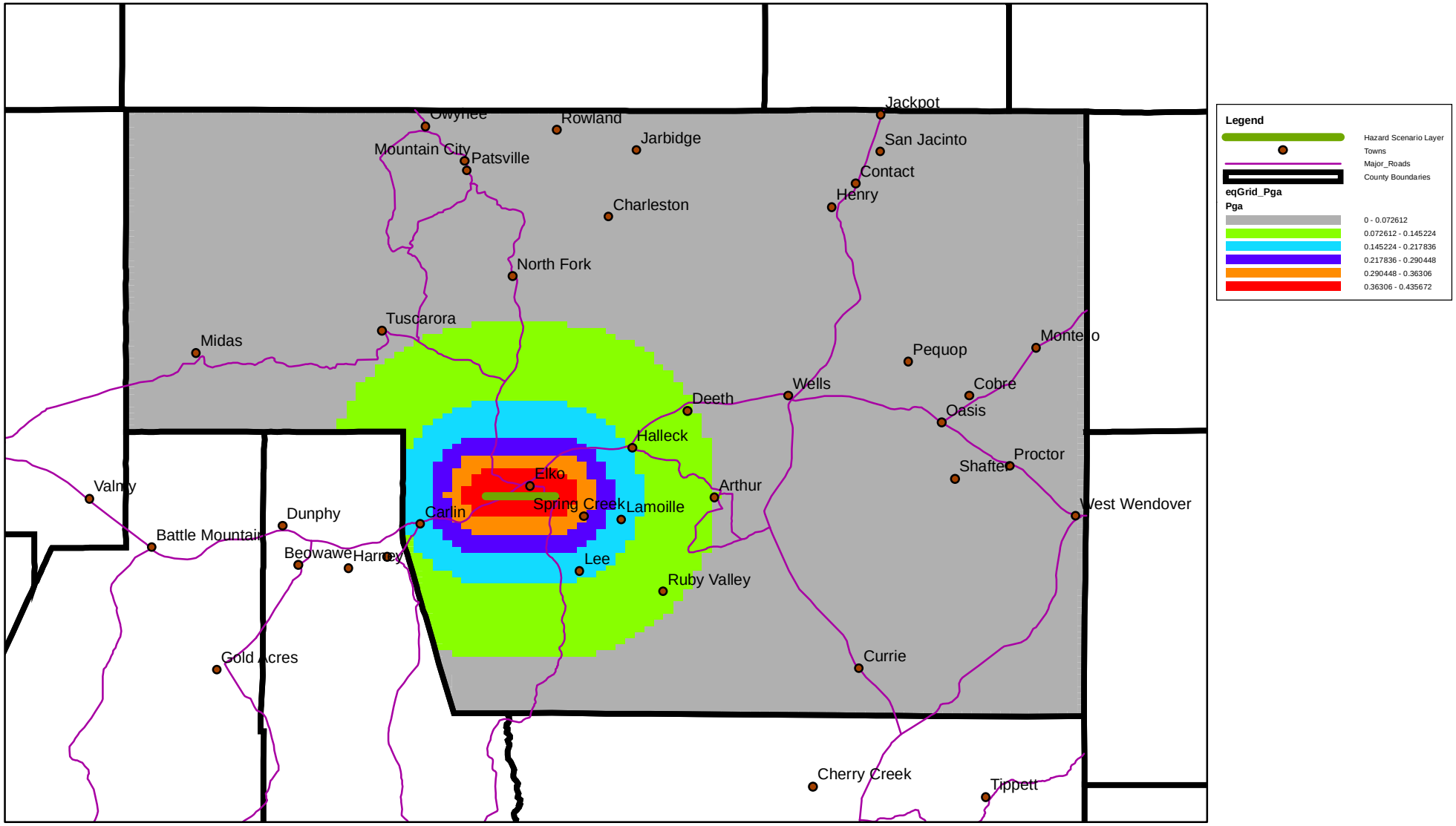
Study Region new : Elko Hazus Scenario

R. Hess

Tuesday, July 26, 2005

Hazard Scenario : Elko Fault M6.5



0 25 50 100 150 200 Kilometers

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HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	0.10 - 0.30
	Building Contents	< 0.1
	Business Interruption	0.00 - 0.10
Infrastructure	Lifelines Damage	
	Total	0.10 - 0.40

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	2 - 8	< 1.0	< 1.0	2 - 8
Major	0 - 1	< 1.0	< 1.0	0 - 1
Total	2 - 10	< 1.0	< 1.0	2 - 10

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	100 - 400
Level 2	Hospital Care	30 - 110
Level 3	Life-threatening	< 20
Level 4	Fatalities	10 - 40

Estimated Shelter Needs

Type	Households	People
Displaced Households	150 - 600	
Public Shelter		40 - 150

Comments :

Disclaimer:
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, goetechnical, and observed ground motion data.

