,115,079	1.8%
Lyndonville (V)	293	$176,743,723	30	10.2%	$16,400,598	9.3%
Medina (V)	2,099	$1,293,259,697	5	0.2%	$2,058,295	0.2%
Murray (T)	1,215	$536,680,953	30	2.5%	$7,164,111	1.3%
Ridgeway (T)	1,277	$683,372,444	7	0.5%	$3,862,432	0.6%
Shelby (T)	948	$485,782,472	10	1.1%	$5,111,678	1.1%
Yates (T)	910	$403,098,338	68	7.5%	$22,502,885	5.6%
Orleans County (Total)	**15,623**	**$8,056,421,436**	**302**	**1.9%**	**$118,791,708**	**1.5%**

Sources: FEMA Q3 Data 1970/1980; Orleans GIS 2020; RS Means 2019
Note: Flood hazard area is depicted by FEMA Q3 data from 1970/1980. This data does not replace any effective DFIRM data for the county.
T = Town; V = Village

Table 5.4.4-8 Estimated General Building Stock Exposure to the 1 percent Annual Chance Flood Event – Commercial Occupancy Class

Jurisdiction	Total Number Buildings (Commercial Buildings Only)	Total Replacement Cost Value (Commercial Buildings Only)	Commercial 1 percent Annual Chance Flood Event			
			Number Buildings	Percent Total	Replacement Cost Value (RCV)	Percent Total
Albion (T)	103	$185,310,150	0	0.0%	$0	0.0%
Albion (V)	198	$516,067,581	1	0.5%	$386,989	0.1%

Jurisdiction	Total Number Buildings (Commercial Buildings Only)	Total Replacement Cost Value (Commercial Buildings Only)	Commercial 1 percent Annual Chance Flood Event			
			Number Buildings	Percent Total	Replacement Cost Value (RCV)	Percent Total
Barre (T)	116	$147,483,755	18	15.5%	$26,833,390	18.2%
Carlton (T)	464	$257,679,099	69	14.9%	$21,231,598	8.2%
Clarendon (T)	84	$58,889,426	0	0.0%	$0	0.0%
Gaines (T)	118	$162,746,098	0	0.0%	$0	0.0%
Holley (V)	69	$212,129,374	1	1.4%	$461,383	0.2%
Kendall (T)	132	$112,539,534	7	5.3%	$4,820,415	4.3%
Lyndonville (V)	30	$36,865,676	3	10.0%	$3,916,272	10.6%
Medina (V)	178	$578,618,084	3	1.7%	$1,450,075	0.3%
Murray (T)	216	$179,330,036	7	3.2%	$8,015,783	4.5%
Ridgeway (T)	298	$218,544,188	1	0.3%	$82,736	0.0%
Shelby (T)	70	$83,032,691	0	0.0%	$0	0.0%
Yates (T)	109	$80,929,399	19	17.4%	$10,654,251	13.2%
Orleans County (Total)	**2,185**	**$2,830,165,090**	**129**	**5.9%**	**$77,852,892**	**2.8%**

Sources: FEMA Q3 Data 1970/1980; Orleans GIS 2020; RS Means 2019
Note: Flood hazard area is depicted by FEMA Q3 data from 1970/1980. This data does not replace any effective DFIRM data for the county.
T = Town; V = Village

Table 5.4.4-9 Estimated General Building Stock Potential Loss to the 1 percent Annual Chance Flood Event – All Occupancies

Jurisdiction	Total Replacement Cost Value (RCV)	All Occupancies 1 percent Annual Chance Flood Event	
		Estimated Loss Replacement Cost Value	Percent of Total
Albion (T)	$1,072,416,436	$0	0.0%
Albion (V)	$2,083,615,553	$76,724	<0.1%
Barre (T)	$903,951,870	$1,408,202	0.2%
Carlton (T)	$1,347,621,840	$5,693,886	0.42%
Clarendon (T)	$907,937,056	$0	0.0%
Gaines (T)	$894,866,214	$39,529	<0.1%
Holley (V)	$743,620,047	$151,505	<0.1%
Kendall (T)	$1,031,876,917	$1,379,650	0.13%
Lyndonville (V)	$309,487,559	$1,936,020	0.6%
Medina (V)	$2,373,119,133	$264,742	<0.1%
Murray (T)	$910,189,285	$238,741	<0.1%
Ridgeway (T)	$1,520,302,743	$154,555	<0.1%
Shelby (T)	$1,074,700,892	$155,151	0.0%
Yates (T)	$820,794,015	$1,014,409	0.1%
Orleans County (Total)	**$15,994,499,560**	**$12,513,115**	**0.1%**

