

## **APPENDIX 1: HAZARD PROFILES, LOSS CALCULATIONS, AND MAPPING**

This appendix contains hazard-specific information created as a result of the comprehensive risk assessment that was completed as part of this project. The appendix is organized alphabetically by hazard name. Each hazard-labeled tab contains a detailed hazard profile, matrices to calculate loss estimations, and mapping that graphically depicts low, moderate, and high susceptibility areas for the hazard in question.

Loss estimates were calculated for all jurisdictions. In some instances, however, a municipal jurisdiction could be more or less susceptible than the balance of the county to a particular hazard.

## 2.2 PROFILE HAZARDS

### 2.2.1. Dam Failure

A dam failure is when downstream flooding occurs as the result of the complete or partial inundation of an impoundment.

#### RESEARCH

- Ohio Department of Natural Resources, Division of Soil and Water Resources – Dam Safety
- National Dam Inventory
- National Performance of Dams Program
- Association of State Dam Safety
- Local media research
- Internet research

Period of Occurrence:	At any time
Number of Events to Date:	0
Probability of Event:	0.0
Warning Time:	Minimal – Depends on frequency of inspection
Potential Impacts:	Potential loss of human life, economic loss, environmental damage, disruption of lifeline facilities
Cause Injury or Death:	Injury and risk of multiple deaths
Potential Facility Shutdown:	30 days or more

#### HAZARD EFFECTS

Dam failure is often the result of prolonged rainfall or flooding or, during prolonged dry periods, erosion. The primary hazard surrounding dam failure is the swift, unpredictable flooding of those areas immediately downstream. While general inundation areas can be determined, it is often impossible to know exactly how and where water held back by a dam will flow during a rapid failure of the dam.

Generally, there are three types of dam failures: hydraulic, seepage, and structural.

- *Hydraulic Failure* – Hydraulic failures result from the uncontrolled flow of water over the dam, around and adjacent to the dam, and the erosive action of water on the dam and its foundation. Earthen dams are particularly vulnerable to hydraulic failure since earth erodes at relatively small velocities.
- *Seepage Failure* – All dams exhibit some seepage that must be controlled in velocity and amount. Seepage occurs both through the dam and the foundation. If uncontrolled, seepage can erode material from the foundation of an earthen dam to form a conduit

through which water can pass. This passing of water often leads to a complete failure of the structure, known as piping.

- *Structural Failure* – Structural failures involve the rupture of the dam and/or its foundation. This is particularly a hazard for large dams and for dams built of low strength materials such as silts, slag, fly ash, etc.

Dam failures generally result from a complex interrelationship of several failure modes. Uncontrolled seepage may weaken the soils and lead to a structural failure. Structural failure may shorten the seepage path and lead to a piping failure. Surface erosion may lead to structural or piping failures.

The Ohio Department of Natural Resources – Dam Safety classifies dams into four categories, including the following:

- *Class 1 (High Hazard)* – Dams located where failure may cause loss of human life or major damage to dwellings, commercial or industrial buildings, main railroads, important public utilities, or where a high risk highway may be affected or damaged.
- *Class 2 (Significant Hazard)* – Dams located where failure may cause minor damage to dwellings, commercial or industrial buildings, important public utilities, main railroads, or cause major damage to unoccupied buildings, or where a low risk highway may be affected or damaged. Loss of human life from a failure of a Class 2 dam is unlikely.
- *Class 3 (Low Hazard)* – Dams located in rural or agricultural areas where failure may cause minor damage to non-residential and normally unoccupied buildings, or rural or agricultural land. Failure of a Class 3 dam would cause only a loss of the dam itself and a loss of property use, such as use of related roads, with little additional damage to adjacent property.
- *Class 4 (Negligible Hazard)* – Dams where failure is expected to have no potential for loss of human life, no potential for property damage, and no potential for significant harm to the environment.

Table 2.2.1.1 lists the Class I-III dams within Clinton County, what is downstream from each dam, and why the dam was constructed. This information can be used to assist in mitigation and assist with possibly seasonal priorities.

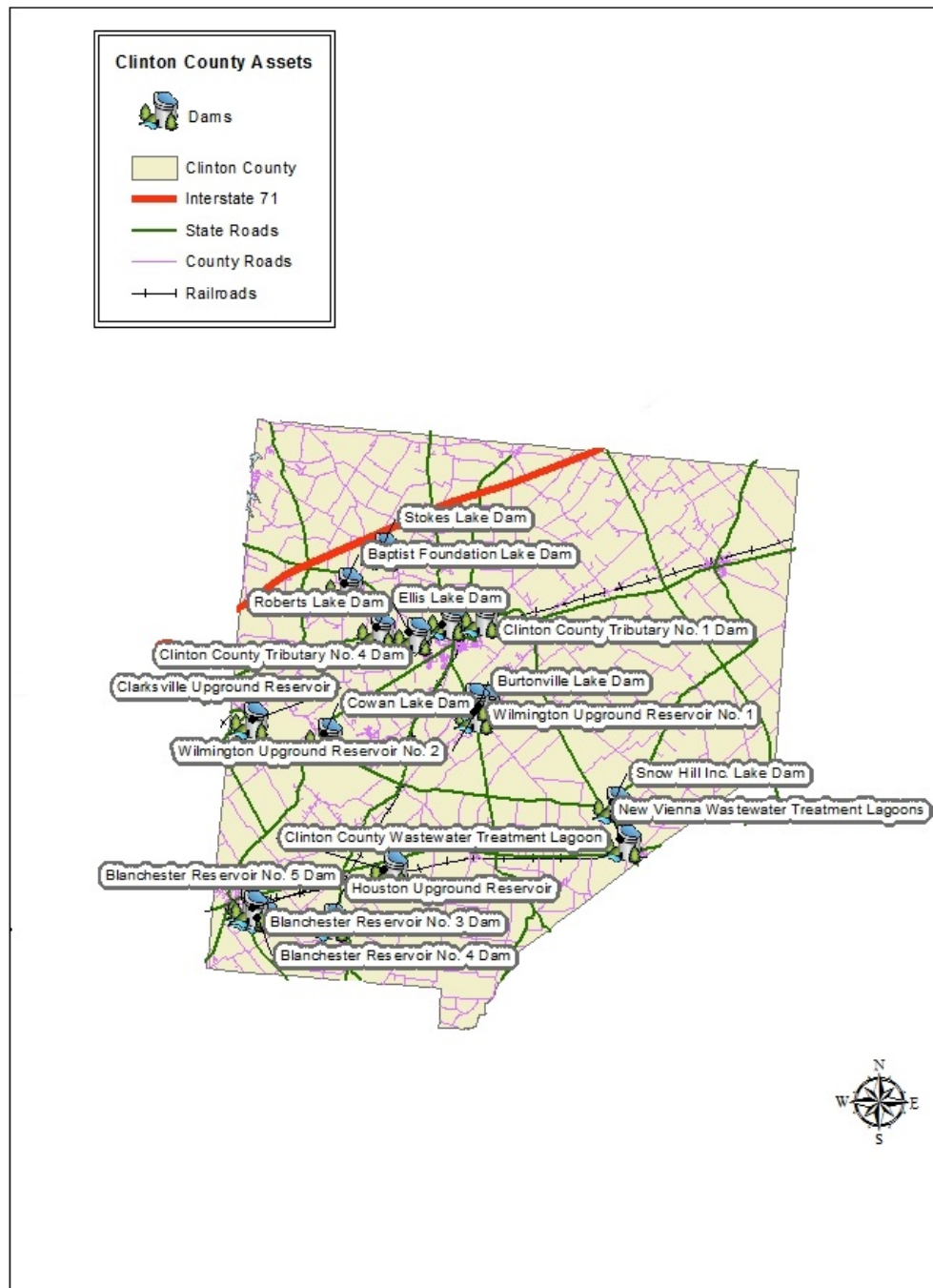
Name of Dam	Class	Stream / Downstream Area	Purpose
Wilmington Upground Reservoir No. 2	I	Offstream	Water Supply, Public
Clinton County Tributary No. 4 Dam	I	Tributary to Lytle Creek	Flood Control, Local
Clinton County Tributary No. 1 Dam	I	Tributary to Lytle Creek	Flood Control, Local
Burtonville Lake Dam	I	Tributary to Cowan Creek	Recreation, Private
Cowan Lake Dam	I	Cowan Creek	Recreation, Public
Wilmington Upground Reservoir No. 1	I	Offstream	Water Supply, Public
Blanchester Reservoir No. 4	I	Offstream	Water Supply, Public
Blanchester Reservoir No. 3	I	Tributary to Second Creek	Water Supply, Public
Blanchester Upground Reservoir No. 6	I	Stonelick Creek – Offstream	Water Supply, Public
Houston Upground Reservoir	II	West Fork East Fork – Offstream	Water Supply, Public
Blanchester Reservoirs No. 1 & 2	II	Offstream	Water Supply, Public
Blanchester Reservoir No. 5	II	Offstream	Water Supply, Public
Snow Hill Inc. Lake Dam	II	Tributary to East Fork Little Miami River	Water Supply, Private
New Vienna Wastewater Treatment Lagoons	II	East Fork Little Miami River – Offstream	Waste Retention
Clarksville Upground Reservoir	II	Offstream	UNKNOWN
Roberts Lake Dam	II	Tributary to Lytle Creek	Recreation, Private
Clinton County Wastewater Treatment Lagoon	II	East Fork of Todd Fork Creek	Wastewater Treatment, Public
Baptist Foundation Lake Dam	III	Tributary to Dutch Creek	Recreation, Private
Ellis Lake Dam	III	Tributary to Todd Fork	Recreation, Private
Stoke Lake Dam	III	Tributary to Dutch Creek	Recreation, Private

Table 2.2.1.1

As can be seen in Table 2.2.1.1, many of the dams within Clinton County are offstream and used for water supply. As a result, if any of these dams fail, not only could there be loss of life, flooding, and structural damages, but also water contamination issues and potable water shortages. In addition to the Class I-III dams listed above, Clinton County has 31 Dams that are Class IV, Exempt, or Abandoned. While currently not of concern, if there are residential, commercial, or industrial developments near these dams, they can be in the future.

Of these dams as well the Wilmington Upground Reservoir No. 2 is listed within the Ohio State Hazard Mitigation Plan as a high priority dam (State of Ohio Hazard Mitigation Plan, 2014). To be classified as a “high priority” dam, it is presumed that a failure would result in a loss of at least 50 human lives. As for actual incidents, the National Performance Of Dams Program at Stanford University lists that on April 26, 2000 the Clinton County Tributary No. 4 Dam (Class I) had inadequate spillway capacity.

## Clinton County Dams



## 2.2 PROFILE HAZARDS

### 2.2.2. Drought/Extreme Heat

Drought is an extended period of deficient rainfall relative to the statistical mean for a region.

#### RESEARCH

- State of Ohio Hazard Mitigation Plan 2014
- ODNR - Division of Soil and Water Resources
- Palmer Drought Severity Index (PDSI)
- Governor's Drought Assessment Committee Meetings
- National Agricultural Statistics Service
- USGS website
- NCDC Event Records
- Local media search

Period of Occurrence:	Summer months or extended periods with no precipitation
Number of Events to Date (1950 - 2013):	6
Probability of Event:	0.095
Warning Time:	Weeks
Potential Impacts:	Activities that rely heavily on high water usage may be impacted significantly, including agriculture, tourism, wildlife protection, municipal water usage, commerce, recreation, electric power generation, and water quality deterioration. Droughts can lead to economic losses such as unemployment, decreased land values, and agro-business losses. Minimal risk of damage or cracking to structural foundations, due to soils.
Cause Injury or Death:	None
Potential Facility Shutdown:	None

#### HAZARD EFFECTS

Droughts are defined according to meteorological, hydrological, and agricultural criteria. Any significant deficit of precipitation is categorized as meteorological. Hydrological drought is apparent in noticeably reduced river and stream flow and critically low groundwater tables. Agricultural drought indicates an extended dry period that results in crop stress and harvest reduction.

The Palmer Drought Severity Index (PDSI) is widely used throughout the United States as a measure of drought and to track moisture conditions. The PDSI is defined as "an interval of time, generally in months or years in duration, during which the actual moisture supply at a given place rather consistently falls short of the climatically expected or climatically appropriate moisture supply". The range of the PDSI is from -

4.0 (extremely dry) to +4.0 (excessively wet), with the central half (-2.0 to +2.0) representing normal or near normal conditions as seen in Table 2.2.2.1.

