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## Hazus-MH: Earthquake Global Risk Report

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**Region Name:** Clark

**Earthquake Scenario:** Springfield, 5 mag, 5km depth

**Print Date:** February 09, 2018

**Disclaimer:**

*This version of Hazus utilizes 2010 Census Data.  
Totals only reflect data for those census tracts/blocks included in the user's study region.*

*The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.*

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## General Description of the Region

Hazus is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop earthquake 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 earthquakes 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 402.42 square miles and contains 44 census tracts. There are over 55 thousand households in the region which has a total population of 138,333 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 57 thousand buildings in the region with a total building replacement value (excluding contents) of 15,813 (millions of dollars). Approximately 92.00 % of the buildings (and 75.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 1,962 and 1,405 (millions of dollars) , respectively.

## Building and Lifeline Inventory

### Building Inventory

Hazus estimates that there are 57 thousand buildings in the region which have an aggregate total replacement value of 15,813 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 68% 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 2 hospitals in the region with a total bed capacity of 430 beds. There are 64 schools, 22 fire stations, 8 police stations and 0 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 0 dams identified within the inventory. Of these, 0 of the dams are classified as 'high hazard'. The inventory also includes 26 hazardous material sites, 0 military installations and 0 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 3,367.00 (millions of dollars). This inventory includes over 229 kilometers of highways, 169 bridges, 12,569 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

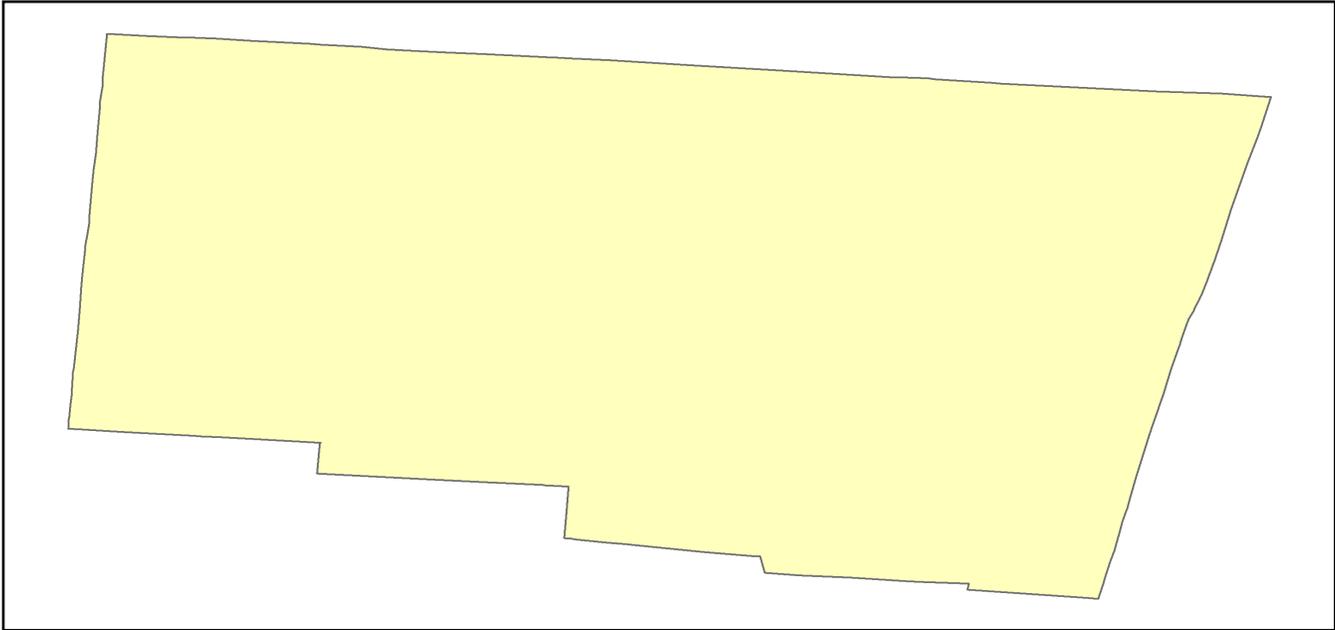
System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
<b>Highway</b>	Bridges	169	241.80
	Segments	105	1,423.80
	Tunnels	0	0.00
	<b>Subtotal</b>		<b>1,665.50</b>
<b>Railways</b>	Bridges	3	0.40
	Facilities	2	5.30
	Segments	46	154.90
	Tunnels	0	0.00
	<b>Subtotal</b>		<b>160.60</b>
<b>Light Rail</b>	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	<b>Subtotal</b>		<b>0.00</b>
<b>Bus</b>	Facilities	1	1.10
	<b>Subtotal</b>		<b>1.10</b>
<b>Ferry</b>	Facilities	0	0.00
	<b>Subtotal</b>		<b>0.00</b>
<b>Port</b>	Facilities	0	0.00
	<b>Subtotal</b>		<b>0.00</b>
<b>Airport</b>	Facilities	2	21.30
	Runways	3	113.90
	<b>Subtotal</b>		<b>135.20</b>
		<b>Total</b>	<b>1,962.50</b>

