This section of the Plan describes the Hazard Identification and Risk Assessment (HIRA) summary undertaken by Belmont County and participating municipalities in the preparation of this Hazard Mitigation Plan Update. This section consists of the following subsections:

- INTRODUCTION AND UPDATE SUMMARY
- FLOODING
- SEVERE SUMMER STORMS
- SEVERE WINTER STORMS
- LANDSLIDE
- DROUGHT
- TORNADO
- TEMPERATURE EXTREMES
- DAM FAILURE
- MINE SUBSIDENCE
- EPIDEMIC (NARRATIVE)
- INFESTATION (NARRATIVE)
- HAZARDOUS MATERIALS (NARRATIVE)
- TERRORISM (NARRATIVE)
- BRUSH/WILDLAND FIRE (NARRATIVE)
- SEISMIC ACTIVITY/EARTHQUAKE (NARRATIVE)

INTRODUCTION AND UPDATE SUMMARY

A key step in preventing disaster losses in Belmont County is developing a comprehensive understanding of the hazards that pose risks to its communities. The following terms can be found throughout this Plan.

Hazard:	Event or physical conditions that have the potential to cause fatalities, injuries, property damage, infrastructure damage, agricultural loss, damage to the environment, interruption of business, other types of harm or loss
Risk:	Product of a hazard's likelihood of occurrence and its consequences to society
Vulnerability:	Degree of susceptibility and resilience of the community and environment to hazards

Source: Federal Emergency Management Agency, 2001.

The HIRA summary is a process or application of a methodology for evaluating risk as defined by probability and frequency of occurrence of a hazard event, exposure to people and property to the hazard, and consequences of that exposure. Different methodologies exist for assessing the risk of hazard events, ranging from qualitative to quantitative.

Belmont County and its communities are vulnerable to a wide range of natural and technological hazards that threaten life and property. The hazards identified by the Belmont County Mitigation Planning Committee for inclusion in this HIRA summary are those determined to be of actual potential threat to Belmont County and its incorporated jurisdictions, and are consistent with the hazards identified by the State of Ohio and the Federal Emergency Management Agency for this part of the State and this region of the country. The hazards for this 2011 Plan update include:

NATURAL HAZARDS

- FLOODING
- SEVERE SUMMER STORMS
- SEVERE WINTER STORMS
- LANDLSIDE
- DROUGHT
- TORNADO
- TEMPERATURE EXTREMES

TECHNOLOGICAL HAZARDS

- DAM FAILURE
- MINE SUBSIDENCE

NON-PROFILED HAZARDS

- EPIDEMIC
- INFESTATION
- HAZARDOUS MATERIALS
- TERRORISM
- BRUSH/WILDLAND FIRES
- SEISMIC ACTIVITY/EARTHQUAKE

Some of these hazards can be interrelated (for example, severe storms can produce high wind/tornado activity and can cause flooding), and thus discussion of these hazards may overlap where necessary throughout the HIRA.

Of the fifteen (15) hazards profiled in the State of Ohio’s 2011 Hazard Mitigation Plan, nine (9) are addressed in this Plan. In addition, four (4) of the hazards will be covered through a narrative, identifying the hazard, and referencing the appropriate county planning mechanism used to deal with the hazard.

Table 2-1: State/Local Plan Hazards Matrix

STATE OF OHIO HAZARD MITIGATION PLAN 2011	INCLUDED IN BELMONT COUNTY HMP 2013	RATIONALE FOR EXCLUSION
FLOODING	•	
SEISCHE / COASTAL FLOODING		Not an identified hazard
TORNADOES	•	
LANDSLIDES	•	
WINTER STORMS	•	
SEVERE SUMMER STORMS	•	
INVASIVE SPECIES		A narrative will be used to cover this hazard
DAM / LEVEE FAILURE	•	
COASTAL EROSION	•	Not an identified hazard
WILDFIRE		A narrative will be used to cover this hazard
LAND SUBSIDENCE		Not an identified hazard
DROUGHTS	•	
EARTHQUAKES	•	
HAZARDOUS MATERIALS (HAZMAT)		A narrative will be used to cover this hazard
TERRORISM		A narrative will be used to cover this hazard

Table 2-2 documents the review by the Belmont County Mitigation Planning Committee as it relates to those hazards that were to be re-evaluated and/or identified, analyzed, and addressed through the updating of the Countywide HIRA summary. Hazards were either *deferred*, *deleted*, *changed*, or *new* hazards were identified.

Table 2-2: Evaluation of Hazards for Inclusion in 2013 HIRA Summary

2007 HAZARD	STATUS	NOTES	2013 HAZARD
Dam Failure	Deferred		Dam Failure
Drought	Deferred		Drought
Earthquake	Deleted	Planning team decided not to include this hazard in the plan update as there is no earthquake history in Belmont County	N/A
Epidemic	Deleted	This hazard is handled by the County Health Department when it occurs, and does not belong in the mitigation plan	N/A
Flood	Deferred		Flooding
Hailstorm	Changed	Hailstorms will be a part of the Severe Summer Storms hazard profile.	Severe Summer Storms
Landslide	Deferred		Landslide
HazMat	Deleted	This hazard is addressed through the haz-mat annex to the County Emergency Operations Plan (EOP)	N/A

Infestation	Deleted	The planning team made the decision to remove this hazard from the plan	N/A
Mine Subsidence	Deferred		Mine Subsidence
Severe Thunderstorm	Deferred/Changed	This hazard will now be called Severe Summer Storms, and encompass thunderstorms, severe winds and hail	Severe Summer Storms
Severe Wind and Tornado	Deferred/Changed	The severe wind hazard has been profiled in the severe summer storms hazard. Tornados will be its own hazard	Severe Summer Storms/Tornado
Severe Winter Storm and Sleet	Deferred/Changed	This hazard will include all aspects of severe storms, and will not differentiate between the different aspects	Severe Winter Storms
Temperature Extreme	Deferred		Temperature Extremes
Terrorism (Biological)	Deleted	Terrorism is addressed through the County EOP, and will not be covered in the mitigation plan	N/A
Terrorism (Chemical)	Deleted	Terrorism is addressed through the County EOP, and will not be covered in the mitigation plan	N/A
Terrorism (WMD)	Deleted	Terrorism is addressed through the County EOP, and will not be covered in the mitigation plan	N/A
Wildfire	Deleted	The planning team made the decision to remove this hazard from the mitigation plan as fires in the County have not historically reached a level which would require their inclusion in the plan.	N/A

The largest change in this plan update is the inclusion of narratives to describe 6 of the hazards included in the plan. Five of these hazards are carried over from the 2007 plan. These narratives will describe the hazard, and identify any local planning mechanism already in place.

Once the hazards were identified and evaluated for inclusion into the 2013 Plan update, the Belmont MPC then ranked these based on a Risk Factor (RF) approach. To further focus on the list of identified hazards for this Plan, Table 2-3 presents a list of all federal disaster and emergency declarations that have occurred in Belmont County since 1964, according to the Federal Emergency Management Agency. This list presents the foundation for identifying what hazards pose the greatest risk within the County and its jurisdictions.

Table 2-3: Presidential Disaster and Emergency Declarations in Belmont County

DECLARATION #	DATE	EVENT DETAILS	PUBLIC ASSISTANCE RECEIVED
FEMA-DR-4077-OH	08/20/2012	Ohio severe storms and straight-line winds	

FEMA-DR-4002-OH	04/04/2011	Ohio Severe Storms and Flooding	$890,443.04
FEMA-EM-3250-OH	09/13/2005	Hurricane Katrina emergency shelter operations	
FEMA-DR-1580-OH	12/22/2004	Ohio Severe Winter Storms, Flooding and Mudslides	$4,400,980.68
FEMA-DR-1556-OH	08/27/2004	Ohio Severe Storms and Flooding	$7,388,394.54
FEMA-DR-1507-OH	01/03/2004	Ohio Severe Storms, Flooding, Mudslides, Landslides	$3,433,274.78
FEMA-DR-1453-OH	02/14/2003	Ohio Severe Winter Storm	$700,177.99
FEMA-DR-1227-OH	06/24/1998	Ohio Severe Storms, Flooding and Tornadoes	
FEMA-DR-1122-OH	05/02/1996	Ohio Flooding	
FEMA-DR-1097-OH	01/20/1996	Ohio Storms/Floods	
FEMA-DR-951-OH	07/12/1992	Ohio Flooding, Severe Storm, Tornadoes	
FEMA-DR-870-OH	05/28/1990	Ohio Flooding, Severe Storm, Tornado	
FEMA-DR-630-OH	08/23/1980	Ohio Severe Storms, Flooding	
FEMA-EM-3055-OH	01/26/1978	Severe Blizzard Conditions	
FEMA-DR-480-OH	09/11/1975	Ohio Winds, Heavy Rains, Flooding	
FEMA-DR-345-OH	07/19/1972	Ohio Tropical Storm Agnes	
FEMA-DR-167-OH	03/24/1964	Heavy rains and flooding	
FEMA-DR-90-OH	01/23/1959	Ohio Floods	

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. First, the quantitative analysis considered all the GIS and HAZUS data available. 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 Belmont County MPC compared the results of the hazard profile against their local 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 MPC. Based upon any unique concerns for the planning area, the MPC may also adjust the RF weighting scheme. 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:

**RF Value = [(Probability x .30) + (Impact x .30) +
(Spatial Extent x .20) + (Warning Time x .10) + (Duration x .10)]**

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 PROBABILTY	**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**	

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.

RANKING RESULTS

Table 2-4: Risk Factor Results for Belmont County and Participating Jurisdictions

#	NATURAL HAZARDS	PROBABILITY	IMPACT	SPATIAL EXTENT	WARNING TIME	DURATION	RF RATING
1	FLOODING	4 (1.2)	4 (1.2)	3 (0.6)	3 (0.3)	4 (0.4)	**3.7**
2	SEVERE SUMMER STORMS	4 (1.2)	3 (0.9)	4 (0.8)	4 (0.4)	3 (0.3)	**3.6**
3	SEVERE WINTER STORMS	3 (0.9)	3 (0.9)	4 (0.8)	1 (0.1)	3 (0.3)	**3.0**
4	DROUGHT	3 (0.9)	2 (0.6)	4 (0.8)	1 (0.1)	4 (0.4)	**2.8**
5	LANDLSIDE	3 (0.9)	2 (0.6)	2 (0.4)	4 (0.4)	4 (0.4)	**2.7**
6	TORNADO	2 (0.6)	3 (0.9)	2 (0.4)	4 (0.4)	4 (0.4)	**2.7**
7	TEMPERATURE EXTREMES	3 (0.9)	1 (0.3)	4 (0.8)	1 (0.1)	3 (0.3)	**2.4**
#	**TECHNOLOGICAL HAZARDS**	**PROBABILITY**	**IMPACT**	**SPATIAL EXTENT**	**WARNING TIME**	**DURATION**	**RF RATING**
1	DAM FAILURE	1 (0.3)	4 (1.2)	3 (0.6)	4 (0.4)	4 (0.4)	**2.9**
2	MINE SUBSIDENCE	2 (0.6)	1 (0.3)	3 (0.6)	4 (0.4)	4 (0.4)	**2.3**

Based on the RF analysis, the natural hazard with the highest risk potential is “Flooding”, which has a value of 3.7. This is primarily due to the probability of the hazard occurring and the probability of occurrence throughout all areas of the county and the impact to infrastructure. “Severe Summer Storms” was qualitatively calculated as second in risk potential, with a risk factor value of 3.6.

The technological or human-made hazard with the highest risk potential was found to be “Dam Failure”, with a value of 2.9. This is primarily due to a lack of warning time and a high level of impact and the vast spatial extent that could be impacted.

The conclusions drawn from the qualitative and quantitative assessments, combined with final determinations from the Belmont County MPC, were fitted into three categories for a final summary of hazard risk for Belmont County and its participating jurisdictions based on High, Moderate or Low risk designations.

Table 2-5 Conclusions on Hazard Risk for Belmont County and Participating Jurisdictions

HIGH RISK (3.0 or higher)	**FLOODING, SEVERE SUMMER STORMS, SEVERE WINTER STORMS**
MODERATE RISK (2.0 – 2.9)	**DAM FAILURE, DROUGHT, LANDSLIDE, TORNADOTEMPERATURE EXTREMES, MINE SUBSIDENCE**
LOW RISK (0.1 – 1.9)	

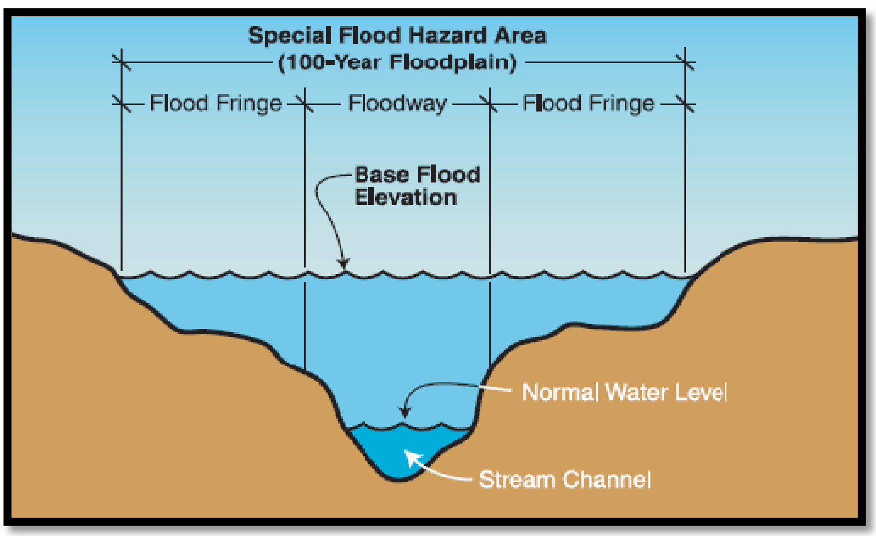
FLOODING

NATURAL HAZARDS	PROBABILITY	IMPACT	SPATIAL EXTENT	WARNING TIME	DURATION	RF RATING (PRIORITY)
FLOODING	4 (1.2)	4 (1.2)	3 (0.6)	3 (0.3)	4 (0.4)	**3.7**
HIGH RISK (3.0 or higher)						

HAZARD IDENTIFICATION

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. As illustrated in the figure below, 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.

Floodplain Terminology



Baker

Floods are considered hazards when people and property are affected. Flooding has been part of Belmont County's history long before the first historical reference in 1883. 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.

Ice Jams are stationary accumulations of ice that restrict 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.

Belmont County and its 32 political subdivisions, which consist of townships, incorporated villages, and incorporated cities, continue to work together to enforce the local floodplain management ordinance requirements set forth by the National Flood Insurance Program (NFIP).

Table 2-6: FEMA Community Status in the NFIP

CID	COMMUNITY NAME	COUNTY	INITIAL FIRM IDENTIFIED	CURRENT EFFECTIVE MAP DATE
390025	BELLAIRE, CITY OF	BELMONT COUNTY	11/02/1983	04/05/2006
390762	BELMONT, COUNTY OF*	BELMONT COUNTY	02/04/1988	04/05/2006
390674	BETHESDA, VILLAGE OF	BELMONT COUNTY	09/18/1987	04/05/2006
390026	BRIDGEPORT, VILLAGE OF	BELMONT COUNTY	02/01/1979	(NSFHA)
390027	BROOKSIDE, VILLAGE OF	BELMONT COUNTY	02/04/1988	04/05/2006
390028	HALLOWAY, VILLAGE OF	BELMONT COUNTY	09/18/1985	04/05/2006
390029	MARTINS FERRY, CITY OF	BELMONT COUNTY	07/05/1983	04/05/2006
390030	POWHATAN POINT, VILLAGE OF	BELMONT COUNTY	07/05/1983	04/05/2006
390031	SHADYSIDE, VILLAGE OF	BELMONT COUNTY	07/18/1983	04/05/2006
390032	ST. CLAIRSVILLE, CITY OF	BELMONT COUNTY	04/05/2006	(NSFHA)
390033	YORKVILLE, VILLAGE OF	BELMONT COUNTY/JEFFERSON COUNTY	10/15/1982	04/05/2006

HAZARD PROFILE

The severity of flooding in Belmont County is determined by a number of local factors, including river basin topography , precipitation patterns, recent soil moisture conditions, and groundcover/vegetative state. Belmont County and its municipalities have many streams and small tributaries that are highly susceptible to flooding, particularly flash flooding. The properties in and near the identified floodplains of Belmont County are subject to flooding events on an almost annual basis. Floodplain management, flood control structures, hazard mitigation, and flood relief funds are strategies that have reduced Belmont County's annual flood damages.

