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Loss-Estimation Modeling of Earthquake Scenarios for Each County in Nevada Using HAZUS-MH

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**This information should be considered preliminary.
It has not been edited or checked for completeness
or accuracy**

Loss-Estimation Modeling of Earthquake Scenarios for Each County in Nevada Using HAZUS-MH

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One of the first pieces of information needed in disaster planning, preparedness, and response is a general estimate of potential damage and costs of an event, such as an earthquake. Nevada has a relatively high level of earthquake hazard, but that hazard is not evenly distributed throughout the state. The characteristics of the population, infrastructure, and societal resources vary dramatically across the state as well. In order to understand the potential consequences of earthquakes in Nevada, we have run an earthquake loss-estimation model (Level 1 of the Federal Emergency Management Agency's HAZUS-MH computer program) for each county seat. A fault that is a likely source of an earthquake was selected near each community. How often such an earthquake may occur, a parameter that varies from thousands to tens of thousands of years, was not considered in this study. In all cases we do not know when the next earthquake will occur, only that it will happen sometime. The earthquake scenario allows us to see what could happen when an earthquake does occur nearby.

HAZUS-MH is a standardized, nationally recognized software program that was designed for the Federal Emergency Management Agency to estimate losses from potential earthquakes and other disasters. It is used for exercises, planning efforts, and disaster declarations. HAZUS-MH estimates losses at three levels of accuracy, Levels 1, 2, and 3.

Level 1: A rough estimate based solely on data from national databases included in the HAZUS-MH software distribution. The national databases that come with HAZUS-MH include Census 2000 demographic data, building stock estimates, earthquake fault data, historical earthquake information, and national transportation and infrastructure data layers.

Level 2: A more accurate estimate based on professional judgment and detailed information on local geology, more up-to-date demographic data, and greater detail on the buildings and other infrastructure within the community that are input into HAZUS-MH at the local level.

Level 3: The most accurate estimate based on detailed engineering and geotechnical input into HAZUS-MH that develops into a customized methodology designed to the specific conditions of a community.

This report summarizes HAZUS-MH Level I analyses, which use the default national data set within the computer model. Level 1 analyses are crude, order-of-magnitude estimates that should be used for risk communication, conceptual preparation, and generalized planning (e.g., on a state level or for a disaster mitigation plan). For more detailed disaster or mitigation planning, a Level 2 or 3 analysis is needed. All county scenarios in this report were run using the WUS shallow crustal event-extensional attenuation function, an option within HAZUS-MH that is applicable in Nevada.

Table 1 lists the counties and county seats analyzed in this study. Table 2 shows the results of the HAZUS-MH runs for each county seat. This table shows both county-specific damage estimates as well as regional estimates. As expected, the potential losses vary dramatically across the state. Earthquakes considered range in magnitude from 6.5 to 7.5, the general range of historical damaging earthquakes in Nevada. Possible economic losses range from about $280,000 in Goldfield to $8.8 billion in Las Vegas.

Keep in mind these are only crude, order-of-magnitude estimates. That is, any given number may be off by a factor of as much as 10, although HAZUS runs for real earthquakes in recent years have been within a factor of two. Significant potential economic losses, on the order of tens of millions of dollars, are indicated for most communities in Nevada. Potential major building damage per event ranges from four buildings (in the Goldfield region) to 30,000 buildings (in the Las Vegas area). Unfortunately, an accurate inventory of building stock is not available for the Level 1 analysis and statistical estimates are usually used. Fatalities are extremely difficult to predict because they are dependent on time of day, what buildings or structures people are in, and how people behave. These factors can vary wildly and dramatically affect the number of casualties listed for a potential earthquake. There is no record of anyone being killed during a historical Nevada earthquake, but this is going to be a hard record to keep in the future. Possible fatalities in future earthquakes range from none to as many as 800 people. The number of people needing shelter, a critical issue in some weather situations in Nevada, ranges from none to 11,000. The different levels of potential earthquake consequences require different levels and types of preparedness across the state, and it is this needed visualization that makes these county seat scenarios of immediate value for the local communities and for state contingency planning.

Table 2 also includes, in the last two fields, the probability of experiencing an earthquake of a given size or greater over a 50-year period within 50 kilometers (31 miles) of the county seat. These data come from maps that were generated using the U.S. Geological Survey PSHA (Probabilistic Seismic Hazard Analysis) Model, which is presented at http://eqint.cr.usgs.gov/eq/html/eqprob.html. The actual maps that the values were taken from can be viewed online at www.nbmg.unr.edu/eqprob/eqprob.htm.

The attached reports include, for each county, a HAZUS-MH produced Pga (peak ground acceleration) ground motion map that shows the location of the selected scenario event for each county; a one-page summary estimating anticipated damages that would occur if the earthquake struck in the early afternoon; and a detailed summary listing the population, building stock, and infrastructure inventory that is at risk and the various impacts that the designated earthquake might have on these resources. The county Pga ground motion maps, located at the beginning of each county section, show the maximum acceleration (a measure of the intensity of shaking) that would be expected during the course of the earthquake, generally decreasing with distance from the hypocenter (initial rupture point of the earthquake). The hotter or redder colors on the map are the areas of strongest shaking from the scenario earthquake, and the cooler colors (blue, green, and gray) are areas of less shaking.

It is important to understand that while the summaries contained in this report are county specific, i.e., only showing the impacts that an earthquake will have on a single county; large earthquakes generally have regional effects that can cover many counties. So, in addition to the individual county summaries contained within this report, there are several regional summaries depicting the multi-county effects of an earthquake from a regional perspective. These include multi-county scenarios for events in Douglas County, Storey County, Washoe County and Carson City. The multi-county scenarios are located immediately following the single county scenario for each of the respective counties. Table 2 provides a quick comparison of the expected losses in the county alone versus the multi-county region.

"A Guide to Using HAZUS for Mitigation" is located at the end of this report. This guide, produced by the National Institute of Building Sciences for the Federal Emergency Management Agency, will help you understand and interpret the various types of information that HAZUS-MH produces. It also identifies various ways that communities can use this information for earthquake mitigation planning.

Table 1: List of Nevada County Seats.

CARSON CITY - STATE CAPITAL
CLARK COUNTY - Las Vegas
CHURCHILL COUNTY – Fallon
DOUGLAS COUNTY – Minden
ESMERALDA COUNTY – Goldfield
HUMBOLDT COUNTY – Winnemucca
LYON COUNTY - Yerington
WHITE PINE COUNTY – Ely
NYE COUNTY - Tonopah
ELKO COUNTY – Elko
EUREKA COUNTY – Eureka
LANDER COUNTY - Battle Mountain
LINCOLN COUNTY – Pioche
MINERAL COUNTY – Hawthorne
PERSHING COUNTY – Lovelock
STOREY COUNTY - Virginia City
WASHOE COUNTY - Reno

Table 2: Summary of loss-estimation output for earthquake scenarios that may affect counties in Nevada, using FEMA's HAZUS model.

County	County Seat	Earthquake Scenario Magnitude	Economic Loss (estimated in multi-county region) In billions of $	Building-Related Economic Loss (estimated in county alone)	Buildings with Major Damage (estimated in multi-county region)	Buildings with Major Damage (estimated in county alone)	Fatalities (estimated in multi-county region)	Fatalities (estimated in county alone)	Number of People Needing Public Shelter (estimated in multi-county region)	Number of People Needing Public Shelter (estimated in county alone)	Earthquake Magnitude (for comparison with probabilities)	Estimated Probability of Occurring within 50 years within 50 km (1)
Carson City	Carson City	6.5	0.6 to 2.2	$665 million	~3,900	~2,800	30 to 110	20 to 100	170 to 700	140 to 600	6.5 6.0	50-55% ~70%
Churchill	Fallon	6.5	0.0 to 0.2	$85 million	~400	~400	< 20	1 to 3	10 to 50	10 to 50	6.5 6.0	20-25% 30-40%
Clark	Las Vegas	6.6	4.4 to 17.7	$8.8 billion	~30,000	~30,000	200 to 800	200 to 800	3,000 to 11,000	3,000 to 11,000	6.5 6.0	<5% 10-20%
Douglas	Minden	7.1	0.6 to 2.5	$471 million	~3,600	~1,300	30 to 120	10 to 50	150 to 600	50 to 190	7.0 6.5 6.0	10-12% 50-60% 60-70%
Elko	Elko	6.5	0.1 to 0.4	$224 million	~900	~900	10 to 40	10 to 40	40 to 150	40 to 150	6.5 6.0	6-8% 10-15%
Esmeralda	Goldfield	6.7	< 0.1	$280 thousand	~4	~2	none	none	none	none	6.5 6.0	5-10% 20-30%
Eureka	Eureka	7.2	< 0.1	$4.1 million	~100	~50	none	none	none	none	7.0 6.5 6.0	<0.5% 4-6% 10-15%
Humboldt	Winnemucca	6.5	0.0 to 0.1	$56 million	~600	~600	< 20	1 to 3	10 to 30	10 to 30	6.5 6.0	5-10% 15-20%
Lander	Battle Mountain	7.5	0.0 to 0.1	$74 million	~1,200	~1,200	< 20	3 to 6	10 to 20	10 to 20	7.5 7.0 6.5 6.0	0.1-0.2% ~1.5% ~10% 15-20%
Lincoln	Pioche	6.5	< 0.1	$5.6 million	~40	~40	none	none	none	none	6.5 6.0	2-3% 6-10%
Lyon	Yerington	6.9	0.0 to 0.2	$88 million	~800	~800	< 20	1 to 3	10 to 30	10 to 30	7.0 6.5 6.0	12% 40-45% ~60%
Mineral	Hawthorne	7.5	0.0 to 0.2	$78 million	~700	~700	< 20	2 to 4	10 to 40	10 to 40	7.5 7.0 6.5 6.0	<0.5% 10-12% 30-40% ~60%
Nye	Tonopah	7.0	< 0.1	$440 thousand	~140	~1	none	none	none	none	7.0 6.5 6.0	<1% 5-10% 20-30%
Pershing	Lovelock	7.3	0.0 to 0.1	$61 million	~800	~800	< 20	2 to 4	10 to 20	10 to 20	7.5 7.0 6.5 6.0	~0.1% 1-2% ~10% 10-20%
Storey	Virginia City	6.5	0.6 to 2.5	$8.5 million	~3,500	~70	20 to 90	none	200 to 800	none	6.5 6.0	50% 65-70%
Washoe	Reno	6.9	1.9 to 7.6	$2.9 billion	~12,000	~8,200	120 to 500	80 to 300	800 to 3,000	600 to 3,000	7.0 6.5 6.0	12-15% ~50% 65-70%
White Pine	Ely	6.8	0.0 to 0.2	$79 million	~400	~400	< 20	1 to 4	10 to 30	10 to 30	7.0 6.5 6.0	<0.5% 1.5-2% 4-6%

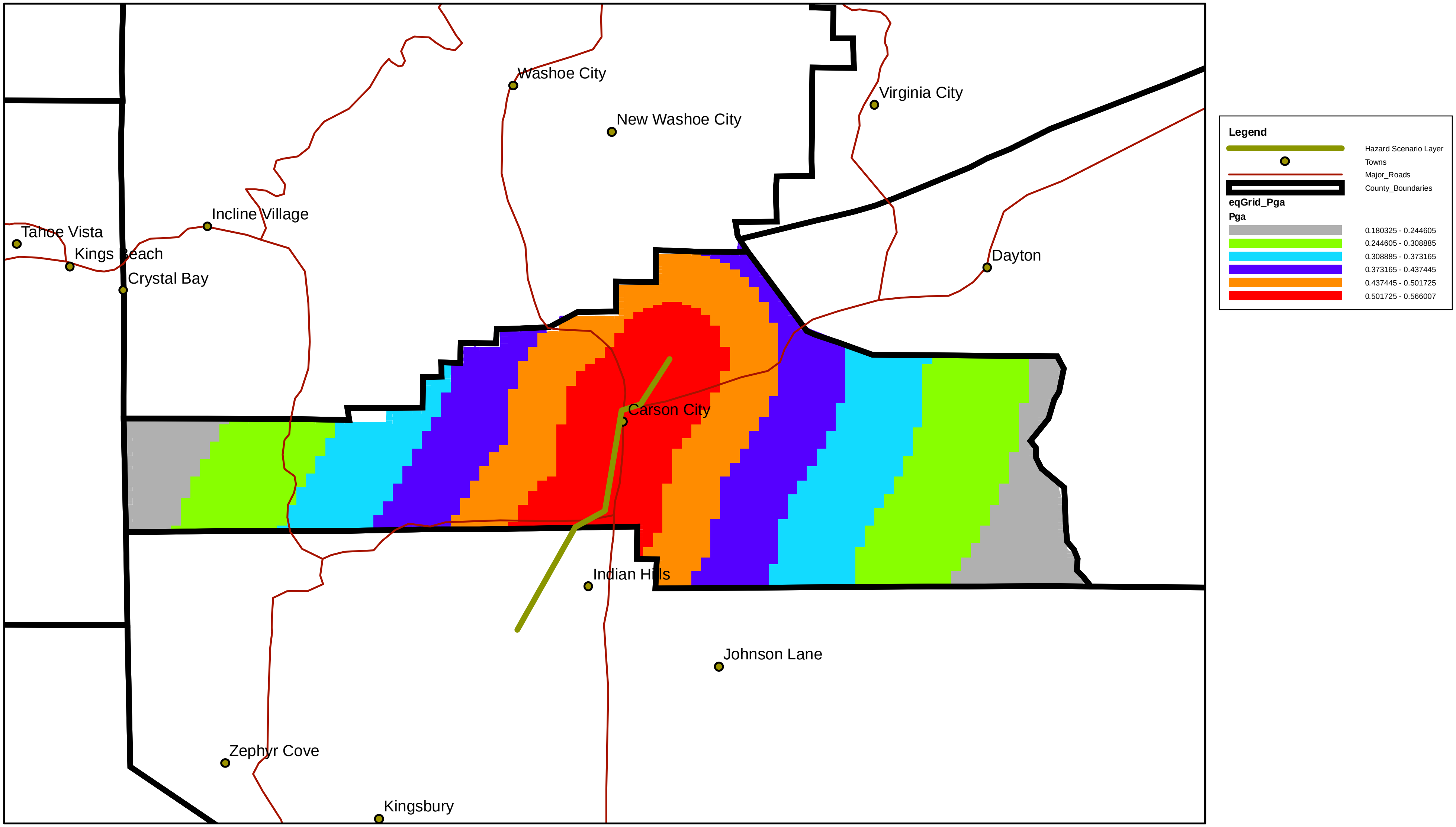
(1) Please refer to http://www.nbmg.unr.edu/eqprob/eqprob.htm for details on earthquake probabilities estimated by the U.S. Geological Survey.

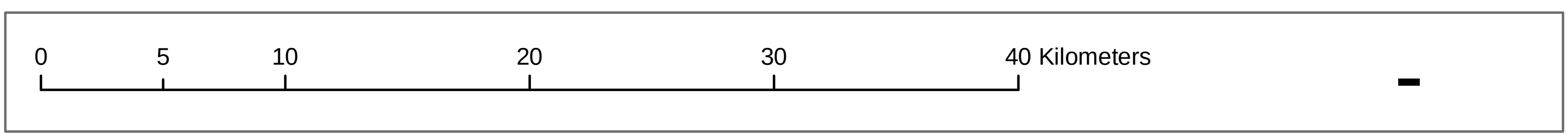
Study Region new : Carson City Hazus Run

R. Hess

Monday, July 25, 2005

Hazard Scenario : Carson City Fault M6.5





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 :

HAZUS-MH: Earthquake Event Report

Region Name: ***Carson_City_Hazus***

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

Print Date: ***July 25, 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 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

		# Facilities		
Classification	**Total**	**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

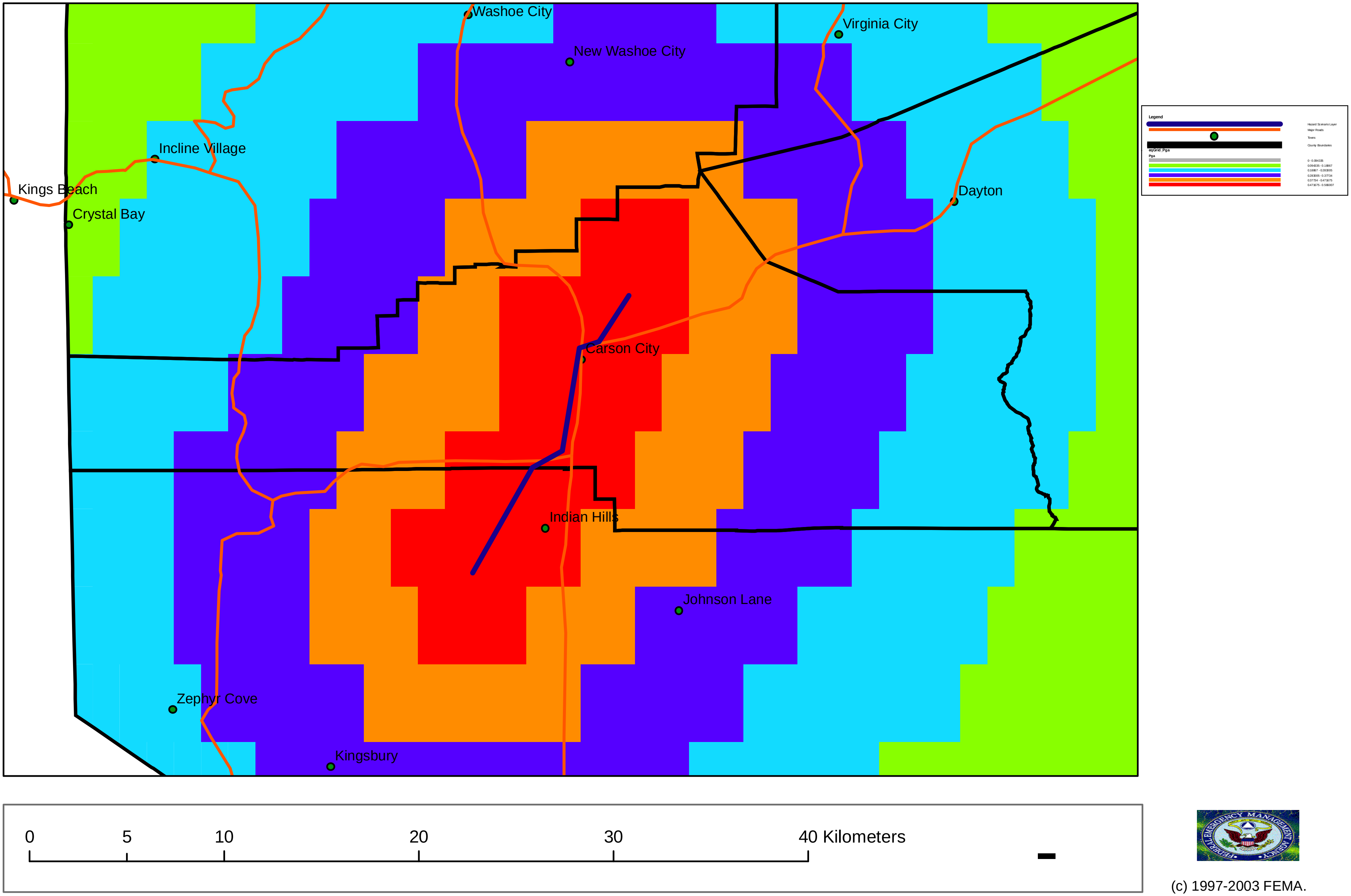
State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Nevada					
	Carson	52,457	2,380	602	2,983
Total State		**52,457**	**2,380**	**602**	**2,983**
Total Region		**52,457**	**2,380**	**602**	**2,983**

Study Region new : Carson City Regional Scenario

R. Hess

Monday, July 25, 2005

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



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 :

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.

Table of Contents

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

		# Facilities		
Classification	Total	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

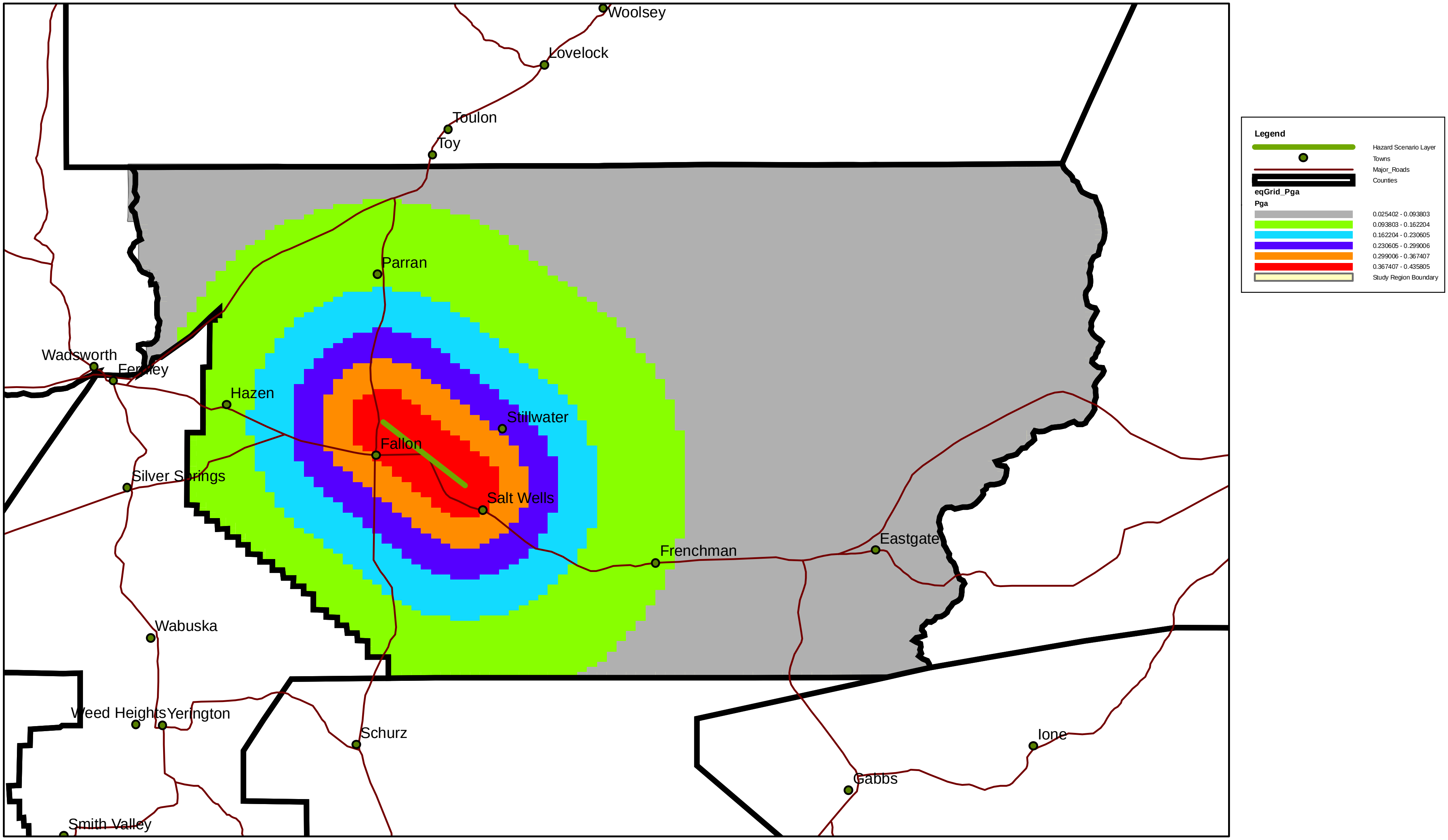
State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Nevada					
	Douglas	41,259	2,701	427	3,128
	Lyon	34,501	1,310	220	1,530
	Storey	3,399	164	22	186
	Washoe	339,486	17,626	3,778	21,405
	Carson	52,457	2,380	602	2,983
Total State		**471,102**	**24,181**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

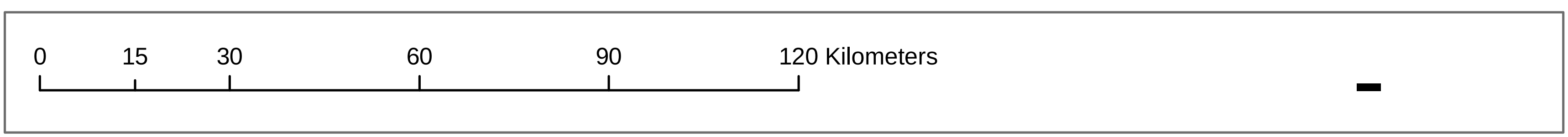
Study Region new : Churchill County Hazus Run

R. Hess

Wednesday, July 13, 2005

Hazard Scenario : Fallon SS 6.5 Magnitude Earthquake





HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	0.00 - 0.10
	Building Contents	< 0.1
	Business Interruption	< 0.1
Infrastructure	Lifelines Damage	
	Total	0.00 - 0.20

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	1 - 6	< 1.0	< 1.0	1 - 6
Major	< 1.0	< 1.0	< 1.0	< 1.0
Total	1 - 7	< 1.0	< 1.0	1 - 7

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	20 - 90
Level 2	Hospital Care	< 20
Level 3	Life-threatening	< 20
Level 4	Fatalities	< 20

Estimated Shelter Needs

Type	Households	People
Displaced Households	50 - 200	
Public Shelter		10 - 50

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 :
39.48 / -118.69

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: 23,982

Building Exposure : ($ Millions)

Residential	1,015
Commerical	135
Other	37
Total	1,187

State:

Counties :
- Churchill,NV

Major Metro Area :

Time of report: July 13, 2005 5:34 pm

HAZUS-MH: Earthquake Event Report

Region Name: *Churchill_Hazus*

Earthquake Scenario: *Fallon SS 6.5*

Print Date: *July 13, 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

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 5,017.12 square miles and contains 7 census tracts. There are over 8 thousand households in the region and has a total population of 23,982 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 8 thousand buildings in the region with a total building replacement value (excluding contents) of 1, 188 (millions of dollars). Approximately 99.00 % of the buildings (and 85.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,292 and 312 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 8 thousand buildings in the region which have an aggregate total replacement value of 1, 188 (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 68% 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 40 beds. There are 10 schools, 2 fire stations, 2 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 11 dams identified within the region. Of these, 1 of the dams are classified as 'high hazard'. The inventory also includes 4 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 2,604.00 (millions of dollars). This inventory includes over 529 kilometers of highways, 43 bridges, 13,572 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	43	17.10
	Segments	32	1,934.40
	Tunnels	0	0.00
		Subtotal	**1,951.60**
Railways	Bridges	0	0.00
	Facilities	0	0.00
	Segments	55	108.00
	Tunnels	0	0.00
		Subtotal	**108.00**
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	5	29.70
	Runways	6	203.30
		Subtotal	**233.00**
		Total	**2,292.50**

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	135.70
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**135.70**
Waste Water	Distribution Lines	NA	81.40
	Facilities	1	72.60
	Pipelines	0	0.00
		Subtotal	**154.00**
Natural Gas	Distribution Lines	NA	54.30
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**54.30**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	2	239.80
		Subtotal	**239.80**
Communication	Facilities	2	0.20
		Subtotal	**0.20**
		Total	**584.10**

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	Fallon SS 6.5
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-118.69
Latitude of Epicenter	39.48
Earthquake Magnitude	6.50
Depth (Km)	8.00
Rupture Length (Km)	18.20
Rupture Orientation (degrees)	135.00
Attenuation Function	WUS Shallow Crustal Event - Extensional

Building Damage

Building Damage

HAZUS estimates that about 1,502 buildings will be at least moderately damaged. This is over 18.00 % of the total number of buildings in the region. There are an estimated 77 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	24	0.50	13	0.62	15	1.38	8	2.40	3	3.83
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	3	0.07	1	0.04	1	0.09	1	0.16	0	0.26
Industrial	2	0.05	1	0.03	1	0.05	0	0.08	0	0.10
Other Residential	1,134	23.33	502	24.56	564	51.25	269	82.95	64	82.39
Religion	1	0.01	1	0.03	1	0.05	0	0.09	0	0.13
Single Family	3,694	76.03	1,528	74.72	519	47.18	46	14.33	10	13.29
Total	**4,858**		**2,045**		**1,100**		**324**		**77**	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	3,628	74.68	1554	75.97	512	46.57	38	11.60	10	12.90
Steel	8	0.17	5	0.26	8	0.77	5	1.41	1	1.67
Concrete	9	0.19	7	0.36	7	0.62	4	1.15	1	1.51
Precast	5	0.11	2	0.09	2	0.22	1	0.41	0	0.54
RM	123	2.53	31	1.52	36	3.26	15	4.58	2	2.62
URM	1	0.02	1	0.04	2	0.15	2	0.52	2	2.37
MH	1,084	22.30	445	21.75	533	48.40	261	80.33	61	78.39
Total	**4,858**		**2,045**		**1,100**		**324**		**77**	

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

Essential Facility Damage

Before the earthquake, the region had 40 hospital beds available for use. On the day of the earthquake, the model estimates that only 7 hospital beds (20.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 56.00% of the beds will be back in service. By 30 days, 91.00% will be operational.

Table 6: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**At Least Moderate Damage > 50%**	**Complete Damage > 50%**	**With Functionality > 50% on day 1**
Hospitals	1	0	0	0
Schools	10	0	0	0
EOCs	0	0	0	0
PoliceStations	2	0	0	0
FireStations	2	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	32	0	0	32	32
	Bridges	43	6	0	37	40
	Tunnels	0	0	0	0	0
Railways	Segments	55	0	0	55	55
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
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	5	1	0	5	5
	Runways	6	0	0	6	6

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	2	1	0	1	2
Communication	2	2	0	2	2

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	6,786	363	91
Waste Water	4,072	287	72
Natural Gas	2,715	306	77
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	8,912	28	0	0	0	0
Electric Power		0	0	0	0	0

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 0.01 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 27 people and burn about 1 (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 41.00% 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 (100 households to be displaced due to the earthquake. Of these, 25 people (out of a total population of 23,982 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	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	1	0	0	0
	Industrial	0	0	0	0
	Other-Residential	25	5	0	1
	Single Family	9	1	0	0
	Total	**35**	**7**	**1**	**1**
2 PM	Commercial	30	8	1	3
	Commuting	0	0	0	0
	Educational	5	1	0	0
	Hotels	0	0	0	0
	Industrial	2	1	0	0
	Other-Residential	5	1	0	0
	Single Family	2	0	0	0
	Total	**44**	**11**	**2**	**3**
5 PM	Commercial	23	6	1	2
	Commuting	2	3	5	1
	Educational	1	0	0	0
	Hotels	0	0	0	0
	Industrial	1	0	0	0
	Other-Residential	9	2	0	0
	Single Family	3	0	0	0
	Total	**40**	**12**	**6**	**3**

Economic Loss

The total economic loss estimated for the earthquake is 134.40 (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 85.48 (millions of dollars); 15 % 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 63 % 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	0.42	4.02	0.04	0.15	4.63
	Capital-Related	0.00	0.18	3.59	0.04	0.02	3.82
	Rental	0.75	1.73	1.43	0.02	0.08	4.01
	Relocation	0.08	0.05	0.08	0.00	0.01	0.23
	Subtotal	**0.83**	**2.38**	**9.13**	**0.10**	**0.26**	**12.69**
Capital Stock Loses							
	Structural	3.75	3.65	3.36	0.32	0.36	11.45
	Non_Structural	19.38	14.81	9.79	1.07	1.12	46.18
	Content	6.02	3.02	4.63	0.70	0.50	14.86
	Inventory	0.00	0.00	0.19	0.11	0.01	0.31
	Subtotal	**29.16**	**21.48**	**17.97**	**2.20**	**1.99**	**72.80**
	Total	**29.98**	**23.86**	**27.10**	**2.30**	**2.25**	**85.48**

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	1,934.44	$0.00	0.00
	Bridges	17.14	$1.03	6.03
	Tunnels	0.00	$0.00	0.00
	Subtotal	**1951.60**	**1.00**	
Railways	Segments	107.98	$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	**108.00**	**0.00**	
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	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	29.70	$5.50	18.50
	Runways	203.26	$0.00	0.00
	Subtotal	**233.00**	**5.50**	
	Total	**2292.50**	**6.50**	

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	135.70	$1.63	1.20
	Subtotal	**135.73**	**$1.63**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	72.60	$16.83	23.19
	Distribution Line	81.40	$1.29	1.58
	Subtotal	**154.03**	**$18.12**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Line	54.30	$1.38	2.54
	Subtotal	**54.29**	**$1.38**	
Oil Systems	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
Electrical Power	Facilities	239.80	$21.21	8.84
	Subtotal	**239.80**	**$21.21**	
Communication	Facilities	0.20	$0.05	21.19
	Subtotal	**0.22**	**$0.05**	
	Total	**584.06**	**$42.38**	

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	(1)	-0.26
Second Year			
	Employment Impact	0	0.00
	Income Impact	(2)	-0.78
Third Year			
	Employment Impact	0	0.00
	Income Impact	(3)	-1.00
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(3)	-1.00
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(3)	-1.00
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(3)	-1.00

Appendix A: County Listing for the Region

Churchill,NV

Appendix B: Regional Population and Building Value Data

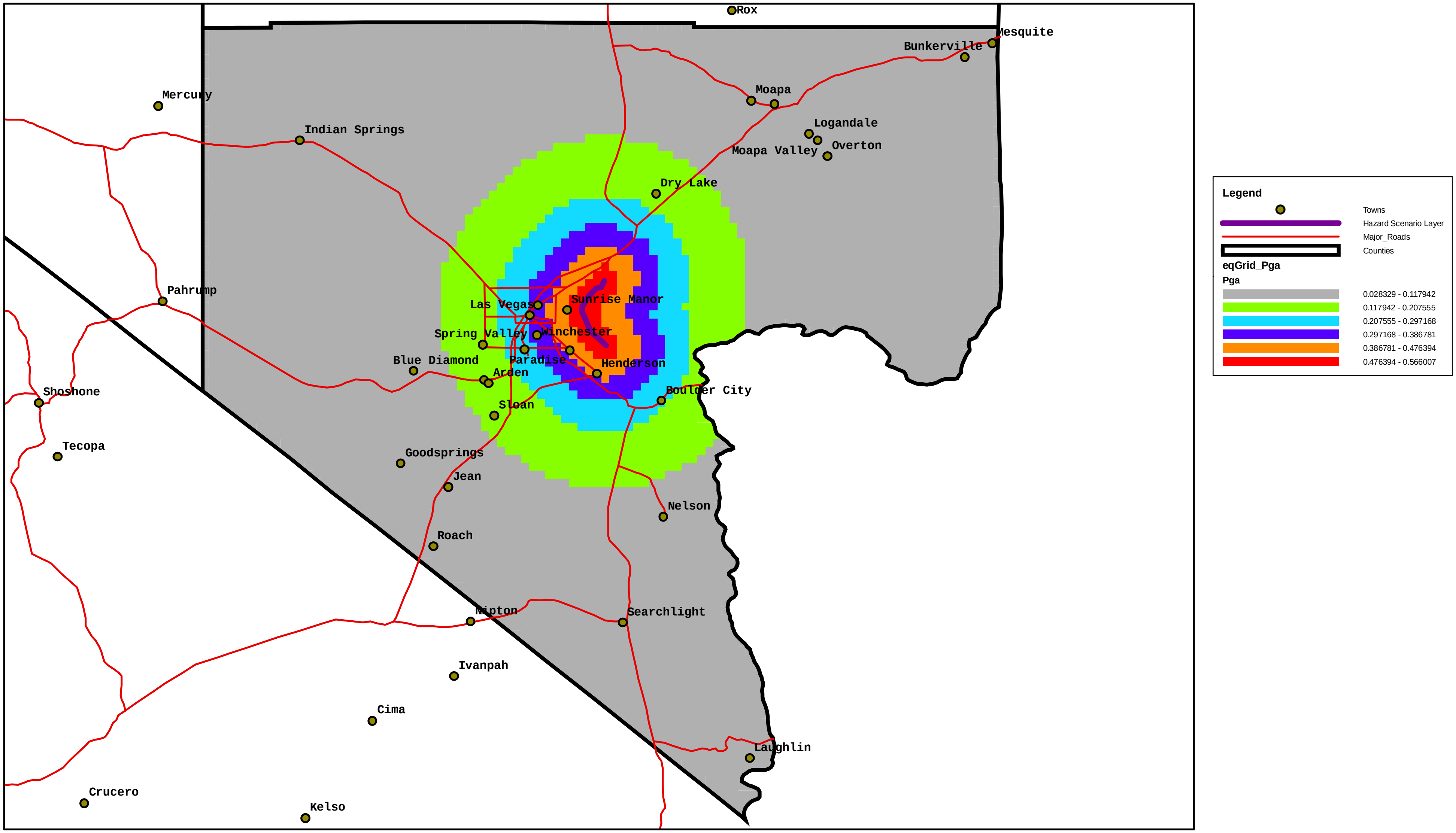
State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Nevada					
	Churchill	23,982	1,015	172	1,188
Total State		**23,982**	**1,015**	**172**	**1,188**
Total Region		**23,982**	**1,015**	**172**	**1,188**

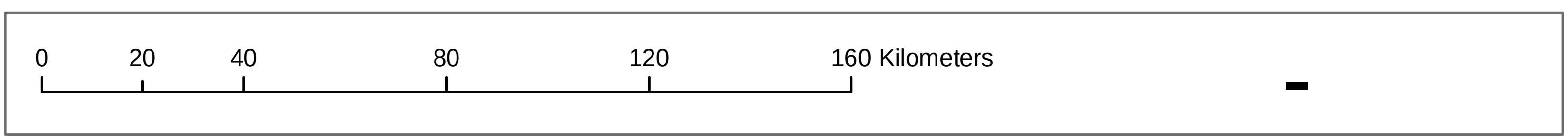
Study Region new : Las Vegas, Clark County, Nevada Scenario

R. Hess

Monday, June 13, 2005

Hazard Scenario : Frenchman Mtn. Fault 6.6M Earthquake





HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	3.00 - 12.10
	Building Contents	0.10 - 0.50
	Business Interruption	0.70 - 2.70
Infrastructure	Lifelines Damage	
	Total	4.40 - 17.70

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	80 - 300	1 - 4	< 1.0	80 - 300
Major	14 - 60	0 - 2	< 1.0	14 - 60
Total	90 - 400	1 - 6	< 1.0	90 - 400

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	3,000 - 11,000
Level 2	Hospital Care	700 - 3,000
Level 3	Life-threatening	100 - 400
Level 4	Fatalities	200 - 800

Estimated Shelter Needs

Type	Households	People
Displaced Households	10,000 - 40,000	
Public Shelter		3,000 - 11,000

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 : 6.60

Epicenter Latitude/Longitude :
36.20 / -115.02

Depth & Type :0.00/S

Fault Name :
Frenchman Mountain 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: 1,375,765

Building Exposure : ($ Millions)

Residential	72,638
Commerical	9,832
Other	1,817
Total	84,287

State:

Counties :
- Clark,NV

Major Metro Area :

Time of report: November 09, 2005 1:17 pm

HAZUS-MH: Earthquake Event Report

Region Name: *Clark_Hazus*

Earthquake Scenario: *Frenchman Mtn. Fault 6.6M*

Print Date: *June 13, 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

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 8,086.61 square miles and contains 345 census tracts. There are over 512 thousand households in the region and has a total population of 1,375,765 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 383 thousand buildings in the region with a total building replacement value (excluding contents) of 84,288 (millions of dollars). Approximately 99.00 % of the buildings (and 86.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 7,303 and 1,652 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 383 thousand buildings in the region which have an aggregate total replacement value of 84,288 (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 86% 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 15 hospitals in the region with a total bed capacity of 2,874 beds. There are 302 schools, 11 fire stations, 21 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 69 dams identified within the region. Of these, 43 of the dams are classified as 'high hazard'. The inventory also includes 43 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 8,955.00 (millions of dollars). This inventory includes over 1,239 kilometers of highways, 423 bridges, 33,679 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	423	1,127.70
	Segments	87	5,231.50
	Tunnels	0	0.00
		Subtotal	**6,359.30**
Railways	Bridges	17	2.40
	Facilities	5	11.90
	Segments	99	226.30
	Tunnels	0	0.00
		Subtotal	**240.60**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	4	4.80
		Subtotal	**4.80**
Ferry	Facilities	0	0.00
		Subtotal	**0.00**
Port	Facilities	0	0.00
		Subtotal	**0.00**
Airport	Facilities	15	89.10
	Runways	18	609.80
		Subtotal	**698.90**
		Total	**7,303.50**

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	336.80
	Facilities	1	36.30
	Pipelines	0	0.00
		Subtotal	**373.10**
Waste Water	Distribution Lines	NA	202.10
	Facilities	4	290.40
	Pipelines	0	0.00
		Subtotal	**492.50**
Natural Gas	Distribution Lines	NA	134.70
	Facilities	1	1.20
	Pipelines	0	0.00
		Subtotal	**135.90**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	11	1,318.90
		Subtotal	**1,318.90**
Communication	Facilities	50	5.50
		Subtotal	**5.50**
		Total	**2,325.80**

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	Frenchman Mtn. Fault 6.6M
Type of Earthquake	Source
Fault Name	Frenchman Mountain fault
Historical Epicenter ID #	795
Probabilistic Return Period	NA
Longitude of Epicenter	-115.02
Latitude of Epicenter	36.20
Earthquake Magnitude	6.60
Depth (Km)	0.00
Rupture Length (Km)	21.58
Rupture Orientation (degrees)	0.00
Attenuation Function	WUS Shallow Crustal Event - Extensional

Building Damage

Building Damage

HAZUS estimates that about 90,944 buildings will be at least moderately damaged. This is over 24.00 % of the total number of buildings in the region. There are an estimated 6,771 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	5	0.00	1	0.00	1	0.00	1	0.00	0	0.00
Commercial	1,338	0.67	783	0.85	1,270	2.07	815	3.56	284	4.20
Education	1	0.00	1	0.00	1	0.00	0	0.00	0	0.00
Government	24	0.01	15	0.02	28	0.05	21	0.09	10	0.14
Industrial	89	0.04	61	0.07	105	0.17	73	0.32	31	0.46
Other Residential	16,748	8.33	9,953	10.83	13,484	22.00	10,095	44.13	4,283	63.25
Religion	29	0.01	18	0.02	27	0.04	19	0.08	8	0.11
Single Family	182,881	90.93	81,030	88.21	46,382	75.67	11,851	51.81	2,156	31.83
Total	**201,114**		**91,862**		**61,298**		**22,875**		**6,771**	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	187,744	93.35	84509	92.00	46,853	76.43	10,441	45.64	1,514	22.35
Steel	554	0.28	298	0.32	660	1.08	526	2.30	268	3.96
Concrete	720	0.36	448	0.49	689	1.12	417	1.82	134	1.97
Precast	207	0.10	109	0.12	248	0.40	238	1.04	96	1.42
RM	4,665	2.32	1513	1.65	2,983	4.87	2,577	11.27	873	12.90
URM	189	0.09	130	0.14	172	0.28	124	0.54	96	1.42
MH	7,034	3.50	4855	5.29	9,692	15.81	8,552	37.39	3,790	55.97
Total	**201,114**		**91,862**		**61,298**		**22,875**		**6,771**	

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

Essential Facility Damage

Before the earthquake, the region had 2,874 hospital beds available for use. On the day of the earthquake, the model estimates that only 721 hospital beds (25.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 54.00% of the beds will be back in service. By 30 days, 89.00% will be operational.