Sources: HAZUSv4.2; FEMA Q3 Data 1970/1980; Orleans GIS 2020; RS Means 2019
Note: Flood hazard area is depicted by FEMA Q3 data from 1970/1980. This data does not replace any effective DFIRM data for the county.
T = Town; V = Village

Table 5.4.4-10 Estimated General Building Stock Potential Loss to the 1 percent Annual Chance Flood Event – Residential Occupancy Class

Jurisdiction	Total Replacement Cost Value (Residential Only)	Residential Losses Only 1 percent Annual Chance Flood Event	
		Estimated Loss Replacement Cost Value	Percent of Total
Albion (T)	$372,084,522	$0	0.0%
Albion (V)	$1,025,988,498	$6,409	<0.1%
Barre (T)	$369,120,544	$309,641	0.1%
Carlton (T)	$739,940,226	$3,863,135	0.5%
Clarendon (T)	$567,780,003	$0	0.0%
Gaines (T)	$452,846,444	$39,529	<0.1%
Holley (V)	$400,288,547	$0	0.0%
Kendall (T)	$549,435,024	$1,098,369	0.2%
Lyndonville (V)	$176,743,723	$1,655,563	0.9%
Medina (V)	$1,293,259,697	$0	0.0%
Murray (T)	$536,680,953	$192,211	<0.1%
Ridgeway (T)	$683,372,444	$154,555	<0.1%
Shelby (T)	$485,782,472	$105,500	<0.1%
Yates (T)	$403,098,338	$1,006,073	0.2%
Orleans County (Total)	**$8,056,421,436**	**$8,430,983**	**0.1%**

Sources: HAZUSv4.2; FEMA Q3 Data 1970/1980; Orleans GIS 2020; RS Means 2019
Note: Flood hazard area is depicted by FEMA Q3 data from 1970/1980. This data does not replace any effective DFIRM data for the county.
T = Town; V = Village

Table 5.4.4-11 Estimated General Building Stock Potential Loss to the 1 percent Annual Chance Flood Event – Commercial Occupancy Class

Jurisdiction	Total Replacement Cost Value (Commercial Only)	Commercial Losses Only 1 percent Annual Chance Flood Event	
		Estimated Loss Replacement Cost Value	Percent of Total
Albion (T)	$185,310,150	$0	0.0%
Albion (V)	$516,067,581	$70,316	<0.1%
Barre (T)	$147,483,755	$179,632	0.1%
Carlton (T)	$257,679,099	$1,830,751	0.7%
Clarendon (T)	$58,889,426	$0	0.0%
Gaines (T)	$162,746,098	$0	0.0%
Holley (V)	$212,129,374	$151,505	0.1%
Kendall (T)	$112,539,534	$281,281	0.2%
Lyndonville (V)	$36,865,676	$280,457	0.8%
Medina (V)	$578,618,084	$264,742	<0.1%
Murray (T)	$179,330,036	$46,530	<0.1%
Ridgeway (T)	$218,544,188	$0	0.0%
Shelby (T)	$83,032,691	$0	0.0%
Yates (T)	$80,929,399	$0	0.0%
Orleans County (Total)	**$2,830,165,090**	**$3,105,214**	**0.1%**

Sources: HAZUSv4.2; FEMA Q3 Data 1970/1980; Orleans GIS 2020; RS Means 2019
Note: Flood hazard area is depicted by FEMA Q3 data from 1970/1980. This data does not replace any effective DFIRM data for the county.
T = Town; V = Village

NFIP Statistics

FEMA Region 2 provided a list of NFIP policies, past claims, and repetitive loss properties (RL) in Orleans County. According to FEMA, a RL property is a NFIP-insured structure that has had at least two paid flood losses of more than $1,000 in any 10-year period since 1978. A SRL property is a NFIP-insured structure that has had four or more separate claim payments made under a standard flood insurance policy, with the amount of each claim exceeding $5,000 and with the cumulative amount of such claims payments exceeding $20,000; or at least two separate claims payments made under a standard flood insurance policy with the cumulative amount of such claim payments exceed the fair market value of the insured building on the day before each loss (FEMA 2018). Table 5.4.4-12 shows that there are more NFIP claims than policies in Orleans County reported. This is likely because multiple repetitive loss properties submitted more than one flood loss claim under their NFIP policy. Note that specific locations of repetitive loss properties were not made available for this plan.