Belmont County has floodplain regulations which were adopted on February 8, 2006 and amended on August 2, 2012. The *Belmont County Special Purpose Flood Damage Reduction Regulations* name a County Floodplain Administrator to administer and implement the regulations. Their duties also include monitoring the floodplain and providing community assistance; to include obtaining flood insurance for property owners. The Belmont County modernized floodplain maps were made effective on April 5, 2006.

Large floods have occurred along the major streams in the basin during all seasons of the year. However, the most devastating floods have occurred between the months of December and March. The maximum flood of record occurred along the Ohio River in March 1936. Along small tributaries, flood stages can rise from normal flow to extreme flood peaks, with accompanying high velocities, in a relatively short period. Along the main stem of the Ohio River, floods rise to their crest over a longer period and remain out of banks for a more extended length of time.

Although many severe floods have occurred in the Upper-Ohio Wheeling River basin since the area was first settled, accurate records prior to 1913 are nonexistent. Considering the available records of all known floods in the basin, it is probable that the ten (10) largest floods in the Upper-Ohio Wheeling River basin occurred in 1936, 1942, 1913, 1907, 1937, 1945, 1964, 1972, and twice in 1937. Discharges for some of the largest floods of record for the Ohio River at Wheeling are shown below.

Table 2-7: Discharge Values for USGS Stream Gauge on the Ohio River	
DATE OF CREST	ESTIMATED PEAK DISCHARGE (CFS)
09/17/2004	22,300 cfs
12/30/1942	22,100 cfs
06/05/1941	20,300 cfs
03/06/1945	19,100 cfs
01/15/1951	15,900 cfs
04/13/1981	15,000 cfs

Information on historical floods in Belmont County along the main stem of the Ohio River and along the lower reaches of its major tributaries was obtained from stream gauging stations maintained by the USGS at several locations within the drainage basin. USGS recording gages within the study area are located at:

- Ohio River at Pike Island Lock & Dam
  - Latitude 40°08'59", Longitude 80°42'06" NAD27
- Ohio River at Wheeling
  - Latitude 40°02'40", Longitude 80°39'40" NAD27
- Captina Creek at S.R. 148 at Armstrongs Mills, Ohio
  - Latitude 39°54'24", Longitude 80°56'10" NAD27
- Wheeling Creek below Blaine, Ohio
  - Latitude 40°04'01", Longitude 80°48'31" NAD27

Table 2-8: Flood Categories for Ohio River at Wheeling (USGS Gauge)	
FLOOD CATEGORIES	FEET
MAJOR FLOOD STAGE	42’
MODERATE FLOOD STAGE	40’
FLOOD STAGE	36’
ACTION STAGE	26.7’

According to the National Climatic Data Center, the greatest impact on Belmont County as a result of flooding that occurred on June 14, 1990 near the Village of Shadyside. It was triggered by ‘perfect storm’ conditions that had 4 inches of rainfall within the span of an hour, causing sheet flow and flash flood conditions. The geographic area has steep slopes that funneled the majority of the rain quickly into tributaries of Pipe and Wegee Creeks. This resulted in rapidly rising water in the tributaries and the creeks. The rising water knocked over trees, destroyed homes and carried debris downstream in a power 6 foot wall of water racing its way to the Ohio River. Over an 80 homes in Shadyside and the

County were classified as destroyed, and an additional 250 classified as damaged. This traumatic flash flood event resulted in the deaths of 26 and over $5,000,000 in damages.

More recently, flash flooding re-emphasized its impact to the county on June 19th, 2011. Heavy rains caused flash flooding in the county particularly in Willow Grove. Roads, bridges, businesses and 97 homes were damaged. There were no deaths or injuries, though 6 people had to be evacuated from their homes. An estimated $1,300,000 in damages occurred.

According to the National Climatic Data Center, Belmont County has been impacted by 98 flood events since 1964.

Table 2-9: Flood Events affecting Belmont County

Location	Date	Type	Death	Injury	Property Damage	Agricultural Damage
Belmont	03/04/1964	Flood	0.11	0.06	$56,818	$0
Belmont	03/09/1964	Flood	0	0	$56,818	$0
Belmont	01/28/1968	Flood	0	0	$568	$0
Belmont	05/23/1968	Flood	0.03	0.11	$13,888	$13,888
Belmont	01/28/1969	Flood	0.01	0	$0	$0
Belmont	03/12/1972	Flood	0	0	$56	$0
Belmont	04/06/1972	Flood	0	0	$568	$0
Belmont	04/12/1972	Flood	0	0	$5,681	$0
Belmont	04/14/1972	Flood	0	0	$568	$0
Belmont	04/19/1972	Flood	0	0	$568	$0
Belmont	06/09/1972	Flood	0	0	$568	$0
Belmont	06/21/1972	Flood	0	0	$31,250	$0
Belmont	03/14/1973	Flood	0	0	$568	$0
Belmont	03/16/1973	Flood	0	0	$5,681	$56
Belmont	02/23/1975	Flood	0	0	$56	$0
Belmont	08/30/1975	Flood	0	0	$250,000	$0
Belmont	02/16/1976	Flood	0	0	$56	$0
Belmont	03/21/1984	Flood	0	0	$5,681	$0
Belmont	02/08/1987	Coastal Flood	0	0	$2,000	$0
Belmont	07/02/1987	Urban Flood	0	0	$18,518	$18,518
Countywide	06/21/1989	Flood	0	0	$17,241	$0
Countywide	05/28/1990	Flash Flood	0	0	$238,095	$2,380
Shadyside	06/14/1990	Flash Flood	0	26	$5,000,000	$5,000
Countywide	12/18/1990	Urban Flood	0	0	$5,681	$0
Countywide	12/29/1990	Urban Flood	0	0	$56,818	$0
Countywide	02/28/1994	Flash Flood	0	0	$50,000	$0
Countywide	06/03/1995	Flash Flood	0	0	$10,000	$0
Countywide	07/15/1995	Flash Flood	0	0	$0	$0
Countywide	07/17/1995	Flash Flood	0	0	$0	$0
Countywide	01/17/1996	Flash Flood	0	0	$25,000	$0
Countywide	01/19/1996	Flash Flood	0	0	$0	$0
Countywide	02/20/1996	Flash Flood	0	0	$0	$0
Countywide	03/20/1996	Flash Flood	0	0	$0	$0
Countywide	05/08/1996	Flash Flood	0	0	$0	$0
Countywide	05/16/1996	Flash Flood	0	0	$20,000	$0

Table 2-9: Flood Events affecting Belmont County

Location	Date	Type	Death	Injury	Property Damage	Agricultural Damage
Countywide	06/19/1996	Flash Flood	0	0	$50,000	$0
Countywide	07/18/1996	Flash Flood	0	0	$0	$0
Countywide	03/02/1997	Flash Flood	0	0	$10,000	$0
Countywide	05/19/1997	Flash Flood	0	0	$3,000	$0
Countywide	05/25/1997	Flash Flood	0	0	$1,000	$0
Countywide	06/02/1997	Flash Flood	0	0	$10,000	$0
Countywide	08/17/1997	Flash Flood	0	0	$5,000	$0
Countywide	08/27/1997	Flash Flood	0	0	$0	$0
Countywide	06/26/1998	Flash Flood	0	0	$0	$0
Countywide	01/07/1998	Flood	0	0	$0	$0
Countywide	01/09/1998	Flood	0	0	$0	$0
Countywide	06/16/1998	Flood	0	0	$20,000	$0
Countywide	06/19/1998	Flood	0	0	$30,000	$0
Countywide	06/26/1998	Flash Flood	0	0	$100,000	$0
Countywide	06/27/1998	Flash Flood	0	0	$0	$0
Countywide	06/28/1998	Flash Flood	1	0	$5,000,000	$5,000,000
Countywide	01/09/1999	Flood	0	0	$20,000	$0
Countywide	01/13/1999	Flood	0	0	$0	$0
Countywide	01/18/1999	Flood	0	0	$0	$0
Countywide	02/13/2000	Flood	0	0	$5,000	$0
Countywide	02/18/2000	Flood	0	0	$0	$0
Countywide	04/17/2000	Flood	0	0	$25,000	$0
Countywide	01/30/2001	Flood	0	0	$0	$0
Countywide	06/06/2001	Flood	0	0	$50,000	$0
Countywide	08/12/2001	Flood	0	0	$2,000	$0
Countywide	06/04/2002	Flood	0	0	$100,000	$0
Countywide	06/06/2002	Flood	0	0	$50,000	$0
Countywide	08/12/2001	Flood	0	0	$2,000	$0
Countywide	06/04/2002	Flood	0	0	$100,000	$0
Countywide	06/06/2002	Flood	0	0	$50,000	$0
Countywide	06/13/2002	Flood	0	0	$0	$0
Countywide	07/16/2002	Flood	0	0	$20,000	$0
Countywide	07/23/2002	Flood	0	0	$5,000	$0
Countywide	02/04/2003	Flash Flood	0	0	$0	$0
Countywide	02/23/2003	Flash Flood	0	0	$0	$0
Countywide	07/31/2003	Flash Flood	0	0	$0	$0
Countywide	08/03/2003	Flash Flood	0	0	$0	$0
Countywide	08/09/2003	Flash Flood	0	0	$0	$0
Countywide	08/15/2003	Flash Flood	0	0	$0	$0
Countywide	08/27/2003	Flash Flood	0	0	$0	$0
Countywide	11/19/2003	Flash Flood	0	0	$0	$0
Countywide	02/03/2004	Flash Flood	0	0	$0	$0
Countywide	05/18/2004	Flash Flood	0	0	$8,000	$0
Countywide	01/02/2006	Flash Flood	0	0	$0	$0
Countywide	07/04/2006	Flash Flood	0	0	$0	$0
Countywide	02/25/2007	Flood	0	0	$0	$0
Shadyside	03/15/2007	Flood	0	0	$0	$0

Table 2-9: Flood Events affecting Belmont County

Location	Date	Type	Death	Injury	Property Damage	Agricultural Damage
Shadyside	03/23/2007	Flash Flood	0	0	$0	$0
St. Clairsville	03/04/2008	Flood	0	0	$5,000	$0
Shadyside	06/17/2009	Flash Flood	0	0	$100,000	$0
St. Clairsville	06/04/2010	Flood	0	0	$35,000	$0
McClainville	06/04/2010	Flood	0	0	$100,000	$0
Busniessburg	06/05/2010	Flash Flood	0	0	$25,000	$0
Morristown	06/05/2010	Flash Flood	0	0	$100,000	$0
Powhatan Pt	02/02/2011	Flood	0	0	$25,000	$0
Businessburg	02/25/2011	Flood	0	0	$25,000	$0
Steinersville	02/25/2011	Flood	0	0	$25,000	$0
Dilles Bottom	04/19/2011	Flood	0	0	$5,000	$0
Bridgeport	05/13/2011	Flood	0	0	$20,000	$0
Countywide	06/19/2011	Flash Flood	0	0	$1,425,000	$0
Martins Ferry	09/26/2011	Flood	0	0	$5,000	$0
Countywide	10/13/2011	Flood	0	0	$15,000	$0
Alledonia	10/13/2011	Flood	0	0	$15,000	$0
		TOTAL:	**1.15**	**26.17**	**$13,463,746**	**$5,039,842**

Reported flood events over the past 48 years provide an acceptable framework for determining the future occurrence in terms of frequency for such events. The probability of the County and its municipalities experiencing a flood event can be difficult to quantify, but based on historical record of 98 flood events since 1964, it can reasonably be assumed that this type of event has occurred once every six months from 1964 through 2012.

[(Current Year) 2012] subtracted by [(Historical Year) 1964] = 48 Years on Record

[(Years on Record) 48] divided by [(Number of Historical Events) 98] = 0.49

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

Figure 2-1: Belmont County Watersheds

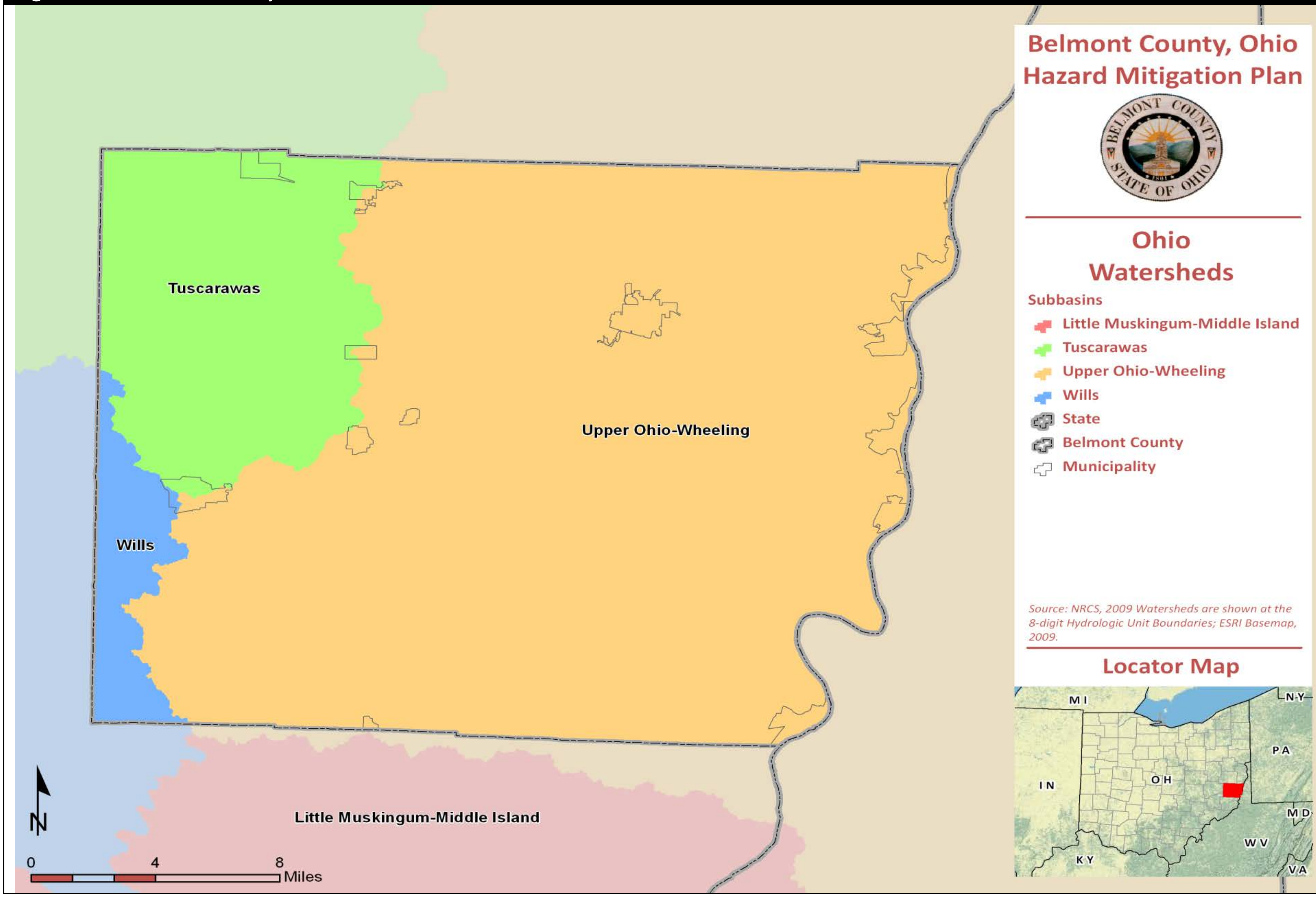
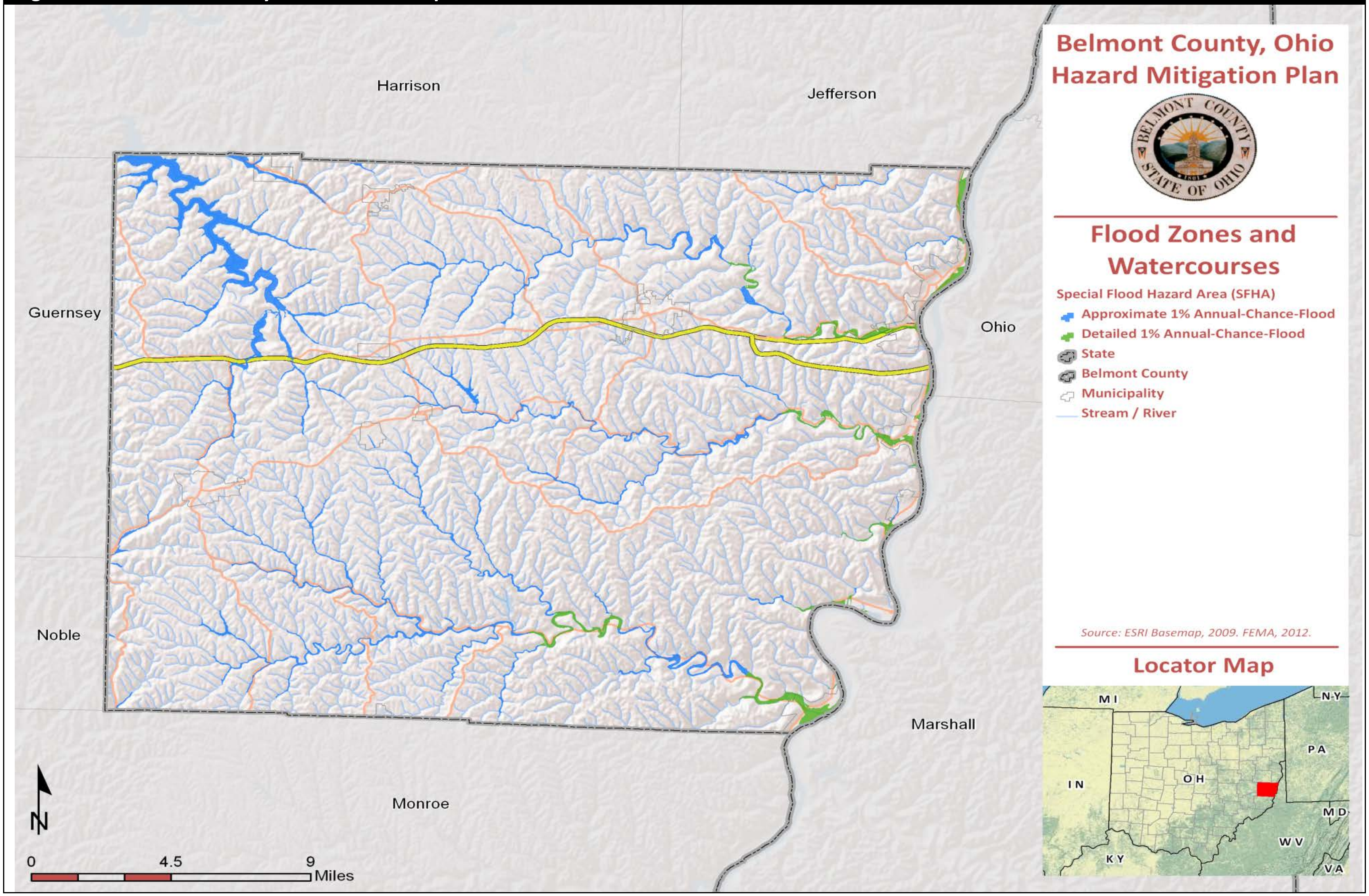


