SECTION 4. HAZARD IDENTIFICATION AND RISK ASSESSMENT (HIRA)

Hazard Identification and Risk Assessment is the process of measuring the potential impact to life, property and the economy resulting from natural, technological, and man-made hazards. The intent of the risk assessment is to identify, as much as practicable given existing/available data, the qualitative and quantitative vulnerabilities of a community. The results of the risk assessment provide a framework for a better understanding of potential impacts to the community and a foundation on which to develop and prioritize mitigation actions (see Section 5). Mitigation actions can reduce damage from all disasters and an implementation strategy can direct scarce resources to areas of greatest vulnerability described in this section.

This risk assessment follows the methodology described in FEMA publication, Understanding Your Risks—Identifying Hazards and Estimating Losses (FEMA 386-2, 2002), which outlines a four-step process:

1) Identify Hazards

2) Profile Hazard Events

3) Inventory Assets

4) Estimate Losses

Information gathered during the Village of Ottawa planning process related to the above four steps are incorporated into the following discussions in this chapter.

This section identifies and prioritizes the identified natural, technological, and man-made hazards that threaten the Village. The reasoning for omitting some hazards from further consideration is also provided in this discussion.

Section 4, Sub-sections 1 through 13: The Hazard Profiles describe each of the hazards that pose a threat to the Village. Information includes the location, extent/magnitude/severity, previous occurrences, and the likelihood of future occurrences.

Each hazard profile includes a Vulnerability Assessment, which presents the Village's exposure to natural, technological, and man-made hazards, identifying at-risk populations and assets, including critical facilities. Where the information was available, potential dollar loss estimates for facilities are provided to show a partial representation of the financial cost of a disaster.

IDENTIFYING THE HAZARDS

Per FEMA Guidance, the first step in developing the Risk Assessment is identifying the hazards. The HMP Planning Committee reviewed a number of previously prepared hazard mitigation plans and other relevant documents to determine the universe of all-hazards planning with respect to the Village of Ottawa.

Hazards were ranked in order to provide structure and prioritize the mitigation goals and actions discussed in this plan. Ranking was both quantitative and qualitative. The quantitative analysis considered all the information available, including GIS data and official government records. Then, a qualitative approach, the Risk Factor (RF) approach, was used to provide additional insights on the specific risks associated with each hazard. This process can also be a valuable cross-check or validation of the quantitative analysis performed.

The RF approach combines historical data, local knowledge, and consensus opinions to produce numerical values that allow identified hazards to be ranked against one another. During the planning process, the HMPC compared the results of the hazard profile against their local and historical knowledge to generate a set of ranking criteria. These criteria were used to evaluate hazards and identify the highest risk hazard.

RF values are obtained by assigning varying degrees of risk to five categories for each hazard: probability, impact, spatial extent, warning time, and duration. Each degree of risk is assigned a value ranging from 1 to 4 and a weighing factor for each category was agreed upon by the HMPC. To calculate the RF value for a given hazard, the assigned risk value for each category is multiplied by the weighting factor. The sum of all five categories equals the final RF value, as demonstrated in the example equation below:

TABLE 4-1 RISK FACTOR CRITERIA

Risk Assessment Category	Level	Degree of Risk Level	Index	Weight
PROBABILITY What is the likelihood of a hazard event occurring in a given year?	**Unlikely**	Less Than 1% Annual Probability	**1**	**30%**
	Possible	Between 1 & 10% Annual Probability	**2**	
	Likely	Between 10 &100% Annual Probability	**3**	
	Highly Likely	100% Annual Probability	**4**	
IMPACT *In terms of injuries, damage, or death, would you anticipate impacts to be minor, limited, critical, or catastrophic when a significant hazard event occurs?*	**Minor**	Very few injuries, if any. Only minor property damage & minimal disruption of quality of life. Temporary shutdown of critical facilities.	**1**	**30%**
	Limited	Minor injuries only. More than 10% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one day.	**2**	
	Critical	Multiple deaths/injuries possible. More than 25% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one week.	**3**	
	Catastrophic	High number of deaths/injuries possible. More than 50% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for 30 days or more.	**4**	
SPATIAL EXTENT *How large of an area could be impacted by a hazard event? Are impacts localized or regional?*	**Negligible**	Less Than 1% Of Area Affected	**1**	**20%**
	Small	Between 1 & 10% Of Area Affected	**2**	
	Moderate	Between 10 & 50% Of Area Affected	**3**	
	LARGE	Between 50 & 100% Of Area Affected	**4**	
WARNING TIME *Is there usually some lead time associated with the hazard event? Have warning measures been implemented?*	**More than 24 HRS**	Self-Defined	**1**	**10%**
	12 to 24 HRS	Self-Defined	**2**	
	6 to 12 HRS	Self-Defined	**3**	
	Less than 6 HRS	Self-Defined	**4**	
DURATION *How long does the hazard event usually last?*	**Less than 6 HRS**	Self-Defined	**1**	**10%**
	Less than 24 HRS	Self-Defined	**2**	
	Less than 1 week	Self-Defined	**3**	
	More than 1 week	Self-Defined	**4**	
RF Value = [(Probability x .30) + (Impact x .30) + (Spatial Extent x .20) + (Warning Time x .10) + (Duration x .10)]				

According to the default weighting scheme applied, the highest possible RF value is 4.0. The methodology illustrated above lists categories that are used to calculate the variables for the RF value.

Table 4-2 provides the risk factor that details the hazards profiled in this plan, as well as the numerical value assigned to that hazard. That Risk Factor is developed through assessing the probability, impact, spatial extent, warning time, and duration of each hazard type.

TABLE 4-2 VILLAGE OF OTTAWA RISK FACTOR HAZARDS

	Natural Hazards	Probability		Impact		Spatial Extent		Warning Time		Duration		RF Factor
1	Earthquake	**1**	0.3	**4**	1.2	**4**	0.8	**4**	0.4	**4**	0.4	**3.1**
2	Public Health Emergencies	**1**	0.3	**4**	1.2	**4**	0.8	**1**	0.1	**4**	0.4	**2.8**
3	Severe Winter Weather	**3**	0.9	**2**	0.6	**4**	0.8	**1**	0.1	**3**	0.3	**2.7**
4	Tornado	**2**	0.6	**2**	0.6	**4**	0.8	**4**	0.4	**3**	0.3	**2.7**
5	Severe Thunderstorms	**4**	1.2	**1**	0.3	**4**	0.8	**1**	0.1	**1**	0.1	**2.5**
6	Water Quality	**2**	0.6	**2**	0.6	**4**	0.8	**4**	0.4	**1**	0.1	**2.5**
7	Flood	**3**	0.9	**2**	0.6	**2**	0.4	**1**	0.1	**3**	0.3	**2.3**
8	Drought	**2**	0.6	**1**	0.3	**4**	0.8	**1**	0.1	**4**	0.4	**2.2**
9	Temperature Extremes	**2**	0.6	**1**	0.3	**4**	0.8	**1**	0.1	**2**	0.2	**2.0**
10	Wildfire	**1**	0.3	**1**	0.3	**1**	0.2	**4**	0.4	**1**	0.1	**1.3**
	Technological Hazards	**Probability**		**Impact**		**Spatial Extent**		**Warning Time**		**Duration**		**RF Factor**
1	Dam Failure	**1**	0.3	**4**	1.2	**4**	0.8	**4**	0.4	**4**	0.4	**3.1**
2	Hazardous Materials Incidents	**3**	0.9	**2**	0.6	**4**	0.8	**4**	0.4	**1**	0.1	**2.8**
3	Terrorism	**1**	0.3	**2**	0.6	**3**	0.6	**4**	0.4	**3**	0.3	**2.2**

Table 4-3 shows the hazards that are included in the State of Ohio's HMP, and those hazards covered in the previous version of the plan, implemented in 2013. For this plan update, several hazards are combined.

TABLE 4-3 HAZARDS INCLUDED IN THE 2018 PLAN UPDATE

Hazard Addressed	Ohio HMP	Ottawa 2013	Ottawa 2018	Notes
Coastal Erosion	O	X	X	There are no coastal areas in Ottawa
Dam Failure	O	O	O	
Levee Failure	O	O	X	The previous plan discussed dams and levees as one unit. This plan separates them. There are no levees in or near Ottawa.
Drought	O	O	O	
Earthquake	O	O	O	
Extreme Temperatures	X	O	O	
Flood	O	O	O	
Hailstorm	X	O	O	Merged with Severe Thunderstorms
Hazardous Materials Incidents	X	O	O	
Invasive Species	O	X	X	Invasive species are not a primary concern for Ottawa
Land Subsidence	O	X	X	Subsidence is not a primary concern for Ottawa
Landslide	O	X	X	There are no hills susceptible to landslides in Ottawa
Seiche/Coastal Flooding	O	X	X	There are no coastal areas in the Village
Thunderstorm / Winds	O	O	O	Changed name to “Severe Thunderstorms”
Tornado	O	O	O	
Wildfire	O	O	O	
Public Health Emergencies	X	X	O	
Severe Winter Storm	O	O	O	
Severe Thunderstorms	O	O	O	
Terrorism	X	X	O	
Water Quality	X	X	O	

Previous hazard occurrences were used to validate existing hazards and identify new hazard risks. Previous hazard occurrences provide a historical view of hazard risk, and a window into potential hazards that can affect Ottawa and its population in the future. Information about Federal and State disaster declarations in the Village was compiled from FEMA and Ohio databases, as shown in Table 4-4. To date, Putnam County has been a part of 11 disaster declarations, 3 of which received public assistance dollars. Assistance amounts were provided by the Ohio Emergency Management Agency.

TABLE 4-4 DECLARED DISASTERS AFFECTING OTTAWA (OEMA, FEMA)

Disaster Number	Declaration Date	Title	Public Assistance (Putnam Co.)
DR-4077	8/20/2012	Severe Storms and Straight-Line Winds	$ 143,988.40
EM-3346	6/30/2012	Severe Storms	-
DR-1720	8/27/2007	Severe Storms, Flooding, and Tornadoes	$ 2,279,164.76
EM-3250	9/13/2005	Hurricane Katrina Evacuation	-
DR-1580	2/15/2005	Severe Winter Storms, Flooding, and Mudslides	$ 8,429.64
DR-1556	9/19/2004	Severe Storms and Flooding	-
DR-1444	11/18/2002	Severe Storms and Tornadoes	-
DR-642	6/30/1981	Severe Storms, Flooding, and Tornadoes	-
EM-3055	1/26/1978	Blizzards & Snowstorms	-
EM-3029	2/2/1977	Snowstorms	-
DR-421	4/4/1974	Tornadoes	-

Based on the review of hazards identified in similar and relevant documents, previous incidents, historical knowledge of localized events, and hazard trends, the HMPC identified a total of 13 hazards. There were 10 natural hazards which included, earthquakes, public health emergencies, severe winter storms, tornadoes, severe thunderstorms, water quality, flooding, drought, extreme temperatures, and wildfire. There were 3 technological or man-made hazards including terrorism, dam failure, and hazardous materials incidents. Stream erosion was combined with flooding.

HAZARD EVENT DATA

In developing the hazard profiles within this plan, a variety of information sources were researched. In order to develop a pattern of historical occurrences for identified hazards, sites like the National Oceanic and Atmospheric Administration's (NOAA), National Climatic Data Center (NCDC) and sites associated with the regional National Weather Service (NWS) locations. Data is largely available at a countywide scale, but often have jurisdictional-level detail, as well.

EVENT NARRATIVES

Within each hazard's section there are a series of narratives that provide greater detail into specific events that have impacted the Village. This section (Historical Occurrences or in some cases Hazard Events/Historical Occurrences) is not meant to be a comprehensive list of events that have occurred in Ottawa. Rather, these incidents are included to provide context as to why this hazard was included in the plan.

HAZARD PROFILES

Hazards are profiled individually in this section in order of priority. The profiles in this section provide a baseline definition and description in relation to Ottawa. Hazard profiles are used to develop a vulnerability assessment, where hazard vulnerability to the community is quantified in terms of population and assets affected for each hazard deemed significant by the Planning Committee.

For those hazards that are technological or man-made, additional details within each profile's summary have been included that briefly discuss mitigation best practices, as these hazards are not included in standard mitigation handbooks.

CRITICAL FACILITIES

The Planning Committee identified the types of structures that they consider to be "critical" to the day-to-day operations of the County. This includes day care facilities, educational centers, fire stations, government buildings, medical facilities, police stations, religious institutions, and utility structures. There is a total of 26 critical facilities in the Village of Ottawa. There are also 1,911 homes in the Village. Costs of structures were derived from GIS data provided by the Putnam County Auditor. A map of Village critical facilities can be found in Figure 4-1.

TABLE 4-5 VILLAGE CRITICAL FACILITIES

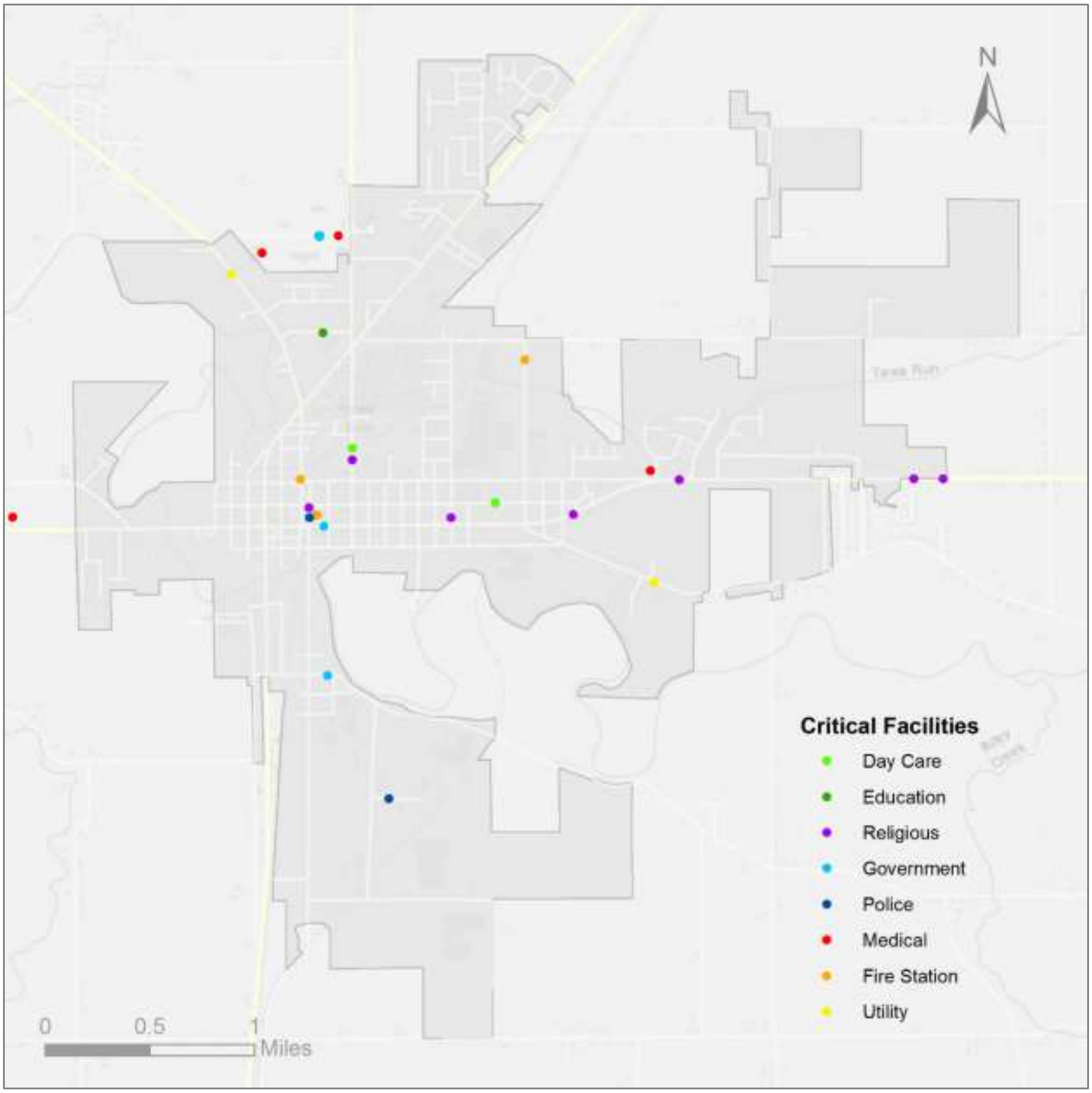
Facility	Classification
Autumn Court Nursing Home	Medical
Faith Assembly of Believers	Religious
Faith Baptist Church	Religious
Head Start Preschool	Day Care
Loving Care Day Care	Day Care
Meadows of Ottawa Nursing Home	Medical
Mercy Health Putnam County Medical Center	Medical
New Creation Lutheran Church	Religious
Ottawa Elementary School	Education
Ottawa Fire Station No. 100	Fire Station
Ottawa Fire Station No. 101	Fire Station
Ottawa Fire Station No. 102	Fire Station
Ottawa Missionary Church	Religious
Ottawa Municipal Building	Government
Ottawa Police Department	Police
Ottawa Presbyterian Church	Religious
Ottawa Wastewater Treatment Plant	Utility
Ottawa Water Works	Utility
Ottawa-Glandorf High School	Education
Putman County Medical And Diagnostic Center	Medical
Putnam County Common Pleas Court	Government

Facility	Classification
Putnam County District Library	Government
Putnam County Educational Service Center	Government
Putnam County Health Department	Government
Putnam County Sheriff's Office	Police
Saints Peter and Paul Catholic Church	Religious
Sts. Peter & Paul Catholic School	Education
Trinity Preschool	Day Care
Trinity United Methodist Church	Religious

TABLE 4-6 VILLAGE CRITICAL FACILITIES COST ESTIMATES

Class	Number	Total Cost	1% Damage	5% Damage
Residential	1,911	$ 171,813,349.00	$ 1,718,133.49	$ 8,590,667.45
Critical Facilities				
Day Care	3	$ 1,445,914.00	$ 14,459.14	$ 72,295.70
Education	3	$ 14,971,229.00	$ 149,712.29	$ 748,561.45
Fire Station	3	$ 986,800.00	$ 9,868.00	$ 49,340.00
Government	5	$ 8,461,400.00	$ 84,614.00	$ 423,070.00
Medical	4	$ 20,657,200.00	$ 206,572.00	$ 1,032,860.00
Police	2	$ 5,781,686.00	$ 57,816.86	$ 289,084.30
Religious	7	$ 3,639,486.00	$ 36,394.86	$ 181,974.30
Utility	2	$ 13,040,057.00	$ 130,400.57	$ 652,002.85
CRIT. FACILITY TOTAL	**29**	**$ 68,983,772.00**	**$ 689,837.72**	**$ 3,449,188.60**
Total Value				
Grand Total	**1,940**	**$ 240,797,121.00**	**$ 2,407,971.21**	**$ 12,039,856.05**

FIGURE 4-1 VILLAGE CRITICAL FACILITIES



HAZARD PROFILES

Natural hazards are grouped together in Section 4, Subsections 1 through 10. Hazards that are man-made or technological are found in 11 through 13. This grouping is consistent with the methodology that the Village used to prioritize each hazard.

1. EARTHQUAKE

Natural Hazards	Probability		Impact		Spatial Extent		Warning Time		Duration		RF Rating
Geologic Hazards	1	0.3	4	1.2	4	0.8	4	0.4	4	0.4	**3.1**
High Risk Hazard (3.0 – 4.0)											

1.1 EARTHQUAKE CHARACTERISTICS

The term "earthquake" refers to the vibration of the Earth's surface caused by movement along a fault, by a volcanic eruption, or even by manmade explosions. The vibration can be violent and cause widespread damage and injury, or may be barely felt. Most destructive earthquakes are caused by movements along faults. An earthquake is both the sudden slip on an active earth fault and the resulting shaking and radiated seismic energy caused by the slip (USGS 2009). Stresses in the earth's outer layer push the sides of the fault together. Stress builds up, and the rocks slip suddenly, releasing energy in waves that travel through the earth's crust and cause the shaking that is felt during an earthquake. The amount of energy released during an earthquake is usually expressed as a magnitude and is measured directly from the earthquake as recorded on seismographs. Another measure of earthquake severity is intensity. Intensity is an expression of the amount of shaking at any given location on the ground surface. Seismic shaking is typically the greatest cause of loss to structures during earthquakes.

Earthquakes may also cause landslides, particularly during the wet season, in areas of high water or saturated soils. The most likely areas for earthquake-induced landslides correlate to areas of high landslide potential discussed later in this section.

Ohio lies on the outermost boundaries of the New Madrid fault, centrally located at New Madrid, Missouri. This particular fault has created significant activity over the last 200 years. The most intense activity occurred in the years 1811-1812. Two earthquakes estimated to be 7's on the Richter scale hit the New Madrid Fault. Damage to chimneys was reported as far north as Cincinnati, Ohio.

Ohio has recorded 170 earthquakes with a magnitude of 2.0 or greater since 1776. Of these earthquakes, 15 were reported to have caused noticeable to moderate damage statewide. Two (2) major centers of seismic activity in Ohio are 1) the Anna Seismogenic Area located in Shelby and Auglaize Counties, and 2) the northeast area of the state on the eastern side of Lake Erie, which is referred to as the Akron Magnetic Boundary. The Anna area has been home to 40 earthquakes since the late 1770's while northeastern Ohio has recorded 60. None of these earthquakes were reported to cause major damage or loss of life. Most sources in the geology science predict that the largest magnitude earthquake that might occur in the state of Ohio would register no higher than five (5). Predicting the amount of damage would be difficult due to lack of historic activity in the area.

The lack of noticeable activity in the Village of Ottawa can be partly attributed to the PGA. PGA is partly determined by what soils and bedrocks are present in the area. In regards to the Village of Ottawa, the PGA is relatively low. As shown in the diagram to the right, the Village is in the border area of eight (8) to ten (10) PGA. According to the Ohio Department of Natural Resources Ohio Seismic Network, this is interpreted as the area having the possibility of eight (8) percent to ten (10) percent of gravities acceleration listed as 1g. These numbers would be denoted as .08g and .10g respectively.

According to the Ohio Seismic Network, when the peak acceleration nears 0.1g, damage may be caused to poorly constructed buildings while acceleration nearing 0.2 would create loss of balance and greater damage to lesser quality structures. Ottawa has peak acceleration much below that number, thus providing a buffer from most seismic activity. However, because of the proximity to a fault zone, and the age of some structures in the Village, earthquakes are a higher priority in this plan. Environmental impacts of earthquakes can be numerous, widespread, and devastating, particularly if indirect impacts are considered. Some examples are shown below, but are unlikely to occur in Ottawa:

- Induced flooding and landslides;
- Poor water quality;
- Damage to vegetation; and
- Breakage in sewage or toxic material containments

Earthquake Mechanics

Regardless of the source of the earthquake, the associated energy travels in waves radiating outward from the point of release. When these waves travel along the surface, the ground shakes and rolls, fractures form, and water waves may be generated. Earthquakes generally last a matter of seconds but the waves may travel for long distances and cause damage well after the initial shaking at the point of origin has subsided.

Breaks in the crust associated with seismic activity are known as “faults” and are classified as either active or inactive. Faults may be expressed on the surface by sharp cliffs or scarps or may be buried below surface deposits.

“Foreshocks,” minor releases of pressure or slippage, may occur months or minutes before the actual onset of the earthquake. “Aftershocks,” which range from minor to major, may occur for months after the main earthquake. In some cases, strong aftershocks may cause significant additional damage, especially if the initial earthquake impacted emergency management and response functions or weakened structures.

Factors Contributing to Damage

The damage associated with each earthquake is subject to four primary variables:

- The nature of the seismic activity

- The composition of the underlying geology and soils
- The level and quality of development of the area struck by the earthquake
- The time of day

Seismic Activity: The properties of earthquakes vary greatly from event to event. Some seismic activity is localized (a small point of energy release), while other activity is widespread (e.g., a major fault letting lose all at once). Earthquakes can be very brief (only a few seconds) or last for a minute or more. The depth of release and type of seismic waves generated also play roles in the nature and location of damage; shallow quakes will hit the area close to the epicenter harder, but tend to be felt across a smaller region than deep earthquakes.

Geology and Soils: The surface geology and soils of an area influence the propagation (conduction) of seismic waves and how strongly the energy is felt. Generally, stable areas (e.g., solid bedrock) experience less destructive shaking than unstable areas (e.g., fill soils). The siting of a community or even individual buildings plays a strong role in the nature and extent of damage from an event.

Development: A small earthquake in the center of a major city can have far greater consequences than a major event in a thinly populated place.

Time of Day: The time of day of an event controls the distribution of the population of an affected area. On work days, the majority of the community will transition between work or school, home, and the commute between the two. The relative seismic vulnerability of each location can strongly influence the loss of life and injury resulting from an event.

Types of Damage

While damage can occur by movement at the fault, most damage from earthquake events is the result of shaking. Shaking also produces phenomena that can generate additional damage:

- Ground displacement
- Landslides and avalanches
- Liquefaction and subsidence
- Seiches

Shaking: In minor events, objects fall from shelves and dishes are rattled. In major events, large structures may be torn apart by the forces of the seismic waves. Structural damage is generally limited to older structures that are poorly maintained, constructed, or designed in all but the largest quakes. Un-reinforced masonry buildings and wood frame homes not anchored to their foundations are typical victims.

Loose or poorly secured objects also pose a significant hazard when they are loosened or dropped by shaking. These “non-structural falling hazard” objects include bookcases, heavy wall hangings, and building facades. Home water heaters pose a special risk due to their tendency to start fires when they topple over and rupture gas lines. Crumbling chimneys may also be responsible for injuries and property damage.

Dam and bridge failures are significant risks during stronger earthquake events, and due to the consequences of such failures, may result in considerable property damage and loss of life. In areas of severe seismic shaking hazard, Intensity VII or higher can be experienced even on solid bedrock. In these areas, older buildings especially are at significant risk.

Ground Displacement: Often, the most dramatic evidence of an earthquake results from displacement of the ground along a fault line. Utility lines and roads may be disrupted but damage directly attributable to ground displacement is generally limited. In rare instances, structure located directly on the fault line may be destroyed by the displacement.

Landslides and Avalanches: Even small earthquake events can cause landslides. Rock falls are common as unstable material on steep slopes is shaken loose, but significant landslides or even debris flows can be generated if conditions are ripe. Roads may be blocked by landslide activity, hampering response and recovery operations.

Liquefaction and Subsidence: Soils may liquefy and/or subside when impacted by the seismic waves. Fill and previously saturated soils are especially at risk. The failure of the soils can lead to possibly widespread structural damage. The oscillation and failure of the soils may result in increased water flow and/or failure of wells as the subsurface flows are disrupted and sometimes permanently altered. Increased flows may be dramatic, resulting in geyser-like water spouts and/or flash floods. Similarly, septic systems may be damaged creating both inconvenience and health concerns.

Seiches: Seismic waves may rock an enclosed body of water (e.g., lake or reservoir), creating an oscillating wave referred to as a “seiche.” Although not a common cause of damage in past Ohio earthquakes, there is a potential for large, forceful waves similar to tsunami (“tidal waves”) to be generated on the large lakes of the state. Such a wave would be a hazard to shoreline development and pose a significant risk on dam-created reservoirs. A seiche could either overtop or damage a dam leading to downstream flash flooding.

1.2 REGULATORY ENVIRONMENT

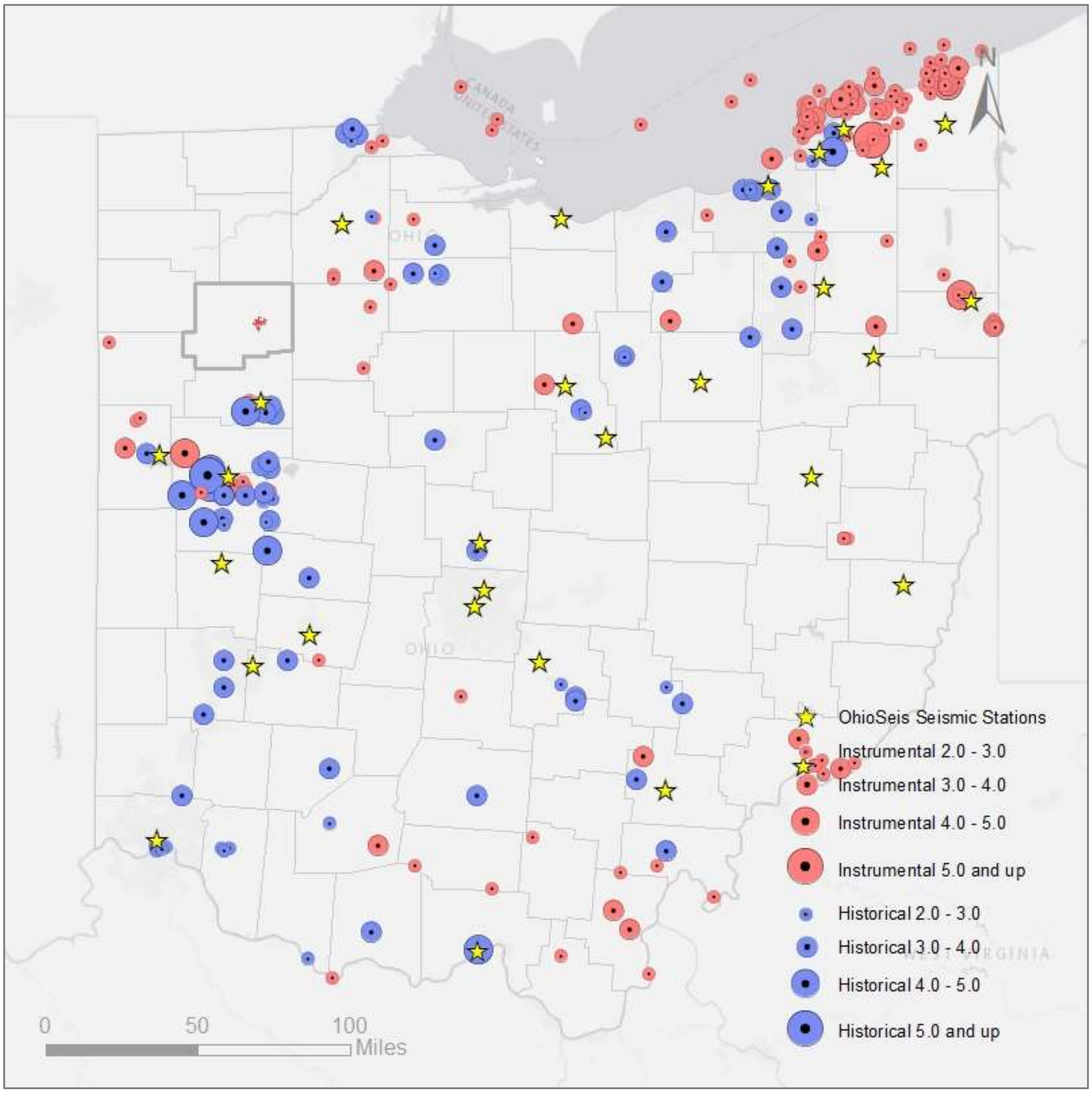
Ohio building codes generally do not focus on construction relative to earthquake loads. In such instances where earthquakes of seismic events are mentioned, it is usually in relation to truss design and anchoring of appliances in structures. Because Ohio does not have strong earthquakes, there are negligible laws or guidelines pertaining to seismic stress on roads, bridges, or buildings.

1.3 HAZARD EVENTS/HISTORICAL OCCURRENCES

While there have been no recorded earthquake epicenters in the Village of Ottawa or within Putnam County, they have occurred in adjacent counties.

Figure 4-2 shows epicenters in the State of Ohio from 1970 – 2014.

FIGURE 4-2 OHIO HISTORIC EARTHQUAKE EPICENTERS



1.4 MAGNITUDE/SEVERITY

The most common method for measuring earthquakes is magnitude, which measures the strengths of earthquake. Although the Richter Scale is known as the measurement for magnitude, the majority of scientists currently use either the Mw Scale or Modified Mercalli Intensity (MMI) Scale. The effects of an earthquake in a particular location are measured by intensity. Earthquake intensity decreases with increasing distance from the epicenter of the earthquake.

The magnitude of an earthquake is related to the total area of the fault that ruptured, as well as the amount of offset (displacement) across the fault. As shown in Table 4-7, there are seven earthquake magnitude classes, ranging from great to micro. A great class of magnitude can cause tremendous damage to infrastructure in the Village, compared to a micro class, which results in minor damage to infrastructure.

TABLE 4-7 MOMENT MAGNITUDE SCALE

Magnitude Class	Magnitude Range (M = Magnitude)	Probable Damage Description
Micro	M < 3	Minor damage
Minor	3 <= M < 3.9	Rarely causes damage.
Light	4 <= M < 4.9	Moderate damage
Moderate	5 <= M < 5.9	Considerable damage
Strong	6 <= M < 6.9	Severe damage
Major	7 <= M < 7.9	Widespread heavy damage
Great	M > 8	Tremendous damage

The MMI Scale measures earthquake intensity as shown in Table 4-8, the MMI Scale has 12 intensity levels. Each level is defined by a group of observable earthquake effects, such as ground shaking and/or damage to infrastructure. Levels I through VI describe what people see and feel during a small to moderate earthquake. Levels VII through XII describe damage to infrastructure during a moderate to catastrophic earthquake.

