Hazus: Earthquake Global Risk Report

Region Name: LoganCo

Earthquake Scenario: Bellefontaine_5mag_5km

Print Date: December 07, 2022

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General Description of the Region

Hazus-MH is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Ohio

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 466.98 square miles and contains 11 census tracts. There are over 19 thousand households in the region which has a total population of 46,150 peopleF. The distribution of population by Total Region and County is provided in Appendix B.

There are an estimated 27 thousand buildings in the region with a total building replacement value (excluding contents) of 13,072 (millions of dollars). Approximately 90.00 % of the buildings (and 65.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 926 and 1,461 (millions of dollars), respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 27 thousand buildings in the region which have an aggregate total replacement value of 13,072 (millions of dollars) . Appendix B provides a general distribution of the building value by Total Region and County.

In terms of building construction types found in the region, wood frame construction makes up 66% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 115 beds. There are 14 schools, 12 fire stations, 6 police stations and 1 emergency operation facilities. With respect to high potential loss facilities (HPL), there are no dams identified within the inventory. The inventory also includes no hazardous material sites, no military installations and no nuclear power plants.

Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 2,387.00 (millions of dollars). This inventory includes over 50.95 miles of highways, 283 bridges, 1,879.03 miles of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	283	290.5869
	Segments	13	360.9447
	Tunnels	0	0.0000
	Subtotal		**651.5316**
Railways	Bridges	33	149.8200
	Facilities	0	0.0000
	Segments	13	113.9324
	Tunnels	0	0.0000
	Subtotal		**263.7524**
Light Rail	Bridges	0	0.0000
	Facilities	0	0.0000
	Segments	0	0.0000
	Tunnels	0	0.0000
	Subtotal		**0.0000**
Bus	Facilities	0	0.0000
	Subtotal		**0.0000**
Ferry	Facilities	0	0.0000
	Subtotal		**0.0000**
Port	Facilities	0	0.0000
	Subtotal		**0.0000**
Airport	Facilities	1	5.3000
	Runways	1	6.1654
	Subtotal		**11.4654**
	Total		**926.70**

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	37.5993
	Facilities	2	69.9300
	Pipelines	0	0.0000
	Subtotal		**107.5293**
Waste Water	Distribution Lines	NA	22.5596
	Facilities	9	1234.7892
	Pipelines	0	0.0000
	Subtotal		**1257.3488**
Natural Gas	Distribution Lines	NA	15.0397
	Facilities	0	0.0000
	Pipelines	2	76.4556
	Subtotal		**91.4953**
Oil Systems	Facilities	0	0.0000
	Pipelines	0	0.0000
	Subtotal		**0.0000**
Electrical Power	Facilities	1	4.9614
	Subtotal		**4.9614**
Communication	Facilities	3	0.3150
	Subtotal		**0.3150**
	Total		**1,461.60**