Table 5.4.4-12 Repetitive Loss Properties and NFIP Data for Putnam County

Jurisdiction	Number of Repetitive Loss Properties	Number of Policies	Number of Claims	Total Losses Claimed
Albion (T)	0	0	0	$0
Albion (V)	0	2	1	$1,973
Barre (T)	0	5	1	$2,797
Carlton (T)	4	22	15	$75,499
Clarendon (T)	0	0	9	$31,482
Gaines (T)	0	0	0	$0
Holley (V)	0	0	1	$0
Kendall (T)	0	16	10	$17,081
Lyndonville (V)	0	13	2	$0
Medina (V)	0	0	3	$1,756
Murray (T)	0	1	0	$0
Ridgeway (T)	0	4	0	$0
Shelby (T)	0	1	0	$0
Yates (T)	0	6	6	$6,995
Orleans County (Total)	**4**	**70**	**48**	**$137,583**

Source: FEMA Region 2, 2020
Note: NFIP = National Flood Insurance Program, V = Village, T = Town

Impact on Land Uses

An exposure analysis was completed to determine the acres of developed residential land and developed non-residential land use types located in the 1 percent flood hazard area. To estimate exposure for developed residential and non-residential land use types to the 1 percent flood hazard area, the floodplain boundary was overlaid upon land use data. Refer to Table 5.4.4-13 for a complete summary of this analysis.

Table 5.4.4-13 Developed Residential and Non-Residential Land Use Exposed to 1 percent Annual Chance Flood Event Hazard Area

Land Use Type	Total Acres for County	1 percent Annual Chance Event	
		Acres	Percent of Total
Residential Land	5,850	267	4.6%
Non-Residential Land	243,515	15,802	6.5%
Natural Land	87,214	10,644	12.2%
Orleans County (Total)	**249,365**	**52,148**	**20.9%**

Sources: FEMA Q3 Data 1970/1980; Orleans GIS 2020; NLCD 2016
Note: Flood hazard area is depicted by FEMA Q3 data from 1970/1980. This data does not replace any effective DFIRM data for the county. Land use areas do not include areas of water. Non-residential area = Agriculture, Barren, Developed – Open Space, Forest, Wetlands; Residential area = Developed – low intensity, Developed – medium intensity, and Developed – high intensity. Natural Land = Wetlands, Forest; This analysis does not incorporate areas delineated as water.
T = Town; V = Village

Impact on Critical Facilities

It is important to determine the critical facilities and infrastructure that may be at risk to flooding, and who may be impacted should damage occur. Critical services during and after a flood event may not be available if critical facilities are directly damaged or transportation routes to access these critical facilities are impacted. Roads that are blocked or damaged can isolate residents and can prevent access throughout the planning area to many service providers needing to reach vulnerable populations or to make repairs.

Major roadways that may be impacted by the 1 percent annual chance flood event include the Parkway, State Roads (i.e., NY-237, NY-279, NY-31, NY-31A, NY-63, NY-98), and various county roads. Approximately 4.2 percent of all roadways are located within the 1 percent annual chance flood event. Table 5.4.4-14 summarizes the road types and mileage located within the 1 percent annual chance flood event. Additional infrastructure can be impacted by flooding such as bridges, water and sewer systems, drinking water facilities, culverts, and sewer systems. For example, bridges that are washed out or blocked by floods or debris can cause isolation. Water and sewer systems can be flooded or backed up, causing health problems. Floodwaters can get into drinking water supplies, causing contamination. Culverts can be blocked by debris from flood events, also causing localized urban flooding. Sewer systems can be backed up, causing wastewater to spill into homes, neighborhoods, rivers, and streams.