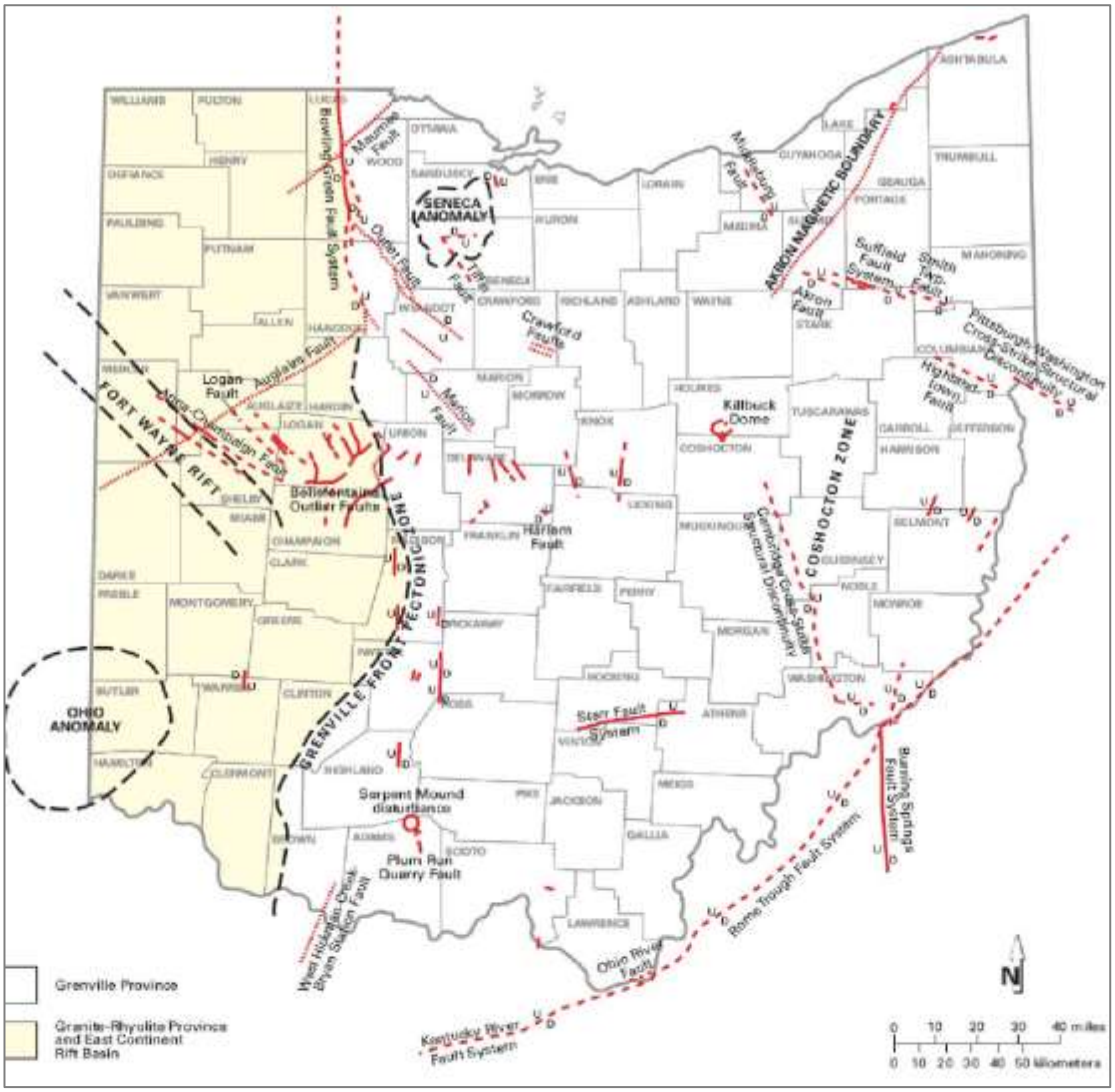
TABLE 4-8 MODIFIED MERCALLI SCALE WITH ASSOCIATED IMPACTS

Scale	Intensity	Description of Effects	Corresponding Richter Scale Magnitude
I	**Instrumental**	Usually detected only on seismographs.	<4.2
II	**Feeble**	Felt only by a few persons at rest, especially on upper floors of buildings.	
III	**Slight**	Felt quite noticeably indoors, especially on upper floors. Most people don't recognize it as an earthquake (i.e. a truck rumbling).	
IV	**Moderate**	Can be felt by people walking; dishes, windows, and doors are disturbed.	
V	**Slightly Strong**	Sleepers are awoken; unstable objects are overturned.	<4.8
VI	**Strong**	Trees sway; suspended objects swing; objects fall off shelves; damage is slight.	<5.4

Scale	Intensity	Description of Effects	Corresponding Richter Scale Magnitude
VII	**Very Strong**	Damage is negligible in buildings of good design and construction, slight to moderate in well-built ordinary structures, and considerable in poorly built or badly designed structures; some chimneys are broken.	<6.1
VIII	**Destructive**	Damage is slight in specially designed structures; considerable in ordinary, substantial buildings. Moving cars become uncontrollable; masonry fractures, poorly constructed buildings damaged.	<6.9
IX	**Ruinous**	Some houses collapse, ground cracks, pipes break open; damage is considerable in specially designed structures; buildings are shifted off foundations.	
X	**Disastrous**	Some well-built wooden structures are destroyed; most masonry and frame structures are destroyed along with foundations. Ground cracks profusely; liquefaction and landslides widespread.	<7.3
XI	**Very Disastrous**	Most buildings and bridges collapse, roads, railways, pipes and cables destroyed.	<8.1
XII	**Catastrophic**	Total destruction; trees fall; lines of sight and level are distorted; ground rises and falls in waves; objects are thrown upward into the air.	>8.1

As indicated earlier, just as there are multiple sources of seismic activity in Ohio, the location of seismic activity varies as well. Many earthquakes do occur along faults. Information about faults can be obtained from the Ohio Seismic Network.

FIGURE 4-3 FAULT LINES IN OHIO



1.5 FREQUENCY/PROBABILITY OF FUTURE OCCURRENCES

There has been an insufficient number of historical occurrences of earthquakes to effectively measure their frequency. Based on their local knowledge, the HMPC determined that earthquakes have an “unlikely” chance of occurring, or a less than 1% annual chance.

1.6 INVENTORY ASSETS EXPOSED TO SEISMIC/EARTHQUAKE ACTIVITY

The method used in determining the types and numbers of potential assets exposed to earthquake damage was conducted using a loss estimation model called HAZUS-MH. HAZUS-MH is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Buildings Sciences (NIBS). This program was conducted at the census block level. For this Plan, a 5.5 magnitude earthquake was modeled and the results are presented below.

Although a 5.5 magnitude has never occurred within the planning area for this document, this is the accepted baseline for simulating potential losses due to seismic events. The software takes into account the depth of the epicenter, as well as its location. In addition, the program helps to determine the potential losses based on the prevailing soil types in the region.

HAZUS-MH HAZUS 5.50 Earthquake

HAZUS estimates that about 951 buildings will be at least moderately damaged. This is over 29.00 % of the total number of buildings in the region. There are an estimated 79 buildings that will be damaged beyond repair. The tables below summarize the expected damage by general occupancy for the buildings and the expected building damage by building type in the study region.

FIGURE 4-4 EXPECTED BUILDING DAMAGE BY OCCUPANCY

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	9	0.62	8	0.88	14	2.15	9	3.85	3	3.96
Commercial	62	4.33	62	6.71	91	14.43	52	21.43	18	22.41
Education	4	0.30	4	0.40	5	0.84	3	1.15	1	1.22
Government	3	0.23	3	0.32	5	0.73	2	0.95	1	1.00
Industrial	15	1.05	14	1.54	23	3.71	15	6.29	5	6.52
Other Residential	72	5.07	52	5.69	50	8.02	26	10.79	7	8.78
Religion	8	0.57	6	0.63	6	0.99	4	1.50	1	1.61
Single Family	1,252	87.82	769	83.83	434	69.13	132	54.05	44	54.50
Total	1,426		917		628		243		80	

FIGURE 4-5 EXPECTED BUILDING DAMAGE BY BUILDING TYPE

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	1,165	81.69	683	74.49	304	48.39	43	17.76	4	4.79
Steel	21	1.50	18	2.01	46	7.35	38	15.51	13	16.78
Concrete	9	0.61	7	0.79	12	1.98	8	3.20	2	2.42
Precast	7	0.52	5	0.57	12	1.86	11	4.44	3	3.64
RM	4	0.25	2	0.20	4	0.67	4	1.50	1	0.82
URM	210	14.71	187	20.41	222	35.36	122	49.95	53	65.82
MH	10	0.72	14	1.52	28	4.40	19	7.64	5	5.73
Total	1,426		917		628		243		80	

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 50,000 tons of debris will be generated. Of the total amount, Brick/Wood comprises 46.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 1,800 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

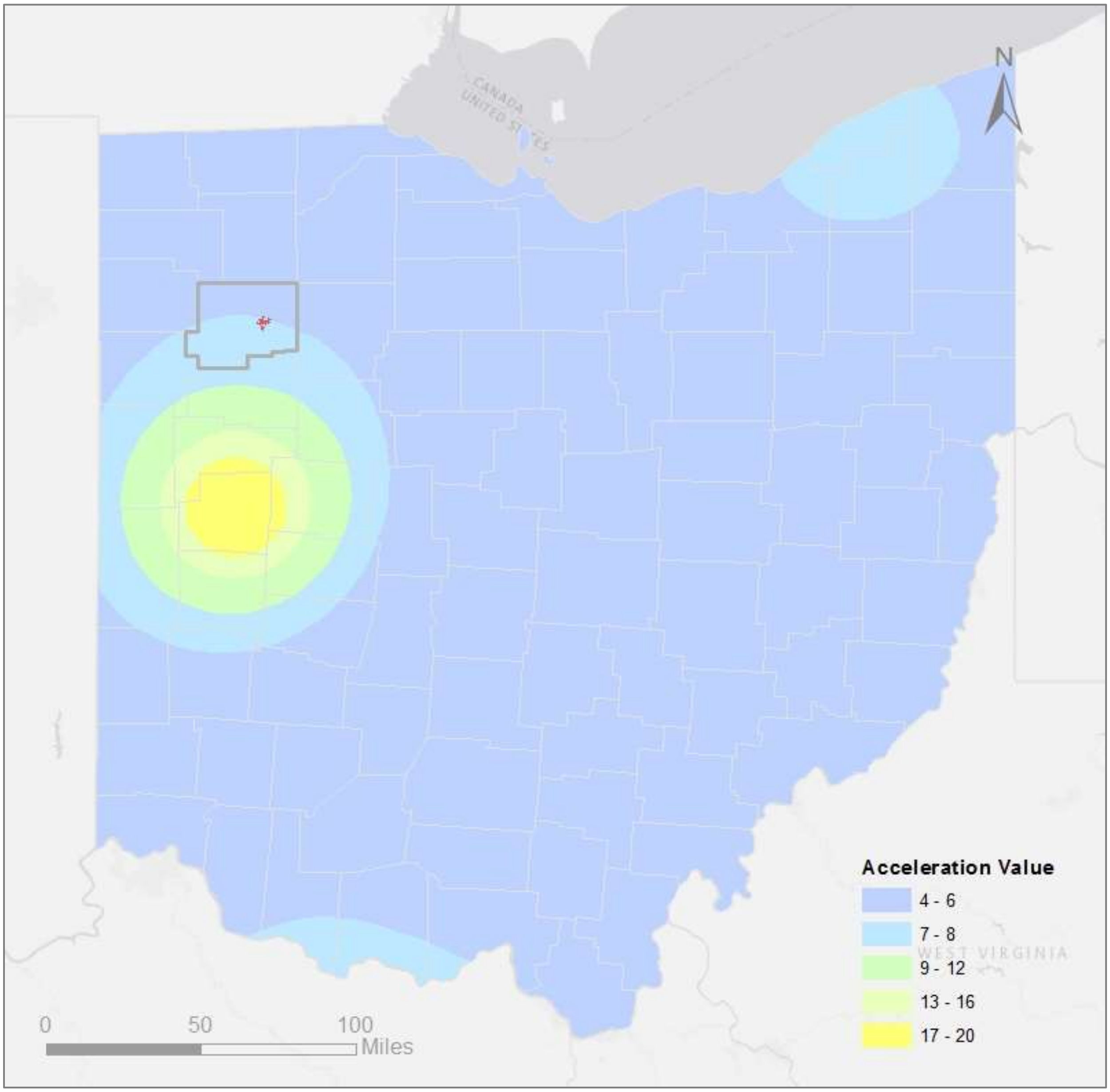
1.7 POTENTIAL LOSSES FROM GEOLOGIC HAZARDS

The risk of seismic hazards to residents of the Village is based on the approximate location of earthquake faults within and outside the region. According to the USGS Fault Zone Maps, Ottawa is a minor fault, the Anna Seismogenic Area.

As noted by the Ohio Seismic Network, when the peak acceleration nears 0.1g, damage may be caused to poorly constructed buildings while acceleration nearing 0.2 would create loss of balance and greater damage to lesser quality structures. The Village of Ottawa is only exposed to a peak acceleration of 0.08.

The Village of Ottawa is at a very low vulnerability to seismic activity. The nearest major fault, the New Madrid Fault, is hundreds of miles away. The lack of major historical events in the Village, along with the relatively low PGA associated with the lands around the area put seismic events very low in the category of probability of occurrence. However, if for some reason an event were to occur with the Village near the epicenter, there is no way to comprehend the amount of damage that could be sustained.

FIGURE 4-6 OTTAWA PEAK GROUND ACCELERATION



1.8 LAND USE & DEVELOPMENT TRENDS

As discussed, some earthquakes are only detectable by seismograph. Earthquakes that can be felt may result in continuum of damages, from minor to severe. The more minor incidents may have no damage, or very light damage, such as items falling off of shelves, or bricks coming loose from buildings. Major earthquakes, should they strike, could result in fallen trees, ground rises and falls, and buildings being destroyed.

Infrastructure, including office buildings, government buildings, and homes, in the Village of Ottawa are not built to withstand the effect of a major earthquake. Continued enforcement of the unified construction code should mitigate this vulnerability.

1.9 EARTHQUAKE HIRA SUMMARY

Most sources in the geology science predict that the largest magnitude earthquake that might occur in the state of Ohio would register no higher than five (5). However, some sources state that a magnitude of six (6), maybe higher, could be registered in the Anna region. An event of this intensity would likely be felt throughout the Village. However, since the area has not been the epicenter to an earthquake or seismic event it is difficult to estimate the damage that could occur.

2. PUBLIC HEALTH EMERGENCIES

Natural Hazards	Probability		Impact		Spatial Extent		Warning Time		Duration		RF Rating
Public Health Emergencies	1	0.3	4	1.2	4	0.8	1	0.1	4	0.4	**2.8**
Medium Risk Hazard (3.0 – 4.0)											

2.1 PUBLIC HEALTH CHARACTERISTICS

Pandemic

Pandemic is defined as a disease affecting or attacking the population of an extensive region which may include several countries and/or continents. It is further described as extensively epidemic. Generally, pandemic events cause sudden, pervasive illness in all age groups on a global scale, though some age groups may be more at risk. As such, pandemic events cover a wide geographic area and can affect large populations, depending on the disease. The exact size and extent of the infected population is dependent upon how easily the illness is spread, the mode of transmission, and the amount of contact between infected and non-infected persons. Two recent pandemics that have affected the Village of Ottawa and wider Ohio, are West Nile Virus and Influenza.

West Nile Virus is a vector-borne disease that can cause headache, high fever, neck stiffness, disorientation, tremors, convulsions, muscle weakness, paralysis, and, in its most serious form, death. The virus spreads via mosquito bite and is aided by warm temperatures and wet climates conducive to mosquito breeding. The virus is highly temporal with most cases occurring between April and October.

Influenza, also known as “the flu,” is a contagious disease that is caused by the influenza virus and typically presents with fever, headache, sore throat, cough, and muscle aches. Influenza is considered to have pandemic potential if it is novel, meaning that people have no immunity to it, virulent, it causes deaths in normally healthy individuals, and it is easily transmittable from person-to-person. Influenza spreads via the air in crowded populations in enclosed spaces, and it may persist on surfaces and in the air. Individuals are communicable for 3-5 days after clinical onset. Pandemic influenza planning began in response to the H5N1 (avian) flu outbreak in Asia, Africa, Europe, the Pacific, and the Near East in the late 1990s and early 2000s. In 2009, the US experienced a pandemic of H1N1. Preparation and planning for future pandemics needs to continue. As stated in the Ohio Department of Health Pandemic Influenza Preparedness and Response Plan, “The impact of an influenza pandemic on the health care system could be devastating. The CDC estimates in the United States a moderate pandemic could result in 90 million people becoming ill; 45 million outpatient visits; 865,000 hospitalizations; and 209,000 deaths.” This underscores the importance of planning for this hazard (Ohio Department of Health, 2006).

Epidemic

Epidemic is defined as something affecting many persons at the same time, and spreading from person to person in a locality where the disease is not permanently prevalent. The amount of a particular disease that is usually present in a community is referred to as the baseline or endemic level of the disease. This level is not necessarily the desired level, which may in fact be zero, but rather is the observed level. In the absence of intervention and assuming that the level is not high enough to deplete the pool of susceptible persons, the disease may continue to occur at this level indefinitely. Thus, the baseline level is often regarded as the expected level of the disease.

While some diseases are so rare in a given population that a single case warrants an epidemiologic investigation (e.g., rabies, plague, polio), other diseases occur more commonly so that only deviations from the norm warrant investigation. Sporadic refers to a disease that occurs infrequently and irregularly. Endemic refers to the constant presence and/or usual prevalence of a disease or infectious agent in a population within a geographic area. Hyperendemic refers to persistent, high levels of disease occurrence.

Occasionally, the amount of disease in a community rises above the expected level. Epidemic refers to an increase, often sudden, in the number of cases of a disease above what is normally expected in that population in that area. Outbreak carries the same definition of epidemic, but is often used for a more limited geographic area. Cluster refers to an aggregation of cases grouped in place and time that are suspected to be greater than the number expected, even though the expected number may not be known. Pandemic refers to an epidemic that has spread over several countries or continents, usually affecting a large number of people.

Epidemics occur when an agent and susceptible hosts are present in adequate numbers, and the agent can be effectively conveyed from a source to the susceptible hosts. More specifically, an epidemic may result from:

- A recent increase in amount or virulence of the agent,
- The recent introduction of the agent into a setting where it has not been before,
- An enhanced mode of transmission so that more susceptible persons are exposed,
- A change in the susceptibility of the host response to the agent, and/or
- Factors that increase host exposure or involve introduction through new portals of entry

2.2 REGULATORY ENVIRONMENT

There are a variety of regulations which drive the health industry, and as a result, the treatment of pandemics and epidemics. The Ohio Revised Code, Chapter 3701-59 specifically deals with hospitals. Mercy Health Putnam County Medical Center is accredited by the Joint commission, which is an independent, not-for-profit organization. The Joint Commission accredits and certifies nearly 21,000 health care organizations and programs in the United States. Joint Commission accreditation and certification is recognized nationwide as a symbol of quality that reflects an organization’s commitment to meeting certain performance standards.

2.3 HAZARD EVENTS/HISTORICAL OCCURRENCES

2009 H1N1 Pandemic: The 2009 H1N1 influenza (flu) pandemic occurred against a backdrop of pandemic response planning at all levels of government including years of developing, refining and regularly exercising response plans at the international, federal, state, local, and community levels. At the time, experts believed that avian influenza A (H5N1) viruses posed the greatest pandemic threat. H5N1 viruses were endemic in poultry in parts of the world and were infecting people sporadically, often with deadly results. Given that reality, pandemic preparedness efforts were largely based on a scenario of severe human illness caused by an H5N1 virus. Despite differences in planning scenarios and the actual 2009 H1N1 pandemic, many of the systems established through pandemic planning were used and useful for the 2009 H1N1 pandemic response.

2009 H1N1 was first detected in the United States in April 2009. This virus was a unique combination of influenza virus genes never previously identified in either animals or people. The virus genes were a combination of genes most closely related to North American swine-lineage H1N1 and Eurasian lineage swine-origin H1N1 influenza viruses. Because of this, initial reports referred to the virus as a swine origin influenza virus. However, investigations of initial human cases did not identify exposures to pigs and quickly it became apparent that this new virus was circulating among humans and not among U.S. pig herds.

Infection with this new influenza A virus (then referred to as ‘swine origin influenza A virus’) was first detected in a 10-year-old patient in California on April 15, 2009, who was tested for influenza as part of a clinical study. Laboratory testing at Centers for Disease Control (CDC) confirmed that this virus was new to humans. Two days later, CDC laboratory testing confirmed a second infection with this virus in another patient, an 8-year-old living in California about 130 miles away from the first patient who was tested as part of an influenza surveillance project. There was no known connection between the two patients. Laboratory analysis at CDC determined that the viruses obtained from these two patients were very similar to each other, and different from any other influenza viruses previously seen either in humans or animals.

2014/2015 Ebola Virus: The 2014 Ebola epidemic is the largest in history, affecting multiple countries in West Africa. There were a small number of cases reported in Nigeria and Mali and a single case reported in Senegal; however, these cases were contained, with no further spread in these countries. Two imported cases, including one death, and two locally acquired cases in healthcare workers were reported in the United States. CDC and its partners are taking precautions to prevent additional Ebola cases in the United States. CDC is working with other U.S. government agencies, the World Health Organization (WHO), and other domestic and international partners and has activated its Emergency Operations Center to help coordinate technical assistance and control activities with partners. CDC has also deployed teams of public health experts to West Africa and will continue to send experts to the affected countries. At the time, the general public and media feared that the epidemic would spread to Ohio after a nurse from Texas traveled to the Akron, Ohio area in advance of a wedding.

The Putnam County Health Department played an active role in Ebola response in the Fall of 2014. It was reported that Putnam county residents had visited the same bridal shop in Akron, Ohio at the same time as the Ebola infected nurse. Putnam County Health Department conducted investigative follow-up of the residents who had potential contact with the nurse. Putnam County Health Department worked in conjunction with Summit County Ohio Public Health, Ohio Department of Health and the CDC to successfully mitigate and rectify the issue.

2.4 MAGNITUDE/SEVERITY

The magnitude of a public health emergencies will range significantly depending on the aggressiveness of the virus in question and the ease of transmission. Pandemic influenza is more easily transmitted from person-to-person and is more easily transmitted than West Nile, but advances in medical technologies have greatly reduced the number of deaths caused by influenza over time. In terms of lives lost, the impact various pandemic influenza outbreaks have had globally over the last century has declined. The 1918 Spanish flu pandemic remains the worst-case pandemic event on record.

In contrast, the severity of illness from the 2009 H1N1 influenza flu virus has varied, with the gravest cases occurring mainly among those considered at high risk. High risk populations considered more vulnerable include children, the elderly, pregnant women, and chronic disease patients with reduced immune system capacity. Most people infected with H1N1 in 2009 have recovered without needing medical treatment. According to the CDC, about 70% of those who have been hospitalized with the 2009 H1N1 flu virus in the United States have belonged to a high-risk group (CDC, 2009).

The magnitude of a health-related emergency may be exacerbated by the fact that outbreaks across the United States could limit the ability to transfer assistance from one jurisdiction to another. Additionally, effective preventative and therapeutic measures, including vaccines and other medications, will likely be in short supply or will not be available. There are no true environmental impacts in pandemic disease outbreaks, but there may be significant economic and social costs beyond the possibility of deaths. Widespread illness may increase the likelihood of shortages of personnel to perform essential community services. In addition, high rates of illness and worker absenteeism occur within the business community, and these contribute to social and economic disruption. Social and economic disruptions could be temporary but may be amplified in today’s closely interrelated and interdependent systems of trade and commerce. Social disruption may be greatest when rates of absenteeism impair essential services, such as power, transportation, and communications.

2.5 FREQUENCY/PROBABILITY OF FUTURE OCCURRENCE

The precise timing of a health-related emergency is uncertain. Pandemic occurrences are most likely when the Influenza Type A virus makes a dramatic change, or antigenic shift, that results in a new or “novel” virus to which the population has no immunity. Epidemic occurrences are more likely when there are ecological changes, the pathogen mutates, or the pathogen is introduced into an unprepared host population.

The HMPC determined, based on their knowledge and experience, that a public health emergency is “unlikely” from year to year, meaning that there is less than a 1% annual chance of this type of hazard occurring. There have been insufficient historical cases to determine how often they have happened in the past.

2.6 INVENTORY ASSETS EXPOSED TO PUBLIC HEALTH EMERGENCIES

The Village’s population of 4,424 is at risk from public health emergencies. Certain population groups are at higher risk of pandemic flu infection. This population group includes people 65 years and older, children younger than 5 years old, pregnant women, and people of any age with certain chronic medical conditions. Such conditions include but are not limited to diabetes, heart disease, asthma and kidney disease (CDC, 2015). Schools, colleges, convalescent centers, and other institutions serving those younger than 5 years old and older than 65 years old, are locations conducive to faster transmission of pandemic influenza since populations identified as being at high risk are concentrated at these facilities or because of a large number of people living in close quarters. The hospital system would be the most likely point of introduction for an epidemic or pandemic to enter the Village.

2.7 POTENTIAL LOSSES FROM PUBLIC HEALTH EMERGENCIES

Health related emergencies are unlikely to directly impact buildings and infrastructure. However, losses can be measured in lost productivity from employees unable to perform their job duties and students not able to attend classes. Human impacts such as death or long-term illness are the largest impacts that could result.

2.8 PUBLIC HEALTH EMERGENCIES HIRA SUMMARY

Pandemic and infectious disease events cover a wide geographical area and can affect large populations. The exact size and extent of an infected population is dependent upon how easily the illness is spread, the mode of transmission and the amount of contact between infected and uninfected individuals. The transmission rates of pandemic illnesses are often higher in denser areas where there are large concentrations of people. The transmission rate of infectious disease will depend on the mode of transmission of a given illness.

3. SEVERE WINTER STORMS

Natural Hazards	Probability		Impact		Spatial Extent		Warning Time		Duration		RF Rating
Severe Winter Storms	3	0.9	2	0.6	4	0.8	1	0.1	3	0.3	**2.7**
Medium Risk Hazard (2.0 – 2.9)											

3.1 SEVERE WINTER STORM CHARACTERISTICS

The Village of Ottawa has been impacted by varying degrees of winter weather over the last century; however; the occurrence of severe winter weather in the Village is relatively infrequent, even during winter months. Severe winter weather can cause hazardous driving conditions, communications and electrical power failure, community isolation and can adversely affect business continuity. This type of severe weather may include one or more of the following winter factors:

Blizzards, as defined by the National Weather Service, are a combination of sustained winds or frequent gusts of 35 mph or greater and visibilities of less than a quarter mile from falling or blowing snow for 3 hours or more. A blizzard, by definition, does not indicate heavy amounts of snow, although they can happen together. Falling or blowing snow usually creates large drifts from the strong winds. The reduced visibilities make travel, even on foot, particularly treacherous. The strong winds may also support dangerous wind chills. Ground blizzards can develop when strong winds lift snow off the ground and severely reduce visibilities.

Heavy snow, in large quantities, may fall during winter storms. Six inches or more in 12 hours or eight inches or more in 24 hours constitutes conditions that may significantly hamper travel or create hazardous conditions. The National Weather Service issues warnings for such events. Smaller amounts can also make travel hazardous, but in most cases, only results in minor inconveniences. Heavy wet snow before the leaves fall from the trees in the fall or after the trees have leafed out in the spring may cause problems with broken tree branches and power outages.

Ice storms develop when a layer of warm (above freezing), moist air aloft coincides with a shallow cold (below freezing) pool of air at the surface. As snow falls into the warm layer of air, it melts to rain, and then freezes on contact when hitting the frozen ground or cold objects at the surface, creating a smooth layer of ice. This phenomenon is called freezing rain. Similarly, sleet occurs when the rain in the warm layer subsequently freezes into pellets while falling through a cold layer of air at or near the Earth's surface. Extended periods of freezing rain can lead to accumulations of ice on roadways, walkways, power lines, trees, and buildings. Almost any accumulation can make driving and walking hazardous. Thick accumulations can bring down trees and power lines.

Heavy Snow Storms can immobilize a region and paralyze the Village. These events can strand commuters, close airports, stop supplies from reaching their destinations and disrupt emergency and medical services. Accumulations of snow can cause roofs to collapse and knock down trees and power lines. Homes and farms may be isolated and unprotected livestock may be lost. The cost of snow removal, repairing damages, and the loss of business can have economic impacts on cities and towns.

Extreme Cold, in extended periods, although infrequent, could occur throughout the winter months in the Village. Heating systems compensate for the cold outside. Most people limit their time outside during extreme cold conditions, but common complaints usually include pipes freezing and cars refusing to start. When cold temperatures and wind combine, dangerous wind chills can develop.

Wind chill is how cold it “feels” and is based on the rate of heat loss on exposed skin from wind and cold. As the wind increases, it draws heat from the body, driving down skin temperature, and eventually, internal body temperature. Therefore, the wind makes it feel much colder than the actual temperature. For example, if the temperature is 0°F and the wind is blowing at 15 mph, the wind chill is -19°F. At this wind chill, exposed skin can freeze in 30 minutes. Wind chill does not affect inanimate objects. (National Weather Service)

The science of meteorology and records of severe weather are not quite sophisticated enough to identify what areas of the Village are at greater risk for damages. Therefore, all areas of the Village are assumed to have the same winter weather risk.

Severe winter weather can result in the closing of primary and secondary roads, particularly in rural locations, loss of utility services, and depletion of oil heating supplies. Environmental impacts often include damage to shrubbery and trees due to heavy snow loading, ice build-up, and/or high winds which can break limbs or even bring down large trees. Gradual melting of snow and ice provides excellent groundwater recharge; however, high temperatures following a heavy snowfall can cause rapid surface water runoff and severe flash flooding.

The State of Ohio does have an extensive history of severe winter weather. In the winter of 2005, the state was hit by a series of winter storms. These storms included ice storms, followed by unseasonably high temperatures and high rainfall totals, all of which resulted in extensive flooding and mudslides. This series of storms resulted in Presidential Declaration FEMA-DR-1580-OH. This declaration provided over one-hundred and forty million dollars in recovery funds. These funds included Individual assistance, Public assistance, Hazard Mitigation Grant Funds, and a state match to the federal hazard mitigation funds. More specifically, winter weather is a common occurrence in Ohio throughout the winter, and early spring months.

Due to the nature of winter storms, it is extremely difficult to predict, but through identifying various indicators of weather systems, and tracking these indicators, it provides us with a crucial means of monitoring winter weather. Understanding the historical frequency, duration, and spatial extent of winter weather assists in determining the likelihood and potential severity of future occurrences. The characteristics of past severe winter events provide benchmarks for projecting similar conditions into the future.

3.2 REGULATORY ENVIRONMENT

There are negligible formal regulations that pertain to generalized severe winter weather events.

3.3 HAZARD EVENTS

Since 1996, there have been 56 winter weather events according to NOAA, most of which have caused significant damage to property. According to NOAA, there have been no injuries and no deaths. The total amount of property damage done by winter storm events equates to a total of $80,000 throughout Putnam County.

TABLE 4-9 WINTER WEATHER EVENTS IN PUTNAM COUNTY (1996-2017)

Date	Type	Deaths	Injuries	Property Damage	Crop Damage
1/2/1996	Winter Storm	0	0	$ 50,000	0
3/6/1996	Ice Storm	0	0	$ -	0
3/19/1996	Winter Storm	0	0	$ -	0
1/2/1999	Heavy Snow	0	0	$ -	0
3/11/2000	Heavy Snow	0	0	$ -	0
12/13/2000	Heavy Snow	0	0	$ -	0
12/25/2002	Heavy Snow	0	0	$ -	0
2/17/2003	Heavy Snow	0	0	$ -	0
2/22/2003	Heavy Snow	0	0	$ -	0
1/26/2004	Winter Storm	0	0	$ -	0
12/22/2004	Winter Storm	0	0	$ -	0
1/5/2005	Winter Storm	0	0	$ -	0
1/22/2005	Winter Storm	0	0	$ -	0
12/8/2005	Heavy Snow	0	0	$ -	0
2/13/2007	Blizzard	0	0	$ -	0
2/24/2007	Ice Storm	0	0	$ 30,000	0
12/9/2007	Ice Storm	0	0	$ -	0
12/15/2007	Winter Storm	0	0	$ -	0
2/1/2008	Winter Storm	0	0	$ -	0
2/25/2008	Winter Storm	0	0	$ -	0
3/4/2008	Winter Storm	0	0	$ -	0
3/7/2008	Winter Storm	0	0	$ -	0
12/19/2008	Ice Storm	0	0	$ -	0
1/27/2009	Heavy Snow	0	0	$ -	0
1/7/2010	Winter Weather	0	0	$ -	0
2/9/2010	Winter Storm	0	0	$ -	0
12/12/2010	Winter Storm	0	0	$ -	0
1/11/2011	Winter Weather	0	0	$ -	0
2/1/2011	Winter Storm	0	0	$ -	0
2/5/2011	Heavy Snow	0	0	$ -	0
2/20/2011	Winter Weather	0	0	$ -	0
2/25/2011	Heavy Snow	0	0	$ -	0
1/20/2012	Winter Weather	0	0	$ -	0
12/26/2012	Winter Storm	0	0	$ -	0
12/28/2012	Winter Weather	0	0	$ -	0
1/27/2013	Winter Weather	0	0	$ -	0
2/4/2013	Winter Weather	0	0	$ -	0
2/22/2013	Winter Weather	0	0	$ -	0
2/26/2013	Winter Weather	0	0	$ -	0

Date	Type	Deaths	Injuries	Property Damage	Crop Damage
3/5/2013	Winter Weather	0	0	$ -	0
3/24/2013	Winter Weather	0	0	$ -	0
12/13/2013	Winter Storm	0	0	$ -	0
1/1/2014	Winter Weather	0	0	$ -	0
1/5/2014	Winter Storm	0	0	$ -	0
2/1/2014	Winter Weather	0	0	$ -	0
2/4/2014	Winter Storm	0	0	$ -	0
2/17/2014	Winter Weather	0	0	$ -	0
3/12/2014	Winter Storm	0	0	$ -	0
1/5/2015	Winter Weather	0	0	$ -	0
1/8/2015	Winter Weather	0	0	$ -	0
2/1/2015	Heavy Snow	0	0	$ -	0
2/14/2015	Winter Weather	0	0	$ -	0
3/1/2015	Winter Weather	0	0	$ -	0
3/3/2015	Winter Weather	0	0	$ -	0
1/12/2016	Winter Weather	0	0	$ -	0
12/17/2016	Winter Weather	0	0	$ -	0
Total		0	0	$ 80,000	0

Since 1978, only one federally or state declared severe winter weather events has occurred in the Village of Ottawa, as shown in Table 4-10. According to FEMA Declarations and Ohio Emergency and Disaster Proclamations (1956 to present), these events include blizzards and snowstorms.

TABLE 4-10 DECLARED WINTER DISASTERS

Disaster Number	Declaration Date	Title	Public Assistance
DR-1580	2/15/2005	Severe Winter Storms, Flooding, and Mudslides	$ 8,429.64
EM-3055	1/26/1978	Blizzards & Snowstorms	-
EM-3029	2/2/1977	Snowstorms	-

3.4 HISTORICAL OCCURRENCES

Winter Storm – January 2, 1996: Low pressure strengthening in the Tennessee valley passed southeast of Ohio. The heaviest snow fell near and north of interstate 70, across West Central Ohio where there was up to 1 foot of snowfall and blizzard conditions. Wind gusts up to 40 mph were common in this area with snow drifts between 3 and 5 feet. Across parts of Southern Ohio there was a messy mix of precipitation. Roads oriented east to west were quite hazardous as strong north winds produced large snow drifts shortly after these roads were plowed. Temperatures during much of this event were in the upper teens and 20s.

Blizzard – February 13, 2007: A powerful winter storm blanketed northwest Ohio with heavy snow and strong winds. This caused widespread whiteout conditions across the area with many roads becoming impassable due to drifting snowfall. Numerous schools and businesses were closed on Valentine’s Day as a result of the dangerous weather. The blowing and drifting was so widespread, that many counties pulled the snow plows from the roads and declared travel restrictions to all but emergency vehicles. Snow accumulations ranged from 6 inches in far northern Ohio, to around a foot in Van Wert and Allen counties.

Ice Storm – February 24, 2007: A late February storm system brought widespread precipitation in the form of mainly freezing rain. Several locations did see periods of sleet during the event, however the ice accumulations posed the greatest threat. Reports of around one quarter inch of ice along with a few tenths of an inch of sleet was reported across parts of northwest Ohio. 10 to 20 mph winds caused additional problems with fallen tree limbs and power lines, causing road closures and power outages. Temperatures rose above freezing during the overnight hours keeping overall damage to a minimum. Two to four tenths of an inch of ice covered roads and power lines, creating hazardous driving conditions, widespread power outages and damage to trees. No injuries or deaths were reported in the county.

Ice Storm – December 19, 2008: Significant ice accumulations and light snow/sleet amounts affected the region as a quick moving area of low pressure tracked eastward through central portions of Indiana and Ohio on December 19th. Precipitation started out as a brief period of snow and sleet, with accumulations of a trace to 2 inches. The precipitation then changed over to freezing rain with most locations receiving between a quarter and half an inch of ice accumulation. Freezing rain overspread the area early December 19th and continued through the 10:00 am. Surface temperatures rose to just above freezing by 10am and noon which changed the precipitation over to mainly drizzle and light rain showers. Ice accumulations near a quarter of an inch were reported. Icing on trees and power lines also created numerous power outages across the county, with reports of nearly 500 customers without power according to AEP.

Winter Storm – December 26, 2012: Moderate to heavy snow fell on December 26th, with total snow accumulations ranging between 2 and 6 inches across the county. The heaviest snow was reported across southern Putnam County. The falling snow combined with wind gusts in excess of 30 mph reduced visibilities to less than a quarter of a mile at times. This also resulted is significant blowing and drifting snow. Slide-offs and accidents were reported across the region.

Winter Storm – February 4, 2014: Snow developed during the late afternoon hours of February 4th and became heavy at times that evening into the next morning. Impressive snowfall rates of 1 to 2 inches per hour and reduced visibilities to a quarter of a mile at times created hazardous travel conditions. Numerous schools and businesses were closed on Wednesday, February 5th, due to the heavy snow and poor road conditions. Total snow accumulations across the county generally ranged between 7 and 9 inches.

Winter Weather – February 14, 2015: Wind gusts up to 45 mph and snow squalls along and behind an arctic front created near whiteout conditions at times on February 14th. Visibilities were reduced to less than 200 feet in heavier snow showers, with total snow accumulations generally ranging between 1 and 2 inches. Several multi-vehicle accidents were reported across the region due to reduced visibilities and slick roads.

3.5 MAGNITUDE/SEVERITY

The National Weather Service uses different terminology for winter weather events, depending on the situation.

