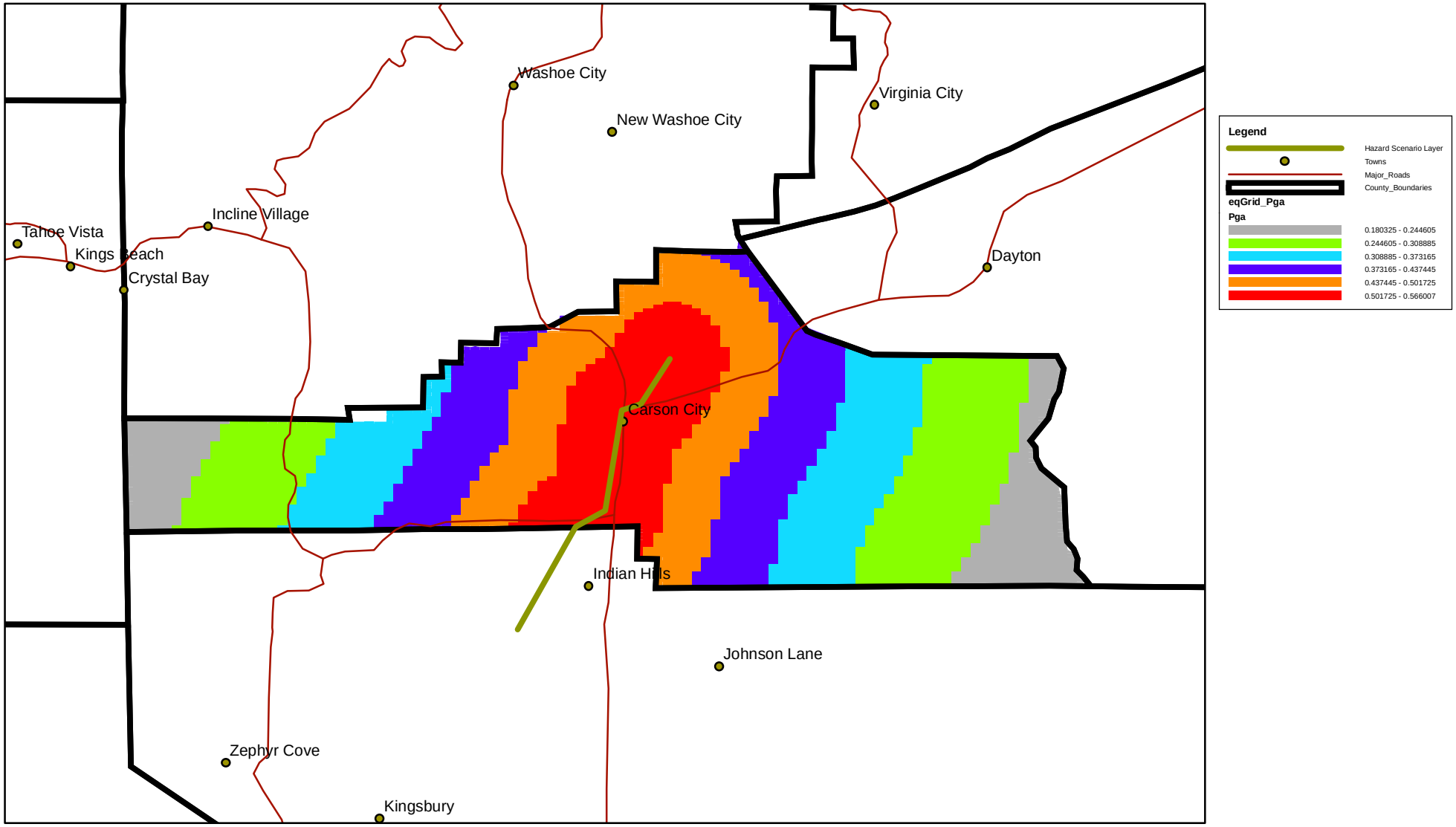
Study Region new : Carson City Hazus Run

R. Hess

Monday, July 25, 2005

Hazard Scenario : Carson City Fault M6.5



0 5 10 20 30 40 Kilometers

(c) 1997-2003 FEMA.