Table 6: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	15	6	0	1
Schools	302	14	0	144
EOCs	0	0	0	0
PoliceStations	21	0	0	8
FireStations	11	0	0	6

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	87	0	0	87	87
	Bridges	423	6	0	417	419
	Tunnels	0	0	0	0	0
Railways	Segments	99	0	0	99	99
	Bridges	17	0	0	17	17
	Tunnels	0	0	0	0	0
	Facilities	5	2	0	5	5
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	4	0	0	4	4
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	15	1	0	15	15
	Runways	18	0	0	18	18

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	1	1	0	0	1
Waste Water	4	3	0	1	4
Natural Gas	1	0	0	1	1
Oil Systems	0	0	0	0	0
Electrical Power	11	7	0	3	11
Communication	50	19	0	50	50

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	16,840	2317	579
Waste Water	10,104	1832	458
Natural Gas	6,736	1959	490
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	512,253	48,975	39,995	23,917	0	0
Electric Power		45,384	26,147	9,686	1,704	68

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 36 ignitions that will burn about 0.36 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 1,413 people and burn about 64 (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 3.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 31.00% 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 120,000 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 (20, 148 households to be displaced due to the earthquake. Of these, 5,499 people (out of a total population of 1,375,765 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	49	13	2	4
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	204	48	7	13
	Industrial	63	17	3	5
	Other-Residential	2,107	482	51	96
	Single Family	1,180	193	15	27
	Total	**3,603**	**753**	**77**	**146**
2 PM	Commercial	3,515	942	150	293
	Commuting	1	1	2	0
	Educational	415	115	19	37
	Hotels	39	9	1	3
	Industrial	464	125	19	38
	Other-Residential	550	125	13	25
	Single Family	273	44	4	6
	Total	**5,257**	**1,362**	**208**	**401**
5 PM	Commercial	2,730	739	118	229
	Commuting	15	21	34	7
	Educational	49	13	2	4
	Hotels	61	14	2	4
	Industrial	290	78	12	23
	Other-Residential	785	180	20	36
	Single Family	460	75	6	10
	Total	**4,389**	**1,121**	**194**	**314**

Economic Loss

The total economic loss estimated for the earthquake is 9,216.38 (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 8,829.70 (millions of dollars); 15 % 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 69 % 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	113.20	317.87	7.07	6.16	444.29
	Capital-Related	0.00	48.34	303.76	4.20	1.51	357.81
	Rental	94.35	281.60	156.16	2.37	3.61	538.08
	Relocation	9.87	5.10	8.34	0.25	0.93	24.50
	Subtotal	**104.22**	**448.24**	**786.13**	**13.89**	**12.21**	**1,364.68**
Capital Stock Loses							
	Structural	522.02	331.43	367.32	40.39	25.69	1,286.86
	Non_Structural	2,178.58	1,549.94	837.10	115.92	62.66	4,744.20
	Content	610.34	334.06	364.24	70.12	27.35	1,406.11
	Inventory	0.00	0.00	12.98	14.45	0.41	27.84
	Subtotal	**3,310.95**	**2,215.43**	**1,581.65**	**240.88**	**116.11**	**7,465.02**
	Total	**3,415.17**	**2,663.67**	**2,367.78**	**254.77**	**128.31**	**8,829.70**

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	5,231.54	$0.00	0.00
	Bridges	1,127.73	$27.23	2.41
	Tunnels	0.00	$0.00	0.00
	Subtotal	**6359.30**	**27.20**	
Railways	Segments	226.31	$0.00	0.00
	Bridges	2.36	$0.03	1.08
	Tunnels	0.00	$0.00	0.00
	Facilities	11.88	$2.10	17.64
	Subtotal	**240.60**	**2.10**	
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	4.75	$1.15	24.22
	Subtotal	**4.80**	**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	89.11	$9.17	10.29
	Runways	609.79	$0.00	0.00
	Subtotal	**698.90**	**9.20**	
	Total	**7303.50**	**39.70**	

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	36.30	$7.49	20.62
	Distribution Line	336.80	$10.43	3.10
	Subtotal	**373.09**	**$17.91**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	290.40	$62.98	21.69
	Distribution Line	202.10	$8.25	4.08
	Subtotal	**492.45**	**$71.22**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	1.20	$0.00	0.23
	Distribution Line	134.70	$8.81	6.54
	Subtotal	**135.91**	**$8.82**	
Oil Systems	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
Electrical Power	Facilities	1,318.90	$248.45	18.84
	Subtotal	**1,318.90**	**$248.45**	
Communication	Facilities	5.50	$0.61	11.16
	Subtotal	**5.45**	**$0.61**	
	Total	**2,325.81**	**$347.02**	

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

	LOSS	Total	%
First Year			
	Employment Impact	72,199	16.90
	Income Impact	138	0.72
Second Year			
	Employment Impact	31,806	7.45
	Income Impact	(87)	-0.45
Third Year			
	Employment Impact	775	0.18
	Income Impact	(245)	-1.28
Fourth Year			
	Employment Impact	42	0.01
	Income Impact	(282)	-1.47
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(284)	-1.48
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(284)	-1.48

Appendix A: County Listing for the Region

Clark,NV

Appendix B: Regional Population and Building Value Data

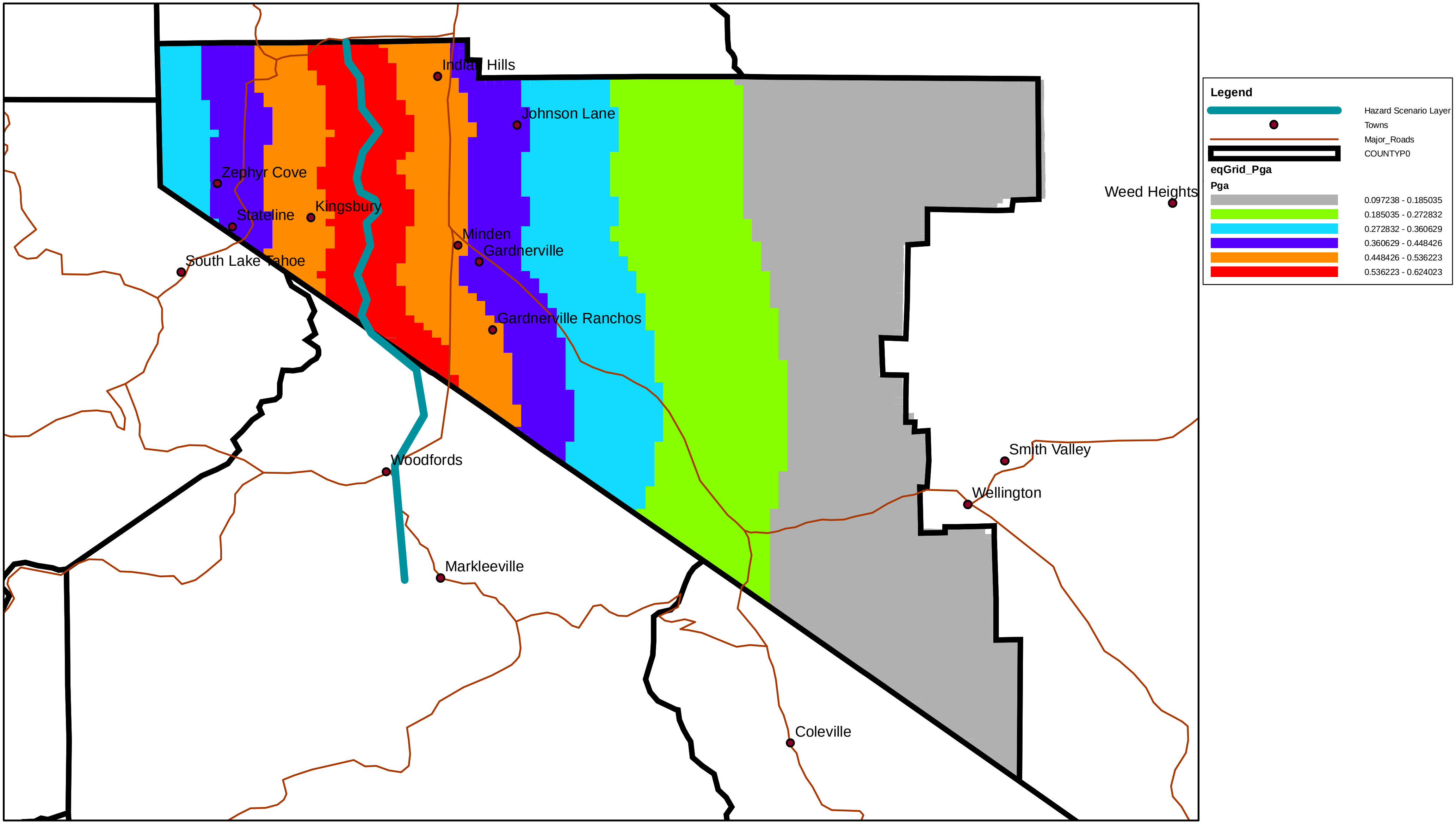
State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Nevada					
	Clark	1,375,765	72,638	11,650	84,288
Total State		**1,375,765**	**72,638**	**11,650**	**84,288**
Total Region		**1,375,765**	**72,638**	**11,650**	**84,288**

Study Region new : Douglas County - Genoa Fault Scenario

R. Hess

Tuesday, August 23, 2005

Hazard Scenario : Minden - Genoa Fault M7.1



HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	0.20 - 0.60
	Building Contents	< 0.1
	Business Interruption	0.00 - 0.20
Infrastructure	Lifelines Damage	
	Total	0.20 - 0.90

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	4 - 19	< 1.0	< 1.0	4 - 19
Major	0 - 2	< 1.0	< 1.0	0 - 2
Total	5 - 20	< 1.0	< 1.0	5 - 20

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	150 - 600
Level 2	Hospital Care	40 - 170
Level 3	Life-threatening	10 - 30
Level 4	Fatalities	10 - 50

Estimated Shelter Needs

Type	Households	People
Displaced Households	200 - 800	
Public Shelter		50 - 190

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 : 7.10

Epicenter Latitude/Longitude :
38.96 / -119.84

Depth & Type :0.00/S

Fault Name :
Carson Range 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: 41,259

Building Exposure : ($ Millions)

Residential	2,701
Commerical	310
Other	116
Total	3,127

State:

Counties :
- Douglas,NV

Major Metro Area :

Time of report: July 26, 2005 2:23 pm

HAZUS-MH: Earthquake Event Report

Region Name: ***Douglas_Hazus***

Earthquake Scenario: ***Minden - Genoa Fault M7.1***

Print Date: ***July 26, 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

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 736.84 square miles and contains 10 census tracts. There are over 16 thousand households in the region and has a total population of 41,259 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 17 thousand buildings in the region with a total building replacement value (excluding contents) of 3, 128 (millions of dollars). Approximately 99.00 % of the buildings (and 86.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 879 and 0 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 17 thousand buildings in the region which have an aggregate total replacement value of 3, 128 (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 86% 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 0 hospitals in the region with a total bed capacity of 0 beds. There are 12 schools, 3 fire stations, 4 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 22 dams identified within the region. Of these, 10 of the dams are classified as 'high hazard'. The inventory also includes 9 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 879.00 (millions of dollars). This inventory includes over 184 kilometers of highways, 29 bridges, 4,626 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	29	16.80
	Segments	25	777.60
	Tunnels	0	0.00
		Subtotal	**794.40**
Railways	Bridges	0	0.00
	Facilities	2	4.80
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**4.80**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	1	1.20
		Subtotal	**1.20**
Ferry	Facilities	0	0.00
		Subtotal	**0.00**
Port	Facilities	0	0.00
		Subtotal	**0.00**
Airport	Facilities	2	11.90
	Runways	2	67.80
		Subtotal	**79.60**
		Total	**880.00**

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	46.30
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**46.30**
Waste Water	Distribution Lines	NA	27.80
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**27.80**
Natural Gas	Distribution Lines	NA	18.50
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**18.50**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	0	0.00
		Subtotal	**0.00**
Communication	Facilities	2	0.20
		Subtotal	**0.20**
		Total	**92.80**

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	Minden - Genoa Fault M7.1
Type of Earthquake	Source
Fault Name	Carson Range fault
Historical Epicenter ID #	763
Probabilistic Return Period	NA
Longitude of Epicenter	-119.84
Latitude of Epicenter	38.96
Earthquake Magnitude	7.10
Depth (Km)	0.00
Rupture Length (Km)	50.58
Rupture Orientation (degrees)	0.00
Attenuation Function	WUS Shallow Crustal Event - Extensional

Building Damage

Building Damage

HAZUS estimates that about 5,333 buildings will be at least moderately damaged. This is over 31.00 % of the total number of buildings in the region. There are an estimated 382 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	39	0.63	25	0.43	41	1.02	27	2.89	15	3.85
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	1	0.02	1	0.01	1	0.03	1	0.07	0	0.10
Industrial	10	0.15	5	0.09	9	0.22	6	0.62	3	0.91
Other Residential	511	8.20	422	7.29	568	14.17	418	44.40	219	57.20
Religion	4	0.06	2	0.03	2	0.05	1	0.14	1	0.16
Single Family	5,668	90.93	5,334	92.14	3,389	84.52	489	51.87	144	37.79
Total	**6,233**		**5,789**		**4,009**		**942**		**382**	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	5,633	90.37	5409	93.43	3,368	84.00	431	45.72	135	35.46
Steel	15	0.23	11	0.19	23	0.57	17	1.86	7	1.86
Concrete	12	0.19	12	0.21	21	0.52	18	1.89	10	2.73
Precast	9	0.14	5	0.08	10	0.24	7	0.76	4	0.95
RM	176	2.82	95	1.65	150	3.75	89	9.40	20	5.25
URM	2	0.03	2	0.03	4	0.10	5	0.50	7	1.96
MH	387	6.21	255	4.41	434	10.82	376	39.88	198	51.80
Total	**6,233**		**5,789**		**4,009**		**942**		**382**	

*Note:

RM	Reinforced Masonry
URM	Unreinforced Masonry
MH	Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 0 hospital beds available for use. On the day of the earthquake, the model estimates that only 0 hospital beds (0.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 0.00% of the beds will be back in service. By 30 days, 0.00% will be operational.

Table 6: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**At Least Moderate Damage > 50%**	**Complete Damage > 50%**	**With Functionality > 50% on day 1**
Hospitals	0	0	0	0
Schools	12	0	0	1
EOCs	0	0	0	0
PoliceStations	4	0	0	0
FireStations	3	1	0	1

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	25	0	0	25	25
	Bridges	29	9	4	20	21
	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	2	2	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	1	0	0	1	1
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	2	1	0	2	2
	Runways	2	0	0	2	2

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	2	2	0	1	2

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	2,313	1374	344
Waste Water	1,388	1087	272
Natural Gas	925	1162	290
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	16,401	10,606	9,344	5,820	0	0
Electric Power		6,075	3,653	1,457	278	9

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 5 ignitions that will burn about 0.06 sq. mi 0.01 % of the region's total area.) The model also estimates that the fires will displace about 66 people and burn about 4 (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 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 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 (413 households to be displaced due to the earthquake. Of these, 93 people (out of a total population of 41,259 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	53	15	2	5
	Industrial	4	1	0	0
	Other-Residential	54	13	1	2
	Single Family	53	9	0	1
	Total	**167**	**38**	**5**	**9**
2 PM	Commercial	200	59	10	19
	Commuting	1	1	1	0
	Educational	26	8	1	3
	Hotels	10	3	0	1
	Industrial	33	10	2	3
	Other-Residential	11	3	0	0
	Single Family	11	2	0	0
	Total	**291**	**84**	**15**	**27**
5 PM	Commercial	165	49	8	16
	Commuting	14	17	31	6
	Educational	3	1	0	0
	Hotels	16	5	1	1
	Industrial	21	6	1	2
	Other-Residential	20	5	0	1
	Single Family	21	3	0	0
	Total	**260**	**85**	**42**	**27**

Economic Loss

The total economic loss estimated for the earthquake is 496.80 (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 471.00 (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 71 % 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	17.33	12.35	0.46	0.50	30.64
	Capital-Related	0.00	7.40	13.18	0.28	0.10	20.96
	Rental	5.70	18.68	6.82	0.23	0.18	31.61
	Relocation	0.60	0.16	0.34	0.03	0.06	1.18
	Subtotal	**6.30**	**43.58**	**32.69**	**0.99**	**0.84**	**84.40**
Capital Stock Loses							
	Structural	28.91	12.03	14.01	2.78	1.50	59.23
	Non_Structural	129.52	60.84	42.49	9.55	4.60	247.01
	Content	39.25	12.87	18.56	6.09	2.08	78.86
	Inventory	0.00	0.00	0.49	0.99	0.02	1.50
	Subtotal	**197.68**	**85.75**	**75.55**	**19.41**	**8.21**	**386.60**
	Total	**203.98**	**129.33**	**108.24**	**20.41**	**9.04**	**471.00**

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	777.60	$0.00	0.00
	Bridges	16.78	$3.97	23.63
	Tunnels	0.00	$0.00	0.00
	Subtotal	**794.40**	**4.00**	
Railways	Segments	0.00	$0.00	0.00
	Bridges	0.00	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	4.75	$1.65	34.67
	Subtotal	**4.80**	**1.60**	
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	1.19	$0.40	33.73
	Subtotal	**1.20**	**0.40**	
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	11.88	$3.41	28.67
	Runways	67.75	$0.00	0.00
	Subtotal	**79.60**	**3.40**	
	Total	**880.00**	**9.40**	

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	46.30	$6.18	13.37
	Subtotal	**46.27**	**$6.18**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Line	27.80	$4.89	17.62
	Subtotal	**27.76**	**$4.89**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Line	18.50	$5.23	28.25
	Subtotal	**18.51**	**$5.23**	
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	0.20	$0.07	33.35
	Subtotal	**0.22**	**$0.07**	
	Total	**92.75**	**$16.38**	

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	(4)	-0.86
Second Year			
	Employment Impact	0	0.00
	Income Impact	(11)	-2.62
Third Year			
	Employment Impact	0	0.00
	Income Impact	(14)	-3.37
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(14)	-3.37
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(14)	-3.37
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(14)	-3.37

Appendix A: County Listing for the Region

Douglas,NV

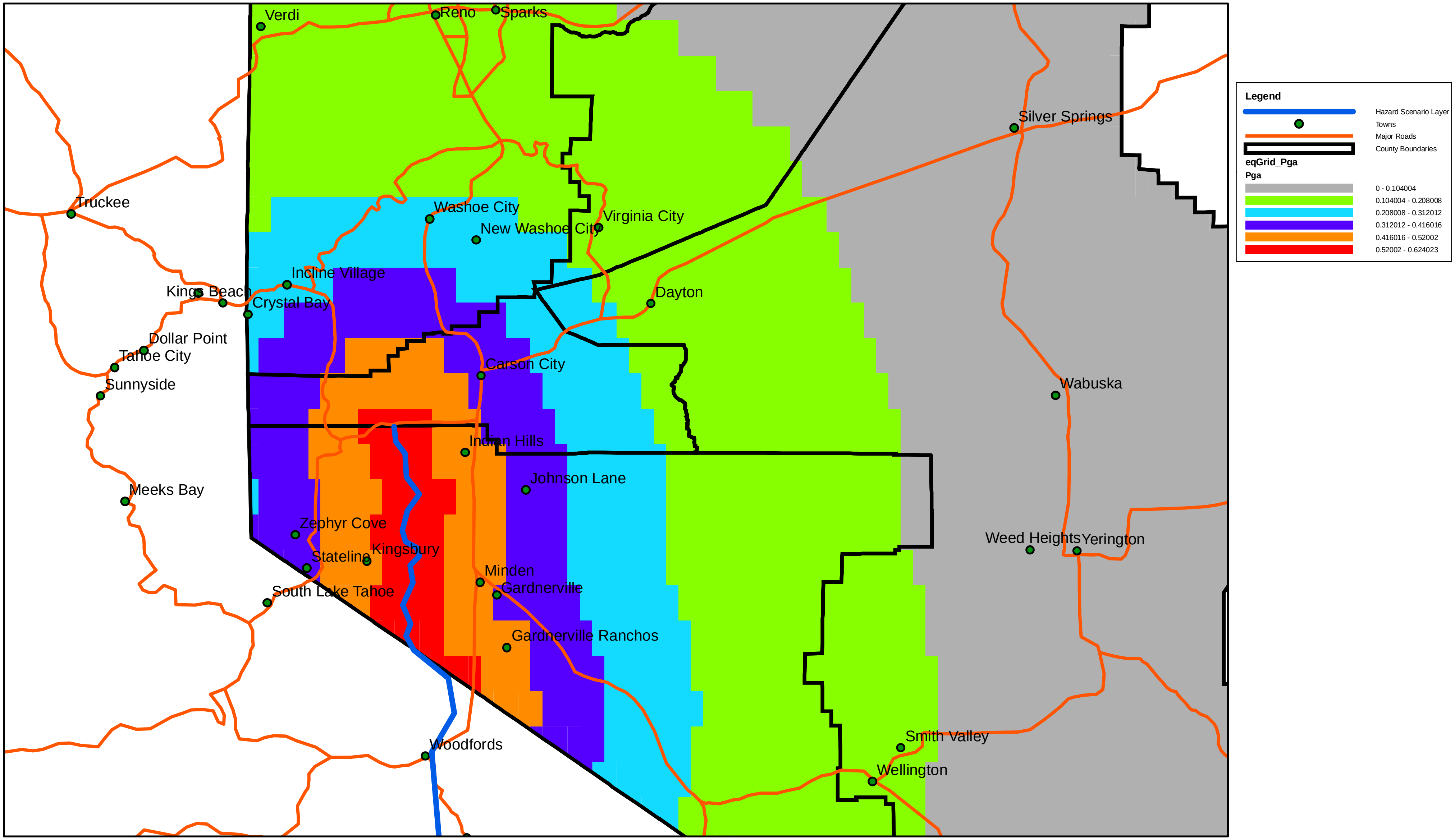
Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Nevada					
	Douglas	41,259	2,701	427	3,128
Total State		**41,259**	**2,701**	**427**	**3,128**
Total Region		**41,259**	**2,701**	**427**	**3,128**

Study Region new : Minden and Northwestern Nevada Counties M7.1 R. Hess

Tuesday, November 08, 2005

Hazard Scenario : Minden 7.1 NW Counties



0 5 10 20 30 40 Kilometers

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	0.40 - 1.60
	Building Contents	0.00 - 0.10
	Business Interruption	0.10 - 0.40
Infrastructure	Lifelines Damage	
	Total	0.60 - 2.50

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	18 - 70	< 1.0	< 1.0	19 - 80
Major	1 - 6	< 1.0	< 1.0	1 - 7
Total	20 - 80	0 - 1	< 1.0	20 - 80

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	400 - 1,500
Level 2	Hospital Care	100 - 400
Level 3	Life-threatening	20 - 60
Level 4	Fatalities	30 - 120

Estimated Shelter Needs

Type	Households	People
Displaced Households	600 - 3,000	
Public Shelter		150 - 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 : 7.10

Epicenter Latitude/Longitude :
38.93 / -119.85

Depth & Type :0.00/S

Fault Name :
Carson Range 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: November 08, 2005 8:46 am

HAZUS-MH: Earthquake Event Report

Region Name: ***County_NW***

Earthquake Scenario: ***Minden 7.1 NW Counties***

Print Date: ***November 08, 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

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	Minden 7.1 NW Counties
Type of Earthquake	Source
Fault Name	Carson Range fault
Historical Epicenter ID #	763
Probabilistic Return Period	NA
Longitude of Epicenter	-119.85
Latitude of Epicenter	38.93
Earthquake Magnitude	7.10
Depth (Km)	0.00
Rupture Length (Km)	50.58
Rupture Orientation (degrees)	0.00
Attenuation Function	WUS Shallow Crustal Event - Extensional

Building Damage

Building Damage

HAZUS estimates that about 15,479 buildings will be at least moderately damaged. This is over 10.00 % of the total number of buildings in the region. There are an estimated 863 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	1,174	1.05	223	0.85	192	1.63	87	3.12	37	4.30
Education	6	0.01	1	0.00	1	0.01	1	0.02	0	0.04
Government	50	0.04	16	0.06	20	0.17	12	0.42	5	0.59
Industrial	245	0.22	50	0.19	46	0.38	19	0.69	7	0.86
Other Residential	17,661	15.74	4,406	16.90	3,947	33.32	1,790	64.55	574	66.50
Religion	31	0.03	6	0.02	5	0.04	2	0.08	1	0.11
Single Family	93,019	82.91	21,363	81.96	7,633	64.45	863	31.11	238	27.61
Total	**112,186**		**26,066**		**11,843**		**2,773**		**863**	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	93,917	83.72	21801	83.64	7,522	63.51	742	26.75	227	26.33
Steel	566	0.50	116	0.44	121	1.02	56	2.02	18	2.13
Concrete	601	0.54	119	0.46	91	0.77	50	1.81	21	2.46
Precast	294	0.26	54	0.21	54	0.45	25	0.88	9	1.04
RM	3,511	3.13	467	1.79	467	3.95	195	7.02	35	4.00
URM	115	0.10	39	0.15	36	0.30	21	0.77	20	2.29
MH	13,182	11.75	3470	13.31	3,553	30.00	1,685	60.75	533	61.76
Total	**112,186**		**26,066**		**11,843**		**2,773**		**863**	

*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 1,219 hospital beds (86.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 95.00% of the beds will be back in service. By 30 days, 99.00% will be operational.

Table 6: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	11	0	0	10
Schools	173	0	0	147
EOCs	2	0	0	0
PoliceStations	24	0	0	18
FireStations	17	1	0	13

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	11	4	281	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	3	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	0	0	5	5
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	22	1	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	0	0	3	3
Waste Water	8	1	0	7	8
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	6	0	0	6	6
Communication	42	3	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	2494	624
Waste Water	11,843	1973	493
Natural Gas	7,895	2109	527
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	22,777	15,408	5,820	0	0
Electric Power		7,071	4,257	1,695	323	10

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 4 ignitions that will burn about 0.10 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 14 people and burn about 1 (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 36.00% 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 (1,269 households to be displaced due to the earthquake. Of these, 303 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	61	17	3	5
	Industrial	12	3	1	1
	Other-Residential	204	42	4	7
	Single Family	121	16	1	1
	Total	**406**	**81**	**8**	**16**
2 PM	Commercial	501	138	22	44
	Commuting	1	1	1	0
	Educational	68	19	3	6
	Hotels	12	3	1	1
	Industrial	89	24	4	7
	Other-Residential	43	9	1	2
	Single Family	25	3	0	0
	Total	**739**	**198**	**32**	**60**
5 PM	Commercial	384	106	17	33
	Commuting	17	21	38	7
	Educational	9	2	0	1
	Hotels	18	5	1	2
	Industrial	56	15	2	5
	Other-Residential	75	16	2	3
	Single Family	47	6	0	1
	Total	**606**	**172**	**60**	**51**

Economic Loss

The total economic loss estimated for the earthquake is 1,332.99 (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 1,232.73 (millions of dollars); 15 % 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 64 % 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	20.73	41.26	1.78	3.02	66.79
	Capital-Related	0.00	8.85	39.85	1.08	0.37	50.15
	Rental	12.02	32.85	21.64	0.84	1.36	68.71
	Relocation	1.23	0.53	1.12	0.08	0.26	3.22
	Subtotal	**13.25**	**62.96**	**103.88**	**3.78**	**5.00**	**188.87**
Capital Stock Loses							
	Structural	65.04	35.76	46.50	9.18	5.83	162.32
	Non_Structural	310.68	167.31	130.29	30.15	19.08	657.49
	Content	95.28	34.96	59.45	19.50	8.77	217.96
	Inventory	0.00	0.00	2.18	3.83	0.08	6.09
	Subtotal	**471.00**	**238.03**	**238.42**	**62.65**	**33.76**	**1,043.86**
	Total	**484.25**	**300.99**	**342.30**	**66.43**	**38.76**	**1,232.73**

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	$6.86	1.43
	Tunnels	0.00	$0.00	0.00
	Subtotal	**5119.10**	**6.90**	
Railways	Segments	294.15	$0.00	0.00
	Bridges	1.46	$0.00	0.04
	Tunnels	0.00	$0.00	0.00
	Facilities	16.63	$2.97	17.84
	Subtotal	**312.20**	**3.00**	
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	$1.29	21.78
	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	$11.01	8.43
	Runways	813.05	$0.00	0.00
	Subtotal	**943.70**	**11.00**	
	Total	**6381.00**	**22.10**	

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	$3.08	2.83
	Distribution Line	394.80	$11.22	2.84
	Subtotal	**503.64**	**$14.30**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	580.80	$26.42	4.55
	Distribution Line	236.90	$8.88	3.75
	Subtotal	**817.60**	**$35.29**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Line	157.90	$9.49	6.01
	Subtotal	**157.90**	**$9.49**	
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	$18.68	2.60
	Subtotal	**719.40**	**$18.68**	
Communication	Facilities	4.60	$0.36	7.77
	Subtotal	**4.58**	**$0.36**	
	Total	**2,203.13**	**$78.12**	

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

	LOSS	Total	%
First Year			
	Employment Impact	1,021	0.67
	Income Impact	(6)	-0.08
Second Year			
	Employment Impact	444	0.29
	Income Impact	(28)	-0.37
Third Year			
	Employment Impact	11	0.01
	Income Impact	(38)	-0.51
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(39)	-0.52
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(39)	-0.52
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(39)	-0.52

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

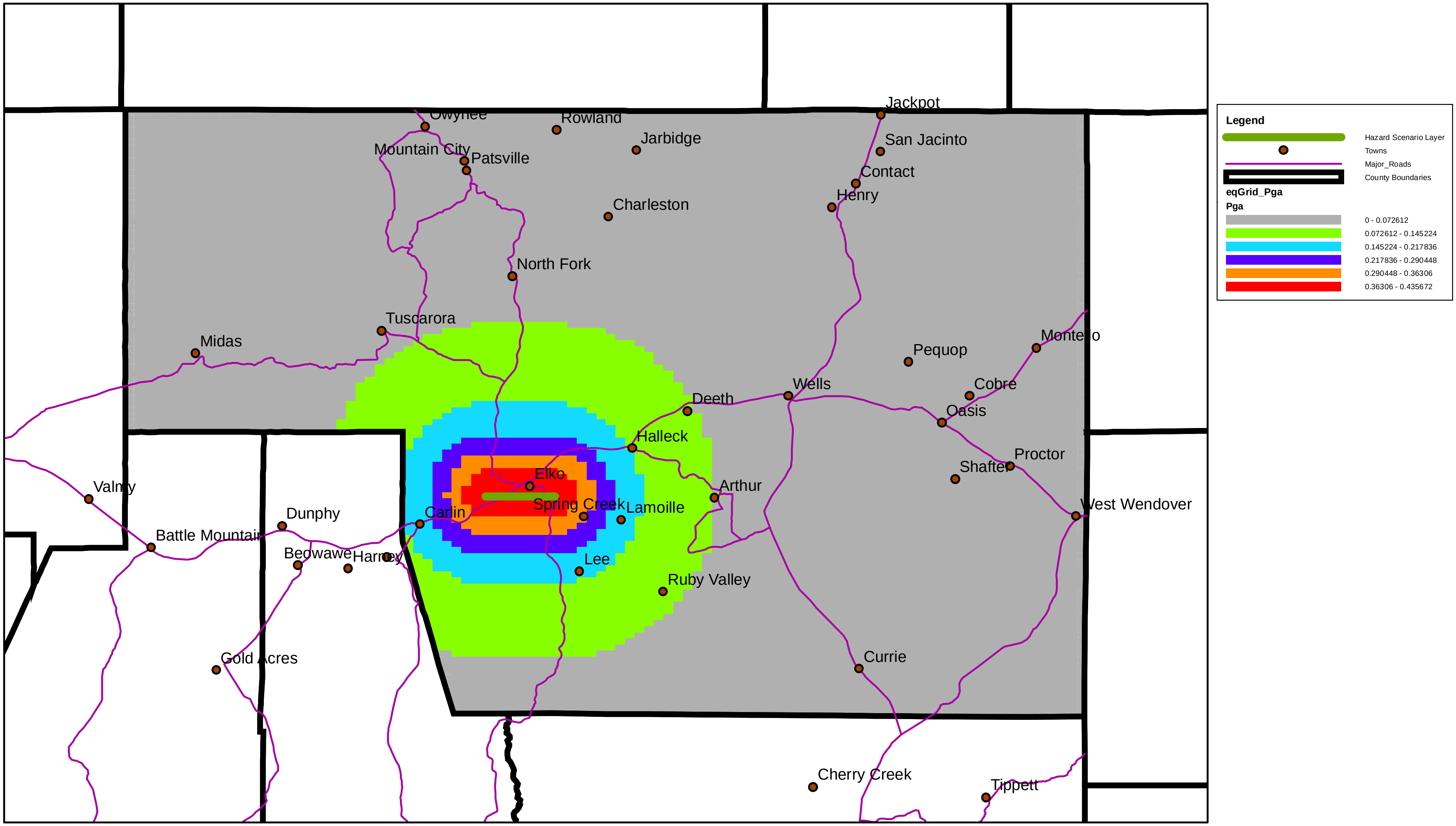
State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Nevada					
	Douglas	41,259	2,701	427	3,128
	Lyon	34,501	1,310	220	1,530
	Storey	3,399	164	22	186
	Washoe	339,486	17,626	3,778	21,405
	Carson	52,457	2,380	602	2,983
Total State		**471,102**	**24,181**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

Study Region new : Elko Hazus Scenario

R. Hess

Tuesday, July 26, 2005

Hazard Scenario : Elko Fault M6.5



0 25 50 100 150 200 Kilometers

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 :

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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 :