Palmer Drought Severity Index (PDSI)	
4.0 or greater	Extremely Wet
3.0 to 3.99	Very Wet
2.0 to 2.99	Moderately Wet
1.0 to 1.99	Slightly Wet
0.5 to 0.99	Incipient Wet
0.49 to -0.49	Near Normal
-0.5 to -0.99	Incipient Dry
-1.0 to -1.99	Mild Drought
-2.0 to -2.99	Moderate Drought
-3.0 to -3.99	Severe Drought
-4.0 or less	Extreme Drought

Table 2.2.2.1

A drought in Clinton could affect the majority of the county's residents. Figure 2.2.2.2 shows all the PDSI values for the southwest region of Ohio from 1950 to 2013 ([http://www.ncdc.noaa.gov/cag/time-series/us/33/08/pdsi/ytd/12/1950-2013?base\\_prd=true&firstbaseyear=1901&lastbaseyear=2000](http://www.ncdc.noaa.gov/cag/time-series/us/33/08/pdsi/ytd/12/1950-2013?base_prd=true&firstbaseyear=1901&lastbaseyear=2000)). Since droughts are the extreme lack of moisture, a look at only the negative values will be necessary. Table 2.2.2.3 lists those values.

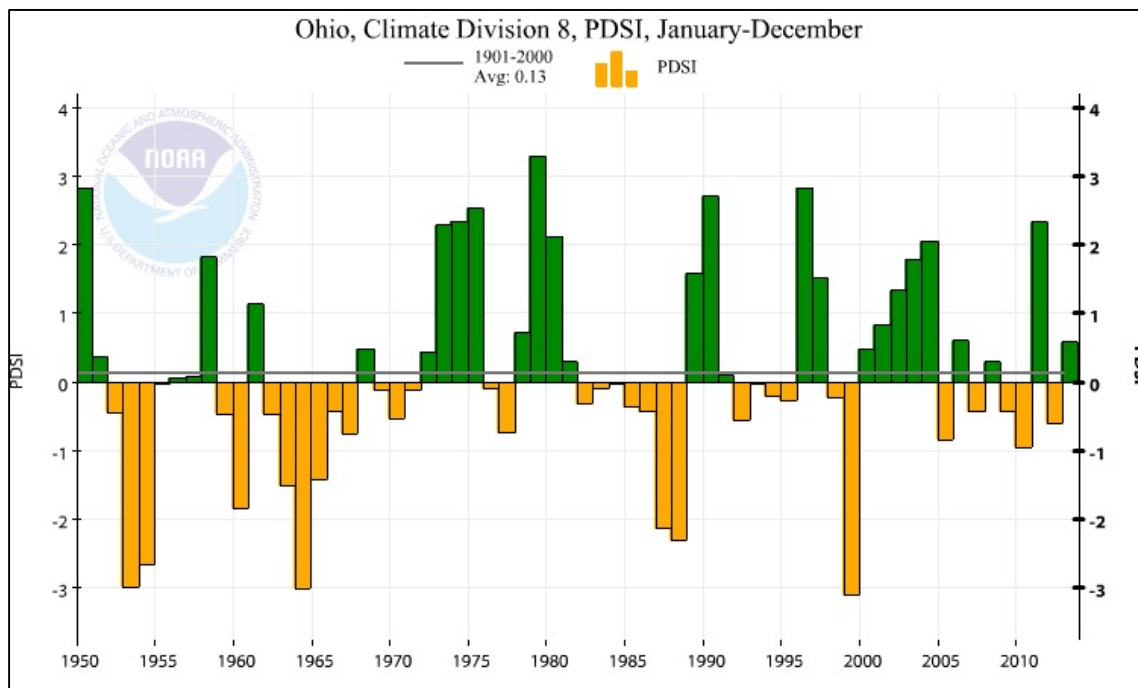


Figure 2.2.2.2



Negative PDSI Years (1950-1980)

Year	PDSI	Classification
1952	-0.45	Near Normal
1953	-2.99	Moderate Drought
1954	-2.67	Moderate Drought
1955	-0.04	Near Normal
1959	-0.47	Near Normal
1960	-1.85	Mild Drought
1962	-0.47	Near Normal
1963	-1.51	Mild Drought
1964	-3.01	Severe Drought
1965	-1.43	Mild Drought
1966	-0.43	Near Normal
1967	-0.76	Incipient Dry
1969	-0.12	Near Normal
1970	-0.54	Incipient Dry
1971	-0.12	Near Normal
1976	-0.10	Near Normal
1977	-0.75	Incipient Dry

Negative PDSI Years (1980-2013)

Year	PDSI	Classification
1982	-0.32	Near Normal
1983	-0.10	Near Normal
1984	-0.04	Near Normal
1985	-0.37	Near Normal
1986	-0.44	Near Normal
1987	-2.14	Moderate Drought
1988	-2.31	Moderate Drought
1992	-0.56	Incipient Dry
1993	-0.04	Near Normal
1994	-0.21	Near Normal
1995	-0.27	Near Normal
1998	-0.23	Near Normal
1999	-3.11	Severe Drought
2005	-0.84	Incipient Dry
2007	-0.44	Near Normal
2009	-0.44	Near Normal
2010	-0.95	Incipient Dry
2012	-0.61	Incipient Dry

Table 2.2.2.3

Between 1950 and 2013, a span of 63 years, 35 had a negative PDSI. Of these 35, 19 (54%) were within the Near Normal range, 7 (20%) were Incipiently Dry, leaving 9 years (26%) at some level of drought. A pattern occurs that for a few years before and after a drought year the PDSI value is negative but in the near normal or incipiently dry range through the 1950s to 1970s. In the 1980s, that pattern led into the 1987 moderate drought but the pattern did not continue with a second year of moderate drought then 4 years with positive PDSIs. The 1999 severe drought, which produced \$45,000 in disaster assistance under a USDA secretarial disaster declaration (<http://public.droughtreporter.unl.edu/advancedsearch/impacts.aspx>), listed a near normal wetness the year prior and 5 years of positive PDSIs afterwards.

In 1988/89, Ohio was in a moderate drought as seen in table 2.2.2.3 above. This drought was widespread with heat waves that killed 4,800 to 17,000 people in the United States and livestock. Possible reasons for the increased damage from this drought are marginally arable land being cultivated and pumping groundwater that is near the depletion mark. Other reasons, as stated by the State Climatologist for Ohio, Jeffrey C. Rogers, in notes from the Governor's Drought Assessment Committee Meeting are an increased insect activity and diseases in plants, increased mortality for fishes due to increased industrial contaminant concentrations, failures in dry springs to produce seed and biomass resulting in a lack of feed for deer, wild turkey, and rabbits, and a weakened timber industry as new plantings fail to grow and old growth becomes weakened by the increased insect activity and disease. This drought continued across the Midwest States and North Plains, not officially ending until 1990 because the moderately wet 1989 assisted to replenish groundwater and decrease insect activity.

As for 2012, a continuation of dryness from 2009/2010 with a lack of snow to provide melt water occurred. Along with many other Ohio counties, Clinton County was designated as a moderate drought in mid-June. On September 5, 2012, Clinton County, along with 84 other counties received a Secretarial disaster designation by the Secretary of Agriculture because of sufficient production losses. Table 2.2.2.4 below shows a comparison between a non-drought year (2011) and a drought year (2012) in crop production as determined by the National Agricultural Statistics Service (U.S. Department of Agriculture).

Water supplies are a mix of public and private systems. Public systems are distributed throughout the county, many with dammed reservoirs such as in Blanchester and Wilmington, but the 3,717 households in Clinton County (22.9%) that are supported by private water wells (<https://apps.ohiodnr.gov/water/maptechs/wellogs/appNEW/CountyList.htm>). Many of these private wells have the possibility of becoming dry within a drought situation prior to the public systems showing significant loss depending on use, size, and depth of the well.

If a drought occurs in Clinton County, it not only affects residents' water supply, but it also could impact those whose primary income is in some way based on agriculture. Clinton County's economy originally was based on agriculture. It has maintained this with 759 farms within its borders each averaging 274 acres which totals approximately 81% (71% Cropland and 10% Pasture) of Clinton County's land area with

cash receipts totaling over \$163.8 million annually from crops and livestock (<http://www.development.ohio.gov/files/research/C1015.pdf>).

Agricultural Statistics for Clinton County					
Commodity	Non-Drought (2011)	Drought (2012)	Units	Change	Amount
Corn – Planted	71,400	76,900	Acres	Increase	5,500
Corn, grain – harvested	70,500	74,500	Acres	Increase	4,000
Yield	98.74%	96.88%		Decrease	1.86%
Corn, grain-production	12,148,000	11,090,000	Bushels	Decrease	1,058,000
Yield	172.3	148.9	Bushels/Acre	Decrease	23.4
Hay-harvested	1,600	1,500	Acres	Decrease	100
Hay-production	5,400	4,100	Tons	Decrease	1,300
Yield	3.40	2.75	Tons/Acre	Decrease	0.65
Soybeans-planted	97,500	100,500	Acres	Increase	3,000
Soybeans-harvested	97,400	100,400	Acres	Increase	3,000
Yield	99.90%	99.90%		Unchanged	0.00%
Soybeans-production	4,989,000	4,778,000	Bushels	Decrease	211,000
Yield	51.2	47.6	Bushels/Acre	Decrease	3.6
Wheat-planted	5,900	3,600	Acres	Decrease	2,300
Wheat-harvested	5,850	3,550	Acres	Decrease	2,300
Yield	99.15%	98.61%		Decrease	0.54%
Wheat-production	321,000	218,000	Bushels	Decrease	103,000
Yield	54.9	61.4	Bushels/Acre	Increase	6.5

Table 2.2.2.4

## 2.2 PROFILE HAZARDS

### 2.2.3. Earthquake

An earthquake is a sudden motion or trembling that is caused by a release of strain accumulation within or along the edge of the Earth's tectonic plates.

#### RESEARCH SOURCES

- Ohio Seismic Network
- ODNR, Division of Geology
- ESRI GIS Information for Ohio
- HAZUS-MH
- State of Ohio Hazard Mitigation Plan 2014
- USGS National Seismic Hazard Mapping Project
- FEMA Website

Period of Occurrence:	At any time
Number of Events to Date:	0
Probability of Event:	0.0
Warning Time:	None
Potential Impacts:	According to FEMA, areas with a PGA of 3 to 5 (0.03 to 0.05) will incur little to no damage with no function loss.
Cause Injury or Death:	Minor risk of injury
Potential Facility Shutdown:	None

#### HAZARD EFFECTS

An earthquake's sudden release of stored energy may manifest itself by shaking or displacing the ground. The severity of these effects is dependent on the amount of energy released from the fault (or epicenter) of the quake. The effects of an earthquake can be felt far beyond the site of its occurrence. Earthquakes usually occur without warning and, after just a few seconds, can cause massive damage and extensive

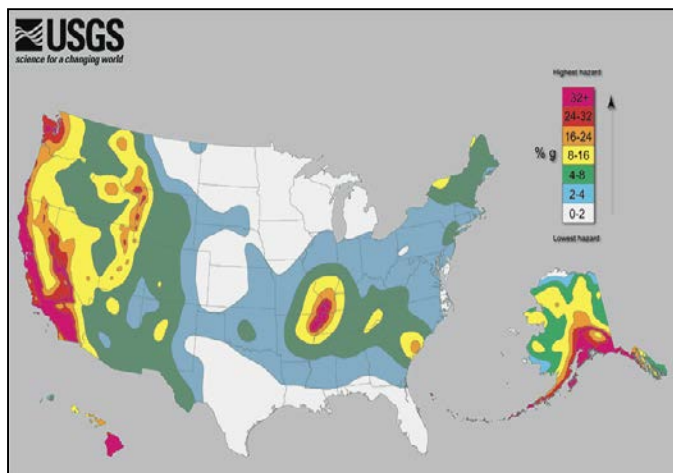


Figure 2.2.3.1

casualties. Common effects of earthquakes are ground motion and shaking, surface fault ruptures, and ground failure. Peak Ground Acceleration (PGA) is a measure of strength of ground movements. The PGA measures the rate in change of motion relative to the established rate of acceleration due to gravity.