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	0.20 - 0.90
	Building Contents	0.00 - 0.10
	Business Interruption	0.00 - 0.20
Infrastructure	Lifelines Damage	
	Total	0.30 - 1.30

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	5 - 20	< 1.0	< 1.0	5 - 20
Major	1 - 5	< 1.0	< 1.0	1 - 5
Total	6 - 30	< 1.0	< 1.0	6 - 30

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	300 - 1,000
Level 2	Hospital Care	80 - 300
Level 3	Life-threatening	10 - 50
Level 4	Fatalities	20 - 100

Estimated Shelter Needs

Type	Households	People
Displaced Households	600 - 2,000	
Public Shelter		140 - 600

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 :
39.15 / -119.77

Depth & Type :0.00/S

Fault Name :
Carson City fault

Maximum PGA : 1.00

Ground Motion /Attenuation : WUS
Shallow Crustal Event - Extensional

Information Sources:

Comments :

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

Population: 52,457

Building Exposure : ($ Millions)

Residential	2,380
Commerical	389
Other	213
Total	2,982

State:

Counties :
- Carson,NV

Major Metro Area :

Time of report: July 25, 2005 9:06 am

HAZUS-MH: Earthquake Event Report

Region Name: ***Carson_City_Hazus***

Earthquake Scenario: ***Carson City Fault M6.5***

Print Date: ***July 25, 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.

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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 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 155.48 square miles and contains 10 census tracts. There are over 20 thousand households in the region and has a total population of 52,457 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 16 thousand buildings in the region with a total building replacement value (excluding contents) of 2, 983 (millions of dollars). Approximately 98.00 % 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 240 and 72 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 16 thousand buildings in the region which have an aggregate total replacement value of 2, 983 (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 77% 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 1 hospitals in the region with a total bed capacity of 128 beds. There are 16 schools, 1 fire stations, 2 police stations and 2 emergency operation facilities. With respect to HPL facilities, there are 2 dams identified within the region. Of these, 1 of the dams are classified as 'high hazard'. The inventory also includes 8 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 312.00 (millions of dollars). This inventory includes over 45 kilometers of highways, 4 bridges, 1,714 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	4	3.90
	Segments	8	192.30
	Tunnels	0	0.00
		Subtotal	**196.20**
Railways	Bridges	0	0.00
	Facilities	1	2.40
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**2.40**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	2	2.40
		Subtotal	**2.40**
Ferry	Facilities	0	0.00
		Subtotal	**0.00**
Port	Facilities	0	0.00
		Subtotal	**0.00**
Airport	Facilities	1	5.90
	Runways	1	33.90
		Subtotal	**39.80**
		Total	**240.80**

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	17.10
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**17.10**
Waste Water	Distribution Lines	NA	10.30
	Facilities	1	72.60
	Pipelines	0	0.00
		Subtotal	**82.90**
Natural Gas	Distribution Lines	NA	6.90
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**6.90**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	0	0.00
		Subtotal	**0.00**
Communication	Facilities	1	0.10
		Subtotal	**0.10**
		Total	**107.00**

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	Carson City Fault M6.5
Type of Earthquake	Source
Fault Name	Carson City fault
Historical Epicenter ID #	601
Probabilistic Return Period	NA
Longitude of Epicenter	-119.77
Latitude of Epicenter	39.15
Earthquake Magnitude	6.50
Depth (Km)	0.00
Rupture Length (Km)	18.20
Rupture Orientation (degrees)	0.00
Attenuation Function	WUS Shallow Crustal Event - Extensional

Building Damage

Building Damage

HAZUS estimates that about 7,847 buildings will be at least moderately damaged. This is over 48.00 % of the total number of buildings in the region. There are an estimated 918 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	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	15	0.45	25	0.47	55	1.09	45	2.37	28	3.08
Education	0	0.01	0	0.01	1	0.02	1	0.04	1	0.06
Government	4	0.12	8	0.15	17	0.33	14	0.73	9	0.94
Industrial	4	0.11	6	0.12	16	0.32	14	0.74	9	1.01
Other Residential	175	5.25	431	8.33	1,064	21.21	1,177	61.45	667	72.67
Religion	0	0.01	1	0.01	1	0.03	1	0.05	1	0.06
Single Family	3,134	94.05	4,700	90.90	3,861	77.00	663	34.62	204	22.18
Total	**3,332**		**5,171**		**5,014**		**1,916**		**918**	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	3,164	94.95	4799	92.81	3,876	77.31	598	31.22	192	20.95
Steel	10	0.29	13	0.26	35	0.70	31	1.60	16	1.72
Concrete	8	0.24	15	0.30	31	0.61	28	1.44	17	1.88
Precast	3	0.09	5	0.09	13	0.27	13	0.69	9	0.95
RM	85	2.55	77	1.50	160	3.18	121	6.31	35	3.79
URM	1	0.02	2	0.03	5	0.09	6	0.33	12	1.26
MH	62	1.86	260	5.02	894	17.84	1,119	58.42	638	69.44
Total	**3,332**		**5,171**		**5,014**		**1,916**		**918**	