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

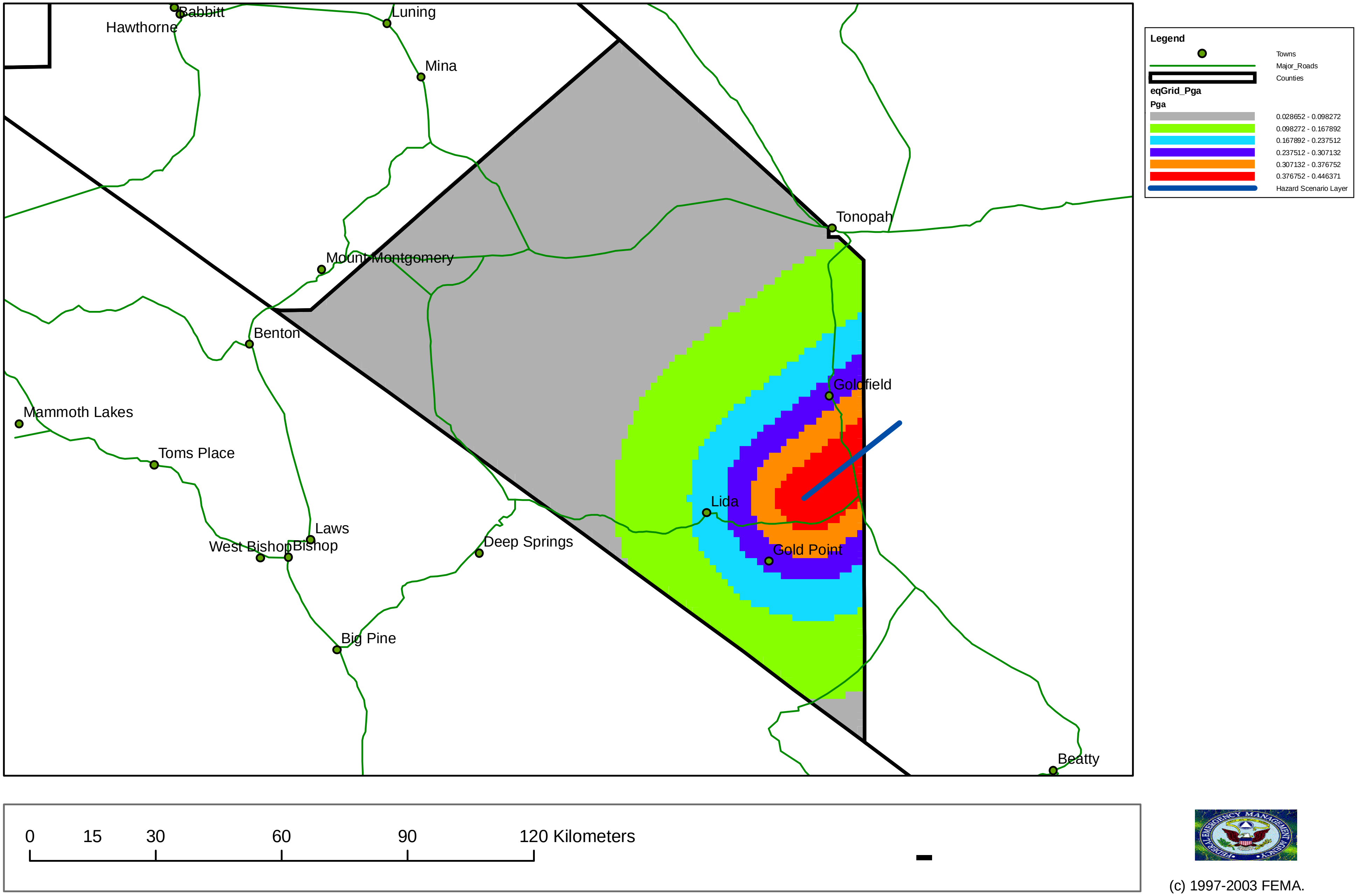
State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Nevada					
	Elko	45,291	1,807	334	2,141
Total State		**45,291**	**1,807**	**334**	**2,141**
Total Region		**45,291**	**1,807**	**334**	**2,141**

Study Region new : Esmeralda County, Goldfield Scenario

R. Hess

Tuesday, November 29, 2005

Hazard Scenario : Goldfield, M6.7 Esmeralda County



HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	< 0.1
	Building Contents	< 0.1
	Business Interruption	< 0.1
Infrastructure	Lifelines Damage	
	Total	< 0.1

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	< 1.0	< 1.0	< 1.0	< 1.0
Major	< 1.0	< 1.0	< 1.0	< 1.0
Total	< 1.0	< 1.0	< 1.0	< 1.0

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	< 20
Level 2	Hospital Care	< 20
Level 3	Life-threatening	< 20
Level 4	Fatalities	< 20

Estimated Shelter Needs

Type	Households	People
Displaced Households	< 1.0	
Public Shelter		< 1.0

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 : 6.70

Epicenter Latitude/Longitude :
37.57 / -117.19

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: 971

Building Exposure : ($ Millions)

Residential	54
Commerical	2
Other	2
Total	58

State:

Counties :
- Esmeralda,NV

Major Metro Area :

HAZUS-MH: Earthquake Event Report

Region Name: *Esmeralda_Hazus*

Earthquake Scenario: *Goldfield, M6.7, Esmeralda County*

Print Date: *December 01, 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

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 3,586.11 square miles and contains 1 census tracts. There are over 0 thousand households in the region and has a total population of 971 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 0 thousand buildings in the region with a total building replacement value (excluding contents) of 58 (millions of dollars). Approximately 100.00 % of the buildings (and 92.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 1,923 and 0 (millions of dollars), respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 0 thousand buildings in the region which have an aggregate total replacement value of 58 (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 36% 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 0 hospitals in the region with a total bed capacity of 0 beds. There are 1 schools, 0 fire stations, 2 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 4 dams identified within the region. Of these, 1 of the dams are classified as 'high hazard'. The inventory also includes 1 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 1,923.00 (millions of dollars). This inventory includes over 406 kilometers of highways, 0 bridges, 9,976 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	0	0.00
	Segments	14	1,764.00
	Tunnels	0	0.00
		Subtotal	**1,764.00**
Railways	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
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	4	23.80
	Runways	4	135.50
		Subtotal	**159.30**
		Total	**1,923.30**

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	99.80
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**99.80**
Waste Water	Distribution Lines	NA	59.90
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**59.90**
Natural Gas	Distribution Lines	NA	39.90
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**39.90**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	0	0.00
		Subtotal	**0.00**
Communication	Facilities	0	0.00
		Subtotal	**0.00**
		Total	**199.50**

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	Goldfield, M6.7, Esmeralda County
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-117.19
Latitude of Epicenter	37.57
Earthquake Magnitude	6.70
Depth (Km)	8.00
Rupture Length (Km)	25.59
Rupture Orientation (degrees)	45.00
Attenuation Function	WUS Shallow Crustal Event - Extensional

Building Damage

Building Damage

HAZUS estimates that about 30 buildings will be at least moderately damaged. This is over 5.00 % of the total number of buildings in the region. There are an estimated 0 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	1	0.17	0	0.11	0	0.09	0	0.15	0	0.88
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	1	0.17	0	0.11	0	0.09	0	0.14	0	0.72
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Other Residential	320	59.53	50	82.71	28	97.39	2	98.71	0	98.40
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Single Family	216	40.14	10	17.08	1	2.43	0	1.00	0	0.00
Total	**538**		**60**		**28**		**2**		**0**	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	213	39.60	10	16.96	1	2.07	0	0.51	0	0.00
Steel	1	0.15	0	0.11	0	0.10	0	0.10	0	0.74
Concrete	1	0.15	0	0.09	0	0.05	0	0.07	0	0.06
Precast	0	0.02	0	0.01	0	0.02	0	0.03	0	0.03
RM	7	1.36	0	0.47	0	0.45	0	0.62	0	0.05
URM	0	0.02	0	0.04	0	0.06	0	0.17	0	1.77
MH	316	58.70	49	82.32	28	97.25	2	98.51	0	97.34
Total	**538**		**60**		**28**		**2**		**0**	

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

Essential Facility Damage

Before the earthquake, the region had 0 hospital beds available for use. On the day of the earthquake, the model estimates that only 0 hospital beds (0.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 0.00% of the beds will be back in service. By 30 days, 0.00% will be operational.

Table 6: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**At Least Moderate Damage > 50%**	**Complete Damage > 50%**	**With Functionality > 50% on day 1**
Hospitals	0	0	0	0
Schools	1	0	0	1
EOCs	0	0	0	0
PoliceStations	2	0	0	2
FireStations	0	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	14	0	0	14	14
	Bridges	0	0	0	0	0
	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	0	0	0	0	0
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	4	1	0	4	4
	Runways	4	0	0	4	4

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	0	0	0	0	0

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	4,988	102	26
Waste Water	2,993	81	20
Natural Gas	1,995	86	22
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	455	0	0	0	0	0
Electric Power		0	0	0	0	0

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 0 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 69.00% 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 (0 households to be displaced due to the earthquake. Of these, 0 people (out of a total population of 971 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	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**0**	**0**	**0**	**0**
2 PM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**0**	**0**	**0**	**0**
5 PM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**0**	**0**	**0**	**0**

Economic Loss

The total economic loss estimated for the earthquake is 4.99 (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 0.28 (millions of dollars); 5 % 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 87 % 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	0.00	0.00	0.00	0.00	0.00
	Capital-Related	0.00	0.00	0.00	0.00	0.00	0.00
	Rental	0.00	0.00	0.00	0.00	0.00	0.00
	Relocation	0.00	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.01**
Capital Stock Loses							
	Structural	0.01	0.04	0.00	0.00	0.00	0.05
	Non_Structural	0.05	0.11	0.01	0.00	0.01	0.18
	Content	0.01	0.02	0.00	0.00	0.00	0.04
	Inventory	0.00	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.07**	**0.16**	**0.02**	**0.00**	**0.01**	**0.27**
	Total	**0.08**	**0.17**	**0.02**	**0.00**	**0.01**	**0.28**

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	1,764.02	$0.00	0.00
	Bridges	0.00	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Subtotal	**1764.00**	**0.00**	
Railways	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**	
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	23.76	$3.50	14.72
	Runways	135.51	$0.00	0.00
	Subtotal	**159.30**	**3.50**	
	Total	**1923.30**	**3.50**	

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	99.80	$0.46	0.46
	Subtotal	**99.76**	**$0.46**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Line	59.90	$0.36	0.61
	Subtotal	**59.86**	**$0.36**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Line	39.90	$0.39	0.97
	Subtotal	**39.90**	**$0.39**	
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	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
	Total	**199.52**	**$1.21**	

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

LOSS	Total	%

Appendix A: County Listing for the Region

Esmeralda,NV

Appendix B: Regional Population and Building Value Data

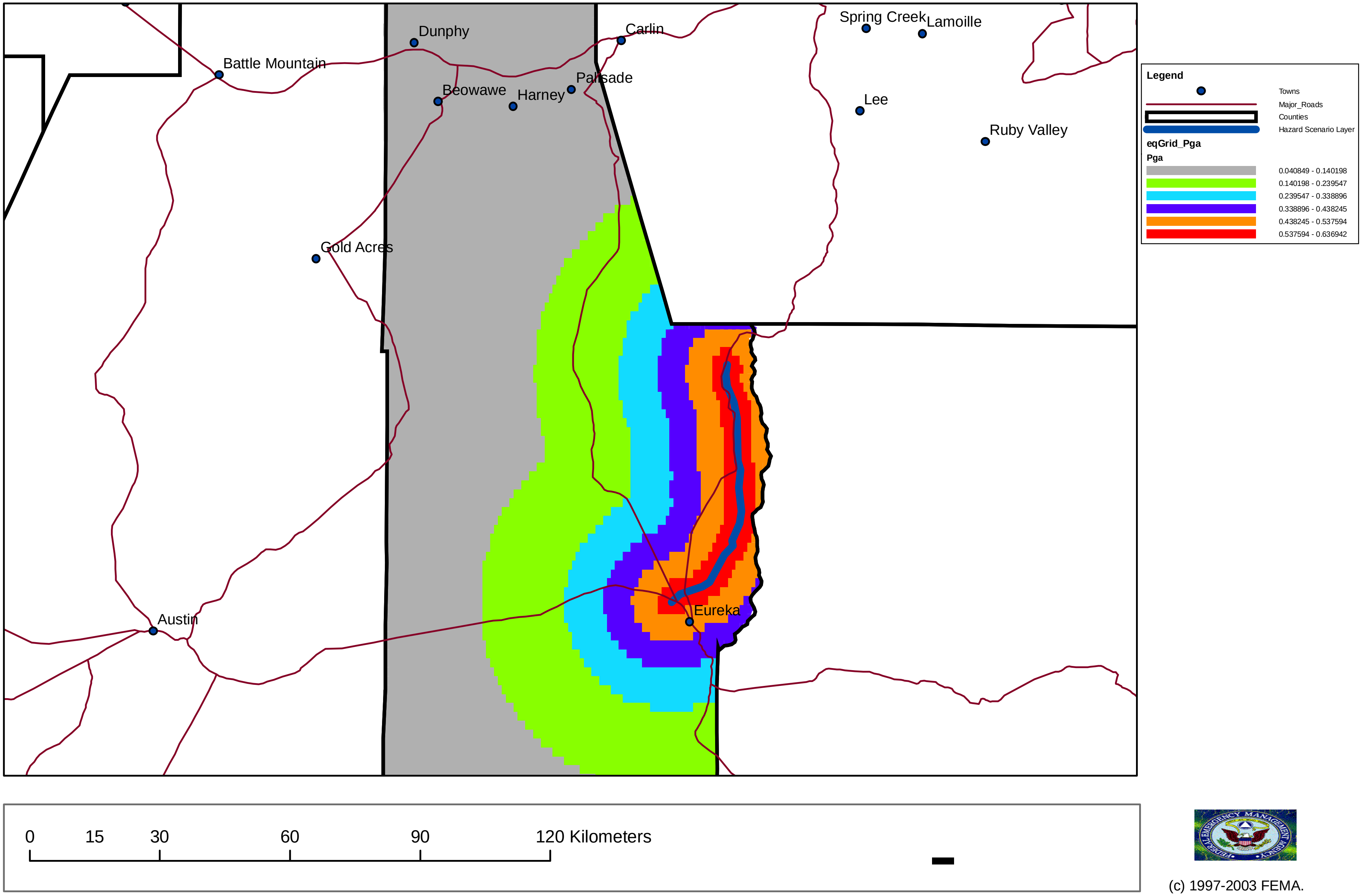
State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Nevada					
	Esmeralda	971	54	4	58
Total State		**971**	**54**	**4**	**58**
Total Region		**971**	**54**	**4**	**58**

Study Region new : Eureka County Scenario M7.2

R. Hess

Monday, November 21, 2005

Hazard Scenario : Eureka Western Diamond Mtns fault zone



HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	< 0.1
	Building Contents	< 0.1
	Business Interruption	< 0.1
Infrastructure	Lifelines Damage	
	Total	< 0.1

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	< 1.0	< 1.0	< 1.0	< 1.0
Major	< 1.0	< 1.0	< 1.0	< 1.0
Total	< 1.0	< 1.0	< 1.0	< 1.0

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	< 20
Level 2	Hospital Care	< 20
Level 3	Life-threatening	< 20
Level 4	Fatalities	< 20

Estimated Shelter Needs

Type	Households	People
Displaced Households	< 1.0	
Public Shelter		< 1.0

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 : 7.20

Epicenter Latitude/Longitude :
39.60 / -115.92

Depth & Type :0.00/S

Fault Name :
Western Diamond Mountains fault zone

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: 1,651

Building Exposure : ($ Millions)

Residential	73
Commerical	28
Other	7
Total	108

State:

Counties :
- Eureka,NV

Major Metro Area :

Time of report: November 21, 2005 5:36 pm

HAZUS-MH: Earthquake Event Report

Region Name: ***Eureka_Hazus***

Earthquake Scenario: ***Eureka Western Diamond Mtns fault zone***

Print Date: ***November 21, 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

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 4,174.43 square miles and contains 1 census tracts. There are over 0 thousand households in the region and has a total population of 1,651 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 0 thousand buildings in the region with a total building replacement value (excluding contents) of 109 (millions of dollars). Approximately 99.00 % of the buildings (and 67.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 1,499 and 119 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 0 thousand buildings in the region which have an aggregate total replacement value of 109 (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 35% 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 0 hospitals in the region with a total bed capacity of 0 beds. There are 3 schools, 0 fire stations, 1 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 48 dams identified within the region. Of these, 6 of the dams are classified as 'high hazard'. The inventory also includes 60 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 1,618.00 (millions of dollars). This inventory includes over 313 kilometers of highways, 22 bridges, 12,414 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	22	19.70
	Segments	18	1,310.50
	Tunnels	0	0.00
		Subtotal	**1,330.10**
Railways	Bridges	0	0.00
	Facilities	0	0.00
	Segments	20	89.30
	Tunnels	0	0.00
		Subtotal	**89.30**
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	2	11.90
	Runways	2	67.80
		Subtotal	**79.60**
		Total	**1,499.00**

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	124.10
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**124.10**
Waste Water	Distribution Lines	NA	74.50
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**74.50**
Natural Gas	Distribution Lines	NA	49.70
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**49.70**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	1	119.90
		Subtotal	**119.90**
Communication	Facilities	0	0.00
		Subtotal	**0.00**
		Total	**368.20**

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	Eureka Western Diamond Mtns fault zone
Type of Earthquake	Source
Fault Name	Western Diamond Mountain
Historical Epicenter ID #	685
Probabilistic Return Period	NA
Longitude of Epicenter	-115.92
Latitude of Epicenter	39.60
Earthquake Magnitude	7.20
Depth (Km)	0.00
Rupture Length (Km)	59.98
Rupture Orientation (degrees)	0.00
Attenuation Function	WUS Shallow Crustal Event - Extensional

Building Damage

Building Damage

HAZUS estimates that about 210 buildings will be at least moderately damaged. This is over 22.00 % of the total number of buildings in the region. There are an estimated 4 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	1	0.11	0	0.09	0	0.09	0	0.12	0	0.14
Commercial	3	0.60	1	0.62	1	0.68	0	0.78	0	0.88
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	1	0.10	0	0.11	0	0.12	0	0.14	0	0.16
Industrial	1	0.09	0	0.10	0	0.14	0	0.16	0	0.24
Other Residential	271	48.66	133	71.89	147	91.39	42	95.74	5	97.64
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Single Family	281	50.44	50	27.20	12	7.57	1	3.06	0	0.94
Total	**558**		**184**		**161**		**44**		**5**	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	276	49.49	49	26.71	11	6.70	1	1.84	0	0.73
Steel	1	0.17	0	0.25	1	0.40	0	0.48	0	0.94
Concrete	1	0.15	0	0.18	0	0.19	0	0.20	0	0.19
Precast	1	0.13	0	0.11	0	0.16	0	0.25	0	0.13
RM	8	1.48	2	0.89	2	1.15	1	1.46	0	0.28
URM	0	0.05	0	0.05	0	0.04	0	0.05	0	0.11
MH	271	48.53	132	71.81	147	91.35	42	95.71	5	97.62
Total	**558**		**184**		**161**		**44**		**5**	

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

Essential Facility Damage

Before the earthquake, the region had 0 hospital beds available for use. On the day of the earthquake, the model estimates that only 0 hospital beds (0.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 0.00% of the beds will be back in service. By 30 days, 0.00% 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	0	0	0	0
Schools	3	0	0	3
EOCs	0	0	0	0
PoliceStations	1	1	0	0
FireStations	0	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	18	0	0	18	18
	Bridges	22	0	0	22	22
	Tunnels	0	0	0	0	0
Railways	Segments	20	0	0	20	20
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
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	2	1	0	2	2
	Runways	2	0	0	2	2

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	with Functionality > 50 % 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	1	0	0	1	1
Communication	0	0	0	0	0

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	6,207	569	142
Waste Water	3,724	450	112
Natural Gas	2,483	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	666	17	3	0	0	0
Electric Power		0	0	0	0	0

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 0 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 40.00% 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 (0 households to be displaced due to the earthquake. Of these, 0 people (out of a total population of 1,651 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	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	2	0	0	0
	Single Family	0	0	0	0
	Total	**2**	**0**	**0**	**0**
2 PM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	1	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**2**	**0**	**0**	**0**
5 PM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	1	0	0	0
	Single Family	0	0	0	0
	Total	**2**	**0**	**0**	**0**

Economic Loss

The total economic loss estimated for the earthquake is 14.56 (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 4.13 (millions of dollars); 16 % 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	0.05	0.15	0.00	0.01	0.22
	Capital-Related	0.00	0.02	0.12	0.00	0.00	0.14
	Rental	0.02	0.07	0.18	0.00	0.01	0.28
	Relocation	0.00	0.00	0.01	0.00	0.00	0.02
	Subtotal	**0.02**	**0.14**	**0.46**	**0.01**	**0.03**	**0.66**
Capital Stock Loses							
	Structural	0.10	0.30	0.43	0.04	0.06	0.92
	Non_Structural	0.47	0.70	0.58	0.08	0.08	1.91
	Content	0.16	0.09	0.27	0.05	0.04	0.61
	Inventory	0.00	0.00	0.02	0.01	0.00	0.03
	Subtotal	**0.73**	**1.09**	**1.29**	**0.18**	**0.18**	**3.47**
	Total	**0.74**	**1.23**	**1.76**	**0.19**	**0.21**	**4.13**

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	1,310.46	$0.00	0.00
	Bridges	19.68	$0.03	0.17
	Tunnels	0.00	$0.00	0.00
	Subtotal	**1330.10**	**0.00**	
Railways	Segments	89.26	$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	**89.30**	**0.00**	
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	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	11.88	$2.78	23.36
	Runways	67.75	$0.00	0.00
	Subtotal	**79.60**	**2.80**	
	Total	**1499.00**	**2.80**	

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	124.10	$2.56	2.06
	Subtotal	**124.14**	**$2.56**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Line	74.50	$2.02	2.72
	Subtotal	**74.48**	**$2.02**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Line	49.70	$2.16	4.36
	Subtotal	**49.66**	**$2.16**	
Oil Systems	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
Electrical Power	Facilities	119.90	$0.87	0.72
	Subtotal	**119.90**	**$0.87**	
Communication	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
	Total	**368.18**	**$7.61**	

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	0	-0.15
Second Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.44
Third Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.57
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.57
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.57
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	0	-0.57

Appendix A: County Listing for the Region

Eureka,NV

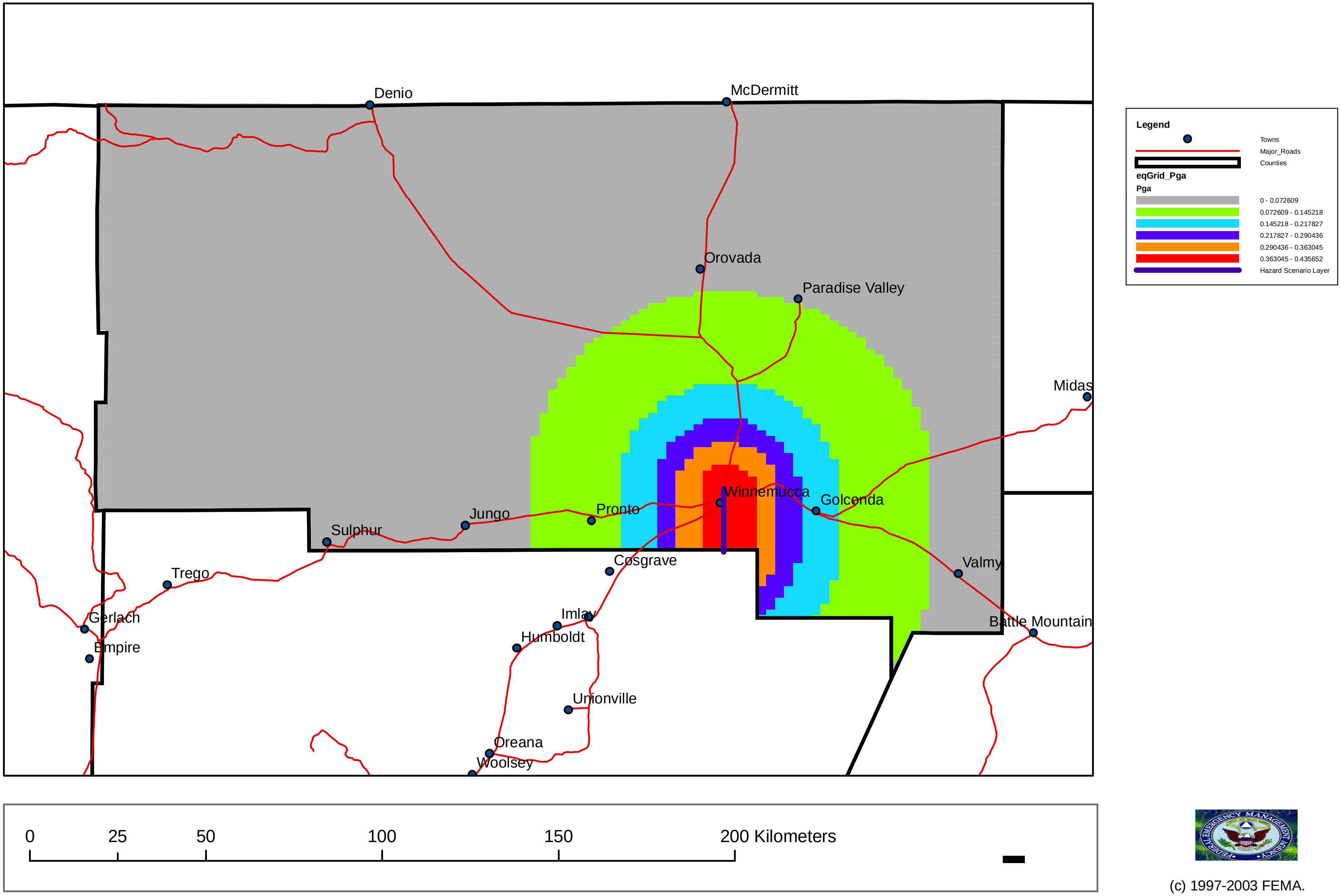
Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Nevada					
	Eureka	1,651	73	36	109
Total State		**1,651**	**73**	**36**	**109**
Total Region		**1,651**	**73**	**36**	**109**

Study Region new : Humboldt County Hazus Scenario R. Hess

Tuesday, June 07, 2005

Hazard Scenario : Winnemucca, 6.5M, 5K due south.



HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

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

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	0 - 3	< 1.0	< 1.0	0 - 3
Major	0 - 1	< 1.0	< 1.0	0 - 1
Total	1 - 4	< 1.0	< 1.0	1 - 4

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	20 - 80
Level 2	Hospital Care	< 20
Level 3	Life-threatening	< 20
Level 4	Fatalities	< 20

Estimated Shelter Needs

Type	Households	People
Displaced Households	30 - 130	
Public Shelter		10 - 30

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 :
40.93 / -117.73

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: 16,106

Building Exposure : ($ Millions)

Residential	614
Commerical	84
Other	52
Total	750

State:

Counties :
- Humboldt,NV

Major Metro Area :

Time of report: November 22, 2005 9:33 am

HAZUS-MH: Earthquake Event Report

Region Name: *Humboldt_Hazus*

Earthquake Scenario: *Winnemucca, 6.5M, 5K due south.*

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

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 9,641.75 square miles and contains 3 census tracts. There are over 5 thousand households in the region and has a total population of 16,106 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 6 thousand buildings in the region with a total building replacement value (excluding contents) of 750 (millions of dollars). Approximately 99.00 % of the buildings (and 82.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,727 and 120 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 6 thousand buildings in the region which have an aggregate total replacement value of 750 (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 50% 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 52 beds. There are 14 schools, 1 fire stations, 1 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 41 dams identified within the region. Of these, 2 of the dams are classified as 'high hazard'. The inventory also includes 81 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 2,847.00 (millions of dollars). This inventory includes over 487 kilometers of highways, 54 bridges, 28,446 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	54	65.20
	Segments	23	2,137.10
	Tunnels	0	0.00
		Subtotal	**2,202.30**
Railways	Bridges	1	0.00
	Facilities	1	2.40
	Segments	61	248.80
	Tunnels	0	0.00
		Subtotal	**251.20**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	1	1.20
		Subtotal	**1.20**
Ferry	Facilities	0	0.00
		Subtotal	**0.00**
Port	Facilities	0	0.00
		Subtotal	**0.00**
Airport	Facilities	6	35.60
	Runways	7	237.10
		Subtotal	**272.80**
		Total	**2,727.50**

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	284.50
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**284.50**
Waste Water	Distribution Lines	NA	170.70
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**170.70**
Natural Gas	Distribution Lines	NA	113.80
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**113.80**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	1	119.90
		Subtotal	**119.90**
Communication	Facilities	3	0.30
		Subtotal	**0.30**
		Total	**689.20**

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	Winnemucca, 6.5M, 5K due south.
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-117.73
Latitude of Epicenter	40.93
Earthquake Magnitude	6.50
Depth (Km)	8.00
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 1,482 buildings will be at least moderately damaged. This is over 24.00 % of the total number of buildings in the region. There are an estimated 161 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	0.05	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	30	0.79	3	0.27	4	0.44	3	0.59	1	0.77
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	3	0.08	0	0.04	1	0.08	0	0.11	0	0.14
Industrial	6	0.15	0	0.05	1	0.06	0	0.06	0	0.08
Other Residential	1,728	45.96	311	31.44	469	52.64	376	87.18	146	90.35
Religion	1	0.03	0	0.00	0	0.00	0	0.00	0	0.00
Single Family	1,991	52.94	674	68.19	416	46.78	52	12.05	14	8.65
Total	**3,761**		**988**		**890**		**431**		**161**	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	1,953	51.92	679	68.70	410	46.11	45	10.49	13	8.36
Steel	12	0.32	1	0.13	2	0.27	2	0.40	1	0.39
Concrete	8	0.21	1	0.14	2	0.26	2	0.43	1	0.55
Precast	6	0.16	1	0.05	1	0.09	1	0.12	0	0.14
RM	70	1.87	12	1.26	19	2.09	10	2.22	1	0.88
URM	2	0.05	0	0.03	0	0.05	1	0.12	1	0.44
MH	1,710	45.47	293	29.68	455	51.12	371	86.22	144	89.25
Total	**3,761**		**988**		**890**		**431**		**161**	

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

Essential Facility Damage

Before the earthquake, the region had 52 hospital beds available for use. On the day of the earthquake, the model estimates that only 7 hospital beds (14.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 47.00% 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	1	1	0	0
Schools	14	0	0	5
EOCs	0	0	0	0
PoliceStations	1	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	23	0	0	23	23
	Bridges	54	3	0	51	51
	Tunnels	0	0	0	0	0
Railways	Segments	61	0	0	61	61
	Bridges	1	0	0	1	1
	Tunnels	0	0	0	0	0
	Facilities	1	1	0	1	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	1	1	0	1	1
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	6	0	0	6	6
	Runways	7	0	0	7	7

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	1	0	0	1	1
Communication	3	3	0	3	3

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	14,224	322	80
Waste Water	8,534	255	64
Natural Gas	5,689	272	68
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	5,733	1	0	0	0	0
Electric Power		1,680	897	295	46	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 0.02 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 2 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 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 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 (66 households to be displaced due to the earthquake. Of these, 15 people (out of a total population of 16,106 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	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	1	0	0	0
	Industrial	0	0	0	0
	Other-Residential	30	6	0	1
	Single Family	8	1	0	0
	Total	**39**	**8**	**1**	**1**
2 PM	Commercial	21	6	1	2
	Commuting	0	0	0	0
	Educational	10	3	0	1
	Hotels	0	0	0	0
	Industrial	2	0	0	0
	Other-Residential	6	1	0	0
	Single Family	2	0	0	0
	Total	**40**	**11**	**2**	**3**
5 PM	Commercial	18	5	1	2
	Commuting	2	2	4	1
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	1	0	0	0
	Other-Residential	11	2	0	0
	Single Family	3	0	0	0
	Total	**35**	**10**	**5**	**3**

Economic Loss

The total economic loss estimated for the earthquake is 69.53 (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 55.62 (millions of dollars); 11 % 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 73 % 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	0.31	1.38	0.03	0.10	1.82
	Capital-Related	0.00	0.13	1.31	0.04	0.02	1.50
	Rental	0.66	1.05	0.64	0.02	0.06	2.42
	Relocation	0.07	0.05	0.03	0.00	0.01	0.16
	Subtotal	**0.73**	**1.54**	**3.36**	**0.09**	**0.18**	**5.90**
Capital Stock Loses							
	Structural	3.20	3.19	1.54	0.34	0.26	8.53
	Non_Structural	14.35	11.32	4.10	1.14	0.85	31.76
	Content	4.28	2.08	1.80	0.73	0.36	9.25
	Inventory	0.00	0.00	0.08	0.10	0.00	0.18
	Subtotal	**21.83**	**16.58**	**7.52**	**2.31**	**1.48**	**49.73**
	Total	**22.56**	**18.12**	**10.88**	**2.40**	**1.66**	**55.62**

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	2,137.14	$0.00	0.00
	Bridges	65.16	$5.92	9.09
	Tunnels	0.00	$0.00	0.00
	Subtotal	**2202.30**	**5.90**	
Railways	Segments	248.82	$0.00	0.00
	Bridges	0.03	$0.00	6.73
	Tunnels	0.00	$0.00	0.00
	Facilities	2.38	$0.91	38.33
	Subtotal	**251.20**	**0.90**	
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	1.19	$0.45	37.64
	Subtotal	**1.20**	**0.40**	
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	35.64	$1.94	5.45
	Runways	237.14	$0.00	0.00
	Subtotal	**272.80**	**1.90**	
	Total	**2727.50**	**9.20**	

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	0.00	$0.00	0.00
	Distribution Line	284.50	$1.45	0.51
	Subtotal	**284.47**	**$1.45**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Line	170.70	$1.15	0.67
	Subtotal	**170.68**	**$1.15**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Line	113.80	$1.22	1.08
	Subtotal	**113.79**	**$1.22**	
Oil Systems	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
Electrical Power	Facilities	119.90	$0.78	0.65
	Subtotal	**119.90**	**$0.78**	
Communication	Facilities	0.30	$0.08	25.47
	Subtotal	**0.33**	**$0.08**	
	Total	**689.17**	**$4.68**	

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	0	-0.91
Second Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-2.77
Third Year			
	Employment Impact	0	0.00
	Income Impact	(2)	-3.57
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(2)	-3.57
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(2)	-3.57
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(2)	-3.57

Appendix A: County Listing for the Region

Humboldt,NV

Appendix B: Regional Population and Building Value Data

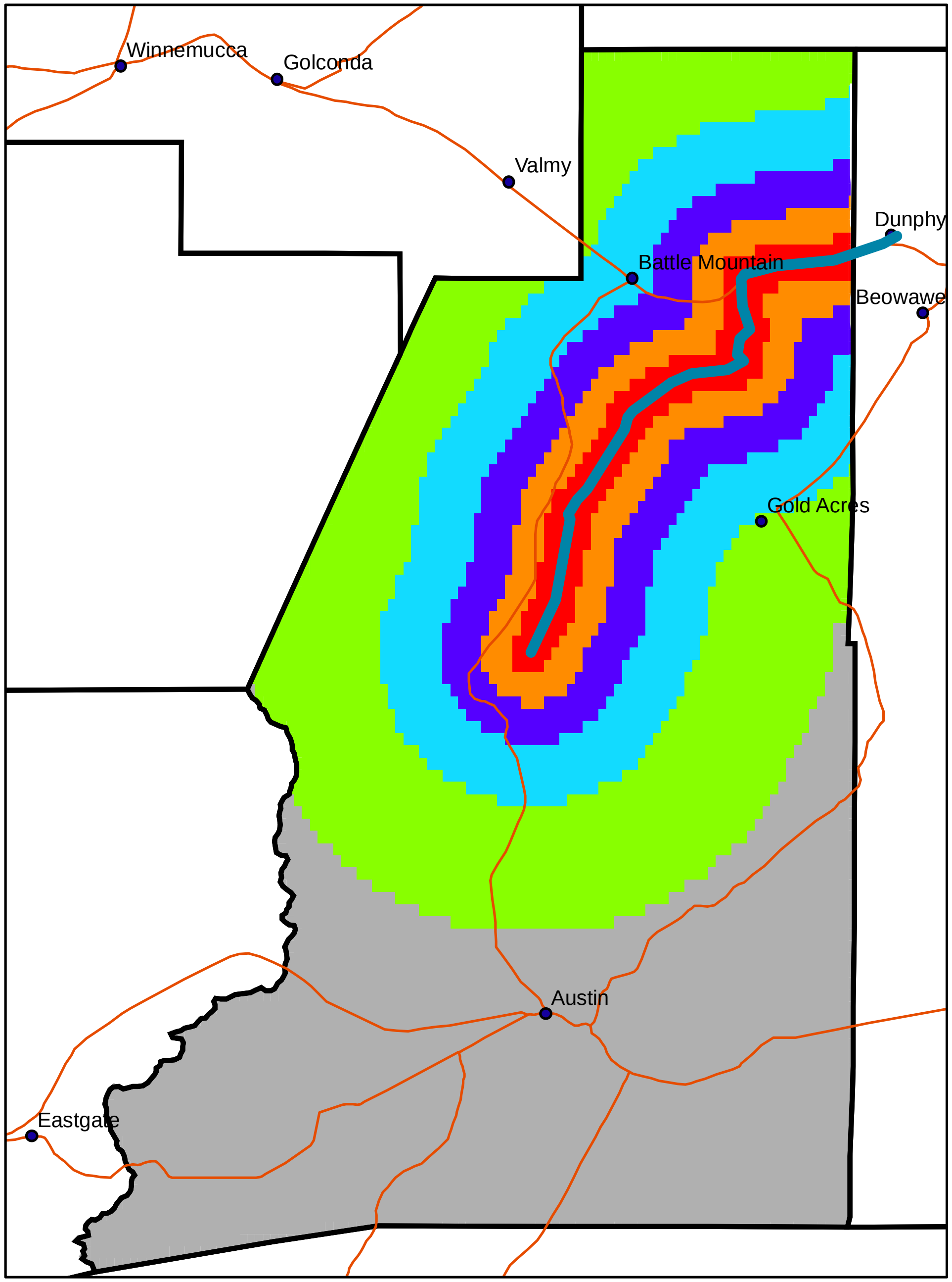
State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Nevada					
	Humboldt	16,106	614	136	750
Total State		**16,106**	**614**	**136**	**750**
Total Region		**16,106**	**614**	**136**	**750**

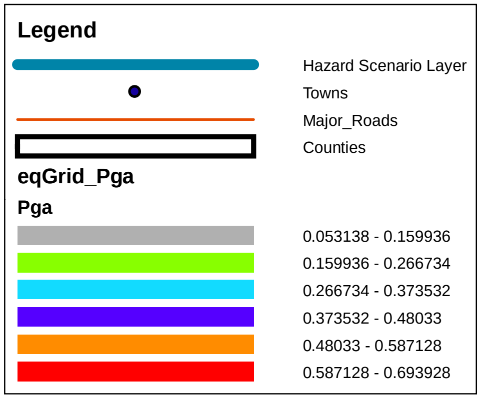
Study Region new : Battle Mountain, Lander County, Scenario

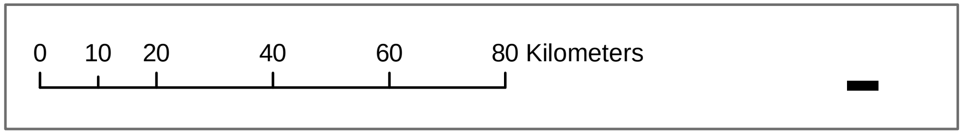
R. Hess

Wednesday, August 24, 2005

Hazard Scenario : Shoshone Range Fault Zone M7.5







HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

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

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	0 - 2	< 1.0	< 1.0	0 - 2
Major	0 - 2	< 1.0	< 1.0	0 - 2
Total	1 - 4	< 1.0	< 1.0	1 - 4

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	30 - 140
Level 2	Hospital Care	10 - 40
Level 3	Life-threatening	< 20
Level 4	Fatalities	< 20

Estimated Shelter Needs

Type	Households	People
Displaced Households	20 - 90	
Public Shelter		10 - 20

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 : 7.50

Epicenter Latitude/Longitude :
40.48 / -116.86

Depth & Type :0.00/S

Fault Name :
Shoshone Range fault zone

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: 5,794

Building Exposure : ($ Millions)

Residential	198
Commerical	19
Other	16
Total	233

State:

Counties :
- Lander,NV

Major Metro Area :

Time of report: August 24, 2005 5:05 pm

HAZUS-MH: Earthquake Event Report

Region Name: *Lander_Hazus*

Earthquake Scenario: *Shoshone Range Fault Zone M7.5*

Print Date: *August 24, 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

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 5,512.27 square miles and contains 2 census tracts. There are over 2 thousand households in the region and has a total population of 5,794 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 2 thousand buildings in the region with a total building replacement value (excluding contents) of 233 (millions of dollars). Approximately 100.00 % of the buildings (and 85.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 1,838 and 0 (millions of dollars), respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 2 thousand buildings in the region which have an aggregate total replacement value of 233 (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 37% 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 14 beds. There are 4 schools, 2 fire stations, 2 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 29 dams identified within the region. Of these, 2 of the dams are classified as 'high hazard'. The inventory also includes 36 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 1,838.00 (millions of dollars). This inventory includes over 387 kilometers of highways, 19 bridges, 16,430 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	19	12.90
	Segments	12	1,557.70
	Tunnels	0	0.00
		Subtotal	**1,570.50**
Railways	Bridges	0	0.00
	Facilities	0	0.00
	Segments	24	74.80
	Tunnels	0	0.00
		Subtotal	**74.80**
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	4	23.80
	Runways	5	169.40
		Subtotal	**193.10**
		Total	**1,838.50**

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	164.30
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**164.30**
Waste Water	Distribution Lines	NA	98.60
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**98.60**
Natural Gas	Distribution Lines	NA	65.70
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**65.70**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	0	0.00
		Subtotal	**0.00**
Communication	Facilities	0	0.00
		Subtotal	**0.00**
		Total	**328.60**

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	Shoshone Range Fault Zone M7.5
Type of Earthquake	Source
Fault Name	Shoshone Range fault zone
Historical Epicenter ID #	761
Probabilistic Return Period	NA
Longitude of Epicenter	-116.86
Latitude of Epicenter	40.48
Earthquake Magnitude	7.50
Depth (Km)	0.00
Rupture Length (Km)	100.00
Rupture Orientation (degrees)	0.00
Attenuation Function	WUS Shallow Crustal Event - Extensional

Building Damage

Building Damage

HAZUS estimates that about 1,780 buildings will be at least moderately damaged. This is over 72.00 % of the total number of buildings in the region. There are an estimated 652 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	1	0.23	1	0.27	2	0.44	2	0.39	3	0.39
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.14	0	0.05	0	0.04	0	0.02	0	0.01
Industrial	0	0.04	0	0.05	1	0.10	1	0.09	1	0.09
Other Residential	16	6.41	69	15.76	293	52.59	523	91.66	635	97.32
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Single Family	236	93.18	365	83.86	261	46.84	45	7.84	14	2.19
Total	**254**		**435**		**557**		**571**		**653**	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	233	92.00	365	83.93	255	45.89	37	6.46	11	1.72
Steel	0	0.09	0	0.10	1	0.22	1	0.23	1	0.18
Concrete	0	0.13	1	0.14	1	0.16	1	0.12	1	0.11
Precast	0	0.02	0	0.03	0	0.06	0	0.06	0	0.06
RM	5	1.94	4	0.88	9	1.67	9	1.65	4	0.67
URM	0	0.00	0	0.00	0	0.01	0	0.02	1	0.09
MH	15	5.82	65	14.92	289	51.99	522	91.47	634	97.17
Total	**254**		**435**		**557**		**571**		**653**	

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

Essential Facility Damage

Before the earthquake, the region had 14 hospital beds available for use. On the day of the earthquake, the model estimates that only 2 hospital beds (18.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 53.00% of the beds will be back in service. By 30 days, 90.00% will be operational.