The map provided by the USGS (shown to the right in Figure 2.2.3.2) depicts the PGA values for areas with a 10% chance of being exceeded over the next 50 years. Ohio does have an earthquake risk as it is located in the 2 and 4%g area as seen in Figure 2.2.3.1. FEMA states that areas with these PGAs are considered to have a low to moderate earthquake risk. As such, earthquake vulnerability is rated “low”.

The Central and Southeast U.S. region covers a large area of

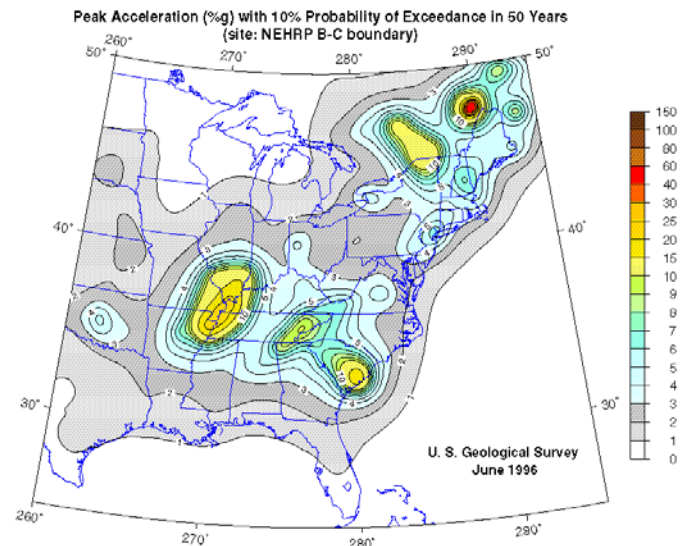


Figure 2.2.3.2

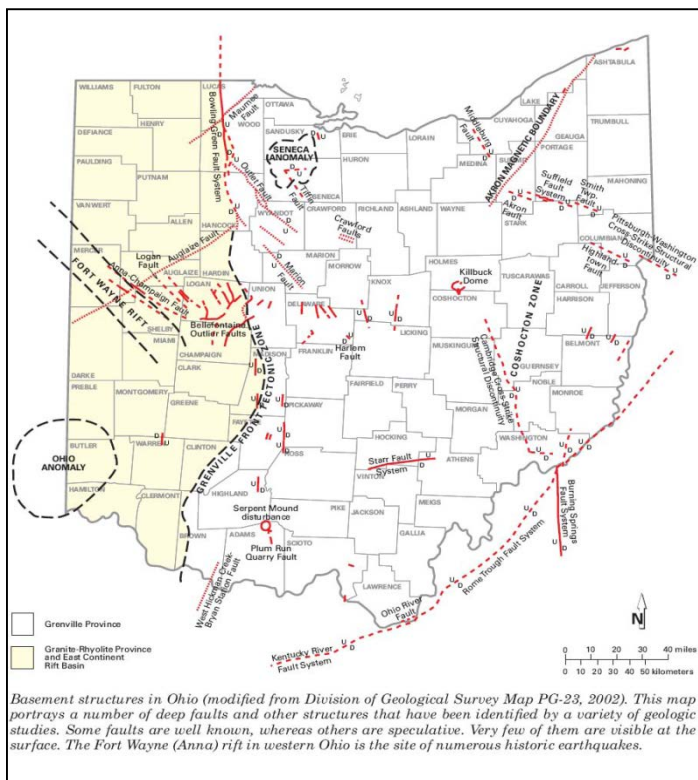


Figure 2.2.3.3

relatively diffuse, low-rate seismicity. Principle areas of activity include the New Madrid Seismic Zone of the central Mississippi Valley and the Southern Appalachian Seismic Zone, extending from Virginia to Alabama. Clinton County is also affected by the Grenville Front Tectonic Zone as seen in Figure 2.2.3.3. These areas of continued seismic activity increase the likelihood of Clinton County experiencing or being affected by an earthquake at some point in time even though there is no historical evidence of an earthquake epicenter occurring in the past as seen in Figure 2.2.3.5.

(<http://geosurvey.ohiodnr.gov/portals/geosurvey/PDFs/OhioSeis/epicentr.pdf>)

<http://geosurvey.ohiodnr.gov/portals/geosurvey/PDFs/OhioSeis/epicentr.pdf>

<b>Modified Mercalli Scale vs. Richter Scale</b>		
Category	Effects	Richter Scale (approximate)
I. Instrumental	Not felt	1-2
II. Just perceptible	Felt by only a few people, especially on upper floors of tall buildings	3
III. Slight	Felt by people lying down, seated on a hard surface, or in the upper stories of tall buildings	3.5
IV. Perceptible	Felt indoors by many, by few outside; dishes and windows rattle	4
V. Rather strong	Generally felt by everyone; sleeping people may be awakened	4.5
VI. Strong	Trees sway, chandeliers swing, bells ring, some damage from falling objects	5
VII. Very strong	General alarm; walls and plaster crack	5.5
VIII. Destructive	Felt in moving vehicles; chimneys collapse; poorly constructed buildings seriously damaged	6
IX. Ruinous	Some houses collapse; pipes break	6.5
X. Disastrous	Obvious ground cracks; railroad tracks bent; some landslides on steep hillsides	7
XI. Very disastrous	Few buildings survive; bridges damaged or destroyed; all services interrupted (electrical, water, sewage, railroad); severe landslides	7.5
XII. Catastrophic	Total destruction; objects thrown into the air; river courses and topography altered	8

Figure 2.2.3.4

([http://www.cposcience.com/home/Portals/2/Media/post\\_sale\\_content/PES/PES\\_Chap\\_20/TeachingIllustrations/20\\_1\\_mercalli\\_vs\\_richter\\_scale.pdf](http://www.cposcience.com/home/Portals/2/Media/post_sale_content/PES/PES_Chap_20/TeachingIllustrations/20_1_mercalli_vs_richter_scale.pdf) )

To describe an earthquake, two methods were developed. The Richter scale was developed to be used in conjunction with seismic instruments and is based upon the level of ground movement. The other method is the Modified Mercalli Scale which, while less precise, is based upon observable damage levels. A comparison of these scales is shown above in Figure 2.2.3.4. Most earthquakes within the Clinton County region are likely to be a VII (Very Strong) or less on the Modified Mercalli scale, resulting in, at most, cracked plaster. This corresponds to a 5.5 or less on the Richter scale.

Also, as seen in Figure 2.2.3.5, Clinton County, being in the southwest corner of Ohio, has a higher chance of an earthquake than other portions of Ohio. Further, there are seismic events nearly encircling Clinton County ranging in size from 3 to nearly 6 in Richter scale magnitude. In any event though earthquakes are a countywide hazard and can affect all areas and jurisdictions of the county consistently.



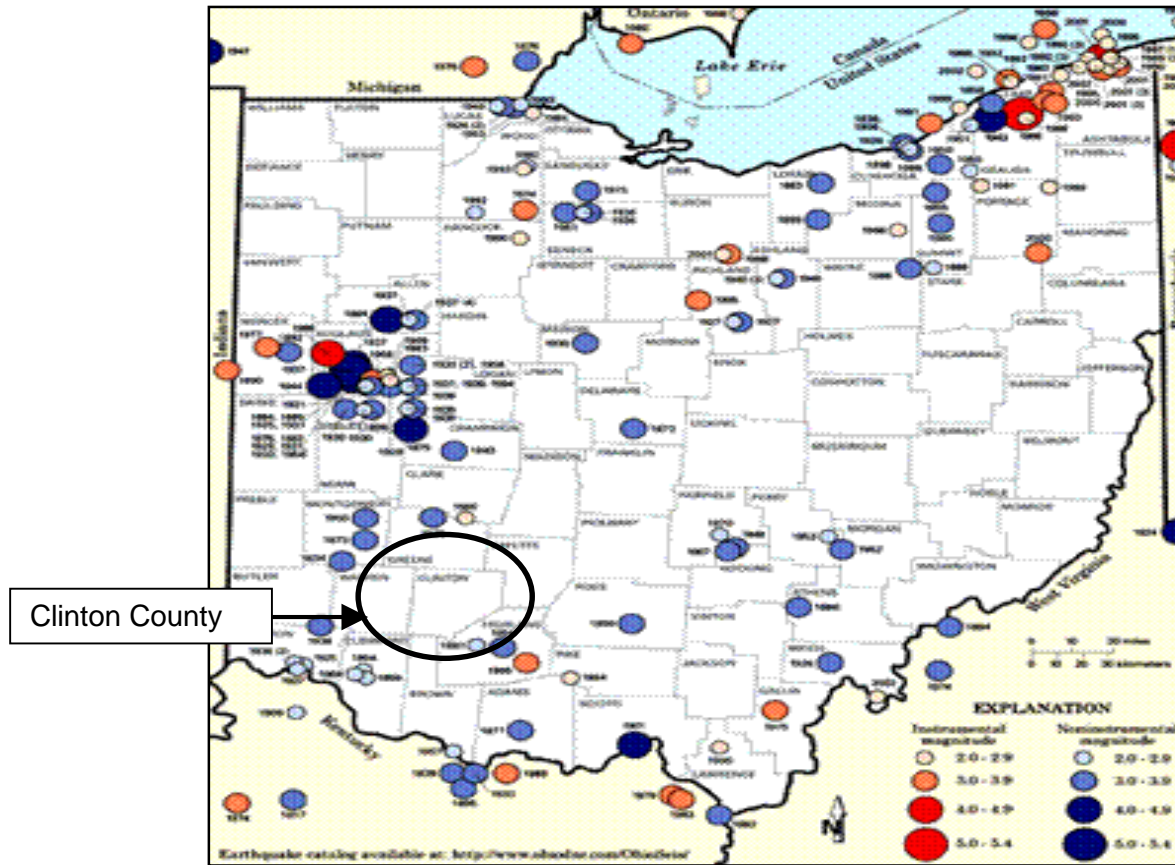


Figure 2.2.3.5



## 2.2 PROFILE HAZARDS

### 2.2.6. Insect Infestation – Emerald Ash Borer

An infestation is to spread or swarm in or over in a troublesome manner. Also, an infestation may mean to live in or on as a parasite.

#### RESEARCH

- Ohio State University
- ODNR – Division of Wildlife
- ODNR – Division of Forestry
- US Forest Service
- USDA/APHIS
- Public Comment
- Internet Search.

Period of Occurrence:	Mostly summer months
Number of Events to Date (2000 – 2012):	0
Probability of Event:	0.0
Warning Time:	Months to Years
Potential Impacts:	Can be particularly damaging to crops
Cause Injury or Death:	N/A
Potential Facility Shutdown:	unlikely

#### HAZARD EFFECTS

According to searches of online information provided by the Ohio Division of Forestry, Clinton County is subject to an infestation of Emerald Ash Borers (EAB). The Emerald Ash Borer was first discovered in 2002, infesting and devouring ash trees throughout Ohio. Stated by the Coalition for Urban Ash Tree Conservation in 2011, Ash trees are abundant within urban forests, representing 10-40% of the canopy cover in many communities of which 249 within Ohio are certified Tree City USAs (ODNR-Division of Forestry, 2014). With an estimated loss to urban forests expected to be \$10-20 billion



Figure 2.2.6.1

over the next 10 years (Urban Ash Tree Conservation, 2011), the entire state of Ohio has been quarantined for Emerald Ash Borers as per the Plant Protection Act limiting the transfer of EABs as seen in Figure 2.2.6.1. While EABs are strong flyers, they often do not fly over ½ mile, as a result, the insertion of the Emerald Ash Borer was assisted by people through commerce having appeared within wooden packing materials from eastern Asia. The EAB continued to propagate with the assistance of people as people move common ash products like firewood, nursery stock, and green lumber.

As for fiscal effects, the amount can be catastrophic substantially damaging the \$15.1 billion annual value within Ohio's forest product industry (ODNR-Division of Forestry, 2014) which employs 119,000 Ohioans. As for Demographic Effects, this is negligible since EABs attack trees. The duration can be long with months or years before an area even shows signs of an infestation. For example, the USDA estimated the EAB's was present for up to 12 years before it was detected initially in Michigan. In addition, an Emerald Ash Borer infestation is always fatal to ash trees (APHIS, 2009), it possibly will take years to recover the canopy growth for an area since new trees must be either transplanted or grown from seeds.

## 2.2 PROFILE HAZARDS

### 2.2.4. Flooding

Flooding is defined as a general temporary condition of partial or complete inundation of normally dry land areas from: overflow of inland or tidal waters; unusual and rapid accumulation of runoff of surface water from any source; mudflows; or the sudden collapse of shoreline land. A flash flood is a rapid flooding of low-lying areas, rivers, and streams that is caused by intense rainfall and is often associated with thunderstorms.