Figure 2-2: Belmont County 100-Yr Flood Map



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 Federal Emergency Management Agency (FEMA) and the National Institute of Buildings Sciences (NIBS). For this Plan update, a 100-year flood scenario was modeled and the results are presented below.

HAZUS-MH (MR4) 100-YEAR FLOOD SCENARIO

HAZUS estimates that approximately 4,596 buildings will be at least moderately damaged and 4,024 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.

Table 2-10: Expected Building Damage by Occupancy (HAZUS Flood Scenario)

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	100.00
Commercial	2	0.80	1	0.40	0	0.00	0	0.00	8	3.20	239	95.60
Education	1	12.50	0	0.00	0	0.00	0	0.00	0	0.00	7	87.50
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	7	100.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	9	13.85	56	86.15
Religion	0	0.00	1	3.85	0	0.00	0	0.00	0	0.00	25	96.15
Residential	0	0.00	6	0.14	38	0.90	108	2.55	401	9.45	3,689	86.96
Total	3		8		38		108		418		4,024	

Table 2-11: Expected Building Damage by Building Type (HAZUS Flood Scenario)

Building	1-10		11-20		21-30		31-40		41-50		Substantially	
Type	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	2	8.00	23	92.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	122	100.00
Masonry	1	0.11	1	0.11	2	0.22	14	1.53	61	6.67	836	91.37
Steel	0	0.00	0	0.00	0	0.00	0	0.00	5	6.02	78	93.98
Wood	0	0.00	7	0.21	36	1.06	94	2.78	343	10.13	2,907	85.83

The scenario reports that no critical facilities in the study region will experience a loss of use or substantial damage by a 100-year flood event. Critical facilities are essential to the health and welfare of the whole population and are especially important following hazard events. HAZUS indicates that there are approximately 80 critical facilities that are floodprone. Please note that HAZUS refers to these buildings as "essential" and the County refers to these as "critical." Also, what the County defines as critical may also differ from what HAZUS refers to as essential facilities.

Table 2-12: HAZUS Determined Critical Facilities that are Floodprone

CRITICAL FACILITIES	# OF FLOODPRONE STRUCTURES
FIRE	27
POLICE	17
HOSPITALS	4
SCHOOLS	35
TOTAL STRUCTURES	**83**

HAZUS estimates the amount of debris that will be generated by the 100-year flood. The model breaks the debris into three general categories: a) Finishes (dry wall, insulation), b) Structural (wood, brick), and c) Foundations (concrete, slab, block, rebar). This distinction is made because of the different types of materials handling equipment required to handle the debris.

The model estimates that a total of 513,463 tons of debris will be generated due to the flood. Of the total amount, finishes comprises 17% of the total, structural comprises of 47% of the total, with the remainder being foundations. If the building tonnage is converted to an estimated number of truckloads, it will require 20,539 truckloads (@25 tons/truck) to remove the debris generated by the flood.

HAZUS estimates the number of households that are expected to be displaced from their homes due to the flood and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 5,267 households to be displaced due to the flood. Of these, 13,215 (out of a total population of 70,226) will seek temporary shelter in public shelters.

The scenario reports that forty-eight critical facilities in the study region will be substantially damaged by a 100-year flood event. Critical facilities are essential to the health and welfare of the whole population and are especially important following hazard events. The following figure illustrates critical facilities located in the flood hazard areas followed by a table providing further data.

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, Belmont County modeled a 100-year flood in Belmont County using FEMA's loss estimation tool: HAZUS-MH.

HAZUS-MH (MR4) 100-YEAR FLOOD SCENARIO

The total economic loss estimated for the flood is 1,504.74 million dollars, which represents 76.29 % of the total replacement value of the scenario buildings.

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 1,497.21 million dollars. 1% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 45.55% of the total loss. The table below provides a summary of the losses associated with the building damage.

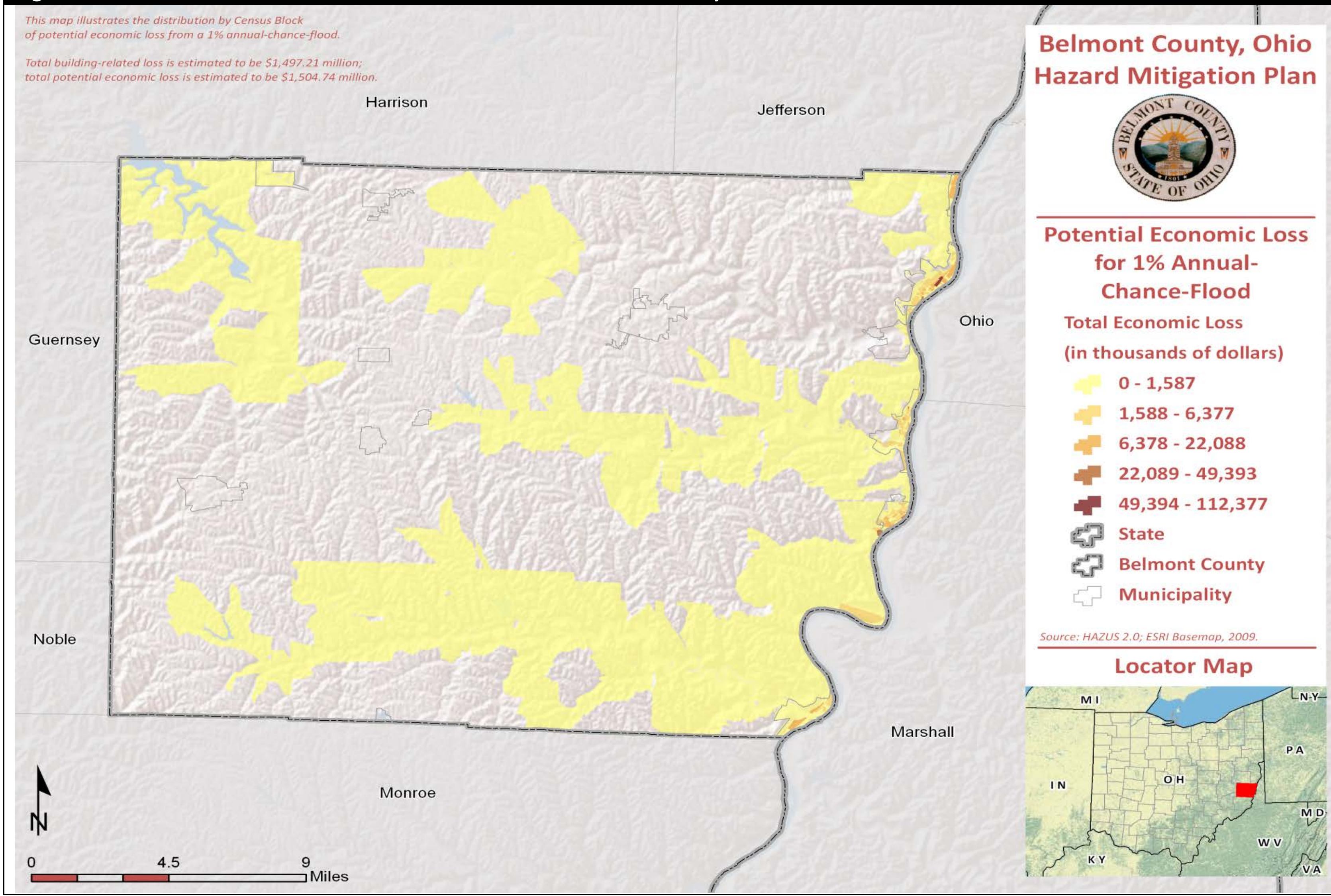
Table 2-13: Building-Related Economic Loss Estimates (HAZUS Flood Scenario)

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	466.79	203.70	44.64	55.78	770.92
	Content	217.97	318.58	86.49	80.26	703.30
	Inventory	0.00	7.59	15.32	0.09	22.99
	Subtotal	**684.76**	**529.87**	**146.45**	**136.13**	**1,497.21**
Business Interruption						
	Income	0.01	1.32	0.02	0.23	1.58
	Relocation	0.50	0.42	0.02	0.11	1.04
	Rental Income	0.09	0.19	0.00	0.00	0.28
	Wage	0.04	1.87	0.02	2.72	4.63
	Subtotal	**0.64**	**3.79**	**0.05**	**3.06**	**7.53**
ALL	**Total**	**685.40**	**533.66**	**146.50**	**139.19**	**1,504.74**

The map on the next page depicts where HAZUS estimated most loss would occur throughout Belmont County.

Figure 2-3: Estimated Loss from 1% Annual Chance Flood as calculated by HAZUS-MH



Baker

The number and value of structures within the 100 year floodplain is significant, as shown by the above map. A flooding event could occur in a highly developed area such as St. Clairsville or Martins Ferry and cause substantial infrastructure damage resulting in high dollar losses. While flooding could certainly affect many facilities in the county, including critical facilities, it is safe to say that few critical facilities in the county are directly located in floodplains. Many fire stations in the county, as well as the county EMA office, are located in the floodplain. Additionally, many measures have been taken to lessen the probability of flooding in the municipal areas, which is where many of the county's critical facilities are located. Many residential structures may be affected by flooding outside of the municipalities. However, with the exception of repetitive loss properties (see discussion below); these structures are not directly located in floodplains either.

Repetitive loss properties are those for which two or more losses of at $1,000 each have been paid under the National Flood Insurance Program (NFIP) within any 10-year period since 1978. The following table details the known repetitive loss properties in Belmont County by location, number of losses, and structure type. As of 2011, there are ten (53) repetitive loss properties located in Belmont County. This number has increased from the previous HMP in 2005. In the previous HMP there were 14 repetitive loss properties listed.

Table 2-14: Repetitive Flood Loss Properties Belmont County

LOCATION	LOSSES	TYPE	BUILDING PAYMENTS	CONTENTS PAYMENTS	TOTAL PAYMENTS	NFIP INSURED
Bellaire, City of	2	ASSMD Condo	$43,572.02	$0.00	$43,572.02	Yes
Bellaire, City of	2	Non-Residential	$47,577.41	$0.00	$47,577.41	No
Bellaire, City of	2	Single-Family Residential	$14,745.69	$0.00	$14,745.69	Yes
Belmont County	2	Non-Residential	$4,430.65	$1,170.08	$5,600.73	No
Belmont County	2	Non-Residential	$22,986.18	$304.00	$23,290.18	Yes
Belmont County	3	Single-Family Residential	$32,994.81	$14,234.50	$47,229.31	Yes
Belmont County	2	Single-Family Residential	$0.00	$4,408.25	$4,408.25	No
Belmont County	2	Single-Family Residential	$6,623.63	$1,091.35	$7,714.98	Yes
Belmont County	3	Single-Family Residential	$1,988.15	$2,890.57	$4,878.72	No
Belmont County	4	Single-Family Residential	$13,728.29	$11,929.22	$25,657.51	No
Belmont County	2	ASSMD Condo	$12,577.97	$8,080.67	$20,658.64	Yes
Belmont County	2	Single-Family Residential	$11,158.42	$3,152.50	$14,310.92	Yes
Belmont County	2	Non-Residential	$10,282.82	$0.00	$10,282.82	No
Belmont County	2	Single-Family Residential	$10,133.20	$321.00	$10,454.20	No
Belmont County	2	Single-Family Residential	$1,906.89	$1,224.39	$3,131.28	No
Belmont County	2	Single-Family Residential	$43,254.20	$0.00	$43,254.20	No
Belmont County	2	Single-Family Residential	$42,961.19	$0.00	$42,961.19	Yes
Belmont County	2	Multi-Family Residential	$44,474.27	$0.00	$44,474.27	Yes
Belmont County	2	Single-Family Residential	$16,668.10	$0.00	$16,668.10	Yes
Belmont County	2	Single-Family Residential	$11,761.38	$4,751.50	$16,512.88	Yes
Belmont County	2	Single-Family Residential	$6,514.00	$0.00	$6,514.00	Yes
Belmont County	5	Single-Family Residential	$41,739.26	$25,982.57	$67,721.83	No
Belmont County	2	Single-Family Residential	$23,851.16	$0.00	$23,851.16	Yes
Belmont County	4	Single-Family Residential	$12,203.26	$0.00	$12,203.26	Yes
Belmont County	2	Single-Family Residential	$44,508.06	$0.00	$44,508.06	No
Belmont County	3	Single-Family Residential	$29,341.34	$1,661.16	$31,002.50	Yes
Belmont County	2	Single-Family Residential	$23,364.19	$0.00	$23,364.19	Yes

Bridgeport, Village of	3	Multi-Family Residential	$27,879.08	$3,589.35	$31,468.43	Yes
Brookside, Village of	3	Non-Residential	$63,530.78	$12,342.17	$75,872.95	Yes
Brookside, Village of	3	Single-Family Residential	$43,447.41	$0.00	$43,447.41	Yes
Brookside, Village of	2	Non-Residential	$29,403.85	$5,669.80	$35,073.65	Yes
Brookside, Village of	2	Single-Family Residential	$10,953.67	$0.00	$10,953.67	Yes
Brookside, Village of	2	Non-Residential	$19,294.61	$5,147.95	$24,442.56	Yes
Martins Ferry, City of	6	Non-Residential	$52,457.33	$5,765.00	$58,222.33	No
Martins Ferry, City of	3	Non-Residential	$138,805.49	$0.00	$138,805.49	Yes
Martins Ferry, City of	2	Non-Residential	$20,281.17	$1,300.00	$21,581.17	Yes
Powhatan Point, Village of	2	Single-Family Residential	$12,112.93	$6,216.04	$18,328.97	No
Powhatan Point, Village of	2	Single-Family Residential	$21,295.94	$0.00	$21,295.94	Yes
Powhatan Point, Village of	2	Single-Family Residential	$38,162.37	$0.00	$38,162.37	Yes
Powhatan Point, Village of	2	Non-Residential	$51,284.30	$0.00	$51,284.30	Yes
Powhatan Point, Village of	2	Non-Residential	$202,200.00	$8,000	$210,200.00	Yes
Powhatan Point, Village of	2	Single-Family Residential	$16,237.91	$0.00	$16,237.91	No
Powhatan Point, Village of	2	Non-Residential	$9,685.77	$11,413.01	$21,098.78	Yes
Powhatan Point, Village of	2	Single-Family Residential	$12,000.00	$0.00	$12,000.00	No
Powhatan Point, Village of	3	Single-Family Residential	$31,979.77	$12,532.23	$44,512.00	Yes
Powhatan Point, Village of	2	Single-Family Residential	$40,036.76	$0.00	$40,036.76	No
Powhatan Point, Village of	2	Multi-Family Residential	$14,000.00	$0.00	$14,000.00	No
Powhatan Point, Village of	2	Non-Residential	$3,254.51	$971.88	$4,226.39	Yes
Powhatan Point, Village of	2	Single-Family Residential	$62,645.07	$0.00	$62,645.07	No
Powhatan Point, Village of	2	Single-Family Residential	$32,806.33	$0.00	$32,806.33	Yes
Powhatan Point, Village of	2	Single-Family Residential	$65,945.95	$10,469.70	$76,415.65	No
Yorkville, Village of	2	Non-Residential	$25,714.92	$0.00	$25,714.92	Yes
TOTAL # OF LOSSES:	**123**					

There is one single-family structure in the county that is categorized as a Severe Repetitive Loss. This property has experienced four losses with building payments of $70,530.00 and contents payments of $5,470.00 for a total of $76,000.