Table 6: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	1	0	0	0
Schools	4	0	0	2
EOCs	0	0	0	0
PoliceStations	2	0	0	1
FireStations	2	0	0	1

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	12	0	0	12	12
	Bridges	19	4	0	15	17
	Tunnels	0	0	0	0	0
Railways	Segments	24	0	0	24	24
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
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	4	1	0	4	4
	Runways	5	0	0	5	5

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	with Functionality > 50 % 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	0	0	0	0	0

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	8,215	3585	896
Waste Water	4,929	2835	709
Natural Gas	3,286	3031	758
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	2,093	1,104	1,046	919	44	0
Electric Power		1,244	756	301	56	2

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 51.00% 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 (47 households to be displaced due to the earthquake. Of these, 10 people (out of a total population of 5,794 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	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	2	1	0	0
	Industrial	2	1	0	0
	Other-Residential	82	20	1	2
	Single Family	6	1	0	0
	Total	**92**	**22**	**2**	**3**
2 PM	Commercial	21	7	1	2
	Commuting	0	0	0	0
	Educational	14	4	1	2
	Hotels	0	0	0	0
	Industrial	13	4	1	1
	Other-Residential	18	4	0	0
	Single Family	1	0	0	0
	Total	**68**	**20**	**3**	**6**
5 PM	Commercial	23	7	1	2
	Commuting	1	2	3	1
	Educational	0	0	0	0
	Hotels	1	0	0	0
	Industrial	8	3	0	1
	Other-Residential	29	7	0	1
	Single Family	2	0	0	0
	Total	**64**	**19**	**5**	**5**

Economic Loss

The total economic loss estimated for the earthquake is 122.40 (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 73.62 (millions of dollars); 8 % 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 72 % 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	0.57	1.40	0.05	0.06	2.09
	Capital-Related	0.00	0.24	1.40	0.08	0.01	1.74
	Rental	0.48	1.14	0.56	0.04	0.03	2.25
	Relocation	0.05	0.08	0.03	0.01	0.01	0.17
	Subtotal	**0.53**	**2.03**	**3.39**	**0.19**	**0.11**	**6.25**
Capital Stock Loses							
	Structural	2.24	7.39	1.68	0.84	0.26	12.40
	Non_Structural	10.12	23.50	4.98	3.24	0.72	42.55
	Content	2.62	4.65	2.21	2.20	0.33	12.01
	Inventory	0.00	0.00	0.11	0.29	0.01	0.41
	Subtotal	**14.98**	**35.54**	**8.98**	**6.56**	**1.31**	**67.38**
	Total	**15.51**	**37.57**	**12.37**	**6.74**	**1.43**	**73.62**

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	1,557.67	$0.00	0.00
	Bridges	12.85	$1.72	13.35
	Tunnels	0.00	$0.00	0.00
	Subtotal	**1570.50**	**1.70**	
Railways	Segments	74.84	$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	**74.80**	**0.00**	
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	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	23.76	$4.53	19.05
	Runways	169.39	$0.00	0.00
	Subtotal	**193.10**	**4.50**	
	Total	**1838.50**	**6.20**	

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	0.00	$0.00	0.00
	Distribution Line	164.30	$16.13	9.82
	Subtotal	164.31	$16.13	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Line	98.60	$12.76	12.94
	Subtotal	98.58	$12.76	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Line	65.70	$13.64	20.75
	Subtotal	65.72	$13.64	
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	0.00	$0.00	0.00
	Subtotal	0.00	$0.00	
	Total	328.61	$42.53	

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	(1)	-12.82
Second Year			
	Employment Impact	0	0.00
	Income Impact	(2)	-39.01
Third Year			
	Employment Impact	0	0.00
	Income Impact	(3)	-50.22
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(3)	-50.22
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(3)	-50.22
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(3)	-50.22

Appendix A: County Listing for the Region

Lander,NV

Appendix B: Regional Population and Building Value Data

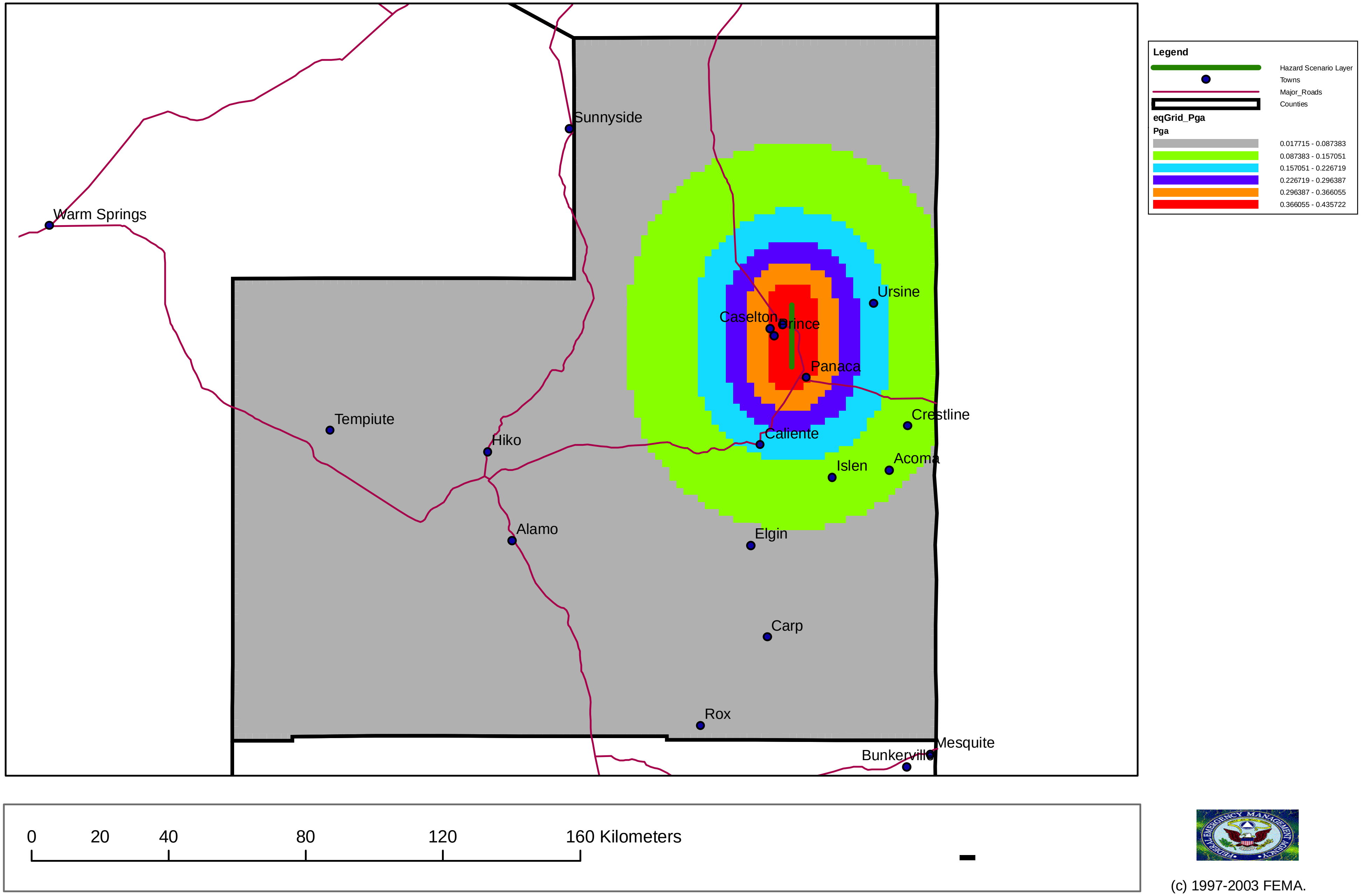
State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Nevada					
	Lander	5,794	198	35	233
Total State		**5,794**	**198**	**35**	**233**
Total Region		**5,794**	**198**	**35**	**233**

Study Region new : Pioche, Lincoln County

R. Hess

Wednesday, November 09, 2005

Hazard Scenario : Pioche M6.5 SS



HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	< 0.1
	Building Contents	< 0.1
	Business Interruption	< 0.1
Infrastructure	Lifelines Damage	
	Total	< 0.1

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	< 1.0	< 1.0	< 1.0	< 1.0
Major	< 1.0	< 1.0	< 1.0	< 1.0
Total	< 1.0	< 1.0	< 1.0	< 1.0

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	< 20
Level 2	Hospital Care	< 20
Level 3	Life-threatening	< 20
Level 4	Fatalities	< 20

Estimated Shelter Needs

Type	Households	People
Displaced Households	0 - 10	
Public Shelter		< 1.0

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 :
37.90 / -114.43

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: 4,165

Building Exposure : ($ Millions)

Residential	221
Commerical	21
Other	12
Total	254

State:

Counties :
- Lincoln,NV

Major Metro Area :

HAZUS-MH: Earthquake Event Report

Region Name: ***Lincoln2***

Earthquake Scenario: ***Pioche 6.5, 8k deep, 10k SE***

Print Date: ***January 24, 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

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 10,628.97 square miles and contains 2 census tracts. There are over 1 thousand households in the region and has a total population of 4,165 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 1 thousand buildings in the region with a total building replacement value (excluding contents) of 258 (millions of dollars). Approximately 99.00 % of the buildings (and 86.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,676 and 0 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 1 thousand buildings in the region which have an aggregate total replacement value of 258 (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 66% 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 20 beds. There are 9 schools, 3 fire stations, 2 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 17 dams identified within the region. Of these, 2 of the dams are classified as 'high hazard'. The inventory also includes 0 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 2,676.00 (millions of dollars). This inventory includes over 497 kilometers of highways, 9 bridges, 24,375 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	9	4.00
	Segments	24	2,296.20
	Tunnels	0	0.00
		Subtotal	**2,300.20**
Railways	Bridges	5	0.90
	Facilities	0	0.00
	Segments	83	215.80
	Tunnels	0	0.00
		Subtotal	**216.70**
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	4	23.80
	Runways	4	135.50
		Subtotal	**159.30**
		Total	**2,676.10**

Table 3: Utility System Lifeline inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	243.80
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**243.80**
Waste Water	Distribution Lines	NA	146.30
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**146.30**
Natural Gas	Distribution Lines	NA	97.50
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**97.50**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	0	0.00
		Subtotal	**0.00**
Communication	Facilities	2	0.20
		Subtotal	**0.20**
		Total	**487.70**

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	Pioche 6.5, 8k deep, 10k SE
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-114.43
Latitude of Epicenter	37.90
Earthquake Magnitude	6.50
Depth (Km)	8.00
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 177 buildings will be at least moderately damaged. This is over 10.00 % of the total number of buildings in the region. There are an estimated 3 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	7	0.50	1	0.45	1	0.85	0	1.31	0	1.96
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	2	0.16	0	0.12	0	0.22	0	0.34	0	0.50
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Other Residential	381	26.38	85	38.29	94	69.07	30	81.66	3	86.83
Religion	1	0.07	0	0.01	0	0.01	0	0.00	0	0.00
Single Family	1,052	72.89	136	61.12	41	29.86	6	16.69	0	10.71
Total	**1,444**		**223**		**136**		**37**		**4**	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	4	0.03	0	0.02	0	0.05	0	0.06	0	0.14
MH*	358	24.79	82	36.79	92	67.77	30	80.12	3	84.84
Precast	1	0.05	0	0.04	0	0.09	0	0.20	0	0.29
RM*	30	2.06	4	1.72	6	4.21	3	8.66	0	6.29
Steel	4	0.03	0	0.03	0	0.10	0	0.31	0	0.56
URM*	1	0.07	0	0.09	0	0.13	0	0.20	0	0.63
Wood	1,045	72.31	135	60.70	36	26.57	3	8.97	0	4.99
Total	**1,444**		**223**		**136**		**37**		**4**	

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

Essential Facility Damage

Before the earthquake, the region had 20 hospital beds available for use. On the day of the earthquake, the model estimates that only 10 hospital beds (54.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 86.00% of the beds will be back in service. By 30 days, 99.00% will be operational.

Table 6: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Least Moderate Damage > 50%**	**Complete Damage > 50%**	**# likely Functional on day 1**
Hospitals	1	0	0	1
Schools	9	0	0	9
EOCs	0	0	0	0
PoliceStations	2	0	0	2
FireStations	3	0	0	3

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	24	0	0	24	24
	Bridges	9	0	0	9	9
	Tunnels	0	0	0	0	0
Railways	Segments	83	0	0	83	83
	Bridges	5	0	0	5	5
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
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	4	1	0	4	4
	Runways	4	0	0	4	4

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	2	0	0	2	2

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	12,188	669	167
Waste Water	7,313	529	132
Natural Gas	4,875	566	141
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	1,540	9	2	0	0	0
Electric Power		0	0	0	0	0

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 0 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 38.00% 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 (4 households to be displaced due to the earthquake. Of these, 1 people (out of a total population of 4,165 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	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	1	0	0	0
	Single Family	0	0	0	0
	Total	**2**	**0**	**0**	**0**
2 PM	Commercial	1	0	0	0
	Commuting	0	0	0	0
	Educational	1	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**2**	**0**	**0**	**0**
5 PM	Commercial	1	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	1	0	0	0
	Single Family	0	0	0	0
	Total	**2**	**0**	**0**	**0**

Economic Loss

The total economic loss estimated for the earthquake is 23.91 (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 5.59 (millions of dollars); 12 % 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 68 % 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	0.00	0.18	0.00	0.03	0.22
	Capital-Related	0.00	0.00	0.20	0.01	0.01	0.21
	Rental	0.06	0.09	0.08	0.00	0.01	0.25
	Relocation	0.01	0.01	0.00	0.00	0.00	0.02
	Subtotal	**0.07**	**0.10**	**0.46**	**0.01**	**0.05**	**0.69**
Capital Stock Loses							
	Structural	0.33	0.27	0.16	0.05	0.10	0.90
	Non_Structural	1.57	0.78	0.34	0.11	0.18	2.98
	Content	0.58	0.13	0.14	0.07	0.08	1.00
	Inventory	0.00	0.00	0.00	0.01	0.00	0.02
	Subtotal	**2.47**	**1.19**	**0.64**	**0.24**	**0.36**	**4.90**
	Total	**2.55**	**1.28**	**1.10**	**0.25**	**0.41**	**5.59**

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	2,296.16	$0.00	0.00
	Bridges	4.03	$0.13	3.13
	Tunnels	0.00	$0.00	0.00
	Subtotal	**2300.20**	**0.10**	
Railways	Segments	215.78	$0.00	0.00
	Bridges	0.89	$0.00	0.01
	Tunnels	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**216.70**	**0.00**	
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	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	23.76	$2.28	9.60
	Runways	135.51	$0.00	0.00
	Subtotal	**159.30**	**2.30**	
	Total	**2676.10**	**2.40**	

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	243.80	$6.03	2.47
	Subtotal	**243.76**	**$6.03**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Line	146.30	$4.77	3.26
	Subtotal	**146.25**	**$4.77**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Line	97.50	$5.09	5.22
	Subtotal	**97.50**	**$5.09**	
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	0.20	$0.02	11.15
	Subtotal	**0.22**	**$0.02**	
	Total	**487.73**	**$15.91**	

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	0	-0.22
Second Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.66
Third Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.85
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.85
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.85
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	0	-0.85

Appendix A: County Listing for the Region

Lincoln,NV

Appendix B: Regional Population and Building Value Data

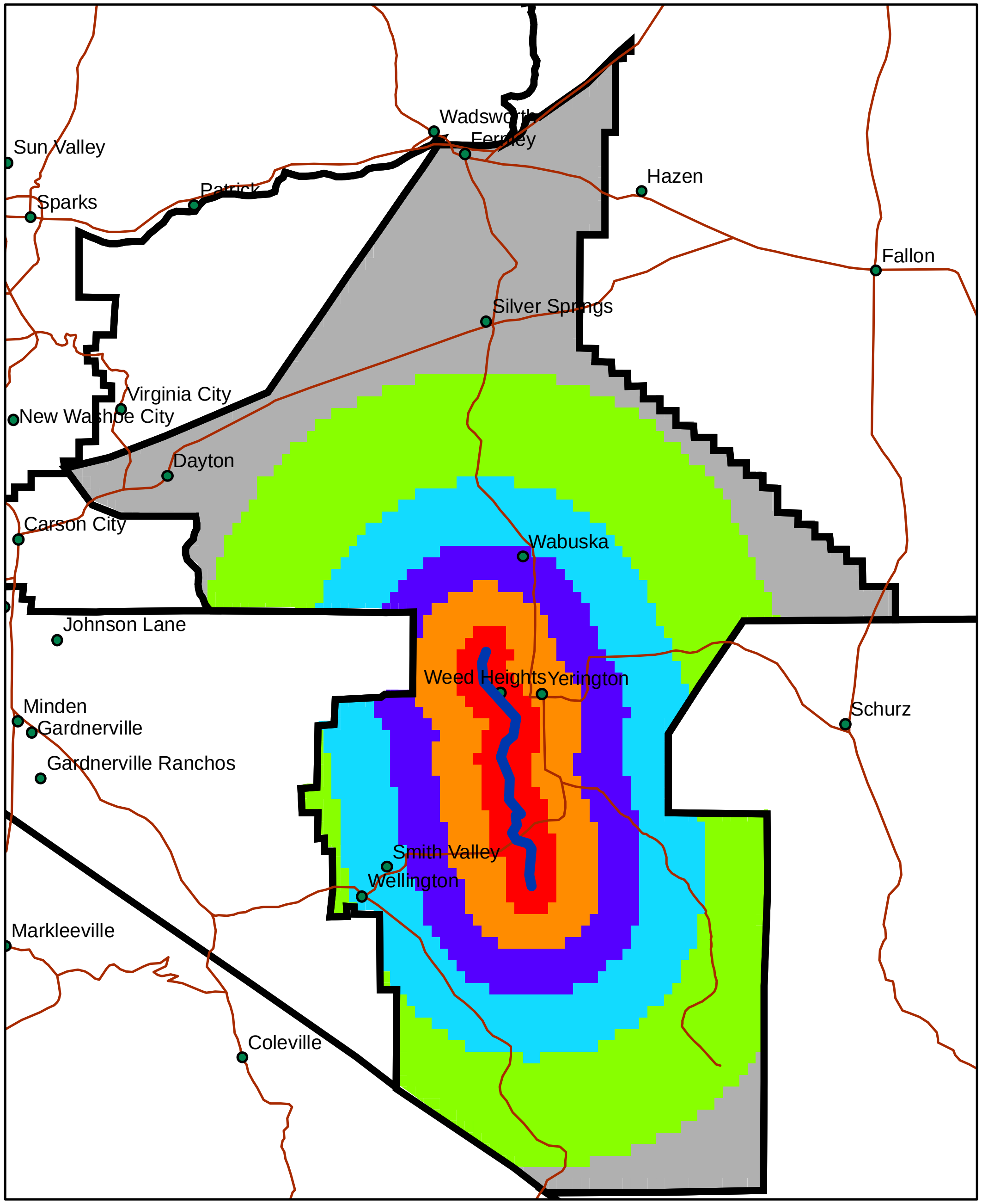
State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Nevada					
	Lincoln	4,165	223	34	258
Total State		**4,165**	**223**	**34**	**258**
Total Region		**4,165**	**223**	**34**	**258**

Study Region new : Lyon County Earthquake Scenario

R. Hess

Thursday, August 11, 2005

Hazard Scenario : Yerington, Singatse Range Fault, M6.9



Legend

Hazard Scenario Layer
Towns
Major_Roads
Counties

eqGrid_Pga

Pga

0.062571 - 0.154072
0.154072 - 0.245573
0.245573 - 0.337074
0.337074 - 0.428575
0.428575 - 0.520076
0.520076 - 0.611578

0 5 10 20 30 40 Kilometers

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	0.00 - 0.10
	Building Contents	< 0.1
	Business Interruption	< 0.1
Infrastructure	Lifelines Damage	
	Total	0.00 - 0.20

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	2 - 9	< 1.0	< 1.0	2 - 9
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	20 - 100
Level 2	Hospital Care	< 20
Level 3	Life-threatening	< 20
Level 4	Fatalities	< 20

Estimated Shelter Needs

Type	Households	People
Displaced Households	30 - 110	
Public Shelter		10 - 30

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 :
38.96 / -119.20

Depth & Type :0.00/S

Fault Name :
Singatse Range fault zone

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: 34,501

Building Exposure : ($ Millions)

Residential	1,310
Commerical	112
Other	107
Total	1,529

State:

Counties :
- Lyon,NV

Major Metro Area :

Time of report: August 11, 2005 4:03 pm

HAZUS-MH: Earthquake Event Report

Region Name: ***Lyon_Hazus***

Earthquake Scenario: ***Yerington, Singatse Range Fault, M6.9***

Print Date: ***August 11, 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

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 2,014.18 square miles and contains 7 census tracts. There are over 13 thousand households in the region and has a total population of 34,501 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 12 thousand buildings in the region with a total building replacement value (excluding contents) of 1, 530 (millions of dollars). Approximately 99.00 % of the buildings (and 86.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 1,912 and 239 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 12 thousand buildings in the region which have an aggregate total replacement value of 1, 530 (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 59% 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 63 beds. There are 17 schools, 8 fire stations, 8 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 15 dams identified within the region. Of these, 2 of the dams are classified as 'high hazard'. The inventory also includes 19 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 2,151.00 (millions of dollars). This inventory includes over 328 kilometers of highways, 42 bridges, 9,739 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	42	24.50
	Segments	58	1,530.60
	Tunnels	0	0.00
		Subtotal	**1,555.10**
Railways	Bridges	1	0.00
	Facilities	0	0.00
	Segments	28	77.40
	Tunnels	0	0.00
		Subtotal	**77.50**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	1	1.20
		Subtotal	**1.20**
Ferry	Facilities	0	0.00
		Subtotal	**0.00**
Port	Facilities	0	0.00
		Subtotal	**0.00**
Airport	Facilities	7	41.60
	Runways	7	237.10
		Subtotal	**278.70**
		Total	**1,912.40**

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	97.40
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**97.40**
Waste Water	Distribution Lines	NA	58.40
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**58.40**
Natural Gas	Distribution Lines	NA	39.00
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**39.00**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	2	239.80
		Subtotal	**239.80**
Communication	Facilities	1	0.10
		Subtotal	**0.10**
		Total	**434.70**

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	Yerington, Singatse Range Fault, M6.9
Type of Earthquake	Source
Fault Name	Singatse Range fault zone
Historical Epicenter ID #	737
Probabilistic Return Period	NA
Longitude of Epicenter	-119.20
Latitude of Epicenter	38.96
Earthquake Magnitude	6.90
Depth (Km)	0.00
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 2,573 buildings will be at least moderately damaged. This is over 20.00 % of the total number of buildings in the region. There are an estimated 169 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	1	0.01	0	0.02	0	0.02	0	0.03	0	0.06
Commercial	25	0.34	8	0.27	8	0.44	4	0.69	2	1.07
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	1	0.02	2	0.06	2	0.11	1	0.21	1	0.34
Industrial	18	0.25	4	0.16	4	0.21	1	0.22	0	0.24
Other Residential	2,219	30.19	1,032	36.66	1,127	62.18	513	86.75	149	88.10
Religion	2	0.02	0	0.02	0	0.02	0	0.04	0	0.06
Single Family	5,084	69.17	1,769	62.83	671	37.02	71	12.06	17	10.13
Total	**7,350**		**2,816**		**1,813**		**592**		**169**	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	5,023	68.34	1775	63.04	650	35.86	57	9.60	16	9.19
Steel	17	0.23	5	0.19	7	0.37	3	0.58	1	0.70
Concrete	15	0.20	5	0.19	4	0.25	2	0.40	1	0.55
Precast	11	0.14	3	0.10	3	0.17	1	0.24	0	0.29
RM	168	2.28	32	1.14	39	2.13	18	3.07	3	1.66
URM	3	0.04	1	0.04	1	0.07	1	0.18	1	0.70
MH	2,114	28.77	994	35.31	1,109	61.15	508	85.93	147	86.91
Total	**7,350**		**2,816**		**1,813**		**592**		**169**	

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

Essential Facility Damage

Before the earthquake, the region had 63 hospital beds available for use. On the day of the earthquake, the model estimates that only 5 hospital beds (9.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 38.00% of the beds will be back in service. By 30 days, 82.00% will be operational.

Table 6: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**At Least Moderate Damage > 50%**	**Complete Damage > 50%**	**With Functionality > 50% on day 1**
Hospitals	1	1	0	0
Schools	17	0	0	12
EOCs	0	0	0	0
PoliceStations	8	0	0	3
FireStations	8	0	0	7

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	With Functionality > 50 % After Day 7
Highway	Segments	58	0	0	58	58
	Bridges	42	2	1	40	41
	Tunnels	0	0	0	0	0
Railways	Segments	28	0	0	28	28
	Bridges	1	0	0	1	1
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
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	1	0	0	1	1
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	7	1	0	7	7
	Runways	7	0	0	7	7

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	2	2	0	0	2
Communication	1	1	0	1	1

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	4,870	2346	586
Waste Water	2,922	1855	464
Natural Gas	1,948	1983	496
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	13,007	7,368	6,803	5,482	0	0
Electric Power		1,028	598	222	39	2

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 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 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 (55 households to be displaced due to the earthquake. Of these, 13 people (out of a total population of 34,501 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	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	37	7	0	1
	Single Family	11	1	0	0
	Total	**49**	**9**	**1**	**1**
2 PM	Commercial	23	6	1	2
	Commuting	0	0	0	0
	Educational	12	3	1	1
	Hotels	0	0	0	0
	Industrial	3	1	0	0
	Other-Residential	9	2	0	0
	Single Family	3	0	0	0
	Total	**49**	**12**	**2**	**3**
5 PM	Commercial	21	6	1	2
	Commuting	1	1	1	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	2	0	0	0
	Other-Residential	13	2	0	0
	Single Family	4	1	0	0
	Total	**41**	**10**	**2**	**2**

Economic Loss

The total economic loss estimated for the earthquake is 184.65 (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 87.89 (millions of dollars); 9 % 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 70 % 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	0.17	1.95	0.13	0.24	2.49
	Capital-Related	0.00	0.07	1.81	0.08	0.04	2.00
	Rental	1.01	1.03	0.94	0.07	0.13	3.17
	Relocation	0.10	0.06	0.05	0.01	0.02	0.24
	Subtotal	**1.12**	**1.32**	**4.74**	**0.29**	**0.43**	**7.90**
Capital Stock Loses							
	Structural	4.98	4.41	2.36	0.71	0.93	13.39
	Non_Structural	25.09	14.52	6.30	2.40	2.05	50.36
	Content	7.58	2.56	2.92	1.60	1.05	15.71
	Inventory	0.00	0.00	0.15	0.32	0.06	0.53
	Subtotal	**37.64**	**21.48**	**11.73**	**5.04**	**4.10**	**79.99**
	Total	**38.76**	**22.80**	**16.47**	**5.32**	**4.53**	**87.89**

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	1,530.58	$0.00	0.00
	Bridges	24.48	$1.30	5.33
	Tunnels	0.00	$0.00	0.00
	Subtotal	**1555.10**	**1.30**	
Railways	Segments	77.43	$0.00	0.00
	Bridges	0.03	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**77.50**	**0.00**	
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	1.19	$0.05	4.21
	Subtotal	**1.20**	**0.10**	
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	41.58	$7.29	17.53
	Runways	237.14	$0.00	0.00
	Subtotal	**278.70**	**7.30**	
	Total	**1912.40**	**8.60**	

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	97.40	$10.56	10.84
	Subtotal	**97.39**	**$10.56**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Line	58.40	$8.35	14.29
	Subtotal	**58.44**	**$8.35**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Line	39.00	$8.92	22.91
	Subtotal	**38.96**	**$8.92**	
Oil Systems	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
Electrical Power	Facilities	239.80	$60.26	25.13
	Subtotal	**239.80**	**$60.26**	
Communication	Facilities	0.10	$0.03	26.51
	Subtotal	**0.11**	**$0.03**	
	Total	**434.70**	**$88.11**	

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	(1)	-0.36
Second Year			
	Employment Impact	0	0.00
	Income Impact	(2)	-1.11
Third Year			
	Employment Impact	0	0.00
	Income Impact	(3)	-1.43
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(3)	-1.43
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(3)	-1.43
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(3)	-1.43

Appendix A: County Listing for the Region

Lyon,NV

Appendix B: Regional Population and Building Value Data

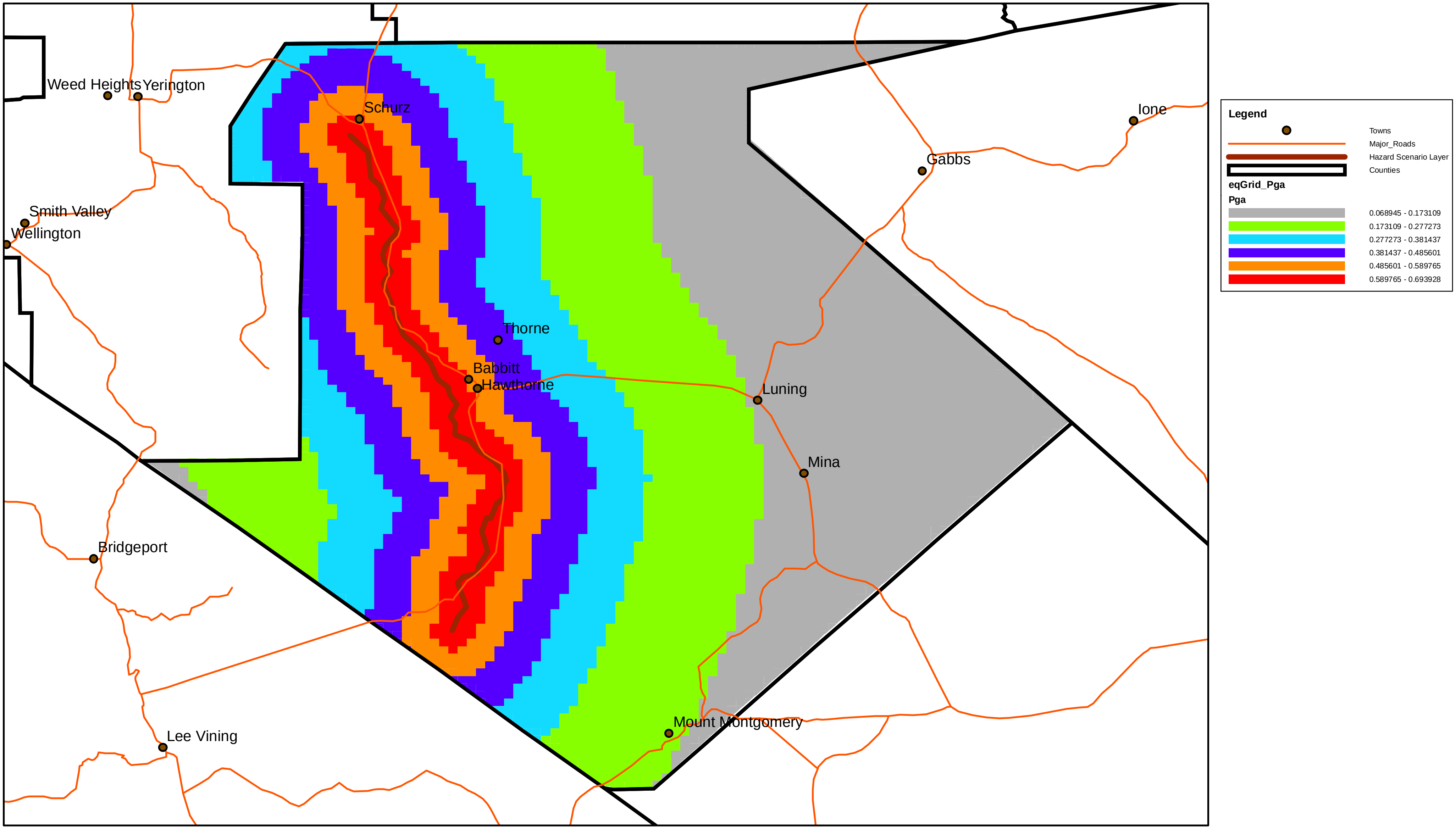
State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Nevada					
	Lyon	34,501	1,310	220	1,530
Total State		**34,501**	**1,310**	**220**	**1,530**
Total Region		**34,501**	**1,310**	**220**	**1,530**

Study Region new : Mineral County Hazus Scenario

R. Hess

Wednesday, November 02, 2005

Hazard Scenario : Hawthorne - Wassuk Range Fault 7.5



0 12.5 25 50 75 100 Kilometers

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	0.00 - 0.10
	Building Contents	< 0.1
	Business Interruption	< 0.1
Infrastructure	Lifelines Damage	
	Total	0.00 - 0.20

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	0 - 2	< 1.0	< 1.0	0 - 2
Major	0 - 1	< 1.0	< 1.0	0 - 1
Total	1 - 4	< 1.0	< 1.0	1 - 4

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	20 - 80
Level 2	Hospital Care	< 20
Level 3	Life-threatening	< 20
Level 4	Fatalities	< 20

Estimated Shelter Needs

Type	Households	People
Displaced Households	40 - 160	
Public Shelter		10 - 40

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 : 7.50

Epicenter Latitude/Longitude :
38.51 / -118.66

Depth & Type :0.00/S

Fault Name :
Wassuk Range fault zone

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: 5,071

Building Exposure : ($ Millions)

Residential	287
Commerical	19
Other	7
Total	313

State:

Counties :
- Mineral,NV

Major Metro Area :

Time of report: November 02, 2005 4:01 pm

HAZUS-MH: Earthquake Event Report

Region Name: *Mineral_Hazus*

Earthquake Scenario: *Hawthorne - Wassuk Range Fault 7.5*

Print Date: *June 15, 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

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 3,809.22 square miles and contains 4 census tracts. There are over 2 thousand households in the region and has a total population of 5,071 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 2 thousand buildings in the region with a total building replacement value (excluding contents) of 314 (millions of dollars). Approximately 99.00 % of the buildings (and 91.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,000 and 0 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 2 thousand buildings in the region which have an aggregate total replacement value of 314 (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 69% 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 35 beds. There are 5 schools, 1 fire stations, 2 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 8 dams identified within the region. Of these, 5 of the dams are classified as ‘high hazard’. The inventory also includes 12 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 2,000.00 (millions of dollars). This inventory includes over 396 kilometers of highways, 0 bridges, 11,956 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	0	0.00
	Segments	27	1,730.70
	Tunnels	0	0.00
		Subtotal	**1,730.70**
Railways	Bridges	0	0.00
	Facilities	0	0.00
	Segments	191	189.80
	Tunnels	0	0.00
		Subtotal	**189.80**
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	2	11.90
	Runways	2	67.80
		Subtotal	**79.60**
		Total	**2,000.20**

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	119.60
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**119.60**
Waste Water	Distribution Lines	NA	71.70
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**71.70**
Natural Gas	Distribution Lines	NA	47.80
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**47.80**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	0	0.00
		Subtotal	**0.00**
Communication	Facilities	0	0.00
		Subtotal	**0.00**
		Total	**239.10**

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	Hawthorne - Wassuk Range Fault 7.5
Type of Earthquake	Source
Fault Name	Wassuk Range fault zone
Historical Epicenter ID #	741
Probabilistic Return Period	NA
Longitude of Epicenter	-118.66
Latitude of Epicenter	38.51
Earthquake Magnitude	7.50
Depth (Km)	0.00
Rupture Length (Km)	100.00
Rupture Orientation (degrees)	0.00
Attenuation Function	WUS Shallow Crustal Event - Extensional

Building Damage

Building Damage

HAZUS estimates that about 1,339 buildings will be at least moderately damaged. This is over 56.00 % of the total number of buildings in the region. There are an estimated 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 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	1	0.26	2	0.23	3	0.48	3	0.97	4	1.20
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.01	0	0.01	0	0.04	0	0.08	0	0.10
Other Residential	11	2.99	42	5.94	136	20.20	218	67.13	301	88.07
Religion	0	0.01	0	0.02	0	0.04	0	0.07	0	0.09
Single Family	340	96.72	658	93.79	534	79.25	103	31.75	36	10.54
Total	**351**		**702**		**674**		**325**		**342**	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	339	96.36	664	94.68	530	78.71	89	27.29	28	8.32
Steel	0	0.05	0	0.05	1	0.20	2	0.60	2	0.58
Concrete	0	0.12	1	0.16	2	0.25	1	0.40	2	0.52
Precast	0	0.02	0	0.02	0	0.07	1	0.17	1	0.20
RM	6	1.66	6	0.89	16	2.45	18	5.64	10	3.06
URM	0	0.00	0	0.00	0	0.01	0	0.06	1	0.38
MH	6	1.78	29	4.20	123	18.31	214	65.85	297	86.94
Total	**351**		**702**		**674**		**325**		**342**	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 35 hospital beds available for use. On the day of the earthquake, the model estimates that only 0 hospital beds (2.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 16.00% of the beds will be back in service. By 30 days, 59.00% will be operational.