#### RESEARCH

- State of Ohio Hazard Mitigation Plan 2014
- Past disaster declarations
- Local media research
- NCDC Event Records
- FIRMs
- FEMA Repetitive Loss List

#### HAZARD EFFECTS

Flooding is arguably the highest priority hazard in Clinton County. Clinton County is very susceptible to flooding largely due to the physical geography of the county, which includes several rivers and creeks as well as varied topography. The worst floods usually occur when a river overflows its banks. Periodic floods occur naturally on most rivers, forming an

area known as a “floodplain”. With enough rainfall, the rivers and creeks will rise up to and over the floodplain, thus causing a flood as resulted in Presidential Disaster Declaration 243 on 6/5/1968 when heavy rain caused flooding.

Period of Occurrence:	Primarily January through May (history shows incidents occurring year-round) Flash Flood – At any time depending on recent weather conditions Result of Dam Failure – At any time
Number of Events to Date (1950-2012):	37
Probability of Event:	0.016
Warning Time:	River Flood – 3 to 5 days Flash Flood – Minutes to hours Dam Failure – None
Potential Impacts:	Impacts to human life, health, and public safety. Utility damage and outages, infrastructure damage (transportation and communication systems), structural damage, fire, damaged or destroyed critical facilities, and hazardous material releases. Can lead to economic losses such as unemployment, decreased land values, and agrobusiness losses. Floodwaters are a public safety issue due to contaminants and pollutants.
Cause Injury or Death:	Injury and moderate risk of death
Potential Facility Shutdown:	Days to Weeks

Identification of floodplain areas within the county and its municipalities is based on Flood Insurance Rate Map (FIRM) data produced by the National Flood Insurance Program (NFIP). Figure 2.2.4.1 below from the Clinton County GIS Office, 2009, depicts the flood zones for the 100-year flood.

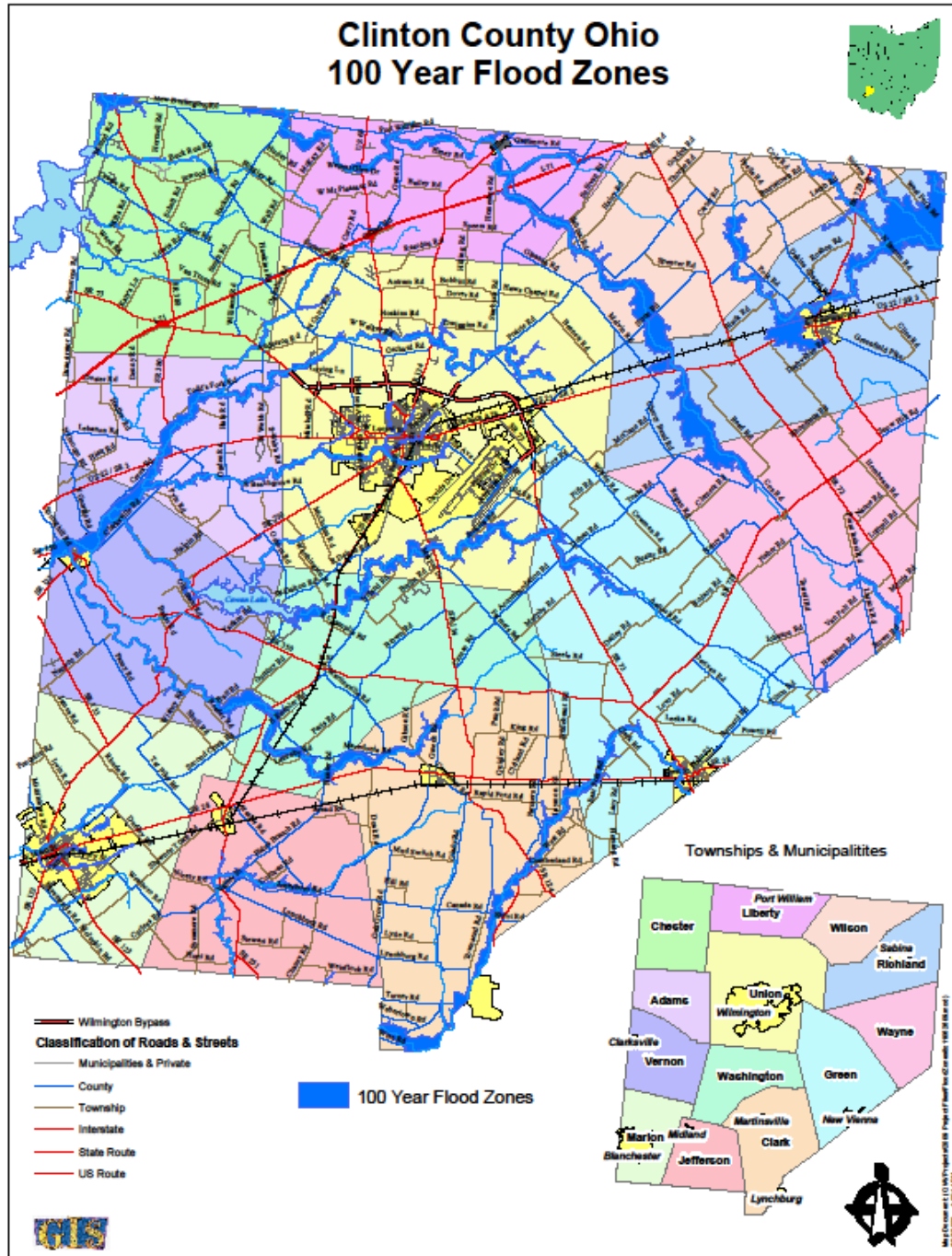


Figure 2.2.4.1

## DESCRIPTION OF EXISTING HAZARD AND IDENTIFICATION OF RISK

Since January 1, 1996, Clinton County has seen 37 floods or flash floods ([www.ncdc.noaa.gov/stormevents/](http://www.ncdc.noaa.gov/stormevents/), 2014) totaling \$111,000 in property and crop damage. On March 19, 2008 a woman, attempting to cross a swollen stream, was swept away and drowned (<http://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=89135>). Some of the floods have been small in fiscal and demographic effect such as a countywide flash flood which did no damage on April 16, 1998 because it simply flooded roads throughout the county (<http://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5633586>) but neighboring county Warren received \$2 million in damages and nearby Hamilton County received \$4 million in property damage. Another example of no damage within Clinton County occurred on February 9, 2003. Minimal property damage occurred in nearby Butler County but persistent heavy rain produced an additional one to two inches across southwest Ohio during the afternoon. The heavy rain caused flooding of roads and several creeks to rise out of their banks. A school bus was stranded in high water near Mason. Kings Mills Road in Mason collapsed in a construction area when the heavy rains washed out a culvert. Twenty-five people were evacuated from an apartment complex in Fairfield due to the high water. The largest documented flooding event occurred on January 5, 2005 with \$20,000 in property damage as a result of heavy rainfall on a saturated ground from snow melt (<http://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5439115>).

As for the results from a 100 year flood event, Figure 2.2.4.1, happening, the State of Ohio Hazard Mitigation Plan from 2011 estimates that 21 structures would have substantial damage and an estimated \$52.3 million in business interruption would occur (Ohio Hazard Mitigation Plan, 2014).

The duration can be long or short depending on the level of damages. In events that cause minimal to no damage the duration can be short because the duration is usually the length of time to remove the water from affected roadways (i.e., hours or days). When significant damage occurs though the duration can be long because of needing to remove water, repair property damage, and drain areas from water covered agricultural fields.

Warning times vary as well. Flash floods occur quickly (i.e., minutes to hours) so little warning time is available. River and stream flooding can supply more warning time

as the water levels rise against the banks allowing for mitigation actions to minimize damage.

#### REPETITIVE LOSS PROPERTIES

In terms of repeated flooding problems, Clinton County and its municipalities have no properties listed by the Federal Emergency Management Agency (FEMA) as “repetitive loss properties”.

VILLAGE	TYPE	NUMBER
TOTALS	Residential	0
	Non-Residential	0

Table 2.2.4.2

Six of the local governments in Clinton County are participants in the National Flood Insurance Program (NFIP) (<http://www.fema.gov/cis/OH.html>). These jurisdictions are listed in Table 5.0.1. Of the six jurisdictions listed as part of the National Flood Insurance Program (NFIP), each has designated an “NFIP Coordinator”. The NFIP Coordinator maintains the jurisdiction’s floodplain ordinance and ensures that development is compliant with that ordinance (and, consequently, the NFIP).

## 2.2 PROFILE HAZARDS

### 2.2.5. Hazardous Material Incident

A technological hazard refers to the origins of incidents that can arise from human activities such as the manufacture, transportation, storage, and use of hazardous materials.

#### RESEARCH

- US EPA – Envirofacts Warehouse
- Local media research
- US DOT – Hazardous Materials Safety
- Public Input

Period of Occurrence:	At any time
Number of Events to Date (1987 – 2014):	499
Probability of Event:	18.481
Warning Time:	None
Potential Impacts:	Potential loss of human life, economic loss, environmental damage
Cause Injury or Death:	Injury and risk of multiple deaths
Potential Facility Shutdown:	Days to weeks

#### HAZARD EFFECTS

The manufacture, storage, transportation, and use of hazardous materials can become a hazard if an accident occurs. Hazardous material incidents typically happen in one of two ways: fixed facility releases or transportation accidents. The major difference between the two is that it is reasonably possible to identify and prepare for a fixed facility incident because laws require those facilities to notify state and local authorities of what materials are being used, stored, and/or produced at that facility. Clinton County contains 122 facilities that must report chemical information per SARA legislation. The majority of these facilities focus on population areas such as Wilmington, Sabina, and Blanchester. 499 releases occurred at 21 facilities throughout the county but nearly 50% of the releases were within the vicinity of Wilmington, 32% near Blanchester, and 14% near Sabina ([TRI Search Results | Envirofacts | US EPA](#)). The kinds of chemicals that were reportedly released include lead, copper, nickel, glycol ethers, butyl alcohols but the most reported items were primary metals of copper, lead, and nickel. As for the hazard related results associated within these locations a look at representative industries and the Risk-Screening Environmental Indicators (RSEI) can be used. These results indicate the comparative level of a toxically released substance to medians across industry, county, state, or nation; they do not identify exact chemical causes or pinpoint facilities as the hazard. It recommends further investigation such as a Tier II



Report review or a more in-depth hazard assessment for the area. An example of RSEI in the primary metals industry for the Wilmington area has a major facility, while decreasing the risk level from 2006 to 2010, at 8x the industry median in 2010 (<http://oaspub.epa.gov/enviro/rsei.html?facid=45177HRSTY2627S>). This means that the population that is exposed to these primary metals in the Wilmington area is eight times more at risk than the industry average. Within Sabina, the release of lead has decreased significantly and, while still above the industry average, is less than the national median and less than half the state median (<http://oaspub.epa.gov/enviro/rsei.html?facid=45169NWSBN12555>).

Transportation incidents are substantially more difficult for which to prepare because it is difficult to determine what material(s) could be involved until the accident actually happens. Information is routinely compiled on the locations of facilities that store hazardous materials through SARA Tier II Reports and these reports can guide the determination of the most predominant chemicals to expect transported, but it still does not account for those chemicals that are simply “passing through” Clinton County. Transportation is not only over the roadways but through pipelines in the northern portion of Clinton County as seen in Figure 2.2.5.1 (<https://www.npms.phmsa.dot.gov/PublicViewer/composite.jsf>) below. A recommendation for an updated Commodity Flow Study is suggested.