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

Essential Facility Damage

Before the earthquake, the region had 128 hospital beds available for use. On the day of the earthquake, the model estimates that only 11 hospital beds (9.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 37.00% of the beds will be back in service. By 30 days, 81.00% 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	1	1	0	0
Schools	16	0	0	0
EOCs	2	0	0	0
PoliceStations	2	0	0	0
FireStations	1	0	0	0

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	8	0	0	8	8
	Bridges	4	2	0	2	2
	Tunnels	0	0	0	0	0
Railways	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	1	1	0	0	1
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	2	2	0	0	2
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	1	1	0	0	1
	Runways	1	0	0	1	1

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	1	1	0	0	1
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	1	1	0	0	1

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	857	609	152
Waste Water	514	482	120
Natural Gas	343	515	129
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	20,171	13,700	9,113	0	0	0
Electric Power		11,856	7,560	3,227	642	16

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 8 ignitions that will burn about 0.07 sq. mi 0.04 % of the region's total area.) The model also estimates that the fires will displace about 184 people and burn about 9 (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 34.00% 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 (1,105 households to be displaced due to the earthquake. Of these, 276 people (out of a total population of 52,457 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	5	2	0	1
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	6	2	0	1
	Industrial	12	4	1	1
	Other-Residential	178	43	4	8
	Single Family	85	15	1	2
	Total	**286**	**64**	**6**	**12**
2 PM	Commercial	314	94	16	31
	Commuting	0	0	0	0
	Educational	52	16	3	5
	Hotels	1	0	0	0
	Industrial	91	27	5	9
	Other-Residential	40	10	1	2
	Single Family	19	3	0	0
	Total	**517**	**151**	**25**	**48**
5 PM	Commercial	230	69	12	22
	Commuting	2	2	4	1
	Educational	7	2	0	1
	Hotels	2	0	0	0
	Industrial	57	17	3	6
	Other-Residential	66	16	2	3
	Single Family	33	6	0	1
	Total	**396**	**112**	**21**	**33**

Economic Loss

The total economic loss estimated for the earthquake is 700.92 (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 665.11 (millions of dollars); 13 % 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 57 % 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	2.02	21.53	1.54	3.15	28.24
	Capital-Related	0.00	0.86	20.63	0.93	0.28	22.71
	Rental	6.97	11.67	11.57	0.66	1.55	32.43
	Relocation	0.74	0.32	0.59	0.04	0.23	1.93
	Subtotal	**7.71**	**14.87**	**54.32**	**3.18**	**5.22**	**85.30**
Capital Stock Loses							
	Structural	33.25	21.14	26.80	7.20	4.98	93.36
	Non_Structural	144.11	94.97	75.84	25.64	18.33	358.89
	Content	41.89	20.24	34.39	17.09	8.62	122.23
	Inventory	0.00	0.00	1.35	3.94	0.04	5.32
	Subtotal	**219.25**	**136.35**	**138.38**	**53.87**	**31.96**	**579.81**
	Total	**226.96**	**151.22**	**192.70**	**57.05**	**37.18**	**665.11**

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	192.27	$0.00	0.00
	Bridges	3.92	$0.58	14.86
	Tunnels	0.00	$0.00	0.00
	Subtotal	**196.20**	**0.60**	
Railways	Segments	0.00	$0.00	0.00
	Bridges	0.00	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	2.38	$1.15	48.25
	Subtotal	**2.40**	**1.10**	
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	2.38	$1.16	48.68
	Subtotal	**2.40**	**1.20**	
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	5.94	$2.86	48.19
	Runways	33.88	$0.00	0.00
	Subtotal	**39.80**	**2.90**	
	Total	**240.80**	**5.70**	