Table 5.4.4-14 Road Miles Located in the 1 percent Annual Chance Flood Hazard Area

Road Type	Total Miles for County	1 percent Annual Chance Event	
		Miles	Percent of Total
Local and Private Roads	611	32.7	5.4%
County Roads	187	4.4	2.4%
State Routes	175	4.1	2.4%
Parkway	26	0.21	0.8%
Orleans County (Total)	**999**	**41**	**4.2%**

Sources: HAZUS v4.2; FEMA Q3 Data 1970/1980; Orleans County GIS 2020
Note: Flood hazard area is depicted by FEMA Q3 data from 1970/1980. This data does not replace any effective DFIRM data for the county.
T = Town; V = Village

Critical facility exposure to the 1 percent annual chance flood hazard event boundary was examined. In addition, HAZUS-MH v4.2 was used to estimate the flood loss potential to critical facilities located in the FEMA mapped floodplains. HAZUS-MH v4.2 results can be found in Volume II, Jurisdiction Annexes. Table 5.4.4-15 summarizes the number of critical facilities exposed to the 1 percent flood inundation areas by jurisdiction. Table 5.4.4-16 summarizes the distribution of critical facilities in the 1 percent annual chance flood event boundary. Of the 132 critical facilities located in the 1 percent annual chance flood event boundary, 115 are considered lifelines for the county (Table 5.4.4-17). Refer to Section 4 (County Profile) for more information about the critical facilities and lifelines in Orleans County.

Table 5.4.4-15 Number of Critical Facilities Located in the 1 percent Annual Chance Flood Hazard Area

Jurisdiction	Total Critical Facilities Located in Jurisdiction	Total Lifelines Located in Jurisdiction	Number of Critical Facilities and Lifeline Facilities Exposed to the 1 percent Annual Chance Flood Event			
			Critical Facilities	Percent of Total Critical Facilities	Lifelines	Percent of Total Lifelines
Albion (T)	48	41	1	2.1%	1	2.4%
Albion (V)	81	56	6	7.4%	5	8.9%
Barre (T)	37	27	5	13.5%	3	11.1%
Carlton (T)	88	66	30	34.1%	26	39.4%
Clarendon (T)	50	44	0	0.0%	0	0.0%
Gaines (T)	32	20	6	18.8%	5	25.0%
Holley (V)	30	20	1	3.3%	1	5.0%
Kendall (T)	52	43	9	17.3%	7	16.3%
Lyndonville (V)	32	19	5	15.6%	3	15.8%
Medina (V)	83	57	16	19.3%	16	28.1%
Murray (T)	40	31	8	20.0%	8	25.8%
Ridgeway (T)	92	69	20	21.7%	20	29.0%
Shelby (T)	87	64	14	16.1%	10	15.6%
Yates (T)	32	22	11	34.4%	10	45.5%
Orleans County (Total)	**784**	**579**	**132**	**16.8%**	**115**	**19.9%**

Sources: HAZUS v4.2; FEMA Q3 Data 1970/1980; Orleans County GIS 2020
Note: Flood hazard area is depicted by FEMA Q3 data from 1970/1980. This data does not replace any effective DFIRM data for the county.
T = Town; V = Village

Table 5.4.4-16 Distribution of Critical Facilities in the 1 percent Annual Chance Flood Event Floodplain by Type and Jurisdiction

Jurisdiction	Facility Types									
	Bridge	Dam	Electric/Gas Facility	Major Employer	Marina	Pollution Discharge Site	Potable Water	Primary Education	Religious	Water Well
Albion (T)	1	0	0	0	0	0	0	0	0	0
Albion (V)	4	1	0	1	0	0	0	0	0	0
Barre (T)	2	2	0	0	0	0	0	0	0	1