Outlook - Winter weather that may cause significant impact in the day 3 to 7 forecast time period and eventually lead to the issuance of a watch or warning is contained in the Hazardous Weather Outlook. More scientific discussion on the event can also be found in the Area Forecast Discussion. Forecasts in the day 3 to 7-time period typically have a lot of forecast uncertainty. Uncertainty is generally in the 30 to 50% range that the event will occur and reach warning criteria. It is intended to provide information to those who need considerable lead time to prepare for the event.

Watch - A watch is generally issued in the 24 to 72-hour forecast time frame when the risk of a hazardous winter weather event has increased (50 to 80% certainty that warning thresholds will be met). It is intended to provide enough lead time so those who need to set their plans in motion can do so. A watch is issued using the WSW Winter Weather Message product and will appear as a headline in some text products such as the Zone Forecast. It will change the color, as shown in the table below, of the counties on the NWS front page map according to what type of watch has been issued.

TABLE 4-11 WINTER STORM WATCH DEFINITIONS

Watch Type	Description
Blizzard Watch	Conditions are favorable for a blizzard event in the next 24 to 72 hours. Sustained wind or frequent gusts greater than or equal to 35 mph will accompany falling and/or blowing snow to frequently reduce visibility to less than 1/4 mile for three or more hours.
Lake Effect Snow Watch	Conditions are favorable for a lake effect snow event to meet or exceed local lake effect snow warning criteria in the next 24 to 72 hours. Widespread or localized lake induced snow squalls or heavy snow showers which produce snowfall accumulation to 7 or more inches in 12 hours or less. Lake effect snow usually develops in narrow bands and impacts a limited area within a county or forecast zone. Use "mid-point" of snowfall range to trigger a watch (i.e. 5 to 8 inches of snow = watch).
Wind Chill Watch	Conditions are favorable for wind chill temperatures to meet or exceed local wind chill warning criteria in the next 24 to 72 hours. Wind chill temperatures may reach or exceed -25°F.
Winter Storm Watch	Conditions are favorable for a winter storm event (heavy sleet, heavy snow, ice storm, heavy snow and blowing snow or a combination of events) to meet or exceed local winter storm warning criteria in the next 24 to 72 hours. Criteria for snow is 7 inches or more in 12 hours or less; or 9 inches or more in 24 hours covering at least 50 percent of the zone or encompassing most of the population. Use "mid-point" of snowfall range to trigger a watch (i.e. 5 to 8 inches of snow = watch). Criteria for ice is 1/2 inch or more over at least 50 percent of the zone or encompassing most of the population.

Advisory - Advisories are issued when a hazardous winter weather event is occurring, is imminent, or has a very high probability of occurrence (generally greater than 80%). An advisory is for less serious conditions that cause significant inconvenience and, if caution is not exercised, could lead to situations that may threaten life and/or property. Advisories are issued using the WSW Winter Weather Message product and will appear as a headline in some text products such as the Zone Forecast. Table 4-12 shows the different type of winter weather advisories and the conditions that it takes for them to be met.

TABLE 4-12 WINTER WEATHER ADVISORY DEFINITIONS

Advisory Type	Description
Winter Weather Advisory	A winter storm event (sleet, snow, freezing rain, snow and blowing snow, or a combination of events) is expected to meet or exceed local winter weather advisory criteria in the next 12 to 36 hours but stay below warning criteria. Criteria for snow is 4 inches or more in 12 hours or less covering at least 50 percent of the zone or encompassing most of the population. Use "mid-point" of snowfall range to trigger advisory (i.e. 2 to 5 inches of snow = advisory). Criteria for ice is any ice accumulation less than 1/2 inch over at least 50 percent of the zone or encompassing most of the population. Winter Weather Advisory can also be issued for black ice. This is optional.
Freezing Rain Advisory	Any accumulation of freezing rain is expected in the next 12 to 36 hours (but will remain below 1/2 inch) for at least 50 percent of the zone or encompassing most of the population.
Lake Effect Snow Advisory	A lake effect snow event is expected to meet or exceed local lake effect snow advisory criteria in the next 12 to 36 hours. Widespread or localized lake induced snow squalls or heavy snow showers which produce snowfall accumulating to 4 or more inches in 12 hours or less, but remain less than 7 inches. Lake effect snow usually develops in narrow bands and impacts a limited area within a county or forecast zone. Use "mid-point" of snowfall range to trigger advisory (i.e. 2 to 5 inches of snow = advisory).
Wind Chill Advisory	Wind chill temperatures are expected to meet or exceed local wind chill advisory criteria in the next 12 to 36 hours. Wind chill temperatures may reach or exceed -15°F.

Warning - Warnings are issued when a hazardous winter weather event is occurring, is imminent, or has a very high probability of occurrence (generally greater than 80%). A warning is used for conditions posing a threat to life or property. Warnings are issued using the WSW Winter Weather Message product and will appear as a headline in some text products such as the Zone Forecast. Table 4-13 discusses the various winter weather storm warnings that can occur and the conditions of each that are required for them to be posted.

TABLE 4-13 WINTER WEATHER WARNING DEFINITIONS

Warning Type	Description
Blizzard Warning	Blizzard event is imminent or expected in the next 12 to 36 hours. Sustained wind or frequent gusts greater than or equal to 35 mph will accompany falling and/or blowing snow to frequently reduce visibility to less than 1/4 mile for three or more hours.

Warning Type	Description
Ice Storm Warning	An ice storm event is expected to meet or exceed local ice storm warning criteria in the next 12 to 36 hours. Criteria for ice is 1/2 inch or more over at least 50 percent of the zone or encompassing most of the population.
Lake Effect Snow Warning	A lake effect snow event is expected to meet or exceed local lake effect snow warning criteria in the next 12 to 36 hours. Widespread or localized lake induced snow squalls or heavy snow showers which produce snowfall accumulation to 7 or more inches in 12 hours or less. Lake effect snow usually develops in narrow bands and impacts a limited area within a county or forecast zone. Use "mid-point" of snowfall range to trigger warning (i.e. 5 to 8 inches of snow = warning).
Wind Chill Warning	Wind chill temperatures are expected to meet or exceed local wind chill warning criteria in the next 12 to 36 hours. Wind chill temperatures may reach or exceed -25°F.
Winter Storm Warning	A winter storm event (heavy sleet, heavy snow, ice storm, heavy snow and blowing snow or a combination of events) is expected to meet or exceed local winter storm warning criteria in the next 12 to 36 hours. Criteria for snow is 7 inches or more in 12 hours or less; or 9 inches or more in 24 hours covering at least 50 percent of the zone or encompassing most of the population. Use "mid-point" of snowfall range to trigger warning (i.e. 5 to 8 inches of snow = warning). Criteria for ice is 1/2 inch or more over at least 50 percent of the zone or encompassing most of the population.

3.6 FREQUENCY/PROBABILITY OF FUTURE OCCURRENCES

Reported winter events over the past 20 years provide an acceptable framework for determining the future occurrence in terms of frequency for such events. The probability of the Village experiencing a winter storm event can be difficult to quantify, but based on historical record of 56 winter storm events since 1996, it can reasonably be assumed that this type of event has occurred more than three times every year from 1996 through 2016.

(**2017** CY) - (**1996** HY) = **21 Years on Record**

(**21 Years**) / (**56 Events**) = **0.375 Years Between Events**

Furthermore, the historic frequency calculates that there is a 100% chance of this type of event occurring each year.

The HMPC, based on their knowledge, determined that Severe Winter Storms are “Likely,” meaning they have between a 10% and 100% chance of occurring each year.

3.7 INVENTORY ASSETS EXPOSED TO WINTER STORMS

A timely forecast may not be able to mitigate property loss, but could reduce the casualties and associated injury. In severe winter storm events, buildings are vulnerable to widespread utility disruptions, including loss of heat and electricity, as well as building collapse or damage from downed trees. The Village of Ottawa is also subject to outages resulting from damages to the electrical grid in other parts of the state.

Winter storms affect the entirety of the Village of Ottawa, as well as all communities and jurisdictions, and all above-ground structures and infrastructure. Although losses to structures are typically minimal and covered by insurance, there can be impacts with lost time, maintenance costs, and contents within structures.

3.8 POTENTIAL LOSSES FROM WINTER STORMS

All Village assets can be considered at risk from severe winter storms. This includes 100 percent of the Village population and all buildings and infrastructure. Damages primarily occur as a result of cold temperatures, heavy snow or ice and sometimes strong winds. Due to their regular occurrence, these storms are considered hazards only when they result in damage to specific structures or cause disruption to traffic, communications, electric power, or other utilities.

A winter storm can adversely affect roadways, utilities, business activities, and can cause loss of life, frostbite and freezing conditions. They can result in the closing of secondary roads, particularly in rural locations, loss of utility services and depletion of oil heating supplies. Most structures, including the Village's critical facilities, should be able to provide adequate protection the structures could suffer damage from snow load on rooftops and large deposits of ice. Those facilities with back-up generators are better equipped to handle a severe weather situation should the power go out, even if only certain systems are powered by that generator.

Winter weather and related storms do not generally have a negative impact on structures. While cold temperatures and power losses can render a structure uninhabitable for a time, they are unlikely to cause structural damages. However, snow and ice accumulation can impact structures and infrastructure. Older structures, in particular are more susceptible to the impacts from winter weather due to older construction and insulation methods.

In addition to the infrastructure of the Village, the population needs to be taken into consideration. The Village is home to an estimated 4,424 people. At particular risk are elderly individuals. The US Census Bureau estimates that there are approximately 18.1% of the Village's population is above the age of 65, leading to an estimated 800 people at risk of severe winter weather.

TABLE 4-14 VILLAGE ASSESTS VULNERABLE TO WINTER STORMS

Class	Number	Total Cost	1% Damage	5% Damage
Residential	1,911	$ 171,813,349.00	$ 1,718,133.49	$ 8,590,667.45
Critical Facilities				
Day Care	3	$ 1,445,914.00	$ 14,459.14	$ 72,295.70
Education	3	$ 14,971,229.00	$ 149,712.29	$ 748,561.45
Fire Station	3	$ 986,800.00	$ 9,868.00	$ 49,340.00
Government	5	$ 8,461,400.00	$ 84,614.00	$ 423,070.00
Medical	4	$ 20,657,200.00	$ 206,572.00	$ 1,032,860.00
Police	2	$ 5,781,686.00	$ 57,816.86	$ 289,084.30
Religious	7	$ 3,639,486.00	$ 36,394.86	$ 181,974.30
Utility	2	$ 13,040,057.00	$ 130,400.57	$ 652,002.85

CRIT. FACILITY TOTAL	**29**	**$ 68,983,772.00**	**$ 689,837.72**	**$ 3,449,188.60**
Total Value				
Grand Total	**1,940**	**$ 240,797,121.00**	**$ 2,407,971.21**	**$ 12,039,856.05**

3.9 LAND USE & DEVELOPMENT TRENDS

As stated above, in severe winter storm events, buildings are vulnerable to widespread utility disruptions, including loss of heat and electricity, as well as building collapse or damage from downed trees. Environmental impacts often include damage shrubbery and trees due to heavy snow loading, ice build-up and/or high winds which can break limbs or even bring down large trees. An indirect effect of winter storms is the treatment of roadway surfaces with salt, chemicals, and other de-icing materials which can impair adjacent surface and ground waters. This is particularly a concern in urban areas. Another important secondary impact for winter storms is building or structure collapses; if there is a heavy snowfall or a significant accumulation over time, the weight of the snow may cause building damage or even collapse.

Winter storms have a positive environmental impact as well; gradual melting of snow and ice provides excellent groundwater recharge. However, abrupt high temperatures following a heavy snowfall can cause rapid surface water runoff and severe flooding.

3.10 WINTER STORM HIRA SUMMARY

The Village of Ottawa is subject to severe winter storms which have the potential to be hazard as a result of cold temperatures, heavy snow or ice and sometimes strong winds. Severe winter storm hazards can cause a range of damage to structures that will depend on the magnitude and duration of storm events. Losses may be as small as lost productivity and wages when workers are unable to travel or as large as sustained roof damage or building collapse. The severe winter storms profile is primarily concerned with past and future damages from cold temperatures, heavy snow or ice and sometimes strong winds.

4. TORNADO

Natural Hazards	Probability		Impact		Spatial Extent		Warning Time		Duration		RF Rating
Tornado	2	0.6	2	0.6	4	0.8	4	0.4	3	0.3	**2.7**
Medium Risk Hazard (2.0 – 2.9)											

4.1 TORNADO CHARACTERISTICS

FIGURE 4-7 EXAMPLE OF A TORNADO

A **tornado** is a violent windstorm characterized by a twisting, funnel-shaped cloud extending to the ground. Tornadoes are most often generated by thunderstorm activity (but sometimes result from hurricanes or tropical storms) when cool, dry air intersects and overrides a layer of warm, moist air forcing the warm air to rise rapidly. The damage caused by a tornado is a result of high wind velocities and wind-blown debris. According to the National Weather Service, tornado wind speeds can range between 30 to more than 300 miles per hour.

They are more likely to occur during the spring and early summer months of March through June and are most likely to form in the late afternoon and early evening. Most tornadoes are a few dozen yards wide and touchdown briefly, but even small, short-lived tornadoes can inflict tremendous damage. Destruction ranges from minor to catastrophic depending on the intensity, size, and duration of the storm. Structures made of light materials such as mobile homes are most susceptible to damage. Each year, an average of over 800 tornadoes is reported nationwide, resulting in an average of 80 deaths and 1,500 injuries.

Strong winds can also occur outside of tornadoes, severe thunderstorms, and winter storms. These winds typically develop with strong pressure gradients and gusty frontal passages. The closer and stronger two systems (one high pressure, one low pressure) are, the stronger the pressure gradient, and therefore, the stronger the winds are.

4.2 REGULATORY ENVIRONMENT

There are negligible formal regulations that pertain to tornadoes. While there are suggested protective measures, especially for mobile/modular homes, these are generally not required in local codes.

4.3 HAZARD EVENTS

The Village may experience intense winds from thunderstorms, tornadoes, and even the remnants of hurricanes and tropical storms. Tornadoes can occur any time of the year, though, peak tornado occurrences are in March through October as past county records indicate. The entire Village, as well as all of Putnam County. All tornadic events in Putnam County will be displayed in this section.

TABLE 4-15 TORNADO EVENTS NEAR THE VILLAGE OF OTTAWA (1951-2016)

Location	Date	Mag	Deaths	Injuries	Property Damage	Crop Damage
Putnam Co.	5/2/1954		0	0	0.00K	0.00K
Putnam Co.	6/15/1964	F2	0	0	25.00K	0.00K
Putnam Co.	7/2/1965	F0	0	0	25.00K	0.00K
Putnam Co.	6/2/1971	F3	0	0	2.500M	0.00K
Putnam Co.	7/20/1973	F1	0	0	25.00K	0.00K
Putnam Co.	9/9/1976	F0	0	0	25.00K	0.00K
Putnam Co.	6/27/1978	F1	0	0	2.500M	0.00K
Putnam Co.	7/5/1978	F1	0	0	250.00K	0.00K
Putnam Co.	4/8/1980	F1	0	0	250.00K	0.00K
Putnam Co.	9/14/1990	F1	0	0	250.00K	0.00K
Continental	5/31/1998	F0	0	0	0.00K	0.00K
Gilboa	7/19/1998	F1	0	0	40.00K	0.00K
Pandora	6/12/2000	F1	0	0	40.00K	0.00K
Ft. Jennings	10/24/2001	F3	0	0	1.000M	0.00K
Continental	11/10/2002	F3	2	0	0.00K	0.00K
Ft. Jennings	8/28/2006	F1	0	0	15.00K	10.00K
Glandorf	5/30/2008	EF0	0	0	1.200M	0.00K
Dupont	10/26/2010	EF1	0	0	0.00K	0.00K
Douglas	11/17/2013	EF1	0	0	0.00K	0.00K
Muntanna	11/17/2013	EF2	0	0	0.00K	0.00K
Dupont	8/24/2016	EF0	0	0	0.00K	0.00K
North Creek	8/24/2016	EF0	0	0	0.00K	0.00K
Totals:			**2**	**0**	**8.145M**	**10.00K**

4.4 HISTORICAL OCCURRENCES

The Village of Ottawa has been directly impacted by 2 tornadoes, with a third skirting the northwestern boundary. The Village has been part of 3 federal disaster declarations relating to tornadoes. No public or individual assistance was awarded for these incidents.

TABLE 4-16 DECLARED DISASTERS AFFECTING THE VILLAGE OF OTTAWA

Disaster Number	Declaration Date	Title	Public Assistance
DR-1444	11/18/2002	Severe Storms and Tornadoes	-
DR-642	6/30/1981	Severe Storms, Flooding, and Tornadoes	-
DR-421	4/4/1974	Tornadoes	-

FIGURE 4-8 HISTORICAL TORNADOES IN OTTAWA

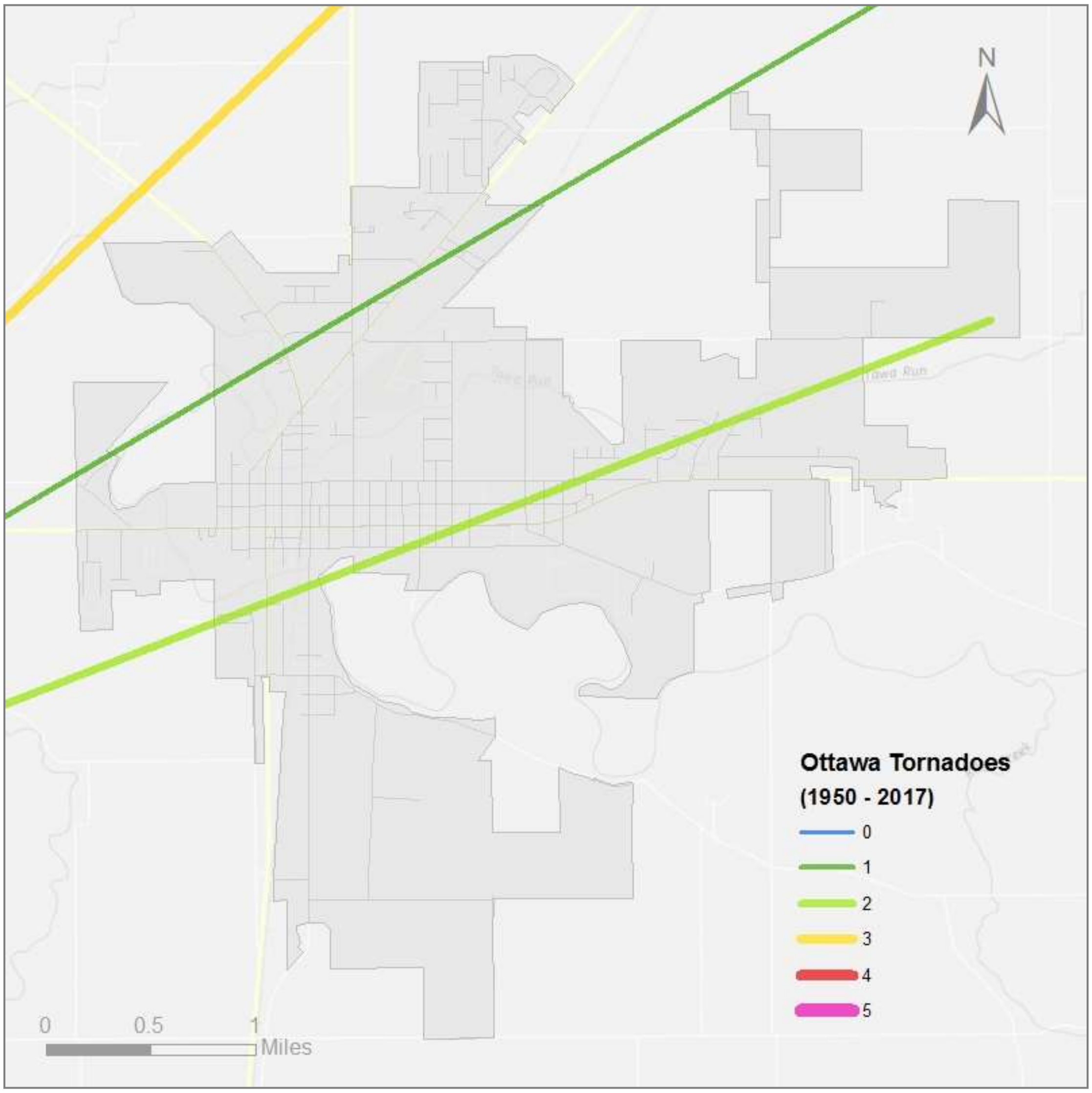
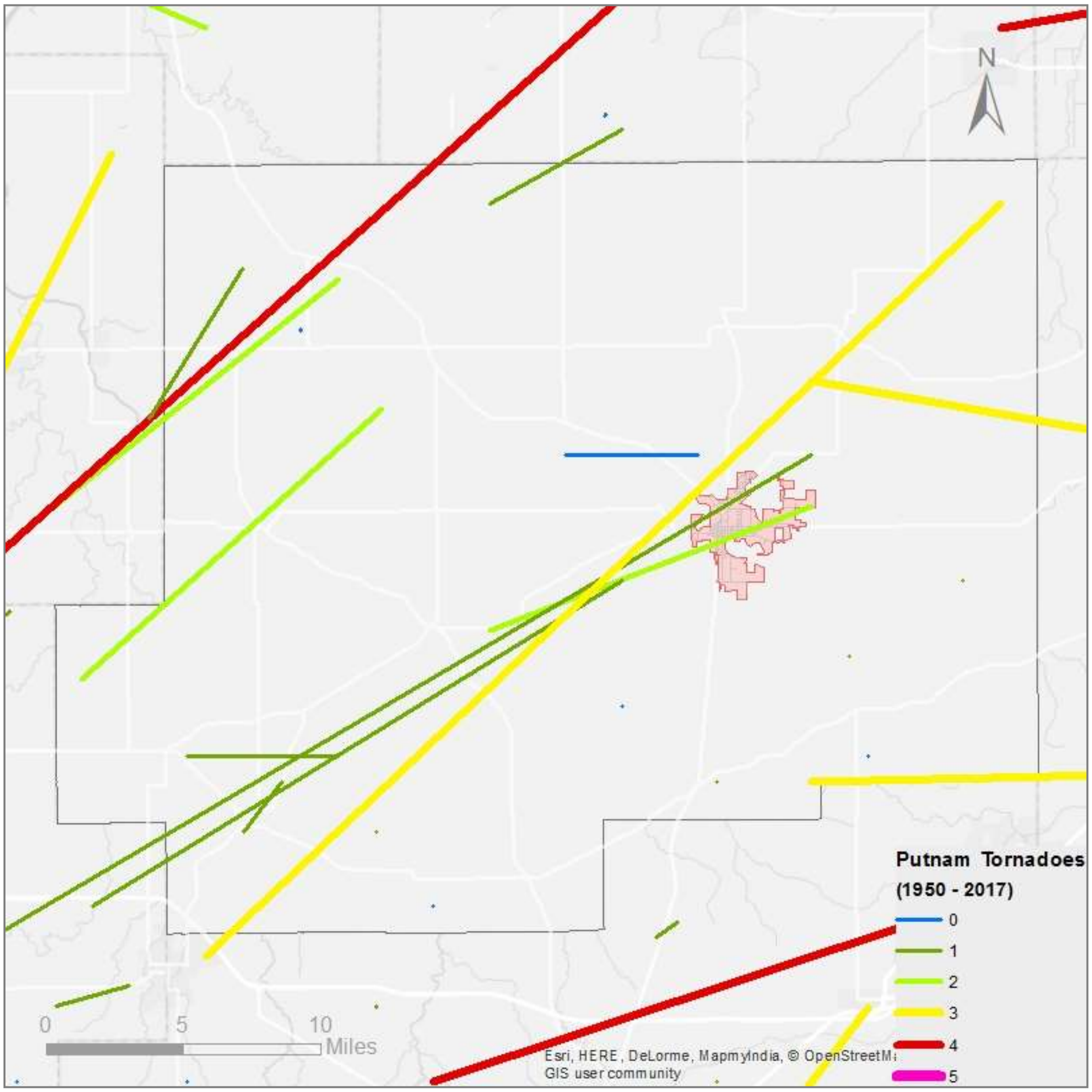


FIGURE 4-9 PUTNAM COUNTY TORNADOES



4.5 MAGNITUDE/SEVERITY

The Enhanced Fujita Scale, also known as the "EF-Scale," measures tornado strength and associated damages. The EF-Scale is an update to the earlier Fujita scale that was published in 1971. It classifies United States tornadoes into six intensity categories, as shown in Table 4-17 below, based upon the estimated maximum winds occurring within the wind vortex. The EF-Scale has become the definitive metric for estimating wind speeds within tornadoes based upon the damage done to buildings and structures since it was implemented through the National Weather Service in 2007.

TABLE 4-17 ENHANCED FUJITA SCALE AND ASSOCIATED DAMAGE

EF-Scale Number	Wind Speed (MPH)	Type of Damage Possible
EFO	65-85	**Minor damage**: Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over. Confirmed tornadoes with no reported damage (i.e., those that remain in open fields) are always rated EF0.
EF1	86-110	**Moderate damage**: Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135	**Considerable damage**: Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF3	136-165	**Severe damage**: Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	166-200	**Devastating damage**: Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
EF5	>200	**Extreme damage**: Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 m (300 ft.); steel reinforced concrete structure badly damaged; high-rise buildings have significant structural deformation.

The Storm Prediction Center (SPC) has developed damage indicators to be used with the Enhanced Fujita Scale for different types of buildings but can be also be used to classify any high wind event. Some of the indicators for different building types are shown in tables below.

TABLE 4-18 SPC INSTITUTIONAL BUILDING DAMAGE INDICATORS

Damage Description	Wind Speed Range (Expected, in Parentheses)
Threshold of visible damage	59-88 MPH (72 MPH)
Loss of roof covering (<20%)	72-109 MPH (86 MPH)
Damage to penthouse roof & walls, loss of rooftop HVAC equipment	75-111 MPH (92 MPH)
Broken glass in windows or doors	78-115 MPH (95 MPH)
Uplift of lightweight roof deck & insulation, significant loss of roofing material (>20%)	95-136 MPH (114 MPH)
Façade components torn from structure	97-140 MPH (118 MPH)
Damage to curtain walls or other wall cladding	110-152 MPH (131 MPH)
Uplift of pre-cast concrete roof slabs	119-163 MPH (142 MPH)
Uplift of metal deck with concrete fill slab	118-170 MPH (146 MPH)
Collapse of some top building envelope	127-172 MPH (148 MPH)
Significant damage to building envelope	178-268 MPH (210 MPH)

Source: Storm Prediction Center, 2009

TABLE 4-19 SPC EDUCATIONAL INSTITUTIONS (ELEMENTARY) DAMAGE INDICATORS

Damage Description	Wind Speed Range (Expected, in Parentheses)
Threshold of visible damage	55-83 MPH (68 MPH)
Loss of roof covering (<20%)	66-99 MPH (79 MPH)
Broken windows	71-106 MPH (87 MPH)
Exterior door failures	83-121 MPH (101 MPH)
Uplift of metal roof decking; significant loss of roofing material (>20%); loss of rooftop HVAC	85-119 MPH (101 MPH)
Damage to or loss of wall cladding	92-127 MPH (108 MPH)
Collapse of tall masonry walls at gym, cafeteria, or auditorium	94-136 MPH (114 MPH)
Uplift or collapse of light steel roof structure	108-148 MPH (125 MPH)
Collapse of exterior walls in top floor	121-153 MPH (139 MPH)
Most interior walls of top floor collapsed	133-186 MPH (158 MPH)
Total destruction of a large section of building envelope	163-224 MPH (192 MPH)

Source: Storm Prediction Center, 2009

TABLE 4-20 SPC METAL BUILDING SYSTEMS DAMAGE INDICATORS

Damage Description	Wind Speed Range (Expected, in Parentheses)
Threshold of visible damage	54-83 MPH (67 MPH)
Inward or outward collapsed of overhead doors	75-108 MPH (89 MPH)
Metal roof or wall panels pulled from the building	78-120 MPH (95 MPH)
Column anchorage failed	96-135 MPH (117 MPH)
Buckling of roof purlins	95-138 MPH (118 MPH)
Failure of X-braces in the lateral load resisting system	118-158 MPH (138 MPH)
Progressive collapse of rigid frames	120-168 MPH (143 MPH)
Total destruction of building	132-178 MPH (155 MPH)

Source: Storm Prediction Center, 2009

TABLE 4-21 SPC ELECTRIC TRANSMISSION LINES DAMAGE INDICATORS

Damage Description	Wind Speed Range (Expected, in Parentheses)
Threshold of visible damage	70-98 MPH (83 MPH)
Broken wood cross member	80-114 MPH (99 MPH)
Wood poles leaning	85-130 MPH (108 MPH)
Broken wood poles	98-142 MPH (118 MPH)

Source: Storm Prediction Center, 2009

Improved and consistent building codes have been considered as a key measure to mitigate life and property losses associated with tornadoes and wind events. All of Ottawa is equally at risk to tornado damage.

4.6 FREQUENCY/PROBABILITY OF FUTURE OCCURRENCES

Reported tornado events over the past 61 years provide an acceptable framework for determining the future occurrence in terms of frequency for such events. The probability of experiencing a tornado event, although infrequent, can be difficult to quantify, but based on historical record of 22 tornado events since 1996, it can reasonably be assumed that this type of event has occurred once every 7 years from 1996 through 2015.

(**2017** CY) - (**1996** HY) = **21 Years on Record**

(**21 Years**) / (**3 Events**) = **7 Years Between Events**

Furthermore, the historic frequency calculates that there is a 14% chance of this type of event occurring each year.

The HMPC, based on their knowledge, determined that Tornadoes are "Possible," meaning there is between a 1% and 10% of these events occurring each year.

4.7 INVENTORY ASSETS EXPOSED TO TORNADOES

All assets located in the Village of Ottawa can be considered at risk from tornadoes and wind events. This includes 4,424, or 100% of the Village's population and all critical facilities, structures, and infrastructure.

4.8 POTENTIAL LOSSES FROM TORNADOES

While all Village assets are considered at risk from this hazard, a particular tornado would only cause damages along its specific track. A high-magnitude tornado sweeping through densely-populated portions of the Village would have extensive injuries, deaths, and economic losses. There is no way to be sure how many people would be injured or killed due to the difference time of day and year can make, but property values can provide an estimate of economic losses.

TABLE 4-22 PROPERTIES VULNERABLE TO TORNADOES

Class	Number	Total Cost	1% Damage	5% Damage
Residential	1,911	$ 171,813,349.00	$ 1,718,133.49	$ 8,590,667.45
Critical Facilities				
Day Care	3	$ 1,445,914.00	$ 14,459.14	$ 72,295.70
Education	3	$ 14,971,229.00	$ 149,712.29	$ 748,561.45
Fire Station	3	$ 986,800.00	$ 9,868.00	$ 49,340.00
Government	5	$ 8,461,400.00	$ 84,614.00	$ 423,070.00
Medical	4	$ 20,657,200.00	$ 206,572.00	$ 1,032,860.00
Police	2	$ 5,781,686.00	$ 57,816.86	$ 289,084.30
Religious	7	$ 3,639,486.00	$ 36,394.86	$ 181,974.30
Utility	2	$ 13,040,057.00	$ 130,400.57	$ 652,002.85
CRIT. FACILITY TOTAL	**29**	**$ 68,983,772.00**	**$ 689,837.72**	**$ 3,449,188.60**
Total Value				
Grand Total	**1,940**	**$ 240,797,121.00**	**$ 2,407,971.21**	**$ 12,039,856.05**

4.9 LAND USE & DEVELOPMENT TRENDS

Improved and consistent building codes have been considered as a key measure to mitigate life and property losses associated with tornadoes and wind events. All Putnam County and Village of Ottawa property is equally at risk to tornado damage, and there are no locations of high-risk exposure.

4.10 TORNADOES HIRA SUMMARY

It's difficult to separate the various wind components that cause damage from other wind-related natural events that often occur to generate tornadoes. For example, hurricanes with intense winds often spawn numerous tornadoes or generate severe thunderstorms producing strong, localized downdrafts. Due to this difficulty, tornadoes are difficult to predict and the entire Village is subject to all categories of windstorms.

In addition to improved construction standards, retrofitting to enhance design standards of infrastructure can limit exposure. Examples include structural cladding, shuttering systems, and materials that are resistant to the penetration of wind-blown debris and projectiles.

5. SEVERE THUNDERSTORMS

Natural Hazards	Probability		Impact		Spatial Extent		Warning Time		Duration		RF Rating
Severe Thunderstorms	4	1.2	1	0.3	4	0.8	1	0.1	1	0.1	**2.5**
Medium Risk Hazard (2.0 – 2.9)											

5.1 SEVERE THUNDERSTORM CHARACTERISTICS

Extreme weather conditions can exist during any season in Ohio. Thunderstorms, associated with strong winds, heavy precipitation, and lightning strikes can all be hazardous under the right conditions and locations. Strong winds and tornadoes can take down trees, damage structures, tip high profile vehicles, and create high velocity flying debris. Large hail can damage crops, dent vehicles, break windows, and injure or kill livestock, pets, and people. Coastal storms, which include hurricanes, tropical storms, and nor'easters, are among the most devastating naturally occurring hazards in the United States and its territories. Past events reveal the magnitude of damage that is possible. In 2005, Hurricane Katrina resulted in the highest total damage of any natural disaster in U.S. history, an estimated $90 billion, eclipsing many times the damage wrought by Hurricane Andrew in 1992.

Thunderstorms affect relatively small areas when compared with hurricanes and winter storms. Despite their small size, all thunderstorms are dangerous. The typical thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. Of the estimated 100,000 thunderstorms that occur each year in the United States, about 10 percent are classified as severe. The National Weather Service considers a thunderstorm severe if it produces hail at least 3/4 inch in diameter, winds of 58 MPH or stronger, or a tornado. Every thunderstorm needs three basic components: (1) moisture to form clouds and rain (2) unstable air which is warm air that rises rapidly and (3) lift, which is a cold or warm front capable of lifting air to help form thunderstorms.

Downburst winds, which can cause more widespread damage than a tornado, occur when air is carried into a storm's updraft, cools rapidly, and comes rushing to the ground. Cold air is denser than warm air, and therefore, wants to fall to the surface. On warm summer days, when the cold air can no longer be supported up by the storm's updraft, or an exceptional downdraft develops, the air crashes to the ground in the form of strong winds. These winds are forced horizontally when they reach the ground and can cause significant damage. These types of strong winds can also be referred to as straight-line winds. Downbursts with a diameter of less than 2.5 miles are called microbursts and those with a diameter of 2.5 miles or greater are called macrobursts. A derecho, or bow echo, is a series of downbursts associated with a line of thunderstorms. This type of phenomenon can extend for hundreds of miles and contain wind speeds in excess of 100 mph.

Lightning, although not considered severe by the National Weather Service definition, can accompany heavy rain during thunderstorms. Lightning develops when ice particles in a cloud move around, colliding with other particles. These collisions cause a separation of electrical charges. Positively charged ice particles rise to the top of the cloud and negatively charged ones fall to the middle and lower sections of the cloud. The negative charges at the base of the cloud attract positive charges at the surface of the Earth. Invisible to the human eye, the negatively charged area of the cloud sends a charge called a stepped leader toward the ground. Once it gets close enough, a channel develops between the cloud and the ground. Lightning is the electrical transfer through this channel. The channel rapidly heats to 50,000 degrees Fahrenheit and contains approximately 100 million electrical volts. The rapid expansion of the heated air causes thunder.

Hail develops when a super cooled droplet collects a layer of ice and continues to grow, sustained by the updraft. Once the hail stone cannot be held up any longer by the updraft, it falls to the ground. Nationally, hailstorms cause nearly $1 billion in property and crop damage annually, as peak activity coincides with peak agricultural seasons. Severe hailstorms also cause considerable damage to buildings and automobiles, but rarely result in loss of life. Hailstones are usually less than two inches in diameter and can fall at speeds of 120 miles per hour (mph), which can be destructive to roofs, buildings, automobiles, vegetation, and crops.