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	17.10	$2.74	15.99
	Subtotal	**17.15**	**$2.74**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	72.60	$22.79	31.39
	Distribution Line	10.30	$2.17	21.08
	Subtotal	**82.88**	**$24.96**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Line	6.90	$2.32	33.80
	Subtotal	**6.86**	**$2.32**	
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	0.10	$0.03	31.83
	Subtotal	**0.11**	**$0.03**	
	Total	**107.00**	**$30.05**	

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	(5)	-0.61
Second Year			
	Employment Impact	0	0.00
	Income Impact	(17)	-1.85
Third Year			
	Employment Impact	0	0.00
	Income Impact	(21)	-2.38
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(21)	-2.38
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(21)	-2.38
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(21)	-2.38

Appendix A: County Listing for the Region

Carson,NV

Appendix B: Regional Population and Building Value Data

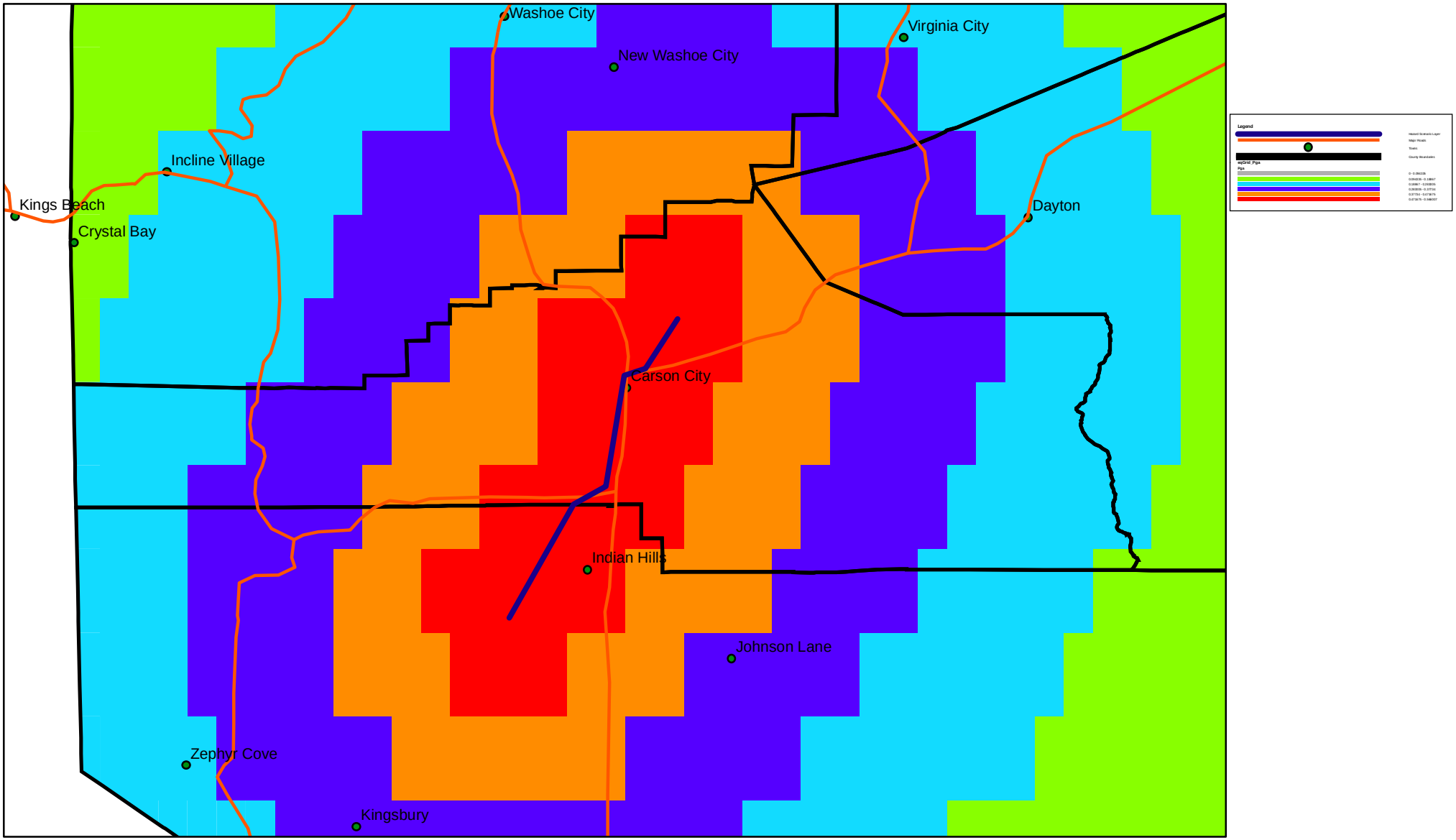
State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Nevada					
	Carson	52,457	2,380	602	2,983
Total State		**52,457**	**2,380**	**602**	**2,983**
Total Region		**52,457**	**2,380**	**602**	**2,983**