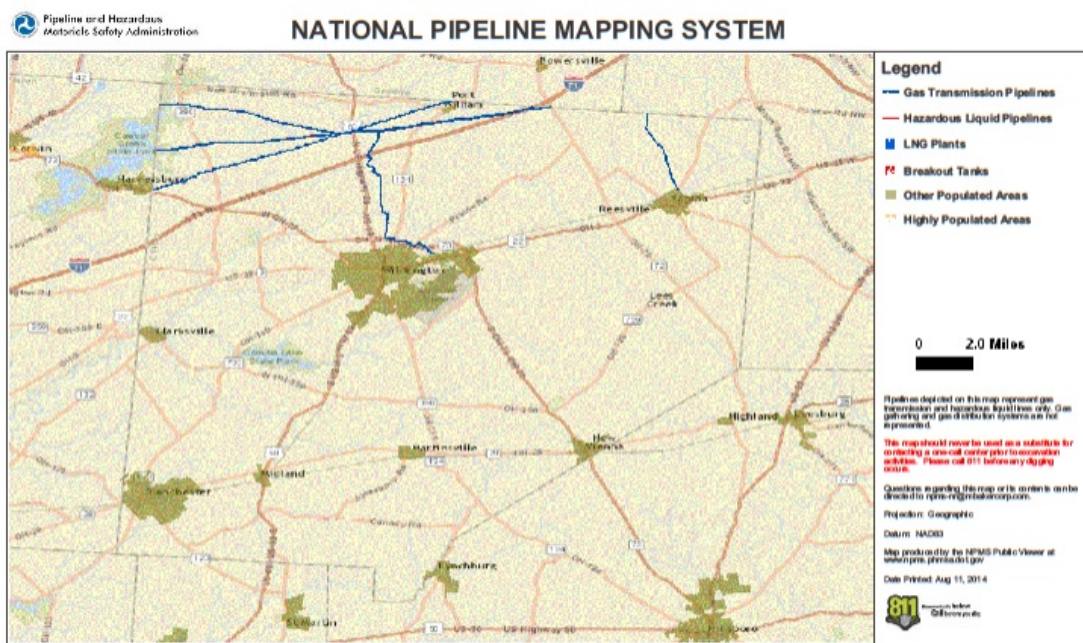


Figure 2.2.5.1



## 2.2 PROFILE HAZARDS

### 2.2.7. Land Subsidence/Landslide

Land subsidence refers to any failures in the ground that cause collapses in the earth's surface.  
Landslide refers to the downward falling or sliding of a mass of soil, detritus, or rock on or from a steep

#### RESEARCH SOURCES

- Local media research
- State of Ohio Hazard Mitigation Plan 2014
- ODOT – Division of Engineering Policy
- ODNR – Division of Geology
- Clinton County Engineer Interview
- Public Input
- USGS
- USGS Soil Survey
- nationalatlas.gov

Period of Occurrence:	At any time – Chance of occurrence increases following long periods of heavy rain, snowmelt, or near construction activity
No. of Events (1988–2010):	0
Probability of Event:	0.0
Warning Time:	Weeks to months – Some instances of land subsidence can occur quickly without warning, but often in the context of other storm events.
Potential Impacts:	Economic losses such as decreased land values, agrobusiness losses, disruption of utility and transportation systems, and costs for any litigation. May cause geological movement, causing infrastructure damages ranging from minimal to severe.
Cause Injury or Death:	Injury
Potential Facility Shutdown:	Days to weeks

#### HAZARD EFFECTS – LAND SUBSIDENCE

Land subsidence hazards involve expansive soils which is the swelling and sinking of soil. These hazards can be caused by natural processes such as the dissolving of limestone underground, earthquakes, or volcanic activity. Land subsidence hazards can also occur as a result of human actions such as the withdrawal of subsurface fluids or underground mining; unplanned commercial, residential or industrial developments; roadway construction; etc.

Most of Clinton County lies on a geological formation containing Karst from carbonate rock as seen in Figure 2.2.7.1.

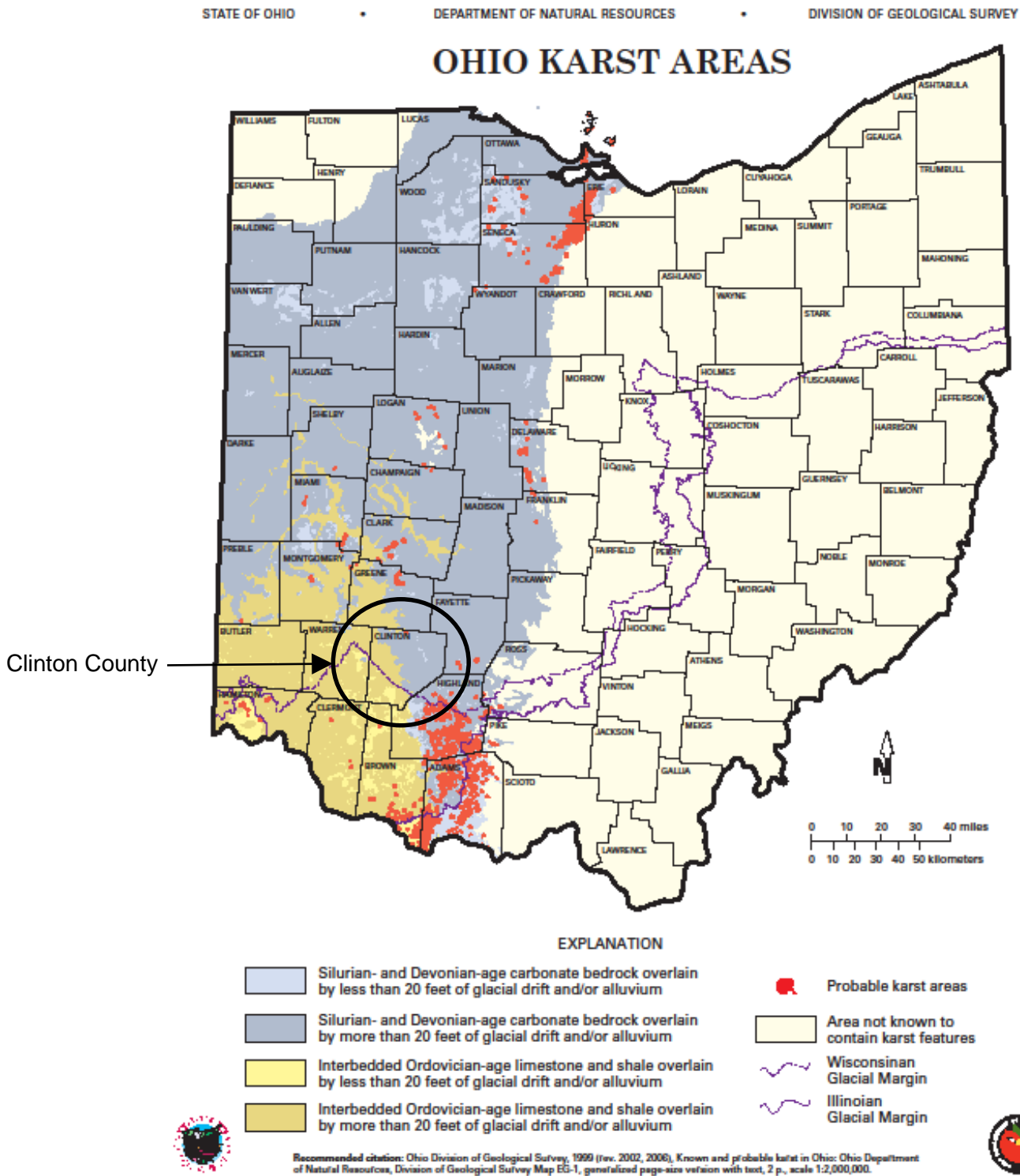


Figure 2.2.7.1

As Figure 2.2.7.2 ([http://ohiosharpp.ema.state.oh.us/OhioSHARPP/Documents/SHMP/2-HIRA/SOHMP\\_Sec\\_2\\_14.pdf](http://ohiosharpp.ema.state.oh.us/OhioSHARPP/Documents/SHMP/2-HIRA/SOHMP_Sec_2_14.pdf)) shows, mines have not resulted in extensive subsidence events and investigations within Clinton County but Karst has a characteristic feature of sinkholes, underground drainage, and caves as are present in nearby counties of Brown and Clermont.. A larger possibility in Clinton County could be from earthquakes as a result of Clinton County being on the Grenville Front Tectonic Zone as seen in figure 2.2.7.3. For further information regarding earthquakes see section 2.2.3.

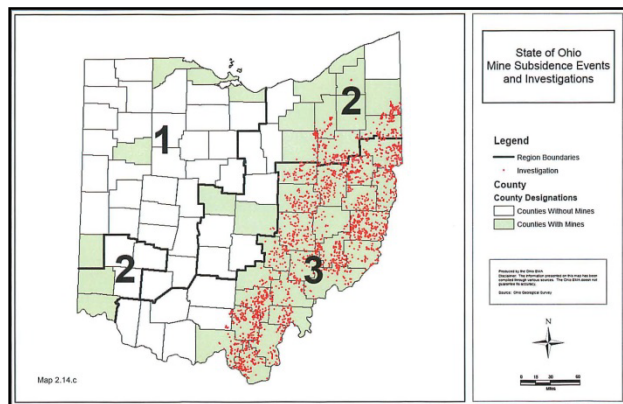


Figure 2.2.7.2

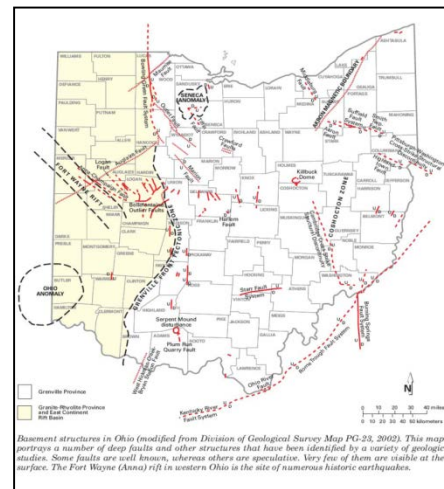


Figure 2.2.7.3

## HAZARD EFFECTS - LANDSLIDE

Landslides (a wide range of earth movement such as rock falls) and debris flow (e.g. mudslides and avalanches), both of which involve ground movement in or on the earth's surface. These hazards can be caused by natural processes such as the dissolving of limestone underground, earthquakes, or volcanic activity. Landslides hazards can also occur as a result of human actions such as the withdrawal of subsurface fluids or underground mining; unplanned commercial, residential or industrial developments; roadway construction; etc.

According to [nationalatlas.gov](http://nationalatlas.gov), sink holes and other subsidence are not predicted to be extensive in the areas of Ohio containing these formations.

While no events were known of by the Clinton County Engineer, as seen within Figure 2.2.7.4, Clinton County has two distinct landslide "zones". While the majority of the

county is low in landslide incidences, the village of Clarksville is considered to be “Moderate susceptibility and low incidence”.

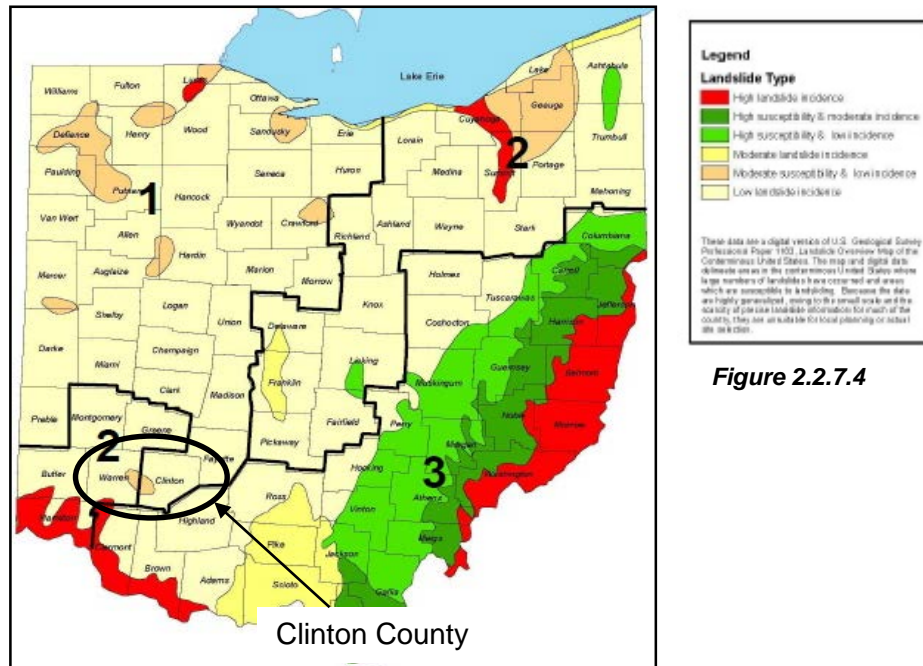


Figure 2.2.7.4

Additionally, the State of Ohio Hazard Mitigation Plan rates Clinton County as a “Moderate” in economic losses as a result from landslides, estimating over \$105,185 in losses (Ohio Hazard Mitigation Plan, 2011).