5.2 REGULATORY ENVIRONMENT

There are negligible formal regulations that pertain to thunderstorm events.

5.3 HAZARD EVENTS

Dangerous and damaging aspects of a severe storm are tornadoes, hail, lightning strikes, flash flooding, and winds associated with downbursts and microbursts. Reported severe weather events over the past 60 years provides an acceptable framework for determining the magnitude of such storms that can be expected and planned for accordingly. FEMA places this region in Zone IV (250 MPH) for structural wind design (Federal Emergency Management Agency, 2004b).

Thunderstorm Wind Events

Non-tornadic, thunderstorm and non-thunderstorm winds over 100 mph should also be considered in future planning initiatives. These types of winds can remove roofs, move mobile homes, topple trees, take down utility lines, and destroy poorly-built or weak structures.

There have been 135 recorded severe wind events associated with thunderstorms since 1950. A full list of events by date, and with additional detail, can be found at the end of this hazard profile.

TABLE 4-23 THUNDERSTORM WIND EVENTS SINCE 1950

Date Range	# Of Events	Type	Death	Injury	Property Damage	Crop Damage
1950 - 2017	135	Thunderstorm Wind	1	3	$1,536,000	$0
		TOTALS:		**3**	**$1,536,000**	**$0**

Hail Events

Large hail can damage structures, break windows, dent vehicles, ruin crops, and kill or injure people and livestock. Based on past occurrences, hail sizes greater than 3 inches in diameter are possible and should be accounted for in future planning activities.

There have been 70 recorded hail events associated with thunderstorms that have either directly or indirectly impacted the Village and the immediately surrounding jurisdictions since 1950. A full list of events by date, and with additional detail, can be found at the end of this hazard profile.

TABLE 4-24 VILLAGE OF OTTAWA HAIL EVENTS SINCE 1955

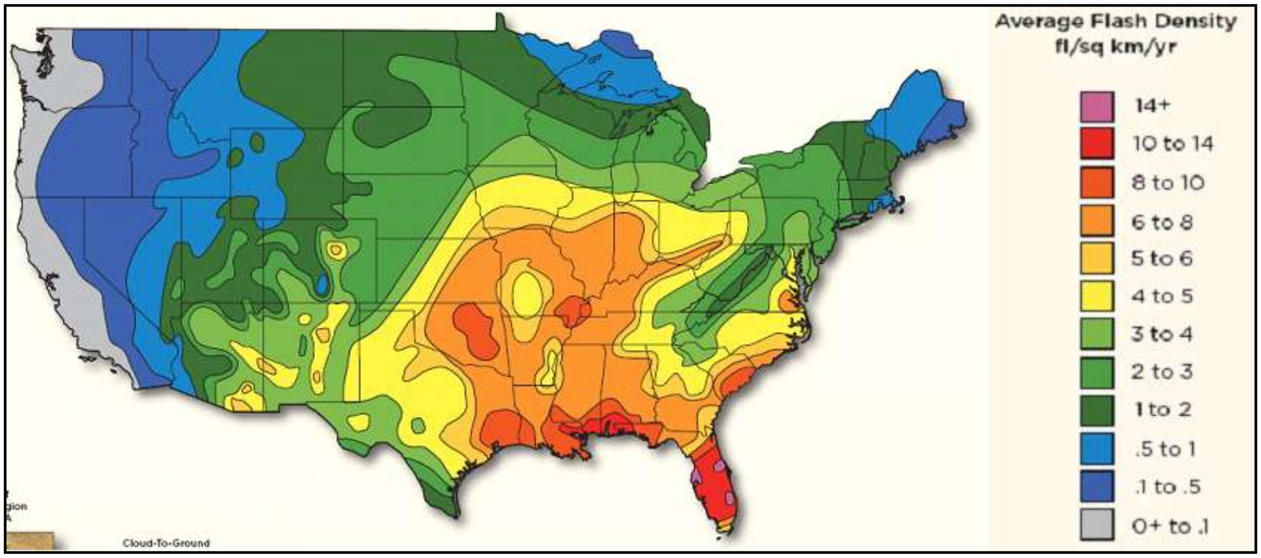
Date Range	# Of Events	Death	Injury	Property Damage	Crop Damage
1950 - 2017	70	0	0	$ 500,000	$0
TOTALS:		**0**	**0**	**$ 500,000**	**$0**

Furthermore, the historic frequency calculates that there is a 100% chance of this type of event occurring each year.

Lightning Events

Except in cases where significant forest or range fires are ignited, lightning generally does not result in disasters. There have been no recorded instances of lightning-related incidents in the Village of Ottawa, or the rest of Putnam County.

FIGURE 4-10 FLASH DENSITY ASSOCIATED WITH LIGHTNING STRIKES



5.4 HISTORICAL OCCURRENCES

Since 1956, 6 federally or state declared severe thunderstorm weather events have occurred in the Village of Ottawa as shown in Table 4-25. According to FEMA Declarations and Ohio Emergency and Disaster Proclamations (1956 to present), these events include: severe storms, straight-line winds, flooding, and tornadoes.

TABLE 4-25 SEVERE STORM DISASTER DECLARATIONS

Disaster Number	Declaration Date	Title	Public Assistance
DR-4077	8/20/2012	Severe Storms and Straight-Line Winds	$ 143,988.40
EM-3346	6/30/2012	Severe Storms	-
DR-1720	8/27/2007	Severe Storms, Flooding, and Tornadoes	$ 2,279,164.76
DR-1556	9/19/2004	Severe Storms and Flooding	-
DR-1444	11/18/2002	Severe Storms and Tornadoes	-
DR-642	6/30/1981	Severe Storms, Flooding, and Tornadoes	-

July 21, 1998: A stationary front draped across southern Lake Michigan into northern Ohio began to shift slowly southward during the 21st. A weak shortwave trough would interact with this boundary by late afternoon producing another outbreak of severe thunderstorms. Capes the afternoon of the 21st exceeded 5000 J/kg thanks in part to surface dewpoints in the mid-70s and mid-level cold air advection under the approaching mid-level shortwave. An east-west line of multicellular severe thunderstorms quickly developed along the front by late afternoon. As the convectively generated cold pool deepened... a large outflow boundary developed and began to spread southward generating new convection along the leading edge. Very heavy rain fell within this line of storms as they pushed slowly south as evidenced by reported rainfall amounts. Many locations experienced wet microbursts within the stronger multicell storms. Freezing level temperatures and wet bulb zero temperatures were quit high which greatly inhibited large hail formation. The convective outflow weakened later that evening with echo training developing across central Indiana which went on to produce widespread flash flooding during the morning of July 22nd.

One man ended up paralyzed when a large tree limb fell onto his car. Countless large trees were blown down across the county. One house and two barns were destroyed on Road J-3 and Road K. Another two-story house completely lost its upper floor. Another barn along Road 7-D and X was flattened while the Leipsic elementary school sustained extensive damage to its roof and water damage to the interior.

April 28, 2011: Deep low pressure tracked northeast along a stationary boundary laying across portions of central Indiana into northern Ohio. Numerous strong to severe storms occurred during the evening and moved towards the area, but did not produce any severe weather. As the low passed by, strong mixing to the ground occurred of much stronger winds. These winds caused pockets of non-thunderstorm wind damage across northwestern Ohio. Emergency management officials reported 13 power poles downed and snapped along State Road 65, between Roads M and O, south of Ottawa. A semi-truck was blown off near the area of the power poles being snapped.

June 29, 2012: A shallow quasi-stationary frontal boundary was located from Iowa and Nebraska into portions of northern Indiana. Steep mid-level lapse rates, extreme instability (CAPES in excess of 8000 j/kg per Lincoln, IL sounding and strong mid-level flow allowed for a favorable environment for a cluster of storms over northeastern Illinois to rapidly intensify as they moved into northern Indiana. A derecho was well underway as the line entered northwestern Ohio with widespread damage occurring in many locations. A trained spotter reported a portion of a roof being blown off a factory as well as trees being uprooted in the area.

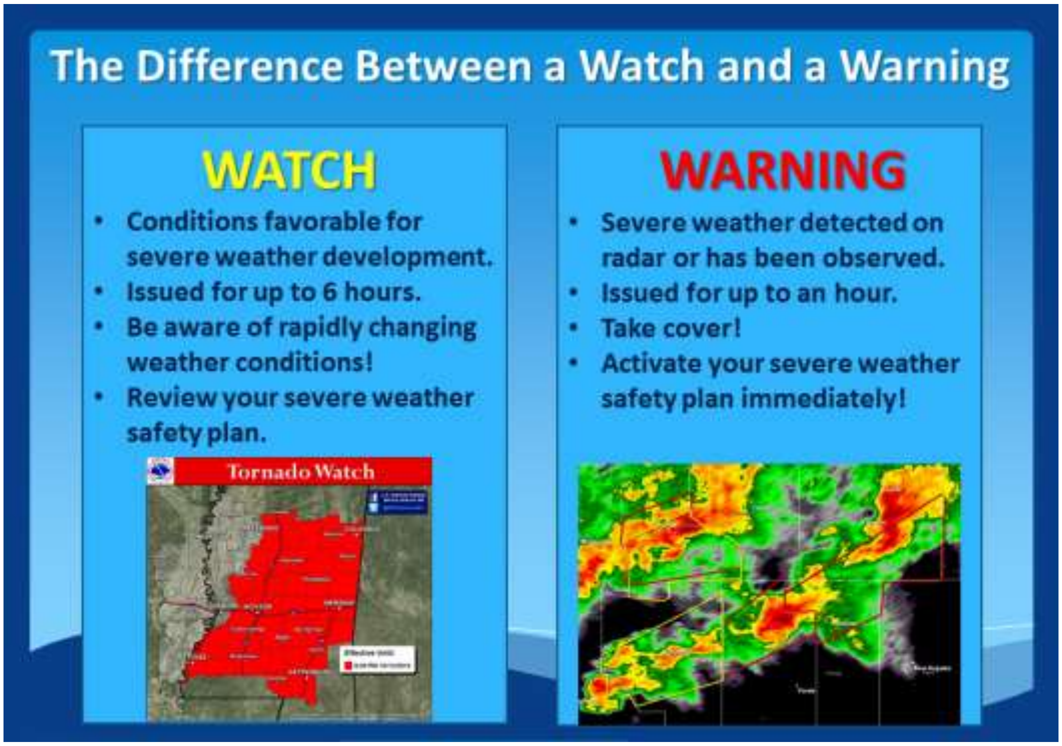
May 26, 2015: With a surface low over the upper Mississippi River valley and strong southerly flow from the Gulf to the Great Lakes, a weak trough and associated frontal boundary moved into a low CAPE, high shear environment. This favored development of several clusters of thunderstorms. The stronger convection merged into small, fast moving bow segments that produced sporadic wind damage. The public reported a six inch diameter tree limb down at the intersection of Locust and 3rd Street.

July 13, 2016: The remnants of earlier convection moved into portions of east central Indiana and eventually northwestern Ohio. MLCAPE in excess of 2000 j/kg was in place with mid-level lapse rates around 7 C/km across much of the forecast area. Bulk shear was quite low, barely reaching 25 knots. While storms overall struggled to maintain any appreciable intensity, they eventually congealed into a line with brief bursts of severe weather during core collapses. A trained spotter measured a 58-mph wind gust and observed some smaller tree branches down, up to three inches in diameter.

5.5 MAGNITUDE/SEVERITY

Thunderstorm watches and warnings are issued by the National Weather Service. There are no watches or warnings for lightning. Figure 4-11 explains the difference between watches and warnings, as used by the NWS.

FIGURE 4-11 NWS WATCH VS. WARNING



The Beaufort scale is a scale for measuring wind speeds. It is based on observation rather than accurate measurement. It is the most widely used system to measure wind speed today. There are twelve levels, plus 0 for "no wind."

TABLE 4-26 BEAUFORT SCALE

Beaufort number	MPH	Description	Observation
0	**<1**	Calm	Calm. Smoke rises vertically.
1	**1-3**	Light air	Wind motion visible in smoke
2	**3-7**	Light breeze	Wind felt on exposed skin. Leaves rustle.
3	**8-12**	Gentle breeze	Leaves and smaller twigs in constant motion.
4	**13-17**	Moderate breeze	Dust and loose paper raised. Small branches begin to move.
5	**18-24**	Fresh breeze	Branches of a moderate size move. Small trees begin to sway.

Beaufort number	MPH	Description	Observation
6	25-30	Strong breeze	Large branches in motion. Whistling heard in overhead wires. Umbrella use becomes difficult. Empty plastic garbage cans tip over.
7	31-38	High wind, Moderate Gale, Near Gale	Whole trees in motion. Effort needed to walk against the wind. Swaying of skyscrapers may be felt, especially by people on upper floors.
8	39-46	Fresh Gale	Twigs broken from trees. Cars veer on road.
9	47-54	Strong Gale	Larger branches break off trees, and some small trees blow over. Construction/temporary signs and barricades blow over. Damage to circus tents and canopies.
10	55-63	Whole Gale/Storm	Trees are broken off or uprooted, saplings bent and deformed, poorly attached asphalt shingles and shingles in poor condition peel off roofs.
11	64-72	Violent storm	Widespread vegetation damage. More damage to most roofing surfaces, asphalt tiles that have curled up and/or fractured due to age may break away completely.
12	≥73	Hurricane-force	Considerable and widespread damage to vegetation, a few windows broken, structural damage to mobile homes and poorly constructed sheds and barns. Debris may be hurled about.

Hail sizes can differ greatly from one storm to another depending on the strength of the storm's updraft. Stronger updrafts can create larger hailstones, which in turn causes more damage. This makes reporting the size of hail important for public safety. The preferred hail measurement method is to use a ruler to measure the diameter of the hail stone along its longest axis. However, various coins and balls are often used when reporting hail size.

TABLE 4-27 HAIL SIZE COMPARISON CHART

Common Object	Size in Diameter
Pea	0.25 Inch
Penny or Dime	0.75 Inch
Quarter	1.00 Inch
Half Dollar	1.25 Inch
Golf Ball	1.75 Inch
Tennis Ball	2.50 Inch
Baseball	2.75 Inch
Grapefruit	4.00 Inch

5.6 PROBABILITY OF FUTURE OCCURRENCES

The HMPC, based on their knowledge and experience, decided that Severe Thunderstorm events are "Highly Likely," meaning that they have a 100% chance of occurring each year.

TABLE 4-28 PROBABILITY OF THUNDERSTORM EVENTS

Hazard	Number of Events in Historic Record	Number of Years in Historic Record	Historic Recurrence Interval (years)	Historic Frequency (% chance/year)
Thunderstorm Wind	135	67	0.49	100%
Hail	70	67	0.95	100%
Lightning	0	67	-	-

Thunderstorm Probability

Reported thunderstorm winds over the past 67 years provide an acceptable framework for determining the future occurrence in terms of frequency for such events. The probability of experiencing thunderstorm winds associated with damages or injury can be difficult to quantify, but based on historical record of 135 thunderstorm wind events since 1950, it can reasonably be assumed that this type of event has occurred once every 0.49 years from 1955 through 2017.

(**2017** CY) - (**1950** HY) = **67 Years on Record**

(**67 Years**) / (**135 Events**) = **0.49 Years Between Events**

Furthermore, the historic frequency calculates that there is a 100% chance of this type of event occurring each year.

Hail Probability

Reported hail events over the past 67 years provide an acceptable framework for determining the future occurrence in terms of frequency for such events. The probability of experiencing a hail event associated with damages or injury can be difficult to quantify, but based on historical record of 70 hail events since 1950, it can reasonably be assumed that this type of event has occurred once every 0.96 years from 1950 through 2017.

(**2017** CY) - (**1950** HY) = **67 Years on Record**

(**67 Years**) / (**70 Events**) = **0.96 Years Between Events**

Lightning Probability

There have been no recorded instances of lightning-related incidents in the Village of Ottawa, or the rest of Putnam County. There is not a sufficient history of lightning strikes to determine the probability of such events in the future.

5.7 INVENTORY ASSETS EXPOSED TO THUNDERSTORMS

Damage to inventory assets exposed to severe thunderstorms is dependent on the age of the building, type, construction material used, and condition of the structure. Heavy wind loads on structures can cause poorly constructed roofs to fail, and hail is known to damage roofs and siding of structures, rendering the building more susceptible to water damage.

All Village assets can be considered at risk from severe thunderstorms. This includes 100 percent of the Village population and all buildings and infrastructure. Damages primarily occur as a result of high winds, lightning strikes, hail, and flooding. Most structures, including critical facilities, should be able to provide adequate protection from hail but the structures could suffer broken windows and dented exteriors. Those facilities with back-up generators are better equipped to handle a severe weather situation should the power go out.

5.8 POTENTIAL LOSSES FROM THUNDERSTORMS

A timely forecast may not be able to mitigate the property loss, but could reduce the casualties and associated injury. It appears possible to forecast these extreme events with some skill, but further research needs to be done to test the existing hypothesis about the interaction between the convective storm and its environment that produces the extensive swath of high winds. Severe thunderstorms will remain a highly likely occurrence for the Village. Lightning and hail may also be experienced in the area due to such storms.

TABLE 4-29 DAMAGE ESTIMATES FOR THUNDERSTORMS

Category	Time Period on Record	# Events	Damages
Thunderstorm Winds	1950-2017	135	$22,072,000
Hail	1950-2017	70	$ 500,000
Lightning	1950-2017	-	-

There is no way to predict an area that will be impacted by thunderstorm winds, hail storms or lightning strikes. An individual thunderstorm is unlikely to damage large numbers of structures on its own. However, the side effects of a thunderstorm (hail, winds and lightning), have the ability to cause damage to structures and property throughout the Village. Nationally, insurance claims resulting from hailstorm damage increased 84% ($467,602 to $861,579) from 2010 to 2012 according to the National Insurance Crime Bureau. From 2013 to 2015, the number of hail claims decreased by 21%.

Hail can damage homes and vehicles, as well as crops. Hail is the third leading cause of crop failure in the United States. While drought was by far the leading cause of crop failures in 2012, at 79%, thunderstorms and their hazards accounted for over $1 Billion in losses nationwide in 2012. These losses, resulting from thunderstorms, can be difficult to overcome. Insurance policies offer some relief from the losses, both for homeowners and farmers.

TABLE 4-30 PROPERTIES VULNERABLE TO SEVERE THUNDERSTORMS

Class	Number	Total Cost	1% Damage	5% Damage
Residential	1,911	$ 171,813,349.00	$ 1,718,133.49	$ 8,590,667.45
Critical Facilities				
Day Care	3	$ 1,445,914.00	$ 14,459.14	$ 72,295.70
Education	3	$ 14,971,229.00	$ 149,712.29	$ 748,561.45
Fire Station	3	$ 986,800.00	$ 9,868.00	$ 49,340.00
Government	5	$ 8,461,400.00	$ 84,614.00	$ 423,070.00
Medical	4	$ 20,657,200.00	$ 206,572.00	$ 1,032,860.00
Police	2	$ 5,781,686.00	$ 57,816.86	$ 289,084.30
Religious	7	$ 3,639,486.00	$ 36,394.86	$ 181,974.30
Utility	2	$ 13,040,057.00	$ 130,400.57	$ 652,002.85
CRIT. FACILITY TOTAL	**29**	**$ 68,983,772.00**	**$ 689,837.72**	**$ 3,449,188.60**
Total Value				
Grand Total	**1,940**	**$ 240,797,121.00**	**$ 2,407,971.21**	**$ 12,039,856.05**

5.9 LAND USE & DEVELOPMENT TRENDS

All future structures built in the Village will likely be exposed to severe thunderstorm damage. The Village needs to adhere to building codes so that new development can be built to current standards.

5.10 THUNDERSTORM HIRA SUMMARY

The Village of Ottawa is subject to severe storms ranging from thunderstorms to tropical storms which have the potential to cause flash flooding, tornadoes, downbursts, and debris. The severe thunderstorms profile is primarily concerned with past and future damages from high winds, lightning, and hail. Flooding is covered as a separate hazard, including flooding that occurs from a heavy precipitation event.

Mitigation of building damage has been most successful where strict building codes for high-wind influence areas and designated special flood hazard areas have been adopted and enforced by local governments, and the builders have complied. Proven techniques are available to reduce lightning damage by grounding techniques for buildings.

Post-disaster mitigation efforts include buyout programs, relocations, structural elevations, improved open-space preservation, and land use planning within high-risk areas. Due to the significant risk from severe storms, the Village will remain proactive in its mitigation efforts to help build sustainability.

Severe Thunderstorm NCDC Data

TABLE 4-31 THUNDERSTORM WIND EVENTS

Date	Time	Type	Mag	Deaths	Injuries	Property Damage	Crop Damage
6/16/1967	16:30	Thunderstorm Wind	50 kts.	0	0	0.00K	0.00K
7/3/1973	14:15	Thunderstorm Wind	0 kts.	0	0	0.00K	0.00K
1/11/1975	0:40	Thunderstorm Wind	0 kts.	0	0	0.00K	0.00K
5/30/1980	14:30	Thunderstorm Wind	0 kts.	0	0	0.00K	0.00K
7/5/1980	7:15	Thunderstorm Wind	0 kts.	0	0	0.00K	0.00K
6/15/1982	15:50	Thunderstorm Wind	0 kts.	0	0	0.00K	0.00K
5/2/1983	0:15	Thunderstorm Wind	62 kts.	0	0	0.00K	0.00K
5/2/1983	10:25	Thunderstorm Wind	0 kts.	0	0	0.00K	0.00K
7/1/1983	11:40	Thunderstorm Wind	0 kts.	0	0	0.00K	0.00K
9/6/1983	15:04	Thunderstorm Wind	0 kts.	0	0	0.00K	0.00K
8/8/1984	15:00	Thunderstorm Wind	0 kts.	0	0	0.00K	0.00K
9/2/1984	18:16	Thunderstorm Wind	0 kts.	0	0	0.00K	0.00K
9/8/1985	13:30	Thunderstorm Wind	0 kts.	0	0	0.00K	0.00K
5/6/1986	18:15	Thunderstorm Wind	0 kts.	0	0	0.00K	0.00K
6/15/1986	14:30	Thunderstorm Wind	0 kts.	0	0	0.00K	0.00K
6/2/1987	10:09	Thunderstorm Wind	0 kts.	0	0	0.00K	0.00K
6/29/1987	17:43	Thunderstorm Wind	0 kts.	0	0	0.00K	0.00K
8/2/1987	17:46	Thunderstorm Wind	0 kts.	0	0	0.00K	0.00K
8/2/1987	17:46	Thunderstorm Wind	0 kts.	0	0	0.00K	0.00K
1/7/1989	21:00	Thunderstorm Wind	0 kts.	0	0	0.00K	0.00K
1/7/1989	21:20	Thunderstorm Wind	0 kts.	0	0	0.00K	0.00K
6/3/1990	16:02	Thunderstorm Wind	0 kts.	0	0	0.00K	0.00K
3/27/1991	20:30	Thunderstorm Wind	52 kts.	0	0	0.00K	0.00K
6/15/1991	18:15	Thunderstorm Wind	55 kts.	0	0	0.00K	0.00K
6/15/1991	18:30	Thunderstorm Wind	0 kts.	0	0	0.00K	0.00K
7/29/1991	17:30	Thunderstorm Wind	0 kts.	0	0	0.00K	0.00K
4/16/1992	15:10	Thunderstorm Wind	0 kts.	0	0	0.00K	0.00K
6/17/1992	22:00	Thunderstorm Wind	0 kts.	0	0	0.00K	0.00K
7/13/1992	14:44	Thunderstorm Wind	0 kts.	0	0	0.00K	0.00K
7/14/1992	16:10	Thunderstorm Wind	0 kts.	0	0	0.00K	0.00K
9/9/1992	15:00	Thunderstorm Wind	0 kts.	0	0	0.00K	0.00K
9/9/1992	15:35	Thunderstorm Wind	0 kts.	0	0	0.00K	0.00K
9/2/1993	16:50	Thunderstorm Wind	0 kts.	0	0	5.00K	0.00K
11/27/1994	23:45	Thunderstorm Wind	0 kts.	0	0	5.00K	0.00K
5/28/1995	20:00	Thunderstorm Wind	0 kts.	0	0	3.00K	0.00K
4/20/1996	2:25	Thunderstorm Wind	70 kts.	0	0	10.00K	0.00K
10/30/1996	0:12	Thunderstorm Wind	54 kts.	0	0	0.00K	0.00K
5/18/1997	23:00	Thunderstorm Wind	50 kts.	1	0	10.00K	0.00K
6/21/1997	19:10	Thunderstorm Wind	50 kts.	0	0	5.00K	0.00K
6/25/1997	18:30	Thunderstorm Wind	54 kts.	0	0	0.00K	0.00K
7/8/1997	21:10	Thunderstorm Wind	52 kts.	0	0	0.00K	0.00K
7/8/1997	23:07	Thunderstorm Wind	53 kts.	0	0	0.00K	0.00K
7/26/1997	20:08	Thunderstorm Wind	50 kts.	0	0	3.00K	0.00K
6/12/1998	17:45	Thunderstorm Wind	52 kts.	0	0	100.00K	0.00K
6/19/1998	1:40	Thunderstorm Wind	53 kts.	0	0	0.00K	0.00K
6/29/1998	13:34	Thunderstorm Wind	53 kts.	0	0	0.00K	0.00K
6/29/1998	13:54	Thunderstorm Wind	61 kts.	0	0	0.00K	0.00K
7/19/1998	18:55	Thunderstorm Wind	50 kts.	0	0	0.00K	0.00K
7/19/1998	19:00	Thunderstorm Wind	55 kts.	0	0	0.00K	0.00K
7/21/1998	21:00	Thunderstorm Wind		0	1	250.00K	0.00K
8/24/1998	17:10	Thunderstorm Wind	61 kts.	0	0	0.00K	0.00K
11/10/1998	13:10	Thunderstorm Wind		0	0	10.00K	0.00K
11/10/1998	13:10	Thunderstorm Wind	61 kts.	0	0	0.00K	0.00K
12/6/1998	23:20	Thunderstorm Wind		0	0	10.00K	0.00K
5/17/1999	17:25	Thunderstorm Wind		0	0	70.00K	0.00K

Date	Time	Type	Mag	Deaths	Injuries	Property Damage	Crop Damage
6/10/1999	22:05	Thunderstorm Wind		0	0	2.00K	0.00K
7/6/1999	14:00	Thunderstorm Wind		0	0	2.00K	0.00K
7/21/1999	18:20	Thunderstorm Wind		0	0	0.20K	0.00K
7/25/1999	1:15	Thunderstorm Wind	53 kts.	0	0	0.00K	0.00K
4/20/2000	16:00	Thunderstorm Wind		0	0	0.00K	0.00K
5/9/2000	18:50	Thunderstorm Wind	61 kts. E	0	0	0.00K	0.00K
6/14/2000	16:07	Thunderstorm Wind		0	0	0.00K	0.00K
6/20/2000	20:10	Thunderstorm Wind		0	0	0.00K	0.00K
8/6/2000	20:14	Thunderstorm Wind		0	0	0.00K	0.00K
8/6/2000	20:15	Thunderstorm Wind		0	0	0.00K	0.00K
8/6/2000	20:20	Thunderstorm Wind	60 kts. E	0	0	0.00K	0.00K
8/6/2000	20:26	Thunderstorm Wind		0	0	0.00K	0.00K
8/6/2000	20:27	Thunderstorm Wind		0	0	10.00K	0.00K
9/20/2000	17:00	Thunderstorm Wind	65 kts. M	0	0	0.00K	0.00K
6/12/2001	3:10	Thunderstorm Wind		0	0	0.00K	0.00K
6/12/2001	3:10	Thunderstorm Wind		0	0	0.00K	0.00K
6/12/2001	3:20	Thunderstorm Wind		0	0	0.00K	0.00K
7/29/2002	16:35	Thunderstorm Wind		0	0	580.00K	0.00K
7/29/2002	16:35	Thunderstorm Wind		0	0	0.00K	0.00K
7/29/2002	16:35	Thunderstorm Wind		0	0	0.00K	0.00K
7/29/2002	16:35	Thunderstorm Wind		0	0	0.00K	0.00K
7/29/2002	16:35	Thunderstorm Wind		0	0	0.00K	0.00K
9/20/2002	15:45	Thunderstorm Wind		0	0	0.00K	0.00K
4/20/2003	16:10	Thunderstorm Wind	55 kts. EG	0	0	0.00K	0.00K
7/8/2003	1:42	Thunderstorm Wind	50 kts. EG	0	0	0.00K	0.00K
8/26/2003	17:40	Thunderstorm Wind	50 kts. EG	0	0	0.00K	0.00K
5/12/2004	12:42	Thunderstorm Wind	50 kts. EG	0	0	2.00K	0.00K
5/21/2004	14:10	Thunderstorm Wind	52 kts. EG	0	0	0.00K	0.00K
5/21/2004	14:20	Thunderstorm Wind	55 kts. EG	0	0	0.00K	0.00K
5/23/2004	16:52	Thunderstorm Wind	53 kts. EG	0	0	0.00K	0.00K
6/13/2004	17:15	Thunderstorm Wind	75 kts. EG	0	0	20.00K	0.00K
6/14/2004	14:29	Thunderstorm Wind	50 kts. EG	0	0	0.00K	0.00K
4/20/2005	15:05	Thunderstorm Wind	50 kts. EG	0	0	9.00K	0.00K
5/13/2005	16:40	Thunderstorm Wind	55 kts. EG	0	0	7.50K	0.00K
6/5/2005	18:18	Thunderstorm Wind	50 kts. EG	0	1	15.00K	0.00K
7/21/2005	19:05	Thunderstorm Wind	50 kts. EG	0	0	0.00K	0.00K
7/21/2005	19:07	Thunderstorm Wind	50 kts. EG	0	0	0.00K	0.00K
7/25/2005	11:26	Thunderstorm Wind	50 kts. EG	0	0	2.00K	0.00K
11/6/2005	4:25	Thunderstorm Wind	50 kts. EG	0	0	20.00K	0.00K
6/22/2006	14:05	Thunderstorm Wind	50 kts. EG	0	0	0.00K	0.00K
6/22/2006	14:20	Thunderstorm Wind	50 kts. EG	0	0	10.00K	0.00K
5/15/2007	18:45	Thunderstorm Wind	55 kts. EG	0	0	10.00K	0.00K
5/15/2007	18:55	Thunderstorm Wind	55 kts. EG	0	0	5.00K	0.00K
8/9/2007	13:22	Thunderstorm Wind	52 kts. MG	0	0	0.00K	0.00K
1/29/2008	21:35	Thunderstorm Wind	50 kts. EG	0	0	4.00K	0.00K
4/11/2008	18:09	Thunderstorm Wind	55 kts. EG	0	0	65.00K	0.00K
6/6/2008	19:54	Thunderstorm Wind	50 kts. EG	0	0	0.00K	0.00K
6/6/2008	20:25	Thunderstorm Wind	50 kts. EG	0	0	0.00K	0.00K
6/9/2008	17:35	Thunderstorm Wind	56 kts. EG	0	0	10.00K	0.00K
6/12/2010	20:22	Thunderstorm Wind	60 kts. EG	0	0	25.00K	0.00K
6/18/2010	20:23	Thunderstorm Wind	53 kts. MG	0	0	0.00K	0.00K
6/18/2010	20:30	Thunderstorm Wind	55 kts. EG	0	0	0.00K	0.00K
6/18/2010	20:36	Thunderstorm Wind	60 kts. EG	0	0	0.00K	0.00K
6/23/2010	13:50	Thunderstorm Wind	55 kts. EG	0	0	0.00K	0.00K
6/23/2010	13:55	Thunderstorm Wind	60 kts. EG	0	0	0.00K	0.00K
6/23/2010	13:57	Thunderstorm Wind	55 kts. EG	0	0	0.00K	0.00K
7/18/2010	16:50	Thunderstorm Wind	55 kts. EG	0	0	0.00K	0.00K
10/26/2010	10:35	Thunderstorm Wind	65 kts. EG	0	0	0.00K	0.00K
6/10/2011	17:46	Thunderstorm Wind	55 kts. EG	0	0	0.00K	0.00K
7/11/2011	11:43	Thunderstorm Wind	60 kts. EG	0	0	0.00K	0.00K
7/11/2011	11:47	Thunderstorm Wind	60 kts. EG	0	0	0.00K	0.00K
7/22/2011	14:57	Thunderstorm Wind	49 kts. EG	0	0	5.00K	0.00K
8/24/2011	21:45	Thunderstorm Wind	55 kts. EG	0	0	0.00K	0.00K

Date	Time	Type	Mag	Deaths	Injuries	Property Damage	Crop Damage
9/3/2011	21:15	Thunderstorm Wind	55 kts. EG	0	0	0.00K	0.00K
6/29/2012	14:50	Thunderstorm Wind	75 kts. EG	0	0	0.00K	0.00K
6/29/2012	14:55	Thunderstorm Wind	80 kts. EG	0	0	0.00K	0.00K
6/29/2012	14:55	Thunderstorm Wind	68 kts. MG	0	0	0.00K	0.00K
6/29/2012	14:57	Thunderstorm Wind	65 kts. EG	0	0	100.00K	0.00K
6/29/2012	14:58	Thunderstorm Wind	60 kts. EG	0	0	0.00K	0.00K
6/29/2012	15:08	Thunderstorm Wind	75 kts. EG	0	0	50.00K	0.00K
9/7/2012	12:50	Thunderstorm Wind	50 kts. EG	0	0	0.00K	0.00K
6/12/2013	22:49	Thunderstorm Wind	60 kts. EG	0	0	0.00K	0.00K
6/12/2013	23:00	Thunderstorm Wind	60 kts. EG	0	1	0.00K	0.00K
7/20/2013	5:45	Thunderstorm Wind	55 kts. EG	0	0	0.00K	0.00K
7/20/2013	5:45	Thunderstorm Wind	55 kts. EG	0	0	0.00K	0.00K
5/26/2015	16:05	Thunderstorm Wind	52 kts. EG	0	0	0.00K	0.00K
5/26/2015	16:15	Thunderstorm Wind	50 kts. EG	0	0	0.00K	0.00K
5/26/2015	16:30	Thunderstorm Wind	55 kts. EG	0	0	0.00K	0.00K
5/26/2015	16:35	Thunderstorm Wind	55 kts. EG	0	0	0.00K	0.00K
7/13/2016	18:25	Thunderstorm Wind	50 kts. MG	0	0	0.00K	0.00K

TABLE 4-32 HAIL EVENTS

Date	Time	Type	Mag	Deaths	Injuries	Property Damage	Crop Damage
7/18/1962	14:00	Hail	1.00 in.	0	0	0.00K	0.00K
6/3/1972	18:00	Hail	0.75 in.	0	0	0.00K	0.00K
3/16/1982	16:22	Hail	1.75 in.	0	0	0.00K	0.00K
3/16/1982	16:30	Hail	1.00 in.	0	0	0.00K	0.00K
5/2/1983	10:25	Hail	1.75 in.	0	0	0.00K	0.00K
5/2/1983	11:50	Hail	1.00 in.	0	0	0.00K	0.00K
8/10/1984	16:44	Hail	0.75 in.	0	0	0.00K	0.00K
8/10/1984	17:30	Hail	1.75 in.	0	0	0.00K	0.00K
9/12/1984	15:25	Hail	1.00 in.	0	0	0.00K	0.00K
9/13/1984	15:25	Hail	1.00 in.	0	0	0.00K	0.00K
3/28/1985	18:36	Hail	0.75 in.	0	0	0.00K	0.00K
7/9/1985	21:17	Hail	1.75 in.	0	0	0.00K	0.00K
7/12/1986	18:20	Hail	1.00 in.	0	0	0.00K	0.00K
5/9/1988	12:30	Hail	1.00 in.	0	0	0.00K	0.00K
5/9/1988	12:30	Hail	1.00 in.	0	0	0.00K	0.00K
6/2/1990	21:00	Hail	0.75 in.	0	0	0.00K	0.00K
2/18/1992	17:58	Hail	0.75 in.	0	0	0.00K	0.00K
9/25/1994	12:20	Hail	1.75 in.	0	0	500.00K	500.00K
6/26/1995	19:50	Hail	0.75 in.	0	0	0.00K	0.00K
7/30/1996	8:05	Hail	0.75 in.	0	0	0.00K	0.00K
8/16/1997	18:35	Hail	0.75 in.	0	0	0.00K	0.00K
4/8/1998	10:25	Hail	1.00 in.	0	0	0.00K	0.00K
5/3/1998	17:41	Hail	0.75 in.	0	0	0.00K	0.00K
5/31/1998	14:05	Hail	1.75 in.	0	0	0.00K	0.00K
5/31/1998	14:09	Hail	0.75 in.	0	0	0.00K	0.00K
5/31/1998	14:14	Hail	0.75 in.	0	0	0.00K	0.00K
6/27/1998	17:53	Hail	0.88 in.	0	0	0.00K	0.00K
6/29/1998	13:34	Hail	0.75 in.	0	0	0.00K	0.00K
6/29/1998	13:54	Hail	1.00 in.	0	0	0.00K	0.00K
7/19/1998	18:40	Hail	1.00 in.	0	0	0.00K	0.00K
8/24/1998	17:10	Hail	1.00 in.	0	0	0.00K	0.00K
6/9/1999	13:15	Hail	1.00 in.	0	0	0.00K	0.00K
6/13/1999	14:05	Hail	1.00 in.	0	0	0.00K	0.00K
7/6/1999	13:34	Hail	0.88 in.	0	0	0.00K	0.00K
5/9/2000	18:50	Hail	1.50 in.	0	0	0.00K	0.00K
6/20/2000	20:10	Hail	1.50 in.	0	0	0.00K	0.00K
7/14/2000	11:40	Hail	0.75 in.	0	0	0.00K	0.00K
7/14/2000	11:45	Hail	1.00 in.	0	0	0.00K	0.00K
8/2/2000	19:15	Hail	1.75 in.	0	0	0.00K	0.00K
8/6/2000	20:35	Hail	0.75 in.	0	0	0.00K	0.00K

Date	Time	Type	Mag	Deaths	Injuries	Property Damage	Crop Damage
10/24/2001	18:30	Hail	1.75 in.	0	0	0.00K	0.00K
4/17/2002	17:30	Hail	0.75 in.	0	0	0.00K	0.00K
4/4/2003	18:36	Hail	1.00 in.	0	0	0.00K	0.00K
4/4/2003	18:42	Hail	1.25 in.	0	0	0.00K	0.00K
4/4/2003	18:45	Hail	0.75 in.	0	0	0.00K	0.00K
4/4/2003	18:52	Hail	1.00 in.	0	0	0.00K	0.00K
4/4/2003	20:00	Hail	1.00 in.	0	0	0.00K	0.00K
11/12/2003	16:25	Hail	0.88 in.	0	0	0.00K	0.00K
11/12/2003	16:30	Hail	1.00 in.	0	0	0.00K	0.00K
5/7/2004	8:36	Hail	0.88 in.	0	0	0.00K	0.00K
6/13/2004	17:44	Hail	0.75 in.	0	0	0.00K	0.00K
5/25/2006	14:56	Hail	0.75 in.	0	0	0.00K	0.00K
5/25/2006	18:30	Hail	0.88 in.	0	0	0.00K	0.00K
6/19/2006	18:15	Hail	0.88 in.	0	0	0.00K	0.00K
6/21/2006	22:25	Hail	1.00 in.	0	0	0.00K	0.00K
5/1/2007	19:10	Hail	0.75 in.	0	0	0.00K	0.00K
5/1/2007	20:05	Hail	0.75 in.	0	0	0.00K	0.00K
6/9/2008	17:43	Hail	0.75 in.	0	0	0.00K	0.00K
6/26/2008	15:05	Hail	0.75 in.	0	0	0.00K	0.00K
3/7/2009	7:36	Hail	0.75 in.	0	0	0.00K	0.00K
6/1/2009	19:07	Hail	0.88 in.	0	0	0.00K	0.00K
5/5/2010	18:32	Hail	0.75 in.	0	0	0.00K	0.00K
4/19/2011	14:10	Hail	0.75 in.	0	0	0.00K	0.00K
5/25/2011	15:23	Hail	0.75 in.	0	0	0.00K	0.00K
8/9/2011	18:15	Hail	0.75 in.	0	0	0.00K	0.00K
7/18/2012	13:39	Hail	0.75 in.	0	0	0.00K	0.00K
5/30/2013	16:09	Hail	0.75 in.	0	0	0.00K	0.00K
7/2/2013	18:00	Hail	1.00 in.	0	0	0.00K	0.00K
10/6/2014	16:42	Hail	0.75 in.	0	0	0.00K	0.00K
5/27/2015	15:05	Hail	0.75 in.	0	0	0.00K	0.00K

6. WATER QUALITY

Natural Hazards	Probability		Impact		Spatial Extent		Warning Time		Duration		RF Rating
Water Quality	**2**	0.6	**2**	0.6	**4**	0.8	**4**	0.4	**1**	0.1	**2.5**
Medium Risk Hazard (2.0 – 2.9)											

6.1 WATER QUALITY CHARACTERISTICS

Maintaining a high level of quality for drinking water in communities is an essential part of life. In rural areas where resources can be limited, ensuring that reservoirs are clean and safe becomes an ever more vital part of the maintenance process.

