2.9 EARTHQUAKE

Earthquakes occur as a result of the constant motion of the earth. Current science describes the earth in three major regions: the core, mantle and crust. Figure 2.9.a provides a three dimensional representation of the earth’s regions.

The core is hot and consists of two subsections. The very center of the planet’s core is hottest and solid. Surrounding the solid center is a liquid (i.e. molten material / magma) layer.

The mantle is cooler than the core and although solid circulates with the consistency of malleable plastic. Through convection, the portion of the mantle closest to the core heats and subsequently rises in the same manner as the air in the earth’s atmosphere. Conversely, the upper portion of the mantle transfers its heat to the crust cools and descends back toward the core.

The crust is also solid; however, unlike the mantle it is rigid and brittle. The crust consists of a number of individual plates, each in constant motion, resting on the mantle. The boundaries where plates meet are the locations where new crust develops (spreading boundary) and alternately existing crust material returns to the mantle (convergent boundary.)

Understanding the composition of the earth is crucial because earthquakes are often associated with boundaries where the plates slide against, rise over or sink under each other. The movement at many of the plate boundaries is not smooth and consistent, but rather they grind and jerk. As the entire plates move the boundaries become locked together and enormous amounts of tension build until a sudden release occurs realigning the plate edges and creating the observed earthquake.

The locations where the crust is fractured and sliding are called faults. California has several famous faults, e.g. the San Andreas Fault, which can be clearly observed though aerial photography. In cases where the crust is pulling apart, the location is called a rift. The Reelfoot Rift and associated rift valley located in Missouri is one of the largest in North America. Although many faults are located at...
plate boundaries there can be numerous observed faults and rifts within. Ohio geologically contains both fault and rift zones.

Another significant source of earthquakes is associated with large bodies of magma, which are located near the earth’s crust. The Hawaiian archipelago and Yellowstone National Park are examples where magma deposits are altering the crust and generating both volcanic activity and earthquakes.

Earthquake locations are recorded based on the latitude and longitude of the occurrence, called the epicenter, and the associated depth underneath the earth’s surface. The energy released in earthquakes travels from the epicenter in seismic waves through the earth. The four major types of waves are often referred to as primary, secondary (body waves), Rayleigh and Love (surface waves), see Figure 2.9.b. Primary waves compress the earth’s surface in front of it as they travel. Secondary waves cause the earth’s surface to rise and fall perpendicular to its line of travel. Rayleigh waves travel in a circulating pattern similar to those in an ocean wave. Finally, Love waves cause the earth’s surface to oscillate from side to side perpendicular to its line of travel. The primary and secondary waves travel faster than the Rayleigh and Love waves providing the initial evidence of an event.

Each wave impacts structures differently. For example, secondary waves have much greater impact in tall structures. Additionally, each wave has unique characteristics. The secondary wave, for example, cannot travel through fluids, including the molten outer core.

Location of earthquake events has the added dimension of land / crust composition. Within the United States, areas like southern California are primarily young, hot rock that is broken by mountain ranges. Under these conditions seismic waves are somewhat limited in their ability to travel (attenuation) reducing the overall area of impact. Conversely, seismic zones in the central and eastern United States have flat-lying, cold, brittle rocks with much thicker deposits of soil and sediments. Loosely consolidated materials such as sand and soil cause seismic waves to amplify ground motion.

When seismic waves travel through unconsolidated materials it can have the effect of turning solid land into quicksand. When this phenomenon, called liquefaction, occurs, any object located in the affected area may slide over or sink into the soil. Entire buildings, roadways and bridges may be significantly damaged.
One factor which greatly determines the extent of damage from an event is duration. Events can last anywhere from a few seconds to minutes. The longer the event is promulgating seismic waves the greater the opportunity for damage.

Earthquake forces are generally measured using an instrumental scale developed initially in 1935 by Charles Richter. The scale is open ended but generally ranges to 9+ (severe damage and ground deformation). The scale is logarithmic which can be confusing. For example, an earthquake rated as 2.0 magnitude is 30 times more powerful, in terms of energy released, than one rated 1.0. or a 7-magnitude earthquake is 900 times larger than a 5-magnitude earthquake.

Another method of measuring an earthquake event is by describing its intensity. Italian volcanologist Giuseppi Mercalli developed a widely used, simple scale in 1902 based on the previous Rossi-Forel scale. Over time experts have altered the original scale creating the currently used version named the Modified Mercalli Intensity Scale (MMI.)