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
<b>Potable Water</b>	Distribution Lines	NA	125.70
	Facilities	1	35.00
	Pipelines	0	0.00
		<b>Subtotal</b>	<b>160.70</b>
<b>Waste Water</b>	Distribution Lines	NA	75.40
	Facilities	16	1,118.90
	Pipelines	0	0.00
		<b>Subtotal</b>	<b>1,194.30</b>
<b>Natural Gas</b>	Distribution Lines	NA	50.30
	Facilities	0	0.00
	Pipelines	0	0.00
		<b>Subtotal</b>	<b>50.30</b>
<b>Oil Systems</b>	Facilities	0	0.00
	Pipelines	0	0.00
		<b>Subtotal</b>	<b>0.00</b>
<b>Electrical Power</b>	Facilities	0	0.00
		<b>Subtotal</b>	<b>0.00</b>
<b>Communication</b>	Facilities	5	0.50
		<b>Subtotal</b>	<b>0.50</b>
		<b>Total</b>	<b>1,405.80</b>

## Earthquake Scenario

Hazus uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.



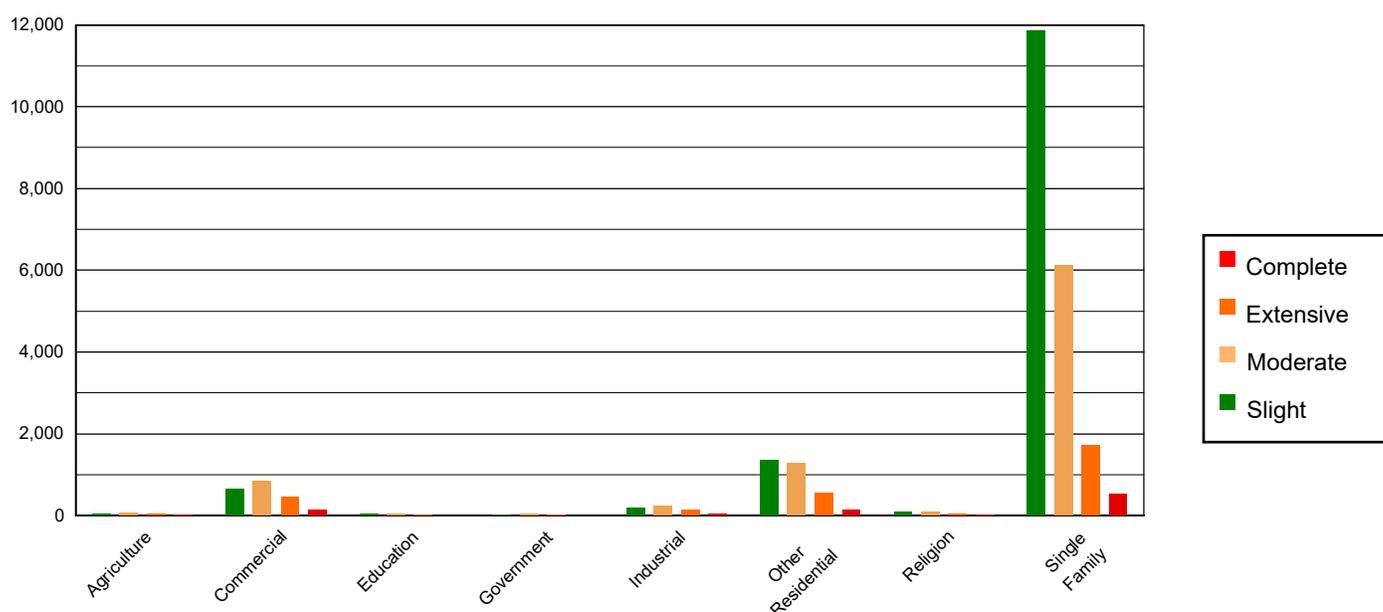
<b>Scenario Name</b>	Springfield, 5 mag, 5km depth
<b>Type of Earthquake</b>	Arbitrary
<b>Fault Name</b>	NA
<b>Historical Epicenter ID #</b>	NA
<b>Probabilistic Return Period</b>	NA
<b>Longitude of Epicenter</b>	-83.81
<b>Latitude of Epicenter</b>	39.92
<b>Earthquake Magnitude</b>	5.00
<b>Depth (km)</b>	5.00
<b>Rupture Length (Km)</b>	NA
<b>Rupture Orientation (degrees)</b>	NA
<b>Attenuation Function</b>	Central & East US (CEUS 2008)