Table 6: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	1	1	0	0
Schools	5	3	0	1
EOCs	0	0	0	0
PoliceStations	2	2	0	0
FireStations	1	1	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	With Functionality > 50 % After Day 7
Highway	Segments	27	0	0	27	27
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
Railways	Segments	191	0	0	191	191
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
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	2	1	0	1	2
	Runways	2	0	0	2	2

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	0	0	0	0	0

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	5,978	4649	1162
Waste Water	3,587	3677	919
Natural Gas	2,391	3931	983
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	2,197	1,703	1,668	1,587	727	0
Electric Power		1,174	766	337	69	2

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 0.02 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 17 people and burn about 1 (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 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 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 (80 households to be displaced due to the earthquake. Of these, 21 people (out of a total population of 5,071 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	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	1	0	0	0
	Industrial	0	0	0	0
	Other-Residential	35	9	1	1
	Single Family	10	2	0	0
	Total	**47**	**11**	**1**	**2**
2 PM	Commercial	28	9	2	3
	Commuting	0	0	0	0
	Educational	1	0	0	0
	Hotels	0	0	0	0
	Industrial	1	0	0	0
	Other-Residential	9	2	0	0
	Single Family	3	1	0	0
	Total	**41**	**12**	**2**	**4**
5 PM	Commercial	24	8	1	3
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	1	0	0	0
	Other-Residential	12	3	0	0
	Single Family	4	1	0	0
	Total	**42**	**12**	**2**	**3**

Economic Loss

The total economic loss estimated for the earthquake is 136.33 (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 77.75 (millions of dollars); 9 % 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 76 % 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	0.35	1.66	0.04	0.05	2.11
	Capital-Related	0.00	0.15	1.49	0.03	0.01	1.68
	Rental	1.04	1.34	0.69	0.01	0.04	3.12
	Relocation	0.11	0.05	0.04	0.00	0.01	0.21
	Subtotal	**1.15**	**1.89**	**3.87**	**0.09**	**0.11**	**7.12**
Capital Stock Loses							
	Structural	4.94	4.37	1.95	0.27	0.24	11.76
	Non_Structural	21.95	16.06	6.07	1.02	0.80	45.91
	Content	5.61	3.31	2.74	0.68	0.35	12.69
	Inventory	0.00	0.00	0.13	0.15	0.00	0.28
	Subtotal	**32.50**	**23.74**	**10.89**	**2.11**	**1.40**	**70.63**
	Total	**33.65**	**25.63**	**14.76**	**2.20**	**1.51**	**77.75**

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	1,730.68	$0.00	0.00
	Bridges	0.00	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Subtotal	**1730.70**	**0.00**	
Railways	Segments	189.84	$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	**189.80**	**0.00**	
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	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	11.88	$3.43	28.83
	Runways	67.75	$0.00	0.00
	Subtotal	**79.60**	**3.40**	
	Total	**2000.20**	**3.40**	

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	119.60	$20.92	17.50
	Subtotal	**119.57**	**$20.92**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Line	71.70	$16.55	23.07
	Subtotal	**71.74**	**$16.55**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Line	47.80	$17.69	36.98
	Subtotal	**47.83**	**$17.69**	
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	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
	Total	**239.14**	**$55.16**	

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	(1)	-11.12
Second Year			
	Employment Impact	0	0.00
	Income Impact	(2)	-33.85
Third Year			
	Employment Impact	0	0.00
	Income Impact	(3)	-43.57
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(3)	-43.57
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(3)	-43.57
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(3)	-43.57

Appendix A: County Listing for the Region

Mineral,NV

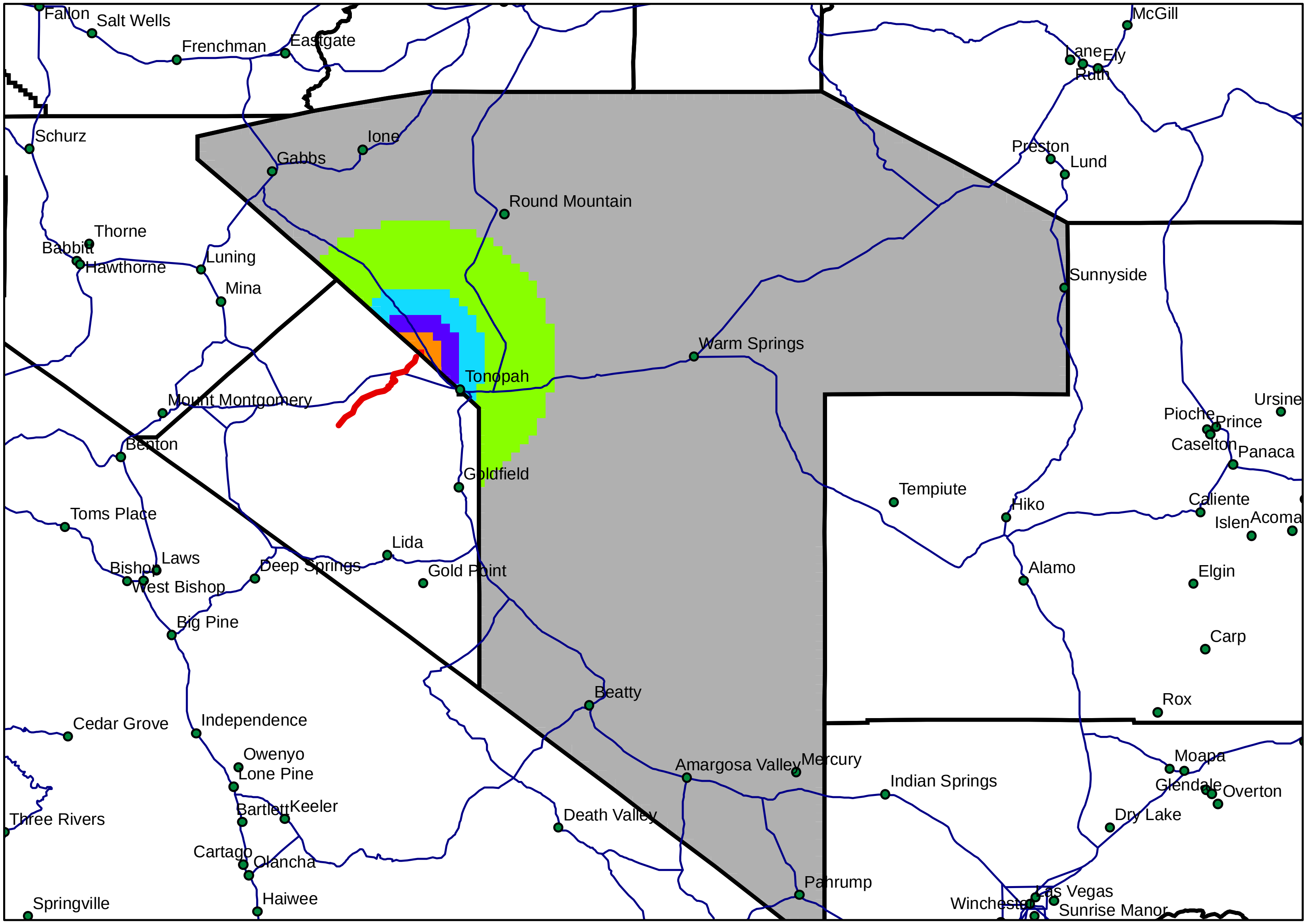
Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Nevada					
	Mineral	5,071	287	27	314
Total State		**5,071**	**287**	**27**	**314**
Total Region		**5,071**	**287**	**27**	**314**

Study Region new : Nye County, Tonopah Scenario R. Hess

Tuesday, November 22, 2005

Hazard Scenario : Lone Mtn fault zone M7.0, Tonopah Event



Legend

Hazard Scenario Layer

Towns

Major_Roads

Counties

eqGrid_Pga

Pga

0 - 0.099643

0.099643 - 0.199286

0.199286 - 0.298929

0.298929 - 0.398572

0.398572 - 0.498215

0.498215 - 0.597858

0 30 60 120 180 240 Kilometers

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	< 0.1
	Building Contents	< 0.1
	Business Interruption	< 0.1
Infrastructure	Lifelines Damage	
	Total	< 0.1

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	< 1.0	< 1.0	< 1.0	< 1.0
Major	< 1.0	< 1.0	< 1.0	< 1.0
Total	< 1.0	< 1.0	< 1.0	< 1.0

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	< 20
Level 2	Hospital Care	< 20
Level 3	Life-threatening	< 20
Level 4	Fatalities	< 20

Estimated Shelter Needs

Type	Households	People
Displaced Households	< 1.0	
Public Shelter		< 1.0

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 : 7.00

Epicenter Latitude/Longitude :
38.15 / -117.43

Depth & Type :0.00/S

Fault Name :
Lone Mountain fault zone

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: 32,485

Building Exposure : ($ Millions)

Residential	1,158
Commerical	122
Other	52
Total	1,332

State:

Counties :
- Nye,NV

Major Metro Area :

Time of report: November 22, 2005 12:20 pm

HAZUS-MH: Earthquake Event Report

Region Name: *Nye_Hazus*

Earthquake Scenario: *Lone Mtn fault zone M7.0, Tonopah Event*

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

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 18,142.78 square miles and contains 10 census tracts. There are over 13 thousand households in the region and has a total population of 32,485 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 13 thousand buildings in the region with a total building replacement value (excluding contents) of 1,333 (millions of dollars). Approximately 100.00 % of the buildings (and 87.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 5,288 and 0 (millions of dollars), respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 13 thousand buildings in the region which have an aggregate total replacement value of 1, 333 (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 41% 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 0 hospitals in the region with a total bed capacity of 0 beds. There are 18 schools, 3 fire stations, 3 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 42 dams identified within the region. Of these, 0 of the dams are classified as 'high hazard'. The inventory also includes 49 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 5,288.00 (millions of dollars). This inventory includes over 1,176 kilometers of highways, 9 bridges, 50,683 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	9	5.00
	Segments	55	4,532.10
	Tunnels	0	0.00
		Subtotal	**4,537.10**
Railways	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	1	1.20
		Subtotal	**1.20**
Ferry	Facilities	0	0.00
		Subtotal	**0.00**
Port	Facilities	0	0.00
		Subtotal	**0.00**
Airport	Facilities	18	106.90
	Runways	19	643.70
		Subtotal	**750.60**
		Total	**5,288.80**

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	506.80
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**506.80**
Waste Water	Distribution Lines	NA	304.10
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**304.10**
Natural Gas	Distribution Lines	NA	202.70
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**202.70**
Oil Systems	Facilities	2	0.20
	Pipelines	0	0.00
		Subtotal	**0.20**
Electrical Power	Facilities	0	0.00
		Subtotal	**0.00**
Communication	Facilities	2	0.20
		Subtotal	**0.20**
		Total	**1,014.10**

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	Lone Mtn fault zone M7.0, Tonopah Event
Type of Earthquake	Source
Fault Name	Lone Mountain fault zone
Historical Epicenter ID #	691
Probabilistic Return Period	NA
Longitude of Epicenter	-117.43
Latitude of Epicenter	38.15
Earthquake Magnitude	7.00
Depth (Km)	0.00
Rupture Length (Km)	42.66
Rupture Orientation (degrees)	0.00
Attenuation Function	WUS Shallow Crustal Event - Extensional

Building Damage

Building Damage

HAZUS estimates that about 32 buildings will be at least moderately damaged. This is over 0.00 % of the total number of buildings in the region. There are an estimated 0 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	1	0.01	0	0.01	0	0.01	0	0.02	0	0.09
Commercial	50	0.36	0	0.26	0	0.28	0	0.75	0	6.04
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	3	0.02	0	0.08	0	0.08	0	0.18	0	1.65
Industrial	3	0.02	0	0.04	0	0.04	0	0.08	0	0.36
Other Residential	7,918	57.88	79	83.13	30	96.92	1	97.89	0	91.67
Religion	3	0.02	0	0.01	0	0.01	0	0.02	0	0.19
Single Family	5,702	41.68	16	16.46	1	2.66	0	1.07	0	0.00
Total	**13,679**		**95**		**31**		**1**		**0**	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	5,630	41.16	16	16.72	1	2.19	0	0.00	0	0.00
Steel	22	0.16	0	0.20	0	0.21	0	0.31	0	1.44
Concrete	21	0.15	0	0.20	0	0.12	0	0.20	0	0.01
Precast	7	0.05	0	0.06	0	0.09	0	0.26	0	0.32
RM	197	1.44	1	0.63	0	0.76	0	1.57	0	0.00
URM	5	0.04	0	0.20	0	0.29	0	1.20	0	22.18
MH	7,796	57.00	78	81.99	30	96.33	1	96.45	0	76.06
Total	**13,679**		**95**		**31**		**1**		**0**	

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

Essential Facility Damage

Before the earthquake, the region had 0 hospital beds available for use. On the day of the earthquake, the model estimates that only 0 hospital beds (0.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 0.00% of the beds will be back in service. By 30 days, 0.00% 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	0	0	0	0
Schools	18	0	0	18
EOCs	0	0	0	0
PoliceStations	3	0	0	3
FireStations	3	0	0	3

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	55	0	0	55	55
	Bridges	9	0	0	9	9
	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	0	0	0	0	0
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	1	0	0	1	1
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	18	0	0	18	18
	Runways	19	0	0	19	19

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	2	0	0	2	2
Electrical Power	0	0	0	0	0
Communication	2	0	0	2	2

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	25,342	175	44
Waste Water	15,205	139	35
Natural Gas	10,137	148	37
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	13,309	0	0	0	0	0
Electric Power		0	0	0	0	0

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 0 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 67.00% 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 (0 households to be displaced due to the earthquake. Of these, 0 people (out of a total population of 32,485 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	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**0**	**0**	**0**	**0**
2 PM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**0**	**0**	**0**	**0**
5 PM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**0**	**0**	**0**	**0**

Economic Loss

The total economic loss estimated for the earthquake is 4.34 (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 0.44 (millions of dollars); 11 % 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 74 % 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	0.01	0.01	0.00	0.00	0.02
	Capital-Related	0.00	0.00	0.01	0.00	0.00	0.01
	Rental	0.00	0.01	0.00	0.00	0.00	0.01
	Relocation	0.00	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.00**	**0.02**	**0.02**	**0.00**	**0.00**	**0.05**
Capital Stock Loses							
	Structural	0.01	0.05	0.01	0.00	0.00	0.08
	Non_Structural	0.07	0.13	0.03	0.01	0.01	0.25
	Content	0.02	0.02	0.01	0.01	0.00	0.05
	Inventory	0.00	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.10**	**0.20**	**0.05**	**0.02**	**0.02**	**0.39**
	Total	**0.10**	**0.22**	**0.07**	**0.02**	**0.02**	**0.44**

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	4,532.06	$0.00	0.00
	Bridges	4.99	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Subtotal	**4537.10**	**0.00**	
Railways	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**	
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	1.19	$0.01	1.13
	Subtotal	**1.20**	**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	106.93	$1.78	1.67
	Runways	643.67	$0.00	0.00
	Subtotal	**750.60**	**1.80**	
	Total	**5288.80**	**1.80**	

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	506.80	$0.79	0.16
	Subtotal	**506.84**	**$0.79**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Line	304.10	$0.62	0.21
	Subtotal	**304.10**	**$0.62**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Line	202.70	$0.67	0.33
	Subtotal	**202.73**	**$0.67**	
Oil Systems	Pipelines	0.00	$0.00	0.00
	Facilities	0.20	$0.01	2.66
	Subtotal	**0.22**	**$0.01**	
Electrical Power	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
Communication	Facilities	0.20	$0.02	10.87
	Subtotal	**0.22**	**$0.02**	
	Total	**1,014.11**	**$2.11**	

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	0	-0.01
Second Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.03
Third Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.04
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.04
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.04
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	0	-0.04

Appendix A: County Listing for the Region

Nye,NV

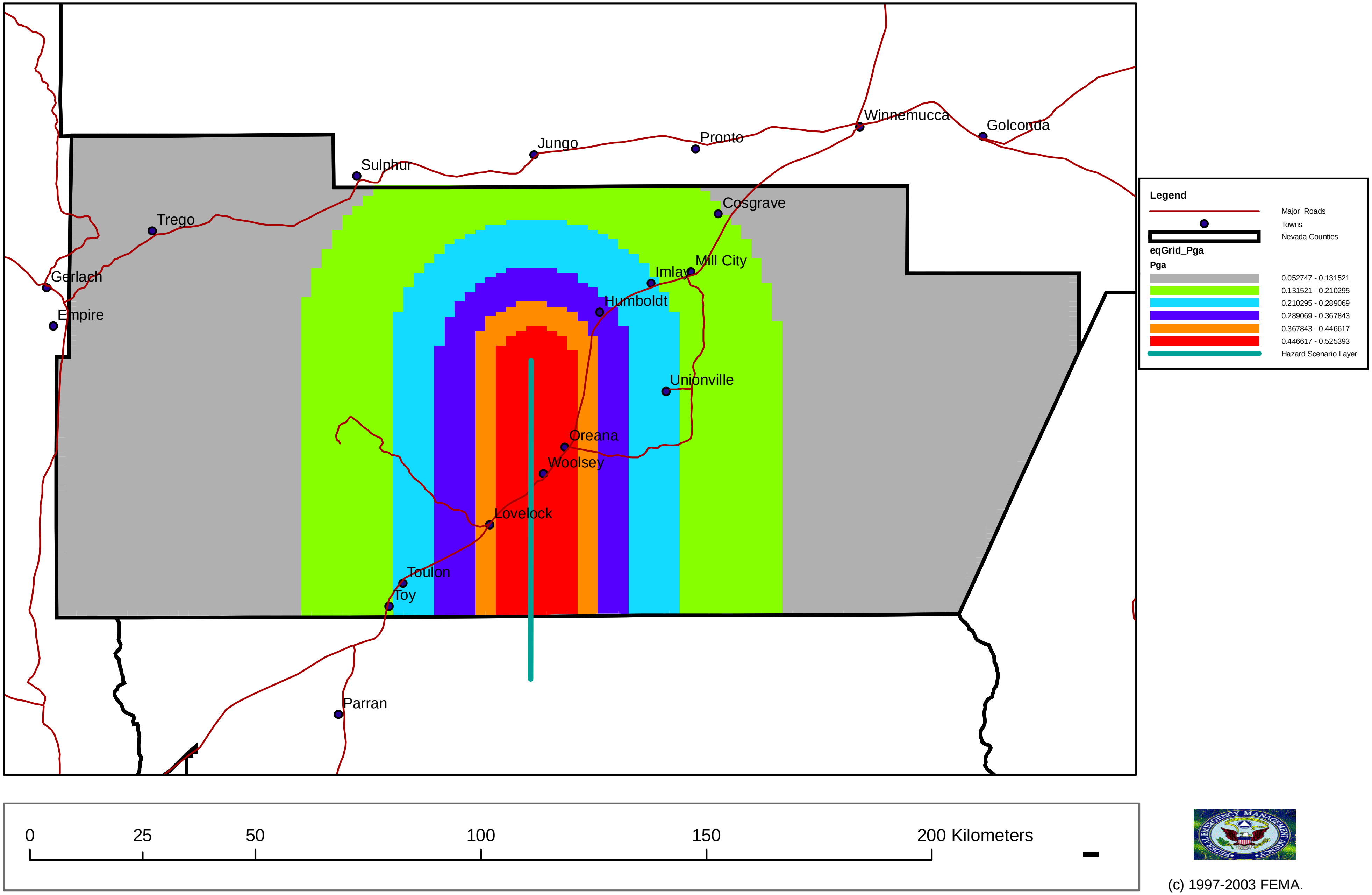
Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Nevada					
	Nye	32,485	1,158	175	1,333
Total State		**32,485**	**1,158**	**175**	**1,333**
Total Region		**32,485**	**1,158**	**175**	**1,333**

Study Region new : Pershing County HAZUS Scenario R. Hess

Tuesday, June 07, 2005

Hazard Scenario : Lovelock 7.3, Western Humboldt Range Fault Event



HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

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

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	0 - 2	< 1.0	< 1.0	0 - 2
Major	0 - 1	< 1.0	< 1.0	0 - 1
Total	0 - 3	< 1.0	< 1.0	0 - 3

Estimated Casualties : Day Time

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

Estimated Shelter Needs

Type	Households	People
Displaced Households	30 - 100	
Public Shelter		10 - 20

Comments :

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Earthquake Information

Location :

Origin Time:

Magnitude : 7.30

Epicenter Latitude/Longitude :
40.19 / -118.39

Depth & Type :8.00/A

Fault Name :
NA

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: 6,693

Building Exposure : ($ Millions)

Residential	211
Commerical	13
Other	12
Total	236

State:

Counties :
- Pershing,NV

Major Metro Area :

HAZUS-MH: Earthquake Event Report

Region Name: ***Pershing_Hazus***

Earthquake Scenario: ***Lovelock 7.3***

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

Disclaimer:

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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 6,058.80 square miles and contains 1 census tracts. There are over 1 thousand households in the region and has a total population of 6,693 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 2 thousand buildings in the region with a total building replacement value (excluding contents) of 237 (millions of dollars). Approximately 100.00 % of the buildings (and 89.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 1,805 and 72 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 2 thousand buildings in the region which have an aggregate total replacement value of 237 (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 48% 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 34 beds. There are 3 schools, 0 fire stations, 2 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 12 dams identified within the region. Of these, 1 of the dams are classified as 'high hazard'. The inventory also includes 24 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 1,877.00 (millions of dollars). This inventory includes over 380 kilometers of highways, 49 bridges, 18,680 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	49	75.60
	Segments	56	1,493.20
	Tunnels	0	0.00
		Subtotal	**1,568.80**
Railways	Bridges	0	0.00
	Facilities	0	0.00
	Segments	37	162.70
	Tunnels	0	0.00
		Subtotal	**162.70**
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	1	5.90
	Runways	2	67.80
		Subtotal	**73.70**
		Total	**1,805.10**

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	186.80
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**186.80**
Waste Water	Distribution Lines	NA	112.10
	Facilities	1	72.60
	Pipelines	0	0.00
		Subtotal	**184.70**
Natural Gas	Distribution Lines	NA	74.70
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**74.70**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	0	0.00
		Subtotal	**0.00**
Communication	Facilities	0	0.00
		Subtotal	**0.00**
		Total	**446.20**

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	Lovelock 7.3
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-118.39
Latitude of Epicenter	40.19
Earthquake Magnitude	7.30
Depth (Km)	8.00
Rupture Length (Km)	71.12
Rupture Orientation (degrees)	0.00
Attenuation Function	WUS Shallow Crustal Event - Extensional

Building Damage

Building Damage

HAZUS estimates that about 1,344 buildings will be at least moderately damaged. This is over 67.00 % of the total number of buildings in the region. There are an estimated 342 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	1	0.34	1	0.24	2	0.39	2	0.39	1	0.40
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.04	0	0.03	0	0.06	0	0.06	0	0.06
Other Residential	8	4.39	51	10.82	240	43.23	396	88.67	328	95.57
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Single Family	178	95.24	421	88.92	313	56.33	49	10.88	14	3.97
Total	**187**		**474**		**555**		**447**		**343**	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	176	94.37	420	88.68	304	54.84	40	8.99	12	3.37
Steel	0	0.13	0	0.10	1	0.23	1	0.26	1	0.22
Concrete	0	0.17	1	0.15	1	0.19	1	0.18	1	0.18
Precast	0	0.02	0	0.01	0	0.03	0	0.04	0	0.04
RM	4	1.90	5	1.07	12	2.16	10	2.19	3	0.84
URM	0	0.00	0	0.01	0	0.02	0	0.04	1	0.15
MH	6	3.41	47	9.98	236	42.52	394	88.30	326	95.20
Total	**187**		**474**		**555**		**447**		**343**	

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

Essential Facility Damage

Before the earthquake, the region had 34 hospital beds available for use. On the day of the earthquake, the model estimates that only 4 hospital beds (14.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 48.00% of the beds will be back in service. By 30 days, 88.00% 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	3	0	0	1
EOCs	0	0	0	0
PoliceStations	2	0	0	0
FireStations	0	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	56	0	0	56	56
	Bridges	49	9	5	40	40
	Tunnels	0	0	0	0	0
Railways	Segments	37	0	0	37	37
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
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	1	0	0	1	1
	Runways	2	0	0	2	2

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	0	0	0	0	0

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	9,340	18330	4583
Waste Water	5,604	14498	3624
Natural Gas	3,736	15497	3874
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	1,962	1,901	1,899	1,895	1,867	1,686
Electric Power		1,442	899	369	71	2

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 49.00% 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 (51 households to be displaced due to the earthquake. Of these, 11 people (out of a total population of 6,693 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	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	1	0	0	0
	Industrial	0	0	0	0
	Other-Residential	64	15	1	2
	Single Family	8	1	0	0
	Total	**72**	**17**	**1**	**2**
2 PM	Commercial	19	6	1	2
	Commuting	0	0	0	0
	Educational	14	4	1	1
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	17	4	0	1
	Single Family	2	0	0	0
	Total	**53**	**15**	**2**	**4**
5 PM	Commercial	17	5	1	2
	Commuting	0	0	0	0
	Educational	1	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	23	5	0	1
	Single Family	3	1	0	0
	Total	**45**	**12**	**2**	**3**

Economic Loss

The total economic loss estimated for the earthquake is 311.26 (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 61.00 (millions of dollars); 8 % 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 78 % 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	0.21	1.17	0.03	0.04	1.46
	Capital-Related	0.00	0.09	1.12	0.05	0.02	1.28
	Rental	0.55	1.05	0.38	0.03	0.01	2.02
	Relocation	0.06	0.06	0.02	0.00	0.01	0.15
	Subtotal	**0.61**	**1.41**	**2.69**	**0.11**	**0.08**	**4.91**
Capital Stock Loses							
	Structural	2.57	5.37	1.02	0.46	0.34	9.75
	Non_Structural	12.06	18.52	3.06	1.71	0.79	36.15
	Content	3.31	3.69	1.40	1.18	0.38	9.96
	Inventory	0.00	0.00	0.07	0.15	0.02	0.24
	Subtotal	**17.94**	**27.57**	**5.55**	**3.50**	**1.54**	**56.10**
	Total	**18.55**	**28.98**	**8.24**	**3.61**	**1.62**	**61.00**

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	1,493.22	$0.00	0.00
	Bridges	75.56	$12.34	16.33
	Tunnels	0.00	$0.00	0.00
	Subtotal	**1568.80**	**12.30**	
Railways	Segments	162.66	$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	**162.70**	**0.00**	
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	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	5.94	$1.48	24.94
	Runways	67.75	$0.00	0.00
	Subtotal	**73.70**	**1.50**	
	Total	**1805.10**	**13.80**	

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	186.80	$82.49	44.16
	Subtotal	**186.81**	**$82.49**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	72.60	$18.98	26.14
	Distribution Line	112.10	$65.24	58.20
	Subtotal	**184.68**	**$84.22**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Line	74.70	$69.74	93.33
	Subtotal	**74.72**	**$69.74**	
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	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
	Total	**446.21**	**$236.44**	

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	(1)	-0.98
Second Year			
	Employment Impact	0	0.00
	Income Impact	(2)	-2.98
Third Year			
	Employment Impact	0	0.00
	Income Impact	(2)	-3.83
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(2)	-3.83
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(2)	-3.83
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(2)	-3.83

Appendix A: County Listing for the Region

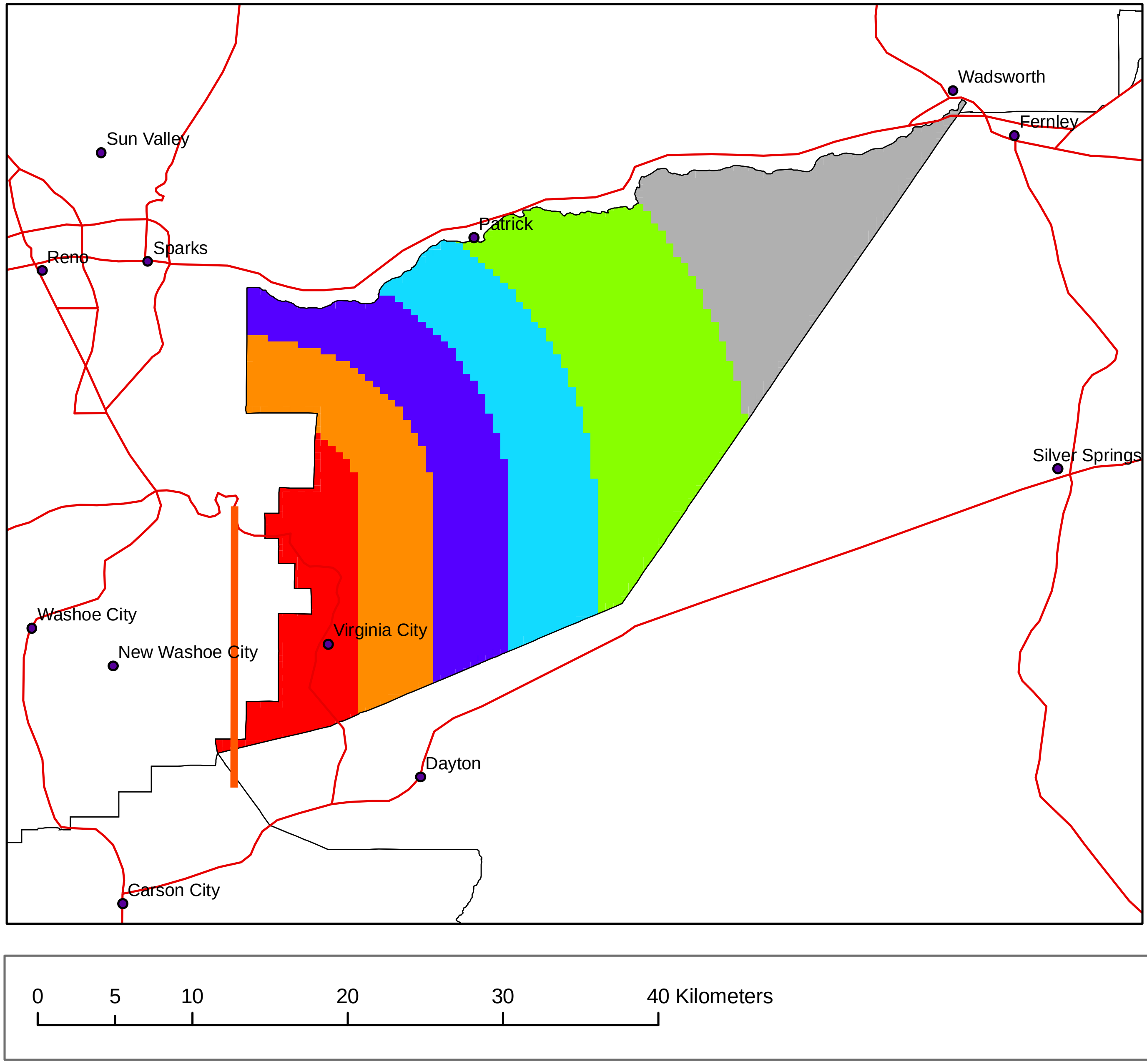
Pershing,NV

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Nevada					
	Pershing	6,693	211	25	237
Total State		**6,693**	**211**	**25**	**237**
Total Region		**6,693**	**211**	**25**	**237**

Study Region : Storey County - Hazus

Hazard Scenario : Virginia City 6.5m - 5K due west R. Hess



Legend

	Hazard Scenario
	Towns
	Major Roads
	County Boundaries

eqGrid_Pga

Pga

	0.080915 - 0.140064
	0.140064 - 0.199213
	0.199213 - 0.258362
	0.258362 - 0.317511
	0.317511 - 0.37666
	0.37666 - 0.435807

Thursday, May 05, 2005

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	< 0.1
	Building Contents	< 0.1
	Business Interruption	< 0.1
Infrastructure	Lifelines Damage	
	Total	< 0.1

Estimated Building Damage(Thousands of Buildings)

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

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	< 20
Level 2	Hospital Care	< 20
Level 3	Life-threatening	< 20
Level 4	Fatalities	< 20

Estimated Shelter Needs

Type	Households	People
Displaced Households	0 - 10	
Public Shelter		< 1.0

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 :
39.31 / -119.70

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: 3,399

Building Exposure : ($ Millions)

Residential	164
Commerical	16
Other	5
Total	185

State:

Counties :
- Storey,NV

Major Metro Area :

Time of report: November 09, 2005 3:40 pm

HAZUS-MH: Earthquake Event Report

Region Name: ***Storey_Hazus***

Earthquake Scenario: ***Virginia City 6.5m - 5K due west***

Print Date: ***May 05, 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

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 263.48 square miles and contains 2 census tracts. There are over 1 thousand households in the region and has a total population of 3,399 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 1 thousand buildings in the region with a total building replacement value (excluding contents) of 186 (millions of dollars). Approximately 99.00 % of the buildings (and 88.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 83 and 73 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 1 thousand buildings in the region which have an aggregate total replacement value of 186 (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 69% 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 0 hospitals in the region with a total bed capacity of 0 beds. There are 4 schools, 0 fire stations, 1 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 4 dams identified within the region. Of these, 2 of the dams are classified as 'high hazard'. The inventory also includes 0 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 156.00 (millions of dollars). This inventory includes over 17 kilometers of highways, 14 bridges, 1,526 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	14	10.80
	Segments	3	55.20
	Tunnels	0	0.00
		Subtotal	**66.00**
Railways	Bridges	0	0.00
	Facilities	0	0.00
	Segments	19	17.60
	Tunnels	0	0.00
		Subtotal	**17.60**
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	0	0.00
	Runways	0	0.00
		Subtotal	**0.00**
		Total	**83.60**

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	15.30
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**15.30**
Waste Water	Distribution Lines	NA	9.20
	Facilities	1	72.60
	Pipelines	0	0.00
		Subtotal	**81.80**
Natural Gas	Distribution Lines	NA	6.10
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**6.10**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	0	0.00
		Subtotal	**0.00**
Communication	Facilities	4	0.40
		Subtotal	**0.40**
		Total	**103.60**

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	Virginia City 6.5m - 5K due west
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-119.70
Latitude of Epicenter	39.31
Earthquake Magnitude	6.50
Depth (Km)	8.00
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 280 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 6 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	5	0.63	2	0.56	2	0.97	1	1.23	0	2.03
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Other Residential	96	12.28	105	27.92	141	66.49	56	92.95	6	85.94
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Single Family	683	87.09	269	71.53	69	32.54	4	5.82	1	12.03
Total	**785**		**376**		**213**		**61**		**7**	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	666	84.87	266	70.61	66	30.88	3	4.46	1	11.79
Steel	2	0.23	1	0.23	1	0.42	0	0.39	0	0.71
Concrete	1	0.14	1	0.14	0	0.22	0	0.29	0	0.29
Precast	0	0.03	0	0.03	0	0.06	0	0.08	0	0.14
RM	23	2.96	6	1.47	5	2.15	1	1.89	0	0.79
URM	0	0.03	0	0.05	0	0.09	0	0.18	0	0.69
MH	92	11.75	103	27.47	141	66.18	56	92.70	6	85.58
Total	**785**		**376**		**213**		**61**		**7**	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 0 hospital beds available for use. On the day of the earthquake, the model estimates that only 0 hospital beds (0.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 0.00% of the beds will be back in service. By 30 days, 0.00% 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	0	0	0	0
Schools	4	0	0	4
EOCs	0	0	0	0
PoliceStations	1	0	0	0
FireStations	0	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	With Functionality > 50 % After Day 7
Highway	Segments	3	0	0	3	3
	Bridges	14	0	0	14	14
	Tunnels	0	0	0	0	0
Railways	Segments	19	0	0	19	19
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
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	0	0	0	0	0
	Runways	0	0	0	0	0

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	4	4	0	4	4

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	763	112	28
Waste Water	458	89	22
Natural Gas	305	95	24
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	1,462	0	0	0	0	0
Electric Power		0	0	0	0	0

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 0 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 51.00% 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 (4 households to be displaced due to the earthquake. Of these, 0 people (out of a total population of 3,399 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	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	2	0	0	0
	Single Family	1	0	0	0
	Total	**3**	**0**	**0**	**0**
2 PM	Commercial	1	0	0	0
	Commuting	0	0	0	0
	Educational	1	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**3**	**1**	**0**	**0**
5 PM	Commercial	2	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	1	0	0	0
	Single Family	0	0	0	0
	Total	**3**	**1**	**0**	**0**