The following chart summarizes the data produced by the level I, 100-year flood scenario performed on Belmont County.

Structure Type	Number	Exposure for 100-year Scenario
Residential	10,469	$1,388,080,000
Non-residential	3,552	$471,071,000
Critical Facilities	839	$113,140,000

LAND USE & DEVELOPMENT TRENDS

Besides the localized flooding, there is also the great amount of property, both private and public that is at risk from flooding. As development grows within the county, there is added risk and probability for damage. It is essential that zoning and 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.

MULTI-JURISDICTIONAL DIFFERENCES

Jurisdiction difference in regard to flooding in Belmont County are determined by a number of local factors, including river basin topography , precipitation patterns, recent soil moisture conditions, and groundcover/vegetative state. Belmont County and its municipalities have many streams and small tributaries that are highly susceptible to flooding. The properties in and near the identified floodplains of Belmont County are subject to flooding events on an almost annual basis. FEMA Flood Insurance Rate Maps (FIRMs) are a good tool for each jurisdiction to use to identify the geographic extent for risk to flooding.

FLOODING HIRA SUMMARY

Severe flooding has the potential to inflict significant damage in Belmont County. Assessing flood damage requires the communities throughout Belmont County to remain alert and notify County officials of potential flood prone areas near infrastructure such as roads, bridges, and buildings. While flooding remains a likely occurrence throughout the identified flood hazard areas of Belmont County, 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, Belmont County does have policies and regulations for development that should help lessen potential damage due to floods.

SEVERE SUMMER STORMS

NATURAL HAZARDS	PROBABILITY	IMPACT	SPATIAL EXTENT	WARNING TIME	DURATION	RF RATING (PRIORITY)
SEVERE SUMMER STORMS	4 (1.2)	3 (0.9)	4 (0.8)	4 (0.4)	3 (0.3)	**3.6**
HIGH RISK (3.0 or higher)						

HAZARD IDENTIFICATION

Severs storms can occur during any season in Belmont County. 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.

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.

Damage from a severe storm in Ohio on March 6th, 2012

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.

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 (NOAA, 2002). ***Tornadoes will also be addressed as a high wind hazard.***

HAZARD PROFILE

Dangerous and damaging factors of a severe storm include tornadoes, hail, lightning strikes, flash flooding, and winds associated with downbursts and microbursts. Reported severe weather events over the past 57 years provide 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, 2008). 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 1.75 inches in diameter are possible and should be accounted for in future planning activities. Non-tornadic, thunderstorm, and non-thunderstorm winds over 100 mph will be addressed in the high wind hazard section. 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 over two hundred recorded severe storms that have either directly or indirectly impacted Belmont County since 1950. Reported damages to infrastructure and agriculture have been significant. One particular storm occurred on July 20, 2008 in Morristown. This storm was a slow moving cold front combined with very unstable air produced scattered severe thunderstorms across eastern Ohio, western Pennsylvania, and northern West Virginia. The storm resulted in trees down in Morristown, structural damage to the roof of a house and a barn near SR 149 southeast of Morristown, and trees and power lines down south of Belmont.

Table 2-15: Severe Storms in Belmont County Since 1950

JURISDICTION AFFECTED	# OF EVENTS	# OF INJURIES	# OF FATALITIES	RECORDED PROPERTY DAMAGES
Belmont County	**257**	**12**	**3**	**$3,217,600**

Reported severe storm events over the past 62 years provide an acceptable framework for determining the future occurrence in terms of frequency for such events. The probability of the County and its municipalities experiencing a severe storm event can be difficult to quantify, but based on historical record of 257 severe storms since 1950, it can reasonably be assumed that this type of event has occurred once every 0.24 years from 1950 through 2012.

[(Current Year) 2012] subtracted by [(Historical Year) 1950] = 62 Years on Record

[(Years on Record) 62] divided by [(Number of Historical Events) 257] = 0.24

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

[LIGHTNING]

In terms of lightning strikes as a result of a severe thunderstorm, according to past occurences, there have been 3 notable events since 1950. The greatest impact due to a lightning strike in Belmont County occurred on May 31, 2010. On this date, Scattered severe thunderstorms developed across eastern Ohio and western Pennsylvania as a warm front slowly pushed north across the region. Heavy rainfall with the storms also caused minor flooding. The storm resulted in an inmate being killed and five others injured after a lightning strike at the Belmont County Correctional Facility while prisoners were in the recreational yard. Three of the injured were taken to the hospital for treatment.

Table 2-16: Lightning Strikes in Belmont County since 1950

JURISDICTION AFFECTED	DATE	# OF INJURIES	# OF FATALITIES	RECORDED PROPERTY DAMAGES
St. Clairsville	7/15/1995	0	0	$5,000
St. Clairsville	7/15/1995	0	0	$5,000
Somerton	06/28/1998	0	1	$0
St. Clairsville	05/31/2010	5	1	$0
TOTALS		**6**	**1**	**$10,000**

Reported lightning strikes over the past 17 years provide an acceptable framework for determining the future occurrence in terms of frequency for such events. The probability of the County and its municipalities experiencing a lightning strike associated with damages or injury can be difficult to quantify, but based on historical record of 3 lightning strikes since 1995, that have either caused damages to buildings and infrastructure or resulted in an injury or death, it can reasonably be assumed that this type of event has occurred once every 5.7 years from 1995 through 2012.

[(Current Year) 2012] subtracted by [(Historical Year) 1995] = 17 Years on Record

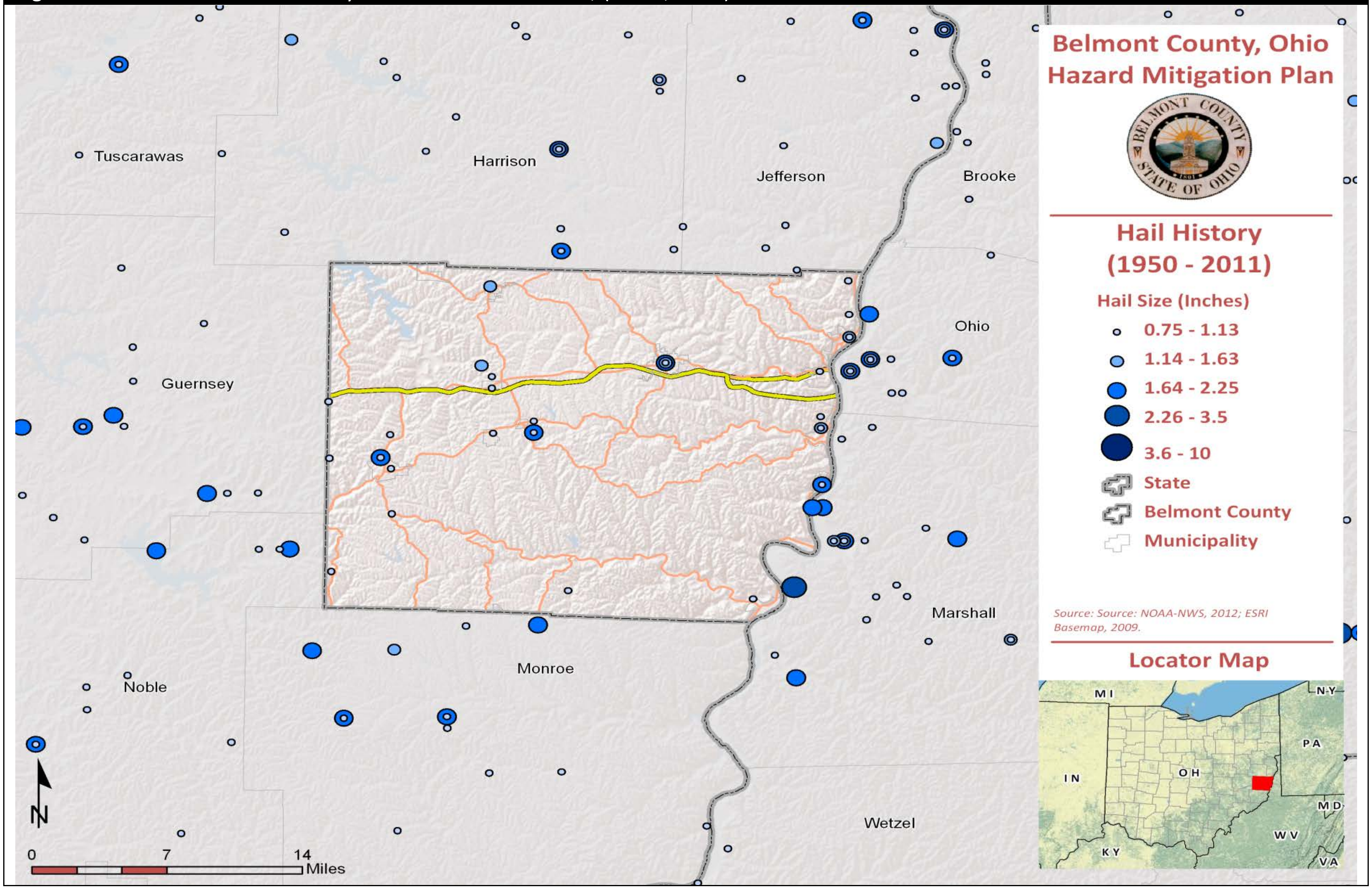
[(Years on Record) 17] divided by [(Number of Historical Events) 3] = 5.7

Furthermore, the historic frequency calculates that there is a 17% chance of this type of event occurring each year.

[HAIL]

Hail is a product of raindrops that are frozen in the upper atmosphere that fall to the earth due to gravity. The size of individual hail stones vary, contingent upon their being repeatedly blown into higher elevations. Hailstorms are always associated with heavy rain, gusty winds, thunderstorms, and lightning. Depending upon the size of the hailstones and the severity of respective storm, damage can occur to property (structures, vehicles, as well as crops). The figure on the next page shows the location of previous hailstorm events for Belmont County.

Figure 2-4: Hailstorm Event History and Associated Hail Size, (NCDC, 2011)



The NCDC and SHELDUS databases show only crop damages resulting directly from hail events in Belmont County. In addition, there have been no injuries or fatalities resulting from hail. Recorded hail size has ranged from .75 inches to 1.75 inches.

Table 2-17: Hail Events in Belmont County Since 1950				
NATURAL HAZARD	# OF EVENTS	# OF INJURIES	RECORDED PROPERTY DAMAGE	RECORDED CROP DAMAGES
Hail Event	65	0	$0	$21,000

Reported hail events over the past 62 years provide an acceptable framework for determining the future occurrence in terms of frequency for such events. The probability of the County and its municipalities experiencing a hail event can be difficult to quantify, but based on historical record of 65 hail events since 1950, it can reasonably be assumed that this type of event has occurred once every 0.53 years from 1963 through 2012.

[(Current Year) 2012] subtracted by [(Historical Year) 1950] = 62 Years on Record

[(Years on Record) 62] divided by [(Number of Historical Events) 65] = 0.95

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

INVENTORY ASSETS EXPOSED TO SEVERE STORMS AND LIGHTNING

All assets located in Belmont County can be considered at risk from severe storms. This includes 70,151 people, or 100 percent of the County's population and all buildings and infrastructure within the County. Damages primarily occur as a result of high winds, lightning strikes, hail, and flooding. Most structures, including the county's 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.

POTENTIAL LOSSES FROM SEVERE STORMS AND LIGHTNING

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 summer storms will remain a highly likely occurrence for Belmont County. Lightning, hail and tornadoes may also be experienced in the area due to such storms.

Table 2-18: Damage Estimates for Several Categories of Severe Weather				
CATEGORY	TIME PERIOD ON RECORD	# EVENTS	DAMAGES	AVG. DAMAGE PER EVENT
Thunderstorms	1950-2012	257	$3,217,600	$12,519
Hail	1950-2012	65	$0	$0

Table 2-18: Damage Estimates for Several Categories of Severe Weather				
CATEGORY	TIME PERIOD ON RECORD	# EVENTS	DAMAGES	AVG. DAMAGE PER EVENT
Lightning	1950-2012	4	$10,000	$2,500

There is no way to predict an area that will be impacted by thunderstorm winds, hail storms or lightning strikes. As a result, all property located within the County must be viewed as susceptible to the effects of a thunderstorm. The Belmont County Auditor has determined that the Cities of Martins Ferry and St. Clairsville have property valued at over $200 million. These cities represent the largest population centers for the County, and will be used as an example of the property at risk. Those properties break down as follows:

Structure Type	Number	Loss Estimate
Residential	6638	$130,802,060.00
Non-residential	888	$67,965,660.00
Critical Facilities	287	$1,445,840.00

LAND USE & DEVELOPMENT TRENDS RELATED TO SEVERE STORMS AND LIGHTNING

All future structures and infrastructure built in Belmont County will likely be exposed to severe storms, lightning, and hail and may experience damage. Since the previous statement is assumed to be uniform countywide, the location of development does not increase or reduce the risk necessarily. Belmont County and its jurisdiction need to adhere to building codes, and therefore, new development can be built to current standards for wind resistance. Additionally, as homes are built throughout the county, accessing the majority of residents may become difficult should sheltering or emergency services be needed in an extreme event.

MULTI-JURISDICTIONAL DIFFERENCES

In the case of lightning strikes, population and building density has a correlation with hazard vulnerability and loss. In particular, the urban and suburban areas around Norwalk have higher population and structure density as well as taller buildings that can act as lightning rods; therefore, they naturally have experienced greater vulnerability and loss during past lightning events. The environmental impacts most often associated with lightning strikes include damage or death to trees and ignition of wildfires. Jurisdictions that are heavily forested and that have, in the past, experienced wildfires that start because of a lightning strike are also vulnerable to losses due to lightning. Additionally older homes that are in deteriorating condition and those mobile homes composed aluminum-clad are also more susceptible to severe storms that generate high winds.

SEVERE STORMS AND LIGHTNING HIRA SUMMARY

In summary, Belmont County along with all its municipalities is subject to severe summer storms. Dangerous and damaging aspects of a severe storm, other than tornadoes, are hail, lightning strikes, flash flooding, and the winds associated with downbursts and microbursts. Compared with other atmospheric hazards such as tropical cyclones and winter low pressure systems, individual thunderstorms affect relatively small geographic areas.

SEVERE WINTER STORMS

NATURAL HAZARDS	PROBABILITY	IMPACT	SPATIAL EXTENT	WARNING TIME	DURATION	RF RATING
SEVERE WINTER STORMS	3 (0.9)	3 (0.9)	4 (0.8)	1 (0.1)	3 (0.3)	**3.0**
HIGH RISK (3.0 – 3.9)						

HAZARD IDENTIFICATION

Ice build-up on a tree limb

Belmont County has been impacted by varying degrees of winter weather over the last century; however; the occurrence of severe winter weather in the county 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. The 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.

Extreme Cold, in extended periods, although infrequent, could occur throughout the winter months in Belmont County. 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)

HAZARD PROFILE

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

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 Maryland does have an extensive history of severe winter weather. Maryland's greatest winter storms are the nor'easters. For nor'easters to occur in Maryland, an arctic air mass would be in place. While high pressure builds over New England, cold arctic air flows south from the high pressure area. The dense cold air is unable to move west over the Appalachian Mountains; therefore, it funnels south down the valleys and along the Coastal Plain. Winds around the nor'easter's center can become intense. The strong northeast winds that rack the East Coast and inland areas give the storm its name. The wind builds large waves that batter the coastline and sometimes pile water inland, causing major coastal flooding and severe beach erosion. Unlike hurricanes, which usually come and go within one tide cycle, the nor'easter can linger through several tides, each one piling more and more water on shore and into the bays while dragging more sand away from the beaches.