Jurisdiction	Facility Types									
	Bridge	Dam	Electric/Gas Facility	Major Employer	Marina	Pollution Discharge Site	Potable Water	Primary Education	Religious	Water Well
Carlton (T)	22	3	2	0	3	0	0	0	0	0
Clarendon (T)	0	0	0	0	0	0	0	0	0	0
Gaines (T)	4	1	1	0	0	0	0	0	0	0
Holley (V)	1	0	0	0	0	0	0	0	0	0
Kendall (T)	5	0	0	0	1	0	0	0	1	2
Lyndonville (V)	1	2	1	0	0	1	0	0	0	0
Medina (V)	6	2	2	0	0	0	6	0	0	0
Murray (T)	8	0	0	0	0	0	0	0	0	0
Ridgeway (T)	9	2	5	0	0	0	4	0	0	0
Shelby (T)	4	4	2	3	0	0	1	0	0	0
Yates (T)	9	1	0	0	0	0	0	1	0	0
Orleans County (Total)	**76**	**18**	**13**	**4**	**4**	**1**	**11**	**1**	**1**	**3**

Sources: HAZUS v4.2; FEMA Q3 Data 1970/1980; Orleans County GIS 2020
Note: Flood hazard area is depicted by FEMA Q3 data from 1970/1980. This data does not replace any effective DFIRM data for the county.
T = Town; V = Village

Table 5.4.4-17 Lifelines Exposed to the 1 percent Annual Chance Flood Event Boundary

FEMA Lifeline Category	Number of Lifelines	Number of Lifelines Exposed to 1 percent Annual Chance Flood Event
Communication	9	0
Energy	78	18
Food, Water, Shelter	172	14
Hazardous Material	11	1
Health and Medical	24	0
Safety and Security	130	4
Transportation	155	78
Orleans County (Total)	**579**	**115**

Sources: HAZUS v4.2; FEMA Q3 Data 1970/1980; Orleans County GIS 2020; FEMA 2020
Note: Flood hazard area is depicted by FEMA Q3 data from 1970/1980. This data does not replace any effective DFIRM data for the county.
T = Town; V = Village

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.

Impact on the Economy

Flood events can significantly impact the local and regional economy. This includes but is not limited to general building stock damages and associated tax loss, impacts to utilities and infrastructure, business interruption, and impacts on tourism. In areas that are directly flooded, renovations of commercial and industrial buildings may be necessary, disrupting associated services. Refer to the 'Impact on Buildings' subsection earlier, which discusses direct impacts to buildings in Orleans County.

Debris management may also be a large expense after a flood event. HAZUS-MH v4.2 estimates the amount of structural debris generated during a flood event. The model breaks down debris into three categories: (1) finishes (drywall, insulation, etc.); (2) structural (wood, brick, etc.); and (3) foundations (concrete slab and block, rebar, etc.). These distinctions are necessary because of the different types of equipment needed to handle debris. Table 5.4.4-18 summarizes the HAZUS-MH v4.2 countywide debris estimates for the 1 percent annual chance flood event. This table only estimates structural debris generated by flooding and does not include non-structural debris or additional potential damage and debris possibly generated by wind that may be associated with a flood event or storm that causes flooding. Overall, HAZUS-MH v4.2 estimates that there will be 5,417 tons of debris generated during the 1 percent annual chance flood event in Orleans County.

Table 5.4.4-18 Estimated Debris Generated from the 1 percent Annual Chance Flood Event

Jurisdiction	1 percent Annual Chance Event			
	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
Albion (T)	16	15	0	1
Albion (V)	155	88	36	31
Barre (T)	712	451	148	114
Carlton (T)	1,430	554	442	435
Clarendon (T)	0	0	0	0
Gaines (T)	52	37	9	6
Holley (V)	8	8	0	0
Kendall (T)	249	174	39	36
Lyndonville (V)	345	140	119	85
Medina (V)	947	252	402	294
Murray (T)	139	72	36	31
Ridgeway (T)	566	203	204	159
Shelby (T)	293	134	87	73
Yates (T)	506	224	156	126
Orleans County (Total)	**5,417**	**2,349**	**1,678**	**1,390**

Source: HAZUS-MH 4.2
Notes: V = Village, T = Town

Impact on the Environment

As Orleans County and its jurisdictions evolve with changes in population and density, flood events may increase in frequency and/or severity as land use changes, more structures are built, and impervious surfaces expand. Furthermore, flood extents for the 1 percent annual chance flood event will continue to evolve alongside natural occurrences such as climate change and/or severe weather events. These flood events will inevitably impact Orleans County's natural and local environment.