Earthquake Scenario

Hazus uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.
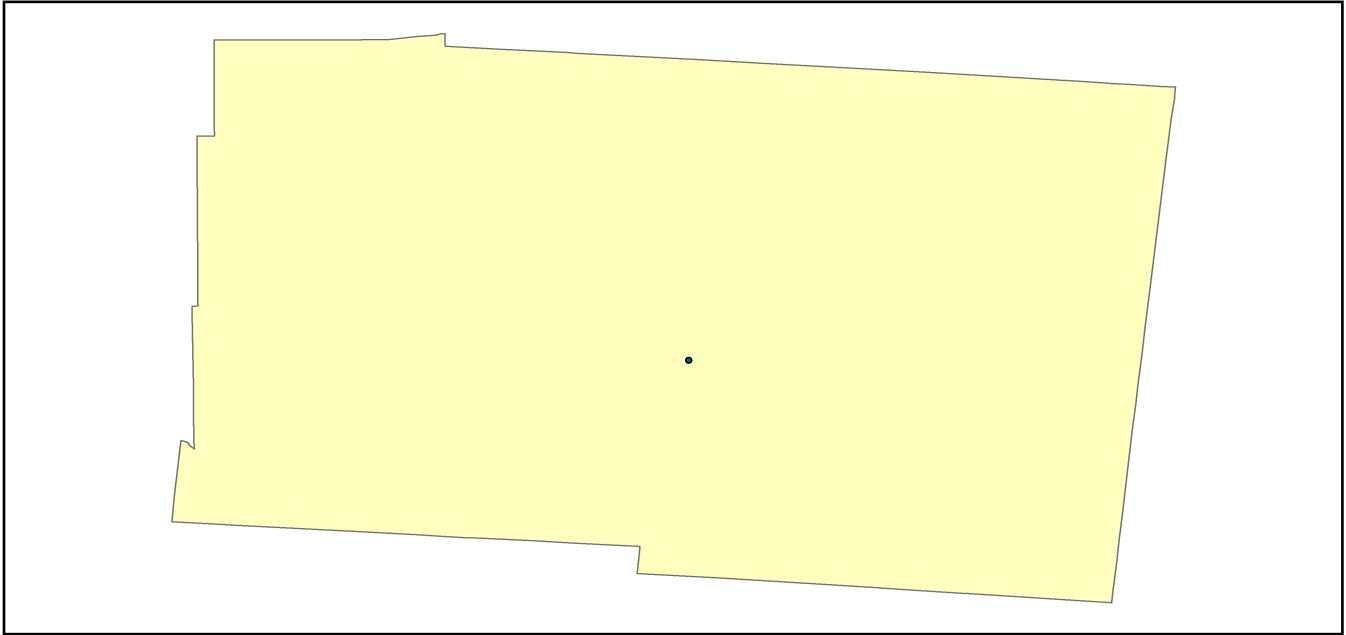
Scenario Name	Bellefontaine_5mag_5km
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-83.76
Latitude of Epicenter	40.36
Earthquake Magnitude	5.00
Depth (km)	5.00
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	Central & East US (CEUS 2008)

Direct Earthquake Damage

Building Damage

Hazus estimates that about 5,070 buildings will be at least moderately damaged. This is over 18.00 % of the buildings in the region. There are an estimated 313 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