Ice accumulations can lead to downed trees, utility poles and communication towers. Ice can disrupt communications and power while utility companies repair significant damage. Even small accumulations of ice can be extremely dangerous to motorists and pedestrians. Bridges can overpasses are particularly dangerous because they freeze before other surfaces. An ice storm is a type of winter storm characterized by freezing rain. The US National Weather Service defines an ice storm as a storm which results in the accumulation of at least .25 inch of ice on exposed surfaces.

Table 2-19: Severe Winter Storms Since 1950

NATURAL HAZARD	# OF EVENTS	# OF INJURIES	# OF FATALITIES	RECORDED PROPERTY DAMAGES
Winter Storm/Heavy Snow/Ice	52	36	1	$6,292,224
TOTALS	**52**	**36**	**1**	**$6,292,224**

Reported heavy snow events over the past 46 years provide an acceptable framework for determining the future occurrence in terms of frequency for such events. The probability of the County and its municipalities experiencing a severe winter storm can be difficult to quantify, but based on historical record of 52 winter storm events since 1966, it can reasonably be assumed that this type of event has occurred roughly once every year from 1966 through 2012.

[(Current Year) 2012] subtracted by [(Historical Year) 1966] = 46 Years on Record

[(Years on Record) 46] divided by [(Number of Historical Events) 52] = 0 .88

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

Of these storms, occurring on January 26th, 1978, was a devastating one, causing over $5.6 million in property damages. Another winter event occurred on, February 8th, 1994 and resulted in injuring 33 people and causing $117,021.28 worth of total damage.

INVENTORY ASSETS EXPOSED TO SEVERE WINTER STORMS

All assets located in Belmont County can be considered at risk from severe winter storms. This includes 100 percent of the County's population and all buildings and infrastructure within the County. 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 county'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.

There is no way to predict an area that will be impacted severe winter storms. As a result, all property located within the County must be viewed as susceptible to the effects of a winter storms. However, it is unlikely that a winter storm will actually destroy property. It is far more likely that property would be rendered unusable due to a lack of heat, or an inability to reach it due to road closures. In the blizzard of 1978, many schools, industrial areas and other properties were rendered inert for two days. That two day period will be used as a worst case scenario for this evaluation. Based on property values provided by the Belmont County Auditor, the dollar loss from unusable residential, non-residential and critical facilities would look like this:

Structure Type	Number	Loss Estimate
Residential	6638	$716,723.61
Non-residential	888	$372,414.57
Critical Facilities	287	$7,922.41

These figures were derived from taking the total value of each property type, and dividing it by 365 (days in a year) and then multiplying it by 2 (the number of days that they could be rendered unusable).

POTENTIAL LOSSES FROM SEVERE WINTER STORMS

A timely forecast may not be able to mitigate the 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.

LAND USE & DEVELOPMENT TRENDS RELATED TO SEVERE WINTER STORMS

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 highly 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.

MULTI-JURISDICTIONAL DIFFERENCES

In the case of severe winter storms, population and building density has a correlation with hazard vulnerability and loss.

SEVERE WINTER STORMS HIRA SUMMARY

Belmont County 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.

DROUGHT

NATURAL HAZARDS	PROBABILITY	IMPACT	SPATIAL EXTENT	WARNING TIME	DURATION	RF RATING (PRIORITY)
DROUGHT	3 (0.9)	2 (0.6)	4 (0.8)	1 (0.1)	4 (0.4)	**2.8**
MODERATE RISK HAZARD (2.0 – 2.9)						

HAZARD IDENTIFICATION

Drought is a normal part of virtually all climates, including areas with high and low average rainfall. It is caused by a deficiency of precipitation and can be aggravated by other factors such as high temperatures, high winds, and low relative humidity.

Droughts can be grouped as meteorological, hydrologic, agricultural, and socioeconomic. Representative definitions commonly used to describe the types of drought are summarized below.

Meteorological drought is defined solely on the degrees of dryness, expressed as a departure of actual precipitation from an expected average or normal amount based on monthly, seasonal, or annual time scales.

Hydrologic drought is related to the effects of precipitation shortfalls on streamflows and reservoir, lake, and groundwater levels.

Agricultural drought is defined principally in terms of soil moisture deficiencies relative to water demands of plant life, usually crops.

Socioeconomic drought 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 a weather related supply shortfall. The incidence of this type of drought can increase because of a change in the amount of rainfall, a change in societal demands for water (or vulnerability to water shortages), or both.

The Standardized Precipitation Index (SPI) is a drought index based on the probability of an observed precipitation deficit occurring over a given prior time period. The assessment periods considered range from 1 to 36 months. The variable time scale allows the SPI to describe drought conditions important for a range of meteorological, agricultural, and hydrological applications. For example, soil moisture conditions respond to precipitation deficits occurring on a relatively short time scale, whereas groundwater, stream flow, and reservoir storage respond to precipitation deficits arising over many months.

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 2-20: Drought Severity Classification

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

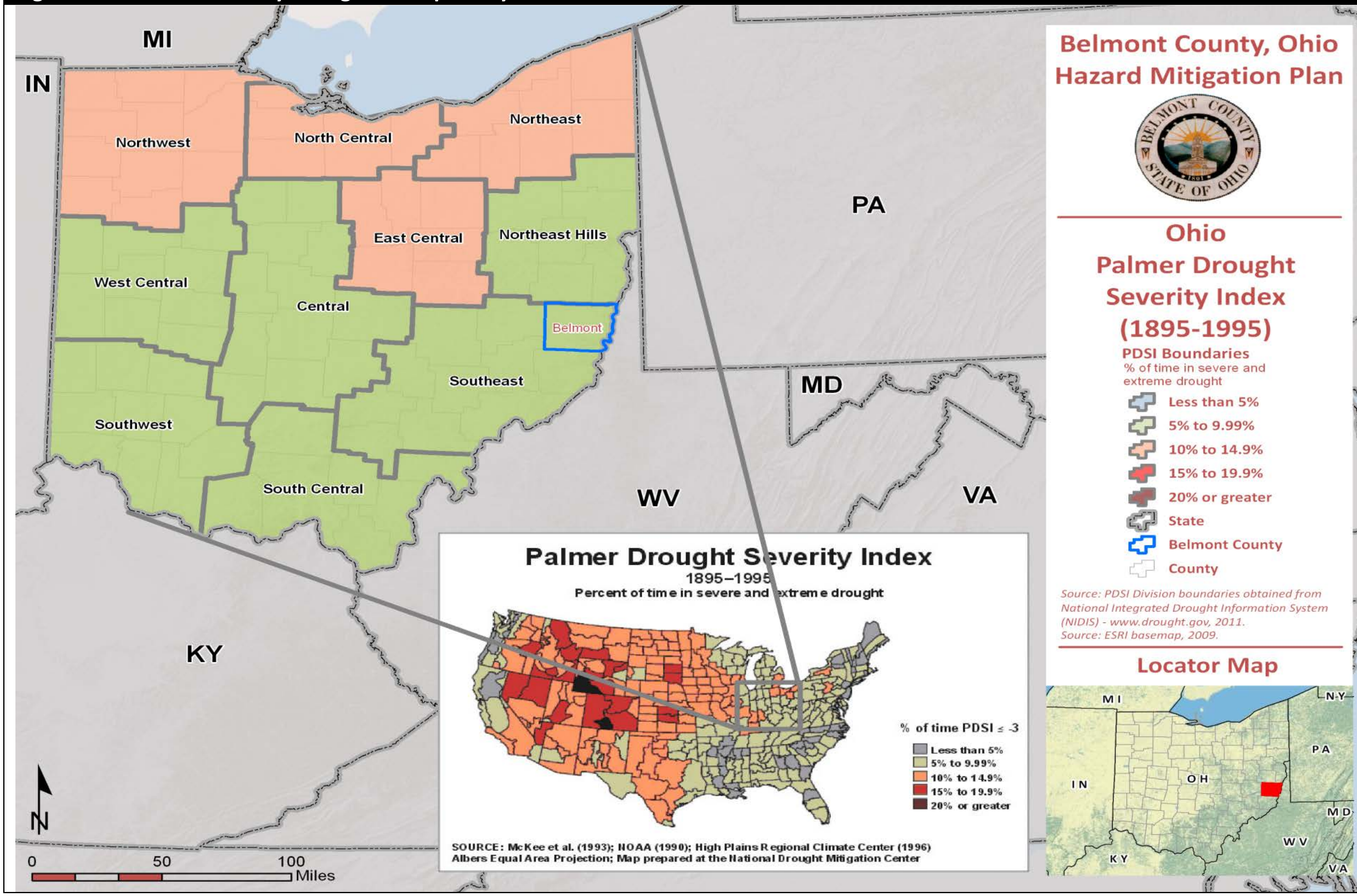
Source: National Drought Mitigation Center

HAZARD PROFILE

There is no commonly accepted approach for assessing risk associated with droughts given the varying types and indices. Drought risk is 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 Belmont County'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 County-level mapping. All jurisdictions are assumed to have the same risk level within Belmont County. Mapping of the current drought status is published by the National Integrated Drought Information System (NIDIS): U.S. Drought Portal which can be found online at: www.drought.gov.

Figure 2-5: Belmont County Drought Susceptibility



According to SHELDUS and NOAA, since 1960, Belmont County has not been subjected to a period of drought. In addition, in 2012, much of the United States is suffering from drought conditions due to lack of rainfall. The damages from these conditions have not yet been calculated.

Table 2-21: Drought Events in Belmont County since 1999

#	LOCATION	DATE	TYPE	DEATH	INJURY	AGRICULTURAL DAMAGE
2	Countywide	06/12/2012	Drought	0	0	$0
TOTAL				0	0	$0

The 2012-2013 North American drought 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.

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 streamflow, 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.).

- *Other:*
  Drought impacts that do not easily fit into any of the above categories.

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 Belmont County and its municipality experiencing a drought event can be difficult to quantify, even more so when the county has no historical record of drought. It can be reasonably assumed that the

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. (National Oceanic and Atmospheric Administration, 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.

INVENTORY ASSETS EXPOSED 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. In addition, Belmont County has over 230 farms that historically have agricultural crops valued at $14.3 million.

But a drought evolves slowly 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.

Although drought effects are generally seen as limited to agriculture losses, drought conditions can also impact buildings. The loss of water, or reduction in the amount of available water can lead to a building being unusable for a time being. If there were to be a prolonged drought in Belmont County, and structures became unusable due to the absence of water available, then those structures could be considered to be impacted by the drought conditions. The Belmont County Auditor has determined that the Cities of Martins Ferry and St. Clairsville have property valued at over $200 million. These cities represent the largest population centers for the County, and will be used as an example of the property at risk. Those properties break down as follows:

Structure Type	Number	Loss Estimate
Residential	6638	$130,802,060.00
Non-residential	888	$67,965,660.00
Critical Facilities	287	$1,445,840.00

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.

MULTI-JURISDICTIONAL DIFFERENCES

Due to the nature of drought, all jurisdictions within Belmont County are expected to be impacted equally due to drought conditions. Land use codes do require that firebreaks be utilized in areas susceptible to wildfire.

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 Belmont County 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 Belmont County gains more experience assessing and responding to drought, future actions will undoubtedly become more timely, effective, and less reactive.

LANDSLIDE

NATURAL HAZARDS	PROBABILITY	IMPACT	SPATIAL EXTENT	WARNING TIME	DURATION	RF RATING (PRIORITY)
LANDSLIDE	3 (0.9)	2 (0.6)	2 (0.4)	4 (0.4)	4 (0.4)	**2.7**
MODERATE RISK HAZARD (2.0 – 2.9)						

HAZARD IDENTIFICATION

A **landslide** is the downward and outward movement of slope-forming soil, rock, and vegetation, which is driven by gravity. Landslides may be triggered by both natural and human-caused changes in the environment, including heavy rain, rapid snow melt, steepening of slopes due to construction or erosion, earthquakes, volcanic eruptions, and changes in groundwater levels.

There are several types of landslides:

Rock falls are rapid movements of bedrock, which result in bouncing or rolling.

A *topple* is a section or block of rock that rotates or tilts before falling to the slope below.

Slides are movements of soil or rock along a distinct surface of rupture, which separates the slide material from the more stable underlying material.

Mudflows, sometimes referred to as mudslides, mudflows, lahars or debris avalanches, are fast-moving rivers of rock, earth, and other debris saturated with water. They develop when water rapidly accumulates in the ground, such as heavy rainfall or rapid snowmelt, changing the soil into a flowing river of mud or "slurry." Slurry can flow rapidly down slopes or through channels, and can strike with little or no warning at avalanche speeds. Slurry can travel several miles from its source, growing in size as it picks up trees, cars, and other materials along the way. As the flows reach flatter ground, the mudflow spreads over a broad area where it can accumulate in thick deposits.

Landslides are typically associated with periods of heavy rainfall or rapid snow melt and tend to worsen the effects of flooding that often accompanies these events. In areas burned by forest and brush fires, a lower threshold of precipitation may initiate landslides. Some landslides move slowly and cause damage gradually, whereas others move so rapidly that they can destroy property and take lives suddenly and unexpectedly. Among the most destructive types of debris flows are those that accompany volcanic eruptions. A spectacular example in the United States was a massive debris flow resulting from the 1980 eruptions of Mount St. Helens, Washington. Areas near the bases of many volcanoes in the Cascade Mountain Range of California, Oregon and Washington are at risk from the same types of flows during future volcanic eruptions.

Areas that are generally prone to landslide hazards include previous landslide areas; the bases of steep slopes; the bases of drainage channels; and developed hillsides where leach-field septic systems are used. Areas that are typically considered safe from landslides include areas that have not moved in the past; relatively flat-lying areas away from sudden changes in slope; and areas at the top or along ridges, set back from the tops of slopes. In the United States, it is estimated that landslides cause up to $2 billion in damages and from 25 to 50 deaths annually. Globally, landslides cause billions of dollars in damage and thousands of deaths and injuries each year.

HAZARD PROFILE

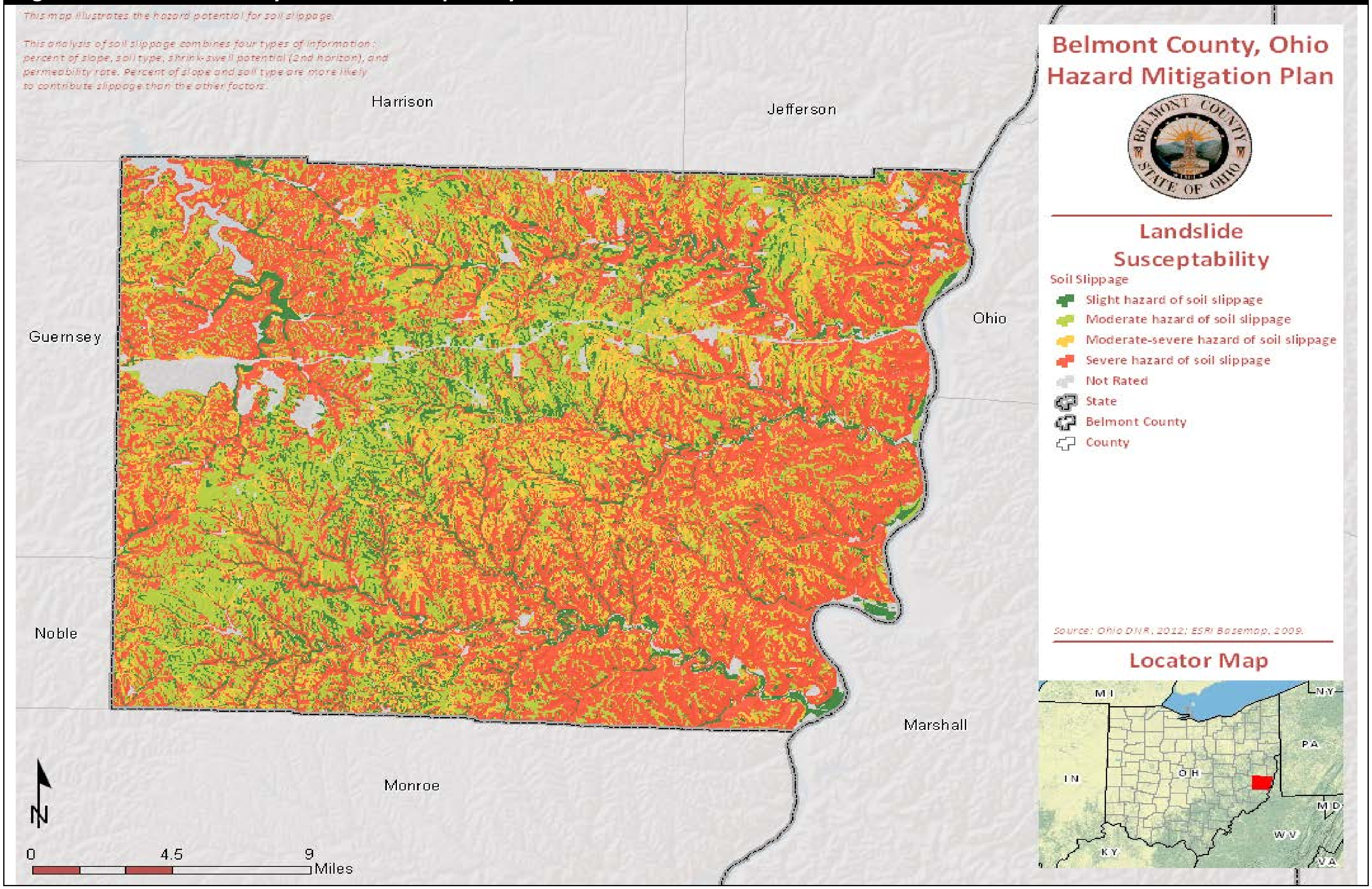
Location, Extent & Magnitude

Belmont County, located in Eastern Ohio, has low susceptibility to the landslide hazard. However, Southeast Ohio has by far the highest concentration of landslides throughout the commonwealth. Landslides occur primarily in colluvial (loose) soil and old landslide debris on steep slopes. Most major and minor highways have sections cut in rock or soil that can fail. Steep mountain slopes across the state have experienced debris avalanches associated with extreme rainfall or rain-on-snow events. Glacial and glacial-lake sediments underlie stream bank and lake bluff slumps and other failure areas across the much of the northern part of the state.