## Building Damage

### Building Damage

Hazus estimates that about 12,563 buildings will be at least moderately damaged. This is over 22.00 % of the buildings in the region. There are an estimated 880 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	(%)
<b>Agriculture</b>	121	0.39	54	0.38	68	0.78	38	1.26	10	1.16
<b>Commercial</b>	964	3.11	655	4.60	847	9.74	450	15.06	143	16.26
<b>Education</b>	45	0.15	28	0.19	36	0.41	18	0.59	6	0.66
<b>Government</b>	30	0.10	20	0.14	27	0.31	13	0.42	4	0.47
<b>Industrial</b>	295	0.95	167	1.18	232	2.67	137	4.58	42	4.74
<b>Other Residential</b>	2,477	7.99	1,362	9.57	1,279	14.71	551	18.43	134	15.24
<b>Religion</b>	166	0.54	88	0.62	88	1.01	48	1.60	15	1.76
<b>Single Family</b>	26,896	86.78	11,857	83.32	6,118	70.36	1,735	58.06	526	59.72
<b>Total</b>	<b>30,995</b>		<b>14,231</b>		<b>8,695</b>		<b>2,988</b>		<b>880</b>	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
<b>Wood</b>	24,290	78.37	10211	71.75	3,979	45.76	519	17.35	40	4.56
<b>Steel</b>	390	1.26	213	1.50	441	5.07	327	10.94	106	12.07
<b>Concrete</b>	133	0.43	71	0.50	103	1.18	58	1.94	13	1.48
<b>Precast</b>	124	0.40	55	0.39	103	1.19	83	2.76	18	2.08
<b>RM</b>	62	0.20	23	0.16	45	0.52	35	1.16	5	0.60
<b>URM</b>	4,958	16.00	3058	21.49	3,183	36.61	1,561	52.23	607	68.96
<b>MH</b>	1,038	3.35	601	4.22	841	9.68	407	13.62	90	10.25
<b>Total</b>	<b>30,995</b>		<b>14,231</b>		<b>8,695</b>		<b>2,988</b>		<b>880</b>	

\*Note:

RM Reinforced Masonry  
 URM Unreinforced Masonry  
 MH Manufactured Housing

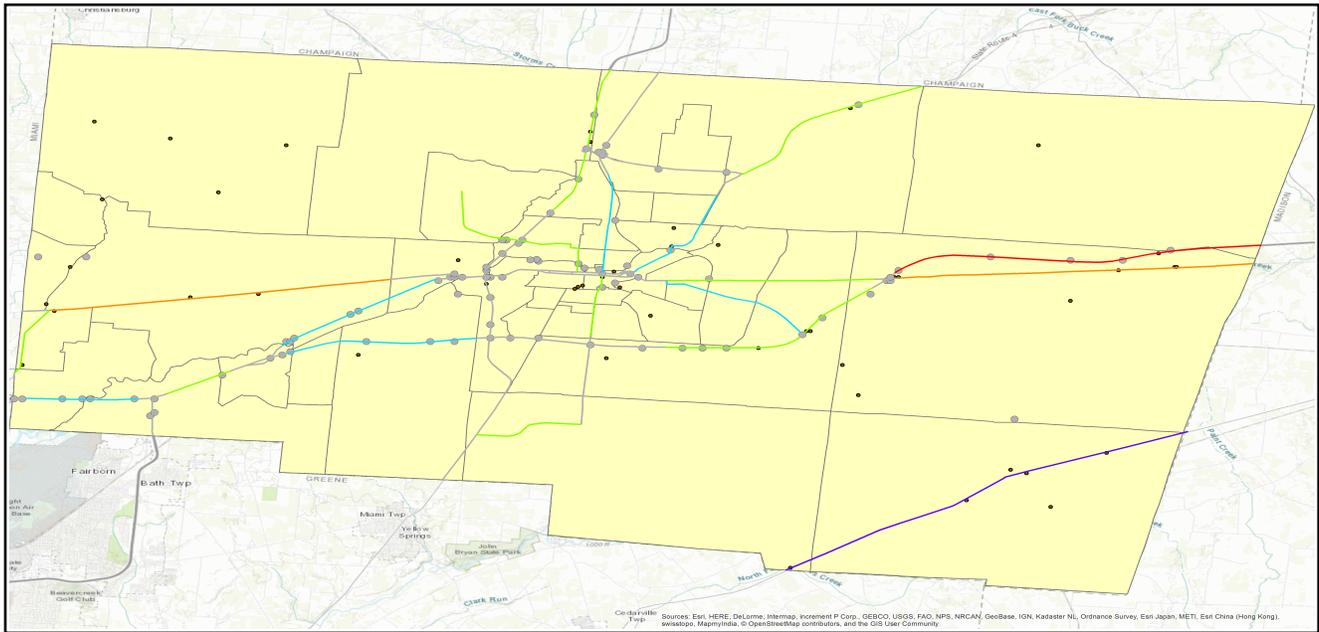
### Essential Facility Damage

Before the earthquake, the region had 430 hospital beds available for use. On the day of the earthquake, the model estimates that only 75 hospital beds (18.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 30.00% of the beds will be back in service. By 30 days, 61.00% 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	2	2	0	0
Schools	64	36	0	11
EOCs	0	0	0	0
PoliceStations	8	0	0	5
FireStations	22	11	0	6

**Transportation Lifeline Damage**



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

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	105	0	0	105	105
	Bridges	169	1	0	169	169
	Tunnels	0	0	0	0	0
Railways	Segments	46	0	0	46	46
	Bridges	3	0	0	3	3
	Tunnels	0	0	0	0	0
	Facilities	2	2	0	2	2
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	1	1	0	1	1
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	2	1	0	2	2
	Runways	3	0	0	3	3

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	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	1	1	0	0	1
Waste Water	16	9	0	4	16
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	5	5	0	3	5

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	6,285	660	165
Waste Water	3,771	473	118
Natural Gas	2,514	136	34
Oil	0	0	0