Damage Categories by General Occupancy Type
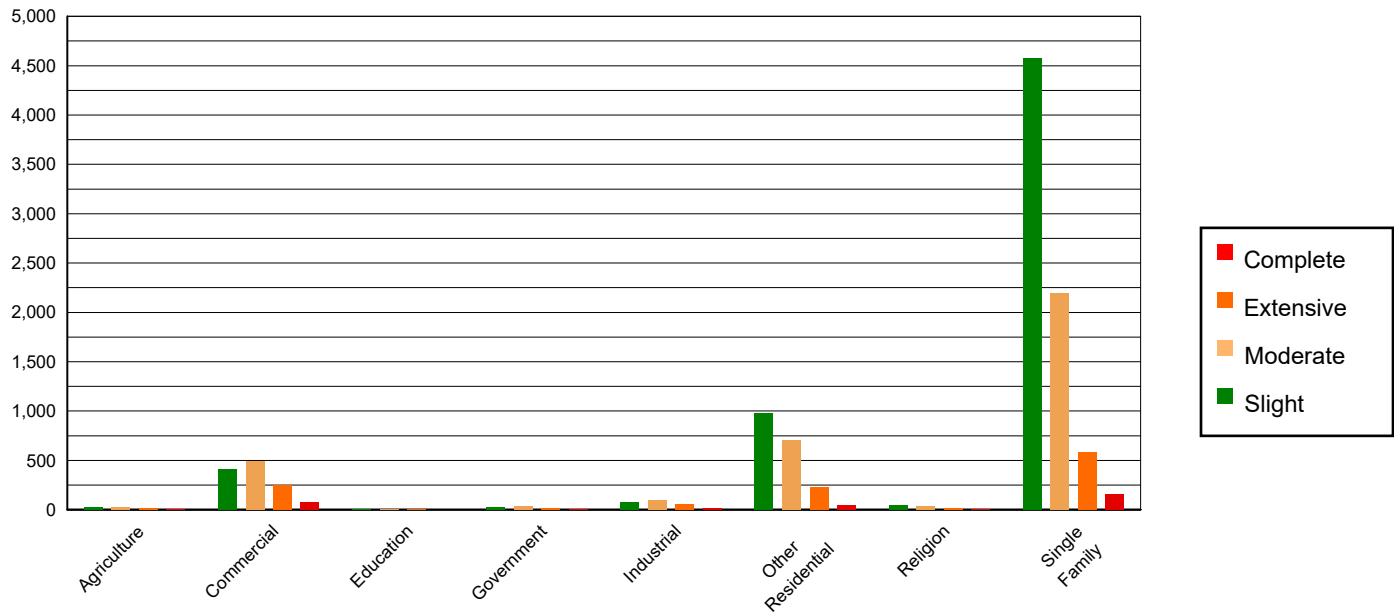
Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	43.66	0.27	22.84	0.37	28.61	0.80	15.17	1.30	3.72	1.19
Commercial	729.13	4.45	414.29	6.75	488.89	13.61	244.89	20.99	73.80	23.57
Education	10.86	0.07	6.24	0.10	7.46	0.21	3.37	0.29	1.07	0.34
Government	40.95	0.25	26.45	0.43	36.42	1.01	16.68	1.43	5.50	1.76
Industrial	127.42	0.78	74.02	1.21	98.39	2.74	54.37	4.66	14.80	4.73
Other Residential	2854.60	17.43	973.95	15.87	701.88	19.55	227.72	19.52	46.84	14.96
Religion	100.64	0.61	44.23	0.72	39.68	1.11	19.01	1.63	5.43	1.73
Single Family	12470.92	76.14	4574.08	74.54	2189.59	60.98	585.42	50.18	161.99	51.73
Total	16,378		6,136		3,591		1,167		313	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Wood	12468.63	76.13	4185.83	68.22	1486.55	41.40	180.50	15.47	12.95	4.14
Steel	257.42	1.57	130.56	2.13	245.39	6.83	165.72	14.20	49.49	15.80
Concrete	81.78	0.50	39.34	0.64	51.68	1.44	26.38	2.26	5.44	1.74
Precast	74.38	0.45	29.65	0.48	51.59	1.44	38.09	3.26	7.76	2.48
RM	62.71	0.38	16.13	0.26	26.10	0.73	17.02	1.46	2.29	0.73
URM	2805.77	17.13	1418.67	23.12	1334.58	37.17	594.09	50.92	209.51	66.91
MH	627.50	3.83	315.94	5.15	395.03	11.00	144.85	12.42	25.69	8.20
Total	**16,378**		**6,136**		**3,591**		**1,167**		**313**	

*Note:

RM   Reinforced Masonry
URM   Unreinforced Masonry
MH   Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 115 hospital beds available for use. On the day of the earthquake, the model estimates that only 26 hospital beds (23.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 45.00% of the beds will be back in service. By 30 days, 74.00% will be operational.

Table 5: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	1	1	0	0
Schools	14	6	0	0
EOCs	1	1	0	0
PoliceStations	6	1	0	3
FireStations	12	0	0	8