Urban and rural land development is increasing both the number of landslides and the economic effects of natural slides. Major highway construction with large excavations and fills located in mountainous areas creates potential for many landslides.

Landslides cause damage to transportation routes, utilities, and buildings, create travel delays and other side effects. Fortunately, deaths and injuries due to landslides are rare in Ohio. Almost all of the known deaths due to landslides have occurred when boulders/rocks fall along highways and involve vehicles. Storm induced debris flows are the only other type of landslide likely to cause death and injury. Most landslides that do occur in Ohio are moderate to slow moving and damage infrastructure rather than people. The Ohio Department of Transportation and large municipalities incur substantial costs due to landslide damage and to extra construction costs for new roads in known landslide-prone areas.

Figure 2-6: Belmont County Landslide Susceptibility



FREQUENCY OF OCCURENCE

There have been several landslides in the state and in Belmont County and landslides remain a possible occurrence in localized areas of Belmont County, but impacts from such an event would likely cause minimal localized damage and are unlikely. The USGS continues to devote fewer resources to landslide mapping (and no resources to landslide probability modeling) because landslides tend to have much more isolated impacts. Thus, the probability of Belmont County experiencing a landslide in a given year is low and would be typically localized.

INVENTORY ASSETS EXPOSED AND POTENTIAL LOSSES FROM LANDSLIDES

Several communities in Belmont County are vulnerable to landslides. Any events would take place in steeply sloped areas. In addition, places where landforms have been altered for purposes of highway construction or other development may be uniquely vulnerable to landslide hazards. This is especially true if development is located at the base or crest of cliffs or near large highway cut-outs. Although considered low, the susceptibility of landslide is greatest in the eastern area of the county. These areas should be considered vulnerable to landslides, particularly if mitigation measures have not been implemented.

There is no way to predict an area that will be impacted landslides. However, based on information provided by ODNR, the City of Martins Ferry is located in an area deemed to have a severe soil slippage issue. Martins Ferry has over $100 million in residential and non-residential properties, as well as almost $1 million in critical facilities that could be at risk to landslides.

Structure Type	Number	Loss Estimate
Residential	3926	$77,361,830.00
Non-residential	441	$33,769,917.00
Critical Facilities	287	$755,550.00

LAND USE & DEVELOPMENT TRENDS

The effects of a landslide can play a factor in the development and future use of land within Belmont County. Avoid building in high landslide risk zones.

LANDSLIDES HIRA SUMMARY

Landslides gives little to no warning. The after-effects from a landslide can include impacts to roadways, homes, buildings and critical infrastructure. They are not seasonal, though most likely occur in high rainfall events, and can happen year round. This can present its own set of issues.

TORNADO

NATURAL HAZARDS	PROBABILITY	IMPACT	SPATIAL EXTENT	WARNING TIME	DURATION	RF RATING (PRIORITY)
TORNADO	2 (0.6)	3 (0.9)	2 (0.4)	4 (0.4)	4 (0.4)	**2.7**
MODERATE RISK HAZARD (2.0 – 2.9)						

HAZARD IDENTIFICATION

Wind can be defined as the motion of air relative to the earth's surface. The horizontal component of the three-dimensional flow and the near-surface wind phenomenon are the most significant aspects of the hazard. Extreme windstorm events are associated with extratropical and tropical cyclones, winter cyclones, and severe thunderstorms and accompanying mesoscale offspring such as tornadoes and downbursts. Winds vary from zero at ground level to 200-mph in the upper atmospheric jet stream at 6 to 8 miles above the earth's surface.

The damaging effects of windstorms associated with hurricanes may extend for distances in excess of 100 miles from the center of storm activity. For coastal areas from Texas to Maine, tropical cyclone winds may exceed 100 mph. Severe thunderstorms can produce wind downbursts and microbursts, as well as tornadoes. Severe windstorms result in as many as 1,000 tornadoes annually.

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 (NOAA, 2002).

Tornado damage in Ohio from a storm on March 6th, 2012

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 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 2-22: 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 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 following tables.

Table 2-23: Institutional Buildings	
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 2-24: Educational Institutions (Elementary Schools, High Schools)	
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 2-25: Metal Building Systems	
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 2-26: Electric Transmission Lines	
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)

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.

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.

HAZARD PROFILE

Belmont County may experience intense winds from hurricanes and tropical storms and while tornadoes can occur any time of the year, peak tornado occurrences are in March through May as past records further indicate below.

According to the University of South Carolina's Hazards and Vulnerability Research Institute (SHELDUS) as well as the National Climatic Data Center, Belmont County has been impacted by 2 tornado events since 1950.

Table 2-27 Tornado History Since 1950							
LOCATION	**DATE**	**TYPE**	**MAGNITUDE**	**DEATH**	**INJURY**	**PROPERTY DAMAGE**	**CROP DAMAGE**
Belmont County	6/22/1985	Tornado	EF1	0	0	$25,000	$0
Belmont County	6/29/1987	Tornado	EF0	0	0	$25,000	$0
			TOTALS:	**0**	**0**	**$50,000**	**$0**

Reported tornado events over the past 62 years provide an acceptable framework for determining the future occurrence in terms of frequency for such events. The probability of the County and its municipalities experiencing a tornado event, although infrequent, can be difficult to quantify, but based on historical record of 2 tornado events since 1950, it can reasonably be assumed that this type of event has occurred once every 31 years from 1950 through 2012.

[(Current Year) 2012] subtracted by [(Historical Year) 1950] = 62 Years on Record

[(Years on Record) 62] divided by [(Number of Historical Events) 2] = 31

Furthermore, the historic frequency calculates that there is a 0.04% chance of this type of event occurring each year.

INVENTORY ASSETS EXPOSED TO TORNADOES

All assets located in Belmont County can be considered at risk from tornadoes and wind events. This includes 70,400 people, or 100% of the County's population and all critical facilities, structures, and infrastructure.

There is no way to predict an area that will be impacted by tornadoes. An EF5 tornado is capable of having a width of over a mile wide. At that size, the entire inventory of properties within the cities of Martins Ferry or St. Clairsville would be at risk. The property breakdown (number and value) for Martins Ferry are as follows:

Structure Type	Number	Loss Estimate
Residential	3926	$77,361,830.00
Non-residential	441	$33,769,917.00
Critical Facilities	287	$755,550.00

POTENTIAL LOSSES FROM TORNADOES

While all assets are considered at risk from this hazard, a particular tornado would only cause damages along its specific track.

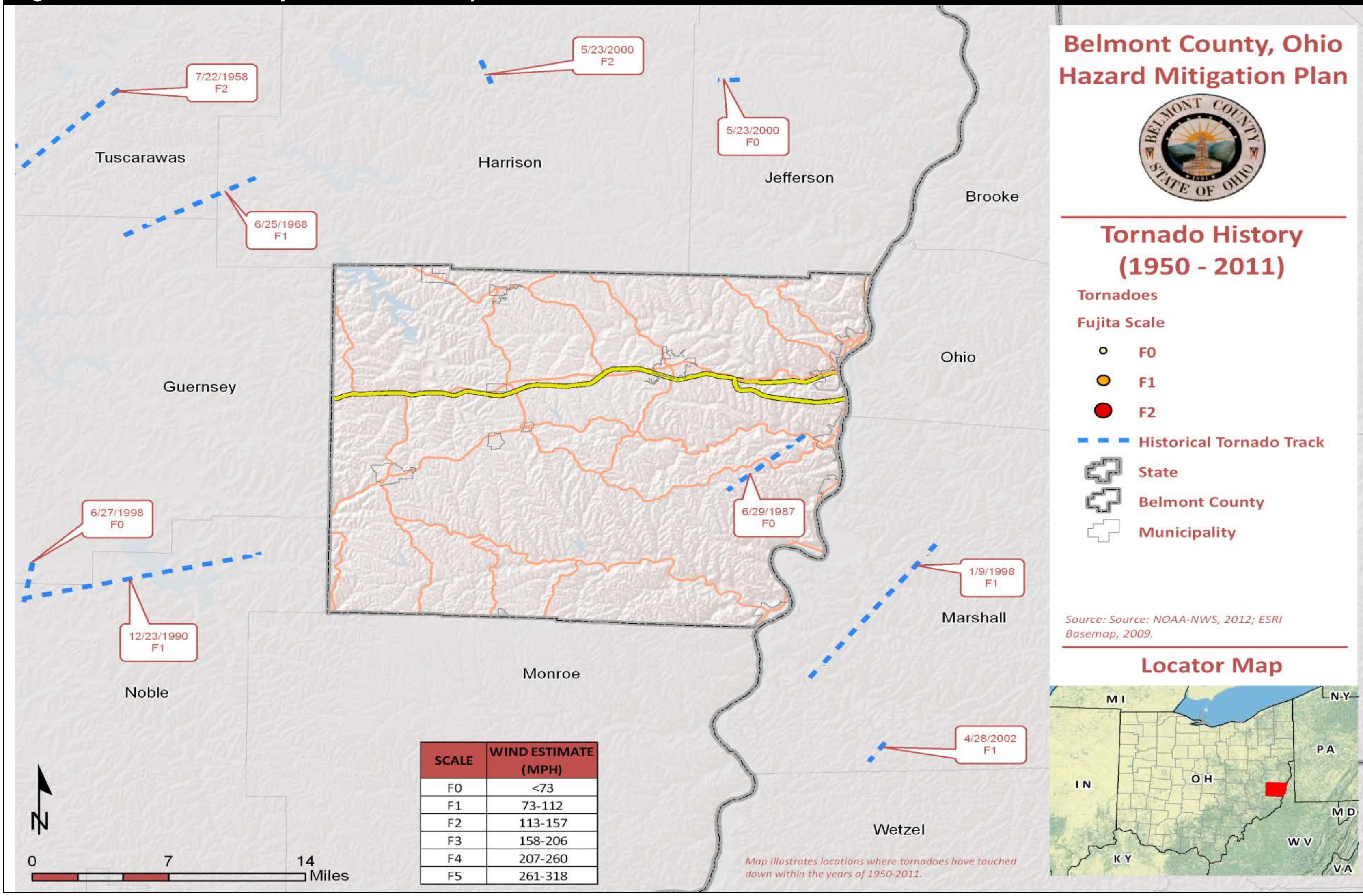
LAND USE & DEVELOPMENT TRENDS

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 of Belmont County is equally at risk and there are no locations of high risk exposure.

MULTI-JURISDICTIONAL DIFFERENCES

Each municipality in the County has an equal susceptibility to high winds from tornadic activity. The deteriorating condition of older homes and the use of aluminum-clad mobile homes continue to remain highly susceptible to wind events. Please refer to the map below to see the average tornadic activity within Belmont County.

Figure 2-7: Tornado Activity in Belmont County



SCALE	WIND ESTIMATE (MPH)
F0	<73
F1	73-112
F2	113-157
F3	158-206
F4	207-260
F5	261-318

TORNADOES HIRA SUMMARY

It's difficult to separate the various wind components that cause damage throughout Belmont County 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/windstorms in Belmont County are difficult to predict and the entire County 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.

TEMPERATURE EXTREMES

NATURAL HAZARD	PROBABILITY	IMPACT	SPATIAL EXTENT	WARNING TIME	DURATION	RF RATING (PRIORITY)
TEMPERATURE EXTREMES	3 (0.9)	1 (0.3)	4 (0.8)	1 (0.1)	3 (0.3)	**2.4**
MODERATE RISK (2.0 – 2.9)						

HAZARD IDENTIFICATION

Temperature extremes can occur at almost any time of the year, but are most prevalent in the summer and winter. Extreme temperatures can be dangerous due to the way that they affect individuals who are exposed to them. Extreme heat is usually defined through a combination of temperature and humidity. Extreme cold is based on the temperature with wind chill. The recorded extreme heat events have occurred from June through September. Recorded extreme cold events in Ohio have occurred from December through April. Extreme temperatures can be dangerous to people, and crops. The next two figures show extreme temperatures for Belmont County Ohio.