Economic Loss

The total economic loss estimated for the earthquake is 26.38 (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 8.49 (millions of dollars); 15 % 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 69 % 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	0.03	0.41	0.00	0.03	0.47
	Capital-Related	0.00	0.01	0.48	0.00	0.00	0.50
	Rental	0.09	0.10	0.12	0.00	0.00	0.32
	Relocation	0.01	0.01	0.00	0.00	0.00	0.02
	Subtotal	**0.10**	**0.15**	**1.02**	**0.01**	**0.04**	**1.31**
Capital Stock Loses							
	Structural	0.48	0.37	0.23	0.03	0.04	1.15
	Non_Structural	2.54	1.14	0.68	0.08	0.11	4.56
	Content	0.87	0.17	0.30	0.05	0.06	1.46
	Inventory	0.00	0.00	0.01	0.01	0.00	0.02
	Subtotal	**3.89**	**1.68**	**1.23**	**0.17**	**0.21**	**7.18**
	Total	**3.99**	**1.83**	**2.25**	**0.18**	**0.25**	**8.49**

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	55.20	$0.00	0.00
	Bridges	10.83	$0.33	3.04
	Tunnels	0.00	$0.00	0.00
	Subtotal	**66.00**	**0.30**	
Railways	Segments	17.56	$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	**17.60**	**0.00**	
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	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	0.00	$0.00	0.00
	Runways	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
	Total	**83.60**	**0.30**	

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	0.00	$0.00	0.00
	Distribution Line	15.30	$0.51	3.31
	Subtotal	**15.27**	**$0.51**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	72.60	$16.10	22.18
	Distribution Line	9.20	$0.40	4.36
	Subtotal	**81.76**	**$16.50**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Line	6.10	$0.43	7.00
	Subtotal	**6.11**	**$0.43**	
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	0.40	$0.12	27.55
	Subtotal	**0.44**	**$0.12**	
	Total	**103.57**	**$17.56**	

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	0	-3.96
Second Year			
	Employment Impact	0	0.00
	Income Impact	0	-12.06
Third Year			
	Employment Impact	0	0.00
	Income Impact	0	-15.53
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	0	-15.53
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	0	-15.53
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	0	-15.53

Appendix A: County Listing for the Region

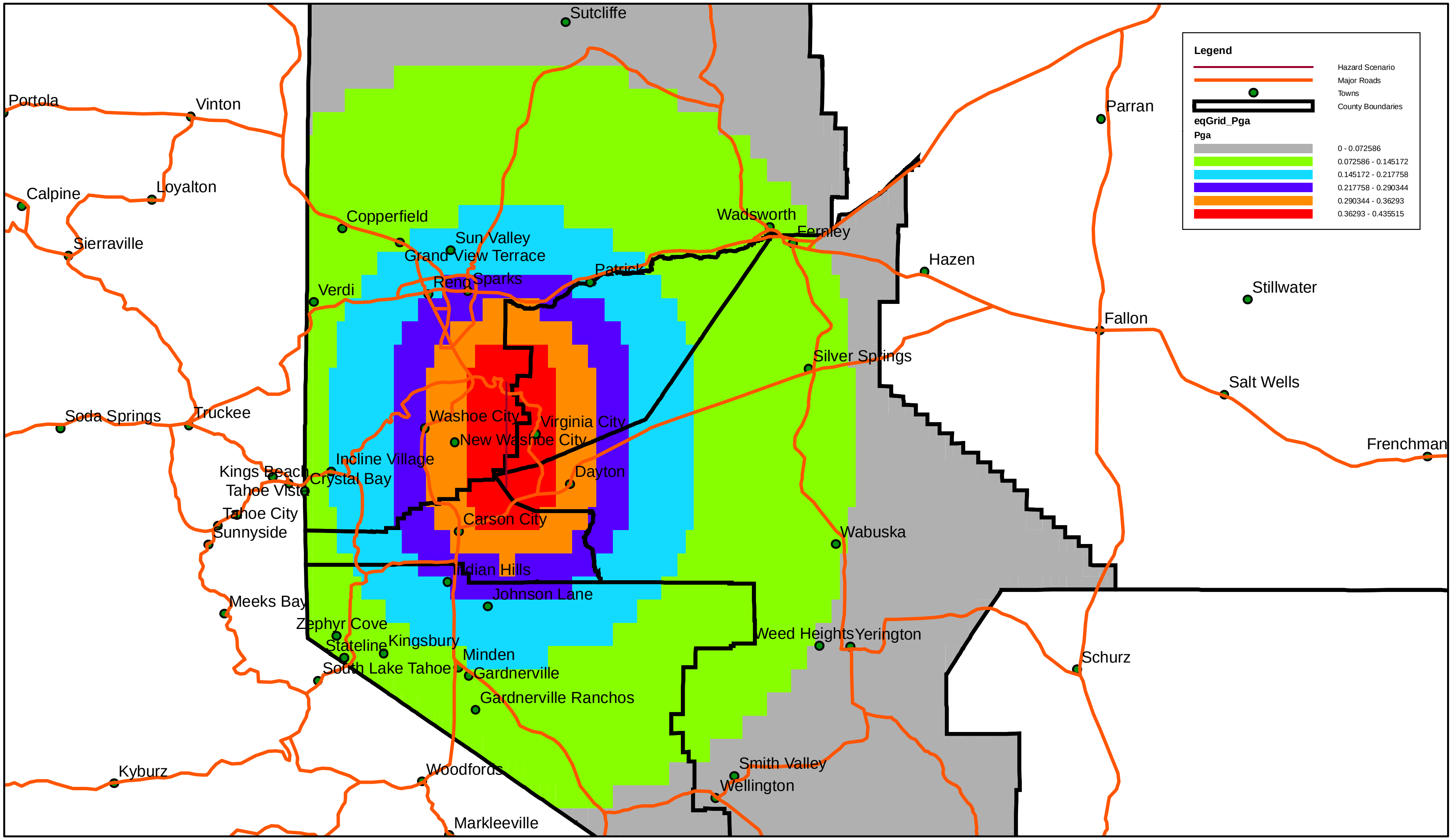
Storey,NV

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Nevada					
	Storey	3,399	164	22	186
Total State		**3,399**	**164**	**22**	**186**
Total Region		**3,399**	**164**	**22**	**186**

Study Region new : Storey, Washoe, Carson, Lyon, and Douglas Counties R. Hess

Hazard Scenario : Virginia City, 6.5, 5K West Wednesday, May 11, 2005



30 15 0 30 60 90 Kilometers

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	0.40 - 1.70
	Building Contents	0.00 - 0.10
	Business Interruption	0.10 - 0.30
Infrastructure	Lifelines Damage	
	Total	0.60 - 2.50

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	20 - 90	0 - 1	< 1.0	20 - 90
Major	1 - 6	< 1.0	< 1.0	1 - 7
Total	20 - 100	0 - 1	< 1.0	20 - 100

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	300 - 1,300
Level 2	Hospital Care	80 - 300
Level 3	Life-threatening	10 - 50
Level 4	Fatalities	20 - 90

Estimated Shelter Needs

Type	Households	People
Displaced Households	800 - 3,000	
Public Shelter		200 - 800

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 :
39.31 / -119.70

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 09, 2005 8:14 am

HAZUS-MH: Earthquake Event Report

Region Name: ***County_NW***

Earthquake Scenario: ***Storey County Area***

Print Date: ***November 09, 2005***

Table of Contents

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	Storey County Area
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-119.70
Latitude of Epicenter	39.31
Earthquake Magnitude	6.50
Depth (Km)	8.00
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 15,977 buildings will be at least moderately damaged. This is over 10.00 % of the total number of buildings in the region. There are an estimated 607 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	914	0.87	347	1.05	307	2.48	116	3.91	29	4.72
Education	5	0.00	2	0.01	2	0.01	1	0.03	0	0.03
Government	45	0.04	21	0.06	23	0.18	11	0.36	3	0.48
Industrial	166	0.16	75	0.23	80	0.65	35	1.19	11	1.83
Other Residential	14,131	13.50	5,738	17.33	5,643	45.54	2,395	80.39	471	77.52
Religion	27	0.03	9	0.03	6	0.05	2	0.08	1	0.09
Single Family	89,356	85.39	26,919	81.30	6,330	51.08	419	14.06	93	15.34
Total	**104,644**		**33,110**		**12,391**		**2,979**		**607**	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	89,932	85.94	27649	83.51	6,209	50.11	327	10.97	92	15.15
Steel	437	0.42	173	0.52	188	1.52	66	2.21	13	2.15
Concrete	485	0.46	193	0.58	137	1.11	57	1.91	10	1.70
Precast	205	0.20	83	0.25	94	0.76	42	1.41	11	1.84
RM	3,320	3.17	628	1.90	543	4.39	169	5.66	15	2.42
URM	74	0.07	47	0.14	56	0.45	34	1.15	20	3.27
MH	10,191	9.74	4337	13.10	5,164	41.67	2,285	76.69	446	73.47
Total	**104,644**		**33,110**		**12,391**		**2,979**		**607**	

*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 855 hospital beds (60.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 87.00% of the beds will be back in service. By 30 days, 99.00% will be operational.

Table 6: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	11	0	0	9
Schools	173	0	0	155
EOCs	2	0	0	2
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	With Functionality > 50 % After Day 7
Highway	Segments	141	0	0	141	141
	Bridges	292	5	0	289	290
	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	0	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	0	0	5	5
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	22	0	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	0	0	3	3
Waste Water	8	2	0	3	8
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	6	1	0	3	6
Communication	42	9	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	1176	294
Waste Water	11,843	930	232
Natural Gas	7,895	994	248
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	4,512	138	0	0	0
Electric Power		3,282	1,751	573	89	5

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 4 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 119 people and burn about 6 (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 (1,606 households to be displaced due to the earthquake. Of these, 417 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	9	2	0	0
	Industrial	14	4	1	1
	Other-Residential	243	44	4	7
	Single Family	100	10	0	1
	Total	**373**	**61**	**5**	**9**
2 PM	Commercial	432	104	16	30
	Commuting	0	0	1	0
	Educational	56	13	2	4
	Hotels	2	0	0	0
	Industrial	104	26	4	8
	Other-Residential	50	9	1	1
	Single Family	19	2	0	0
	Total	**663**	**156**	**23**	**44**
5 PM	Commercial	322	78	12	22
	Commuting	12	16	28	5
	Educational	8	2	0	1
	Hotels	3	1	0	0
	Industrial	65	16	2	5
	Other-Residential	89	16	1	3
	Single Family	38	4	0	0
	Total	**537**	**133**	**44**	**36**

Economic Loss

The total economic loss estimated for the earthquake is 1,445.89 (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 1,270.76 (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 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	4.07	50.86	2.89	2.64	60.46
	Capital-Related	0.00	1.74	44.73	1.75	0.36	48.57
	Rental	8.88	23.82	25.85	1.52	1.18	61.25
	Relocation	0.87	0.64	1.46	0.15	0.24	3.35
	Subtotal	**9.75**	**30.27**	**122.90**	**6.30**	**4.42**	**173.64**
Capital Stock Loses							
	Structural	51.74	38.63	57.80	14.81	5.17	168.16
	Non_Structural	276.59	182.24	150.13	48.88	16.35	674.20
	Content	90.11	39.69	73.87	33.13	8.03	244.83
	Inventory	0.00	0.00	3.21	6.64	0.08	9.93
	Subtotal	**418.44**	**260.56**	**285.02**	**103.46**	**29.64**	**1,097.12**
	Total	**428.20**	**290.82**	**407.92**	**109.76**	**34.06**	**1,270.76**

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	$9.74	2.03
	Tunnels	0.00	$0.00	0.00
	Subtotal	**5119.10**	**9.70**	
Railways	Segments	294.15	$0.00	0.00
	Bridges	1.46	$0.00	0.32
	Tunnels	0.00	$0.00	0.00
	Facilities	16.63	$2.49	14.97
	Subtotal	**312.20**	**2.50**	
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	$1.03	17.30
	Subtotal	**5.90**	**1.00**	
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	130.69	$11.11	8.50
	Runways	813.05	$0.00	0.00
	Subtotal	**943.70**	**11.10**	
	Total	**6381.00**	**24.40**	

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	$9.04	8.30
	Distribution Line	394.80	$5.29	1.34
	Subtotal	**503.64**	**$14.33**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	580.80	$64.75	11.15
	Distribution Line	236.90	$4.18	1.77
	Subtotal	**817.60**	**$68.94**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Line	157.90	$4.47	2.83
	Subtotal	**157.90**	**$4.47**	
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	$62.52	8.69
	Subtotal	**719.40**	**$62.52**	
Communication	Facilities	4.60	$0.50	10.93
	Subtotal	**4.58**	**$0.50**	
	Total	**2,203.13**	**$150.76**	

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

	LOSS	Total	%
First Year			
	Employment Impact	1,200	0.78
	Income Impact	(6)	-0.08
Second Year			
	Employment Impact	490	0.32
	Income Impact	(28)	-0.38
Third Year			
	Employment Impact	12	0.01
	Income Impact	(39)	-0.52
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(40)	-0.53
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(40)	-0.53
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(40)	-0.53

Appendix A: County Listing for the Region

Douglas,NV

Lyon,NV

Storey,NV

Washoe,NV

Carson,NV

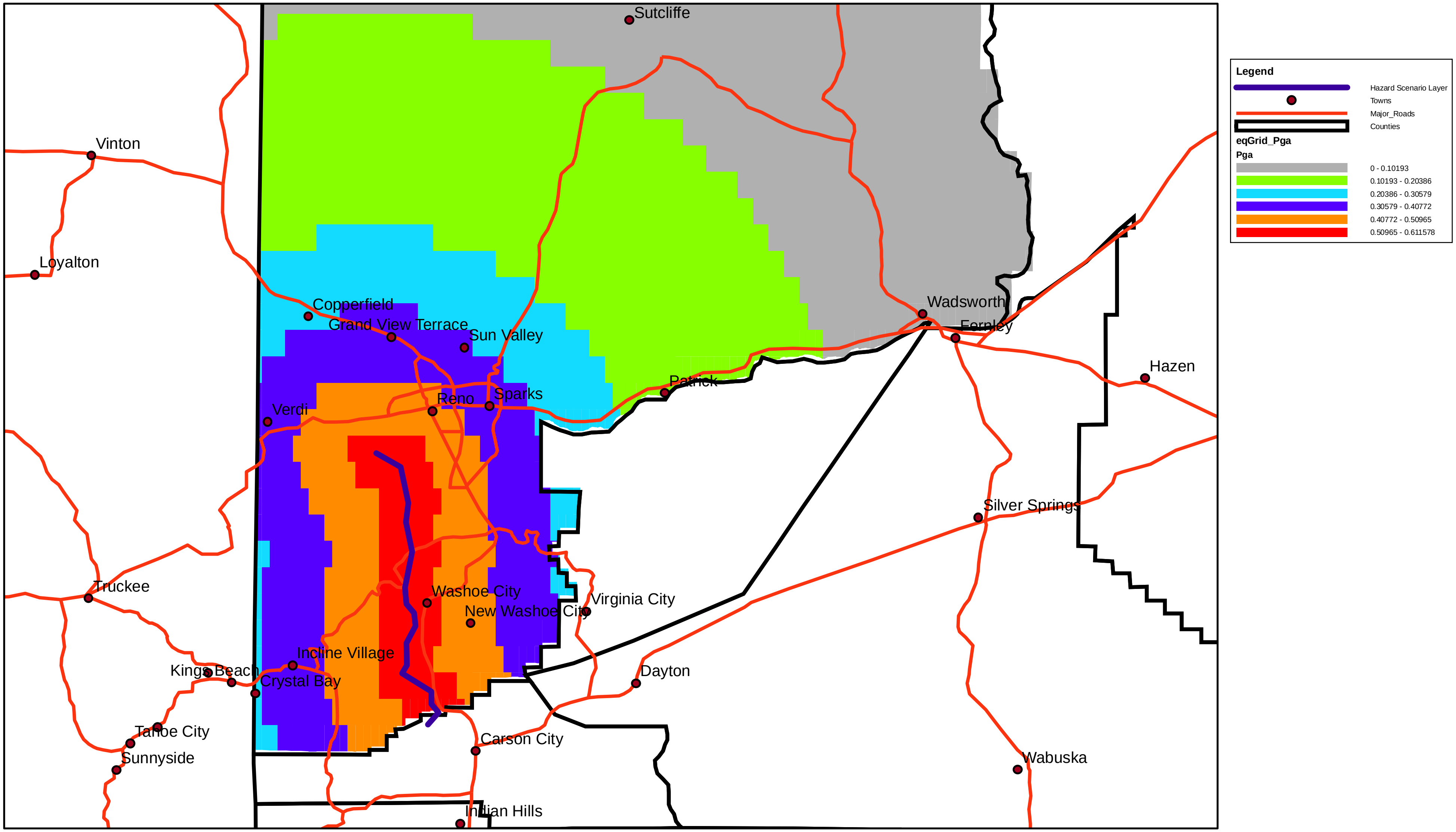
Appendix B: Regional Population and Building Value Data

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 : Reno, Mt. Rose Fault zone, Washoe County M6.9 R. Hess

Tuesday, November 08, 2005

Hazard Scenario : Reno, Washoe County Mt. Rose flt. 6.9



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	1.00 - 4.00
	Building Contents	0.10 - 0.30
	Business Interruption	0.20 - 0.80
Infrastructure	Lifelines Damage	
	Total	1.50 - 5.90

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	30 - 120	0 - 1	< 1.0	30 - 120
Major	3 - 15	< 1.0	< 1.0	4 - 16
Total	30 - 140	0 - 2	< 1.0	30 - 140

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	900 - 4,000
Level 2	Hospital Care	300 - 1,000
Level 3	Life-threatening	40 - 170
Level 4	Fatalities	80 - 300

Estimated Shelter Needs

Type	Households	People
Displaced Households	2,000 - 10,000	
Public Shelter		600 - 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 :
39.34 / -119.84

Depth & Type :0.00/S

Fault Name :
Mount Rose fault zone

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: 339,486

Building Exposure : ($ Millions)

Residential	17,626
Commerical	2,886
Other	892
Total	21,404

State:

Counties :
- Washoe,NV

Major Metro Area :

Time of report: November 08, 2005 5:40 pm

HAZUS-MH: Earthquake Event Report

Region Name: *Washoe_Hazus*

Earthquake Scenario: *Reno, Washoe County Mt. Rose flt. 6.9*

Print Date: *November 08, 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

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 6,541.48 square miles and contains 67 census tracts. There are over 132 thousand households in the region and has a total population of 339,486 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 105 thousand buildings in the region with a total building replacement value (excluding contents) of 21,405 (millions of dollars). Approximately 98.00 % of the buildings (and 82.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 3,264 and 1,027 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 105 thousand buildings in the region which have an aggregate total replacement value of 21,405 (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 83% 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 9 hospitals in the region with a total bed capacity of 1,233 beds. There are 124 schools, 5 fire stations, 9 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 78 dams identified within the region. Of these, 28 of the dams are classified as 'high hazard'. The inventory also includes 37 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 4,291.00 (millions of dollars). This inventory includes over 553 kilometers of highways, 203 bridges, 21,867 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	203	424.00
	Segments	47	2,083.40
	Tunnels	0	0.00
		Subtotal	**2,507.40**
Railways	Bridges	8	1.40
	Facilities	4	9.50
	Segments	107	199.20
	Tunnels	0	0.00
		Subtotal	**210.10**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	1	1.20
		Subtotal	**1.20**
Ferry	Facilities	0	0.00
		Subtotal	**0.00**
Port	Facilities	0	0.00
		Subtotal	**0.00**
Airport	Facilities	12	71.30
	Runways	14	474.30
		Subtotal	**545.60**
		Total	**3,264.30**

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	218.70
	Facilities	3	108.90
	Pipelines	0	0.00
		Subtotal	**327.60**
Waste Water	Distribution Lines	NA	131.20
	Facilities	6	435.60
	Pipelines	0	0.00
		Subtotal	**566.80**
Natural Gas	Distribution Lines	NA	87.50
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**87.50**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	4	479.60
		Subtotal	**479.60**
Communication	Facilities	34	3.70
		Subtotal	**3.70**
		Total	**1,465.10**

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	Reno, Washoe County Mt. Rose flt. 6.9
Type of Earthquake	Source
Fault Name	Mount Rose fault zone
Historical Epicenter ID #	708
Probabilistic Return Period	NA
Longitude of Epicenter	-119.84
Latitude of Epicenter	39.34
Earthquake Magnitude	6.90
Depth (Km)	0.00
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 30,655 buildings will be at least moderately damaged. This is over 29.00 % of the total number of buildings in the region. There are an estimated 1,979 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	284	0.77	295	0.77	404	1.80	239	3.83	121	6.13
Education	2	0.00	1	0.00	2	0.01	1	0.02	0	0.02
Government	7	0.02	9	0.02	12	0.05	8	0.13	4	0.20
Industrial	60	0.16	56	0.15	77	0.34	43	0.70	21	1.05
Other Residential	2,671	7.27	3,790	9.86	5,535	24.65	3,958	63.59	1,326	66.98
Religion	6	0.02	7	0.02	8	0.04	4	0.07	2	0.11
Single Family	33,711	91.75	34,290	89.18	16,415	73.11	1,971	31.67	505	25.50
Total	**36,740**		**38,448**		**22,452**		**6,225**		**1,979**	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	34,082	92.77	35406	92.09	16,467	73.35	1,660	26.67	465	23.52
Steel	108	0.29	120	0.31	229	1.02	153	2.45	53	2.68
Concrete	153	0.42	184	0.48	184	0.82	109	1.76	50	2.54
Precast	65	0.18	66	0.17	108	0.48	68	1.09	32	1.63
RM	1,144	3.11	659	1.72	941	4.19	515	8.27	114	5.77
URM	9	0.02	17	0.04	39	0.18	47	0.76	66	3.34
MH	1,180	3.21	1996	5.19	4,483	19.97	3,672	59.00	1,198	60.52
Total	**36,740**		**38,448**		**22,452**		**6,225**		**1,979**	

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

Essential Facility Damage

Before the earthquake, the region had 1,233 hospital beds available for use. On the day of the earthquake, the model estimates that only 265 hospital beds (22.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 56.00% of the beds will be back in service. By 30 days, 90.00% will be operational.

Table 6: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**At Least Moderate Damage > 50%**	**Complete Damage > 50%**	**With Functionality > 50% on day 1**
Hospitals	9	4	0	0
Schools	124	0	0	25
EOCs	0	0	0	0
PoliceStations	9	0	0	3
FireStations	5	0	0	2

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	47	0	0	47	47
	Bridges	203	21	3	183	184
	Tunnels	0	0	0	0	0
Railways	Segments	107	0	0	107	107
	Bridges	8	0	0	8	8
	Tunnels	0	0	0	0	0
	Facilities	4	4	0	4	4
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	1	1	0	1	1
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	12	2	0	11	12
	Runways	14	0	0	14	14

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	6	3	0	0	6
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	4	3	0	0	4
Communication	34	29	0	23	34

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	10,934	2771	693
Waste Water	6,560	2192	548
Natural Gas	4,374	2343	586
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	132,084	37,113	33,148	25,051	0	0
Electric Power		40,867	24,103	9,244	1,680	59

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 0.18 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 160 people and burn about 11 (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 (4,926 households to be displaced due to the earthquake. Of these, 1,291 people (out of a total population of 339,486 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	21	6	1	2
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	31	9	1	3
	Industrial	23	7	1	2
	Other-Residential	632	145	15	29
	Single Family	261	37	2	4
	Total	**969**	**204**	**21**	**40**
2 PM	Commercial	1,280	369	60	119
	Commuting	1	2	3	1
	Educational	203	59	10	19
	Hotels	6	2	0	1
	Industrial	171	48	8	15
	Other-Residential	129	30	3	6
	Single Family	47	7	0	1
	Total	**1,837**	**516**	**85**	**161**
5 PM	Commercial	955	274	45	87
	Commuting	35	49	79	15
	Educational	32	9	2	3
	Hotels	9	3	0	1
	Industrial	107	30	5	9
	Other-Residential	236	55	6	11
	Single Family	101	15	1	1
	Total	**1,474**	**434**	**138**	**129**

Economic Loss

The total economic loss estimated for the earthquake is 3,260.71 (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 2,940.26 (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 60 % 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	11.05	121.00	3.78	3.02	138.86
	Capital-Related	0.00	4.72	102.58	2.31	0.71	110.31
	Rental	25.73	61.65	51.06	1.90	1.43	141.76
	Relocation	2.68	1.47	3.18	0.19	0.40	7.91
	Subtotal	**28.41**	**78.88**	**277.82**	**8.18**	**5.55**	**398.84**
Capital Stock Loses							
	Structural	137.01	87.40	127.69	20.93	8.77	381.80
	Non_Structural	681.83	455.43	363.41	73.03	29.91	1,603.61
	Content	205.06	99.16	172.71	48.50	14.13	539.56
	Inventory	0.00	0.00	6.98	9.31	0.16	16.44
	Subtotal	**1,023.90**	**642.00**	**670.79**	**151.76**	**52.97**	**2,541.41**
	Total	**1,052.30**	**720.88**	**948.61**	**159.95**	**58.52**	**2,940.26**

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	2,083.41	$0.00	0.00
	Bridges	424.00	$45.62	10.76
	Tunnels	0.00	$0.00	0.00
	Subtotal	**2507.40**	**45.60**	
Railways	Segments	199.16	$0.00	0.00
	Bridges	1.43	$0.08	5.27
	Tunnels	0.00	$0.00	0.00
	Facilities	9.50	$3.18	33.42
	Subtotal	**210.10**	**3.30**	
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	1.19	$0.43	36.57
	Subtotal	**1.20**	**0.40**	
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	71.29	$10.95	15.36
	Runways	474.28	$0.00	0.00
	Subtotal	**545.60**	**10.90**	
	Total	**3264.30**	**60.30**	

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	$32.76	30.09
	Distribution Line	218.70	$12.47	5.70
	Subtotal	**327.57**	**$45.23**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	435.60	$74.47	17.10
	Distribution Line	131.20	$9.86	7.52
	Subtotal	**566.77**	**$84.33**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Line	87.50	$10.54	12.05
	Subtotal	**87.47**	**$10.54**	
Oil Systems	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
Electrical Power	Facilities	479.60	$119.26	24.87
	Subtotal	**479.60**	**$119.26**	
Communication	Facilities	3.70	$0.83	22.36
	Subtotal	**3.71**	**$0.83**	
	Total	**1,465.11**	**$260.19**	

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

	LOSS	Total	%
First Year			
	Employment Impact	1,562	1.35
	Income Impact	(18)	-0.31
Second Year			
	Employment Impact	653	0.57
	Income Impact	(69)	-1.17
Third Year			
	Employment Impact	15	0.01
	Income Impact	(92)	-1.56
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(93)	-1.58
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(93)	-1.58
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(93)	-1.58

Appendix A: County Listing for the Region

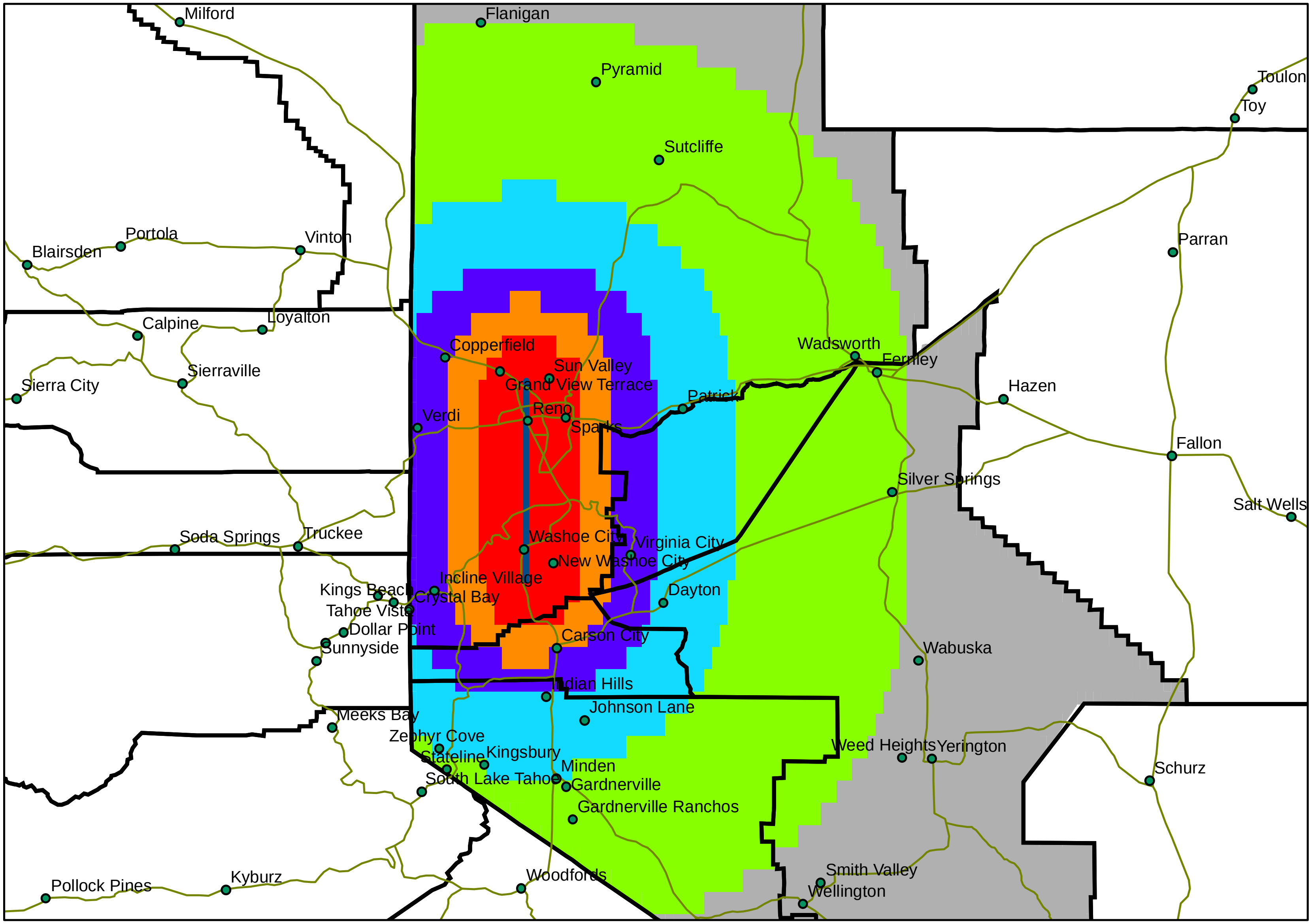
Washoe,NV

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Nevada					
	Washoe	339,486	17,626	3,778	21,405
Total State		**339,486**	**17,626**	**3,778**	**21,405**
Total Region		**339,486**	**17,626**	**3,778**	**21,405**

Study Region new : Washoe and Surrounding Counties, Reno Scenario — R. Hess

Hazard Scenario : Mt Rose M6.9 event — Tuesday, November 22, 2005



Legend

●	Towns
	Major_Roads
	Hazard Scenario Layer
	COUNTYP0
eqGrid_Pga	
Pga	
	0 - 0.079373
	0.079373 - 0.158746
	0.158746 - 0.238119
	0.238119 - 0.317492
	0.317492 - 0.396865
	0.396865 - 0.476236

0 15 30 60 90 120 Kilometers

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

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

		# Facilities		
Classification	Total	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

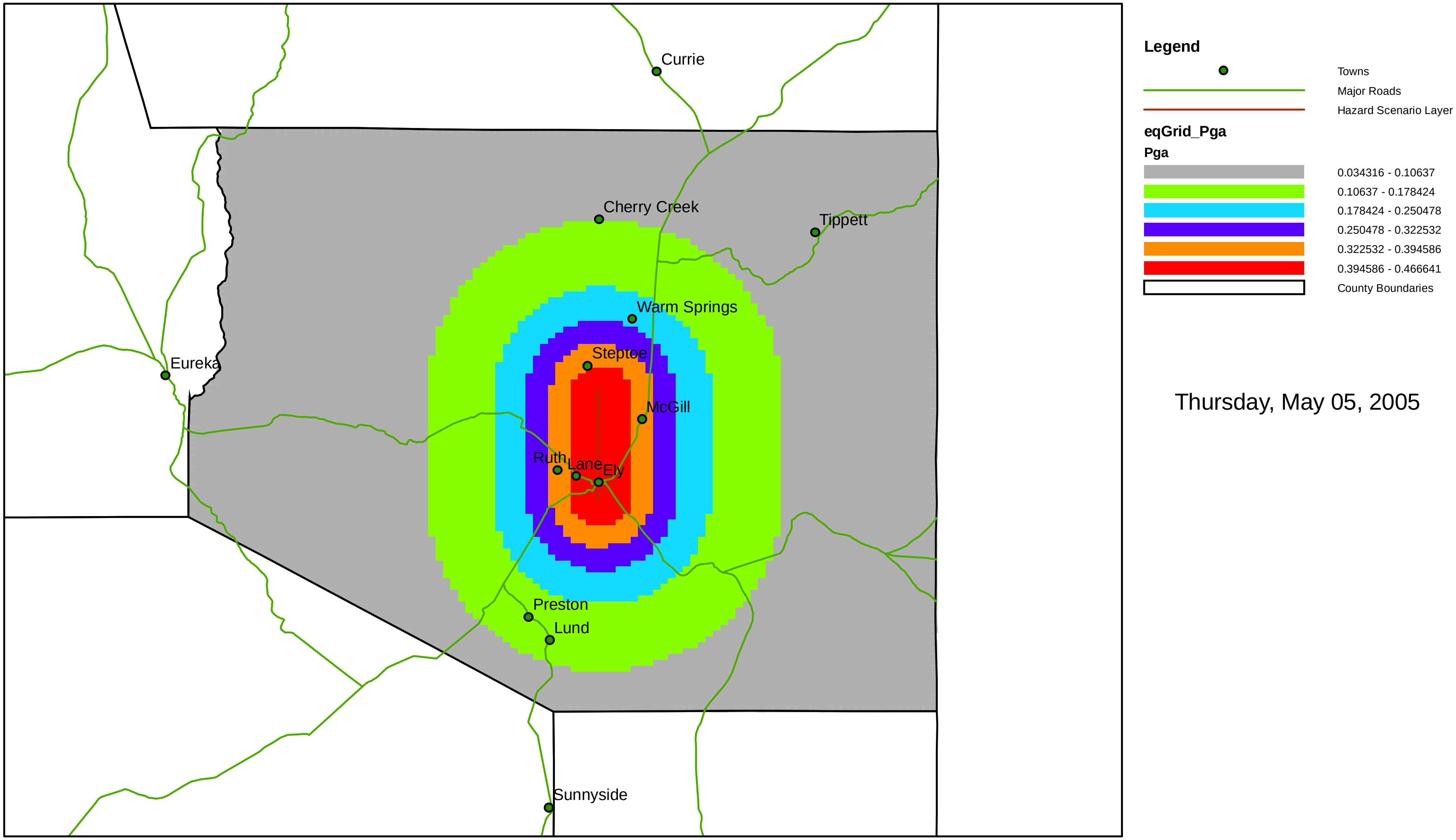
Carson,NV

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**

Study Region new : White_Pine_Hazus

Hazard Scenario : Ely 6.8



Thursday, May 05, 2005

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	0.00 - 0.10
	Building Contents	< 0.1
	Business Interruption	< 0.1
Infrastructure	Lifelines Damage	
	Total	0.00 - 0.20

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	0 - 3	< 1.0	< 1.0	0 - 3
Major	< 1.0	< 1.0	< 1.0	< 1.0
Total	1 - 4	< 1.0	< 1.0	1 - 4

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	20 - 80
Level 2	Hospital Care	< 20
Level 3	Life-threatening	< 20
Level 4	Fatalities	< 20

Estimated Shelter Needs

Type	Households	People
Displaced Households	30 - 110	
Public Shelter		10 - 30

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 : 6.80

Epicenter Latitude/Longitude :
39.34 / -114.89

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: 9,181

Building Exposure : ($ Millions)

Residential	509
Commerical	47
Other	11
Total	567

State:

Counties :
- White Pine,NV

Major Metro Area :

Time of report: November 08, 2005 6:06 pm

HAZUS-MH: Earthquake Event Report

Region Name: *White_Pine_Hazus*

Earthquake Scenario: *Ely 6.8*

Print Date: *May 05, 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

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 8,885.98 square miles and contains 3 census tracts. There are over 3 thousand households in the region and has a total population of 9,181 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 3 thousand buildings in the region with a total building replacement value (excluding contents) of 568 (millions of dollars). Approximately 100.00 % of the buildings (and 90.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,978 and 0 (millions of dollars), respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 3 thousand buildings in the region which have an aggregate total replacement value of 568 (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 40 beds. There are 9 schools, 1 fire stations, 1 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 25 dams identified within the region. Of these, 2 of the dams are classified as 'high hazard'. The inventory also includes 4 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 2,978.00 (millions of dollars). This inventory includes over 499 kilometers of highways, 3 bridges, 33,473 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	3	3.40
	Segments	29	2,743.70
	Tunnels	0	0.00
		Subtotal	**2,747.10**
Railways	Bridges	0	0.00
	Facilities	0	0.00
	Segments	53	117.80
	Tunnels	0	0.00
		Subtotal	**117.80**
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	2	11.90
	Runways	3	101.60
		Subtotal	**113.50**
		Total	**2,978.40**

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	334.70
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**334.70**
Waste Water	Distribution Lines	NA	200.80
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**200.80**
Natural Gas	Distribution Lines	NA	133.90
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**133.90**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	0	0.00
		Subtotal	**0.00**
Communication	Facilities	4	0.40
		Subtotal	**0.40**
		Total	**669.90**

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	Ely 6.8
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-114.89
Latitude of Epicenter	39.34
Earthquake Magnitude	6.80
Depth (Km)	8.00
Rupture Length (Km)	30.34
Rupture Orientation (degrees)	0.00
Attenuation Function	WUS Shallow Crustal Event - Extensional

Building Damage

Building Damage

HAZUS estimates that about 1,166 buildings will be at least moderately damaged. This is over 30.00 % of the total number of buildings in the region. There are an estimated 126 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	4	0.21	2	0.18	3	0.39	3	1.05	3	2.72
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.02	0	0.05	1	0.16	1	0.39	1	0.61
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Other Residential	215	11.94	129	14.87	207	28.62	163	51.48	89	70.21
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Single Family	1,578	87.82	735	84.90	512	70.83	149	47.08	33	26.46
Total	**1,797**		**865**		**723**		**317**		**126**	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	1,563	86.97	730	84.35	497	68.65	131	41.39	21	16.82
Steel	2	0.09	1	0.09	2	0.23	2	0.56	2	1.21
Concrete	3	0.14	1	0.13	2	0.24	1	0.46	1	0.75
Precast	0	0.03	0	0.02	0	0.05	0	0.12	0	0.34
RM	37	2.04	10	1.10	19	2.62	20	6.38	14	10.74
URM	1	0.04	0	0.03	0	0.05	0	0.10	0	0.29
MH	192	10.70	124	14.27	204	28.17	162	51.00	88	69.84
Total	**1,797**		**865**		**723**		**317**		**126**	

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

Essential Facility Damage

Before the earthquake, the region had 40 hospital beds available for use. On the day of the earthquake, the model estimates that only 0 hospital beds (2.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 11.00% of the beds will be back in service. By 30 days, 47.00% will be operational.