Earthquake Information

Location :

Origin Time:

Magnitude : 6.50

Epicenter Latitude/Longitude :
40.80 / -115.79

Depth & Type :8.00/A

Fault Name :
NA

Maximum PGA : 0.00

Ground Motion /Attenuation : WUS
Shallow Crustal Event - Extensional

Information Sources:

Comments :

Population and Building Exposure (2002 D&B) (2000 Census)

Population: 45,291

Building Exposure : ($ Millions)

Residential	1,807
Commerical	226
Other	108
Total	2,141

State:

Counties :
- Elko,NV

Major Metro Area :

Time of report: July 26, 2005 5:14 pm

HAZUS-MH: Earthquake Event Report

Region Name: ***Elko_Hazus***

Earthquake Scenario: ***Elko Fault M6.5***

Print Date: ***July 26, 2005***

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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):

Nevada

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

The geographical size of the region is 17,175.54 square miles and contains 12 census tracts. There are over 15 thousand households in the region and has a total population of 45,291 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 15 thousand buildings in the region with a total building replacement value (excluding contents) of 2, 141 (millions of dollars). Approximately 99.00 % of the buildings (and 84.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 6,350 and 0 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 15 thousand buildings in the region which have an aggregate total replacement value of 2, 141 (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 60% 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 (HPL) facilities. 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 65 beds. There are 27 schools, 6 fire stations, 9 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 66 dams identified within the region. Of these, 12 of the dams are classified as 'high hazard'. The inventory also includes 22 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 2 and 3.

The total value of the lifeline inventory is over 6,350.00 (millions of dollars). This inventory includes over 1,163 kilometers of highways, 177 bridges, 56,785 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	177	150.70
	Segments	50	5,173.60
	Tunnels	0	0.00
		Subtotal	**5,324.30**
Railways	Bridges	1	0.00
	Facilities	3	7.10
	Segments	172	547.10
	Tunnels	0	0.00
		Subtotal	**554.20**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	0	0.00
		Subtotal	**0.00**
Ferry	Facilities	0	0.00
		Subtotal	**0.00**
Port	Facilities	0	0.00
		Subtotal	**0.00**
Airport	Facilities	11	65.30
	Runways	12	406.50
		Subtotal	**471.90**
		Total	**6,350.40**

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	567.90
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**567.90**
Waste Water	Distribution Lines	NA	340.70
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**340.70**
Natural Gas	Distribution Lines	NA	227.10
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**227.10**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	0	0.00
		Subtotal	**0.00**
Communication	Facilities	6	0.70
		Subtotal	**0.70**
		Total	**1,136.40**

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	Elko Fault M6.5
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-115.79
Latitude of Epicenter	40.80
Earthquake Magnitude	6.50
Depth (Km)	8.00
Rupture Length (Km)	18.20
Rupture Orientation (degrees)	90.00
Attenuation Function	WUS Shallow Crustal Event - Extensional

Building Damage

Building Damage

HAZUS estimates that about 2,898 buildings will be at least moderately damaged. This is over 19.00 % of the total number of buildings in the region. There are an estimated 228 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 4 below summaries the expected damage by general occupancy for the buildings in the region. Table 5 summaries the expected damage by general building type.

Table 4: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	2	0.02	0	0.01	0	0.01	0	0.01	0	0.00
Commercial	58	0.57	19	0.78	35	1.78	29	4.03	18	7.74
Education	0	0.00	0	0.00	0	0.01	0	0.05	0	0.12
Government	7	0.07	1	0.06	3	0.17	4	0.56	3	1.41
Industrial	3	0.03	2	0.07	3	0.16	2	0.30	1	0.44
Other Residential	3,382	33.20	952	38.79	1,068	54.75	455	63.33	159	69.53
Religion	3	0.03	0	0.02	1	0.04	1	0.13	1	0.33
Single Family	6,733	66.08	1,479	60.26	841	43.08	227	31.60	47	20.43
Total	**10,188**		**2,454**		**1,951**		**719**		**229**	

Table 5: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	6,791	66.66	1505	61.34	843	43.21	208	28.97	32	14.04
Steel	33	0.32	8	0.33	15	0.79	13	1.86	11	4.61
Concrete	34	0.33	7	0.29	12	0.61	10	1.44	6	2.67
Precast	8	0.08	2	0.08	4	0.23	5	0.75	4	1.94
RM	211	2.07	33	1.33	53	2.74	46	6.40	24	10.63
URM	9	0.09	2	0.10	3	0.16	3	0.35	3	1.23
MH	3,102	30.45	896	36.53	1,020	52.26	433	60.23	148	64.88
Total	**10,188**		**2,454**		**1,951**		**719**		**229**	

*Note:
RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 65 hospital beds available for use. On the day of the earthquake, the model estimates that only 33 hospital beds (52.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 59.00% of the beds will be back in service. By 30 days, 80.00% will be operational.

