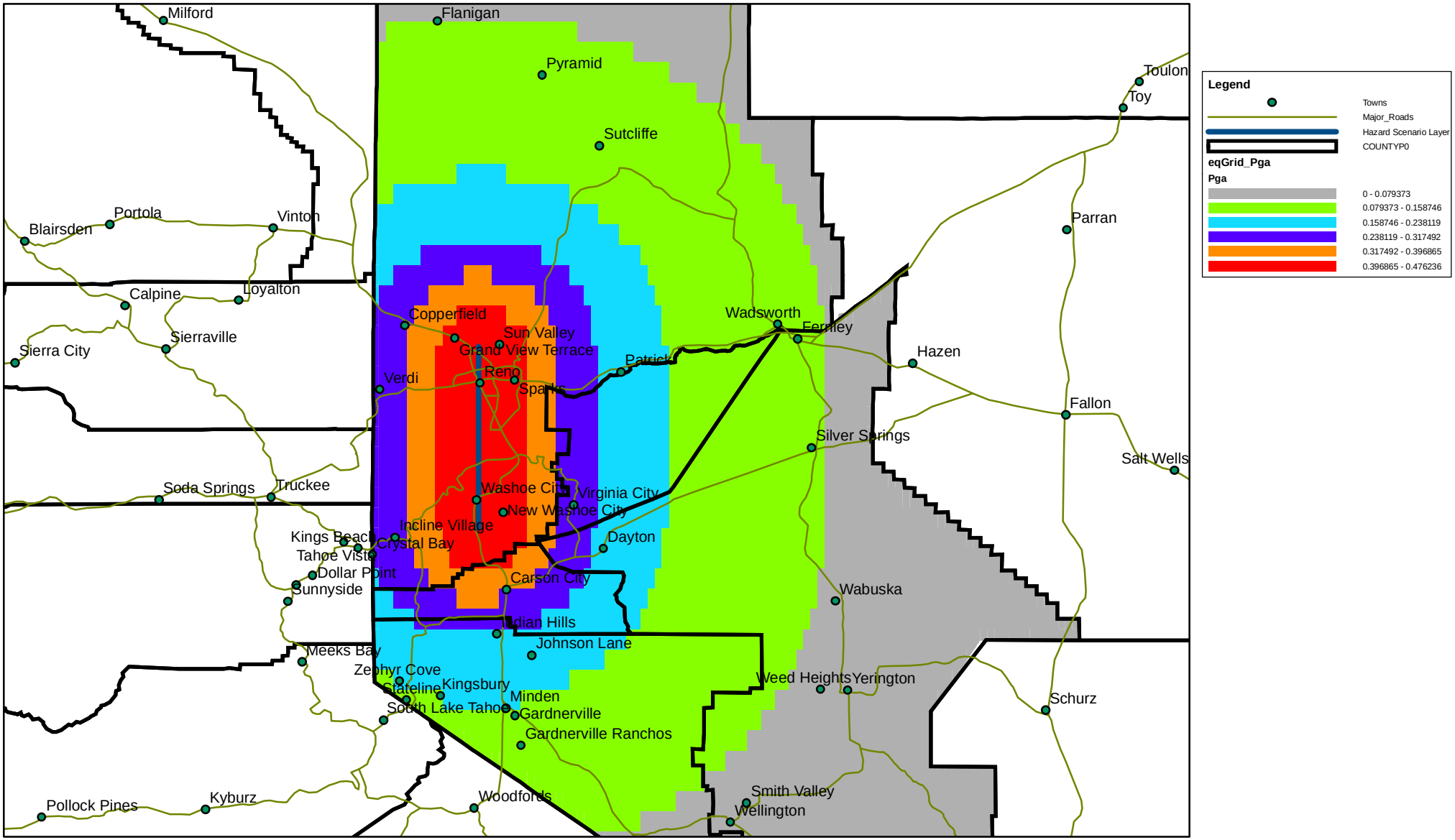
Study Region new : Washoe and Surrounding Counties, Reno Scenario

R. Hess

Hazard Scenario : Mt Rose M6.9 event

Tuesday, November 22, 2005



0 15 30 60 90 120 Kilometers

(c) 1997-2003 FEMA.

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	1.30 - 5.10
	Building Contents	0.10 - 0.40
	Business Interruption	0.30 - 1.00
Infrastructure	Lifelines Damage	
	Total	1.90 - 7.60

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	40 - 150	0 - 1	< 1.0	40 - 160
Major	5 - 20	0 - 1	< 1.0	6 - 20
Total	40 - 180	0 - 2	< 1.0	40 - 180

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	1,300 - 5,000
Level 2	Hospital Care	400 - 1,500
Level 3	Life-threatening	60 - 200
Level 4	Fatalities	120 - 500

Estimated Shelter Needs

Type	Households	People
Displaced Households	3,000 - 12,000	
Public Shelter		800 - 3,000

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 : 6.90

Epicenter Latitude/Longitude :
39.43 / -119.82

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: 471,102

Building Exposure : ($ Millions)