Figure 2-8: Average Maximum Temperatures for Belmont County, Ohio

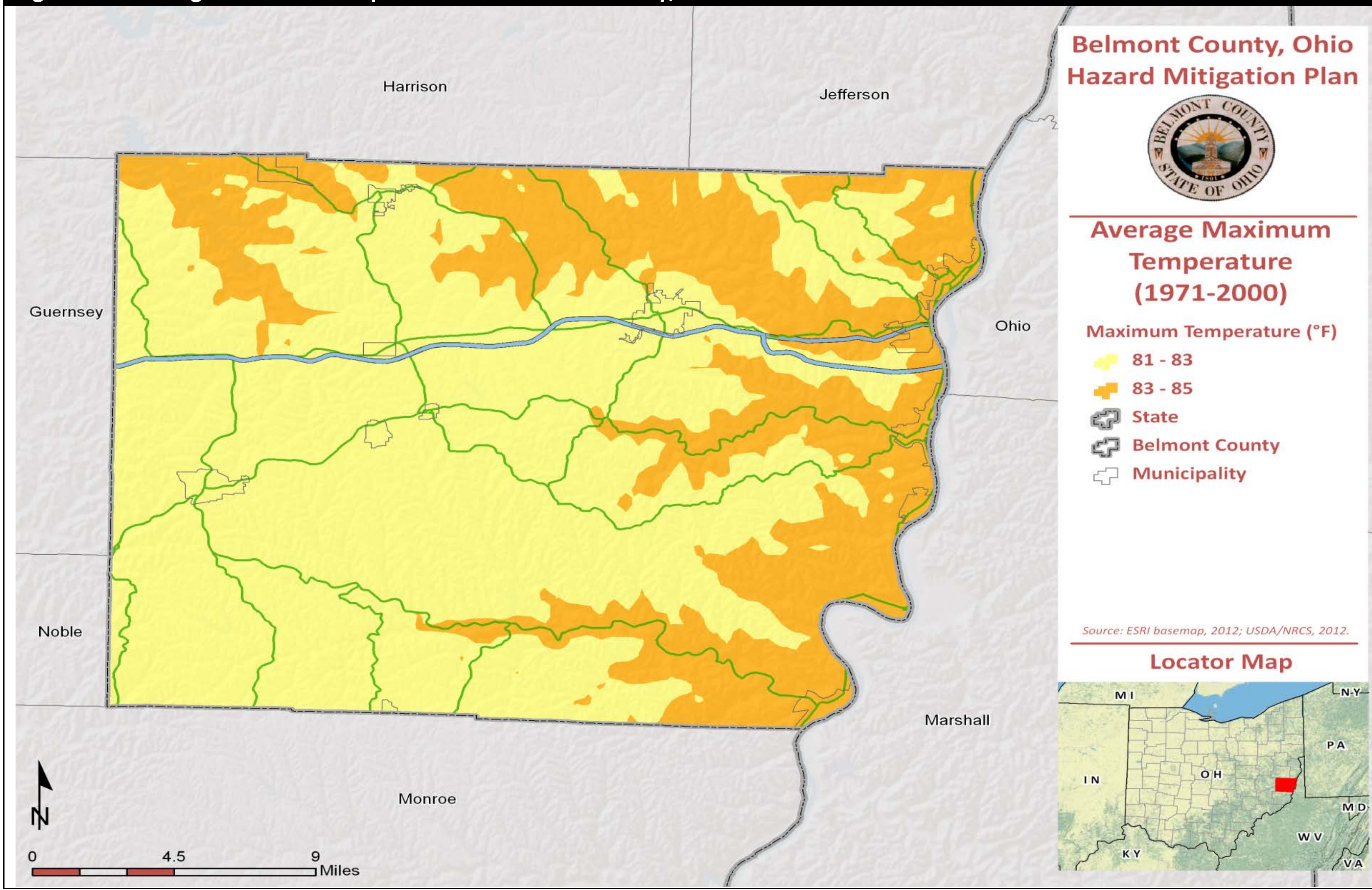


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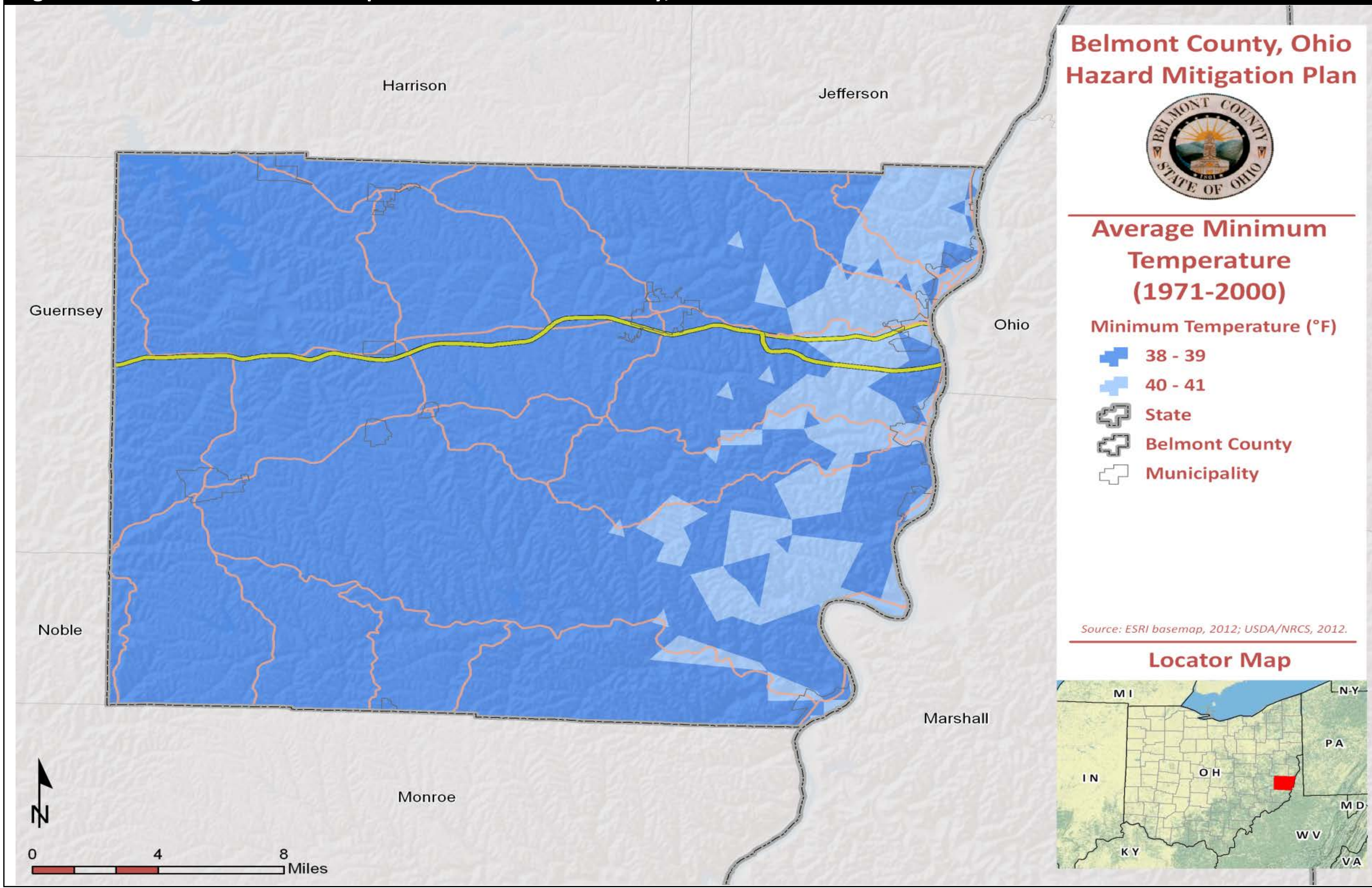
Figure 2-9: Average Minimum Temperatures for Belmont County, Ohio



HAZARD PROFILE

According to NCDC, Belmont County has been exposed to 14 occurrences of temperature extremes. Of the 14 events, 3 were extreme heat and the other 11 were extreme cold. A summary is provided in the table below.

Table 2-28: Temperature Extremes Since 1950

LOCATION	DATE	TYPE	DEATH	INJURY	PROPERTY DAMAGE	CROP DAMAGE
Countywide	05/09/1966	Extreme Cold	0	0	0	$50,000
Countywide	01/16/1977	Extreme Cold	0	0	$500	$0
Countywide	12/06/1977	Extreme Cold	0	0	$0	$0
Countywide	02/12/1981	Extreme Cold	0	0	$0	$0
Countywide	01/11/1982	Extreme Cold	0	0	$500	$0
Countywide	09/01/1983	Extreme Heat	0	0	$0	$50,000
Countywide	01/19/1984	Extreme Cold	0	0	$500	$0
Countywide	03/08/1984	Extreme Cold	0	0	$500	$0
Countywide	01/19/1985	Extreme Cold	0	0	$500	$0
Countywide	02/14/1994	Extreme Cold	0	0	$500	$0
Countywide	06/13/1994	Extreme Heat	0	0	$0	$5,000
Countywide	02/11/1995	Extreme Cold	0	0	$1000	$0
Countywide	07/15/1995	Extreme Heat	0	25	$0	$0
Countywide	12/09/1995	Extreme Cold	0	00	$100	$0
		TOTALS	**0**	**25**	**$4,100**	**$105,000**

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 024). 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. Note that while the temperatures in 0 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.

Table 2-29: Four categories of heat stress (FEMA, 1997).

DANGER CATEGORY	HEAT DISORDERS	APPARENT TEMPERATURE (°F)
I (Caution)	Fatigue possible with prolonged exposure and physical	80 to 90

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	activity.	
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

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 including Belmont County, 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 Warning*s 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).

Figure 2-10: NOAA'S National Weather Service Heat Index.

NOAA's National Weather Service

Heat Index

Temperature (°F)

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

Reported high heat events over the past 62 years provide an acceptable framework for determining the future occurrence in terms of frequency for such events. The probability of the County and its municipalities experiencing a high heat event can be difficult to quantify, but based on historical record of 3 heat events since 1950, it can reasonably be assumed that this type of event has occurred once every 20.67 years from 1950 through 2012.

[(Current Year) 2012] subtracted by [(Historical Year) 1950] = 62 Years on Record

[(Years on Record) 62] divided by [(Number of Historical Events) 3] = 20.67

Furthermore, the historic frequency calculates that there is a 4.84% chance of this type of event occurring each year.

According to the National Climatic Data Center, these extreme heat events include numbers reported from multiple counties per each event. The most significant regional event occurred from The most significant event occurred on February 11th, 1995, in which extreme cold caused over $1,000 in property damages. An additional event on May 10th 1966 caused over $50,000 in crop damages.

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 sixty years of age. More than seventy-five percent happen to males, and almost twenty 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.

Table 2-30: Temperature and Associated Threat Level

Excessive Cold Threat Level	Threat Level Descriptions
Extreme	**"An Extreme Threat to Life and Property from Excessive Cold."** It is likely that wind chill values will drop to -35° F or below for 3 hours or more. Or, lowest air temperature less than or equal to -20° F.
High	**"A High Threat to Life and Property from Excessive Cold."** It is likely that wind chill values will drop to -28° F to -35 ° F for 3 hours or more. Or, lowest air temperature -15° to -20° F.
Moderate	**"A Moderate Threat to Life and Property from Excessive Cold."**

Table 2-30: Temperature and Associated Threat Level

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

Reported extreme cold events over the past 62 years provide an acceptable framework for determining the future occurrence in terms of frequency for such events. The probability of the County and its municipalities experiencing an extreme cold event can be difficult to quantify, but based on historical record of 11 extreme cold events since 1950, it can reasonably be assumed that this type of event has occurred once every 5.64 years from 1950 through 2012.

[(Current Year) 2012] subtracted by [(Historical Year) 1950] = 62 Years on Record

[(Years on Record) 62] divided by [(Number of Historical Events) 11] = 5.64

Furthermore, the historic frequency calculates that there is a 17.74% chance of this type of event occurring each year.

According to the National Climatic Data Center, these extreme cold events include numbers reported from multiple counties per each event. The most significant event occurred on Sept 1st, 1983 when extreme heave caused over $500,000 in crop damages.

INVENTORY ASSETS EXPOSED TO TEMPERATURE EXTREMES

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 (see Table 2-24). Extreme heat does not generally impact buildings; instead, they

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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 a 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.

POTENTIAL LOSSES FROM TEMPERATURE EXTREMES

It is evident from past events that extreme heat is dangerous and can cause human related illnesses and death. As temperature goes up so do the number of people hospitalized for heat related illnesses. 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. Additionally, extreme heat can cause damage to buildings or contents by overheating HVAC or air conditioning systems, contributing to jurisdictional losses. It is unlikely that an entire building would be impacted in an extreme heat event, though.

The NCDC reported 11 extreme cold events in Belmont County resulting in property damage. Extreme cold is dangerous and can cause death. Therefore it's 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. Additionally, extreme cold can cause damage to structures; for example, burst pipes will damage buildings and will necessitate repairs. It is unlikely that an entire building would be impacted in an extreme cold event.

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 a extreme temperatures. While temperature extremes are not usually thought of as damaging to structures, they can make structures unusable. The Belmont County Auditor has determined that the Cities of Martins Ferry and St. Clairsville have property valued at over $200 million. These cities represent the largest population centers for the County, and will be used as an example of the property at risk. Those properties break down as follows:

Structure Type	Number	Loss Estimate
Residential	6638	$130,802,060.00
Non-residential	888	$67,965,660.00
Critical Facilities	287	$1,445,840.00

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LAND USE & DEVELOPMENT TRENDS TEMPERATURE EXTREMES

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.

EXTREME TEMPERATURES HIRA SUMMARY

Belmont County is subject to temperature extremes. The affect temperature extremes will have on the County will vary due to population density, age of population, and the age of structures. Nonetheless, facilities need to be maintained to ensure that they operate in appropriate conditions for people. 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. Those that are most prone to temperature extremes are jurisdictions with the highest populations, buildings and building costs.

DAM FAILURE

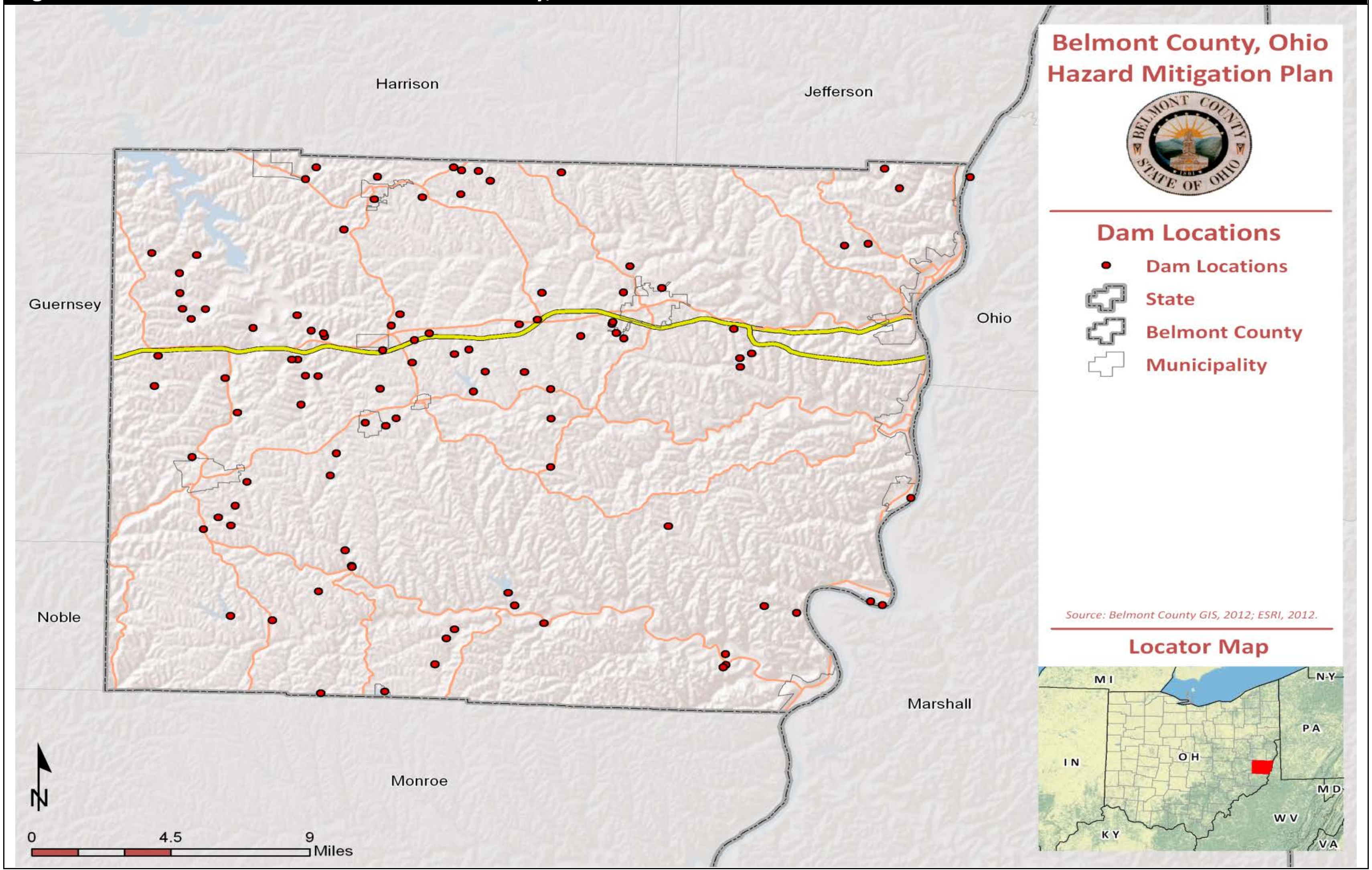
NATURAL HAZARDS	PROBABILITY	IMPACT	SPATIAL EXTENT	WARNING TIME	DURATION	RF RATING (PRIORITY)
DAM FAILURE	1 (0.3)	4 (1.2)	3 (0.6)	4 (0.4)	4 (0.4)	**2.9**
MODERATE RISK HAZARD (2.0 – 2.9)						

HAZARD IDENTIFICATION

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 of the water barrier, often resulting in down-stream flooding.

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.

Figure 2-11: Locations of Dams within Belmont County, OH



Dams built in Belmont County are built for a variety of uses. Uses include agriculture, flood protection, power generation, recreation, and water supply. Dam failure can occur with little warning and 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 components;
- 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.

The two most common modes of dam failure for embankment dams are piping and over-topping. High and significant hazard dams are designed to prevent over-topping during most storm events occurring in the County. The high hazard structures are designed to prevent over-topping during PMF, an extreme event well in excess of a 100-year storm. As the name suggests the likelihood of an extreme event is very low.

Dam failures due to piping may occur at any time. Piping is internal erosion inside the dam embankment. This condition may take years to develop, and may be difficult to detect. Piping failure may be prevented through proper inspection and maintenance. MDE requires annual inspections of high hazard dams and corrective actions to be taken if conditions are observed through inspections.

HAZARD PROFILE

Dams are considered to be localized hazards are most likely to affect inundation areas downstream and immediate areas around a particular dam or levee in Belmont County. 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.

The Ohio Department of the Natural Resources, Division of Soil and Water Resources, regulatory agency for the State, defines a dam as, "A dam is an artificial barrier usually constructed across a stream channel to impound water. Timber, rock, concrete, earth, steel or a combination of these materials may be used to build the dam". Most of the dams in Belmont County consist of an earthen embankment in combination with spillways, and a majority of these dams are built as stormwater management structures.