Transportation Lifeline Damage
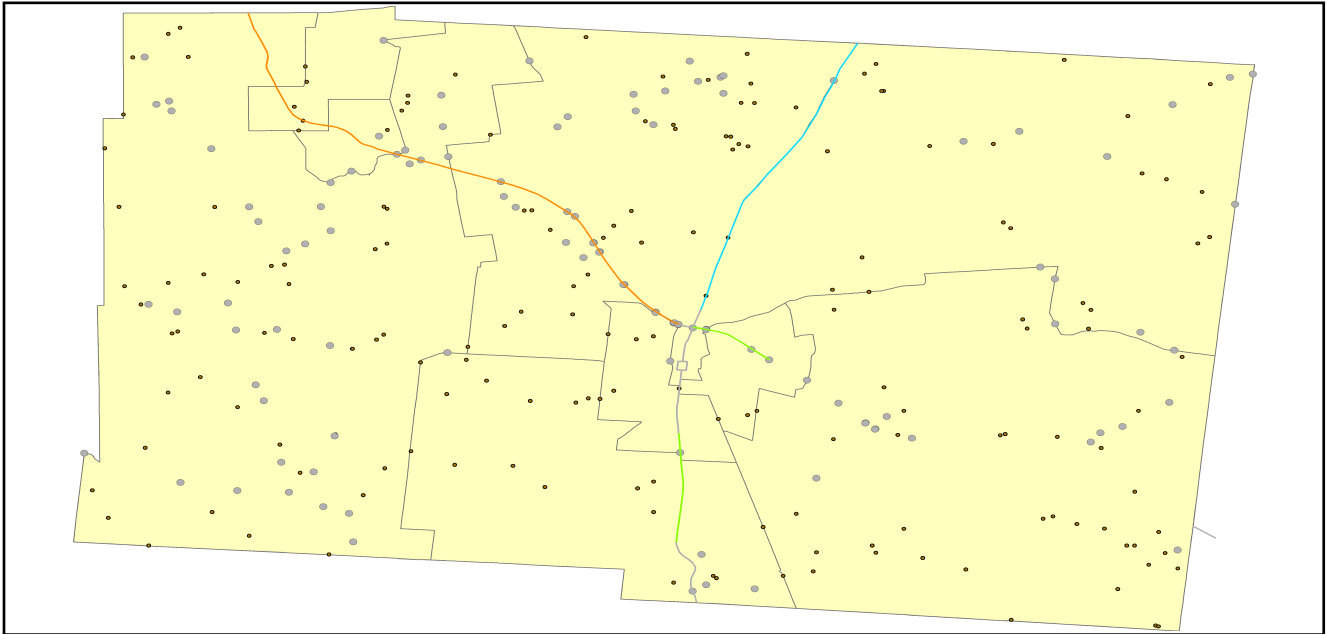
Table 6: Expected Damage to the Transportation Systems

System	Component	Locations/ Segments	Number of Locations		With Functionality > 50 %	
			With at Least Mod. Damage	With Complete Damage	After Day 1	After Day 7
Highway	Segments	13	0	0	13	13
	Bridges	283	0	0	283	283
	Tunnels	0	0	0	0	0
Railways	Segments	13	0	0	13	13
	Bridges	33	0	0	33	33
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	1	1	0	1	1
	Runways	1	0	0	1	1

Table 6 provides damage estimates for the transportation system.

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.

Table 7 : Expected Utility System Facility Damage

System	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	2	0	0	1	2
Waste Water	9	5	0	2	9
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	1	1	0	0	1
Communication	3	2	0	1	3

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (miles)	Number of Leaks	Number of Breaks
Potable Water	1,168	179	45
Waste Water	701	90	22
Natural Gas	11	0	0
Oil	0	0	0