Table 9: Expected Potable Water and Electric Power System Performance

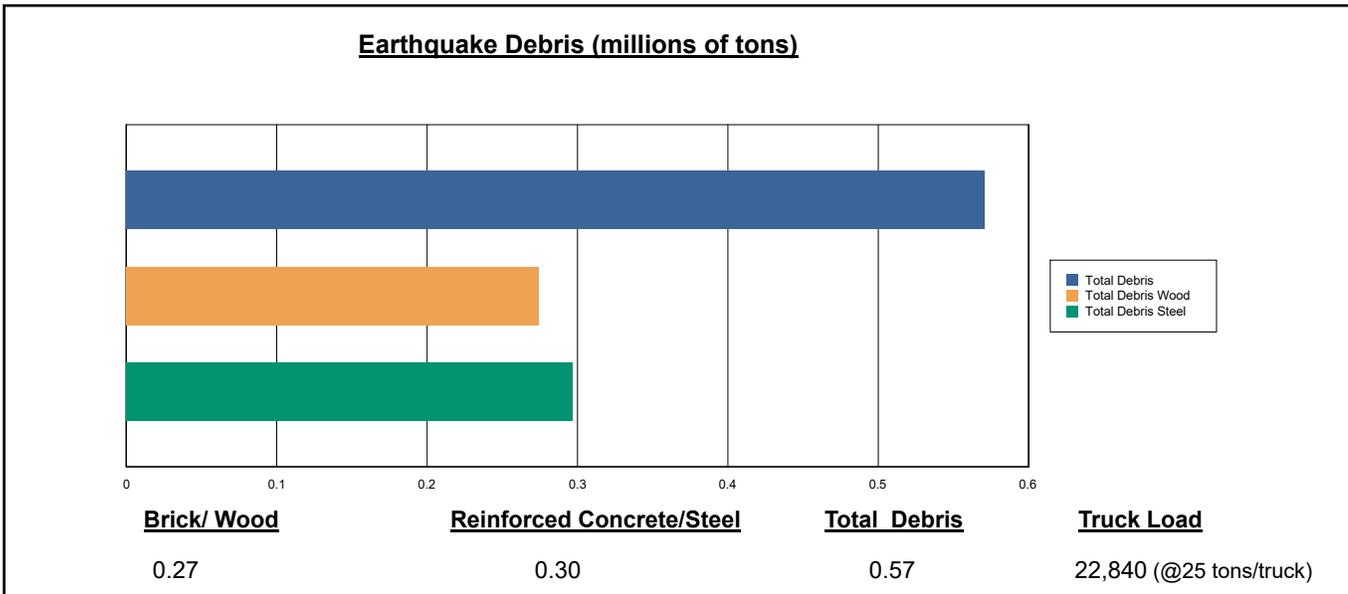
	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	55,244	2,145	622	0	0	0
Electric Power		32,958	20,991	8,232	1,394	40

**Induced Earthquake Damage**

**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.

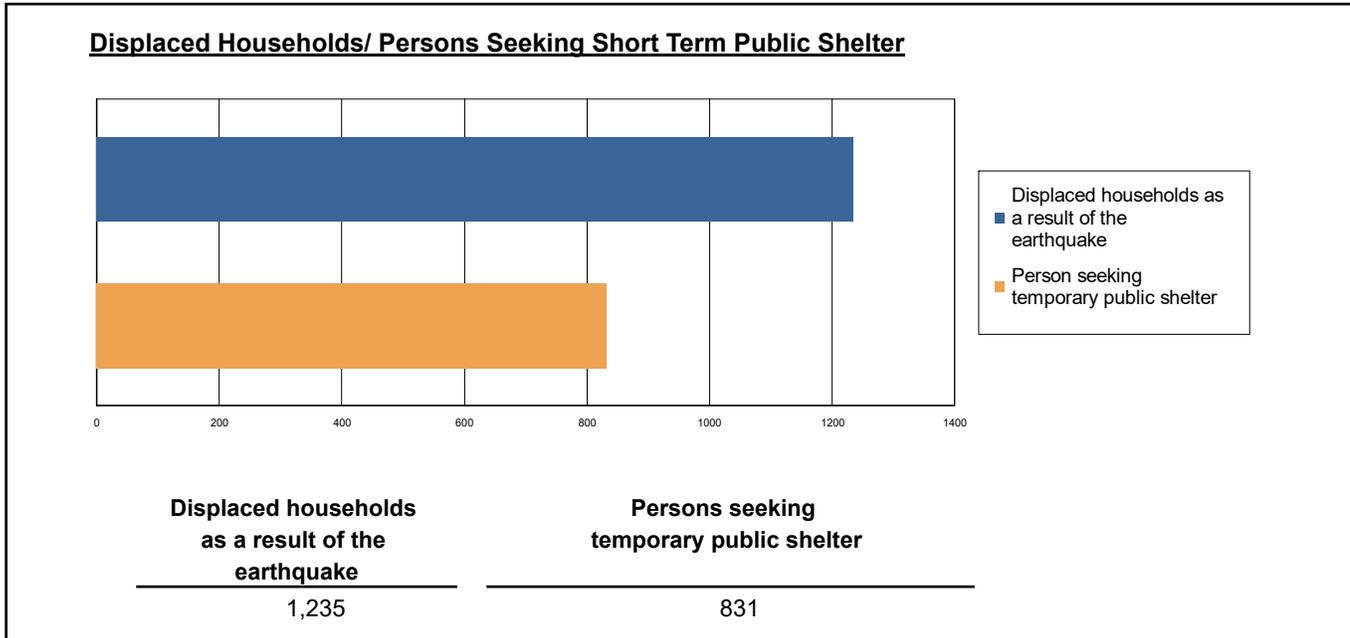
The model estimates that a total of 0.57 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 48.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 22,840 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.