Study Region new : Carson City Regional Scenario

R. Hess

Monday, July 25, 2005

Hazard Scenario : Carson City Fault M6.5 (Region)



0 5 10 20 30 40 Kilometers

(c) 1997-2003 FEMA.

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	0.40 - 1.50
	Building Contents	0.00 - 0.10
	Business Interruption	0.10 - 0.30
Infrastructure	Lifelines Damage	
	Total	0.60 - 2.20

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	16 - 60	< 1.0	< 1.0	16 - 70
Major	1 - 7	< 1.0	< 1.0	1 - 7
Total	18 - 70	< 1.0	< 1.0	18 - 70

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	300 - 1,400
Level 2	Hospital Care	90 - 400
Level 3	Life-threatening	20 - 60
Level 4	Fatalities	30 - 110

Estimated Shelter Needs

Type	Households	People
Displaced Households	700 - 3,000	
Public Shelter		170 - 700

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 :
39.15 / -119.77

Depth & Type :0.00/S

Fault Name :
Carson City fault

Maximum PGA : 1.00

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: July 25, 2005 5:18 pm

HAZUS-MH: Earthquake Event Report

Region Name: ***County_NW***

Earthquake Scenario: ***Carson City Fault M6.5 (Region)***

Print Date: ***July 25, 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.

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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	Carson City Fault M6.5 (Region)
Type of Earthquake	Source
Fault Name	Carson City fault
Historical Epicenter ID #	601
Probabilistic Return Period	NA
Longitude of Epicenter	-119.77
Latitude of Epicenter	39.15
Earthquake Magnitude	6.50
Depth (Km)	0.00
Rupture Length (Km)	18.20
Rupture Orientation (degrees)	0.00
Attenuation Function	WUS Shallow Crustal Event - Extensional

Building Damage

Building Damage

HAZUS estimates that about 14,210 buildings will be at least moderately damaged. This is over 9.00 % of the total number of buildings in the region. There are an estimated 1,073 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	1,246	1.06	200	0.89	162	1.56	72	2.61	33	3.06
Education	5	0.00	1	0.00	1	0.01	1	0.03	1	0.06
Government	46	0.04	13	0.06	19	0.19	15	0.53	9	0.81
Industrial	248	0.21	45	0.20	42	0.41	21	0.76	10	0.97
Other Residential	18,643	15.92	3,765	16.77	3,392	32.75	1,809	65.05	769	71.64
Religion	32	0.03	6	0.03	4	0.04	2	0.07	1	0.07
Single Family	96,852	82.73	18,416	82.04	6,735	65.04	861	30.96	251	23.40
Total	**117,075**		**22,447**		**10,356**		**2,782**		**1,073**	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	97,803	83.54	18772	83.63	6,642	64.14	754	27.10	238	22.23
Steel	610	0.52	105	0.47	99	0.96	45	1.61	18	1.65
Concrete	636	0.54	108	0.48	78	0.76	42	1.51	19	1.78
Precast	304	0.26	50	0.22	48	0.46	23	0.83	10	0.94
RM	3,650	3.12	407	1.81	399	3.85	181	6.50	38	3.57
URM	124	0.11	39	0.18	34	0.33	18	0.63	16	1.45
MH	13,948	11.91	2966	13.21	3,056	29.51	1,720	61.82	734	68.37
Total	**117,075**		**22,447**		**10,356**		**2,782**		**1,073**	

*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 1,196 hospital beds (84.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 93.00% of the beds will be back in service. By 30 days, 98.00% 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	1	0	10
Schools	173	0	0	154
EOCs	2	0	0	0
PoliceStations	24	0	0	21
FireStations	17	0	0	15