The dams represent the greatest risk to the people who live below the dam in the area designated as the "inundation zone" for overflow or catastrophic failure. Based on the hazard potential and the possible inundation zone location, the dams in Ohio are classified by the Division of Soil & Water Resources into four categories:

- Class I: Dams having a total storage volume greater than five thousand acre-feet or a height of greater than sixty feet shall be placed in class I. A dam shall be placed in class I when sudden failure of the dam would result in one of the following conditions.
    - Probable loss of human life.
    - Structural collapse of at least one residence or one commercial or industrial business.
- Class II: Dams having a total storage volume greater than five hundred acre-feet or a height of greater than forty feet shall be placed in class II. A dam shall be placed in class II when sudden failure of the dam would result in at least one of the following conditions, but loss of human life is not probable.
    - Disruption of a public water supply or wastewater treatment facility, release of health hazardous industrial or commercial waste, or other health hazards.
    - Flooding of residential, commercial, industrial, or publicly owned structures.
    - Flooding of high-value property.
    - Damage or disruption to major roads including but not limited to interstate and state highways, and the only access to residential or other critical areas such as hospitals, nursing homes, or correctional facilities as determined by the chief.
    - Damage or disruption to railroads or public utilities.
    - Damage to downstream class I, II or III dams or levees, or other dams or levees of high value. Damage to dams or levees can include, but is not limited to, overtopping of the structure.
- Class III: Dams having a total storage volume greater than fifty acre-feet or a height of greater than twenty-five feet shall be placed in class III. A dam shall be placed in class III when sudden failure of the dam would result in at least one of the following conditions, but loss of human life is not probable.
    - Property losses including but not limited to rural buildings not otherwise described in paragraph (A) of this rule, and class IV dams and levees not otherwise listed as high-value property in paragraph (A) of this rule. At the request of the dam owner, the chief may exempt dams from the criterion of this paragraph if the dam owner owns the potentially affected property.
    - Damage or disruption to local roads including but not limited to roads not otherwise listed as major roads in paragraph (A) of this rule.
- Class IV: Dams which are twenty-five feet or less in height and have a total storage volume of fifty acre-feet or less may be placed in class IV. When sudden failure of the dam would result in

property losses restricted mainly to the dam and rural lands, and loss of human life is not probable, the dam may be placed in class IV. Class IV dams are exempt from the permit requirements of section 1521.06 of the Revised Code pursuant to paragraph (C) of rule 1501:21-19-01 of the Administrative Code.

Of the 36 dams or impoundments located in Belmont County, there are currently 8 dams that are classified as Class I. Of these 8 designated class I dams, 5 are owned and operated by the local government and 3 are privately owned.

Table 2-31: Dams within Belmont County

DAM NAME	HAZARD CLASS	EAP	OWNER
MEIGS-PHILLIPS I NO. 1 DAM	I		Capstone Mining Company
THE OHIO VALLEY COAL SLURRY DISPOSAL DAM	I		The Ohio Valley Coal Company
BELMONT HILLS COUNTRY CLUB LAKE DAM	I		Belmont Hills Country Club
BETHESDA RESERVOIR DAM	I		Village of Bethesda
BARNESVILLE RESERVOIR NO. 1 DAM	I	Yes	Village of Barnesville
BARNESVILLE RESERVOIR NO. 2 DAM	I	Yes	Village of Barnesville
BARNESVILLE RESERVOIR NO. 3 DAM	I	Yes	Village of Barnesville
BARNESVILLE LAKE DAM	I	Yes	Village of Barnesville
ST. CLAIRSVILLE RESERVOIR NO. 2 DAM	I		City of St. Clairsville
BELMONT LAKE DAM	I	Yes	ODNR, Division of Parks & Recreation
R & F LAMIRA FRESHWATER DAM	II		Capstone Mining Company
SWITZERLAND LAKE DAM	II		Switzerland of Ohio Country Club
ST. CLAIRSVILLE RESERVOIR NO. 1 DAM	II	Yes	City of St. Clairsville
SHADYSIDE WWTP LEVEE	II	Yes	Village of Shadyside
RE BURGER WEST ASH POND DAM	II		FirstEnergy
ALLISON MINE FRESHWATER DAM	III		American Energy Corporation
LIVEZEY LAKE DAM	III	Yes	Olney Friends School
MYERS POND DAM	III		Eric Waggoner and Tammy Surv
BETHESDA SPORTSMANS CLUB POND DAM	III		Farmer's & Sportsmen's Conservation
NACCO POND DAM	IV		North American Coal Company
NACCO POND DAM	IV		North American Coal Company
NACCO POND DAM	IV		North American Coal Company
WATER QUALITY CONTROL POND NO. 10 DAM	IV		NACCO Mining Company
CONSOL POND DAM	IV		Consolidation Coal Company
CONSOL POND DAM	IV		Consolidation Coal Company
BURKHART FARM POND DAM	IV		Burkhart Nursery
WARD POND DAM	IV		Daryl Ward
PEDDICORD LAKE DAM	IV		Frank Peddicord
BROWN LAKE NO. 1 DAM	IV		William Brown
BROWN LAKE NO. 2 DAM	IV		William Brown
BOND POND DAM	IV		John L. Bond
BELMONT COUNTY LAKE DAM	IV		Board of County Commissioners
UNION LOCAL POND DAM	IV		Board of Education
EGYPT WILDLIFE AREA DAM	IV		ODNR, Division of Wildlife
OHIO COAL LAKE DAM	IV		Ohio Coal & Construction Company

According to the National Performance of Dams Program, there have been two incidents since 1950 for dams in Belmont County.

Table 2-32: Dam incidents in Belmont County since 1950

LOCATION	DATE	INCIDENT	DAM FAILURE
Barnesville Lake Dam	01/18/2011	Concrete Deterioration	No
Bethesda Sportsman's Club Pond Dam	01/18/2011	Inadequate Spillway Capacity	No

INVENTORY ASSETS EXPOSED TO HAZARD

The Ohio Department of the Natural Resources, Division of Soil and Water Resources requires dam owners to develop an Emergency Action Plan (EAP) for each high and significant hazard dam. The purpose of the EAP is to provide the Dam Operator with procedures to follow in order to safeguard the lives and property of the citizens living downstream and predict the dam inundation path to allow for proper evacuation and land uses below the dam.

As a part of the State of Ohio requirements dam owners and operators have provided danger reach maps for all high hazard dams delineating the areas downstream that would be impacted as a result of potential dam breach. These maps are included in the EAPs and include extent of the dam inundation zone, wave arrival times, and velocity of water at time of wave arrival. This assists emergency personnel to understand population, county facilities and critical facilities at risk when planning for a localized hazard incident such as dam failure.

Dam failure inundation zones can also be used to run exposure analysis for population, value and critical infrastructure at risk. Critical facilities are those community components that are most needed to withstand the impacts of disaster as previously described.

Of the Class I dams in the county, Belmont Lake Dam is the closest to a nearby community. Downstream from the dam are communities of Loomis and Lamira. Map analyses provide a combined vulnerability assessment for these two communities.

Table 2-33: Belmont Lake Dam Failure Vulnerability

STRUCTURE TYPE	NUMBER	LOSS ESTIMATE
Residential	51	$3,543,582.00
Non-Residential	1	$100,061.00
Critical Facilities	0	$0.00
TOTAL	52	$3,643,643.00

POTENTIAL LOSSES

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.

LAND USE & DEVELOPMENT TRENDS

Land use and new development in or near the danger reach of a dam can be de-conflicted through proper preparedness and mitigation planning. Ohio Department of the Natural Resources, Division of Soil and Water Resources provides the permitting for dam structures within the county. A dam breach analysis is needed to delineate the area potentially impacted should a dam fail. These maps are used to aid dam classification for any existing and proposed facilities. A dam breach analysis may be required for:

- Any proposed pond construction that could potentially affect the downstream properties or right of way.
- Any existing upstream pond embankment that could potentially affect proposed downstream construction.
- Establishment of a dam hazard class for embankments as part of the development.

Most of the safety analysis is done through modeling a dam failure scenario and mapping the "danger reach" in the form of an inundation zone. To minimization of loss of life and property damage land use and development restrictions can be implemented local legislation.

Staff from the Belmont County Emergency Management Agency (EMA) annually works with dam operators and owners to update the EAPs and operators are required to notify Belmont EMA immediately whenever there are changes to dam operating procedures.

DAM FAILURE HIRA SUMMARY

Dam failure flooding can occur as the result of partial or complete collapse of an impoundment. Dam failures often result from prolonged rainfall and flooding. The primary danger associated with dam failure is the high velocity flooding of those properties downstream of the dam.

A dam failure can range from a small, uncontrolled release to a catastrophic failure. Secondary losses would include loss of the multi-use functions of the facility and associated revenues that accompany those functions.

MINE SUBSIDENCE

NATURAL HAZARDS	PROBABILITY	IMPACT	SPATIAL EXTENT	WARNING TIME	DURATION	RF RATING (PRIORITY)
MINE SUBSIDENCE	2 (0.6)	1 (0.3)	3 (0.6)	4 (0.4)	4 (0.4)	**2.3**
MODERATE RISK HAZARD (2.0 – 2.9)						

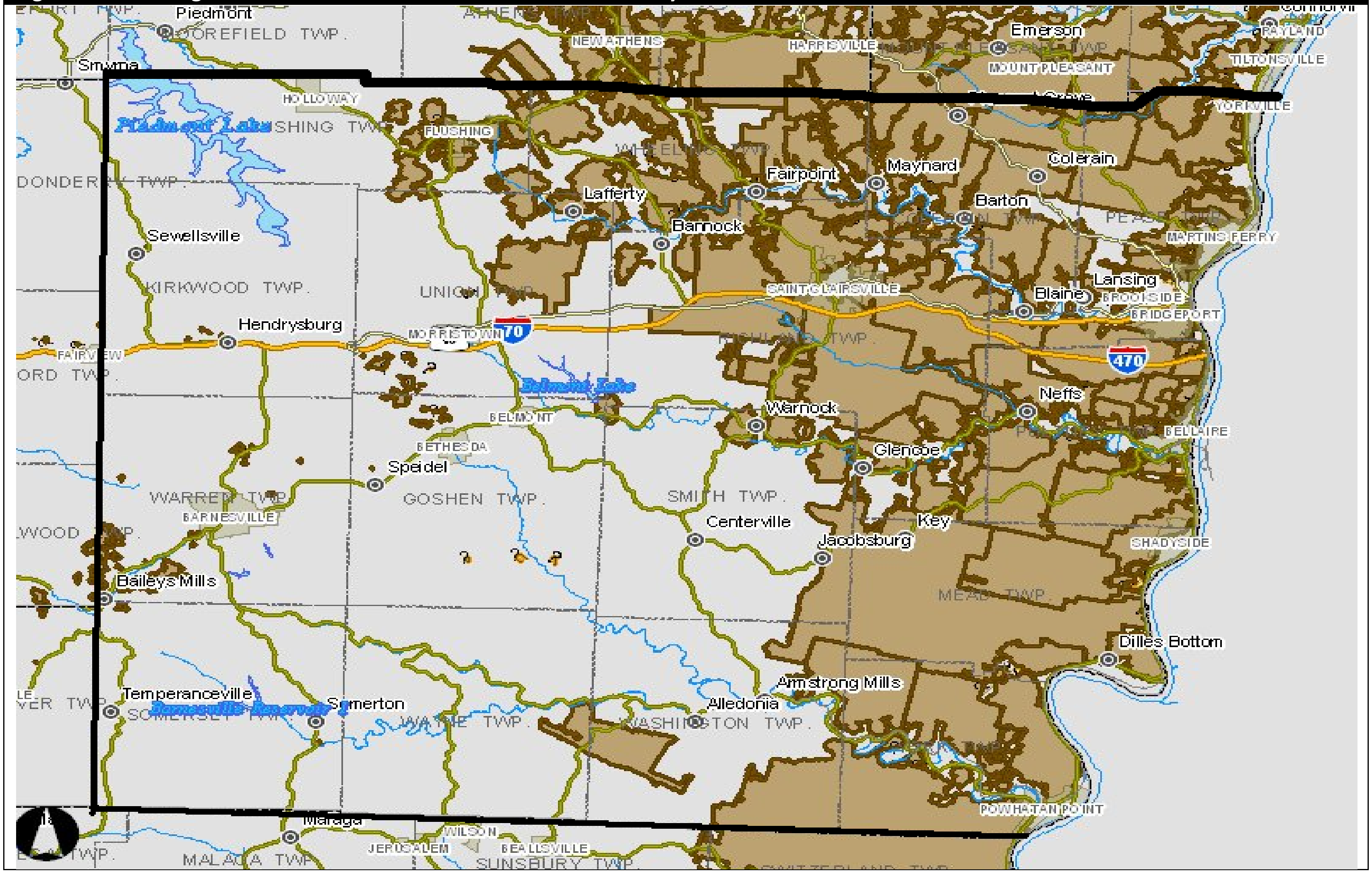
HAZARD IDENTIFICATION

Mine Subsidence is a readjustment of the overburden due to collapse or failures of underground mine workings. Surface subsidence features usually take the form of either sinkholes or troughs.

Sinkholes are typically associated with abandoned mine workings, since most active underground mines operate at depths sufficient to preclude the development of sinkhole subsidence

Troughs are induced by room-and-pillar mining can occur over active or abandoned mines. The resultant surface impacts and damages can be similar; however, the mechanisms that trigger the subsidence are dramatically different. In abandoned mines, troughs usually occur when the overburden sags downward due to the failure of remnant mine pillars, or by punching of the pillars into a soft mine floor or roof.

Figure 2-11 Underground Mines and their extent in Belmont County



Source: Ohio Department of Natural Resources Abandoned Underground Mines Mapping Tool

HAZARD PROFILE

Location, Extent & Magnitude

Belmont County, located in Eastern Ohio, has a moderate susceptibility to the mine subsidence hazard. Eastern Ohio has by far the highest concentration of abandoned mines throughout the commonwealth. Abandoned mines across the state have the potential to subside and cause localized yet severe damage. Urban and rural land development is increasing the number of mine subsidence and the economic effects.

Areas of the state that have underlying mines are subject to subsidence and constitute a potential threat to people living in those areas. Isolated incidents throughout the coal regions over the years have been houses, garages, and trees swallowed up by subsidence holes. Lengths of local streets, highways, and countless building foundations have been damaged.

Subsidence cause damage to transportation routes, utilities, and buildings, create travel delays and other side effects. Fortunately, deaths and injuries due to subsidence are rare in Ohio. Almost all of the known deaths due to subsidence have occurred when boulders/rocks fall along highways and involve vehicles. The Ohio Department of Transportation and large municipalities incur substantial costs due to subsidence damage and to extra construction costs for new roads in known subsidence-prone areas.

Belmont County has a moderate risk to mine subsidence due to the 560+ abandoned mines within the county. It is difficult, if not impossible, to predict if or when failure in an abandoned mine might occur, since abandoned mines may collapse many decades after the mining is completed, if the mine workings were not designed to provide long-term support.

Frequency of Occurrence

There have been several subsidence events in the state, and in Belmont County and subsidence remain a possible occurrence in localized areas of Belmont County, but impacts from such an event would likely cause minimal localized damage and are unlikely. Thus, the probability of Belmont County experiencing a mine subsidence in a given year is low and would be typically localized.

INVENTORY ASSETS EXPOSED AND POTENTIAL LOSSES FROM SUBSIDENCE

Several communities in Belmont County are vulnerable to subsidence. Any probable events would take place in areas known to be above abandoned mines. In addition, places where landforms have been altered for purposes of highway construction or other development may be uniquely vulnerable to subsidence hazards. This is especially true if development is located at or near a known abandoned mine.

There is no way to predict an area that will be impacted by mine subsidence. Based on mapping conducted by the Ohio Department of Natural Resources, the eastern portion of Belmont County is most susceptible to underground mines and potential mine subsidence. St. Clairsville, in particular is surrounded and on top of abandoned mines, as shown in figure 2-15. If an event were to occur that resulted in a catastrophic mine subsidence event, the whole of St. Clairsville could be impacted. The Belmont County auditor has identified the number of residential structures, non-residential structures and critical facilities located in St. Clairsville. Those numbers and the associated loss estimates can be seen in the following table:

Structure Type	Number	Loss Estimate
Residential	2712	$53,439,960.00
Non-residential	447	$34,212,039.00
Critical Facilities	137	$690,069.00

LAND USE & DEVELOPMENT TRENDS

The effects of mine subsidence can play a factor in the development and future use of land within Belmont County. Avoid building in high subsidence risk zones or in areas that have known subsidence.

MINE SUBSIDENCE HIRA SUMMARY

Mine subsidence gives little to no warning. The after-effects from mine subsidence can include impacts to roadways, homes, buildings and critical infrastructure. They are not seasonal and can happen year round. This can present its own set of issues.