Looking at Figure 2.9.c the exponential increases in damage for each single digit increase in the intensity scale is apparent. For example, MMI IX discusses shifted and damaged building while X describes mass destruction of masonry (brick) and frame (wood) buildings.

**Figure 2.9.c**

<table>
<thead>
<tr>
<th>Modified Mercalli Intensity Scale</th>
<th>Magnitude Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Detected only by sensitive instruments</td>
</tr>
<tr>
<td>II</td>
<td>Felt by few persons at rest, especially on upper floors; delicately suspended objects may swing</td>
</tr>
<tr>
<td>III</td>
<td>Felt noticeably indoors, but not always recognized as earthquake; standing autos rock slightly, vibrations like passing truck</td>
</tr>
<tr>
<td>IV</td>
<td>Felt indoors by many, outdoors by few, at night some awaken; dishes, windows, doors disturbed; standing autos rock noticeably</td>
</tr>
<tr>
<td>V</td>
<td>Felt by most people; some breakage of dishes, windows, and plaster; disturbance of tall objects</td>
</tr>
<tr>
<td>VI</td>
<td>Felt by all, many frightened and run outdoors; falling plaster and chimneys, damage small</td>
</tr>
<tr>
<td>VII</td>
<td>Everybody runs outdoors; damage to buildings varies depending on quality of construction; noticed by drivers of autos</td>
</tr>
<tr>
<td>VIII</td>
<td>Plates walls thrown out of frames; walls, monuments, chimneys fall; sand and mud ejected; drivers of autos disturbed</td>
</tr>
<tr>
<td>IX</td>
<td>Buildings shifted off foundations, cracked, thrown out of plumb; ground cracked; underground pipes broken</td>
</tr>
<tr>
<td>X</td>
<td>Most masonry and frame structures destroyed; ground cracked, rails bent, landslides</td>
</tr>
<tr>
<td>XI</td>
<td>Few structures remain standing; bridges destroyed, fissures in ground, pipes broken, landslides, rails bent</td>
</tr>
<tr>
<td>XII</td>
<td>Damage total; waves seen on ground surface, lines of sight and level distorted, objects thrown up into air</td>
</tr>
</tbody>
</table>

*General relationship between epicentral Modified Mercalli intensities and magnitude. Intensities can be highly variable, depending on local geologic conditions. (Modified from D. W. Steeple's, 1978, Earthquakes: Kansas Geological Survey pamphlet.)*

*Source: Educational Leaflet No. 9 Revised Edition 2007 Division of Geological Survey*
RISK ASSESSMENT

Location

Earthquakes in Ohio are primarily located the northeast and far west-central portions of the state and historically have not exceed 5.4 magnitude (see Map 2.9.a). The map of historical epicenters lists all the events with magnitudes greater than 2.0. The size of the location marker increases with the magnitude of the event. Red circles represent instrumentally recorded events. Blue circles represent non-instrument recorded events.

The epicenter map clearly identifies the northeast Ohio counties of Ashtabula, Geauga and Lake in Region One as one of the most earthquake prone areas. Similarly in the west central counties of Auglaize, Champaign, Logan, Mercer, and Shelby represent a second nucleus of seismic activity in Region 3. Although there are clear clusters of activity, a limited number of events have occurred which are spread over a large portion of the state.

According to information published by the Ohio Division of Geological Survey, the origins of Ohio earthquakes, as with earthquakes throughout the eastern United States, are poorly understood at this time. Those in Ohio appear to be associated with ancient zones of weakness in the Earth's crust that formed during continental collision and mountain-building events about a billion years ago.

These zones are characterized by deeply buried and poorly known faults, some of which serve as the sites for periodic release of strain that is constantly building up in the North American continental plate due to continuous movement of the tectonic plates that make up the Earth's crust.
The Division of Geological Survey has developed a map of geologic features referred to as basement structures, which lie far below the earth’s surface (see Map 2.9.b). The Region One active zone corresponds with the structure called the Akron Magnetic Boundary. Several geologists have speculated the boundary is a fracture zone in crystalline rocks lying more than 6,000 feet below the surface. The active area of Region Two matches to better understood features. The Fort Wayne Rift along with the Anna-Champaign, Logan and Auglaize faults, though still poorly understood, can be evaluated using the existing understanding of how these structures behave.