Harmful algal blooms are overgrowths of algae in water. Some produce toxins that are dangerous to freshwater or marine environments. These blooms can affect local fisheries and reservoirs, which can be damaging to the health of local populations, as well as local economies. There are several factors that contribute to the trigger and sustainability of an algal bloom.

- **Nutrients**: The eutrophication (nutrient enrichment) of waters is a major contributor to algal blooms. Much of this enrichment comes from nitrogen and phosphorus found in agricultural and household fertilizers. When these drain into bodies of water, they have the potential to greatly promote the spread of algae.
- **Temperature**: Algae develops and thrives best in warm waters, typically in the spring and summer months. Temperatures above 77°F are ideal for the growth of harmful algae. When water becomes warmer, harmful algae varieties have a competitive advantage over others that have lower temperature thresholds.
- **Light**: Algae grows best when exposed intermittently to light. Highly adaptable algae varieties, such as blue-green algae, can exist and thrive in many different kinds of lighted environments, giving them an advantage over other organisms.
- **Stable Conditions**: Water that is stagnant or has a low flow is very conducive to growing algae. Droughts, humans and livestock, and the regulation of river flows all contribute to decreased flows of water.
- **Turbidity**: Floating organic or sedimentary materials decrease the amount of light that penetrates through water. Low turbidity means that there is more light, which is conducive to algae growth.

6.2 REGULATORY ENVIRONMENT

The Ohio Environmental Protection Agency provides guidelines and regulations regarding water quality. Regulations regarding farm runoff, including nitrate and phosphates, are governed by the Ohio Department of Agriculture. The Village itself does not have any regulations on farming runoff that might contribute to algal blooms.

6.3 HAZARD EVENTS/HISTORICAL OCCURRENCES

There have been no substantial Water Quality incidents that have affected the Village's drinking water supply. Algal blooms in the Upground Reservoir have always been treated in time prior to them becoming a significant issue.

6.4 MAGNITUDE/SEVERITY

Some algae are capable of producing extremely dangerous toxins in the right settings. These can lead to severe illness, or even deaths. The Ohio Department of Health has a guide for the different levels of algae exposure.

Health Problems Exposure to HABs Can Cause in People & Pets

- Drinking/Swallowing HABs-Contaminated Water
- Skin Contact with HABs-Contaminated Water
- Inhaling HABs-Contaminated Water

Drinking/Swallowing HABs-Contaminated Water

- Severe diarrhea and vomiting
- Liver toxicity (abnormal liver function, abdominal pain)
- Kidney toxicity
- Neurotoxicity (weakness, salivation, tingly fingers, numbness, dizziness)
- Difficulty breathing
- Death

Skin Contact with HABs-Contaminated Water

- Rashes
- Hives
- Skin blisters (especially on the lips and under swimsuits)

Inhaling HABs-Contaminated Water

- Runny eyes and nose
- Sore throat
- Asthma-like symptoms
- Allergic reactions

TABLE 4-33 WATER QUALITY ADVISORIES

Type of Advisory
Do Not Drink Advisory for: • Bottle-fed infants and children younger than school age • Pregnant women • Nursing mothers • Individuals with pre-existing liver conditions • Individuals receiving dialysis treatment *As a precautionary measure, the elderly and people with compromised immune systems may want to consider using an alternate water source, as well during this type of advisory.*
Do Not Drink Advisory for: • All people of all ages • Pets • Livestock

6.5 FREQUENCY/PROBABILITY OF FUTURE EVENTS

There have not been a sufficient number of events to be able to determine how often algal blooms occur. However, the Hazard Mitigation Planning Committee determined, based on their own knowledge that these events are "possible," meaning that there is between a 1% and 10% annual-chance of these events occurring.

6.6 POTENTIAL LOSSES FROM WATER QUALITY INCIDENTS

All residents of Ottawa are at risk if there is a large algal bloom that affects drinking water. If concentrations are high enough, a Do Not Drink Advisory would be issues for all those in the Village. Those under the age of 5, and those over the age of 65, should be given fresh drinking bottled drinking water. These age groups make up 805 people out of the 4,424 residing in Ottawa, or approximately 18% of the Village's population. Table 4-34 shows the locations where vulnerable populations are likely to be throughout the Village, including schools, day care facilities, and nursing homes.

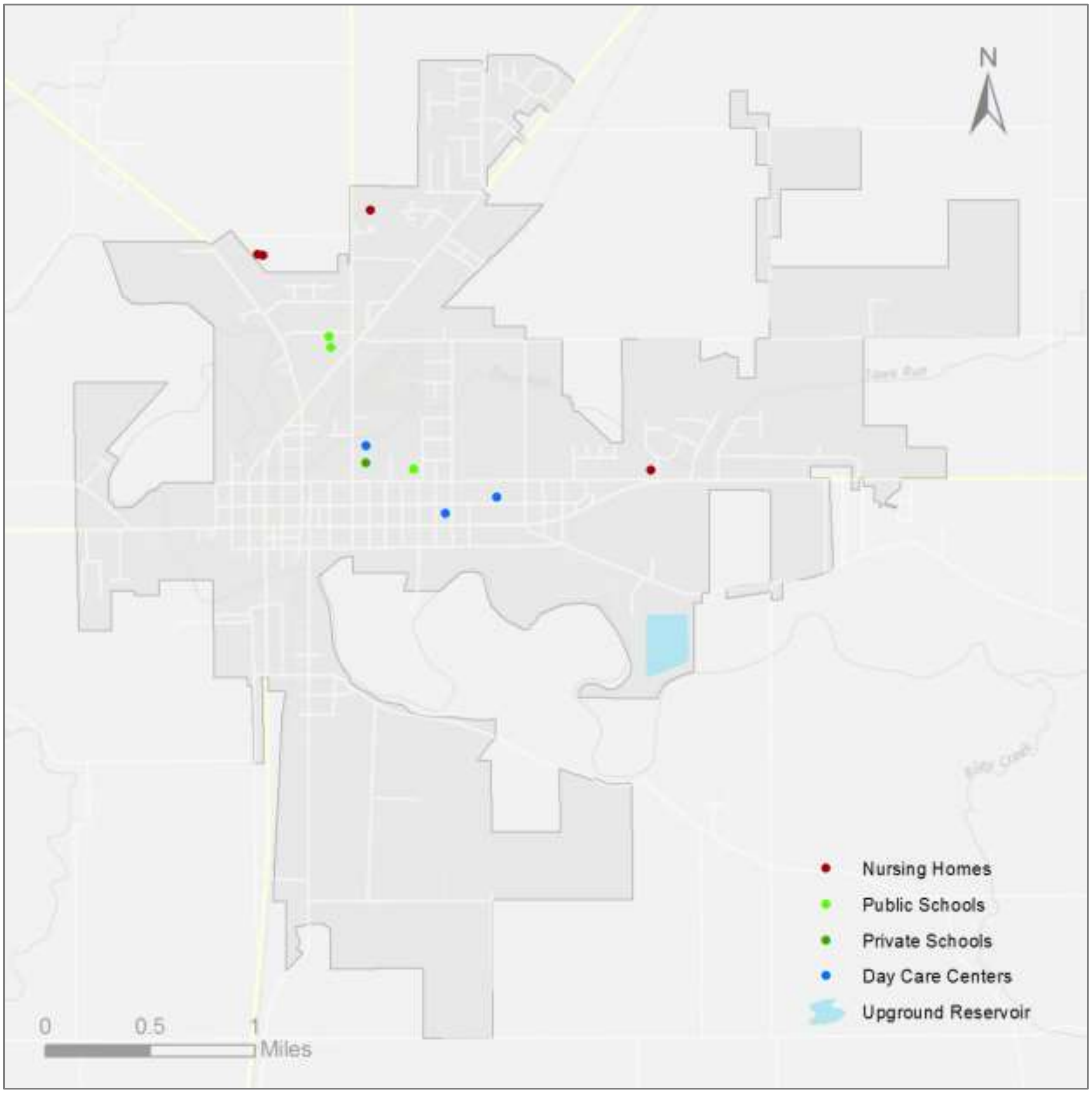
TABLE 4-34 POPULATION VULNERABLE TO ALGAL BLOOMS

Total	Population
Under 5 years	**230**
65 to 69 years	**575**

Land Use & Potential Development

Putnam County is a highly agricultural community, with most of the land being dedicated to farming. This has remained consistent over the past several decades, and is likely to continue for the foreseeable future. Development or redevelopment is not likely to significantly impact the frequency or intensity of algal blooms and water quality events.

FIGURE 4-12 VULNERABLE POPULATION LOCATIONS



Water Quality Incidents HIRA Summary

The Village of Ottawa is heavily reliant upon reservoirs for drinking water. Algal blooms pose a serious threat to the Village should one of them occur in one of these reservoirs and not be treated promptly and with sufficient aggressiveness. Blooms can occur with little to no warning, but are easily managed if they are discovered in time. Reservoirs should be checked regularly to ensure that water for the Village is safe and potable. As development and redevelopment occur, it is important the Village ensures that drinking water quality is sufficient for all of its residents.

7. FLOODING

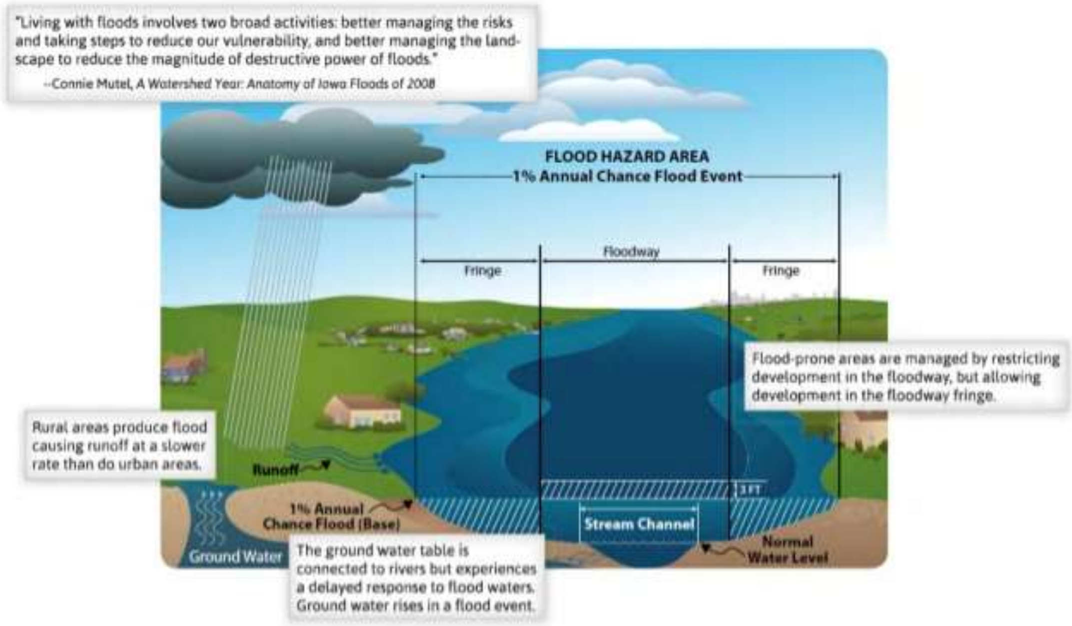
Natural Hazards	Probability		Impact		Spatial Extent		Warning Time		Duration		RF Rating
Flooding	3	0.9	2	0.6	2	0.4	1	0.1	3	0.3	**2.3**
Medium Risk Hazard (2.0 – 2.9)											

7.1 FLOODING CHARACTERISTICS

A flood is a natural event for rivers and streams and occurs when a normally dry area is inundated with water. Excess water from snowmelt or rainfall accumulates and overflows onto the stream banks and adjacent floodplains. Floodplains are lowlands, adjacent to rivers, streams, and creeks that are subject to recurring floods. Flash floods, usually resulting from heavy rains or rapid snowmelt, can flood areas not typically subject to flooding, including urban areas. Extreme cold temperatures can cause streams and rivers to freeze, causing ice jams, and creating flood conditions.

The National Flood Insurance Program (NFIP), for which Flood Insurance Rate Maps (FIRM) are published, identifies the 1% annual chance flood. This 1% annual chance flood event is used to delineate the Special Flood Hazard Area (SFHA) and identify Base Flood Elevations. Figure 4-13 illustrates these terms. The Village of Ottawa does not currently have an updated FIRM panel for its portion of the County.

FIGURE 4-13 DIAGRAM IDENTIFYING THE SPECIAL HAZARD FLOOD AREA



Floods are considered hazards when people and property are affected. Nationwide, hundreds of floods occur each year, making it one of the most common hazards in all 50 states and U.S. territories. In Ohio, flooding occurs commonly and can occur during any season of the year from a variety of sources. Most injuries and deaths from flooding happen when people are swept away by flood currents and most property damage results from inundation by sediment-filled water. Fast-moving water can wash buildings off their foundations and sweep vehicles downstream. Pipelines, bridges, and other infrastructure can be damaged when high water combines with flood debris. Basement flooding can cause extensive damage. Flooding can cause extensive damage to crop lands and bring about the loss of livestock. Several factors determine the severity of floods, including rainfall intensity and duration, topography and ground cover.

- **Riverine flooding** originates from a body of water, typically a river, creek, or stream, as water levels rise onto normally dry land. Water from snowmelt, rainfall, freezing streams, ice flows, or a combination thereof, causes the river or stream to overflow its banks into adjacent floodplains. Winter flooding usually occurs when ice in the rivers creates dams or streams freeze from the bottom up during extreme cold spells. Spring flooding is usually the direct result of melting winter snow packs, heavy spring rains, or a combination of the two.

- **Flash floods** can occur anywhere when a large volume of water flows or melts over a short time period, usually from slow moving thunderstorms or rapid snowmelt. Because of the localized nature of flash floods, clear definitions of hazard areas do not exist. These types of floods often occur rapidly with significant impacts. Rapidly moving water, only a few inches deep, can lift people off their feet, and only a depth of a foot or two, is needed to sweep cars away. Most flood deaths result from flash floods.

- **Urban flooding** is the result of development and the ground’s decreased ability to absorb excess water without adequate drainage systems in place. Typically, this type of flooding occurs when land uses change from fields or woodlands to roads and parking lots. Urbanization can increase runoff two to six times more than natural terrain. (National Oceanic and Atmospheric Administration, 1992) The flooding of developed areas may occur when the amount of water generated from rainfall and runoff exceeds a storm water system's capability to remove it.

- **Stream Bank Erosion** is measured as the rate of the change in the position or horizontal displacement of a stream bank over a period of time. It is generally associated with riverine flooding and discharge, and may be exacerbated by human activities such as bank hardening and dredging.

- **Coastal Erosion** is the wearing-away of land and the removal of beach or dune sediments by wave action, tidal currents, wave currents, drainage, or high winds. Due to its location in Putnam County, away from any large bodies of water, the Village of Ottawa is not susceptible to coastal erosion.

- **Ice Jams** are stationary accumulations of ice that restrict river flow. Ice jams can cause considerable increases in upstream water levels, while at the same time, downstream water levels may drop. Types of ice jams include freeze up jams, breakup jams, or combinations of both. When an ice jam releases, the effects downstream can be similar to that of a flash flood or dam failure. Ice jam flooding generally occurs in the late winter or spring.

Flood reduction, prevention, and mitigation are major challenges to Village of Ottawa residents and its floodplain manager. Many areas of Ottawa are at risk to flooding, especially properties near creeks. Heavy seasonal rainfall, which typically occurs from late October through April, can result in stream overflows.

7.2 REGULATORY ENVIRONMENT

There are numerous laws at the federal, state, and local levels throughout the country regarding floodplain management. The Village of Ottawa continues to work to enforce the local floodplain management ordinance requirements set forth by all flooding programs, including the National Flood Insurance Program.

Flood Mitigation Coalition

As a direct result of the August 2007 flood in the Village of Ottawa, the Blanchard River Flood Mitigation Coalition was formed. This task force was organized to formulate and implement solutions to flooding. A Steering Committee was established to develop a mission and to create additional subcommittees that would work in Preparedness, Recovery, Mitigation and Communications.

Village of Ottawa Building and Floodplain Codes

These regulations authorize a Floodplain Manager/Administrator and duties to be performed. Duties include, but are not limited to, routine monitoring of the floodplains, enforcing floodplain regulations, and providing community assistance, such as encouraging owners to maintain flood insurance.

Local Building Codes

The Village of Ottawa Codified Ordinances, Chapter 1333 specifically deals with the flood hazard present in the Village. The ordinances provide the basis for the Village to establish areas of special flood hazard, establish development standards for flood hazard reduction. In addition, these ordinances provide for the enforcement of the statutes within Chapter 1333.

RiskMAP

Ottawa has not been the recipient of any FEMA RiskMAP projects.

National Flood Insurance Program (NFIP)

The NFIP makes federally-backed flood insurance available to homeowners, renters, and business owners in participating communities. As a participating member of the NFIP, Ottawa is dedicated to protecting homes with 231 NFIP policies currently in force.

TABLE 4-35 VILLAGE OF OTTAWA NFIP STATUS SUMMARY

NFIP Component	Status / Date
CID	390472
Community Name	Village of Ottawa
Initial FHBM Identified	6/7/1974
Initial FIRM Identified	2/15/1979
Current Effective Map Date	1/3/1986 (Expired)
Reg-Emer Date	2/15/1979

The Village of Ottawa entered the NFIP on June 7, 1974. As a participant in the NFIP, Ottawa is dedicated to regulating development in the FEMA floodplain areas in accordance with NFIP criteria. Structures permitted or built in the Village before the NFIP regulatory requirements were incorporated into the ordinances (before the effective date of the Village's FIRM) and are called "pre-FIRM" structures.

A RL property is a FEMA designation defined as an insured property that has made two or more claims of more than $1,000 in any rolling 10-year period since 1978. The term "rolling 10-year period" means that a claim of $1,000 can be made in 1991 and another claim for $2,500 in 2000; or one claim in 2001 and another in 2007, as long as both qualifying claims happen within ten years of each other. Claims must be at least ten days apart but within ten years of each other. RL properties may be classified as a Severe Repetitive Loss (SRL) property under certain conditions. A SRL property has had four or more claims of at least $5,000, or at least two claims that cumulatively exceed the building's reported value. A property that sustains repetitive flooding may or may not be on the Village's RL property list for a number of reasons:

- Not everyone is required to carry flood insurance. Structures carrying federally-backed mortgages that are in a SFHA are required to carry flood insurance in Ottawa;
- Owners who have completed the terms of the mortgage or who purchased their property outright may not choose to carry flood insurance and instead bear the costs of recovery on their own;
- The owner of a flooded property that does carry flood insurance may choose not to file a claim;

- Even insured properties that are flooded regularly with filed claims may not meet the $1,000 minimum threshold to be recognized as an RL property; or
- The owner adopted mitigation measures that reduce the impact of flooding on the structure, removing it from the RL threat, and the RL list (in accordance with FEMA's mitigation reporting requirements).

According to the Ohio Emergency Management Agency, there are 28 Repetitive Loss (RL) properties insured by the NFIP in the Village of Ottawa, 23 of which are residential, and 5 are non-residential. 5 properties, all residential, are in the process of being mitigated. 11 properties have been mitigated in the past. There are no severe repetitive loss properties in Ottawa.

Extensive FEMA NFIP databases are used to track claims for every participating community. FEMA databases maintain all NFIP claims which allow for the examination of single-loss (SL) properties and RL properties.

TABLE 4-36 VILLAGE OF OTTAWA NFIP POLICIES

Community Name	Policies In-force	Insurance In-Force	Premium In-force
Village of Ottawa	231	$35,246,700	$208,021

TABLE 4-37 VILLAGE OF OTTAWA REPETITIVE LOSS PROPERTIES

Municipality	CID	Structure Type	Properties
Ottawa	390472	Residential	23
Ottawa	390472	Non-Residential	5

7.3 HAZARD EVENTS

According to the NCDC, since 1997, there have been 17 flood or flash flood events in Putnam County, which have resulted in one death. These events have caused a total of $780,000 in property damage, and $100,000 in crop damage.

TABLE 4-38 FLOOD EVENTS SINCE 1997

Location	Date	Type	Deaths	Injuries	Property Damage	Crop Damage
Putnam (Zone)	2/27/1997	Flood	0	0	0.00K	0.00K
Putnam (Zone)	3/1/1997	Flood	0	0	0.00K	0.00K
Ottawa	5/25/1997	Flash Flood	0	0	10.00K	0.00K
Putnam (Zone)	5/26/1997	Flood	0	0	0.00K	0.00K
Putnam (Zone)	6/1/1997	Flood	0	0	0.00K	0.00K
Countywide	6/1/1997	Flash Flood	0	0	5.00K	0.00K
Ottawa	7/8/1997	Flash Flood	0	0	10.00K	0.00K

Location	Date	Type	Deaths	Injuries	Property Damage	Crop Damage
Putnam (Zone)	7/9/1997	Flood	0	0	0.00K	0.00K
Ottawa	8/16/1997	Flash Flood	0	0	5.00K	0.00K
Putnam (Zone)	1/8/1998	Flood	0	0	0.00K	0.00K
Continental	8/5/1998	Flash Flood	0	0	250.00K	100.00K
Continental	4/20/2000	Flood	0	0	0.00K	0.00K
Leipsic Jct	8/22/2007	Flash Flood	0	0	500.00K	0.00K
Glandorf	3/10/2009	Flood	1	0	0.00K	0.00K
Glandorf	5/27/2010	Flash Flood	0	0	0.00K	0.00K
Cloverdale	6/15/2015	Flood	0	0	0.00K	0.00K
Cloverdale	6/16/2015	Flash Flood	0	0	0.00K	0.00K
Totals: 17 Events			**1**	**0**	**780.00K**	**100.00K**

7.4 HISTORICAL OCCURRENCES

The Village of Ottawa has been a part of 4 Federal Disaster Declarations that included flooding. Two resulted in public assistance. There have been no instances of individual assistance being given as a result of a flood event.

TABLE 4-39 DECLARED DISASTERS AFFECTING OTTAWA

Disaster Number	Declaration Date	Title	Public Assistance
DR-1720	8/27/2007	Severe Storms, Flooding, and Tornadoes	$ 2,279,164.76
DR-1580	2/15/2005	Severe Winter Storms, Flooding, and Mudslides	$ 8,429.64
DR-1556	9/19/2004	Severe Storms and Flooding	-
DR-642	6/30/1981	Severe Storms, Flooding, and Tornadoes	-

August 5, 1998 – Flash Flood: The same storm system which had plagued parts of eastern Indiana the night before with very heavy rain shifted its focus into northwest Ohio the night of August 5. A warm top heavy rain event developed late in the afternoon of the 5th as thunderstorms developed along a warm front which stretched from the surface low now in western Illinois into northwest Ohio. Storms continued to backbuild along the front towards the theta-e ridge which extended from central Illinois into northern Indiana and train across the same areas in northwest Ohio into the morning of the 6th. Several locations from Paulding to Napoleon received from 3 to 7 inches of rain.

August 22, 2007 – Flash Flood: Several rounds of moderate to heavy rainfall occurred across parts of northwestern Ohio, beginning early on the 20th and continuing through the 22nd. Much of this rainfall fell into the Maumee River basin, with the Blanchard River near Ottawa suffering the worst effects of the rainfall, which totaled upwards of 15 inches in some areas. Flooding started out rather general across much of the county with numerous road closures and some evacuations. However, the greatest damage occurred in and around the town of Ottawa which was completely underwater as a result of a near record crest of the Blanchard River at 31.7 feet. The most recent crest which caused significant flooding of the town was June 15, 1981 when the river crested at 29.75 feet. The record crest for this site is 33.3 feet set on March 13, 1913.

March 10, 2009 – Flooding: Several systems moved across the area, bringing with them not only some severe weather in spots, but areas of flooding as well. Rainfall amounts through this period averaged between two and four inches in many locations. Numerous counties reported high water on roads, but much of this flooding was in areas that tend to flood easily. At least one fatality occurred as a result of the flood waters when a truck was swept off a road by the Blanchard River in Putnam County, near Glandorf. It appears the driver of the truck attempted to escape and was swept away by the flood waters. Flood waters from the Blanchard River, near Glandorf, caused a truck to be swept off the road on Road 15, north of Road J. Investigators believe that the driver exited the truck attempting to escape the flood water and was swept away. The body of the 74 year old male was recovered about 900 yards from the truck a few days after flood waters receded.

7.5 MAGNITUDE/SEVERITY

Magnitude and severity of flooding generally results from prolonged heavy rainfall and are characterized by high intensity, short duration events. Floods usually occur during the season of highest precipitations or during heavy rainfalls after long dry spells. Widespread storms over the region can occur anytime from September through April. Flooding is more severe when the ground is frozen and infiltration is minimal due to saturated ground conditions, or when rain-on-snow in the higher elevations adds snowmelt to rainfall runoff, resulting in intensified flood conditions.

Cloudburst storms, sometimes lasting as long as 3 hours, can occur over the region anytime from late spring to early fall. They also may occur as extremely severe sequences within general winter rainstorms or during unseasonable rains. The intensity of cloudburst storms is very high, and the storms can produce enough precipitation to result in significant runoff.

Surface flooding, including some street flooding, can occur during severe storms. Reports of minor flooding to garages and outbuildings, landscape erosion, and flooded streets have occurred in and around the Village. Trash and other debris can also be found obstructing culvert and pipe openings during even moderate flows in smaller channels, which can lead to clogging, obstruction, and eventual flooding of nearby properties.

Flood Warning and Notification

The magnitude and severity of flood damage can be reduced with longer periods of warning time and proper notification before flood waters arrive. Warning times of 12 hours or more have proven adequate for preparing communities for flooding and reducing flood damages. More than 12 hours advance warning of a flood can reduce a community's flood damage by approximately 40% in comparison with unprepared communities (Read Sturgess and Associates 2000). In addition, seasonal notification for flooding can enhance awareness for residents at risk, and when communicated effectively advance notification can reach target audiences on a large scale. The Village of Ottawa and Putnam County coordinate with the National Weather Service.

Blanchard River Characteristics

Information on historical floods along the Blanchard River was obtained from stream gauging stations maintained by NOAA. Table 4-40 shows the flood stage categories as determined by the National Oceanic and Atmospheric Administration and the National Weather Service (NWS).

There is a USGS river gage located near where the Blanchard River runs underneath S. Oak St. in Ottawa. This gage provides discharge information, historic crests, recent crests, flood categories, as well as river height, in feet. Historical Crests for the ten largest floods of record for the Blanchard River at Ottawa are shown below. To date, the highest crest reached 33.30 feet during the Flood of 1913, a time when much of the State of Ohio experienced heavy flooding.

TABLE 4-40 HIGHEST HISTORICAL CRESTS ON THE BLANCHARD RIVER

Crest Feet	Date of Crest
33.30	03/13/1913
31.40	08/23/2007
29.75	06/15/1981
29.72	02/11/1959
29.29	02/07/2008
28.85	12/23/2013
28.72	03/09/2009
28.46	03/02/2011
28.40	06/02/1997
27.31	04/13/2013

TABLE 4-41 FLOOD STATE CATEGORIES FOR THE BLANCHARD RIVER

Flood Categories	Feet
Action Stage:	20
Flood Stage:	23
Moderate Flood Stage:	27
Major Flood Stage:	30

7.6 FREQUENCY/PROBABILITY OF FUTURE OCCURRENCES

Reported flood events over the past 19 years provide an acceptable framework for determining the future occurrence in terms of frequency for such events. The probability of the Village experiencing a flood event can be difficult to quantify, but based on historical record of 70 flood events since 1996, it can reasonably be assumed that this type of event has occurred once every 1.23 years from 1996 through 2017.

(**2017** CY) - (**1996** HY) = **21 Years on Record**

(**21 Years**) / (**17 Events**) = **1.23 Years Between Events**

Furthermore, the historic frequency calculates that there is an 81% chance of this type of event occurring each year.

The HMPC, based on their knowledge, determined that flood events are "Likely," meaning they have between a 10% and 100% annual chance of occurring.

7.7 INVENTORY ASSETS EXPOSED TO FLOODING

The method used in determining the types and numbers of potential assets exposed to flooding was conducted using a loss estimation model called HAZUS-MH. HAZUS-MH is a regional multi-hazard loss estimation model that was developed by the FEMA and the National Institute of Building Sciences (NIBS). For this Plan, a 100-year flood scenario was modeled and the results are presented below.

Hazus-MH 100-Year Flood Scenario

Hazus estimates that about 25 buildings will be at least moderately damaged. This is over 73% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The tables below summarize the expected damage by general occupancy for the buildings and the expected building damage by building type in the study region.

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 12.69 million dollars. 1% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 44.98% of the total loss.

FIGURE 4-14 EXPECTED BUILDING DAMAGE BY OCCUPANCY

Occupancy	1-10 Count	1-10 (%)	11-20 Count	11-20 (%)	21-30 Count	21-30 (%)	31-40 Count	31-40 (%)	41-50 Count	41-50 (%)	Substantially Count	Substantially (%)
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	33	56.90	25	43.10	0	0.00	0	0.00	0	0.00	0	0.00
Total	**33**		**25**		**0**		**0**		**0**		**0**	

FIGURE 4-15 EXPECTED BUILDING DAMAGE BY OCCUPANCY

Building Type	1-10 Count	1-10 (%)	11-20 Count	11-20 (%)	21-30 Count	21-30 (%)	31-40 Count	31-40 (%)	41-50 Count	41-50 (%)	Substantially Count	Substantially (%)
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	2	40	3	60	0	0	0	0	0	0	0	0
Steel	0	0	0	0	0	0	0	0	0	0	0	0
Wood	31	58	22	42	0	0	0	0	0	0	0	0

FIGURE 4-16 EXPECTED BUILDING DAMAGE BY TYPE

Building Type	1-10 Count	1-10 (%)	11-20 Count	11-20 (%)	21-30 Count	21-30 (%)	31-40 Count	31-40 (%)	41-50 Count	41-50 (%)	Substantially Count	Substantially (%)
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	2	40	3	60	0	0	0	0	0	0	0	0
Steel	0	0	0	0	0	0	0	0	0	0	0	0
Wood	31	58	22	42	0	0	0	0	0	0	0	0

FIGURE 4-17 HAZUS DETERMINED CRITICAL FACILITIES IN OTTAWA THAT ARE FLOOD PRONE

Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	2	0	0	0
Hospitals	0	0	0	0
Police Stations	3	0	0	0
Schools	6	0	0	0

The scenario reports that no essential facilities in the study region will experience moderate damage by a 100-year flood event, and one will suffer a loss of use. Critical facilities are essential to the health and welfare of the whole population and are especially important following hazard events. Please note that HAZUS refers to these buildings as “essential.” The definition of these facilities may differ between the County and what HAZUS refers to as essential.

Hazus-MH 100-Year Flood Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 268 tons of debris will be generated. Of the total amount, Finishes comprises 97% of the total, Structure comprises 1% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 11 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Hazus-MH 100-Year Flood Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 220 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 229 people (out of a total population of 7,845 in the census tract) will seek temporary shelter in public shelters.

7.8 POTENTIAL LOSSES FROM FLOODING

All assets are considered at risk from flooding; however, losses may vary widely depending on the type and factors contributing to the flood. To examine the potential losses from a flood, Ottawa modeled a 100-year flood using FEMA’s loss estimation tool: HAZUS-MH.