Furthermore, the environmental impacts of a dam failure can include significant water quality and debris-disposal issues. Flood waters can back up sanitary sewer systems and inundate wastewater treatment plants, causing raw sewage to contaminate residential and commercial buildings and the flooded waterway. The contents of unsecured containers of oil, fertilizers, pesticides, and other chemicals get added to flood waters. Hazardous materials may be released and distributed widely across the floodplain. Water supply and wastewater treatment facilities could be offline for weeks. After the flood waters subside, contaminated and flood-damaged building materials and contents must be properly disposed of. Contaminated sediment must be removed from buildings, yards, and properties. In addition, severe erosion is likely; such erosion can negatively impact local ecosystems.

The acreage of natural land makes up 40 percent of the county's total land area (NLCD 2016). Natural land areas from the 2016 land use type dataset includes areas of forested land and wetlands. Severe flooding will not only influence the habitat of these natural land areas, it can be disruptive to species that reside in these natural habitats.

Overall, 12.2 percent of the natural land area in the county is exposed to the 1 percent annual chance flood event boundary.

Cascading Impacts on Other Hazards

Flood events can exacerbate the impacts of landsliding and utility failure. The New York City 2019 Hazard Mitigation Plan suggests that flooding may cause a loss of stabilizing plant material caused by inundation and erosion (NYC 2020). Flooding of contaminated waters and flood water containing debris may also cause failure of utilities, particularly if the utilities are disrupted by debris clogging treatment systems or flood waters inundating power sources. More information about these hazards of concern can be found in Section 5.4.7 (Landslide) and Section 5.4.10 (Utility Failure).

Future Changes That May Impact Vulnerability

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

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

Projected Development

As discussed in Section 4, areas targeted for future growth and development have been identified across the county. Any areas of growth located in the flood inundation areas could be potentially impacted by flooding. It is recommended that the county and municipal partners implement design strategies that mitigate against the risk of flooding. Refer to the maps in the jurisdictional annexes (Section 9) to view the new development locations throughout the county and their proximity to the 1 percent annual chance flood hazard event boundary.

Projected Changes in Population

Estimated population projections provided by the 2017 Cornell Program on Applied Demographics indicates that the county's population will decrease slowly into 2040, increasing the total population to approximately 36,235 persons (Cornell Program on Applied Demographics 2017). While projections indicate less people will reside in the county, those that remain may move into locations that are more susceptible than others to flooding. This includes areas that are directly impacted by flood events and those that are indirectly impacted (i.e., isolated neighborhoods, flood-prone roadways, etc.). Refer to Section 4 (County Profile) for additional discussion on population trends.

Climate Change

As discussed earlier, annual precipitation amounts in the region are projected to increase, primarily in the form of heavy rainfalls, which have the potential to increase the risk to flash flooding and riverine flooding, and flood critical transportation corridors and infrastructure (NYSERDA 2014). Increases in precipitation may alter and expand the floodplain boundaries and runoff patterns, resulting in the exposure of populations, buildings, and critical facilities and infrastructure that were previously outside the floodplain. This increase in exposure would result in an increased risk to life and health, an increase in structural losses, a diversion of additional resources to response and recovery efforts, and an increase in business closures affected by future flooding events due to loss of service or access.

Existing dams may not be able to retain and manage increases in water flow from more frequent, heavy rainfall events. Heavy rainfalls may result in more frequent overtopping of these dams and flooding of the county's assets in adjacent inundation areas. However, the probable maximum flood used to design each dam may be able to accommodate changes in climate.

Change of Vulnerability Since 2008 HMP

Population statistics have been updated using the 5-Year 2014-2018 American Community Survey Population Estimates. The general building stock was also updated using RS Means 2019 building valuations that estimated replacement cost value for each building in the inventory. Updated building stock data received from Orleans County GIS was utilized to update the user-defined facility inventory and critical facility inventory dataset. Parcel information from the Orleans tax assessor was used to update building attributes, such as year built, number of stories, basement type, property class, and square footage. In addition, 1970/1980 Q3 data from FEMA was referenced to assess the 1 percent annual chance flood extents. The updated building stock inventory and flood data was imported into HAZUS-MH v4.2 to complete a riverine analysis for the 100-year annual chance flood event.

Overall, this vulnerability assessment uses a more accurate and updated building inventory, which provides more accurate estimated exposure and potential losses for Orleans County.