Table 6: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**At Least Moderate Damage > 50%**	**Complete Damage > 50%**	**With Functionality > 50% on day 1**
Hospitals	1	1	0	0
Schools	9	5	0	2
EOCs	0	0	0	0
PoliceStations	1	1	0	0
FireStations	1	1	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	With Functionality > 50 % After Day 7
Highway	Segments	29	0	0	29	29
	Bridges	3	2	0	1	1
	Tunnels	0	0	0	0	0
Railways	Segments	53	0	0	53	53
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
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	2	1	0	2	2
	Runways	3	0	0	3	3

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	4	3	0	4	4

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	16,737	4586	1147
Waste Water	10,042	3627	907
Natural Gas	6,695	3877	969
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	3,282	1,047	984	857	148	0
Electric Power		501	288	105	18	1

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 0.02 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 1 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 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 (52 households to be displaced due to the earthquake. Of these, 12 people (out of a total population of 9,181 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	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	6	2	0	1
	Industrial	0	0	0	0
	Other-Residential	19	4	0	1
	Single Family	11	2	0	0
	Total	**36**	**8**	**1**	**1**
2 PM	Commercial	29	9	1	3
	Commuting	0	0	0	0
	Educational	3	1	0	0
	Hotels	1	0	0	0
	Industrial	1	0	0	0
	Other-Residential	5	1	0	0
	Single Family	3	0	0	0
	Total	**42**	**12**	**2**	**4**
5 PM	Commercial	25	7	1	2
	Commuting	0	0	1	0
	Educational	0	0	0	0
	Hotels	2	0	0	0
	Industrial	1	0	0	0
	Other-Residential	7	2	0	0
	Single Family	4	1	0	0
	Total	**39**	**11**	**2**	**3**

Economic Loss

The total economic loss estimated for the earthquake is 137.12 (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 79.19 (millions of dollars); 17 % 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 72 % 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	2.37	2.45	0.02	0.21	5.05
	Capital-Related	0.00	1.01	2.11	0.01	0.02	3.15
	Rental	1.14	2.48	1.06	0.00	0.11	4.79
	Relocation	0.12	0.03	0.05	0.00	0.02	0.22
	Subtotal	**1.26**	**5.90**	**5.68**	**0.03**	**0.35**	**13.22**
Capital Stock Loses							
	Structural	5.56	2.96	2.86	0.10	0.45	11.93
	Non_Structural	22.41	10.86	7.23	0.33	1.19	42.01
	Content	5.75	2.12	3.24	0.19	0.53	11.83
	Inventory	0.00	0.00	0.16	0.03	0.01	0.20
	Subtotal	**33.72**	**15.94**	**13.49**	**0.65**	**2.17**	**65.97**
	Total	**34.98**	**21.84**	**19.17**	**0.68**	**2.52**	**79.19**

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	2,743.70	$0.00	0.00
	Bridges	3.40	$1.03	30.33
	Tunnels	0.00	$0.00	0.00
	Subtotal	**2747.10**	**1.00**	
Railways	Segments	117.81	$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	**117.80**	**0.00**	
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	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	11.88	$2.38	20.04
	Runways	101.63	$0.00	0.00
	Subtotal	**113.50**	**2.40**	
	Total	**2978.40**	**3.40**	

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	334.70	$20.64	6.17
	Subtotal	**334.73**	**$20.64**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Line	200.80	$16.32	8.13
	Subtotal	**200.84**	**$16.32**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Line	133.90	$17.45	13.03
	Subtotal	**133.89**	**$17.45**	
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	0.40	$0.11	24.22
	Subtotal	**0.44**	**$0.11**	
	Total	**669.90**	**$54.51**	

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	(1)	-0.93
Second Year			
	Employment Impact	0	0.00
	Income Impact	(2)	-2.82
Third Year			
	Employment Impact	0	0.00
	Income Impact	(3)	-3.63
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(3)	-3.63
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(3)	-3.63
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(3)	-3.63

Appendix A: County Listing for the Region

White Pine,NV

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Nevada					
	White Pine	9,181	509	58	568
Total State		**9,181**	**509**	**58**	**568**
Total Region		**9,181**	**509**	**58**	**568**

A GUIDE TO USING HAZUS FOR MITIGATION

April 2002

Prepared by

The National Institute of Building Sciences

For

The Federal Emergency Management Agency

Contents

Why This Guide Was Developed

A Guide to Using HAZUS for Mitigation (hereinafter referred to as the *Guide*) describes how HAZUS can help your local community, county, region or state identify, develop and implement measures to accomplish effective earthquake hazard risk reduction. The *Guide* will assist you in using HAZUS to ask questions about your community's vulnerability to earthquake damage and how such losses might be reduced by implementing preventive (mitigative) actions. It will help you understand how to use HAZUS loss estimates to develop and implement an effective community mitigation plan.

The Federal Emergency Management Agency (FEMA) defines mitigation as "sustained action taken to reduce or eliminate long-term risk to people and property from hazards and their effects." One of FEMA's principal objectives in promoting HAZUS is to encourage users to analyze, in advance, potential estimates of deaths, injuries, building damage and economic loss, and disruption to lifelines and critical facilities due to earthquakes (other natural hazards will be addressed in future versions of HAZUS), and then to design and implement measures to reduce expected losses.

Mitigation measures such as incorporating seismic design requirements into new buildings, or accomplishing seismic rehabilitation of existing buildings, will reduce the expected losses but not totally eliminate them. Improvement gained from a mitigation measure is the difference between the original condition and the improved (mitigated) condition.

Nevertheless, there are several values to be achieved when state and local governments, the private sector, public utilities, and others invest in earthquake risk reduction as part of their ongoing efforts to ensure the continuity and survivability (i.e., disaster resistance) of their respective physical assets. Besides reduced human losses and reduced physical losses from damage to the built environment, mitigation:

- Saves money by increasing the resistance of communities to earthquakes.
- When earthquakes do occur, serves to reduce community disruption; lowers response costs; lessens demands on emergency response organizations for search and rescue, fire suppression, emergency medical services, and emergency sheltering and feeding and temporary housing; and reduces the need for potentially massive assistance.
- Reduces short-term and long-term recovery costs and indirect economic impacts on the local and regional economies, such as business interruption, unemployment and business closures.

Overview of the Guide

To assist you in using HAZUS for mitigation, this *Guide* contains two sections: **Using HAZUS for the Analysis of Earthquake Risk Reduction Measures**, and **Community Mitigation Planning - The 10 Steps to Preparing a Successful Plan**.

The first section, **Using HAZUS for the Analysis of Earthquake Risk Reduction Measures**, suggests risk reduction measures and general information on how HAZUS can assist you with testing the effectiveness of these measures.

The second section, **Community Mitigation Planning - The 10 Steps to Preparing a Successful Plan**, offers a model for developing a community earthquake risk reduction plan. This process is based on the flood hazard risk reduction planning process associated with the Federal Insurance Administration's Community Rating System.

HAZUS Software Defined

HAZUS is a standardized software program that estimates losses from potential earthquakes. It is a CD-ROM-based product that requires the use of GIS (geographic information system) software to operate. HAZUS, which stands for Hazards, U.S., contains a methodology that uses mathematical formulas and information about building stock, geology, and the location and size of potential earthquakes as well as economic data and other information to produce loss estimation results. HAZUS includes databases containing the best available nationwide information on building stock, essential facilities, high potential loss facilities, population and the regional economy for all areas of the U.S. (and territories). HAZUS also provides the user with information about techniques for obtaining more accurate local data so that loss estimates can be tailored to your geographic area.

In addition to the national data provided with HAZUS, supplemental data is available on separate CD-ROMs for each U.S. state. This information can be used to assess exposure to wind and flood hazards, as well as helping communities direct response resources to their most disaster-vulnerable areas. HAZUS flood and hurricane loss estimation methodologies, analogous to the existing earthquake methodology, are being developed.

HAZUS produces easy-to-understand analytical reports and full-color maps. These products allow communities to anticipate the possible nature and scope of disaster-related damages. They can also be used to identify vulnerable areas that may require special land use or building code requirements and to assess the vulnerability of housing and essential facilities. This loss information can also be used to determine mitigation needs and to set priorities for the adoption and implementation of disaster prevention measures. A users' manual and a technical manual are available on the Internet at www.fema.gov.

This *Guide* has been written for the community planner and community Geographic Information Systems (GIS) specialist as the principal HAZUS users. The skills or knowledge needed by each to utilize HAZUS depends largely on what level of analyses will be conducted. To provide flexibility, HAZUS estimates earthquake losses at three levels:

Level 1: A rough estimate based solely on data from national databases included in the HAZUS software.

Level 2: A more accurate estimate based on professional judgment and detailed information on local geology, buildings in the community or lifelines input into HAZUS.

Level 3: The most accurate estimate based on detailed engineering and geotechnical input into HAZUS to customize the methodology to the specific conditions of the community.

For all readers, the *Guide* assumes familiarity with HAZUS. To learn more about HAZUS, a basic HAZUS training course is offered, through FEMA, at the campus of the National Emergency Training Center and the Emergency Training Institute in Emmitsburg, MD. For further information on this training, you can contact FEMA at www.fema.gov.

HAZUS – Levels of Analysis

To provide flexibility, users can estimate earthquake losses with HAZUS at three levels.

Analysis Using HAZUS-Supplied Data

Level 1 - Define a study region and choose a scenario earthquake

Analysis With User-Supplied Data

Level 2 - Add a soils map (this addition, sometimes called Level 1A, is so valuable that it should be made if at all possible).

Adjust existing data and parameters in HAZUS using local judgment or partial data.

Import data. In rough order of value and increased effort, these are:
- Improved inventory of highway bridges
- Detailed inventory of buildings or critical facilities
- Detailed inventory for other lifelines and transportation systems

Employ specific modules within HAZUS to:
- Analyze water distribution systems
- Estimate indirect economic effects

Level 3 - Import results from software run independently from HAZUS. Examples include:
- Analysis of interruption of highway system or other lifeline systems
- Flooding from dam breakage or tsunamis

Principal HAZUS Users' Required Knowledge & Skills

To use HAZUS effectively for community mitigation planning, the following knowledge and skills will be needed by planners and GIS specialists.

For the Planner

Knowledge of past, current, and future land uses and the evolution and future development of the community are essential to the planner. This knowledge needs to be linked to zoning, building and infrastructure inventories, economics, hazards, and risk information. The planner should be familiar with the community's spatial characteristics: special areas, such as historic districts; population changes and economic trends and other characteristics typically involving short-term, long-term and special planning processes. Much of the information normally used by planners, may be in GIS formats, which will be useful in applying HAZUS.

For the GIS Specialist

The GIS specialist should have a working knowledge of spatial data operations in MapInfo or ArcView GIS programs. The ability to work with dBase or similar programs is useful for inputting data into HAZUS. If HAZUS maps are to be combined digitally with other local data, such as street grids and parcels, knowledge of map scale coordination, the implications of risk mapping and disclosure, legal issues associated with digital maps, and similar subjects is required.

Basic Computer Skills Required to Use HAZUS

All HAZUS users, as a minimum, should be:

Accustomed to working in a Windows environment,

Knowledgeable of either MapInfo or ArcView, the GIS platforms HAZUS operates on,

Familiar with the general capabilities and limitations of software modeling, and

Capable of understanding and utilizing concepts of accuracy, error, scale, incremental improvements, data collection, validation and similar subjects.

Using HAZUS for The Analysis of Earthquake Risk Reduction Measures

Introduction

General Principles

The principal mitigation measures available to communities to successfully manage risk reduction are organized, for the purposes of this *Guide,* into the following categories:

- Land-Use and Geologic Hazards
- Buildings, Nonstructural Building Components and Essential Facilities
- Infrastructure: Transportation and Utilities
- Flood, Hazardous Materials and Fire Exposure

The persons involved in an analysis are likely to be land-use planners, risk managers and emergency planners. HAZUS output will consist of estimates of potential damage and loss presented in maps and tables. Examples of how HAZUS output is used in targeting and analyzing potential risk reduction measures are provided for the categories defined above in the following sections.

Using HAZUS, you can make initial, approximate loss estimates for your community, and with the assistance of the Guide, determine loss categories that may be unacceptably high and that could be significantly reduced by adopting and implementing realistic mitigation measures. The effects of various mitigation measures can then be estimated by changing certain HAZUS input characteristics that describe your community and comparing the second run's losses with the initial results. More accurate or targeted results can be obtained by improving the overall physical description of your community in HAZUS by inputting local soil maps or inventory information and then making comparative loss estimates with this improved model.

For example, Table 1 demonstrates that a 6.9 magnitude scenario earthquake is expected to cause about $1.7 billion in direct economic losses to

Table 1 - Direct Economic Losses for Buildings *(in thousands)*

	Capital Stock Losses							Income Losses		
	Cost Structural Damage	Cost Non-struct. Damage	Cost Contents Damage	Inventory Loss	Loss Ratio %	Relocation Loss	Capital Related Loss	Wages Losses	Rental Income Loss	Total
Study Region Total	205,387	825,044	269,813	2,960	14.19	149,975	98,588	93,479	94,963	1,740,209

Study Region: Thirty Census Tracts in Alameda County Comprising the City of Berkeley, California

Scenario: North Hayward Fault, Magnitude 6.9

Table 2 - Casualties

	2:00 AM				2:00 PM				5:00 PM			
	At Home	At Work	Commute	Total	At Home	At Work	Commute	Total	At Home	At Work	Commute	Total
Severity 1	430	12	0	442	82	498	0	580	97	235	2	334
Severity 2	75	2	0	78	14	92	0	106	17	43	2	62
Severity 3	7	0	0	8	1	12	1	14	2	6	3	11
Severity 4	7	0	0	8	1	12	0	13	2	6	1	8
Total:	520	15	0	535	99	613	2	714	118	290	7	415

Severity 1 - Injuries requiring basic medical aid without requireing hospitalization
Severity 2 - Injuries requiring a greater degree of medical care and hospitalization, but not expected to progress to a life threatening status
Severity 3 - Injuries that pose an immediate life threating condition if not treated adequately and expitiously. The majority of these injuries are a result of structural collapse and subsequent collapse or impairment of the occupants.
Severity 4 - Instantaneously killed or mortally injured

Study Region: Thirty Census Tracts in Alameda County Comprising of City of Berkeley, California

Scenario: North Hayward Fault, Magnitude 6.9

Berkeley, California. About $1.3 billion will result from structural and non-structural damage to buildings, damages to building contents and furnishings, and losses of commercial inventories. Added to these capital stock losses is about another $437 million of income losses to wage earners, property owners and others.

Table 2 indicates that relatively minor injuries can be expected during the night (2:00 a.m.) when people are home (largely in wood frame dwellings, which are safer compared to other types of construction), but casualties at the two other times (2:00 p.m. and 5:00 p.m.) raise questions about building safety, particularly in office buildings and other work places during the day.

These economic and casualty loss results from HAZUS might be used as a basis to develop, enact, and enforce new building code provisions requiring earthquake resistant design of new buildings. This would at least prevent the construction of new non-earthquake resistant buildings, and leave the city in a better position to address issues associated with its existing stock of potentially earthquake hazardous buildings. Table 1 also demonstrates that non-structural losses are about four times larger than structural losses. This factor alone might trigger consideration of a combined regulatory-voluntary non-structural hazard mitigation program to reduce an earthquake's direct economic impacts. In either of these cases, the approximate reduction in losses from a mitigation measure can be estimated by changing the characteristics of the inventory to model the mitigated state, rerunning HAZUS and comparing the results with the original runs.

Table 3 - Potential Uses of HAZUS to Develop Mitigation Measures lists the types of analyses performed with

Table 3 – Potential Uses of HAZUS to Develop Mitigation Measures					
Uses of HAZUS	**Type of Loss Estimate**	**Data Requirements**	**Audience**	**Output**	**Comments**
1. Raise public awareness of earthquake threat and consequences	Regional Scenario	Level 1 or Level 2 with soils map	General public, elected officials, emergency managers, land use planners	Casualties, economic loss	
2. Create political understanding and build constituencies	Local or Regional Scenarios	Level 2, soils map, building inventory, regional utilities or transportation systems	General public, elected officials, emergency managers, land use planners	Casualties, utility disruption, regional transportation damage dollar loss	
3. Understand relative risk, planning, siting, and access issues	Local or Regional Scenarios	Level 2, detailed geology, lifelines, transportation	Land use planners, regional agencies, growth management agencies, utilities	Peak Ground Acceleration (PGA)/ Peak Ground Velocity (PGV)/ Peak Ground Deformation (PGD)	Requires input from a geologist
4. Understand extent of injuries and fatalities	Multiple Scenarios	Level 2, detailed geology and building inventory, essential facilities, schools, hospitals	Medical agencies, emergency managers, risk managers	Casualties by structure type	Requires input from a geologist
5. Assess performance of emergency shelters	Local Scenario	Level 2, detailed geology and building inventory	Land use planners, risk managers, emergency planners	Structural damage	Requires input from a geologist
6. Assess performance of fire stations	Local Scenario	Level 2, detailed geology, fire station inventory, water system	Fire officials, emergency managers, planners	Number of ignitions, area burned, essential facilities damage, water utility damage	Requires input from a geologist, water system engineer, structural engineer to classify structures
7. Identify infrastructure vulnerability	Regional Scenario	Level 2, detailed geology and building inventory	Utility companies, emergency planners, transportation agencies	Utility damage and recovery, transportation system damage	Requires input from a geologist, structural engineers and architects
8. Understand overall building damage	Local Scenario	Level 2, detailed building inventory, essential facilities, schools, hospitals	Land use planners, elected officials, emergency and facility managers	Damage by building type and location, utility, transportation system damage	Requires input from engineers, architects, building officials and planners
9. Set mitigation program priorities	Local Scenario	Level 2, detailed geology, building inventory	Land use planners, risk managers, fire safety officials	Multiple runs of building damage	Requires input from a geologist, structural engineers and architects

HAZUS for assessing common mitigation measures. For example, if your community wants to conduct a study of mitigation requirements for emergency shelters, Table 3 shows that Level 2 data in the form of soils data and local inventory is required for assessing shelter performance in an earthquake. Typically as mitigation measures are identified and refined, an improved representation of the actual conditions in your community is needed.

Improving Mitigation Analyses by Modifying HAZUS' Databases

A community-specific inventory of buildings, or groups of buildings (e.g., fire stations, a defined district, critical facilities), is required for developing details of a program to reduce structural damage and loss. More detailed geologic and soils information and the building inventory data will give your community a more accurate view of its vulnerability to earthquake damage so appropriate local mitigation measures can be determined.

HAZUS contains national inventory information for the building stock of the U.S., but it requires upgrading to be more locally accurate. Within HAZUS are tools to be used with field work, examination of local records and in consultation with local experts for collecting building inventory data for your community and uploading it into HAZUS. For example, incorporating local county tax assessor data can upgrade the square footage by occupancy per census tract, building count by occupancy per census tract, and dollar exposure and occupancy mapping for your community's general building stock. Adding local data and modifying existing national data and parameters within HAZUS will enhance the accuracy of HAZUS outputs. The following are suggested data improvements:

Add geologic hazard data
- ✔ Add soils map
- ✔ Add local liquefaction, landslide, and surface fault rupture maps

Improve general building stock data
- ✔ Modify occupancy class to model building type scheme to more accurately reflect local construction
- ✔ Update census tract values of aggregate building count, square footage, and dollar exposure
- ✔ Enhance seismic design level and construction quality data

MODIFYING HAZUS DATA BASES

Modifying the HAZUS databases to characterize in detail a study area is a formidable task because of the time and effort required to collect large amounts of information and input these data into HAZUS. Suggestions concerning the collection of data and the steps required for inputting are covered in the User's Manual.

Local land-use planners and engineers working together with a GIS specialist can more readily achieve improvements to the HAZUS database just by using professional judgement. A first step is to examine the default databases, as explained in section 7.2 of the Users Manual. Section 7.3 tells how these databases can be modified "manually." For example, by working with Figure 7.4, the mix of building heights and seismic resistances can be tailored to fit local knowledge. By following instructions in section 7.4, different new database mapping schemes can be applied to different groups of census tracts. This approach can significantly improve upon a Level 1 loss estimate without a long delay while large quantities of data are acquired, and may even reduce the need for such effort.

Improve school, emergency response center and hospital data

- ✔ Add shelter and kitchen capacity and building area for schools and emergency response centers
- ✔ Add number of students for schools
- ✔ Add beds for hospitals
- ✔ Add number of trucks for fire stations
- ✔ Add building structural data
- ✔ Add year built
- ✔ Add number of stories for emergency response centers
- ✔ Add backup power capability
- ✔ Include replacement costs

Improve transportation lifelines data

- ✔ Add highway and rail segments, bridges and tunnels
- ✔ Add rail, bus, port, ferry and airport facilities
- ✔ Add airport runways
- ✔ Add dollar exposure.

Improve utilities lifelines data

- ✔ Add pipelines for water, waste water, oil and gas
- ✔ Add electric and communication lines
- ✔ Add water, waste water, oil, gas, electric and communication lifeline facilities
- ✔ Add dollar exposure

Developing occupancy to model building type mapping schemes (assigning building types to occupancies) that accurately reflect your community will require combining available data with input from local experts. The occupancy-mapping scheme is a group of tables designed to describe the building stock by occupancy, structural building type, and location. National data in the tables are based on ATC-13 (an Applied Technology Council report, *Earthquake Damage Evaluation Data for California*), proprietary insurance data, expert opinion, and inferences drawn from tax assessor's records. Further information on occupancy mapping is provided in Chapter 7 of the HAZUS *User's Manual.*

> "There is an urgent need to develop an inventory of buildings in seismically active areas of the U.S. to identify where non-ductile concrete buildings and other vulnerable structures (e.g., unreinforced masonry and open-first-story timber frame apartments) are located. All citizens should have access to knowledge about the buildings they live and/or work in, but this type of inventory is not currently available."
>
> Thomas O'Rourke
> Testimony to Congress;
> Hearing: The Turkey, Taiwan, and Mexico City Earthquakes;
> Lessons Learned

The Building Data Inventory Tool (BIT) described in Chapter 8 of the HAZUS *User's Manual* has a utility that develops occupancy to model building type mapping schemes from tax assessor's data or other commercially available property data. Collecting supplemental information about local building practices through the use of a questionnaire and/or a workshop also is recommended.

Additional lifeline data are required to use HAZUS' Potable Water System Analysis Model (POWSAM) as described in Chapter 9 (pp. 9-33, 34) of the *HAZUS User's Manual*. POWSAM is a sophisticated tool primarily meant for use by engineers at Level 2 only.

Land-Use and Geologic Hazards

Earthquake risk reduction measures that involve land-use planning provide your community with opportunities to mitigate the potential effects of earthquakes on buildings and infrastructure. Such measures are oriented toward future development, although some can be applied to reusing land or redeveloping portions of your community.

Land-use planning measures are embodied in development policies, community plans, hazards information for the public and those interested in developing parcels, or regulations restricting or prohibiting all or some types of developments in specific hazard areas. Commonly applied land-use and planning-related mitigation measures are indicated in the shaded box. Planning measures are particularly effective in mitigating losses from earthquake-induced ground failures, such as fault rupture, landslides and liquefaction.

Land-Use Planning and Geologic Hazards Mitigation Measures

Land-Use Planning Mitigation Measures

- Identify seismic safety/geologic hazards/natural hazards in general plans.
- Enact zoning ordinances consistent with general plans that regulate densities and uses in hazardous districts or parcels.
- Adopt subdivision regulations that set lot patterns to avoid geologic hazards.
- Adopt grading regulations that prescribe limits on excavations or fills for building sites.
- Apply special development regulations that recognize that some parcels are more suitable for building than others in designated areas.
- Recognize in local capital improvement programs and budgets earthquake hazards that influence the location, timing and pace of new development and public facilities.
- Ensure that environmental and related impact analyses address earthquake hazards and include effective mitigation measures.
- Redevelop areas to replace deteriorating and unsafe buildings with new construction that also avoids geologic hazards.
- Designate open spaces in urban areas for firebreaks, evacuation areas, emergency housing sites, temporary hospitals, and post-earthquake supply distribution centers.

Geologic Hazards Mitigation Measures

- Develop detailed hazard and ground-failure maps for local use.
- Recommend hazard avoidance mechanisms, such as setbacks or “special studies zones” where detailed geologic reports may be needed.
- Provide specialized design and construction techniques, where required, for site-specific mitigation: dewatering, removal and replacement of soils, grading, construction on pilings, adding retaining walls or other barriers and foundation design.
- Establish adequate internal and independent project review procedures for geotechnical reports.
- Record and disclose site conditions or hazards before issuing permits or transferring ownership of properties.

Where the ground is subject to surface fault rupture, landslides, liquefaction, slumps, lateral spreading, amplified ground shaking or flooding, your community should consider implementing geotechnical mitigation measures as summarized in the shaded box. The principal measures involve avoiding potentially hazardous locations or modifying the soil under or near new or existing building sites to enhance their earthquake resistance. Implementing these measures requires input from seismologists to identify and characterize fault breaks and geotechnical engineers to describe soil conditions.

Using HAZUS and Land-Use Planning for Mitigation

Let us look at how the graphic information that HAZUS produces might support the adoption and implementation of planning-related measures. Figures 1 and 2 demonstrate how an earthquake impacts communities within the region vary differently depending on their location, demographics, building stock, and other variables. Based on this analysis, neighboring communities may choose to adopt different risk reduction measures.

Figure 1 – Sample HAZUS Map: Land-Use/Land Cover

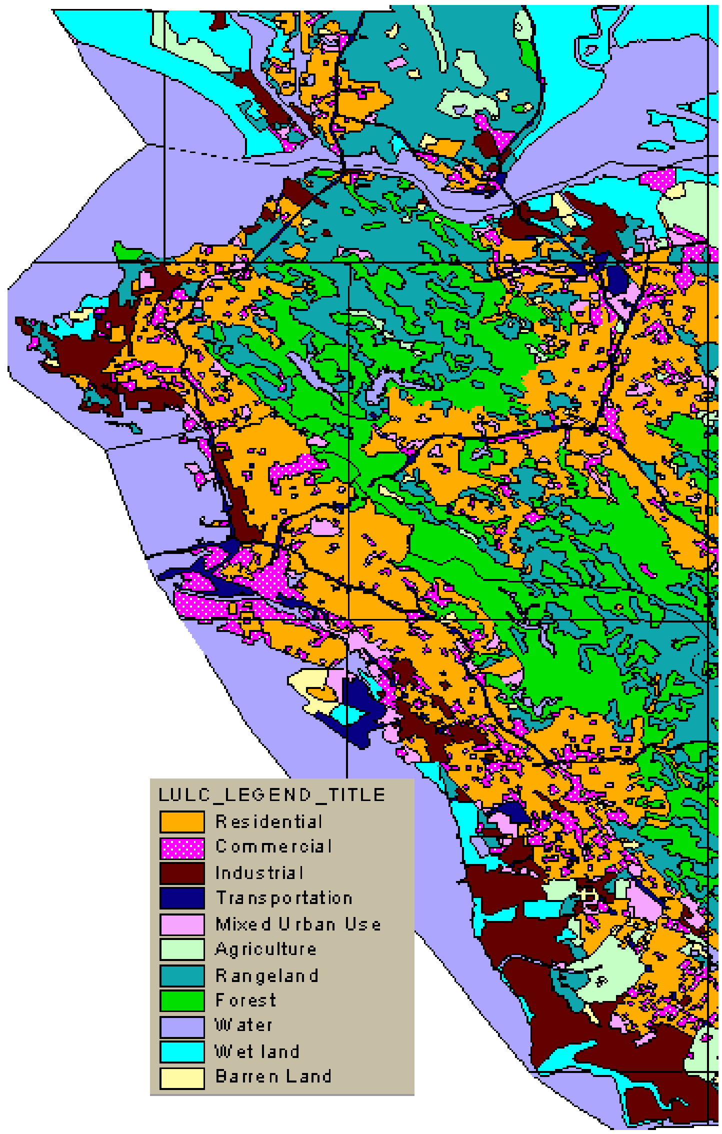
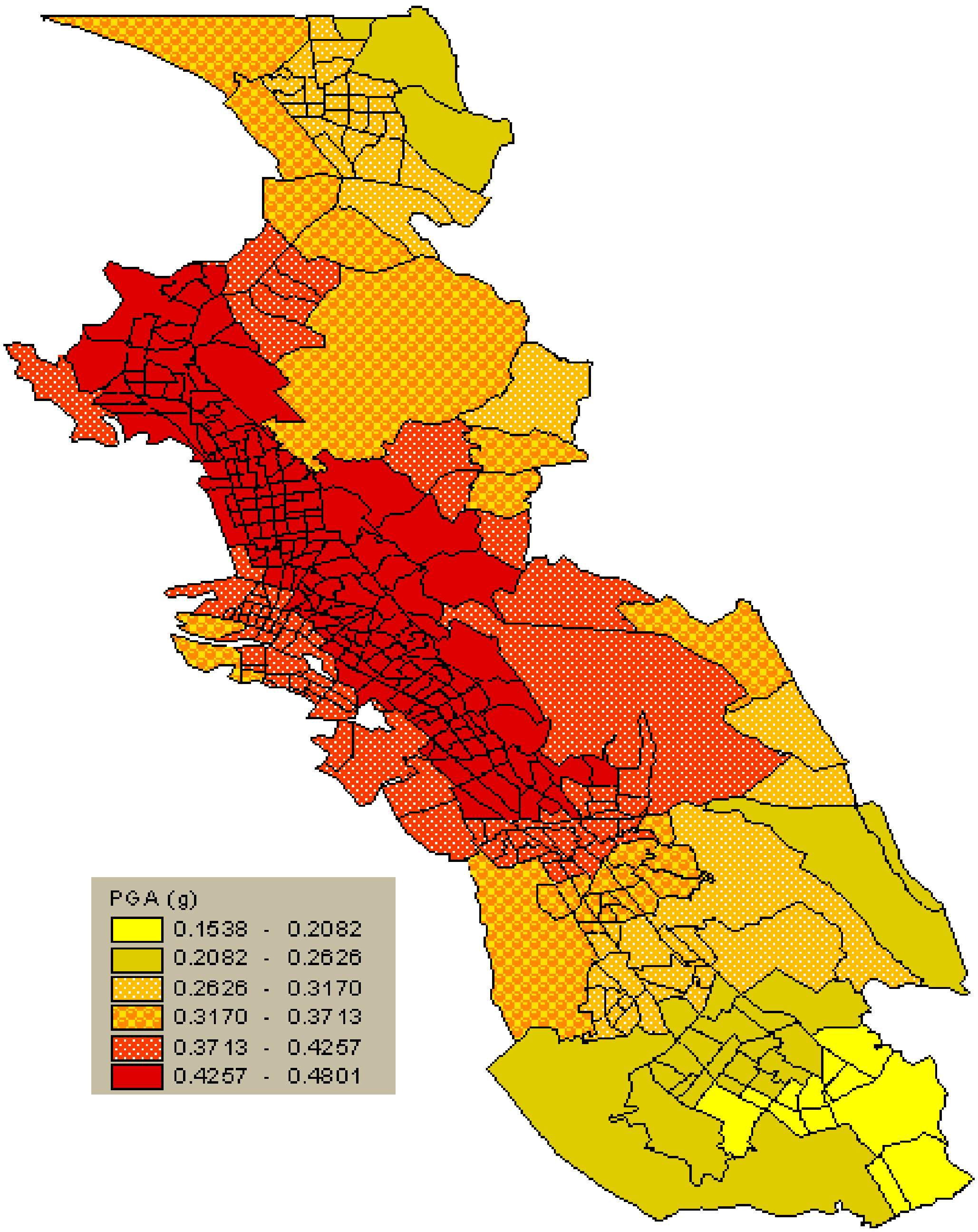


Figure 1 shows land-use/land cover data from HAZUS' Supplemental Data mapped on a study region generated by HAZUS. Supplemental Data sets provide land use/land cover maps for each U.S. state that can, through GIS, be overlaid with user-supplied maps for soils, liquefaction, and landslide as well as HAZUS-generated ground shaking maps to identify areas of existing or planned development that may be at risk for damage and loss.

Figure 2 shows the same study region with anticipated ground-shaking

Figure 2 – Sample HAZUS Map: Ground Shaking by Census Tract



generated by HAZUS by census tract. Several observations may be drawn by comparing the two maps: 1) The region's commercial district largely lies in the second highest area of anticipated shaking; 2) The industrial area at the top of the map lies largely in the area of highest anticipated shaking while the industrial area at the bottom of the map lies mostly in the area of the lowest anticipated shaking; and 3) Most of the residential building stock is in the area of the highest anticipated shaking.

Using this information, local officials could, for example, consider a mitigation program to preserve structures in the commercial district and the higher-risk industrial region. An ordinance might be enacted to demolish abandoned buildings, and, assuming that the forested area bordering the residential area is mountainous, subdivision regulations may be enacted to restrict building on or near steep slopes.

Additionally, for mitigation planning, community development representatives can analyze the community's historic evolution, current configuration, future development patterns, and current growth management policies and determine economic impacts in light of potential hazards issues. The conclusions from this analysis might be used in the development of capital improvement programs.

Using HAZUS and Geologic Hazards Analysis for Mitigation

HAZUS can be used to identify geotechnical mitigation strategies. HAZUS provides nationally based data on active earthquake faults and expected ground motions and assumes an average soil condition for the entire U.S. For a more refined estimation, seismologists can input into HAZUS information on locally known active faults. Geotechnical engineers can input site-specific information on potential liquefaction, landslides, and soil amplification.

Figure 3 demonstrates how levels of ground shaking shown in Figure 2 are increased by inputting local soils data into HAZUS. Observations on the effects of an earthquake drawn in the land-use planning section using Figure 1 may be revised as follows: 1) The region's commercial district now totally lies in the second highest area of anticipated shaking; and 2) The industrial area at the bottom of the map will experience considerably increased anticipated shaking.

HAZUS and Local Soil Conditions

Local soil conditions will, in many communities and regions, have a major effect upon the losses caused by earthquakes, and especially upon the geographical distribution of these losses. Using HAZUS, it is possible to enter the soil conditions approximately and simply, or to use maps prepared after detailed studies.

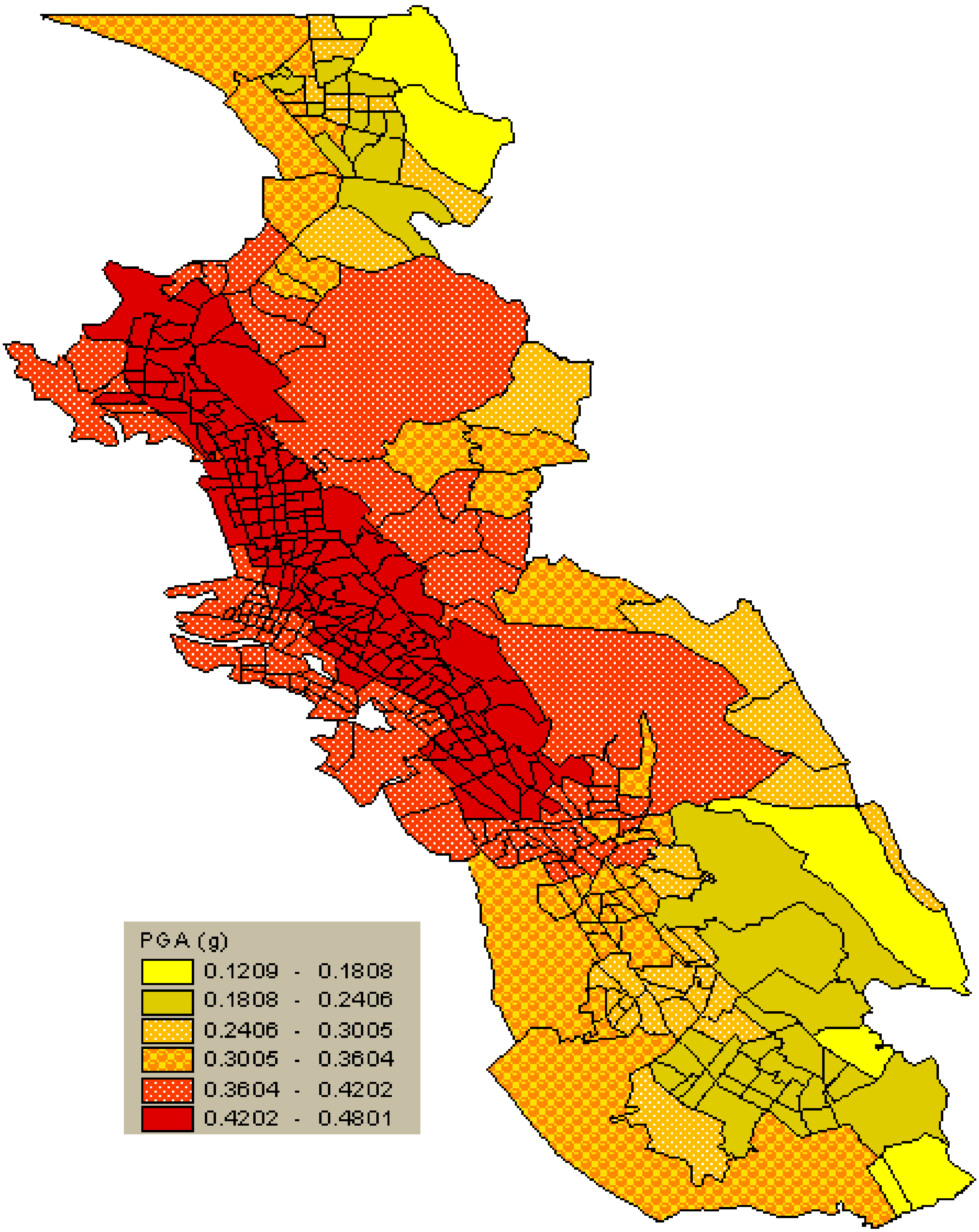
At the simplest level, local experts may use their experience and judgement to assign a soil type and a liquefaction susceptibility to each census tract.

If soil type and liquefaction susceptibility maps are available, they may be entered directly into HAZUS, after converting them to the proper format. This step will require expertise in the use of GIS.

It will be necessary to assess carefully results from any census tract where pockets of hazardous soils exist under buildings since HAZUS can only have a single soil type for each census tract.

HAZUS includes the means for analyzing the effects of landslides for areas with unstable slopes.