Hazus estimates that there are 3,294 buildings in the region which have an aggregate total replacement value of 946 million (2014 dollars). Figure 4-18 through Figure 4-20 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively.

FIGURE 4-18 BUILDING EXPOSURE BY OCCUPANCY TYPE FOR THE STUDY REGIONS

Occupancy	Exposure ($1000)	Percent of Total
Residential	666,205	70.5%
Commercial	153,533	16.2%
Industrial	70,876	7.5%
Agricultural	8,712	0.9%
Religion	16,668	1.8%
Government	11,762	1.2%
Education	17,868	1.9%
Total	**945,624**	**100.0%**

FIGURE 4-19 BUILDING EXPOSURE BY OCCUPANCY TYPE FOR THE SCENARIO

Occupancy	Exposure ($1000)	Percent of Total
Residential	242,131	67.2%
Commercial	50,499	14.0%
Industrial	53,619	14.9%
Agricultural	4,059	1.1%
Religion	3,398	0.9%
Government	5,309	1.5%
Education	1,287	0.4%
Total	**360,302**	**100.0%**

FIGURE 4-20 BUILDING-RELATED ECONOMIC LOSS ESTIMATES

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	4.06	0.72	0.66	0.15	5.59
	Content	1.70	2.44	1.70	0.87	6.72
	Inventory	0.00	0.03	0.30	0.04	0.37
	Subtotal	**5.76**	**3.19**	**2.67**	**1.07**	**12.69**
Business Interruption						
	Income	0.00	0.02	0.00	0.00	0.02
	Relocation	0.00	0.00	0.00	0.00	0.00
	Rental Income	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.01	0.00	0.10	0.11
	Subtotal	**0.00**	**0.03**	**0.00**	**0.10**	**0.13**
ALL	**Total**	**5.76**	**3.22**	**2.67**	**1.17**	**12.82**

FIGURE 4-21 100-YEAR SFHA DEBRIS GENERATION

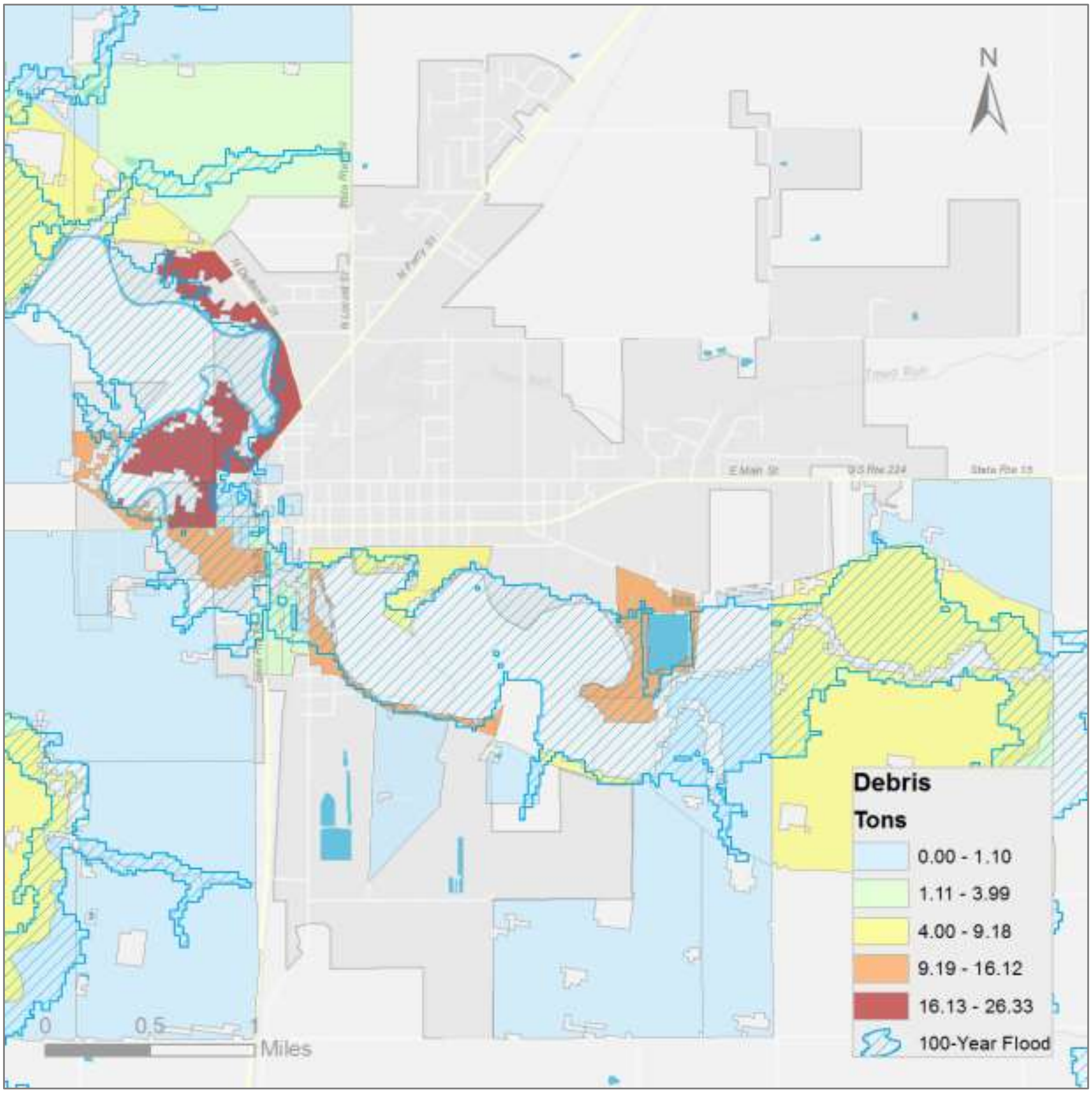


FIGURE 4-22 100-YEAR SFHA TOTAL ECONOMIC LOSS

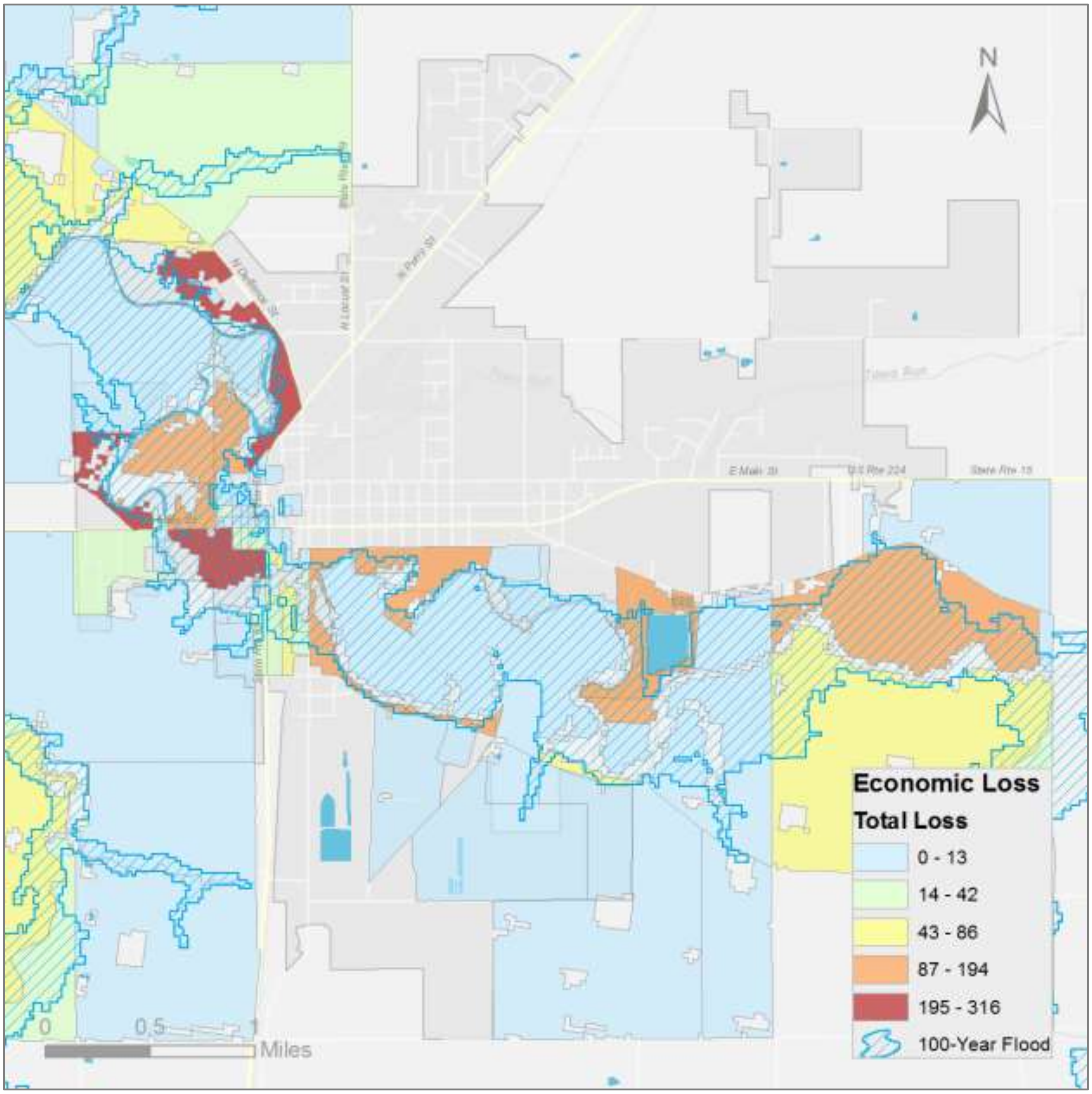
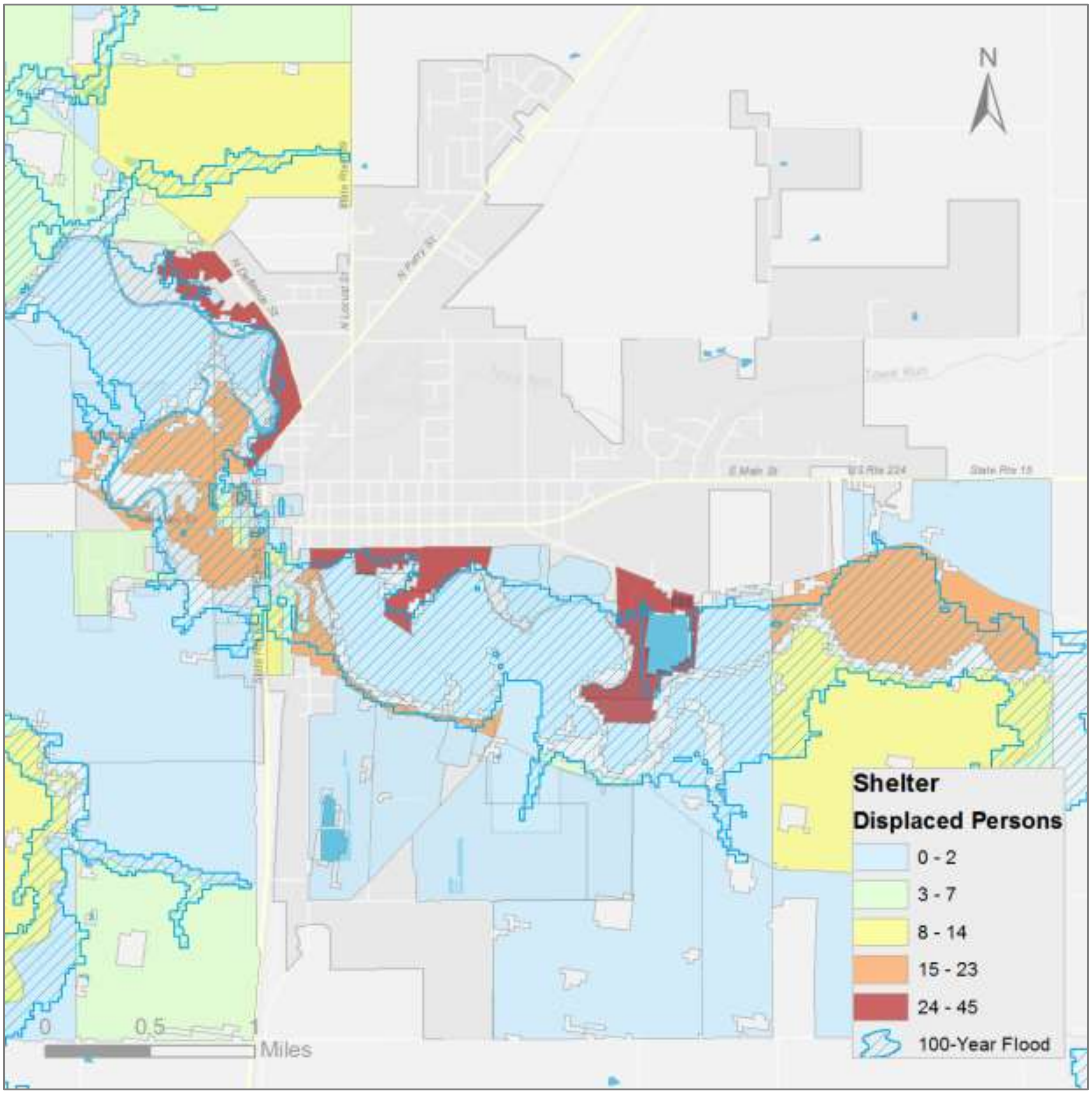


FIGURE 4-23 100-YEAR SFHA SHELTER REQUIREMENTS



The entire Village is susceptible to flooding, either directly or through cleanup efforts and lasting economic impacts. Those closest to the Blanchard River will be actual river waters. It is still possible for the rest of the Village to be affected by localized flash flooding.

7.9 LAND USE & DEVELOPMENT TRENDS

The Village of Ottawa is largely developed within its borders, with the majority of the land being covered by single family housing units. Besides the localized flooding, there is also the great amount of property, both private and public that is at risk from flooding. It is essential that land use plans take into account not only the dollar amount of damage that buildings near waterways could incur, but also the added risk of flood debris and narrowing the floodplains by building close to the rivers.

7.10 FLOODING HIRA SUMMARY

Severe flooding has the potential to inflict significant damage along the river and small creeks that run throughout the Village. Assessing flood damage requires residents throughout the Village to remain alert and notify local officials of potential flood prone areas near infrastructure such as roads, bridges, and buildings. While flooding remains a highly likely occurrence for the Village, smaller floods caused by heavy rains and inadequate drainage capacity will be more frequent, but not as costly as the large-scale floods which may occur at much less frequent intervals. While the potential for flood is always present, the Village does have policies and regulations for development that should help lessen potential damage due to floods.

8. DROUGHT

Natural Hazards	Probability		Impact		Spatial Extent		Warning Time		Duration		RF Rating
Drought	2	0.6	1	0.3	4	0.8	1	0.1	4	0.4	**2.2**
Medium Risk Hazard (2.0 – 2.9)											

8.1 DROUGHT CHARACTERISTICS

Drought is a normal, recurrent, feature of climate and originates from a deficiency of precipitation over an extended period, usually one or more seasons. Drought can result in a water shortage for some activity, group, or environmental sector. Drought is a complex natural hazard, which is reflected in the following four definitions commonly used to describe it:

- **Agricultural:** Defined principally in terms of naturally occurring soil moisture deficiencies relative to water demands of plant life, usually arid crops.
- **Hydrological:** Related to the effects of precipitation shortfalls on stream flows and reservoir, lake, and groundwater levels.
- **Meteorological:** Defined solely on the degree of dryness, expressed as a departure of actual precipitation from an expected average or normal amount based on monthly, seasonal, or annual time scales.
- **Socio-economic:** Associates the supply and demand of economic goods or services with elements of meteorological, hydrologic, and agricultural drought. Socioeconomic drought occurs when the demand for water exceeds the supply as a result of weather-related supply shortfall. It may also be called a water management drought.

Although climate is a primary contributor to hydrological drought, other factors such as changes in land use (e.g., deforestation), land degradation, and the construction of dams all affect the hydrological characteristics of a particular region. Since regions are interconnected by natural systems, the impact of meteorological drought may extend well beyond the borders of the precipitation-deficient area. Changes in land use upstream may alter hydrologic characteristics such as infiltration and runoff rates, resulting in more variable stream flow and a higher incidence of hydrologic drought downstream. Land use change is one way human actions alter the frequency of water shortage even when no change in precipitation has been observed.

Drought risk is assessed based on a combination of the frequency, severity, and spatial extent (the physical nature of drought) and the degree to which a population or activity is vulnerable to the effects of drought. The degree of the Village's vulnerability to drought depends on the environmental and social characteristics of the region and is measured by its ability to anticipate, cope with, resist, and recover from drought.

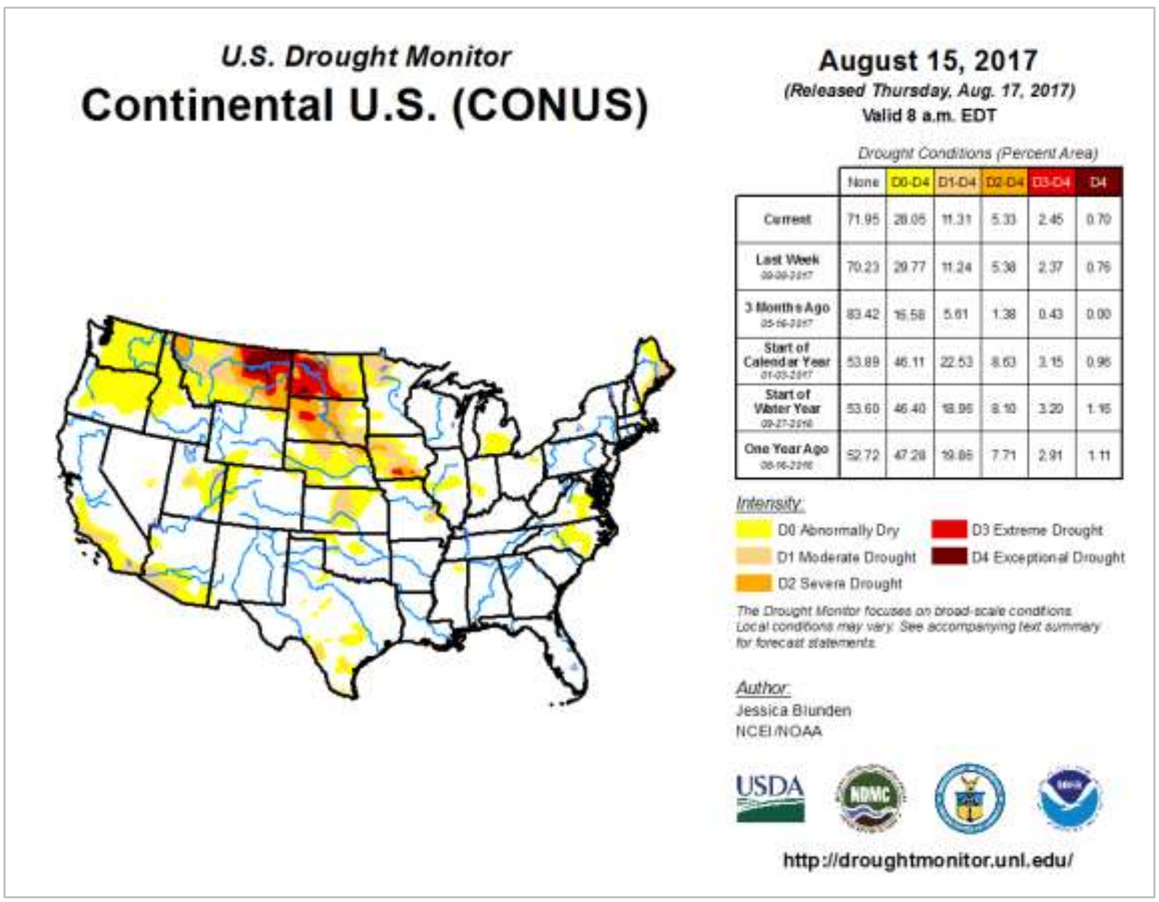
Because drought is usually considered a regional hazard, it is not enhanced or analyzed by Village- or County-level mapping. Mapping of the current drought status is published by the National Integrated Drought Information System (NIDIS).

According to the NCDC, there have been no recorded drought events in Putnam County. However, in 2012, extremely dry conditions pushed into the month of September. These same dry conditions had persisted for most of the month resulting in crop losses throughout Ohio.

The 2012-2013 North American droughts began in the spring of 2012, when the lack of snow in the continental United States resulted in very little melt water being absorbed into the soil. Drought conditions were experienced almost nationwide. Multiple Ohio counties were designated as being in a moderate drought condition by June. The Governor of Ohio sent a memorandum to the USDA State Executive Director requesting primary county natural disaster designations for eligible counties due to agricultural losses caused by drought. The USDA reviewed this memorandum and determined that there were sufficient production losses in 85 counties to warrant a Secretarial disaster designation.

Figure 4-24 is an example map from the US Drought Monitor. These maps are updated on a regular basis.

FIGURE 4-24 EXAMPLE US DROUGHT MONITOR MAP



8.2 DROUGHT IMPACT CATEGORIES

Agriculture: Impacts associated with agriculture, farming, and ranching. Examples of drought-induced agricultural impacts include: damage to crop quality; income loss for farmers due to reduced crop yields; reduced productivity of cropland (due to wind erosion, long-term loss of organic matter, etc.); insect infestation; plant disease; increased irrigation costs; costs of new or supplemental water resource development (wells, dams, pipelines); reduced productivity of rangeland; forced reduction of foundation stock; closure/limitation of public lands to grazing; high cost/unavailability of water for livestock; and range fires.

Water/Energy: Impacts associated with surface or subsurface water supplies (i.e., reservoirs or aquifers), stream levels or stream flow, hydropower generation, or navigation. Examples of drought-induced water/energy impacts include: lower water levels in reservoirs, lakes, and ponds; reduced flow from springs; reduced stream flow; loss of wetlands; estuarine impacts (e.g., changes in salinity levels); increased groundwater depletion, land subsidence, reduced recharge; water quality effects (e.g., salt concentration, increased water temperature, pH, dissolved oxygen, turbidity); revenue shortfalls and/or windfall profits; cost of water transport or transfer; cost of new or supplemental water resource development; loss from impaired navigability of streams, rivers, and canals.

Environment: Impacts associated with wildlife, fisheries, forests, and other fauna. Examples of drought-induced environment impacts include: loss of biodiversity of plants or wildlife; loss of trees from urban landscapes, shelterbelts, wooded conservation areas; reduction and degradation of fish and wildlife habitat; lack of feed and drinking water; greater mortality due to increased contact with agricultural producers, as animals seek food from farms and producers are less tolerant of the intrusion; disease; increased vulnerability to predation (from species concentrated near water); migration and concentration (loss of wildlife in some areas and too many wildlife in other areas); and increased stress to endangered species.

Fire: Impacts associated with forest and range fires that occur during drought events. The relationship between fires and droughts is very complex. Not all fires are caused by droughts and serious fires can result when droughts are not taking place.

Social: Impacts associated with the public, or the recreation/tourism sector. Examples of drought-induced social impacts include: health-related low-flow problems (e.g., cross-connection contamination, diminished sewage flows, increased pollutant concentrations, reduced firefighting capability, etc.); loss of human life (e.g., from heat stress, suicides); public safety from forest and range fires; increased respiratory ailments; increased disease caused by wildlife concentrations; population migrations (rural to urban areas, migrants into the United States); loss of aesthetic values; reduction or modification of recreational activities; losses to manufacturers and sellers of recreational equipment; losses related to curtailed activities (hunting and fishing, bird watching, boating, etc.).

8.3 REGULATORY ENVIRONMENT

There are negligible formal regulations that pertain to drought events.

8.4 HAZARD EVENTS/HISTORICAL OCCURENCES

The Village of Ottawa, and Putnam County as a whole, have been in 2 notable droughts in recent years.

Drought of 2012: The first is the aforementioned occurrence in 2012. While NOAA and its National Climactic Database do not list a drought in 2012, there were nationwide drought conditions observed that year. The 2012-2013 North American droughts began in the spring of 2012, when the lack of snow in the continental United States resulted in very little melt water being absorbed into the soil. Drought conditions were experienced almost nationwide. Multiple Ohio counties were designated as being in a moderate drought condition by June. The Governor of Ohio sent a memorandum to the USDA State Executive Director requesting primary county natural disaster designations for eligible counties due to agricultural losses caused by drought. The USDA reviewed this memorandum and determined that there were sufficient production losses in eighty-five counties to warrant a Secretarial disaster designation.

Drought of 2016: The second drought occurred from July through August of 2016. During this time, there was little rain, and approximately 15% of the state was labeled as being in "severe drought" status. As a result of the drought in the early summer months, only 45% of corn, and 54% of soybeans rated good or better. The drought ended in August, which, after heavy rains, ended up being a wetter than normal month.

No injuries, death, or property damage has been recorded as a result of drought in the Village of Ottawa.

8.5 MAGNITUDE/SEVERITY

The Palmer Drought Severity Index (PDSI) was developed by Wayne Palmer in the 1960s and uses temperature and rainfall information in a formula to determine dryness. It has become the semi-official drought index. The Palmer Index is most effective in determining long term drought—a matter of several months—and is not as good with short-term forecasts (a matter of weeks). It uses a 0 as normal, and drought is shown in terms of minus numbers; for example, minus 2 is moderate drought, minus 3 is severe drought, and minus 4 is extreme drought.

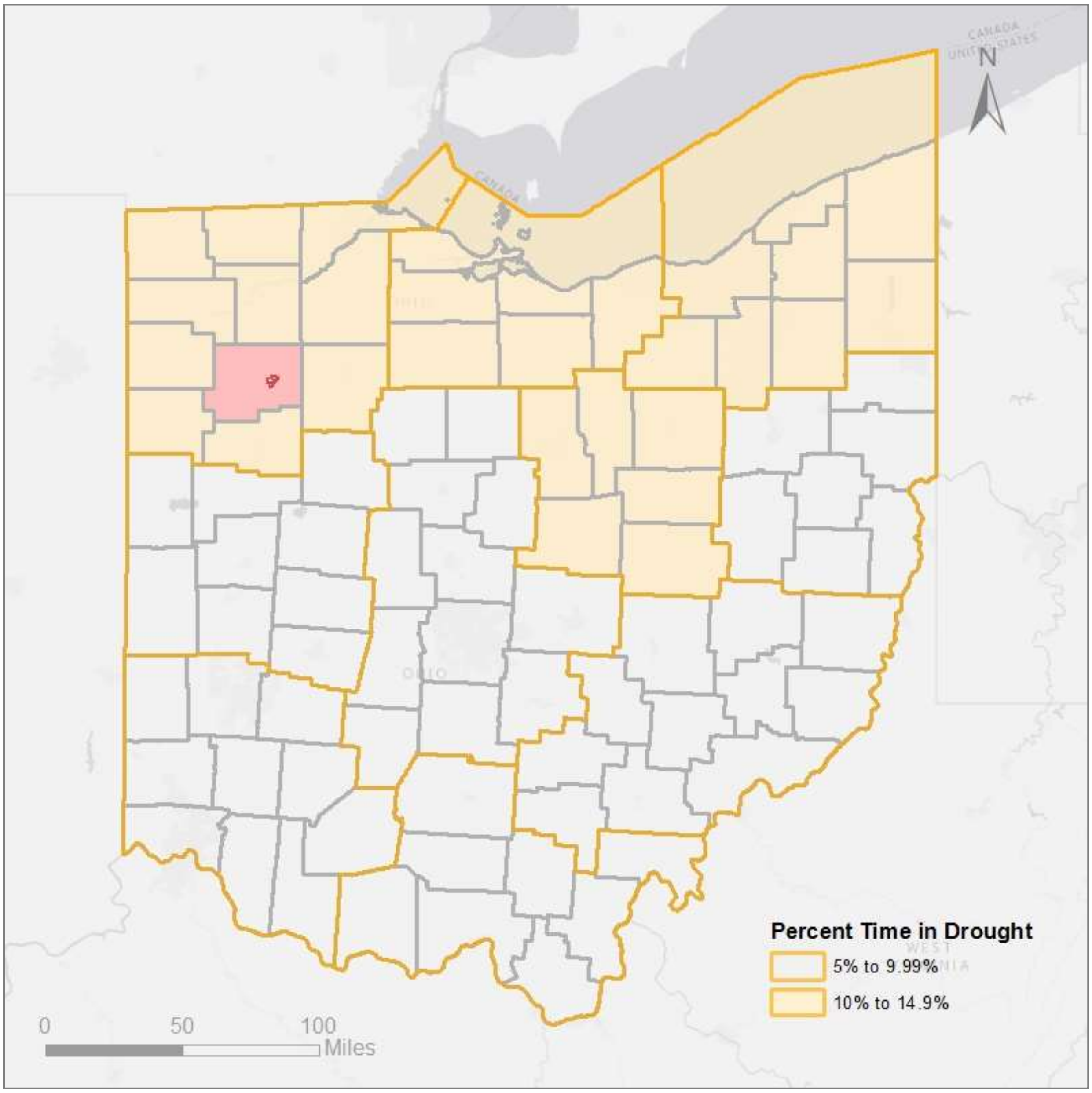
TABLE 4-42 PALMER DROUGHT SEVERITY INDEX

Drought Severity	Return Period (Years)	Description of Possible Impacts	Drought Monitoring Indices		
			Standardized Precipitation Index (SPI)	NDMC* Drought Category	Palmer Drought Index
Minor Drought	3 to 4	Going into drought; short-term dryness slowing growth of crops or pastures; fire risk above average. Coming out of drought; some lingering water deficits; pastures or crops not fully recovered.	-0.5 to -0.7	D0	-1.0 to -1.9
Moderate Drought	5 to 9	Some damage to crops or pastures; fire risk high; streams, reservoirs, or wells low, some water shortages developing or imminent, voluntary water use restrictions requested.	-0.8 to -1.2	D1	-2.0 to -2.9
Severe Drought	10 to 17	Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed	-1.3 to -1.5	D2	-3.0 to -3.9
Extreme Drought	18 to 43	Major crop and pasture losses; extreme fire danger; widespread water shortages or restrictions	-1.6 to -1.9	D3	-4.0 to -4.9
Exceptional Drought	44 +	Exceptional and widespread crop and pasture losses; exceptional fire risk; shortages of water in reservoirs, streams, and wells creating water emergencies	Less than -2	D4	-5.0 or less

Drought severity depends on numerous factors, including duration, intensity, and geographic extent, as well as regional water supply demands by humans and vegetation. The severity of drought can be aggravated by other climatic factors, such as prolonged high winds and low relative humidity. The magnitude of drought is usually measured in time and the severity of the hydrologic deficit.

Several resources are available to evaluate drought status and estimate future expected conditions. The National Integrated Drought Information System (NIDIS) Act of 2006 (Public Law 109-430) prescribes an interagency approach for drought monitoring, forecasting, and early warning. The NIDIS maintains the U.S. Drought Portal (www.drought.gov), a web-based access point to several drought related resources. Resources include the U.S. Drought Monitor (USDM) and the U.S. Seasonal Drought Outlook (USSDO).

FIGURE 4-25 PERCENT TIME SPENT IN DROUGHT BY COUNTY



8.6 FREQUENCY/PROBABILITY OF FUTURE OCCURRENCES

Drought conditions are likely to become more frequent and persistent over the 21st century due to climate change. Drought related to climate change will increase pressure on Ohio water resources. Decreasing snowmelt and spring stream flows coupled with increasing populations, anticipated hotter climate, and demand for water in southern portions of Ohio may lead to water shortages for residents.

Due to the nature of drought, it is extremely difficult to predict, but through identifying various indicators of drought, and tracking these indicators, it provides us with a crucial means of monitoring drought. Understanding the historical frequency, duration, and spatial extent of drought assists in determining the likelihood and potential severity of future droughts. The characteristics of past droughts provide benchmarks for projecting similar conditions into the future. The probability of the Village experiencing a drought event can be difficult to quantify, but based on historical record of 2 recorded droughts since 2012, it can be stated that this type of event has occurred once every 2.5 years from 2012 through 2017.

(**2017** CY) - (**2012** HY) = **5 Years on Record**

(**5 Years**) / (**2 Events**) = **2.5 Years Between Events**

Furthermore, the historic frequency calculates that there is a 40% chance of this type of event occurring each year.

The National Oceanic and Atmospheric Administration Paleoclimatology Program studies drought by analyzing records from tree rings, lake and dune sediments, archaeological remains, historical documents, and other environmental indicators to obtain a broader picture of the frequency of droughts in the United States. According to their research, "…paleoclimatic data suggest that droughts as severe as the 1950's drought have occurred in central North America several times a century over the past 300-400 years, and thus we should expect (and plan for) similar droughts in the future. The paleoclimatic record also indicates that droughts of a much greater duration than any in the 20th century have occurred in parts of North America as recently as 500 years ago." Based on this research, the 1950's drought situation could be expected approximately once every 50 years or a 20% chance every ten years. An extreme drought, worse than the 1930's "Dust Bowl," has an approximate probability of occurring once every 500 years or a 2% chance of occurring each decade. (NOAA, 2003) A 500-year drought with a magnitude similar to that of the 1930's that destroys the agricultural economy and leads to wildfires is an example of a high magnitude event.

Impacts to vegetation and wildlife can include death from dehydration and spread of invasive species or disease because of stressed conditions. However, drought is a natural part of the environment in Ohio and native species are likely to be adapted to surviving periodic drought conditions. It is unlikely that drought would jeopardize the existence of rare species or vegetative communities.

Environmental impacts are more likely at the interface of the human and natural world. The loss of crops or livestock due to drought can have far-reaching economic effects. Wind and water erosion can alter the visual landscape and dust can damage property. Water-based recreational resources are affected by drought conditions. Indirect impacts from drought arise from wildfire, which may have additional effects on the landscape and sensitive resources such as historic or archeological sites.

8.7 INVENTORY ASSETS AND POTENTIAL LOSSES DUE TO DROUGHT

Drought typically does not have a direct impact on critical facilities or structures. However, possible losses/impacts to critical facilities include the loss of critical function due to low water supplies. Severe droughts can negatively affect drinking water supplies. Should a public water system be affected, the losses could total into the millions of dollars if outside water is shipped in. Private springs/wells could also dry up. Possible losses to infrastructure include the loss of potable water.

Droughts slowly evolve over time and the population typically has ample time to prepare for its effects. Should a drought affect the water available for public water systems or individual wells, the availability of clean drinking water could be compromised. This situation would require emergency actions and could possibly overwhelm the local government and financial resources.

Droughts are not likely to impact structures or infrastructure. The prolonged absence of precipitation is more likely to have an impact on agricultural operations than on more urban settings. While the Village's infrastructure may not be susceptible to the effects of a drought, the agricultural program's various project areas may be impacted.

8.8 POTENTIAL LOSSES FROM DROUGHT

Due to the nature of drought, all property in the Village is expected to be impacted equally due to drought conditions. Agricultural land outside of the Village limits will take the brunt of the losses incurred by Drought.

TABLE 4-43 VILLAGE ASSETS VULNERABLE TO DROUGHT

Class	Number	Total Cost	1% Damage	5% Damage
Residential	1,911	$ 171,813,349.00	$ 1,718,133.49	$ 8,590,667.45
Critical Facilities				
Day Care	3	$ 1,445,914.00	$ 14,459.14	$ 72,295.70
Education	3	$ 14,971,229.00	$ 149,712.29	$ 748,561.45
Fire Station	3	$ 986,800.00	$ 9,868.00	$ 49,340.00
Government	5	$ 8,461,400.00	$ 84,614.00	$ 423,070.00
Medical	4	$ 20,657,200.00	$ 206,572.00	$ 1,032,860.00
Police	2	$ 5,781,686.00	$ 57,816.86	$ 289,084.30
Religious	7	$ 3,639,486.00	$ 36,394.86	$ 181,974.30
Utility	2	$ 13,040,057.00	$ 130,400.57	$ 652,002.85
CRIT. FACILITY TOTAL	**29**	**$ 68,983,772.00**	**$ 689,837.72**	**$ 3,449,188.60**
Total Value				
Grand Total	**1,940**	**$ 240,797,121.00**	**$ 2,407,971.21**	**$ 12,039,856.05**

8.9 LAND USE & DEVELOPMENT TRENDS

Society's vulnerability to drought is affected by (among other things) population growth and shifts, urbanization, demographic characteristics, technology, water use trends, government policy, social behavior, and environmental awareness. These factors are continually changing, and society's vulnerability to drought may rise or fall in response to these changes. For example, increasing and shifting populations put increasing pressure on water and other natural resources - more people need more water.