The demographic effect can be large depending on the location of the collapse. If the collapse is within a higher populated area such as Wilmington in the central portion of the county, it can be higher than in the middle of a more open area such as central Green or Wayne Township.

The fiscal effects can be large as well, again dependent on the location. If an event occurs within a more populated area, the fiscal loss can be higher with the loss to infrastructure (i.e., roads and rails), commercial and industrial facilities, and the workforce. While if a land subsidence/landslide event occurs within an agricultural field, the loss of cultivatable land can be insignificant to the whole field size resulting in little to no measurable loss.

The duration can be long in both warning and recovery depending on the vigilance of the population. If a constant watch for deformations such as sinking areas in relation to the surrounding area occurs, the warning time can be longer; otherwise the event can occur quickly with little to no notification. As for the recovery time, it can be

long or short depending on the location. As stated, if the loss is within an open field, the recovery time can be short resulting from little to no disruption in activities but if the occurrence is within a more developed area then the recovery time can be longer with blocked transportation routes, loss of industry, or commercial support.

## 2.2 PROFILE HAZARDS

### 2.2.8. Oil and Gas Industry

A technological hazard refers to the origins of incidents that can arise from human activities such as the manufacture, transportation, storage, and use of hazardous materials.

#### RESEARCH

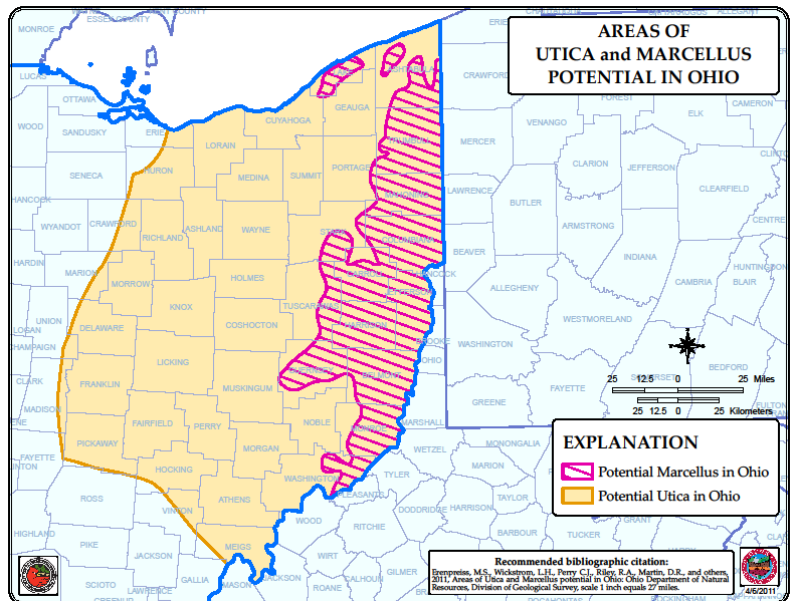
- US EPA – Evirofacts Warehouse
- Local media research
- US DOT – Hazardous Materials Safety
- ODNR – Division of Geology
- ODNR – Division of Geological Survey
- Internet search
- Public Input

Period of Occurrence:	At any time
Number of Events to Date:	0
Probability of Event:	0.0
Warning Time:	None
Potential Impacts:	Potential loss of human life, economic loss, environmental damage
Cause Injury or Death:	Injury and risk of multiple deaths
Potential Facility Shutdown:	Days to weeks

#### HAZARD EFFECTS

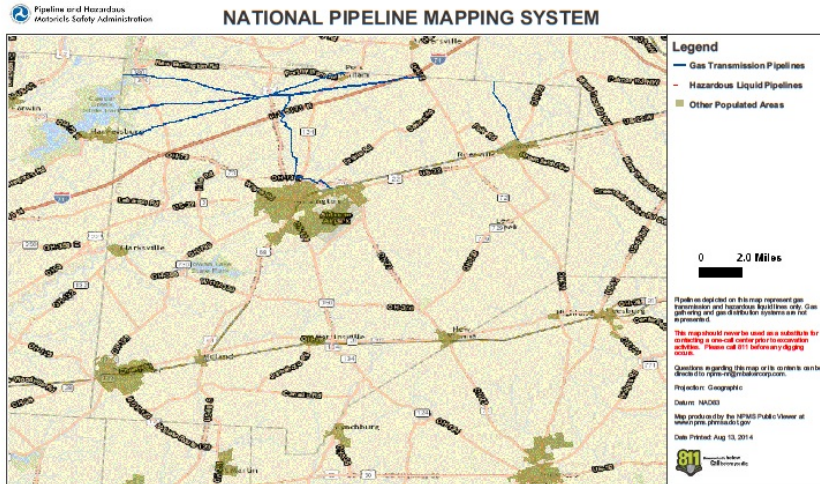
Beginning in 2009, the advancement of new technology allowed for more efficient drilling within the Marcellus and Utica Shale beds for oil and natural gas of which Clinton County is not a portion of as see in Figure 2.2.8.1. While the drilling for new material is not a concern for Clinton County, the transmission of oil and natural gas refined products can occur as is seen in Figure 2.2.8.2

Figure 2.2.8.1



(<https://www.npms.phmsa.dot.gov/PublicViewer/composite.jsf>).





**Table 2.2.8.2**

To transport these hazardous materials pipelines, rails, and trucks will possibly be used in large numbers throughout the entire county. This aspect is discussed in more detail under

the hazardous materials profile along with the recommendation for an updated Commodity Flow Study especially since currently, as seen in Figure 2.2.8.2, the majority of the pipeline is in the northern portion while the rail system is in the central and southern portions of the county. These pipelines are being constructed with modern protected steel and plastic lines, but some transmission lines have existed for years, transporting NGL and oil across Ohio and these lines are constructed out of cast-iron and bare steel. As a result, the Pipeline Utilities Commission of Ohio (PUCO) has required the four major natural gas utilities of Duke Energy, Columbia Gas, Dominion East Ohio, and Vectron to replace pipelines over a set number of years. Table 2.2.8.3 shows the timeframes for the programs, how far into the program each company is, the total mileage in replacement line needed and how many miles have been replaced as of December 31, 2013 (<http://www.puco.ohio.gov/puco/index.cfm/consumer-information/consumer-topics/natural-gas-pipeline-safety-in-ohio/>). Duke Energy does not own any pipeline in Clinton County so they are not displayed in the table below. In addition to these companies, Clinton County has two other pipeline owners not within this program and further investigation into the age and capacities of their pipelines would be recommended.

Company	Columbia Gas	Dominion East Ohio	Vectron
Term of the program	25 years	25 years	20 years
Current year of program	6	6	6
Proposed replacement mileage	4,153	5,572	708
Miles replaced to date	910	805	157

**NOTE:** all information is as of December 31, 2013

**Table 2.2.11.3**

As for what kind of incidents could affect the oil and gas industry, they include all forms that can affect Clinton County as a whole and discussed. For instance, earthquakes have been registered in the surrounding counties as discussed in the earthquake section. An explosion could start a fire and damage infrastructure as occurred within Sissonville, WV. Terrorist events can occur to disrupt the flow of energy. Landslides or land subsidence can occur as a result of the geologic makeup of Clinton County as discussed in Section 2.2.7, shifting the earth and possibly breaking transmission lines,

With all of this natural gas being transported through Clinton County the economic effect can be catastrophic due to the decrease in revenue from the sale and taxation of the products. The number of employees which can be affected is within the support industries such as the trucking companies, the rail industry, and retail since many of the actual processing facilities require only a hand full of people to maintain. It is within these support industries that if an incident occurred to the oil and gas industry there could be large losses. Depending on the location of the incident, the demographic effect can be small or large. If an explosion occurs within the 70% of Clinton County associated with agriculture, then the demographic effect can be small, but if the incident occurs at a distribution facility in Wilmington or Sabina then the demographic effect can be large because these facilities are closer to more populated areas.

With constant vigilance and inspection of pipelines and distribution facilities the notification time can be long as damage can be detected early, but can also be difficult with the vast area. This makes a constant oversight for all pieces very difficult resulting in the possibility for a short notification time. Also, dependent on where the incident



occurs, the recovery time can be long or short. If a distribution facility is the site of an incident, it can be a long time, stopping distribution at that facility and the corresponding economic loss created in the supplemental industries that facility supports. In contrast, a break in a section of pipeline can possibly disrupt flow for a short time, less than a day, if it can be diverted to another transportation method such as rail or truck.

## 2.2 PROFILE HAZARDS

### 2.2.9. Severe Storms (Thunderstorms, Heavy Rain, Lightning, and Hail)

A thunderstorm is considered severe when that storm produces a tornado, winds of at least 58 mph (50 knots), and/or hail at least ¾" in diameter. Structural wind damage may imply the occurrence of a severe thunderstorm. A thunderstorm wind equal to or greater than 40 mph (35 knots) and/or hail of at least ½" is defined as "approaching severe".

#### RESEARCH SOURCES

- State of Ohio Hazard Mitigation Plan, 2014
- National Weather Service
- NCDC Event Records
- Past Declarations
- Internet Research

Period of Occurrence:	Spring, summer, and fall
Number of Events to Date (1950 – 2013):	193
Probability of Event:	3.063
Warning Time:	Minutes to hours
Potential Impacts:	Utility damage and outages, infrastructure damage (transportation and communication systems). Impacts human life, health, and public safety.
Cause Injury or Death:	Injury
Potential Facility Shutdown:	Days

#### HAZARD EFFECTS – THUNDERSTORM

The National Weather Service defines a thunderstorm as "severe" when wind speeds reach 58 mph or stronger, and/or hail is produced that is ¾ (.75) inch in diameter or larger, and/or a tornado is produced. Thunderstorms are one of the most common types of hazards in Clinton County. As can be seen in Figure 2.2.9.1, Ohio is from 4.0-5.5 m/s or 8-12 mph. Winds at the speeds represented on this graphic are capable of doing little damage but these are average wind speeds. During the 83 thunderstorm events that the

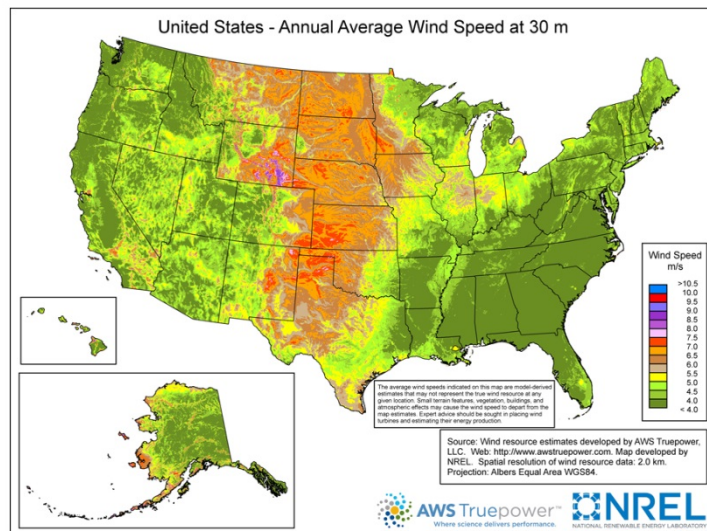


Figure 2.2.9.1

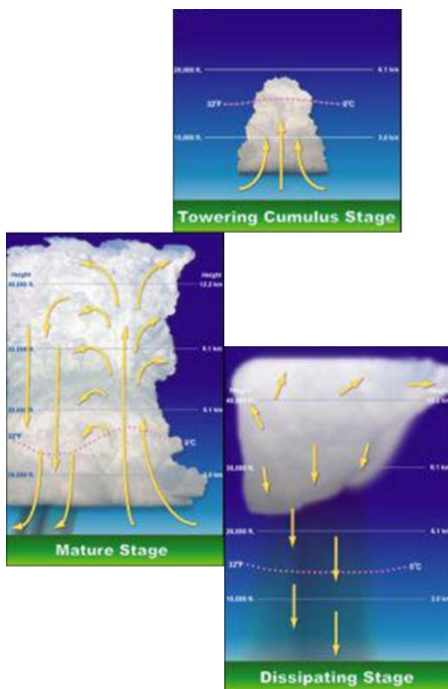
National Climatic Data Center lists between January 1, 1950 and December 31, 2013 the majority are listed at 50 knots (57 mph) or greater.