LHMP Data

As indicated in the vulnerability analysis below, Hamilton County and Shelby County are the most likely counties in Ohio to be affected by a significant earthquake (Hamilton County’s issues are compounded by the county’s susceptibility to landslide and soil liquefaction). Both the Hamilton County and the Shelby County LHMP considers earthquakes, ranked fifth and sixth respectively, to be a high ranking concern for them. They acknowledge that an earthquake is a low probability, high consequence event. The lack of public awareness, building standards, and aging infrastructure were the reasons cited by Hamilton County for ranking earthquakes within their top five concerns. Shelby County, considered to be one of the most active seismic zones within the state, experiencing more than 40 since 1875, ranked earthquakes sixth based on past history of earthquakes including the most damaging earthquake to strike the state.

Past Occurrences

Earthquakes are a continuously occurring hazard in Ohio. Eleven events were recorded by the Division of Geological Survey for the first 11 months of 2007. Data are available for events dating back over 200 years.
Most of Ohio’s earthquake events are small, registering between 2 and 4 magnitudes. Significant events are discussed in Geological Survey document Educational Leaflet No. 9 which follows.

**Summer 1776:** The earliest Ohio earthquake to be noted occurred at 8 a.m. sometime in the summer of 1776 and was chronicled by John Heckewelder, a Moravian missionary, who reported that “the southwest side of the house was raised with such violence that the furniture of the room was nearly overturned.” Heckewelder spent the summer of 1776 at the Moravian mission of Lichtenau, which was in present-day Coshocton County. Because his report is the only account of this event, it is impossible to determine an epicentral location with any certainty. In deed, the epicenter of this earthquake may not have been in Ohio.

**1811 and 1812:** On December 16, 1811, and January 23 and February 7, 1812, the largest earthquakes ever to strike the continental United States occurred at New Madrid, Missouri. These events were felt throughout an area of about 2 million square miles, including all of Ohio. In Ohio, some chimneys were toppled in the Cincinnati area, which experienced the strongest shaking from these events. Should earthquakes of this intensity be repeated at New Madrid, they would probably cause considerable damage in southwestern Ohio.

**June 18, 1875:** This earthquake was felt throughout an area of at least 40,000 square miles and was most in tense at Sidney (Shelby County) and Urbana (Champaign County), where masonry walls were cracked and chimneys toppled. It has been interpreted to have had an MMI of VII.

**September 19, 1884:** An earthquake in the vicinity of Lima (Allen County) had an epicentral MMI of VI. There were reports of fallen ceiling plaster as far away as Zanesville (Muskingum County) and Parkersburg, West Virginia. On the basis of a felt area of more than 140,000 square miles, this earthquake is estimated to have had a magnitude of 4.8. Workmen on top of the Washington Monument in Washington, D.C., reported feeling this earthquake.

**May 17, 1901:** During this earthquake, bricks were dislodged from chimneys and some windows were cracked in Portsmouth (Scioto County) and chimneys were damaged in Sciotoville. Modified Mercalli intensities of VI were generated in the epicentral area. Based on felt area, this earthquake is as signed a magnitude of 4.3.

**November 5, 1926:** This earthquake was centered near Pomeroy and Kenosha, in Meigs County, where chimneys were toppled. A stove was over turned at Chester. Modified Mercalli intensities of VII were generated in the epicentral area, but the earthquake apparently was felt only in portions of Meigs County and adjacent parts of West Virginia. On the basis of this small felt area, this event has been as signed a magnitude of 3.6. Explosive earth sounds were reported to have accompanied this earthquake.

**September 30, 1930:** This earthquake cracked plaster and toppled a chimney in Anna (Shelby County). An epicentral MMI of VII and a magnitude of 4.2 have been as signed to this event.
September 20, 1931: In this event, Anna and Sidney in Shelby County experienced toppled chimneys and cracked plaster. Store merchandise and crockery were knocked off shelves, and stones were jarred loose from the foundation of the Lutheran church in Anna. A ceiling collapsed in a school at Botkins, north of Anna. An MMI of VII and a magnitude of 4.7 have been ascribed to this earthquake.