Table 9: Expected Potable Water and Electric Power System Performance

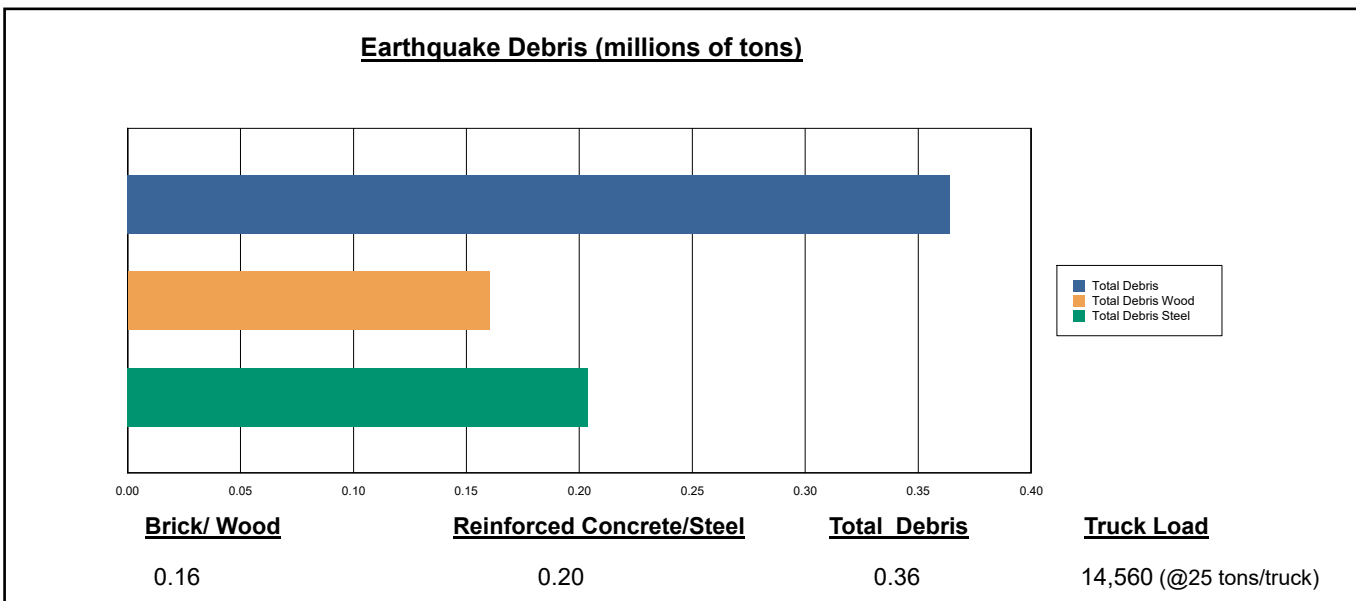|	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	19,062	78	0	0	0	0
Electric Power		13,250	10,215	5,790	767	16

Induced Earthquake Damage

Fire Following Earthquake

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 0 ignitions that will burn about 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

Debris Generation

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

The model estimates that a total of 364,000 tons of debris will be generated. Of the total amount, Brick/Wood comprises 44.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 14,560 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Earthquake Debris (millions of tons)

Legend:
- Total Debris
- Total Debris Wood
- Total Debris Steel

Brick/ Wood	Reinforced Concrete/Steel	Total Debris	Truck Load
0.16	0.20	0.36	14,560 (@25 tons/truck)

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 430 households to be displaced due to the earthquake. Of these, 219 people (out of a total population of 46,150) will seek temporary shelter in public shelters.

Displaced Households/ Persons Seeking Short Term Public Shelter

Legend:
- Displaced households as a result of the earthquake
- Person seeking temporary public shelter