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	8	0	284	284
	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	1	0	6	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	2	0	3	5
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	22	1	0	21	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	0	0	3	3
Waste Water	8	1	0	6	8
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	6	0	0	6	6
Communication	42	8	0	41	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	1353	338
Waste Water	11,843	1070	268
Natural Gas	7,895	1144	286
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	15,109	9,160	0	0	0
Electric Power		13,526	8,465	3,532	690	19

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 6 ignitions that will burn about 0.11 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 58 people and burn about 2 (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 37.00% 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 (1,402 households to be displaced due to the earthquake. Of these, 348 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	7	2	0	1
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	23	6	1	2
	Industrial	15	4	1	1
	Other-Residential	235	51	5	9
	Single Family	126	18	1	2
	Total	**405**	**81**	**8**	**14**
2 PM	Commercial	429	119	19	38
	Commuting	0	0	1	0
	Educational	70	20	3	6
	Hotels	4	1	0	0
	Industrial	112	32	5	10
	Other-Residential	51	11	1	2
	Single Family	27	4	0	0
	Total	**694**	**187**	**30**	**57**
5 PM	Commercial	325	89	14	28
	Commuting	7	8	15	3
	Educational	9	3	0	1
	Hotels	7	2	0	0
	Industrial	70	20	3	6
	Other-Residential	86	19	2	3
	Single Family	49	7	0	1
	Total	**552**	**148**	**36**	**42**

Economic Loss

The total economic loss estimated for the earthquake is 1,211.07 (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 1,117.15 (millions of dollars); 13 % 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 62 % 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	9.36	35.04	2.11	3.62	50.14
	Capital-Related	0.00	4.00	33.46	1.27	0.38	39.12
	Rental	11.11	23.52	18.90	0.98	1.68	56.19
	Relocation	1.14	0.51	0.98	0.08	0.28	3.00
	Subtotal	**12.25**	**37.39**	**88.39**	**4.44**	**5.97**	**148.44**
Capital Stock Loses							
	Structural	58.93	33.45	41.38	10.48	6.29	150.53
	Non_Structural	277.31	153.13	116.30	36.43	22.25	605.41
	Content	83.70	32.56	54.39	24.20	10.57	205.42
	Inventory	0.00	0.00	2.06	5.21	0.07	7.35
	Subtotal	**419.94**	**219.15**	**214.13**	**76.32**	**39.17**	**968.71**
	Total	**432.19**	**256.54**	**302.51**	**80.76**	**45.14**	**1,117.15**

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	$3.63	0.76
	Tunnels	0.00	$0.00	0.00
	Subtotal	**5119.10**	**3.60**	
Railways	Segments	294.15	$0.00	0.00
	Bridges	1.46	$0.00	0.01
	Tunnels	0.00	$0.00	0.00
	Facilities	16.63	$2.57	15.45
	Subtotal	**312.20**	**2.60**	
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	$1.51	25.45
	Subtotal	**5.90**	**1.50**	
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	$10.52	8.05
	Runways	813.05	$0.00	0.00
	Subtotal	**943.70**	**10.50**	
	Total	**6381.00**	**18.20**	

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	$2.45	2.25
	Distribution Line	394.80	$6.09	1.54
	Subtotal	**503.64**	**$8.54**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	580.80	$38.24	6.59
	Distribution Line	236.90	$4.82	2.03
	Subtotal	**817.60**	**$43.06**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Line	157.90	$5.15	3.26
	Subtotal	**157.90**	**$5.15**	
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	$18.55	2.58
	Subtotal	**719.40**	**$18.55**	
Communication	Facilities	4.60	$0.39	8.46
	Subtotal	**4.58**	**$0.39**	
	Total	**2,203.13**	**$75.69**	

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

	LOSS	Total	%
First Year			
	Employment Impact	961	0.63
	Income Impact	(6)	-0.08
Second Year			
	Employment Impact	404	0.26
	Income Impact	(25)	-0.34
Third Year			
	Employment Impact	10	0.01
	Income Impact	(35)	-0.47
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(36)	-0.48
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(36)	-0.48
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(36)	-0.48