Table 6: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	2	1	0	1
Schools	27	0	0	14
EOCs	0	0	0	0
PoliceStations	9	0	0	5
FireStations	6	0	0	5

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: 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	50	0	0	50	50
	Bridges	177	2	0	175	175
	Tunnels	0	0	0	0	0
Railways	Segments	172	0	0	172	172
	Bridges	1	0	0	1	1
	Tunnels	0	0	0	0	0
	Facilities	3	1	0	3	3
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	11	1	0	11	11
	Runways	12	0	0	12	12

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 8-10 provide information on the damage to the utility lifeline systems. Table 8 provides damage to the utility system facilities. Table 9 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 10 provides a summary of the system performance information.

Table 8 : 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	0	0	0	0	0
Waste Water	0	0	0	0	0
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	6	6	0	6	6

Table 9 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	28,393	570	142
Waste Water	17,036	450	113
Natural Gas	11,357	481	120
Oil	0	0	0

Table 10: 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	15,638	3	0	0	0	0
Electric Power		1,756	958	326	52	3

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 1 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 0.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 30.00% 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 0 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 (302 households to be displaced due to the earthquake. Of these, 75 people (out of a total population of 45,291 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 11 provides a summary of the casualties estimated for this earthquake

Table 11: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	2	1	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	11	3	1	1
	Industrial	3	1	0	0
	Other-Residential	57	13	1	2
	Single Family	20	3	0	1
	Total	**94**	**21**	**2**	**4**
2 PM	Commercial	140	42	7	14
	Commuting	0	0	0	0
	Educational	10	3	0	1
	Hotels	2	1	0	0
	Industrial	25	8	1	2
	Other-Residential	12	3	0	0
	Single Family	5	1	0	0
	Total	**194**	**57**	**9**	**18**
5 PM	Commercial	93	28	5	9
	Commuting	0	1	1	0
	Educational	1	0	0	0
	Hotels	3	1	0	0
	Industrial	16	5	1	2
	Other-Residential	21	5	0	1
	Single Family	8	1	0	0
	Total	**142**	**40**	**7**	**12**

Economic Loss

The total economic loss estimated for the earthquake is 238.90 (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 224.46 (millions of dollars); 21 % 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 48 % of the total loss. Table 12 below provides a summary of the losses associated with the building damage.

Table 12: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Loses							
	Wage	0.00	3.99	12.62	0.21	1.26	18.07
	Capital-Related	0.00	1.70	12.80	0.21	0.15	14.86
	Rental	1.79	6.35	4.94	0.11	0.49	13.69
	Relocation	0.19	0.11	0.23	0.02	0.11	0.65
	Subtotal	**1.98**	**12.15**	**30.59**	**0.54**	**2.01**	**47.27**
Capital Stock Loses							
	Structural	8.27	7.34	12.46	1.78	2.32	32.17
	Non_Structural	34.23	29.86	31.80	5.02	7.42	108.32
	Content	9.20	5.77	13.86	3.14	3.44	35.42
	Inventory	0.00	0.00	0.75	0.50	0.03	1.28
	Subtotal	**51.71**	**42.97**	**58.86**	**10.44**	**13.20**	**177.19**
	Total	**53.69**	**55.12**	**89.45**	**10.98**	**15.22**	**224.46**

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 13 & 14 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 15 presents the results of the region for the given earthquake.

Table 13: Transportation System Economic Losses
(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	5,173.63	$0.00	0.00
	Bridges	150.70	$3.55	2.36
	Tunnels	0.00	$0.00	0.00
	Subtotal	**5324.30**	**3.50**	
Railways	Segments	547.05	$0.00	0.00
	Bridges	0.03	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	7.13	$1.16	16.32
	Subtotal	**554.20**	**1.20**	
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	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
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	65.35	$2.84	4.34
	Runways	406.53	$0.00	0.00
	Subtotal	**471.90**	**2.80**	
	Total	**6350.40**	**7.50**	

Table 14: 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	0.00	$0.00	0.00
	Distribution Line	567.90	$2.56	0.45
	Subtotal	**567.85**	**$2.56**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Line	340.70	$2.03	0.59
	Subtotal	**340.71**	**$2.03**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Line	227.10	$2.17	0.95
	Subtotal	**227.14**	**$2.17**	
Oil Systems	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
Electrical Power	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
Communication	Facilities	0.70	$0.13	19.45
	Subtotal	**0.65**	**$0.13**	
	Total	**1,136.35**	**$6.88**	

Table 15. Indirect Economic Impact with outside aid
(Employment as # of people and Income in millions of $)

	LOSS	Total	%
First Year			
	Employment Impact	0	0.00
	Income Impact	(2)	-0.53
Second Year			
	Employment Impact	0	0.00
	Income Impact	(5)	-1.61
Third Year			
	Employment Impact	0	0.00
	Income Impact	(7)	-2.07
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(7)	-2.07
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(7)	-2.07
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(7)	-2.07

Appendix A: County Listing for the Region

Elko, NV

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Nevada					
	Elko	45,291	1,807	334	2,141
Total State		**45,291**	**1,807**	**334**	**2,141**
Total Region		**45,291**	**1,807**	**334**	**2,141**