March 2 and 9, 1937: These two earthquakes are the most damaging to have struck Ohio. Maximum intensities were experienced at Anna (Shelby County), where an MMI of VII was associated with the March 2 event and an MMI of VIII with the March 9 event. In Anna, chimneys were toppled, organ pipes were twisted in the Lutheran church, the masonry school building was so badly cracked that it was razed, water wells were disturbed, and cemetery monuments were rotated. Both earthquakes were felt throughout a multi-state area—plaster was cracked as far away as Fort Wayne, Indiana. The March 9 event was felt throughout an area of about 150,000 square miles. Analysis of seismograms from these earthquakes by the U.S. Geological Survey (Stover and Coffman, 1993) assigned magnitudes of 4.7 and 4.9, respectively, to these events. On the basis of felt area, these earthquakes have been assigned magnitudes of 4.9 and 5.4, respectively.

January 31, 1986: This earthquake, which had a magnitude of 5.0 and an MMI in the high VI range, occurred in Lake County, east of Cleveland, in the general vicinity of a magnitude 4.5 event in 1943. The 1986 earthquake cracked plaster and masonry, broke windows, and caused changes in water wells. The epicenter was only a few miles from the Perry nuclear power plant. It is the most intensively studied earthquake in Ohio and was the subject of several scientific reports (for example, Nicholson and others, 1988).

July 12, 1986: Minor damage, consisting primarily of cracked windows and plaster and fallen bricks from chimneys, was reported from this MMI VI earthquake centered northwest of Anna, near St. Mary’s, in Auglaize County. It had a magnitude of 4.5.

January 25, 2001: The city of Ashtabula was struck by a 4.5-magnitude earthquake that caused minor damage to about 50 homes and businesses. This earthquake was the largest in a series of shallow earthquakes that began in 1987 and were attributed to fluids from a Class I deep-injection well. Nearly 40 earthquakes above 2.0 magnitude were recorded at Ashtabula through 2001. Prior to 1987, no earthquakes had been noted in the area.

Probability of Future Events

Earthquakes have impacted Ohio as far back in history as written and oral records exist. There is clear precedence set to expect Ohio will continue to experience seismic
events for the foreseeable future. Probabilities of future events have been developed and mapped by the USGS (see Map 2.9.c). The measurement used in this estimation is based on the chance of ground shaking (e.g. peak ground acceleration) as a percentage of the natural force of gravity over time. In this analysis the extreme south western portion of Ohio has one in ten chance of experiencing an earthquake equal in force to three percent of the earth’s gravity in the next 50 years due to its proximity to the New Madrid seismic zone.

Although future earthquakes events are guaranteed to occur in Ohio, the state has fortunately has not experienced any loss of life due to earthquakes. Damages are commonly limited to poorly built structures.

Environmental Impacts

Earthquakes have the potential to have a large impact on the environment. Fault ruptures and landslides can dramatically alter the landscape. This alteration can cause habitat loss and alter groundwater and aquifers.

Secondary impacts would be similar to that of a tornado. Releasing hazardous materials, into the environment, from damaged facilities or pipelines that have hazardous materials, either chemical or petroleum based. The severity of the impact would be determined by the amount and type of material released. Air quality can be affected by lead and asbestos from damaged older structures. The smoke from fires caused by ruptured gas lines would also contribute to polluting the air. Water sources and supplies can become contaminated with not only hazardous materials, but also from debris and damage to treatment facilities that could permit raw sewage to enter the water supply.

VULNERABILITY ANALYSIS & LOSS ESTIMATION

Methodology

Loss estimates for Ohio’s earthquake hazard were developed using FEMA’s hazard analysis and loss estimation software HAZUS-MH and its extensive inventory of historical events. HAZUS has been used successfully for over a decade in California’s earthquake preparation and response efforts. For the purpose of this initial effort, the analysis was completed using the program, data and estimated affects of ground shaking provided with the software which is also known as a level 1 analysis. It is important to interpret HAZUS-MH MR3 results with the clear understanding they are estimates and cannot be considered precise losses.

For the northeast Ohio analysis, the historical event of January 31, 1986, which strongly shook Ohio and was felt in 10 other states and southern Canada with a magnitude of 5.0, was used. Estimates for the west central area used the event of March 2, 1937 with an estimated magnitude of 5.4. Analysis for the 1811/1812 New Madrid event could not be performed due to constraints within the software.

Beginning with the county where the epicenter of where each event occurred, HAZUS-MH MR3 runs were performed on each contiguous county expanding outward, until loss estimates became negligible.
Results

Region 1 counties with notable losses included: Allen, Auglaize, Darke, Hardin, Logan, Mercer and Shelby, (see table 2.9.a). Upon review of the HAZUS-MH MR3 analysis the results indicated very minimal impact of utility, transportation and critical facilities. The categories which reflected the greatest impact are associated with the building inventory and are the focus of the loss estimation. The only other category with any loss is wastewater treatment and those were negligible by comparison.