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

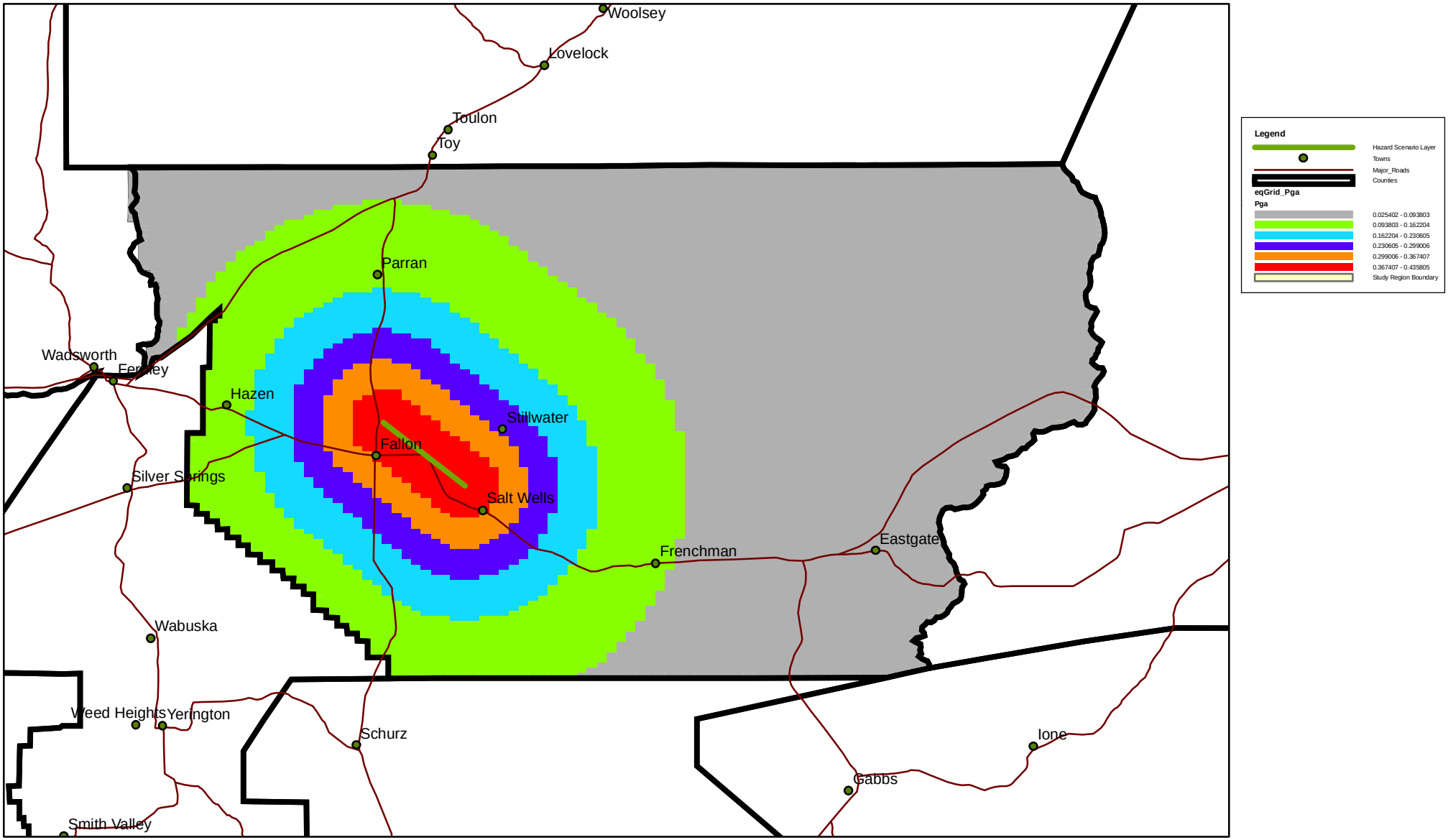
State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Nevada					
	Douglas	41,259	2,701	427	3,128
	Lyon	34,501	1,310	220	1,530
	Storey	3,399	164	22	186
	Washoe	339,486	17,626	3,778	21,405
	Carson	52,457	2,380	602	2,983
Total State		**471,102**	**24,181**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

Study Region new : Churchill County Hazus Run

R. Hess

Wednesday, July 13, 2005

Hazard Scenario : Fallon SS 6.5 Magnitude Earthquake



0 15 30 60 90 120 Kilometers

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