The thunderstorms incurred no injuries or deaths during this time period, but property damage did occur over a wide range. On April 9, 1999 a thunderstorm with wind speeds recorded at 100 knots (115.1 mph) southwest of Clarksville causing \$1.0 million in property damage. Three homes and a business were destroyed while an additional 20 other properties sustained damage. At the other extreme though on April 20, 2011 at the Wilmington Air Park, Thunderstorm winds reached 69 knots (79.4 mph), And no property damage, no deaths, and no injuries occurred (<http://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=289820>). There was one Presidential Emergency Declaration declared on June 30, 2012 involving severe storms. It assisted the entire state of Ohio.

Secondly, severe storms often contain heavy rain such as on July 9, 2013 when

heavy rains caused creeks to exceed their banks near Jonesboro. No injuries, deaths, or property damage occurred, but flooding began to appear (<http://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=464818>). See Section 2.2.4 above for more information about flooding. Another example that led to minor flooding along US 68 from heavy rains occurred on May 16, 2013 near Lumberton. Again no deaths, injuries, or property damage, but a primary transportation route was affected.

Thirdly, severe storms can produce destructive lightning strikes, large quantities of electrical discharge. While the National Climatic Data Center only lists strikes that cause death, injury, or property damage, Clinton County has two events so recorded. On May 24, 1996 and June 11, 1996



**Figure 2.2.9.2**

lightning strikes in Wilmington caused \$50,000 and \$100,000 in property damage respectively. The May 24<sup>th</sup> event was a house and attached garage being destroyed (<http://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5558779>) while the June 11<sup>th</sup> event struck a house causing extensive damage (<http://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5567524>).

When hail occurs, it can cause damage by battering crops, structures, automobiles, and transportation systems. When hailstorms are large, especially when combined with high winds, damage can be somewhat extensive. Hailstorms are more common in elevated areas, such as the mountains, than tropical areas since locations such as mountains are closer to the bottom of thunderstorms. In mountainous areas, the falling hail has less time to melt before touching the ground. Clinton County is less susceptible to hailstorms than the eastern portions of Ohio.

According to the National Climatic Data Center (NCDC), Clinton County experiences hailstorm relatively frequently though with 49 recorded events between January 1, 1950 and December 31, 2013. Most hailstorms are not severe in destruction (77.6% of those in Clinton County had no property damage [[http://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28C%29+Hail&beginDate\\_mm=01&beginDate\\_dd=01&beginDate\\_yyyy=1950&endDate\\_mm=12&endDate\\_dd=31&endDate\\_yyyy=2013&county=CLINTON&hailfilter=0.00&tornfilter=0&windfilter=0.00&sort=DT&submitbutton=Search&statefips=39%2COHIO](http://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28C%29+Hail&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=12&endDate_dd=31&endDate_yyyy=2013&county=CLINTON&hailfilter=0.00&tornfilter=0&windfilter=0.00&sort=DT&submitbutton=Search&statefips=39%2COHIO)]) but Clinton County has experienced hailstorms that caused property or other damage during this timeframe totaling \$231,000. The reported storms contained hail ranging from 0.75 inches (19.05 mm) to 2.75 inches (44.45 mm) diameter. Hail often occurs in conjunction with other storm types such as thunderstorms and high winds. These topics are covered in more detail in Section 2.2.10 and above.

Damage to community assets from hailstorms usually comes in the form of broken windows, damaged HVAC systems, destroyed landscaping, etc. Hail rarely does enough damage to close an asset or keep employees from reporting to work. Even when \$100,000 in property damage in Wilmington occurred, the damage was to 4 airplanes at the Wilmington Air Park and car windows. The size of the hail was measured at 2.75 inches for this event (<http://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5641971>).

Thunderstorms, heavy rain, lightning, and hail are all countywide hazard and can affect all areas and jurisdictions of the county consistently.

## 2.2 PROFILE HAZARDS

### 2.2.10. Severe Wind/Tornado

Wind storms are destructive wind events that occur with or without the presence of other storm events, such as tornados or severe thunderstorms.

A tornado is a violently rotating column of air extending from a thunderstorm to the ground.

#### RESEARCH

- State of Ohio Hazard Mitigation Plan, 2014
- Tornado History Project
- National Weather Service
- NCDC Event Records
- Internet Research

#### HAZARD EFFECTS – WIND STORM

A wind storm is a severe weather condition

indicated by high winds and with little or no rain. Localized geographical conditions can

Period of Occurrence:	At any time – Primarily during March through August
Number of Events to Date (1950 – 2013):	33
Probability of Event:	0.524
Warning Time:	Minutes to hours
Potential Impacts:	Utility damage and outages, infrastructure damage (transportation and communication systems), structural damage, and damaged or destroyed critical facilities. Impacts human life, health, and public safety.
Cause Injury or Death:	Injury and risk of multiple deaths
Potential Facility Shutdown:	Days to weeks or more

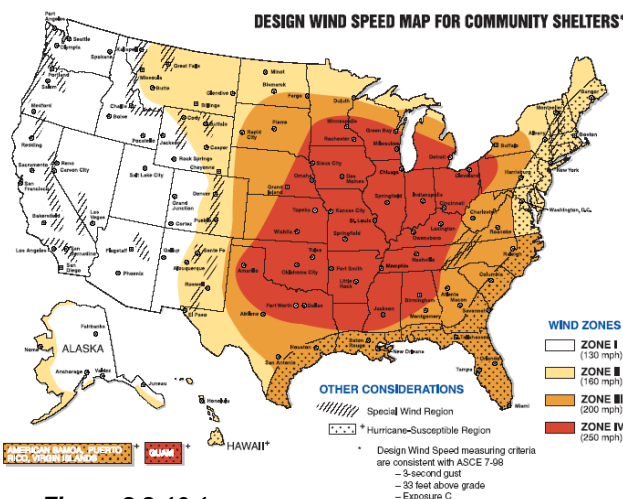


Figure 2.2.10.1

(<http://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=8513>) by blowing down trees, powerlines, and some structure

damage in Blanchester. A more severe high wind occurred on September 14, 2008 causing \$5.1 million in structural damage (<http://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=134611>). This storm was caused by remnants from Hurricane Ike and had winds recorded up to 77 mph near Wilmington. One Presidential Major Disaster Declaration was declared on October 24, 2008 to support Ohio counties who suffered from severe wind storms created by Tropical Depression Ike (<http://www.fema.gov/disaster/1805#tabs-2>).

The “Design Wind Speed Map for Community Shelters” (Figure 2.2.10.1) is one way of graphically analyzing wind risks. As can be seen, Clinton County is in “Zone IV” with respect to design wind speeds, which means that shelters constructed for protective purposes (from wind hazards) should be designed to withstand up to 200 mph winds.

Severe wind events can cause a variety of secondary, or cascading, hazard events. For instance, wind may blow limbs from trees down knocking out electric power or blocking roadways. Wind often results in damages to roofs and other home finishings (i.e., siding, etc.).

#### HAZARD EFFECTS - TORNADO

The most violent tornadoes are capable of tremendous destruction with wind speeds of 250 mph or more. Damage paths can be in excess of one mile wide and 50 miles long. Tornadoes are among the most unpredictable of weather phenomena. Tornadoes can occur in any state in the U.S. but are more frequent in the Midwest, Southeast, and Southwest.

The nature of tornadoes is that they strike at random. While it is known that some areas of the country experience tornadoes more than others, predicting exactly what parts of Clinton County have a greater chance of being struck by a tornado is difficult. While the Ohio Hazard Mitigation Plan describes Clinton County as a “High Risk” in table 2.3.f of that plan (2011), the best predictor of future tornadoes is the occurrence of previous tornadoes. According to Tornado History Project (<http://www.tornadohistoryproject.com/tornado/Ohio/Clinton>), there have been 29 tornadoes recorded in Clinton County from 1950 – 2013. The National Climatic Data Center

([http://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28C%29+Tornado&beginDate\\_mm=01&beginDate\\_dd=01&beginDate\\_yyyy=1950&endDate\\_mm=12&endDate\\_dd=31&endDate\\_yyyy=2013&county=CLINTON&hailfilter=0.00&tornfilter=0&windfilt](http://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28C%29+Tornado&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=12&endDate_dd=31&endDate_yyyy=2013&county=CLINTON&hailfilter=0.00&tornfilter=0&windfilt)



[er=000&sort=DT&submitbutton=Search&statefips=39%2COHIO](#) ) lists 25 events within the same time period.

For planning purposes, it is less important to map the tornado risk than it is to identify it. This is because it is so difficult to predict the path of future tornadoes. The Fujita scale, Figure 2.2.10.2, provides us with an idea of the strength and extent of damages from tornadoes that can occur in Clinton County. The majority of the events

	Description	Wind Speeds (mph)
F0	<b>Gale Tornado:</b> Some damage to chimneys; break branches off of trees, pushes over shallow-rooted trees, damages signs.	40-70
F1	<b>Moderate Tornado:</b> The lower limit is the beginning of hurricane wind speed; peels surfaces off of roofs; mobile homes destroyed.	73-112
F2	<b>Significant Tornado:</b> Considerable damage; roofs torn off frame houses; mobile homes demolished; boxcars pushed over; larger trees snapped or uprooted; light object missiles generated.	113-157
F3	<b>Severe Tornado:</b> Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted.	158-206
F4	<b>Devastating Tornado:</b> Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown; large missiles generated.	207-260
F5	<b>Incredible Tornado:</b> Strong frame houses lifted off foundations and carried considerable distances; automobile-sized missiles fly in excess of 100 meters.	261-318
F6	<b>Inconceivable Tornado:</b> The area of damage produced would be unrecognizable.	319-379

Figure 2.2.10.2

within Clinton County have been F0 (68%), but a F4 occurred on April 23, 1968; and an F3 occurred on May 10, 1969; and three F2s occurred on April 25, 1961, March 10, 1986, and September 14, 1990. The F2 occurring in 1961 resulted in 2 deaths, 4 injuries, and \$250,000 in property damages (<http://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=10085662>). In contrast, the F2 that occurred in 1986 recorded 10 injuries and \$2.5 million in property damage as the tornado touched down in western Wilmington (<http://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=10100122>) or the F3 in 1969. While this tornado was recorded at faster speeds and more destructive in force, there were no deaths, no injuries, and only \$250 in damages for Clinton County (<http://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=10084357>) as the F3 traveled through Butler, Warren, northwestern Clinton, and Greene Counties. The difference between the F2 in 1986 and the F3 in 1969 is the population density where the event

occurred. The F2 occurred in a much higher population area of Clinton County than the F3.

As for possible losses, the Ohio Hazard Mitigation Plan separates damages into residential, commercial, and governmental from an EF 2 tornado (Ohio Mitigation Plan, 2011). An estimated 70% of the residents are at “high risk” with an at risk value of \$884 million in residential structures, 82% of commercial buildings with an at-risk value of \$26,111,532, and 80% of governmental buildings with an estimated at-risk value of \$4,694,208.

Wind Storms and tornados are countywide hazards and can affect all areas and jurisdictions of the county consistently.



## 2.2 PROFILE HAZARDS

### 2.2.11. Terrorism – Chemical, Biological, Radiological, Nuclear, and Explosive

Terrorism is the use of force or violence, including threats of force or violence, against persons or property in violation of the criminal laws of the United States for the purposes of intimidate, coercion, or ransom.

#### RESEARCH

- USAMRIID Handbooks
- USAMRICD Handbooks
- National Fire Academy
- State of Ohio Hazard Mitigation Plan, 2014
- Internet research
- FEMA Website

Period of Occurrence:	At any time
Number of Events to Date:	0
Probability of Event:	0.0
Warning Time:	Minimal – Depends on the presence of a threat
Potential Impacts:	Potential loss of human life, economic loss, environmental damage, disruption of lifeline facilities
Cause Injury or Death:	Injury and risk of multiple deaths
Potential Facility Shutdown:	Days to weeks or more

#### HAZARD EFFECTS

“Acts of terrorism include threats of terrorism; assassinations; kidnappings; hijackings; bomb scares and bombings; cyber-attacks (computer-based); and the use of chemical, biological, nuclear and radiological weapons. High-risk targets for acts of terrorism include military and civilian government facilities, international airports, large cities, and high-profile landmarks. Terrorists might also target large public gatherings, water and food supplies, utilities, and corporate centers. Further, terrorists are capable of spreading fear by sending explosives or chemical and biological agents through the mail.” (FEMA)

Clinton County contains numerous sites that might be of interest to terrorists. For example, the National Registry Landmarks in Clinton County are tourist attractions, places of local pride, and have historical significance. In addition the large distribution and processing hubs for the oil and gas industries such as the processing facility in Cadiz or Scio can be targets because of the economic significance of these facilities and the disruption to the national fuel systems.