The total population for the impacted are is 375,332 with a total building value of $27,914,000,000. Impacts are reported in terms of damage degree, income losses and property damage. The HAZUS-MH MR3 User’s Manual provide basic diagram to depict the degrees of damage, (see Figure 2.9.d).

Using the building category Wood, Light Frame as an example the following descriptions are provided in the User’s Manual to clarify the degrees of damage.

Slight: Small plaster or gypsum board cracks at corners of door and window openings and wall ceiling intersections; small cracks in masonry chimneys and masonry veneer.

Moderate: Large plaster or gypsum-board cracks at corners of door and window openings; small diagonal cracks across shear wall panels exhibited by small cracks in stucco and gypsum wall panels; large cracks in brick chimneys; toppling of tall masonry chimneys.

Extensive: Large diagonal cracks across shear wall panels or large cracks at plywood joints; permanent lateral movement of floors and roof; toppling of most brick chimneys; cracks in foundations; splitting of wood sill plates and/or slippage of structure over foundations; partial collapse of room-over-garage or other soft-story configurations; small foundations cracks.

Complete: Structure may have large permanent lateral displacement, may collapse, or be in imminent danger of collapse due to cripple wall failure or the failure of the lateral load resisting system; some structures may slip and fall off the foundations; large foundation cracks.

HAZUS results for building counts indicate 3,029 slight, 904 moderate, 120 extensive and 13 completely impacted structures. The total loss of income is estimated at $9,550,000 and total property losses are estimated at $174,710,000. This represents approximately a .6 percent overall loss ratio.
State of Ohio Hazard Mitigation Plan

Section 2: Hazard Identification & Risk Assessment

Table 2.9.a

<table>
<thead>
<tr>
<th>Region 1</th>
<th>County</th>
<th>2001 Pop.</th>
<th>Total Building Value</th>
<th>Slight Damage Count</th>
<th>Moderate Damage Count</th>
<th>Extensive Damage Count</th>
<th>Complete Damage Count</th>
<th>Income Loss</th>
<th>Property Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allen</td>
<td>108,522</td>
<td>$8,283,000,000</td>
<td>548</td>
<td>148</td>
<td>15</td>
<td>1</td>
<td>$1,600,000</td>
<td>$23,290,000</td>
<td></td>
</tr>
<tr>
<td>Auglaize</td>
<td>46,453</td>
<td>$3,495,000,000</td>
<td>1,130</td>
<td>365</td>
<td>57</td>
<td>7</td>
<td>$4,390,000</td>
<td>$88,120,000</td>
<td></td>
</tr>
<tr>
<td>Darke</td>
<td>53,178</td>
<td>$3,774,000,000</td>
<td>110</td>
<td>28</td>
<td>3</td>
<td>0</td>
<td>$240,000</td>
<td>$2,450,000</td>
<td></td>
</tr>
<tr>
<td>Hardin</td>
<td>31,945</td>
<td>$2,115,000,000</td>
<td>50</td>
<td>12</td>
<td>1</td>
<td>0</td>
<td>$100,000</td>
<td>$750,000</td>
<td></td>
</tr>
<tr>
<td>Logan</td>
<td>46,115</td>
<td>$3,503,000,000</td>
<td>224</td>
<td>60</td>
<td>5</td>
<td>0</td>
<td>$350,000</td>
<td>$3,940,000</td>
<td></td>
</tr>
<tr>
<td>Mercer</td>
<td>40,886</td>
<td>$2,938,000,000</td>
<td>305</td>
<td>87</td>
<td>9</td>
<td>1</td>
<td>$860,000</td>
<td>$12,870,000</td>
<td></td>
</tr>
<tr>
<td>Shelby</td>
<td>48,233</td>
<td>$3,806,000,000</td>
<td>662</td>
<td>204</td>
<td>30</td>
<td>4</td>
<td>$2,010,000</td>
<td>$43,290,000</td>
<td></td>
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<tr>
<td>TOTAL</td>
<td>375,332</td>
<td>$27,914,000,000</td>
<td>3,029</td>
<td>904</td>
<td>120</td>
<td>13</td>
<td>$9,550,000</td>
<td>$174,710,000</td>
<td></td>
</tr>
</tbody>
</table>

Region 2 counties with notable losses included: Ashtabula, Cuyahoga, Geauga, Lake and Trumbull (see Table 2.9.b). Again the notable losses are associated with building stock with relatively negligible losses to wastewater treatment facilities. The total population for the impacted area is 2,030,122 with a total building value of $179,136,000,000. HAZUS results for building counts indicate 9,394 slight, 2,759 moderate, 380 extensive and 41 completely impacted structures. The total loss of income is estimated at $35,580,000 and total property losses are estimated at $590,750,000. This represents approximately a .4 percent overall loss ratio.