Future development's greatest impact on the drought hazard would possibly be to ground water resources. New water and sewer systems or significant well and septic sites could use up more of the water available, particularly during periods of drought. Public water systems are monitored, but individual wells and septic systems are not as strictly regulated. Therefore, future development could have an impact on the drought vulnerabilities.

8.10 DROUGHT HIRA SUMMARY

As stated prior, due to the nature of drought, it is extremely difficult to predict, but through identifying various indicators of drought, and tracking these indicators, it provides us with a crucial means of monitoring drought. Several mitigation measures will be reviewed and considered by the Village for incorporation into future Plan updates.

- Assessment programs
- Water supply augmentation and development of new supplies
- Public awareness and education programs
- Technical assistance on water conservation
- Reduction and water conservation programs
- Emergency response programs
- Drought contingency plans

Some of these actions can have long-term impacts, such as contingency plan development, and the development of water conservation and public awareness programs. As the Village of Ottawa gains more experience assessing and responding to drought, future actions will undoubtedly become more timely, effective, and less reactive.

9. EXTREME TEMPERATURES

Natural Hazards	Probability		Impact		Spatial Extent		Warning Time		Duration		RF Rating
Extreme Temperatures	2	0.6	1	0.3	4	0.8	1	0.1	4	0.4	**2.2**
Medium Risk Hazard (2.0 – 2.9)											

In the State Hazard Mitigation Plan (SHMP), climate change is treated as a condition that will occur and potentially exacerbate the impact of hazardous extreme temperatures. According to the SHMP, extreme heat and heat waves are existing hazards that will be exacerbated by climate change. Heat is one of the leading weather-related killers in the United States, resulting in hundreds of fatalities each year. Extreme Cold can cause hazardous driving conditions, communications and electrical power failure, community isolation and can adversely affect business continuity. This section provides definitions and profiles for the hazard of extreme heat and extreme cold.

9.1 EXTREME TEMPERATURE CHARACTERISTICS

Extreme Heat

Temperatures that remain at 10 degrees or more above the average high temperature for the area are defined as extreme heat. The National Weather Service (NWS) issues an Excessive Heat Warning/Advisory when an extreme heat event (a "heat wave") is expected within 36 hours. The NWS issues these warnings based on a "Heat Index" - a combination of heat and humidity - that is predicted to be 105 degrees or greater for two or more consecutive days. Local weather forecast offices may use different criteria for Excessive Heat Warning/Advisories based on maximum temperatures, nighttime temperatures, and other methods.

Extreme Heat is the number one weather-related killer in the United States. It causes more fatalities each year than floods, lightning, tornadoes and hurricanes combined. In the Midwest, summers tend to combine both high temperature and high humidity. Heat disorders generally have to do with a reduction or collapse of the body's ability to shed heat by circulatory changes and sweating or a chemical (salt) imbalance caused by too much sweating. When the body heats too quickly, to cool itself safely, or when too much fluid is lost through dehydration or sweating, the body temperature rises, and heat-related illnesses may develop.

Extreme temperatures can result in elevated utility costs to consumers and also can cause human risks. Extremely high temperatures cause heat stress which can be divided into four categories (see Table 4-44). Each category is defined by apparent temperature which is associated with a heat index value that captures the combined effects of dry air temperature and relative humidity on humans and animals. Major human risks for these temperatures include heat cramps, heat syncope, heat exhaustion, heatstroke, and death.

Extreme Cold

Extreme Cold, in extended periods, although infrequent, could occur throughout the winter months in the Village of Ottawa. Heating systems compensate for the cold outside. Most people limit their time outside during extreme cold conditions, but common complaints usually include pipes freezing and cars refusing to start. When cold temperatures and wind combine, dangerous wind chills can develop.

Wind chill is how cold it "feels" and is based on the rate of heat loss on exposed skin from wind and cold. As the wind increases, it draws heat from the body, driving down skin temperature, and eventually, internal body temperature. Therefore, the wind makes it feel much colder than the actual temperature. For example, if the temperature is 0°F and the wind is blowing at 15 mph, the wind chill is -19°F. At this wind chill, exposed skin can freeze in 30 minutes. Wind chill does not affect inanimate objects. (National Weather Service)

Extreme Cold is also responsible for a number of fatalities each year. Threats, such as hypothermia and frostbite, can lead to loss of fingers and toes or cause permanent kidney, pancreas and liver injury and even death. Major winter storms can last for several days and be accompanied by high winds, freezing rain or sleet, heavy snowfall and cold temperatures. Fifty percent of cold-related injuries happen to people over 60 years of age. More than 75 percent of injuries happen to males, and almost 20 percent occur within the home.

The dangers associated with extreme cold include frostbite and hypothermia. Frostbite is damage to body tissue caused by that tissue being frozen. Frostbite causes a loss of feeling in extremities, such as fingers, toes, ear lobes, or the tip of the nose. Hypothermia, or low body temperature can lead to uncontrollable shivering, memory loss, disorientation, slurred speech, drowsiness, and apparent exhaustion.

9.2 REGULATORY ENVIRONMENT

There are negligible formal regulations that pertain to generalized extreme temperature events.

9.3 HAZARD EVENTS

Extreme temperatures are hazards that affect areas as large as an entire state or region. As such, all Putnam County, Ohio instances of these events were looked at as previous hazard events.

The National Oceanic and Atmospheric Administration (NOAA) Climatic Data Center (NCDC) does not list any occurrences of either excessive heat. Since 2014, there have been 2 extreme cold/wind chill events for Putnam County, Ohio. There have been no recorded deaths or injuries from extreme cold/wind chill events.

According to the NCDC, there have been no documented cases of Extreme Heat in Putnam County. However, other resources, such as the Putnam County Sentinel, were used to obtain information about these events.

9.4 HISTORICAL OCCURRENCES

HEAT – Summer, 2005: Extreme heat affected Northwest Ohio resulting in heat advisories for much of this part of the state. Pools that were normally closed on certain days remained open while the advisories were in effect, and public information campaigns were carried out on local news networks to inform citizens on how to remain protected during the heat.

HEAT – July 6, 2012: Near record heat pushed Northwest Ohio toward historic high temperatures set in the Drought Summer of 1988. The wave was responsible for at least 3 deaths statewide, though none occurring in the Village or within Putnam County. Severe storms had rattled the state, resulting in a great number of power outages. This resulted in homes losing air conditioning, which led to deaths.

COLD – January 6-7, 2014: Brutal cold weather settled over the area on January 6th and 7th. This event was categorized as a polar vortex. This is a whirling and persistent large area of low pressure, found typically over both North and South poles. The northern polar vortex was pushing southward over western Wisconsin and eastern Minnesota on Monday, Jan. 6, 2014, and brought frigid temperatures to half of the continental United States. Extreme temperatures were reported for much of the US.

FIGURE 4-26 JANUARY 2014 POLAR VORTEX

9.5 MAGNITUDE/SEVERITY

While cold temperatures and power losses can render a structure uninhabitable for a time, they are unlikely to cause structural damages. Those people living in these older homes are more likely to need services offered in response to extreme cold.

Extremely high temperatures cause heat stress which can be divided into four categories. Each category is defined by apparent temperature. Apparent temperature is the general term for the perceived outdoor temperature, caused by the combined effects of air temperature, relative humidity, and wind speed. Apparent temperature is associated with a heat index value that captures the combined effects of dry air temperature and relative humidity on humans and animals. Major human risks for these temperatures include heat cramps, fainting, heat exhaustion, heatstroke, and death. Note that while the temperatures in Table 4-44 serve as a guide for various danger categories, the impacts of high temperatures will vary from person to person based on individual age, health, and other factors.

Temperature advisories, watches, and warnings are issued by the National Weather Service relating the above impacts to the range of temperatures typically experienced in Ohio. Exact thresholds vary across the State, but in general Heat Advisories are issued when the heat index will be equal to or greater than 100°F, but less than 105°F, Excessive Heat Warnings are issued when heat indices will attain or exceed 105°F, and Excessive Heat Watches are issued when there is a possibility that excessive heat warning criteria may be experienced within twelve to forty-eight hours (NOAA NWS, 2010).

TABLE 4-44 FOUR CATEGORIES OF HEAT STRESS

Danger Category	Heat Disorders	Apparent Temperature (°F)
I (Caution)	Fatigue possible with prolonged exposure and physical activity.	80 to 90
II (Extreme Caution)	Sunstroke, heat cramps, and heat exhaustion possible with prolonged exposure and physical activity.	90 to 105
III (Danger)	Sunstroke, heat cramps, or heat exhaustion likely; heat stroke possible with prolonged exposure and physical activity.	105 to 130
IV (Extreme Danger)	Heatstroke or sunstroke imminent.	>130

FIGURE 4-27 NWS SEVERE HEAT INDEX

Temperature (ºF)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	126	130					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Streuous Activity

Caution | Extreme Caution | Danger | Extreme Danger

TABLE 4-45 EXTREME COLD TEMPERATURE AND ASSOCIATED THREAT

Excessive Cold Threat Level	Threat Level Descriptions
Non-Threatening	**"No Discernable Threat to Life and Property from Excessive Cold."** Cold season weather conditions are non-threatening.
Very Low	**"A Very Low Threat to Life and Property from Excessive Cold."** It is likely that that wind chill values will drop to -10º F to -15 º F or below for 3 hours or more. Or, lowest air temperature zero to -5º F.
Low	**"A Low Threat to Life and Property from Excessive Cold."** It is likely that wind chill values will drop to -15º F to -20 º F or below for 3 hours or more. Or, lowest air temperature -5º to -10º F.
Moderate	**"A Moderate Threat to Life and Property from Excessive Cold."** It is likely that wind chill values will drop to -20º F to -28 º F or below for 3 hours or more. Or, lowest air temperature -10º to -15º F.
High	**"A High Threat to Life and Property from Excessive Cold."** It is likely that wind chill values will drop to -28º F to -35 º F for 3 hours or more. Or, lowest air temperature -15º to -20º F.
Extreme	**"An Extreme Threat to Life and Property from Excessive Cold."** It is likely that wind chill values will drop to -35º F or below for 3 hours or more. Or, lowest air temperature less than or equal to -20º F.

FIGURE 4-28 NWS WINDCHILL CHART

Temperature (°F)

Wind (mph) / Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes | 10 minutes | 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

9.6 FREQUENCY/PROBABILITY OF FUTURE OCCURRENCES

The probability of Putnam County experiencing an extreme temperature can be difficult to quantify. Climate models suggest summer global temperatures are likely to increase while changes between temperature extremes would be more pronounced. The length of days above 100 degrees may also extend significantly.

There have not been a sufficient number of events catalogued by the NCDC or other sources to be able to make an accurate numerical estimate on how often these events occur.

However, the HMPC, based on their own knowledge, concluded that Extreme Temperature events are “possible” each year. This means that they have between at 1% and 10% chance of happening annually.

9.7 INVENTORY ASSETS EXPOSED TO EXTREME TEMPERATURES

Vulnerability for extreme heat was classified as areas having a maximum average temperature over 85 degrees, according to the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) study. This range falls within the upper limits of FEMA’s heat stress index, Caution Category 1. Extreme heat does not generally impact buildings; instead, they primarily impact people. Nonetheless, facilities need to be maintained to ensure that they operate in appropriate conditions for people.

Additionally, vulnerability for extreme cold was classified as areas having minimum average temperature less than 14 degrees, according to the USDA NRCS study. Extreme cold does not generally impact buildings; instead, they primarily impact people. Nonetheless, facilities need to be maintained to ensure that they operate in appropriate conditions for people.

9.8 POTENTIAL LOSSES FROM TEMPERATURE EXTREMES

It is evident that extreme temperatures are dangerous and can be potentially life-threatening. Therefore it is important to understand how many people are exposed to such conditions, and how many buildings exist, where potential problems could arise should power be lost. Extreme cold can cause damage to structures; for example, burst pipes will damage buildings and will necessitate repairs.

There is no way to predict an area that will be impacted by extreme temperatures. As a result, all property located within the County must be viewed as susceptible to the effects of extreme temperatures. While temperature extremes are not usually thought of as damaging to structures, they can make structures unusable. The age of a structure is also important to consider when discussing temperature extremes. Older homes are more susceptible to the effects of temperature extremes, due to the prevalent construction methods used at the time.

According to the 2015 American Community Survey, there were approximately 230 children under the age of 5, which is equal to about 5.2% of the total population. There were an estimated 805 people above the age of 65, equating to about 18.2% of the population.

TABLE 4-46 POPULAGE AGE ESTIMATES, 2015

Total	Population	Percent
Under 5 years	**230**	5.2%
5 to 9 years	**190**	4.3%
10 to 14 years	**385**	8.7%
15 to 19 years	**341**	7.7%
20 to 24 years	**173**	3.9%
25 to 29 years	**314**	7.1%
30 to 34 years	**234**	5.3%
35 to 39 years	**221**	5.0%
40 to 44 years	**358**	8.1%
45 to 49 years	**168**	3.8%
50 to 54 years	**257**	5.8%
55 to 59 years	**385**	8.7%
60 to 64 years	**363**	8.2%
65 to 69 years	**283**	6.4%
70 to 74 years	**230**	5.2%
75 to 79 years	**44**	1.0%
80 to 84 years	**102**	2.3%
85 years and over	**146**	3.3%

TABLE 4-47 DATE OF BUILDING CONSTRUCTION

Date	Percent	Number
1939 or earlier	11.70%	224
1940 to 1959	11.40%	218
1960 to 1979	33.00%	631
1980 to 1999	27.50%	526
2000 to 2009	15.80%	302
2010 to 2013	0.70%	13
2014 or later	0.00%	0

TABLE 4-48 POTENTIAL LOSSES FROM EXTREME TEMPERATURES

Class	Number	Total Cost	1% Damage	5% Damage
Residential	1,911	$ 171,813,349.00	$ 1,718,133.49	$ 8,590,667.45
Critical Facilities				
Day Care	3	$ 1,445,914.00	$ 14,459.14	$ 72,295.70
Education	3	$ 14,971,229.00	$ 149,712.29	$ 748,561.45
Fire Station	3	$ 986,800.00	$ 9,868.00	$ 49,340.00
Government	5	$ 8,461,400.00	$ 84,614.00	$ 423,070.00
Medical	4	$ 20,657,200.00	$ 206,572.00	$ 1,032,860.00
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Utility	2	$ 13,040,057.00	$ 130,400.57	$ 652,002.85
CRIT. FACILITY TOTAL	**29**	**$ 68,983,772.00**	**$ 689,837.72**	**$ 3,449,188.60**
Total Value				
Grand Total	**1,940**	**$ 240,797,121.00**	**$ 2,407,971.21**	**$ 12,039,856.05**

9.9 LAND USE & DEVELOPMENT TRENDS

The Village of Ottawa, and Putnam County as a whole, are subject to temperature extremes. They are a countywide hazard and effect all areas of the county and its jurisdictions. The effect temperature extremes will have on the County will vary due to population density, age of population, and the age of structures. Older homes are generally less insulated than newer construction. In addition, the use of modern windows and doors can improve a structure’s ability to resist extreme temperatures. Older structures and infrastructure are likely to be more susceptible to both heat waves and freezes.

The elderly, just like small children, are more susceptible to temperature extremes. Additionally buildings of significant age may be more susceptible to temperature extremes. It is important to identify building stock and special needs populations so that those who have to respond to an emergency will be better prepared.

9.10 TEMPERATURE EXTREME HIRA SUMMARY

Temporary periods of extreme hot or cold temperatures typically do not have significant environmental impact. However, prolonged periods of hot temperatures may be associated with drought conditions and can damage or destroy vegetation, dry up rivers and streams, and reduce water quality. Prolonged exposure to extremely cold temperatures can kill wildlife and vegetation, and poses a potentially-grave danger to the residents of Putnam County and the Village of Ottawa.

10. WILDFIRE

Natural Hazards	Probability		Impact		Spatial Extent		Warning Time		Duration		RF Rating
Wildfire	1	0.3	1	0.3	1	0.2	4	0.4	1	0.1	**1.3**
Low Risk Hazard (1.0 – 1.9)											

10.1 WILDFIRE CHARACTERISTICS

Wildfire events are unwanted wildland fires, including unauthorized human-caused fires, escaped debris burns, and other ignition sources that lead to fire over wildland areas. Throughout Ohio, communities are increasingly concerned about wildfire safety as increased development and subsequent fire control practices have affected the natural cycle of the ecosystem. Wildland fires affect grass, forest, and brush lands, as well as any structures located within them. Human access to wildland areas, such as urban development in forested areas, increases the risk of fire due to a greater chance for human carelessness.

Generally, there are three major factors that sustain wildfires and predict a given area's potential to burn. These factors are fuel, topography, and weather.

- **Fuel:** The material that feeds a fire and is a key factor in wildfire behavior. Fuel is generally classified by type and volume. Fuel sources are diverse and include everything from dead tree leaves, twigs, and branches, to dead standing trees, live trees, brush, and cured grasses. Manmade structures are also considered a fuel source, such as homes and other associated combustibles. The type of prevalent fuel directly influences the behavior of wildfire. Fuel is the only factor that is under human control.
- **Topography:** An area's terrain and slope affect its susceptibility to wildfire spread. Both fire intensity and rate of spread increase as slope increases due to the tendency of heat from a fire to rise via convection. The arrangement of vegetation throughout a hillside can also contribute to increased fire activity on slopes.
- **Weather:** Components such as temperature, relative humidity, wind, and lightning also affect the potential for wildfire. High temperatures and low relative humidity dry out fuels that feed wildfires, creating a situation where fuel will ignite more readily and burn more intensely. Thus, during periods of drought the threat of wildfire increases. Wind is the most treacherous weather factor. The greater the wind, the faster a fire can spread and the more intense it can be. Wind shifts, in addition to wind speed, can occur suddenly due to temperature changes or the interaction of wind with topographical features such as slopes or steep hillsides. As part of a weather system, lightning also ignites wildfires, often in terrain difficult to reach by firefighters.

Wildfires can be classified as either a wildland fire or a wildland-urban interface (WUI) fire. A wildland fire occurs in an area that is relatively undeveloped except for the possible existence of basic infrastructure such as roads and power lines. A WUI fire occurs in an area that is developed with structures and other human developments. In WUI fires, the fire is fueled by both naturally occurring vegetation and the urban structural elements themselves. According to the National Fire Plan issued by the U.S. Departments of Agriculture and Interior, the wildland-urban interface is defined “as the line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels”.

10.2 REGULATORY ENVIRONMENT

Local

Fire protection is handled by the full time and volunteer staff at the Village of Ottawa Fire Department. Stations are spread throughout the Village to ensure a rapid response when needed. The Fire Department covers not only the Village, but parts of Ottawa Township and Pleasant Township, as well.

State

ODNR has statutory responsibility for wildfire protection on private lands in Ohio. ODNR is the agency responsible for fire suppression and prevention on non-federal lands identified as the States responsibility. ODNR may also provide and manage emergency services through cooperative agreements with counties and fire districts.

10.3 HAZARD EVENTS / HISTORICAL OCCURRENCES

There is no recorded history of wildfires occurring within the Village of Ottawa, or the surrounding Putnam County.

10.4 FREQUENCY / PROBABILITY OF FUTURE OCCURRENCES

There is no historical precedence to determine frequency though the probability of wildfires will increase as climate change impacts increase in the region. Based on their knowledge, the HMPC determined that there is an “unlikely” chance of wildfires occurring in the Village of Ottawa, meaning that there is less than a 1% chance.

10.5 MAGNITUDE / SEVERITY

The magnitude and severity of a wildfire event is measured by calculating the number of acres burned in a specific wildfire event and the severity of the burn classification. The below burn severity classifications have been adapted from USDA NRCS.

- **Low Fire Severity (Type III)**
    - **General statements:**
        - Primarily occur on rangeland
        - No sediment delivery
        - Natural recovery likely

- **Indicators:**
    - Duff (decaying leaves and branches covering a forest floor) and debris are partly burned
    - Soil is a normal color
    - Hydrophobicity is low to absent
    - Standing trees may have some brown needles
- **Interpretations:**
    - Root crowns and surface roots will re-sprout quickly
    - Infiltration and erosion potential are not significantly changed

- **Medium Fire Severity (Type II)**
  - **General statements:**
    - Primarily occur on steep, lightly timbered slopes with grass
    - Some sediment delivery
  - **Indicators:**
    - Duff is consumed
    - Burned needles are still evident
    - Ash is generally dark colored
    - Hydrophobicity is low to medium on surface soil up to 1 inch deep
    - Soil is brown to reddish-brown and up to 2 inches of soil is darkened from burning (below ash)
    - Roots are alive below 1 inch
    - Shrub stumps and small fuels are charred but present
    - Standing trees are blackened but not charcoal
  - **Interpretations:**
    - Root crowns will usually re-sprout
    - Roots and rhizomes below 1 inch will re-sprout
    - Most perennial grasses will re-sprout
    - Vegetative recovery (non-tree), depending on conditions, could be one to five years
    - Soil erosion potential will increase due to the lack of ground cover and moderate hydrophobicity

- **High Fire Severity (Type I)**
  - **General statements:**
    - Primarily occurs in unprotected drainages on steep, timbered, north or east slopes with dense forest canopy
    - Sediment delivery likely
    - Natural recovery limited

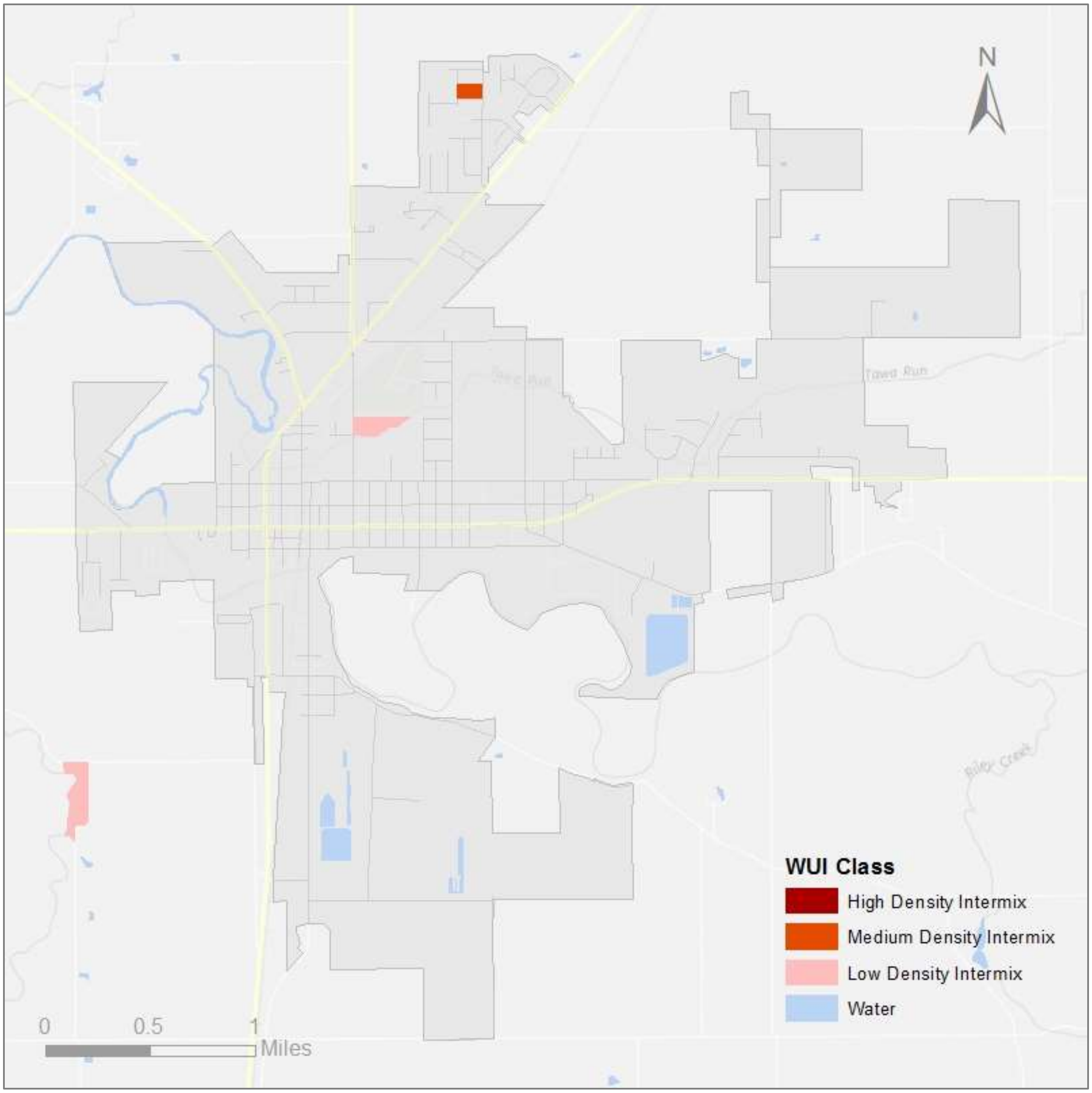
- **Indicators:**
  - Duff consumed
  - Uniformly gray or white ash (in severe cases ash is thin and white or light)
  - No shrub stumps or small fuels remain
  - Hydrophobicity medium to high – up to 2 inches deep
  - 2 to 4 inches of soil is darkened (soil color often reddish orange)
  - Roots burned 2 to 4 inches
  - Soil physically affected (crusting, crystallization, agglomeration)
  - Standing trees charcoal up to 1 inch deep
- **Interpretations:**
  - Soil productivity is significantly reduced
  - Some roots and rhizomes will re-sprout but only those deep in soil
  - Vegetative recovery (non-tree), depending on conditions, could be five to 10 years
  - Soil erosion potential can be significantly increased

10.6 INVENTORY ASSETS EXPOSED TO WILDFIRE

Fires can extensively impact the economy of an affected area, especially the logging, recreation, and tourism industries, upon which many counties depend. Major direct costs associated with forest fires or wildfires include the salvage and removal of downed timber and debris and the restoration of the burned area. If burned-out woodlands and grasslands are not replanted quickly to prevent widespread soil erosion, then landslides, mudflows, and floods could result, compounding the damage.

Class	Number	Total Cost	1% Damage	5% Damage
Residential	1,911	$ 171,813,349.00	$ 1,718,133.49	$ 8,590,667.45
Critical Facilities				
Day Care	3	$ 1,445,914.00	$ 14,459.14	$ 72,295.70
Education	3	$ 14,971,229.00	$ 149,712.29	$ 748,561.45
Fire Station	3	$ 986,800.00	$ 9,868.00	$ 49,340.00
Government	5	$ 8,461,400.00	$ 84,614.00	$ 423,070.00
Medical	4	$ 20,657,200.00	$ 206,572.00	$ 1,032,860.00
Police	2	$ 5,781,686.00	$ 57,816.86	$ 289,084.30
Religious	7	$ 3,639,486.00	$ 36,394.86	$ 181,974.30
Utility	2	$ 13,040,057.00	$ 130,400.57	$ 652,002.85
CRIT. FACILITY TOTAL	**29**	**$ 68,983,772.00**	**$ 689,837.72**	**$ 3,449,188.60**
Total Value				
Grand Total	**1,940**	**$ 240,797,121.00**	**$ 2,407,971.21**	**$ 12,039,856.05**

FIGURE 4-29 WILDLAND URBAN INTERFACE AND INTERMIX



10.7 LAND USE & DEVELOPMENT TRENDS

The wildland-urban interface (WUI) will continue to be an issue for the more rural fringes of the Village. Developed areas of the Village will have little issue with wildfire. Drought conditions can increase the likelihood of fire events in rural areas. The WUI can be seen in Figure 4-29 above.

10.8 WILDFIRE HIRA SUMMARY

Wildfires and brush fires can force school closings, disrupt telephone services by burning fiber optic cables, damage railroads and other infrastructure, and adversely affected tourism, outdoor recreation, and hunting. The likelihood of one of those fires attaining significant size and intensity is unpredictable and highly dependent on environmental conditions and firefighting response. Weather conditions, particularly drought events, increase the likelihood of wildfires occurring. It is important to note that 98% of wildfires are human-caused. Nonetheless, the critical inference to draw from this statistic is the fact that the occurrence of future wildfire events will strongly depend on patterns of human activity. Events are more likely to occur in wildfire-prone areas experiencing new or additional development.

11. DAM FAILURE

Technological Hazard	Probability		Impact		Spatial Extent		Warning Time		Duration		RF Rating
Dam Failure	1	0.3	4	1.2	4	0.8	4	0.4	4	0.4	**3.1**
High Risk Hazard (3.0 – 4.0)											

11.1 DAM FAILURE CHARACTERISTICS

A dam is defined as a barrier constructed across a watercourse for the purpose of storage, control, or diversion of water. Dams typically are constructed of earth, rock, concrete, or mine tailings. A dam failure is the collapse, breach, or other failure, often resulting in down-stream flooding.

A levee is an elongated ridge constructed of fill or wall which regulates water levels. These are usually earthen hills built along a river's floodplain to prevent flooding in nearby population areas. Typically, these run parallel to a river. According to the National Levee Inventory, there are no levees in the Village of Ottawa.

A dam impounds water in the upstream area, referred to as the reservoir. The amount of water impounded is measured in acre-feet. An acre-foot is the volume of water that covers an acre of land to a depth of one foot. As a function of upstream topography, even a very small dam may impound or detain many acre-feet of water. Two factors influence the potential severity of a full or partial dam failure: the amount of water impounded, and the density, type, and value of development and infrastructure located downstream.

Dam failures typically occur when spillway capacity is inadequate and excess flow overtops the dam, or when internal erosion (piping) through the dam or foundation occurs. Complete failure occurs if internal erosion or overtopping results in a complete structural breach, releasing a high-velocity wall of debris-laden water that rushes downstream.

Dam failures can result from any one or a combination of the following causes:

- **Prolonged periods of rainfall and flooding**, which cause most failures;
- **Inadequate spillway capacity**, resulting in excess overtopping flows;
- **Internal erosion** caused by embankment or foundation leakage or piping;
- **Improper maintenance**, including failure to remove trees, repair internal seepage problems, replace lost material from the cross section of the dam and abutments, or maintain gates, valves, and other operational component;
- **Improper design**, including the use of improper construction materials and construction practices;
- **Negligent operation**, including the failure to remove or open gates or valves during high flow periods;
- **Failure of upstream dams** on the same waterway;

- **Landslides into reservoirs**, which cause surges that result in overtopping;
- **High winds**, which can cause significant wave action and result in substantial erosion; and
- **Earthquakes**, which typically cause longitudinal cracks at the tops of the embankments, which can weaken entire structures.

Dams are considered to be localized in the state and are most likely to affect inundation areas downstream and immediate areas around the dam. Discharge from a dam breach is usually several times the 1% chance flood, and, therefore, typical flood studies are of limited use in estimating the extent of flooding.

Determining the impact of flooding is difficult to accomplish, especially for estimating loss of life. Loss of life is a function of the time of day, warning time, awareness of those affected and particular failure scenarios. Many dam safety agencies have used “population at risk”, a more quantifiable measurement of the impact to human life, rather than “loss of life”. Population at risk is the number of people in structures within the inundation area that would be subject to significant personal danger, if they took no action to evacuate. The impacts of a dam failure are contingent on many factors and, therefore, cannot be concisely described.

Dam safety laws are embodied in the Dam Safety and Encroachments Act ("DSE Act") -enacted July 1, 1979 and last amended in 1985. Rules pertaining to dam safety are found in Title 25-Rules and Regulations; Part I-Department of Environmental Resources; Subpart C-Protection of Natural Resources; Article II-Water Resources; Chapter 105-Dam Safety and Waterway Management ("the Rules") -adopted.

11.2 REGULATORY ENVIRONMENT

Ohio’s Department of Natural Resources classifies dams by 2 conditions: height and storage. There are 4 classes of dams, which vary, based on the height of the actual dam, and the amount of water held behind the dam. According to the ODNR Division of Water Resources. In the Village of Ottawa, the only significant dam is the Ottawa Upground Reservoir.

Many dams throughout Ohio were created 50 years ago or more. These dams present the possibility that at some point in time they may fail. If this is the case, there will be damage to the surrounding area. According to the Ohio Department of Natural Resources, the damage predicted by a dam failure coincides with the class of the dam. The potential downstream hazard is broken into four classes.

- **Class I –** Probable loss of life, serious hazard to health, structural damage to high value property (i.e., homes, industries, and major public utilities.).

- **Class II –** Floodwater damage to homes, businesses, and industrial structures (no loss of life envisioned); damage to state and interstate highways, railroads; only access to residential areas.

- **Class III –** Damage to low value non-residential structures, local roads, agricultural crops and livestock.
- **Class IV –** Losses restricted mainly to the dam

TABLE 4-49 CLASS 1 DAM INFORMATION FOR OTTAWA

Name	Owner	Owner Type	Type	Structure	Length (feet)	Height (feet)	Top Dam Storage (Acre Ft.)
Ottawa Upground Reservoir	Village of Ottawa	Public, Local	Upground	Earthfill	3,800	22	400

FIGURE 4-30 VILLAGE OF OTTAWA UPGROUND RESERVOIR

11.3 HAZARD EVENTS/HISTORICAL OCCURRENCES

There have been no recorded dam failure events in the Village of Ottawa.

11.4 MAGNITUDE/SEVERITY

The severity of a dam failure depends mostly on what class the dam is, where it is located, and what caused it to fail. The inundation zone as defined by each Emergency Action Plan (EAP) shows what areas will be the most heavily impacted during a dam failure event. During these events, hazardous materials such as agricultural chemicals and wastes, solid wastes, raw sewage, common household chemicals, and loose mud and concrete can worsen rescue and cleanup operation. Much of the damage done during a dam failure will be downstream and within the immediate area.

11.5 FREQUENCY/PROBABILITY OF OCCURRENCES

For reasons previously mentioned in this section and uncontrollable by humans, it is possible a dam can fail at any time, given the right circumstances. However, the probability of future occurrence is for regulated dams can be reduced due to proactive preventative action in compliance with the Ohio Department of Natural Resources – Dam Safety Program. Ohio's Dam Safety Program provides for the regulation and safety of high hazard dams and reservoirs throughout the state in order to protect the health, safety, and welfare of its citizens and their property.

11.6 INVENTORY ASSETS EXPOSED TO DAM FAILURE

The Ottawa Upground Reservoir holds 400 acre-feet of water. This translates to over 130 million gallons of water. That much water entering the Blanchard River would cause extensive damage to the Village of Ottawa.

Dam failures can have a greater environmental impact than that associated with a flood event. Large amounts of sediment from erosion can alter the landscape changing the ecosystem. Hazardous materials can be carried away from flooded out properties and distributed throughout the floodplain. Industrial and agricultural chemicals and wastes, solid wastes, raw sewage, and common household chemicals comprise the majority of hazardous materials spread by flood waters along the flood zone, polluting the environment and contaminating private property and the community's water supply. The soil loss from erosion and scouring would be significantly greater because of a large amount of fast moving water affecting a small localized area, which would likely change the ecosystem.

11.7 POTENTIAL LOSSES

For reasons previously mentioned in this section and uncontrollable by humans, it is highly possible a dam can fail at any time, given the right circumstances. However the probability of future occurrence for regulated dams is reduced through compliance with the Ohio's Department of Natural Resources, Dam Safety Program. The Village has an Emergency Action Plan that details possible scenarios for a dam break.

Dam Failure Scenarios

The sudden and catastrophic failure of the Ottawa Upground Reservoir would have an immense impact on the area directly adjacent to the dam, and for several miles around. In order to assess the potential impact on the region, four models were constructed using topographic information from the Ohio Geographically Referenced Information Program (OGRIP). This data came in the form of Digital Elevation Models (DEM).