**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 1,235 households to be displaced due to the earthquake. Of these, 831 people (out of a total population of 138,333) will seek temporary shelter in public shelters.



**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
<b>2 AM</b>	Commercial	5	1	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	9	2	0	1
	Other-Residential	102	23	3	6
	Single Family	275	62	8	16
	<b>Total</b>	<b>390</b>	<b>89</b>	<b>12</b>	<b>23</b>
<b>2 PM</b>	Commercial	306	73	10	19
	Commuting	0	0	0	0
	Educational	146	36	5	10
	Hotels	0	0	0	0
	Industrial	64	15	2	4
	Other-Residential	23	5	1	1
	Single Family	67	16	2	4
	<b>Total</b>	<b>607</b>	<b>146</b>	<b>20</b>	<b>38</b>
<b>5 PM</b>	Commercial	217	52	7	13
	Commuting	2	2	4	1
	Educational	16	4	1	1
	Hotels	0	0	0	0
	Industrial	40	9	1	2
	Other-Residential	40	9	1	2
	Single Family	110	26	4	7
	<b>Total</b>	<b>425</b>	<b>103</b>	<b>17</b>	<b>27</b>



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## Economic Loss

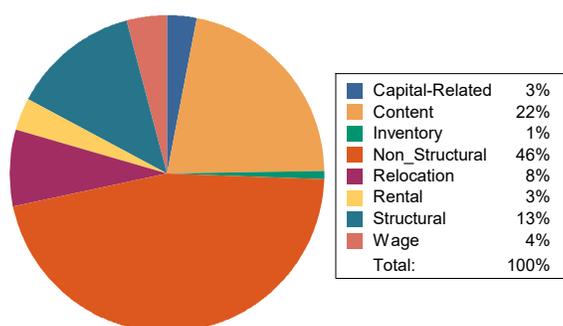
The total economic loss estimated for the earthquake is 2,203.27 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

### Building-Related Losses

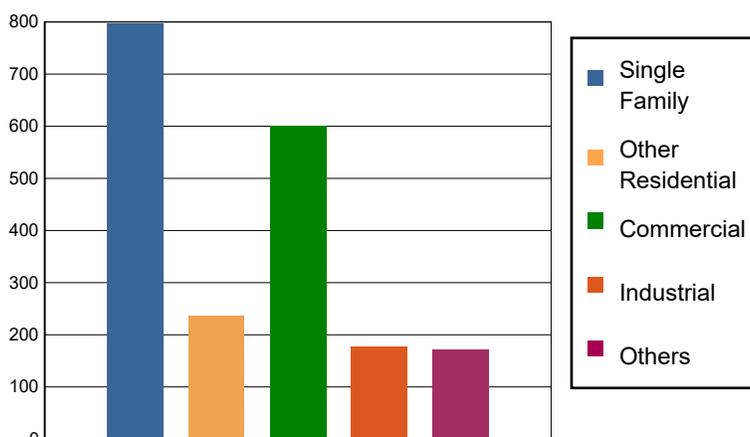
The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability 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 1,981.81 (millions of dollars); 18 % 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 52 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