Residential	24,183
Commerical	3,716
Other	1,334
Total	29,233

State:

Counties :
- Douglas,NV
- Lyon,NV
- Storey,NV
- Washoe,NV
- Carson,NV

Major Metro Area :

Time of report: November 22, 2005 1:23 pm

HAZUS-MH: Earthquake Event Report

Region Name: ***NW_NEVADA***

Earthquake Scenario: ***Mt Rose 6.9***

Print Date: ***November 22, 2005***

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, 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
Fire Following Earthquake	
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 5 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 9,711.46 square miles and contains 96 census tracts. There are over 183 thousand households in the region and has a total population of 471,102 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 153 thousand buildings in the region with a total building replacement value (excluding contents) of 29,234 (millions of dollars). Approximately 99.00 % of the buildings (and 83.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 6,380 and 1,413 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 153 thousand buildings in the region which have an aggregate total replacement value of 29,234 (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 81% 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 11 hospitals in the region with a total bed capacity of 1,424 beds. There are 173 schools, 17 fire stations, 24 police stations and 2 emergency operation facilities. With respect to HPL facilities, there are 121 dams identified within the region. Of these, 43 of the dams are classified as 'high hazard'. The inventory also includes 73 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 7,793.00 (millions of dollars). This inventory includes over 1,130 kilometers of highways, 292 bridges, 39,475 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	292	480.00
	Segments	141	4,639.10
	Tunnels	0	0.00
		Subtotal	**5,119.10**
Railways	Bridges	9	1.50
	Facilities	7	16.60
	Segments	154	294.10
	Tunnels	0	0.00
		Subtotal	**312.20**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	5	5.90
		Subtotal	**5.90**
Ferry	Facilities	0	0.00
		Subtotal	**0.00**
Port	Facilities	0	0.00
		Subtotal	**0.00**
Airport	Facilities	22	130.70
	Runways	24	813.10
		Subtotal	**943.70**
		Total	**6,381.00**

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	394.80
	Facilities	3	108.90
	Pipelines	0	0.00
		Subtotal	**503.60**
Waste Water	Distribution Lines	NA	236.90
	Facilities	8	580.80
	Pipelines	0	0.00
		Subtotal	**817.60**
Natural Gas	Distribution Lines	NA	157.90
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**157.90**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	6	719.40
		Subtotal	**719.40**
Communication	Facilities	42	4.60
		Subtotal	**4.60**
		Total	**2,203.10**

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	Mt Rose 6.9
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-119.82
Latitude of Epicenter	39.43
Earthquake Magnitude	6.90
Depth (Km)	8.00
Rupture Length (Km)	35.97
Rupture Orientation (degrees)	0.00
Attenuation Function	WUS Shallow Crustal Event - Extensional

Building Damage

Building Damage

HAZUS estimates that about 40,411 buildings will be at least moderately damaged. This is over 26.00 % of the total number of buildings in the region. There are an estimated 3,411 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	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	411	0.64	333	0.68	487	1.71	307	3.60	176	5.16
Education	2	0.00	2	0.00	3	0.01	2	0.02	1	0.03
Government	27	0.04	20	0.04	28	0.10	18	0.21	9	0.26
Industrial	95	0.15	69	0.14	104	0.37	64	0.75	35	1.02
Other Residential	7,932	12.36	4,864	9.90	7,125	25.03	5,830	68.31	2,627	76.99
Religion	16	0.03	9	0.02	10	0.04	6	0.07	3	0.09
Single Family	55,690	86.78	43,849	89.22	20,707	72.75	2,309	27.05	561	16.44
Total	**64,175**		**49,146**		**28,464**		**8,536**		**3,412**	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	55,907	87.12	45052	91.67	20,764	72.95	1,950	22.85	537	15.74
Steel	184	0.29	138	0.28	276	0.97	199	2.33	80	2.35
Concrete	223	0.35	212	0.43	229	0.81	144	1.69	76	2.21
Precast	93	0.15	74	0.15	131	0.46	88	1.03	48	1.42
RM	1,869	2.91	841	1.71	1,201	4.22	631	7.39	133	3.90
URM	25	0.04	21	0.04	44	0.15	54	0.63	87	2.55
MH	5,874	9.15	2809	5.72	5,819	20.44	5,471	64.09	2,451	71.83
Total	**64,175**		**49,146**		**28,464**		**8,536**		**3,412**	

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

Essential Facility Damage

Before the earthquake, the region had 1,424 hospital beds available for use. On the day of the earthquake, the model estimates that only 312 hospital beds (22.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 51.00% of the beds will be back in service. By 30 days, 87.00% 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	11	7	0	1
Schools	173	0	0	49
EOCs	2	0	0	1
PoliceStations	24	0	0	16
FireStations	17	0	0	14

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	141	0	0	141	141
	Bridges	292	31	6	263	275
	Tunnels	0	0	0	0	0
Railways	Segments	154	0	0	154	154
	Bridges	9	0	0	9	9
	Tunnels	0	0	0	0	0
	Facilities	7	4	0	7	7
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	5	1	0	5	5
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	22	2	0	22	22
	Runways	24	0	0	24	24