The four models are representative of scenarios in which one of each of the Reservoir's sides suddenly failed. Each of the models shows that much of the water that is spilled over runs into the Blanchard River. However, if a sudden failure did occur, the river would not have sufficient capacity to quickly move the amount of water spilled, leading to structures being damaged in the process. The models accounted for both water depth and the velocity at which water would travel during a failure.

TABLE 4-50 DAM FAILURE MODEL SCENARIOS

Scenario Name	Total Building Value	Parcels Affected	Buildings Affected	Highest Water Elevation
East Failure	$ 17,990,570	124	52	13.31 feet
West Failure	$ 17,971,028	122	52	14.17 feet
North Failure	$ 19,720,742	148	66	13.41 feet
South Failure	$ 12,606,970	122	50	13.65 feet

The East and West failure scenarios are fairly similar, differing by only 2 parcels affected, and under $20,000 in dam difference. The North scenario is the most expensive as it has water sweeping towards the center of town, and includes the water treatment plant. The plant is the only critical facility affected in any of the scenarios. The South failure scenario is the least expensive, by over $5 million. The land to the south of the Village is largely uninhabited and is agricultural land.

The number of buildings affected in each scenario is largely the same for three of the four. The South failure scenario has a total of 50 buildings being affected, while the East and West scenarios both have a total of 52 buildings each.

Each of the scenarios have different Highest Water Elevations. The highest point of each scenario is always in the Blanchard River itself. The different heights are due to the velocities of each scenario.

Figure 4-31 through Figure 4-34 present maps of each of the failure scenarios. Depth grids are included with each of the maps.

FIGURE 4-31 EAST SIDE FAILURE SCENARIO

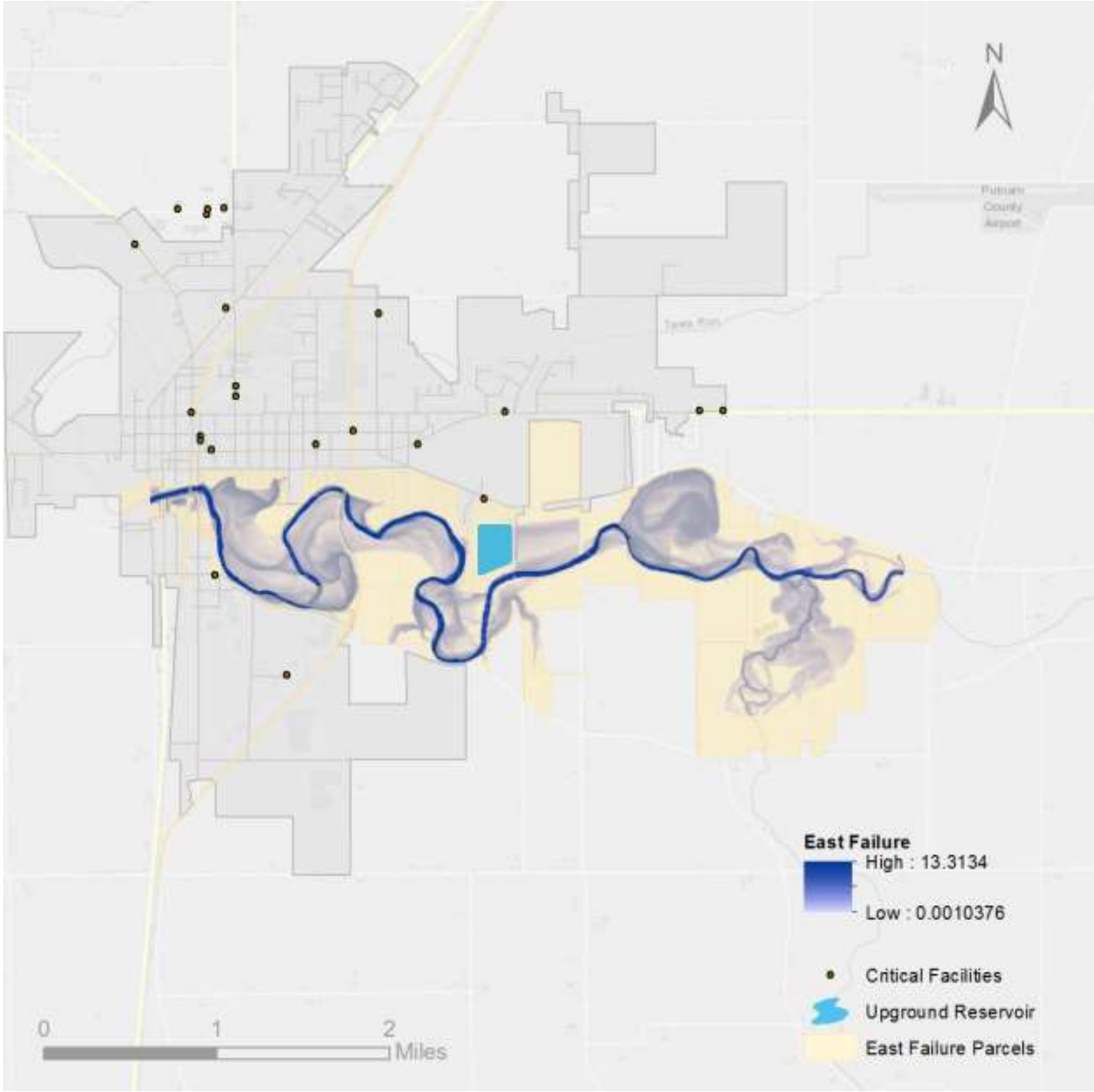


FIGURE 4-32 WEST SIDE FAILURE SCENARIO

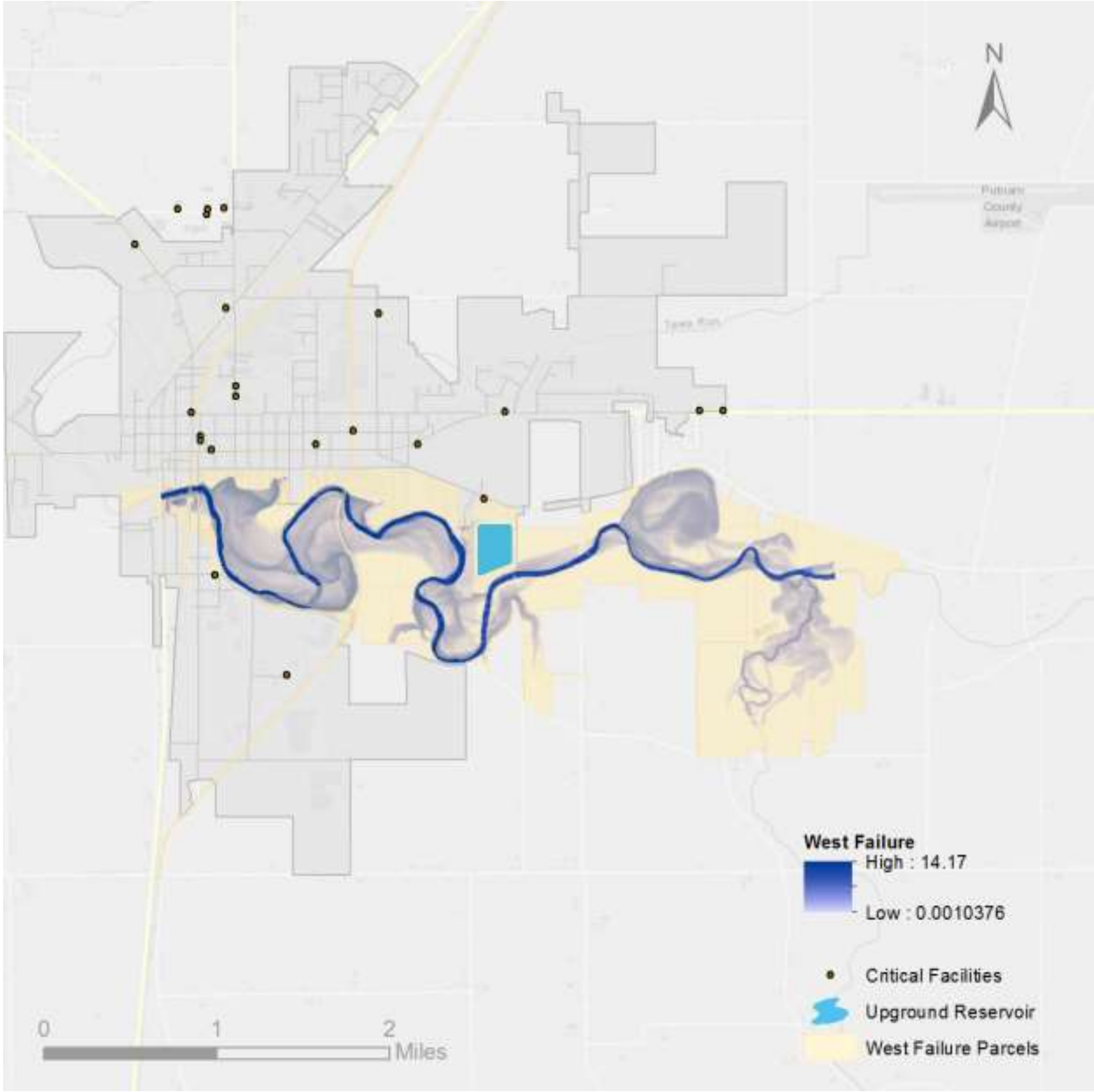


FIGURE 4-33 NORTH SIDE FAILURE SCENARIO

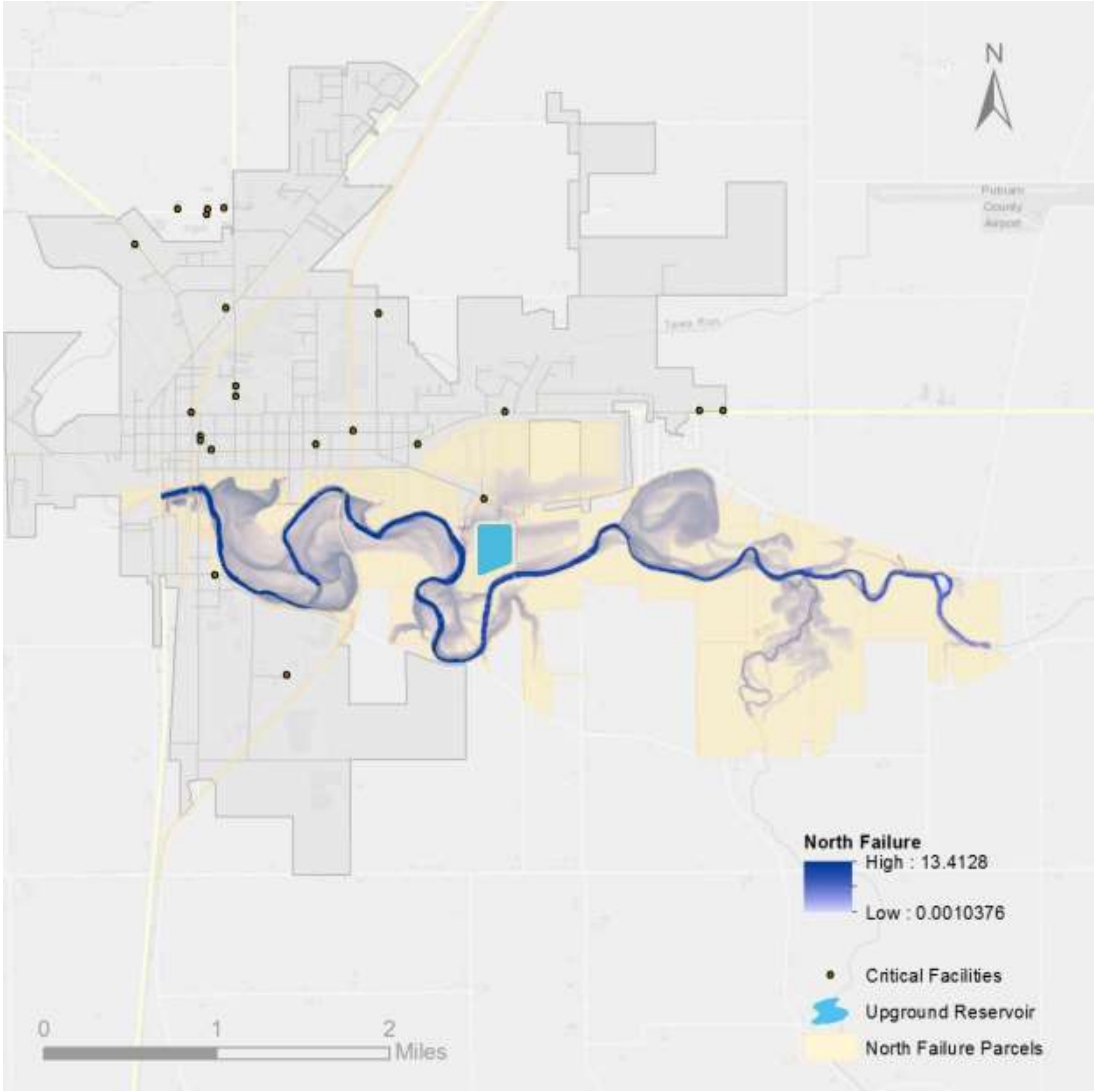
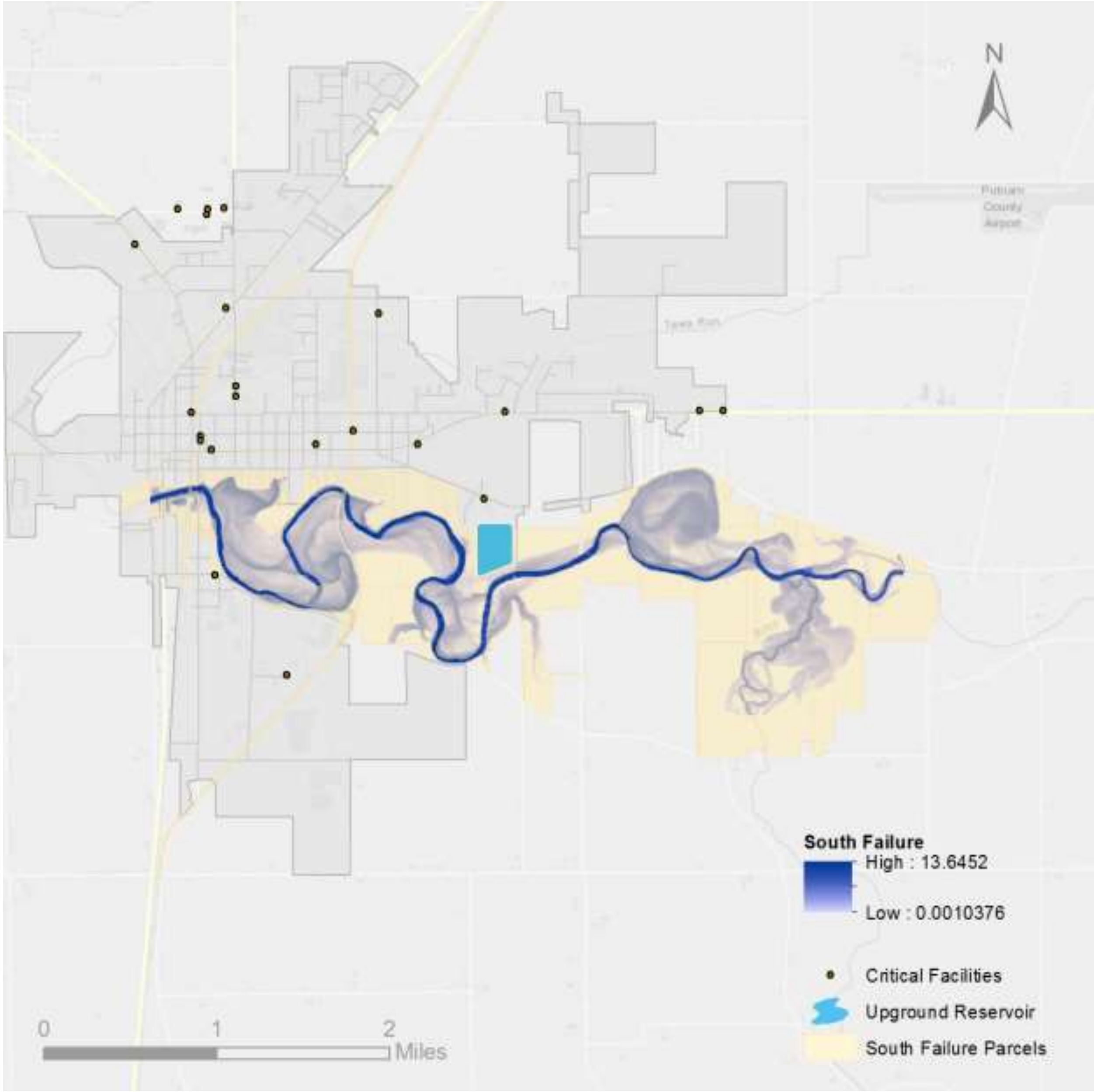


FIGURE 4-34 SOUTH SIDE FAILURE SCENARIO



11.8 LAND USE & DEVELOPMENT TRENDS

Public awareness measures such as notices on final plats and public education on dam safety are proactive mitigation measures that should be implemented by local communities. Also, Emergency Action Plans that identify potential dam failure inundation areas, notification procedures, and thresholds are also prepared for response to potential dam related disaster events. There are no development trends that are likely to affect the vulnerability of the Village to dam failure.

11.9 DAM FAILURE HIRA SUMMARY

As dams continue to age, the likelihood for failure increases as undesirable woody vegetation on the embankment, deteriorated concrete, inoperable gates, and corroded outlet pipes become problems. Since dam failures are often exacerbated by flooding, the probability of dam failures can be associated with projected flood frequencies. Overall, the probability of a dam failure throughout the state should remain low with continued maintenance of dams. Additionally, warning plans in place for designated high hazard dams will continue to decrease the danger for those residents in potential risk areas.

12. HAZARDOUS MATERIALS INCIDENT

Technological Hazard	Probability		Impact		Spatial Extent		Warning Time		Duration		RF Rating
HazMat Incident	3	0.9	2	0.6	4	0.8	4	0.4	1	0.1	**2.8**
Medium Risk Hazard (2.0 – 2.9)											

12.1 HAZARD MATERIAL CHARACTERISTICS

Traditional Hazardous Materials

A hazardous material release is the contamination of the environment (i.e. air, water, soil) by any material that because of its quantity, concentration, physical characteristics, or chemical characteristics threatens human, animal, or plant health, the environment, or property. Hazardous material spills are usually accidental events that arise from human activities such as the manufacture, transportation, storage, and use of hazardous materials. The consequences of such spills are usually unintended. An accidental or intentional release of hazardous materials could produce a health hazard to those in the area, downwind, and/or downstream with immediate, prolonged, and/or delayed effects. The spread of the material may additionally be defined by weather conditions and topography of the area. A hazardous material release can come from a fixed facility, transportation, or an intentional release such as terrorism.

A hazardous material release may also occur due to a transportation accident. The most likely locations for a transportation-related hazardous material release are along the railroads that run through the Village. Gas, propane, and other hazardous materials are delivered throughout the area year-round. The need for gas, propane, fertilizers, and other toxic materials in daily life creates a larger risk for a hazardous materials release.

A hazardous materials release in the Village may not only contaminate dirt or surface material but potentially contaminate flowing water in ditches, rivers, or small streams. Ground water may also be contaminated, depending on the size of the incident. Other potential concerns for spills/leaks are icy road conditions during winter months, sabotage, and terrorism.

Fixed facilities housing hazardous substances at the Village include swimming pools, gas stations, and supply stores containing substances such as fuel, farm chemicals, propane, fuel oil, paint, and small amounts of chlorine.

Hospital Radioactive Isotopes

Hospitals are increasingly using radioactive isotopes for diagnostic and therapeutic applications. The bulk of the hospital radioactive waste is commonly generated in the department of Nuclear Medicine. Generally, most of the radioactive waste is liquid. Some lesser amounts of the waste are solid and gaseous. The solid waste containing traces of radioactivity can be in the form of syringes, needles, cotton swabs, vials, contaminated gloves and absorbent materials.

12.2 REGULATORY ENVIRONMENT

The US EPA's Toxic Release Inventory (TRI) program, tracks hazardous materials release and disposal data for communities throughout the nation. Disposals in the Ottawa area include Acetaldehyde, Methanol, Ammonia, Acrolein, and Manganese. These disposals are largely due to the fabrication of metals in the Village. The TRI data does not provide data regarding the effect on the public of releases or disposals of hazardous materials.

12.3 HAZARD EVENTS/HISTORICAL OCCURRENCES

According the Putnam County Emergency Management Agency, there were 2 large HazMat incidents in 2013. The first occurred when 300 gallons of fertilizer spilled from a truck during an accident. The second was a spill of 500-1000 gallons of diesel fuel, spill from a truck, that made it way to the Blanchard River through the storm sewers.

12.4 MAGNITUDE/SEVERITY

With a hazardous material release, whether accidental or intentional, there are several potentially exacerbating or mitigating circumstances that will affect its severity or impact. Mitigating conditions are precautionary measures taken in advance to reduce the impact of a release on the surrounding environment. Primary and secondary containment or shielding by sheltering-in-place protects people and property from the harmful effects of a hazardous material release. Exacerbating conditions, or characteristics that can enhance or magnify the effects of a hazardous material release, include:

- **Weather conditions**: affects how the hazard occurs and develops
- **Micro-meteorological effects** of buildings and terrain: alters dispersion of hazardous materials
- **Non-compliance with applicable codes** (e.g. building or fire codes) and maintenance failures (e.g. fire protection and containment features): can substantially increase the damage to the facility itself and to surrounding buildings

Whether or not a hazardous materials site is contained in the SFHA is also a concern, as there could be larger-scale water contamination during a flood event should the flood compromise the production or storage of hazardous chemicals. Such a situation could swiftly move toxic chemicals throughout a water supply and across great distances.

The severity of a given incident is dependent not only on the circumstances described above, but also with the type of material released and the distance and related response time for emergency response teams. The areas within closest proximity to the releases are generally at greatest risk, yet depending on the agent, a release can travel great distances or remain present in the environment for a long period of time (e.g., centuries to millennia for radioactive materials), resulting in extensive impacts on people and the environment.

12.5 FREQUENCY/POSSIBILITY OF FUTURE OCCURRENCES

The HMPC, based on their knowledge of previous events, assigned HazMat incidents as being "likely," or having a 10% - 100% chance of happening annually.

12.6 INVENTORY ASSETS EXPOSED TO HAZARDOUS MATERIALS

All Village assets can be considered at risk from hazardous materials releases. This includes 100 percent of the Village population and all buildings and infrastructure. The presence of the surrounding farmland, as well as railroad tracks which pass throughout the Village, make all of Ottawa vulnerable to the effects of a possible incident.

12.7 POTENTIAL LOSSES

A hazardous materials release has the possibility of having a significant impact on the Village. Most hazardous material releases do not usually have an effect on infrastructure, particularly underground infrastructure. Some critical facilities use hazardous materials to operate such as chlorine for water treatment and PCB's for electric transformers. Similarly, the contamination of the water supply may be treated like a hazardous material release. Propane, oil, and natural gas, necessary fuels for heating, can also be hazardous if released during their delivery due to their explosive potential. Transportation may be limited if a key roadway or railway is blocked by an incident.

- **Possible losses to critical facilities include:**
    - Critical functional losses
    - Contamination
    - Structural and contents losses, if an explosion is present

- **Possible losses to structures include:**
    - Inaccessibility
    - Contamination
    - Structural and contents losses, if an explosion is present

- **Possible economic losses include:**
    - Business closures and associated business disruption losses

- **Possible ecologic losses include:**
    - Loss of wildlife
    - Habitat damage
    - Reduced air and water quality

- **Possible social losses include:**
    - Canceled activities
    - Emotional impacts of significant population losses and illnesses

12.8 LAND USE & DEVELOPMENT TRENDS

The population impacts are often greater than the structural impacts during a hazardous material a release. Depending on the material, the health impacts to humans can be long and short term. Generally, an incident will affect only a subset of the total population at risk. In a hazardous materials release, those in the immediate isolation area would have little to no warning, whereas, the population further away in the dispersion path may have some time to evacuate, depending on the weather conditions, material released, and public notification.

There are no land use regulations that restrict building around industrial facilities or along transportation routes. As the population increases, development will also continue to increase in these areas, thereby exposing a greater number of individuals to the risk of a hazardous materials release and increasing the overall vulnerability of Ottawa.

12.9 HAZARDOUS MATERIALS HIRA SUMMARY

Hazardous materials incidents can pose a series of threats to human safety and welfare, as well as the environment. Incidents occur regularly, but are not often of a size to cause a significant village-wide threat. However, it seems likely that incidents will continue and the potential for a significant release is present. Incidents often occur in conjunction with, or as a result of, natural hazards impacting facilities that house hazardous materials. Depending upon the materials released, as well as atmospheric conditions, an incident has the potential to cause significant disruption to the Village.

13. TERRORISM

Technological Hazard	Probability		Impact		Spatial Extent		Warning Time		Duration		RF Rating
Terrorism	1	0.3	2	0.6	3	0.6	4	0.4	3	0.3	**2.2**
Medium Risk Hazard (2.0 – 2.9)											

13.1 TERRORISM CHARACTERISTICS

The term "terrorism" refers to intentional, criminal, malicious acts, but the functional definition of terrorism can be interpreted in many ways. Officially, terrorism is defined in the Code of Federal Regulations as "…the unlawful use of force and violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives" (28 CFR §0.85). Terrorists use threats to create fear, to try to convince citizens of the powerlessness of their government, and/or to get publicity for their cause.

Terrorist attacks can take many forms, including agro-terrorism, arson/incendiary attack, armed attack, assassination, biological agent, chemical agent, cyberterrorism, conventional bomb, hijackings, intentional hazardous material release, kidnapping, nuclear bomb and radiological agent (FEMA April 2009). Explosives have been the traditional method of conducting terrorism, but intelligence suggests that the possibility of biological or chemical terrorism is increasing. The severity of terrorist incidents depends upon the method of attack, the proximity of the attack to people, animals, or other assets and the duration of exposure to the incident or attack device. For example, chemical agents are poisonous gases, liquids or solids that have toxic effects on people, animals, or plants. Many chemical agents can cause serious injuries or death. In this case, severity of injuries depends on the type and amount of the chemical agent used and the duration of exposure.

Biological agents are organisms or toxins that have illness-producing effects on people, livestock and crops. Some biological agents cannot be easily detected and may take time to develop. Therefore, it can be difficult to know that a biological attack has occurred until victims display symptoms. In other cases, the effects are immediate. Those affected by a biological agent require the immediate attention of professional medical personnel. Some agents are contagious which may result in the need for victims to be quarantined.

Terrorism using **explosive** and **incendiary** devices includes bombs and any other technique that creates an explosive, destructive effect. Bombs can take many forms from a car bomb to a mail bomb. They can be remotely detonated using a variety of devices or directly detonated in the case of a suicide bomb.

Radiological terrorism involves the use of radiological dispersal devices or nuclear facilities to attack the population. Exposure to radiation can cause radiation sickness, long-term illness, and even death. Terrorism experts fear the use of explosive and radiological devices in the form of a “dirty bomb” to attack the population. A “dirty bomb” is a low-tech, easily assembled and transported device made up of simple explosives combined with a suitable radioactive agent.

In recent years, **cyber terrorism** has become a larger threat than in years past. Cyber terrorism can be defined as activities intended to damage or disrupt vital computer systems. These acts can range from taking control of a host website to using networked resources to directly cause destruction and harm. Protection of databases and infrastructure appear to be the main goals at this point in time. Cyber terrorists can be difficult to identify because the internet provides a meeting place for individuals from various parts of the world. Individuals or groups planning a cyber-attack are not organized in a traditional manner, as they are able to effectively communicate over long distances without delay. They have been known to overtake websites, and alter the content that is presented to the public. The largest threat to institutions from cyber terrorism comes from any processes that are networked and controlled via computer. Any vulnerability that could allow access to sensitive data or processes should be addressed, and any possible measures taken to harden those resources to attack.

As **drones** have become more available to the public and prevalent in society, they pose a growing risk. These small, remote controlled objects are becoming a tool for criminals and terrorists. Of specific worry to law enforcement is that these small aircraft are difficult to detect and stop. Recently, drones have been used to smuggle drugs and contraband. Another concern is that these drones could be modified to mount attacks with explosives or chemical weapons. Most small drones remain limited by short battery life and small payload capacity. The most popular consumer drones can carry just a few pounds. But some of the features that have made the devices increasingly attractive for businesses and photographers—that they are small, easy to fly and can capture high-definition images—also make them a potentially powerful tool for criminals and terrorists.

NOAA Alerts

When notified by a government official, the NWS has the ability to send alert messages through the Emergency Alert System and over NOAA Weather Radio. Examples include the following:

- **Local Area Emergency Message:** This message defines an event that by itself does not pose a significant threat to public safety and/or property, but the event could escalate, contribute to other more serious events, or disrupt critical public safety services. Instructions, other than public protective actions, may be provided by authorized officials. Examples of when this message may be used include: utility disruptions, road closures, or a potential terrorist threat where the public is asked to remain alert.

- **Civil Emergency Message:** This message outlines a significant threat or threats to public safety and/or property that is imminent or in progress. The hazard is usually less specific or severe than those requiring a Civil Danger Warning.
- **Law Enforcement Warning:** This warning is issued for a bomb explosion, riot, or other criminal event. An authorized law enforcement agency may block roads, waterways, or facilities, evacuate or deny access to affected areas, and arrest violators or suspicious persons.
- **Radiological Hazard Warning:** This warning warns of the loss, discovery, or release of a radiological hazard such as the theft of a radiological isotope used for medical, seismic, or other purposes, discovery of radioactive materials, or a transportation accident involving nuclear weapons, nuclear fuel, or radioactive wastes. Authorized officials may recommend protective actions be taken if a radioactive hazard is discovered.
- **Civil Danger Warning:** This warning is issued when an event presents a danger to a significant civilian population. The message usually warns of a specific hazard and outlines specific protective actions such as evacuation or shelter in place.
- **Shelter in Place Warning:** This warning is issued when the public is recommended to shelter in place (go inside, close doors and windows, turn off air conditioning or heating systems, and turn on the radio or TV for more information). Examples include hazardous material releases or radioactive fallout.

13.2 REGULATORY ENVIRONMENT

Terrorism, by definition, is an act that is against the law. The regulatory environment tied to terrorism falls under law enforcement jurisdiction. Terrorism is investigated by the Federal Bureau of Investigations.

13.3 HAZARD EVENTS/HISTORICAL OCCURRENCES

While there have been no large-scale terrorist attacks on Putnam County or the Village of Ottawa, incidents have occurred within Ohio, as well as throughout a myriad of locations in the United States. Nationally, terrorism continues to be an issue of significant importance.

Listed are several high-profile events that have occurred throughout both the State of Ohio and the broader United States:

May 2003: A series of over 24 sniper attacks concentrated along the Cap-City Beltway I-270 in the Columbus Metropolitan Area caused widespread fear across Ohio and leaving one dead.

May 1, 2012: Five self-described anarchists were arrested in an alleged plot to blow up a bridge in Cuyahoga Valley National Park in Brecksville, Ohio. The group was being monitored as part of an FBI undercover operation and had considered other plots previously. One of the suspects expressed a desire to cause financial damage to companies while avoiding casualties.

July 20, 2012: In Aurora, Colorado, during the midnight screening of the film The Dark Knight Rises, a gunman dressed in tactical clothing set off tear gas grenades and shot into the audience with multiple firearms. Twelve people were killed and seventy others were injured.

December 2, 2015: In San Bernardino, CA a planned shooting occurred at the Inland Regional Center which resulted in 16 deaths and 23 casualties. A shootout occurred between the suspects, ultimately leading to their deaths.

June 12, 2016: A 29-year old man armed with an automatic assault rifle, walked into a nightclub in Orlando, Florida, killing 49 people and injuring 53 more. The man swore allegiance to the leader of the Islamic State of Iraq and the Levant. It has been marked as the deadliest terror attack since the 9/11 attacks in 2001 in the United States.

13.4 MAGNITUDE/SEVERITY

Events classified as terrorism have been shown to impact as few as one person to tens of thousands. One of the inherent risks of terrorism is the unpredictability. Of particular concern are potential threats against local crops, as well as local village computer systems.

Terrorism events impact not only those who are directly killed or injured, but also those around them through psychological trauma afterward. Terrorists are not always easily identified, and events can be unpredictable. Schools and universities have also been sites around the nation where active shooters have been present, putting elementary, middle, and high schools at risk, Government-owned buildings of state or federal agencies also are a potential target.

Terrorism attacks can occur extremely quickly, with some events lasting just a few minutes from beginning to end.

13.5 FREQUENCY/PROBABILITY OF FUTURE OCCURRENCES

There is not enough historical precedence to determine frequency or future probability of terrorism or threatened terroristic events. However, based on their knowledge, the HMPC decided that incidents of terrorism are “unlikely,” meaning less than a 1% annual chance of occurrence.

Since the probability of terrorism occurring cannot be quantified in the same way as that of many natural hazards, it is not possible to assess vulnerability in terms of likelihood of occurrence. Instead, vulnerability is assessed in terms of specific assets. By identifying potentially at-risk terrorist targets, planning efforts can be put in place to reduce the risk of attack. FEMA’s Integrating Manmade Hazards into Mitigation Planning (2003) encourages site-specific assessments that should be based on the relative importance of a particular site to the surrounding community or population, threats that are known to exist and vulnerabilities including:

- **Inherent vulnerability:**
  - Visibility – How aware is the public of the existence of the facility?
  - Utility – How valuable might the place be in meeting the objectives of a potential terrorist?
  - Accessibility – How accessible is the place to the public?
  - Asset mobility – is the asset's location fixed or mobile?
  - Presence of hazardous materials – Are flammable, explosive, biological, chemical and/or radiological materials present on site? If so, are they well secured?
  - Potential for collateral damage – What are the potential consequences for the surrounding area if the asset is attacked or damaged?
  - Occupancy – What is the potential for mass casualties based on the maximum number of individuals on site at a given time?

- **Tactical vulnerability:**
  - Site Perimeter
    - Site planning and Landscape Design – Is the facility designed with security in mind – both site-specific and with regard to adjacent land uses?
    - Parking Security – Are vehicle access and parking managed in a way that separates vehicles and structures?
  - Building Envelope
    - Structural Engineering – Is the building's envelope designed to be blast-resistant? Does it provide collective protection against chemical, biological and radiological contaminants?
  - Facility Interior
    - Architectural and Interior Space Planning – Does security screening cover all public and private areas?
    - Mechanical Engineering – Are utilities and Heating, Ventilating and Air Conditioning (HVAC) systems protected and/or backed up with redundant systems?
    - Electrical Engineering – Are emergency power and telecommunications available? Are alarm systems operational? Is lighting sufficient?
    - Fire Protection Engineering – Are the building's water supply and fire suppression systems adequate, code-compliant and protected? Are on-site personnel trained appropriately? Are local first responders aware of the nature of the operations at the facility?
    - Electronic and Organized Security – Are systems and personnel in place to monitor and protect the facility?

13.6 INVENTORY ASSETS EXPOSED TERRORISM

Due to its unpredictable nature, all Village assets, including 100 percent of the population, as well as all buildings and infrastructure, can be considered at risk from terrorism. Public facilities such as government buildings, schools, and dams can be considered potential targets for terrorism.

13.7 LAND USE & DEVELOPMENT TRENDS

Land use and development are not directly tied to the prevention or discouragement of terrorism. However, structures can be designed with safety devices meant to protect the populations inside. Precautionary devices such as security cameras and alarms are in use throughout the Village already. Any new municipal or County buildings erected should include such devices.

13.8 TERRORISM HIRA SUMMARY

One of the primary attributes of terrorism is its unexpected nature. This makes planning for potential attacks virtually impossible. The key to terrorism mitigation lies in the planning phase, and understanding the potential vulnerability of a specific area. The Village of Ottawa is rural and agricultural, meaning that it is susceptible to threats against local crops. Computer systems that are vital to maintaining the functions of Village infrastructure are also at risk to potential attacks.