Displaced households as a result of the earthquake	Persons seeking temporary public shelter
430	219
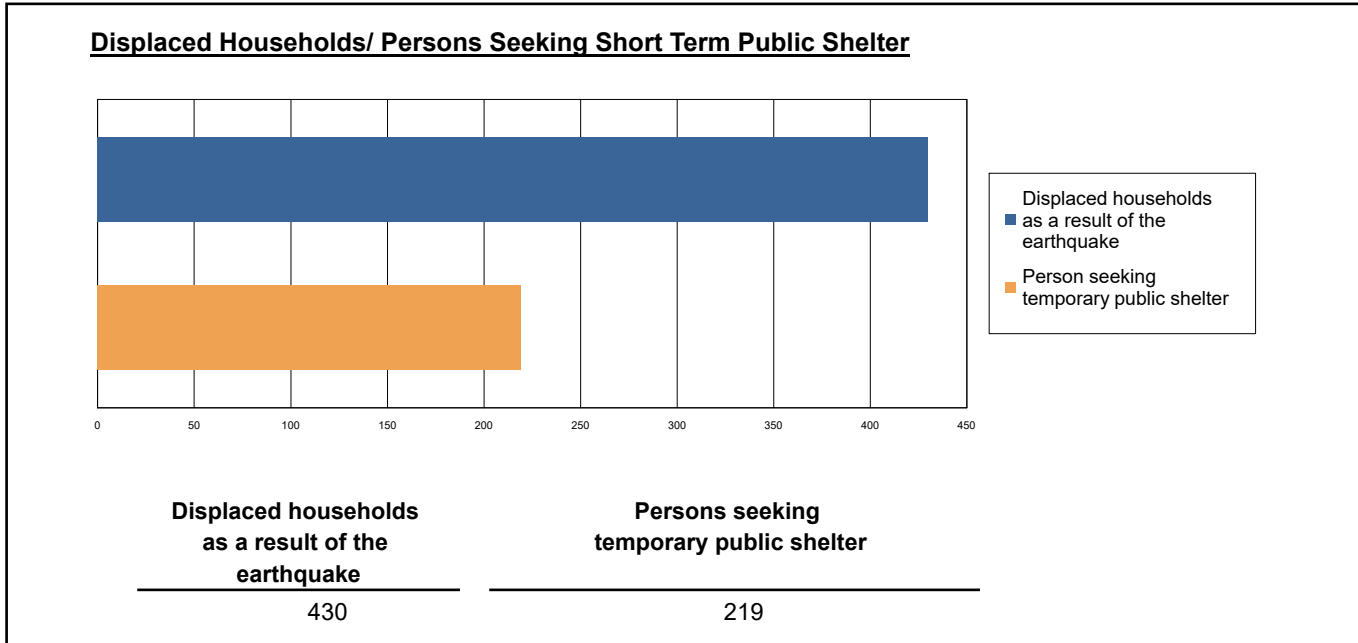
Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- · Severity Level 1:   Injuries will require medical attention but hospitalization is not needed.
- · Severity Level 2:   Injuries will require hospitalization but are not considered life-threatening
- · Severity Level 3:   Injuries will require hospitalization and can become life threatening if not promptly treated.
- · Severity Level 4:   Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake

Table 10: Casualty Estimates

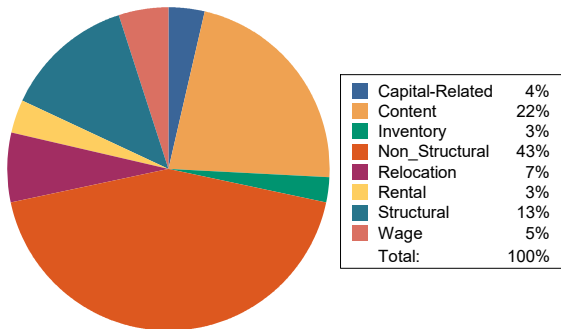|		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	2.31	0.55	0.07	0.14
	Commuting	0.00	0.00	0.00	0.00
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.03	0.01	0.00	0.00
	Industrial	4.36	0.99	0.12	0.24
	Other-Residential	36.34	7.66	0.92	1.78
	Single Family	80.35	18.01	2.42	4.75
	Total	**123**	**27**	**4**	**7**
2 PM	Commercial	141.04	33.52	4.46	8.64
	Commuting	0.02	0.02	0.04	0.01
	Educational	31.15	7.55	1.08	2.10
	Hotels	0.01	0.00	0.00	0.00
	Industrial	32.05	7.33	0.91	1.75
	Other-Residential	11.47	2.50	0.32	0.59
	Single Family	25.52	5.91	0.83	1.56
	Total	**241**	**57**	**8**	**15**
5 PM	Commercial	91.49	21.73	2.91	5.57
	Commuting	0.33	0.47	0.77	0.15
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.01	0.00	0.00	0.00
	Industrial	20.03	4.58	0.57	1.09
	Other-Residential	14.23	3.10	0.39	0.73
	Single Family	32.25	7.46	1.05	1.96
	Total	**158**	**37**	**6**	**10**

Economic Loss

The total economic loss estimated for the earthquake is 1,732.26 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

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 earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 1,480.09 (millions of dollars); 19 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 38 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

Earthquake Losses by Loss Type ($ millions)

Capital-Related	4%
Content	22%
Inventory	3%
Non_Structural	43%
Relocation	7%
Rental	3%
Structural	13%
Wage	5%
Total:	100%

Earthquake Losses by Occupancy Type ($ millions)