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	3	3	0	0	3
Waste Water	8	7	0	0	8
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	6	4	0	2	6
Communication	42	37	0	42	42

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	19,738	3679	920
Waste Water	11,843	2910	727
Natural Gas	7,895	3111	778
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	183,125	47,079	37,969	30,003	0	0
Electric Power		60,912	34,863	12,698	2,179	91

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 33 ignitions that will burn about 0.37 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 579 people and burn about 31 (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 1.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 35.00% 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 40,000 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 (6,240 households to be displaced due to the earthquake. Of these, 1,649 people (out of a total population of 471,102 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	29	9	1	3
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	40	11	2	3
	Industrial	37	11	2	3
	Other-Residential	962	226	23	43
	Single Family	338	47	2	4
	Total	**1,406**	**303**	**31**	**57**
2 PM	Commercial	1,760	515	85	167
	Commuting	2	2	4	1
	Educational	276	81	14	26
	Hotels	8	2	0	1
	Industrial	271	78	13	24
	Other-Residential	197	47	5	9
	Single Family	63	9	1	1
	Total	**2,577**	**734**	**121**	**230**
5 PM	Commercial	1,306	380	63	122
	Commuting	52	73	119	23
	Educational	42	12	2	4
	Hotels	12	3	1	1
	Industrial	170	49	8	15
	Other-Residential	357	84	9	17
	Single Family	130	18	1	2
	Total	**2,069**	**620**	**203**	**184**

Economic Loss

The total economic loss estimated for the earthquake is 4,208.61 (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 3,798.41 (millions of dollars); 14 % 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 58 % 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	14.33	157.50	5.87	5.58	183.29
	Capital-Related	0.00	6.12	134.84	3.58	1.06	145.60
	Rental	31.52	78.59	67.82	2.85	2.69	183.46
	Relocation	3.28	1.95	4.13	0.27	0.63	10.26
	Subtotal	**34.79**	**100.99**	**364.30**	**12.57**	**9.95**	**522.61**
Capital Stock Loses							
	Structural	162.63	120.49	173.17	31.53	13.53	501.35
	Non_Structural	807.27	600.57	488.89	110.29	47.37	2,054.39
	Content	242.81	128.36	229.43	72.97	22.13	695.71
	Inventory	0.00	0.00	9.67	14.49	0.20	24.36
	Subtotal	**1,212.71**	**849.41**	**901.16**	**229.28**	**83.23**	**3,275.80**
	Total	**1,247.50**	**950.40**	**1,265.46**	**241.86**	**93.19**	**3,798.41**

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	4,639.07	$0.00	0.00
	Bridges	480.00	$57.84	12.05
	Tunnels	0.00	$0.00	0.00
	Subtotal	**5119.10**	**57.80**	
Railways	Segments	294.15	$0.00	0.00
	Bridges	1.46	$0.11	7.34
	Tunnels	0.00	$0.00	0.00
	Facilities	16.63	$4.87	29.31
	Subtotal	**312.20**	**5.00**	
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	5.94	$1.32	22.28
	Subtotal	**5.90**	**1.30**	
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	130.69	$19.15	14.66
	Runways	813.05	$0.00	0.00
	Subtotal	**943.70**	**19.20**	
	Total	**6381.00**	**83.30**	

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	108.90	$31.08	28.55
	Distribution Line	394.80	$16.56	4.19
	Subtotal	**503.64**	**$47.64**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	580.80	$123.80	21.32
	Distribution Line	236.90	$13.09	5.53
	Subtotal	**817.60**	**$136.90**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Line	157.90	$14.00	8.86
	Subtotal	**157.90**	**$14.00**	
Oil Systems	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
Electrical Power	Facilities	719.40	$127.37	17.71
	Subtotal	**719.40**	**$127.37**	
Communication	Facilities	4.60	$1.00	21.91
	Subtotal	**4.58**	**$1.00**	
	Total	**2,203.13**	**$326.91**	

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

	LOSS	Total	%
First Year			
	Employment Impact	3,641	2.38
	Income Impact	(19)	-0.25
Second Year			
	Employment Impact	1,546	1.01
	Income Impact	(86)	-1.15
Third Year			
	Employment Impact	33	0.02
	Income Impact	(118)	-1.58
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(120)	-1.61
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(120)	-1.61
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(120)	-1.61

Appendix A: County Listing for the Region

Douglas,NV

Lyon,NV

Storey,NV

Washoe,NV

Carson,NV

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Nevada					
	Douglas	41,259	2,701	427	3,128
	Lyon	34,501	1,310	220	1,530
	Storey	3,399	164	22	186
	Washoe	339,486	17,626	3,778	21,405
	Carson	52,457	2,380	602	2,983
Total State		**471,102**	**24,181**	**5,049**	**29,232**
Total Region		**471,102**	**24,181**	**5,049**	**29,232**