Earthquake Losses by Loss Type (\$ millions)



Earthquake Losses by Occupancy Type (\$ millions)



**Table 11: Building-Related Economic Loss Estimates**  
(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
<b>Income Losses</b>							
	Wage	0.00	5.04	66.91	4.12	5.22	81.29
	Capital-Related	0.00	2.15	52.76	2.61	1.50	59.02
	Rental	18.92	15.06	27.95	1.44	2.33	65.71
	Relocation	65.96	10.37	47.54	6.42	22.43	152.73
	<b>Subtotal</b>	<b>84.89</b>	<b>32.62</b>	<b>195.17</b>	<b>14.59</b>	<b>31.48</b>	<b>358.74</b>
<b>Capital Stock Losses</b>							
	Structural	107.56	24.52	78.87	23.55	27.77	262.28
	Non_Structural	427.65	136.67	207.02	74.72	69.57	915.62
	Content	175.67	43.00	116.64	53.89	40.87	430.07
	Inventory	0.00	0.00	3.73	10.55	0.82	15.10
	<b>Subtotal</b>	<b>710.88</b>	<b>204.19</b>	<b>406.26</b>	<b>162.70</b>	<b>139.03</b>	<b>1,623.06</b>
	<b>Total</b>	<b>795.77</b>	<b>236.82</b>	<b>601.43</b>	<b>177.29</b>	<b>170.50</b>	<b>1,981.81</b>

### 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	1,423.78	\$0.00	0.00
	Bridges	241.75	\$6.66	2.75
	Tunnels	0.00	\$0.00	0.00
	Subtotal	<b>1,666</b>	<b>6.70</b>	
Railways	Segments	154.90	\$0.00	0.00
	Bridges	0.38	\$0.00	0.90
	Tunnels	0.00	\$0.00	0.00
	Facilities	5.33	\$2.31	43.30
	Subtotal	<b>161</b>	<b>2.30</b>	
Light Rail	Segments	0.00	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	<b>0</b>	<b>0.00</b>	
Bus	Facilities	1.14	\$0.51	44.81
	Subtotal	<b>1</b>	<b>0.50</b>	
Ferry	Facilities	0.00	\$0.00	0.00
	Subtotal	<b>0</b>	<b>0.00</b>	
Port	Facilities	0.00	\$0.00	0.00
	Subtotal	<b>0</b>	<b>0.00</b>	
Airport	Facilities	21.30	\$7.36	34.55
	Runways	113.89	\$0.00	0.00
	Subtotal	<b>135</b>	<b>7.40</b>	
<b>Total</b>		<b>1,962.50</b>	<b>16.80</b>	

Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.00	\$0.00	0.00
	Facilities	35.00	\$6.91	19.78
	Distribution Lines	125.70	\$2.97	2.36
	<b>Subtotal</b>	<b>160.66</b>	<b>\$9.89</b>	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	1,118.90	\$191.83	17.14
	Distribution Lines	75.40	\$2.13	2.82
	<b>Subtotal</b>	<b>1,194.30</b>	<b>\$193.96</b>	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Lines	50.30	\$0.61	1.22
	<b>Subtotal</b>	<b>50.28</b>	<b>\$0.61</b>	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	<b>Subtotal</b>	<b>0.00</b>	<b>\$0.00</b>	
Electrical Power	Facilities	0.00	\$0.00	0.00
	<b>Subtotal</b>	<b>0.00</b>	<b>\$0.00</b>	
Communication	Facilities	0.50	\$0.16	31.09
	<b>Subtotal</b>	<b>0.53</b>	<b>\$0.16</b>	
	<b>Total</b>	<b>1,405.76</b>	<b>\$204.62</b>	



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**Appendix A: County Listing for the Region**

Clark, OH

### Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Ohio	Clark	138,333	11,891	3,921	15,813
<b>Total State</b>		<b>138,333</b>	<b>11,891</b>	<b>3,921</b>	<b>15,813</b>
<b>Total Region</b>		<b>138,333</b>	<b>11,891</b>	<b>3,921</b>	<b>15,813</b>