- Single Family
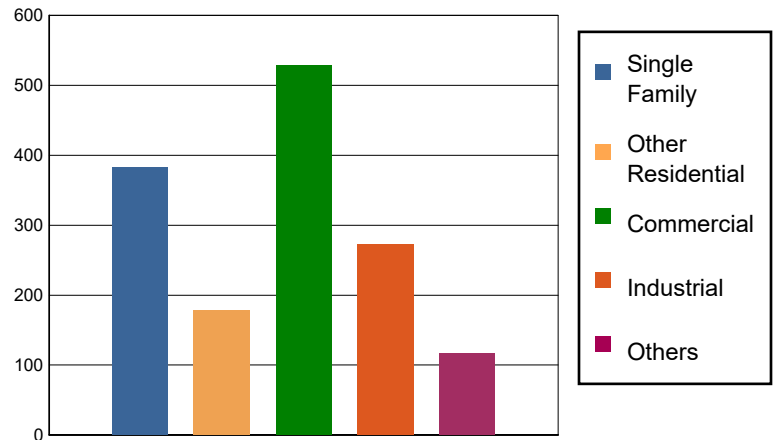- Other Residential
- Commercial
- Industrial
- Others

Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.0000	8.3594	54.1584	7.7366	4.5108	74.7652
	Capital-Related	0.0000	3.5533	45.0237	4.7225	0.8285	54.1280
	Rental	7.9282	13.5957	25.3858	2.1675	1.7598	50.8370
	Relocation	28.4750	8.5902	40.1863	8.5453	14.0127	99.8095
	Subtotal	**36.4032**	**34.0986**	**164.7542**	**23.1719**	**21.1118**	**279.5397**
Capital Stock Losses							
	Structural	52.9194	14.8629	68.1822	38.2088	18.1954	192.3687
	Non_Structural	208.4901	98.4415	175.9682	112.6233	47.3312	642.8543
	Content	85.0934	31.5235	99.9767	82.5151	27.5259	326.6346
	Inventory	0.0000	0.0000	19.1322	16.5615	3.0020	38.6957
	Subtotal	**346.5029**	**144.8279**	**363.2593**	**249.9087**	**96.0545**	**1200.5533**
	Total	**382.91**	**178.93**	**528.01**	**273.08**	**117.17**	**1480.09**

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Table 12: Transportation System Economic Losses
(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	360.9447	0.0000	0.00
	Bridges	290.5869	3.5574	1.22
	Tunnels	0.0000	0.0000	0.00
	Subtotal	**651.5316**	**3.5574**	
Railways	Segments	113.9324	0.0000	0.00
	Bridges	149.8200	0.6985	0.47
	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	**263.7524**	**0.6985**	
Light Rail	Segments	0.0000	0.0000	0.00
	Bridges	0.0000	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Bus	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Ferry	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Port	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Airport	Facilities	5.3000	2.1493	40.55
	Runways	6.1654	0.0000	0.00
	Subtotal	**11.4654**	**2.1493**	
	Total	**926.75**	**6.41**	

Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.0000	0.0000	0.00
	Facilities	69.9300	7.8323	11.20
	Distribution Lines	37.5993	0.8056	2.14
	Subtotal	**107.5293**	**8.6379**	
Waste Water	Pipelines	0.0000	0.0000	0.00
	Facilities	1234.7892	234.5496	19.00
	Distribution Lines	22.5596	0.4047	1.79
	Subtotal	**1257.3488**	**234.9543**	
Natural Gas	Pipelines	76.4556	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	15.0397	0.1386	0.92
	Subtotal	**91.4953**	**0.1386**	
Oil Systems	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Electrical Power	Facilities	4.9614	1.9101	38.50
	Subtotal	**4.9614**	**1.9101**	
Communication	Facilities	0.3150	0.1216	38.60
	Subtotal	**0.3150**	**0.1216**	
	Total	**1,461.65**	**245.76**	

Appendix A: County Listing for the Region

Logan,OH

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Ohio					
	Logan	46,150	8,476	4,596	13,072
Total Region		**46,150**	**8,476**	**4,596**	**13,072**