Terrorism is not always accomplished on a “grand scale”, as is the case with international terrorists who are attempting to coerce the federal government. Such

terrorism, while technically a hazard in Clinton County, is more unlikely than what is known as “domestic terrorism”. Domestic terrorism can involve disgruntled employees (in the case of large industrial plants), angry parents (at schools), upset citizens (at government facilities), etc. Domestic terrorists may often only intend to harm a single individual or a small group of individuals, but the threat of their actions can be highly disruptive.

Terrorism events can appear as other types of hazards, most often hazardous material incidents since the materials, as stated earlier, used are often categorized as hazardous materials: chemical, biological, radiological, nuclear, and explosives (CBRNE). Figure 2.2.12.1 shows where terrorism attacks have occurred near Clinton County. Cincinnati and Columbus are higher risk target areas, placing Clinton County in the vicinity of possible targets. Many perpetrators might, because of the rural open area with a less dense population, use Clinton County as a testing and development area before assaulting the higher risk areas (i.e., Chicago, Pittsburgh, and Columbus) so that their activities can go unnoticed. The following sections review each of the CBRNE types as they relate to Clinton County.

### Terrorism “Hot Spots”

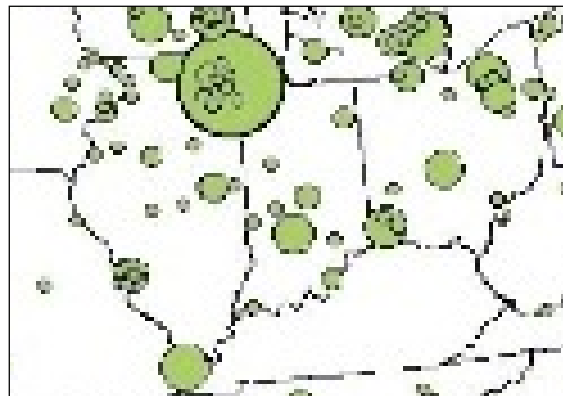
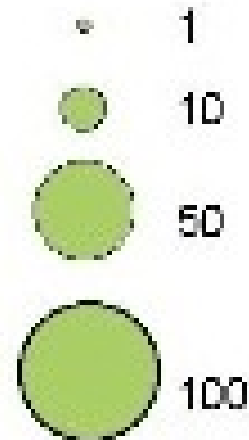


Figure 2.2.11.1

#### # of Attacks



Chemical terrorism has a relatively low probability of occurring but can have an extremely high effect. It is most often mistaken as a hazardous material incident so

responses are often similar, but these releases were purposefully made thereby directed to cause detrimental fiscal and demographic effects. The release is often placed in a certain location because of wind directions or confined areas such as buildings or railcars. These events occur quickly but can often cause long durations to recover depending on the chemical used. The demographic effect is more often higher than the fiscal effect since the use of chemicals is often aimed more at a population than a building. This could disrupt the availability of people, stop workflow, or change processes requiring more time for the same results.

Biological terrorism is the use of living organisms to attack a population. With the use of biological agents the demographic effect is aimed to be higher than fiscal effects even though structures must be decontaminated before being reused. Events of this nature have a low probability of occurring within Clinton County, but events similar to the release of salmonella in Dalles, Oregon by the Rajneeshees in 1984 to gain political power is possible (<http://www.examiner.com/article/25-years-ago-bioterrorism-at-the-salad-bar>). These events could have long durations both in response and recovery because biological terrorism could overwhelm the healthcare system. A long time is often needed to incubate the illness and then a long time to recover from it. There is often no warning time as biological terrorism is considered “detect to treat” (USAMRIID’s Medical Management of Biological Casualties, 2005) which means that a biological agent is already affecting an area and the only response can be to treat the physical symptoms.

Radiological events are the releases of radioactive material into a susceptible population or structure. These are often done in conjunction with explosives to create a “dirty bomb” allowing for a wider distribution of radioactive material. The probability is low since most radioactive sources are heavily regulated and secured, but sources can be found in medical facilities (i.e., x-ray machines, imaging serums, etc.), construction sites (i.e., depth gauges, structural integrity gauges, etc.), and mining locations (i.e., depth gauges, structural integrity gauges, etc.). The duration can be extremely long depending on the level of exposure and distribution within an area. If a dirty bomb has been detonated, a building could become structurally unsound as a result of the explosives as well. Between the unsoundness and diminished inhabitability due to the radiation levels within the structure, there can be increased fiscal effects, disrupted economic flow, or decreased government activities. The radiological source can also cause demographic effects dependent on the time of exposure, distance from the

radiation source, and shielding levels (i.e., lead, dirt, wood, etc. between the source and the individual) resulting in radiation sickness or even death (Radiological Emergency Management, 2013).

Nuclear terrorism involves the use of a nuclear bomb or device. Because nuclear bombs and devices are heavily regulated and controlled, the probability of one being used is extremely low, but if one did get used, the effects would be catastrophic. The duration of the incident would most likely be all within the recovery phase since recovery would take years to overcome (while the event duration is relatively short lasting seconds to minutes). The demographic effects could be significant; depending on the size of the device, a village or the whole county could be destroyed, killing or severely injuring all within the area. Fiscal effects would be extensive with buildings, infrastructure, and government systems all destroyed.

Explosives have the highest probability of occurring in Clinton County being that explosives are readily available for consumer use in industry and the formula for ammonium nitrate can be found on the internet. Additionally, explosives are often used as a dissemination method most commonly in radiological, nuclear, and chemical attacks (Emergency Response to Terrorism, 1999). The duration is dependent on the size of the explosive used. It could take a few hours to weeks or even years to recover from an event.

The demographic and fiscal effects are dependent on where the explosive is placed and the time of day or activity occurring at the location when detonated. If the detonation occurs at a high school football game it could have more demographic effect than a detonation at the courthouse at midnight because there are often more people present at the game than in the courthouse. However, the courthouse explosion could have more fiscal effect since both a nationally-registered landmark and government documents could be destroyed. The warning time can be a wide range depending on the perpetrator. A standard event trained for within schools is a “bomb threat” (Emergency Response to Terrorism, 1999). In cases of this nature, the warning time is often hours while an explosive can be used with no notification, thereby giving no warning time.

## 2.2 PROFILE HAZARDS

### 2.2.12. Severe Winter Weather (Winter Storm/Ice Storm/Extreme Cold)

A winter storm is a type of storm in which the dominant varieties of precipitation are forms that only occur at cold temperatures such as snow or sleet, or a rainstorm where ground temperatures are cold enough to allow ice to form.

Hail is a form of precipitation which occurs when freezing water in thunderstorm type clouds accumulates in layers around an icy core. When this event takes place, balls or irregular lumps of ice are created. On average, hail can be from 5mm to 50mm in diameter.

#### RESEARCH

- State of Ohio Hazard Mitigation Plan, 2014
- NCDC Event Record Database
- Internet search
- Public input

#### HAZARD EFFECTS – WINTER

Winter storms vary in size and strength and can be accompanied by strong winds that create blizzard conditions and dangerous wind chill. There are three categories of winter storms:

- *Blizzard*: A blizzard is the most dangerous of all winter storms. It combines low temperatures, heavy snowfall, and winds of at least 35 miles per hour (mph), reducing visibility to only a few yards.
- *Heavy Snowstorms*: A heavy snowstorm is one that drops four or more inches of snow in a 12-hour period.
- *Ice Storm*: An ice storm occurs when moisture falls and freezes immediately upon impact.

Period of Occurrence:	Winter
Number of Events to Date (1950-2013):	63
Probability of Event:	1.000
Warning Time:	Snow – Days Ice – Minutes to hours
Potential Impacts:	Utility damage and outages, infrastructure damage (transportation and communication systems), structural damage, damaged critical facilities. Can cause severe transportation problems and make travel extremely dangerous. Power outages, which result in loss of electrical power and potentially loss of heat. Extreme cold temperatures may lead to frozen water mains and pipes, damaged car engines, and prolonged exposure to cold resulting in frostbite.
Cause Injury or Death:	Injury
Potential Facility Shutdown:	Days

Winter storms tend to encompass the entire county whereas flooding generally occurs within predictable boundaries along the regulatory Special Flood Hazard Area (SFHA) and its main branches and tributaries. Risks associated and identified with severe winter storms include but are not limited to the following:

- Emergency medical evacuation of the sick, elderly, and infirmed to shelters,
- Power outages to those on life support systems,
- Communications interruptions and/or outages,
- Loss of the ability to heat homes, and
- Interruption of the delivery of home supplies and food.

These above-described events fall within two general categories: 1) road closures due to snow drifts and 2) utility failures (such as damaged supply lines). Additionally, data indicates that structural damage has occurred in several instances in the past as a result of extremely heavy snowfall. Structures damaged were usually buildings such as barns, garages, carports, etc. Additionally, severe winter storms, because of the county's mountainous terrain, frequently result in dangerous driving conditions.



Figure 2.2.12.1

affect all areas and jurisdictions of the county consistently. For example, Clinton County has had several severe winter storms reported to NCDRC. In total, the NCDRC indicates that 61 snow and ice events have occurred between January 1, 1950 and December 31, 2013. Of the 23 winter storm incidents only January 6, 1996 (Figure 2.2.12.1) caused any recorded property damage. This storm was known as the “Blizzard of ‘96” and

affected large portions of southern Ohio, snowing for 30 continuous hours in spots. While no deaths or injuries occurred in Clinton County, Clinton County did report \$500,000 in property damage from collapsed roofs (<http://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5569370>). The 5 ice storms reported by NCDRC, again, no reported deaths or injuries for any ice storm events. In addition, no ice storms have caused property damage but there were significant

transportation disruptions such as in February 13, 2007. This storm brought down power lines and trees along the I-71 corridor. 0.9 inches of ice was measured at the Wilmington National Weather Service office (<http://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=18264>).

As for past Presidential Disaster Declarations, Clinton County received support from three Emergency Disaster Declarations. Clinton County received assistance on February 2, 1977 (EM-3029); January 26, 1978 (EM-3055); and April 24, 2008 (EM-3286) which supplied \$112,163.29 in Public Assistance funding..

Extreme Cold, frost and freezes are often associated with severe winter weather as well. Extreme Cold is determined by the region's average temperatures, so what might be extreme cold for Ohio, would not be extreme cold for Minnesota. In an event occurring on February 1, 1996, The Ohio Valley received a blast of arctic air setting record lows in Cincinnati at -11°F. Clinton County had a recorded \$20,000 in property damages associated with water main breaks and power outages from over usage (<http://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5537631>). With an aging population, Clinton County becomes more susceptible to events of this nature. In addition, with a largely agricultural dependent economy, Clinton County is susceptible to drastic shifts in temperature like occurred on April 6, 2007 when a warm spring caused planting to begin early and then a drop in temperature to the 20's within 31 Ohio counties. Clinton County's estimated share of losses was \$540,000 in crop damage

(<http://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=26277>). Figure 2.2.12.2 shows a new VE Corn plant approximately one week after exposure to similar temperatures experienced on April 6, 2007 in Clinton County.

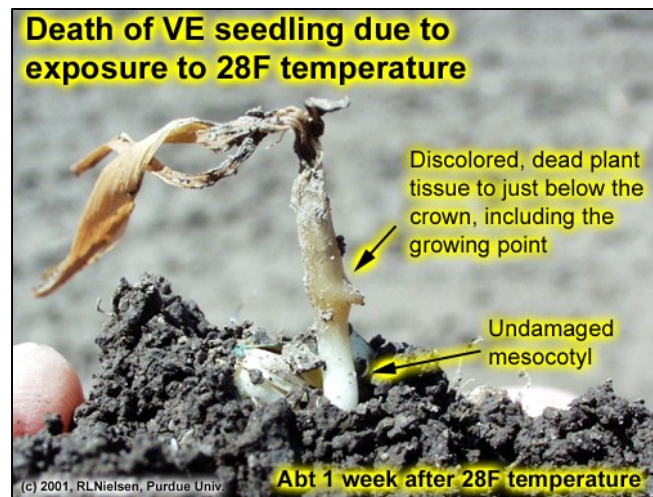


Figure 2.2.12.2