Table 2.9.b

<table>
<thead>
<tr>
<th>Region 2</th>
<th>County</th>
<th>2001 Pop.</th>
<th>Total Building Value</th>
<th>Slight Damage Count</th>
<th>Moderate Damage Count</th>
<th>Extensive Damage Count</th>
<th>Complete Damage Count</th>
<th>Income Loss</th>
<th>Property Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ashtabula</td>
<td>102,729</td>
<td>$7,711,000,000</td>
<td>578</td>
<td>160</td>
<td>15</td>
<td>1</td>
<td>$1,320,000</td>
<td>$19,520,000</td>
</tr>
<tr>
<td></td>
<td>Cuyahoga</td>
<td>1,384,252</td>
<td>$126,164,000,000</td>
<td>2,925</td>
<td>760</td>
<td>83</td>
<td>7</td>
<td>$12,030,000</td>
<td>$121,920,000</td>
</tr>
<tr>
<td></td>
<td>Geauga</td>
<td>92,294</td>
<td>$7,867,000,000</td>
<td>1,467</td>
<td>488</td>
<td>73</td>
<td>9</td>
<td>$4,910,000</td>
<td>$103,840,000</td>
</tr>
<tr>
<td></td>
<td>Lake</td>
<td>227,324</td>
<td>$19,804,000,000</td>
<td>4,118</td>
<td>1,276</td>
<td>202</td>
<td>24</td>
<td>$16,710,000</td>
<td>$339,760,000</td>
</tr>
<tr>
<td></td>
<td>Trumbull</td>
<td>223,513</td>
<td>$17,590,000,000</td>
<td>306</td>
<td>75</td>
<td>7</td>
<td>0</td>
<td>$610,000</td>
<td>$5,710,000</td>
</tr>
<tr>
<td>TOTAL</td>
<td>2,030,112</td>
<td>$179,136,000,000</td>
<td>9,394</td>
<td>2,759</td>
<td>380</td>
<td>41</td>
<td>$35,580,000</td>
<td>$590,750,000</td>
<td></td>
</tr>
</tbody>
</table>

Although HAZUS evaluations of the 1811/1812 New Madrid Event cannot be conducted due to software constraints, the potential for damage from a similar earthquake exists. As part of preparations for a multi-state evaluation of the New Madrid hazard potential the USGS developed an updated damage evaluation for Ohio (see Map 2.9.d). The area marked in solid red would experience the greatest impact with moderate damage (broken windows, damaged chimneys, cracked walls) from a hypothetical 7.6 event.
One consideration which is beyond the scope of this analysis is the impact a New Madrid event would have on the highly landslide prone areas in Hamilton and Clermont counties. These counties are heavily urbanized containing the greater Cincinnati metropolitan area with millions of inhabitants and billions of dollars in development. In the case of Hamilton County, significant damage including the temporary closure of interstate route 75 resulting from roadway slippage has occurred due to landslide, without the impetus of ground shaking or liquefaction. When a major New Madrid event occurs affecting Hamilton County, the impact could include the closure of multiple interstate highways, rail lines, and significant building losses along with displaced inhabitants.

STATE OWNED / CRITICAL FACILITIES VULNERABILITY ANALYSIS & LOSS ESTIMATION

Methodology

HAZUS results for the earthquake prone areas include the category of government facilities. These would include all publicly owned structures. The methodology to earthquakes were identified in section 2.1.determine the vulnerability of state-owned structures and critical facilities to

Results

Reviewing the results of the two epicentral counties yielded fewer than 10 impacted government structures with slight to moderate damage. The building codes in Ohio relative to earthquake design standards for publicly-owned structures have significantly mitigated potential for damage. The potential is further addressed by state-owned structures and critical facilities identified in Section 2.1, Table 2.1.a, and Appendix C.