

Hazus-MH: Earthquake Event Report

Region Name: Aiken_6M

Earthquake Scenario: Aiken_6M_Plan

Print Date: May 23, 2016

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.

Table of Contents

Section	Page #
General Description of the Region	3
Building and Lifeline Inventory	4
Building Inventory	
Critical Facility Inventory	
Transportation and Utility Lifeline Inventory	
Earthquake Scenario Parameters	6
Direct Earthquake Damage	7
Buildings Damage	
Critical Facilities Damage	
Transportation and Utility Lifeline Damage	
Induced Earthquake Damage	11
Debris Generation	
Social Impact	12
Shelter Requirements	
Casualties	
Economic Loss	13
Building Losses	
Transportation and Utility Lifeline Losses	
Long-term Indirect Economic Impacts	
Appendix A: County Listing for the Region	
Appendix B: Regional Population and Building Value Data	

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 6 county(ies) from the following state(s):

South Carolina

Note:

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

The geographical size of the region is 4,490.82 square miles and contains 144 census tracts. There are over 228 thousand households in the region which has a total population of 584,472 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 257 thousand buildings in the region with a total building replacement value (excluding contents) of 57,665 (millions of dollars). Approximately 93.00 % of the buildings (and 80.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 9,635 and 4,500 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 257 thousand buildings in the region which have an aggregate total replacement value of 57,665 (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 64% 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 8 hospitals in the region with a total bed capacity of 1,007 beds. There are 205 schools, 73 fire stations, 32 police stations and 6 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 0 dams identified within the region. Of these, 0 of the dams are classified as 'high hazard'. The inventory also includes 2,150 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 14,135.00 (millions of dollars). This inventory includes over 1,763 kilometers of highways, 1,119 bridges, 5,856 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	1,119	833.20
	Segments	377	7,869.30
	Tunnels	0	0.00
	Subtotal		8,702.50
Railways	Bridges	2	5.90
	Facilities	2	5.30
	Segments	211	518.90
	Tunnels	0	0.00
	Subtotal		530.20
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	9	8.00
	Subtotal		8.00
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	5	53.30
	Runways	9	341.70
	Subtotal		394.90
		Total	9,635.70

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	474.40
	Facilities	307	652.70
	Pipelines	9,826	930.00
		Subtotal	2,057.10
Waste Water	Distribution Lines	NA	284.60
	Facilities	209	40.10
	Pipelines	7,135	977.80
		Subtotal	1,302.50
Natural Gas	Distribution Lines	NA	189.80
	Facilities	0	0.00
	Pipelines	72	256.90
		Subtotal	446.60
Oil Systems	Facilities	5	8.90
	Pipelines	5	52.80
		Subtotal	61.70
Electrical Power	Facilities	81	1,561.80
		Subtotal	1,561.80
Communication	Facilities	27	19.80
		Subtotal	19.80
		Total	5,449.60

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	Aiken_6M_Plan
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-81.59
Latitude of Epicenter	33.60
Earthquake Magnitude	6.00
Depth (Km)	5.00
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	Central & East US (CEUS 2008)

Building Damage

Building Damage

Hazus estimates that about 30,409 buildings will be at least moderately damaged. This is over 12.00 % of the buildings in the region. There are an estimated 3,341 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.

Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	572	0.29	110	0.35	87	0.44	39	0.53	22	0.64
Commercial	8,114	4.15	1,344	4.28	1,229	6.23	644	8.78	379	11.36
Education	302	0.15	44	0.14	39	0.20	19	0.26	12	0.35
Government	280	0.14	43	0.14	42	0.21	25	0.34	17	0.51
Industrial	2,285	1.17	356	1.14	327	1.66	171	2.33	112	3.36
Other Residential	40,968	20.95	10,120	32.26	10,180	51.58	4,650	63.41	2,223	66.53
Religion	1,152	0.59	187	0.60	138	0.70	66	0.90	37	1.12
Single Family	141,845	72.55	19,168	61.10	7,693	38.98	1,718	23.43	539	16.13
Total	195,516		31,371		19,735		7,333		3,342	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	137,917	70.54	18079	57.63	6,667	33.78	1,162	15.85	149	4.45
Steel	5,563	2.85	841	2.68	875	4.44	506	6.90	323	9.66
Concrete	906	0.46	133	0.42	148	0.75	86	1.17	53	1.60
Precast	367	0.19	51	0.16	65	0.33	45	0.61	25	0.76
RM	1,411	0.72	140	0.45	175	0.89	125	1.70	53	1.59
URM	12,525	6.41	2562	8.17	1,973	10.00	915	12.47	600	17.96
MH	36,827	18.84	9566	30.49	9,831	49.82	4,495	61.30	2,138	63.99
Total	195,516		31,371		19,735		7,333		3,342	

*Note:

RM Reinforced Masonry
 URM Unreinforced Masonry
 MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 1,007 hospital beds available for use. On the day of the earthquake, the model estimates that only 644 hospital beds (64.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 79.00% of the beds will be back in service. By 30 days, 92.00% 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	8	1	0	7
Schools	205	30	16	155
EOCs	6	1	1	4
PoliceStations	32	11	8	18
FireStations	73	10	5	49

Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

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	377	0	0	377	377
	Bridges	1,119	101	24	1,019	1,059
	Tunnels	0	0	0	0	0
Railways	Segments	211	0	0	211	211
	Bridges	2	0	0	2	2
	Tunnels	0	0	0	0	0
	Facilities	2	0	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	9	3	0	8	9
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	5	1	0	4	5
	Runways	9	0	0	9	9

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	307	34	0	241	300
Waste Water	209	23	0	168	201
Natural Gas	0	0	0	0	0
Oil Systems	5	0	0	5	5
Electrical Power	81	18	0	51	69
Communication	27	3	0	24	27

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	3,208	191	48
Waste Water	2,024	242	61
Natural Gas	550	37	9
Oil	74	2	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	228,586	0	0	0	0	0
Electric Power		51,648	35,912	19,040	5,176	229

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 0.93 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 47.00% 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 37,160 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

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 1,984 households to be displaced due to the earthquake. Of these, 1,333 people (out of a total population of 584,472) 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
2 AM	Commercial	12	3	0	1
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	24	6	1	2
	Other-Residential	467	103	9	16
	Single Family	290	63	8	16
	Total	793	176	19	34
2 PM	Commercial	725	195	29	56
	Commuting	2	2	4	1
	Educational	358	101	16	31
	Hotels	0	0	0	0
	Industrial	174	47	7	14
	Other-Residential	107	24	2	4
	Single Family	72	16	2	4
	Total	1,437	385	60	110
5 PM	Commercial	520	140	21	40
	Commuting	29	34	63	12
	Educational	28	8	1	2
	Hotels	0	0	0	0
	Industrial	109	30	4	9
	Other-Residential	170	38	3	6
	Single Family	115	26	4	7
	Total	972	276	97	76

Economic Loss

The total economic loss estimated for the earthquake is 2,879.72 (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 2,692.66 (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 55 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	10.27	91.83	4.23	7.81	114.13
	Capital-Related	0.00	4.31	75.06	2.57	1.43	83.37
	Rental	16.68	20.87	41.13	1.54	3.68	83.90
	Relocation	61.11	46.78	67.45	6.80	23.80	205.94
	Subtotal	77.79	82.23	275.47	15.13	36.71	487.33
Capital Stock Losses							
	Structural	132.20	81.59	106.14	27.73	28.94	376.60
	Non_Structural	576.72	265.44	293.62	95.67	82.03	1,313.48
	Content	202.80	53.90	139.88	62.42	39.58	498.59
	Inventory	0.00	0.00	4.02	12.19	0.45	16.66
	Subtotal	911.72	400.94	543.66	198.02	150.99	2,205.33
	Total	989.51	483.17	819.14	213.15	187.70	2,692.66

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.

Hazus estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 14 presents the results of the region for the given earthquake.

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

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	7,869.29	\$0.00	0.00
	Bridges	833.23	\$37.82	4.54
	Tunnels	0.00	\$0.00	0.00
	Subtotal	8702.50	37.80	
Railways	Segments	518.90	\$0.00	0.00
	Bridges	5.95	\$0.00	0.08
	Tunnels	0.00	\$0.00	0.00
	Facilities	5.33	\$0.26	4.89
	Subtotal	530.20	0.30	
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	0.00	0.00	
Bus	Facilities	8.04	\$1.80	22.43
	Subtotal	8.00	1.80	
Ferry	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Port	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Airport	Facilities	53.26	\$9.58	17.98
	Runways	341.68	\$0.00	0.00
	Subtotal	394.90	9.60	
	Total	9635.70	49.50	

Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	930.00	\$0.43	0.05
	Facilities	652.70	\$55.00	8.43
	Distribution Lines	474.40	\$5.06	1.07
	Subtotal	2,057.09	\$60.49	
Waste Water	Pipelines	977.80	\$0.76	0.08
	Facilities	40.10	\$2.33	5.81
	Distribution Lines	284.60	\$3.63	1.27
	Subtotal	1,302.54	\$6.72	
Natural Gas	Pipelines	256.90	\$0.01	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Lines	189.80	\$1.04	0.55
	Subtotal	446.65	\$1.05	
Oil Systems	Pipelines	52.80	\$0.01	0.02
	Facilities	8.90	\$0.46	5.12
	Subtotal	61.75	\$0.47	
Electrical Power	Facilities	1,561.80	\$66.57	4.26
	Subtotal	1,561.83	\$66.57	
Communication	Facilities	19.80	\$2.30	11.66
	Subtotal	19.76	\$2.30	
	Total	5,449.61	\$137.59	

Table 14. Indirect Economic Impact with outside aid

(Employment as # of people and Income in millions of \$)

LOSS	Total	%

Appendix A: County Listing for the Region

Aiken,SC

Barnwell,SC

Edgefield,SC

Lexington,SC

Orangeburg,SC

Saluda,SC

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
South Carolina	Aiken	160,099	12,984	2,969	15,953
	Barnwell	22,621	1,411	497	1,909
	Edgefield	26,985	1,943	526	2,470
	Lexington	262,391	22,611	5,144	27,756
	Orangeburg	92,501	5,768	2,088	7,856
	Saluda	19,875	1,457	261	1,718
Total State		584,472	46,174	11,485	57,662
Total Region		584,472	46,174	11,485	57,662