Figure 3 – Sample HAZUS Map: Ground Shaking with Soils



Based on this new information, waterfront areas in the commercial district with increased potential shaking due to poor soils might be set aside as parkland or for recreational use. Planners, developers, engineers and architects, alerted to higher levels of potential shaking in the industrial district, might want to perform engineering analyses to formulate specialized design and construction mitigation techniques such as dewatering or removal and replacement of soils. Building officials might implement stricter engineering reviews regarding the adequacy of building foundations for a chosen site.

As another example, Figure 4 shows unreinforced masonry buildings (URMs) largely concentrated in an area characterized by poor ground subject to liquefaction (see Figure 5) which amplifies motions. Planners might consider amending the general plan and zoning regulations to designate this area for low density uses, such as for marinas, parks, open space, wildlife refuges, and small buildings. Additionally, geotechnical and engineering analyses might be done to determine the earthquake vulnerability of these existing potentially hazardous buildings and the need to strengthen, replace, or otherwise reduce losses.

Figure 4 – Sample HAZUS Map: Casualties from URMs

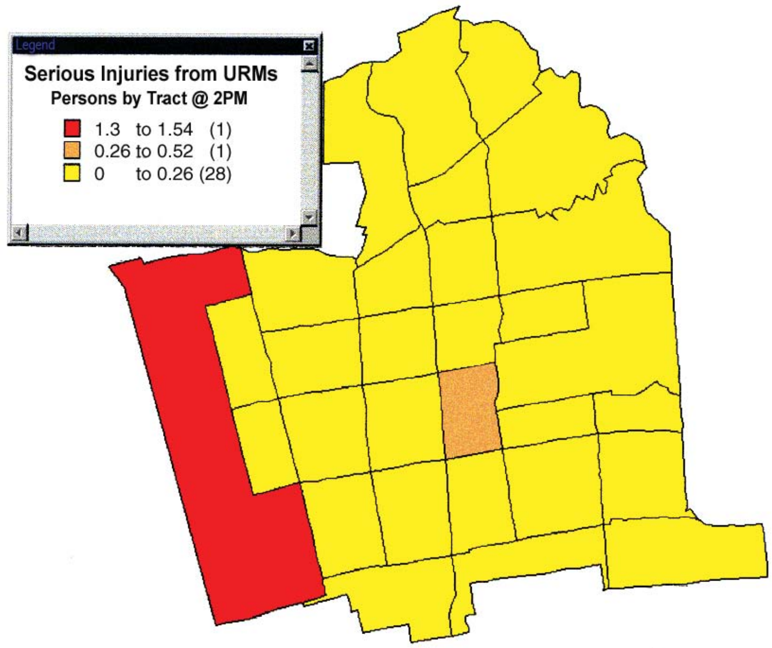
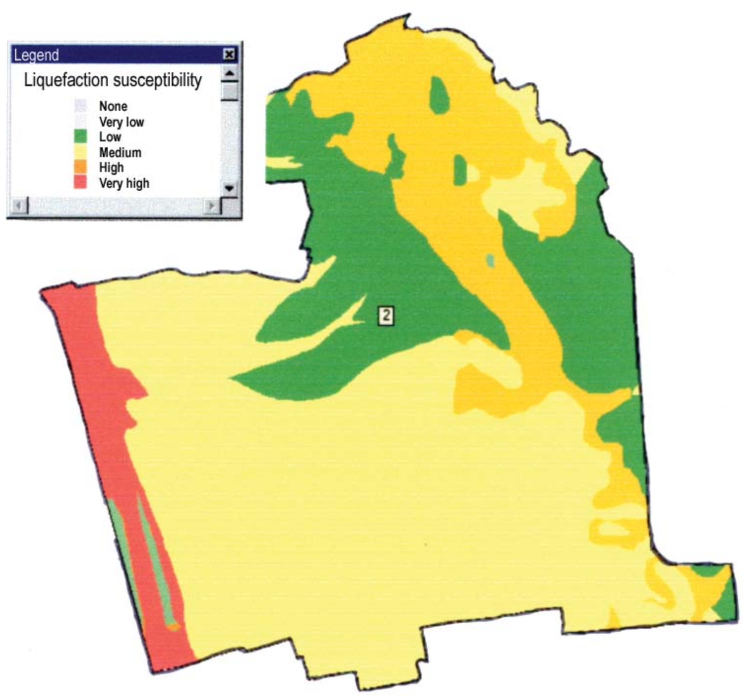


Figure 5 – Sample HAZUS Map: Liquefaction Susceptibility



Buildings

Perhaps the most common mitigation measures taken by communities are related to the seismic resistance of buildings. Significant reduction of losses can be achieved both by improving seismic design and construction of new buildings and by rehabilitating or replacing older buildings.

The most obvious action to be taken for new buildings is to adopt and enforce the seismic provisions of the latest model building codes. Although only a small percentage of the total buildings in a region are "new" each year, losses in future earthquakes can be greatly reduced by establishing good seismic building practices. On the other hand, a community that does not adopt or enforce seismic standards is increasing its risk every day. Special seismic provisions can also be adopted for certain important buildings (sometimes called essential buildings) such as hospitals, schools, police stations, and emergency operations centers. Design provisions for these building are more stringent than

Building Mitigation Measures

Structural Mitigation Measures

- Develop local inventory and identify hazardous building types.
- Adopt building codes with seismic provisions governing design and construction of new buildings.
- Enforce compliance with building codes and construction quality standards.
- Adopt building code provisions to require seismic retrofit at times of significant renovation or change of occupancy.
- Adopt ordinances to mitigate potential falling hazards on streets and sidewalks (roof-top tanks, parapets, cladding, etc.)
- Adopt ordinances requiring retrofit within specified time limits.
- Adopt ordinances for seismic retrofit of various types of high-risk buildings.

Nonstructural Mitigation Measures

- Identify high risk or potentially high dollar loss nonstructural systems.
- Adopt ordinances to reduce falling hazards in public places (warehouse stores, etc.)
- Develop and make available self-help information for mitigation of nonstructural elements.
- Develop programs to provide anchorage and restraint of furniture and other contents.

Essential Facilities Mitigation Measures

- Seismically evaluate essential facilities such as schools, hospitals and emergency response centers.
- Develop programs to improve the seismic performance of essential facilities by retrofit or replacement.
- Develop programs to improve the seismic performance of nonstructural systems in essential facilities.

for average buildings and are intended to allow continued use of the facility immediately after an earthquake.
By far, the most risk in typical communities comes from older buildings that were not designed to modern seismic standards. Of particular concern as life safety risks are older unreinforced masonry buildings and concrete buildings not designed to seismic standards. Mitigation of the risks from the existing building stock can range from redevelopment or replacement of entire neighborhoods to programs that target the highest risks (e.g. bracing or removal of parapets and other falling hazards) to programs that require rehabilitation of certain vulnerable buildings types (e.g. unreinforced masonry or hillside private residences).

The identification of realistic and effective programs to mitigate risks in existing buildings requires knowledge of the type and extent of different building types in your area, their probable vulnerability to earthquake damage, their location with respect to expected earthquake shaking, and the costs of rehabilitation in terms of dollars and disruption of use. HAZUS can help a community determine the risks, but detailed analysis of proposed programs, including costs and schedules, can only be determined at the local level with extensive community-specific analysis.

Table 4 - Modeling in HAZUS of Mitigation Measures for Existing Buildings, lists mitigation actions on existing buildings that have been considered by other communities and gives an indication of the ability of HAZUS to model the conditions. It can be seen that HAZUS is best at modeling complete rehabilitation measures (e.g., completely rehabilitate all unreinforced masonry buildings) as opposed to measures that affect only one aspect of a building's seismic safety (e.g., brace chimneys or anchor water heaters).

Using HAZUS for Structural Mitigation

General Use of HAZUS: Maps and tables generated by HAZUS are particularly useful for making decisions about structural mitigation measures. The most basic form of mitigation analysis using HAZUS is to identify portions of your community where buildings are expected to incur the most damage and economic losses. Most of the damage and loss outputs from HAZUS can be displayed and mapped by census tract for classes of buildings or by individual facility. This information can be used to direct further engineering studies to identify specific problem structures and to develop appropriate mitigation measures. See *Table 1 - Direct Economic Losses for Buildings* for an example of a typical building losses report that lists expected dollar losses for structural, non-structural, and contents damage to buildings for a city.

Table 4 - Modeling Mitigation Measures in HAZUS for Existing Buildings *(See notes at end of table)*		
Model Building Type	**Mitigation Measure**	**Use of HAZUS**
Residential wood	Bolting sills to foundation	Difficult to model mitigation of a specific building element with HAZUS global building techniques; in addition, mitigation may affect only a small percentage of MBT.
Residential wood	Bolting as above and bracing cripple walls	Although this is mitigation of a specific building element, global behavior is affected. An optimistic first cut estimate of improvement can be obtained by comparing *No Code* with *Moderate Code*. This estimate can be improved if the percentage of the MBT with this deficiency was determined and modeled separately. Best if BSDLF is used.
Residential wood	Support and bracing of hillside homes	This is a unique subcategory of MBT. Use of BSDLF is necessary.
Residential wood	Bracing of URM chimneys (above roof)	Difficult to model mitigation of a specific building element with HAZUS global building techniques. Must consider the element by itself as a "building" and develop BSDLF.
Residential wood	Replacement of URM chimneys	Difficult to model mitigation of a specific building element with HAZUS global building techniques. Can consider the element by itself as a "building" and develop BSDLF.
Residential wood	Mitigation of hazards from gas, such as bracing water heaters or installing shut off valves.	Difficult to model mitigation of a specific building element with HAZUS global building techniques. Can change number of ignitions in fire module to estimate improvement.
Residential wood	Complete rehabilitation (foundation and superstructure)	A first cut estimate of improvement can be obtained by changing *No Code* to *Moderate Code*.
Residential URM	Complete rehabilitation	Residential URMs are not well represented in the existing MBTs. URM structural characteristics may overestimate damage to residential URMs. A first cut estimate of improvement can be obtained by comparing *URM No Code* with *Reinforced Masonry Moderate Code.* BSDLF recommended.
URM	Brace parapets	Difficult to model mitigation of a specific building element with HAZUS global building techniques. Can consider the element by itself as a "building" and develop BSDLF. Risk of casualties is not directly related to building occupancy as modeled by HAZUS.
URM	"Bolts Plus" programs	Difficult to model mitigation of a specific building element with HAZUS global building techniques. Can obtain an optimistic first cut estimate of improvement for low to moderate shaking levels by comparing *URM No Code* with *Reinforced Masonry Low or Moderate Code.* Improvement for high levels of shaking is expected to be much less and is difficult to model without BSDLF.
URM	Complete rehabilitation: life safety standard	A first cut optimistic estimate of improvement can be obtained by comparing *URM No Code* with *Reinforced Masonry Moderate Code*. Lower bound improvement can also be estimated by comparing *URM No Code* to *Reinforced Masonry Low Code*

Table 4 - Modeling Mitigation Measures in HAZUS for Existing Buildings

Continued *(See notes at end of table)*

Model Building Type	Mitigation Measure	Use of HAZUS
Tilt-ups (west coast style; actual construction characteristics vary across country)	Primarily mitigation of out-of-plane wall and related roof collapses.	A first cut estimate of improvement can be obtained by comparing *No Code* with *Moderate Code.* Characteristics of local tilt-ups should be confirmed to include out of plane wall anchorage deficiencies. This estimate can be greatly improved by specific consideration of local building characteristics and proposed rehabilitation measures by developing BSDLF.
Nonductile concrete, particularly frames	Complete rehabilitation: life safety standard	A first cut estimate of improvement can be obtained by comparing *No Code* with *Moderate Code*.
Precast garages	Complete Rehabilitation: life safety standard	A first cut estimate of improvement can be obtained by comparing *No Code* with *Moderate Code*.
Concrete with masonry infill	Complete rehabilitation: life safety standard	A first cut estimate of improvement can be obtained by comparing *No Code* with *Moderate Code*.
Steel frame with masonry infill	Complete rehabilitation: life safety standard	A first cut estimate of improvement can be obtained by comparing *No Code* with *Moderate Code*.
Steel welded moment-resisting frame	Complete rehabilitation: life safety standard	A first cut estimate of improvement can be obtained by comparing *No Code* with *Moderate Code*. Damage and loss functions derived from Northridge earthquake damage to modern steel welded steel moment frames is not currently incorporated into HAZUS. BSDLF have been developed as part of the FEMA sponsored SAC Steel Project, and should be used to estimate the results of mitigation to this subset of the MBT.

MBT: HAZUS Model Building Type
BSDLF: Building Specific Damage and Loss Functions
SAC: A joint venture of the Structural Engineers Association of California, the Applied Technology Council, and Califirnia Universities for Research in Earthquake Engineering
No Code: Use mapping scheme parameters of *Low Seismic and Inferior Building Quality*
Moderate Code: Use mapping scheme parameters of *Moderate Seismic and Code Building Quality*
Low Code: Use mapping scheme parameters of *Low Seismic and Code Building Quality*

Another tool for estimating life-safety risks and other impacts are HAZUS' building damage states for structural building types. There are five damage states in HAZUS to describe the nature and extent of damage to the building's components (e.g., beams, columns, walls, ceilings): none, slight, moderate, extensive or complete. Building damage states might be used to study expected damage patterns in a given region for different scenario earthquakes to identify the most vulnerable building types or the areas with the worst expected damage to buildings. This information might then be used to plan in-depth studies of vulnerable areas and the building types therein to determine appropriate mitigative courses of action such as undertaking major structural rehabilitations or strengthening building components. Further information on damage states can be found in the HAZUS User's Manual in section 9.4.2, and in section 5.3 of the Technical Manual. Section 5.3.1 of the Technical Manual provides general descriptions of the structural damage states for a number of typical building types.

Specific Modeling Suggestions: HAZUS will identify risks presented by the local building stock, and it can be used to estimate the results of broad mitigation actions aimed at vulnerable existing buildings or new buildings represented by future development.

The order of magnitude of reduced losses that can be achieved by seismically rehabilitating all buildings or specific types contained in the active inventory (or by incorporating seismic design provisions in future buildings) can be estimated by changing HAZUS' building mapping scheme parameters. In HAZUS, expected seismic performance of a given Model Building Type (MBT) is determined by the combination of the parameters measuring the appropriate code level for the area: *Low, Moderate, and High Seismic* and the Quality Factors: *Code, Inferior, and Superior*. These parameters are discussed more fully in Chapter 7 of the User's Manual and Chapter 5 of the Technical Manual. Although all of the combinations of these factors can create a total of nine variations (3 x 3), only the following four are recommended for use for testing the significance of various mitigation measures for the building inventory.

- *Low Seismic-Inferior*—used to describe buildings with no seismic design ("No Code")
- *Low Seismic-Code*—used to describe buildings designed to modern codes in UBC Seismic Zone 1 or NEHRP map area 3 or lower ("Low Code")
- *Moderate Seismic-Code*—used to describe buildings designed to modern codes in UBC Seismic Zone 2B or NEHRP map area 5 ("Moderate Code")
- *High Seismic-Code*—used to describe buildings designed to modern codes in UBC Seismic Zone 4 or NEHRP map area 7 ("High Code")

Incorporating seismic design into new building construction, or accomplishing seismic rehabilitation of existing buildings will not eliminate the losses but only reduce them. Therefore, the reduction in losses stemming from a mitigation measure cannot be taken as the total loss initially attributed to a given building type or inventory, but is always the difference between the original condition and the mitigated condition. There is little damage data from actual earthquakes on the reduction of losses from mitigation actions. Thus, short of an extensive local study of conditions, improvements can only be roughly estimated by comparing HAZUS runs for different inventory conditions. For the purposes of these estimates, the following changes in inventory parameters are recommended:

1. To test the effect of adopting seismic design for new buildings, enter into HAZUS estimated new development in appropriate locations (in HAZUS by census tracts) and with the expected model building types. Compare losses with the future inventory characterized as *No Code* to that of *Low, Moderate, or High Code*, as applicable to your area.

2. To test the effect of seismic rehabilitation on the inventory or on a specific model building type, compare results with inventory entered as *No Code* to that of *Moderate Code* (in all areas). Seismic performance objectives of local rehabilitation ordinances vary greatly, and it is difficult to capture such variations. A reasonable initial estimate of loss reduction potential from rehabilitation can be obtained with use of the *Moderate Code* description. However, before adoption of mitigation measures, it is recommended that the benefits and costs be estimated locally. This is beyond the model building type calculations of HAZUS.

For the specific model building type of unreinforced masonry construction (URM), it is recommended to compare results with this portion of the inventory entered as *URM-No Code* to the same inventory entered as *Reinforced Masonry-Low Code* for a lower bound estimate of improvements, and to *Reinforced Masonry-Moderate Code* for a upper bound estimate of improvements. A variety of mitigation actions for various specific model building types that have previously been considered or used are listed in Table 4, along with comments concerning the use of HAZUS to study their differing effects.

In earlier versions of HAZUS (HAZUS97, HAZUS99, and HAZUS99-SR1), building value depends soley on occupancy class rather than model building type. These earlier versions calculate an aggregate, although the total loss to the occupancy is calculated correctly, the reassignment of losses to each model building type will not directly reflect changes in performance due to

Building Specific Damage and Loss Functions

HAZUS incorporates 36 Model Building Types (MBTs) of three different height ranges to model a building inventory. In addition, each of these MBTs can be classified by various seismic design attributes, depending on applicable local codes. Expected seismic response, economic value, occupancy, and damage characteristics for each case are embedded in HAZUS. Because HAZUS is a national loss estimation program, there are groups of buildings in various communities that may not be modeled well. In addition, the many different degrees of seismic rehabilitation that can be accomplished are not specifically modeled. However, it is possible in the current version of HAZUS to enter all the parameters necessary to model a unique specific building or group of buildings. These parameters are termed Building Specific Damage and Loss Functions (BSDLF). Earthquake engineering expertise is needed to develop these parameters, and expert knowledge of HAZUS is required to enter the parameters and to examine the results. HAZUS users can contact NIBS for further information on this advanced use of HAZUS. It is expected that this capability will be made more user-friendly in future versions of HAZUS changes in code and quality factors of a single model building type. It is, therefore, recommended to study only the changes in total losses in building stock due to mitigation measures, or to zero out all model building types other than the one (or group) under study. However, this procedure is no longer required starting with HAZUS99-SR2, since building values now are assigned explicity to model building types in addition to occupancies.

A Level 1 loss estimate, using default building inventory, may yield useful overall regional losses, but the results may not be representative when broken down by specific census tracts, building occupancies, or model building types. Promising mitigation schemes must be pursued further using analysis methods incorporating more detail about the inventory itself and considering the applicability of the loss and damage functions of the preset HAZUS model building types. These recommended approaches require the following steps:

1. Run loss estimates using the building inventory within the default database. Investigate various mitigation actions by revising the Seismic/Quality Factors of appropriate portions of the inventory and comparing losses. The significance and value of improvements should be considered based on reviewing the performance of the isolated portion of the inventory affected, rather than changes in overall regional losses, which for many mitigation measures, may be small. The effect of changing seismic design criteria on future construction can be estimated by creating an inventory that will represent expected future development and by making comparisons of losses using various Seismic/Quality Factors.
2. If estimates of improvements using default inventory are promising, investigate the applicability of the default inventory for local conditions. This is most easily done by convening a small group of persons knowledgeable about local building stock, such as real estate personnel, building officials, and architects and engineers. Rerun "before and after" conditions using an improved representation of local building stock. It is also recommended that local soil conditions be utilized for these Level 2 runs.
3. HAZUS results can be made even more applicable to local conditions by collecting more exact information on the buildings proposed for mitigation. Numbers of buildings and square footage per census tract can be collected, the data converted to HAZUS inventory descriptions, and additional comparison runs can be made.
4. If more information is necessary or desirable, seismic structural experts can review HAZUS damage and loss functions for applicability to the building stock being studied. If

not adequate, building specific damage and loss functions (BSDLF) can be developed for use in HAZUS or detailed studies of costs and benefits of the mitigation measure can be performed outside the framework of HAZUS.

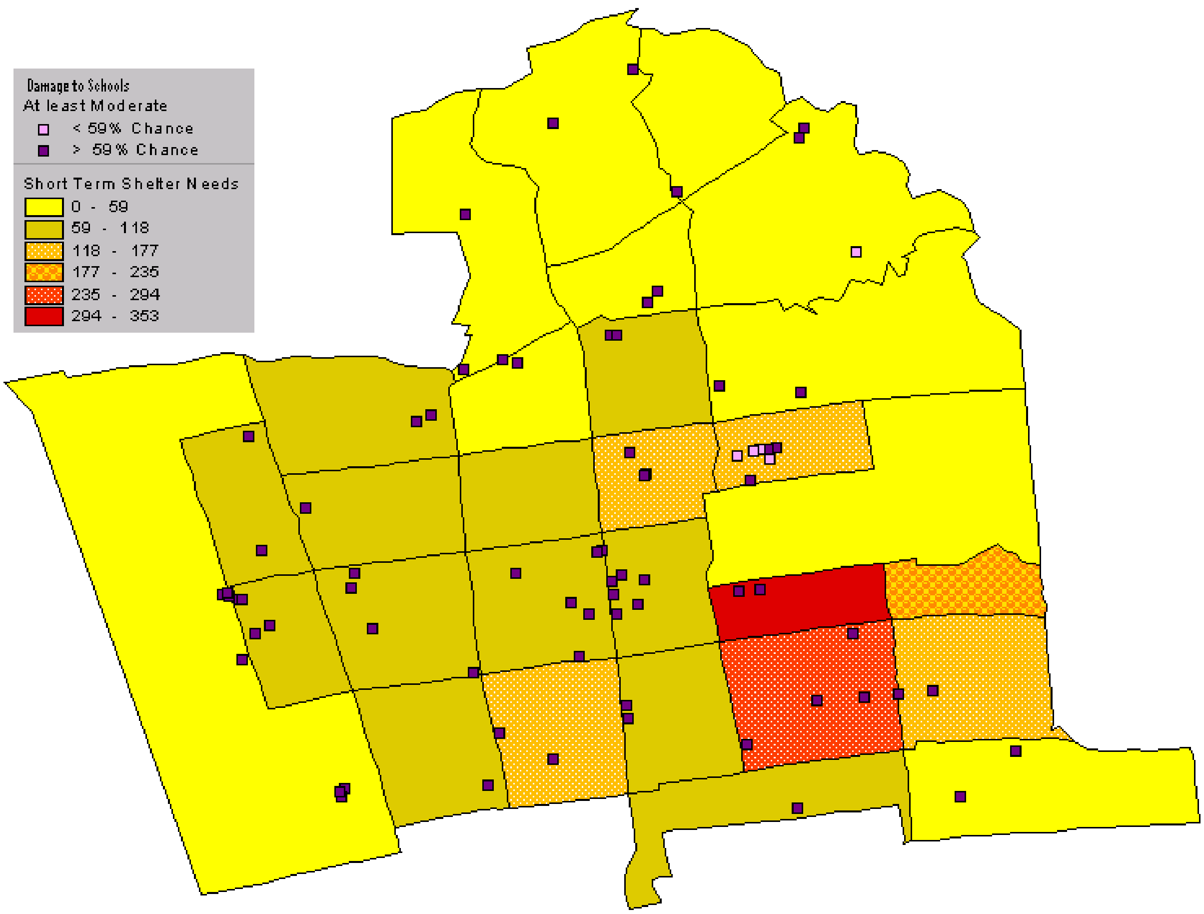
5. Starting with HAZUS99-SR2, an Advanced Engineering Building Module (AEBM) is available to support mitigation efforts by providing building-specific loss estimation tools for use by experienced seismic/structural engineers. HAZUS damage and loss functions for generic model building types are considered to be reliable predictors of earthquake effects for the large groups of buildings represented. However, more directed analysis is required to adequately predict damage for a specific building or groups of buildings that can be described in detail. Using the AEBM procedures in mitigation, an engineer can create building-specific damage and loss functions that can be used to assess single or group building losses both in their existing condition and after some amount of seismic rehabilitation. The accuracy of damage and loss estimates using building-specific functions, and their improvement over predictions using generic building functions, will depend both on the quality and completeness of building-specific data and on ability of the engineer to transform this information into meaningful functions.

Nonstructural Building Components

Nonstructural building components include building mechanical/electrical systems and architectural components such as partition walls, ceilings, windows and exterior cladding that are not designed as part of the building load-carrying system. For future construction, adoption and enforcement of seismic building code provisions will provide requirements for the seismic protection of nonstructural components as well as the structure. For existing buildings, successful mitigation measures have been limited to anchorage of parapets and other falling hazards (although often considered “structural” mitigation), and anchorage of residential water heaters. Mitigation consisting of anchoring a significant portion of nonstructural components in the general inventory has not been attempted. On the other hand, nonstructural programs targeted at essential buildings such as schools, hospitals, and emergency command centers have been successful and will greatly enhance the ability of these buildings to perform their post-earthquake roles.

HAZUS’ current focus is more on global changes to buildings, and the program does not easily facilitate the testing of nonstructural mitigation measures. Expected nonstructural performance is largely tied to the structural code and quality levels previously discussed under *Specific*

Figure 6 – Sample HAZUS Map: School Damage and Short Term Shelter Needs



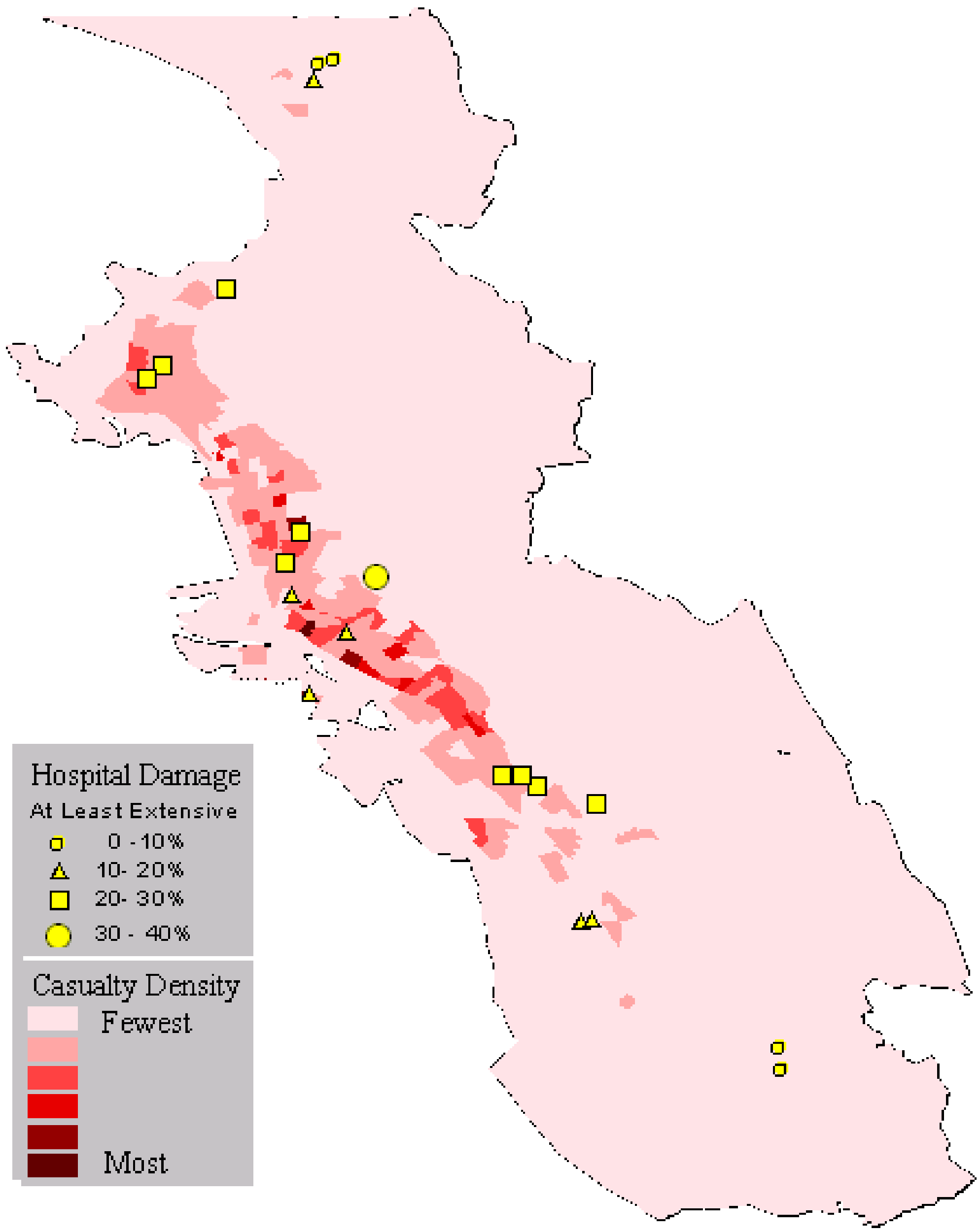
Modeling Suggestions. Future versions of HAZUS may include the ability to more explicitly model changes to the seismic protection levels of nonstructural systems.

Essential Facilities

HAZUS also can be used for mitigation analysis for essential facilities including hospitals, schools and fire and police stations. Maps and summary reports can be used to identify potential damage to these types of facilities after an earthquake and to assess problems with their available service capacity.

In Figure 6, a HAZUS map shows schools that are expected to serve as high occupancy shelters and their expected level of earthquake damage (greater or less than 59%). Your community might evaluate the earthquake resistance of its schools to determine the nature of the expected damage and the implications for life safety and continued functionality for shelter operations. Second, funds might be secured to replace some of

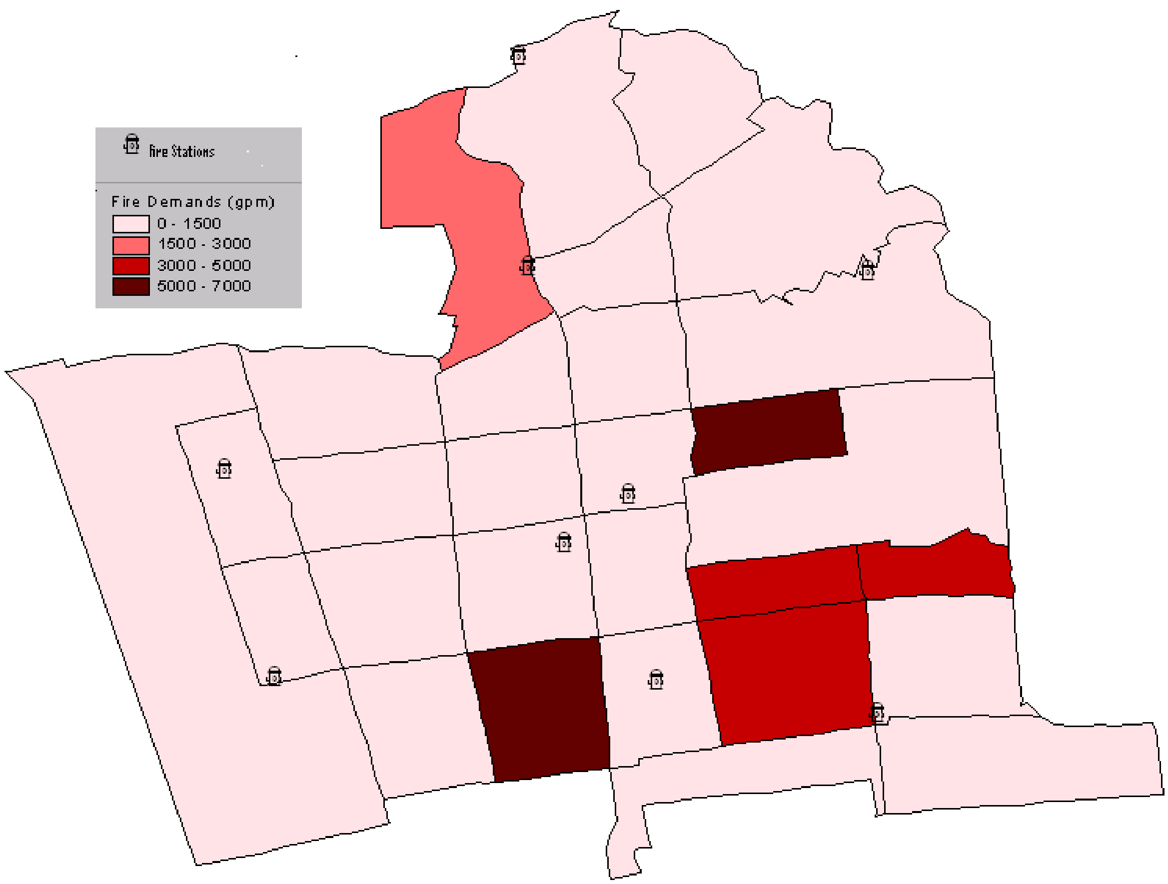
Figure 7 – Sample HAZUS Map: Hospital Damage Overlaid with Casualties Density



school buildings or to mitigate their potential structural and nonstructural damage. And, third, the estimated shelter needs might exceed the schools' capacities, leading city officials to consider evaluating and designating other structures as additional emergency shelters.

Figure 7 shows the location of hospitals in the study region, their expected earthquake damage and the probable concentrations of casualties they will have to serve following an earthquake. Your community might want to structurally evaluate existing hospitals and adopt special standards for up-

Figure 8 – Sample HAZUS Map: Fire Stations and Fire Demand



grading existing or constructing new ones.

In Figure 8, a HAZUS map shows fire station locations and water demands in gallons per minute (gpm), the standard calculation for fire suppression. Potentially high demands (5,000-7,000 gpm) and excessive distances between stations might give your community reason to perform an engineering study of the fire stations to determine which, if any, may need to be replaced or seismically strengthened. Also, working with the water district, your community might determine what, if anything, needs to be done to improve the earthquake resistance of the water storage and distribution system.

For using the methods described in *Specific Modeling Suggestions* for buildings, the Superior Quality Factor is intended for essential facilities designed for superior performance (e.g., use of an importance factor of 1.5 in building codes). The expected improved performance of essential buildings retrofitted or replaced to that level can be tested by assigning this Quality Factor as appropriate.

Infrastructure

Transportation, water, natural gas, electricity, wastewater, and communications systems make up the infrastructure or lifelines of your community. With their varying configurations and geographic distribution, designing and constructing earthquake-resistant lifeline facilities requires specialized expertise.

Seismically-based standards for mitigating potential losses in many of these systems are few and inconsistent. Often, it is easier to replace old systems or elements rather than trying to strengthen existing ones. Some facilities, such as ports, coastal or flood barriers, and refineries may have to be located in poor ground areas. Specialized geotechnical and earthquake engineering expertise may be needed to ensure effective mitigation. In increasingly dense earthquake-prone urban areas, the impact of an earthquake on transportation, communications, and other systems, especially those having little or no redundancy, will quickly contribute to the losses, add great burdens on emergency response forces and slow early recovery actions. The shaded box lists mitigation measures for lifelines.

Using HAZUS for Transportation and Utility Lifelines Mitigation

Lifelines in HAZUS are divided into transportation systems and utility systems. Lifeline damage is described in terms of probable damage to system components for a given level of ground motion, and as the estimated time required to restore full functionality of the system. HAZUS' simplified analyses for water and electric power systems at Level 1 provides a preliminary assessment of vulnerability. To conduct a detailed Level 2 mitigation study of a community's potable water system, a sophisticated user can employ HAZUS' Potable Water System Network Analysis Model (POWSAM), which was developed to allow the importing of the most widely used water network inventory data.

Incapacitated bridges will contribute to projected economic losses to individual communities within the region. Additionally, they will exacerbate economic losses due to the inability of industrial and commercial entities to serve other regional communities and external markets and employees unable to reach their places of employment from their residences. As with building damage, mitigation analysis for lifelines is

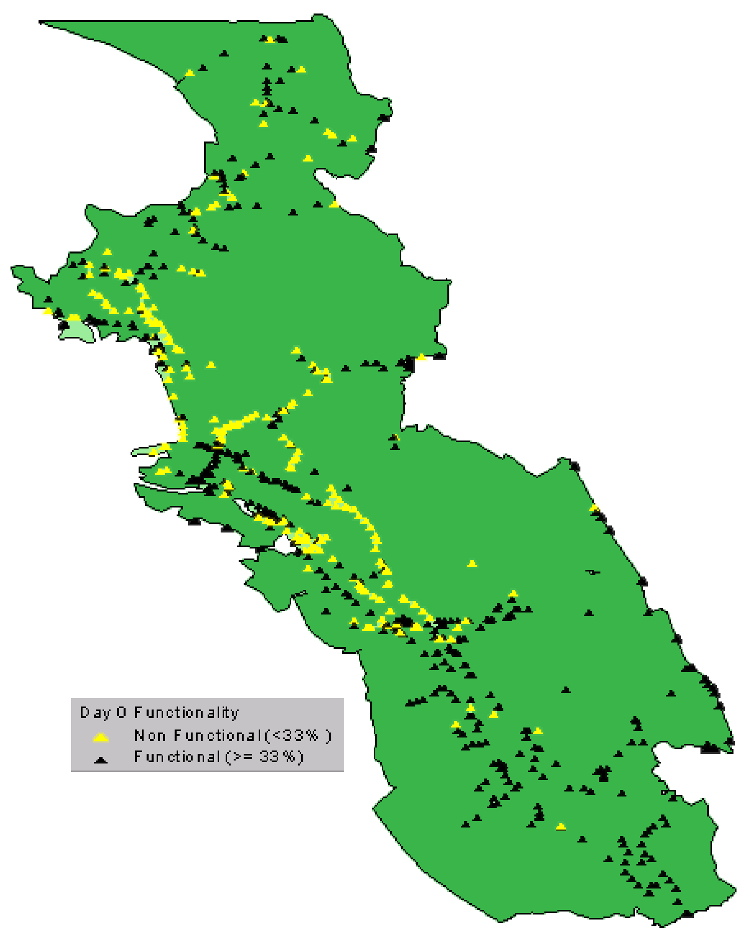
Infrastructure Systems Mitigation Strategies

- **Evaluate the performance of existing lifelines subject to ground motion.**
- **Develop programs to retrofit of replace deficient lifeline components.**
- **Adopt earthquake resistant standards and designs for new community lifelines, including water, transportation, electrical and similar systems.**
- **Design specialized facilities, such as ports, refineries, and others, that are "outside" of building codes for seismic resistance.**

> "It should be recognized that all the major water supply pipelines from external water-sheds for the Los Angeles area cross the San Andreas Fault, and a similar situation pertains to the water supply pipelines for San Francisco crossing either the Hayward or San Andreas faults. East of Los Angeles, the San Andreas Fault crosses Cajon Pass where many vital lifelines (highway; railroad; natural gas, water, and petroleum pipelines; fiber optic lines, and electric power transmission lines) are collocated in a very narrow pass subject to fault rupture."
>
> Thomas O'Rourke
> Testimony to Congress;
> Hearing: Turkey, Taiwan and Mexico City Earthquakes;
> Lessons Learned

performed by examining HAZUS-generated maps, detailed tables of results and summary tables for high-loss features or by comparing losses under unmitigated and mitigated conditions. Figure 9 identifies highway bridges with a poor probability of having functionality restored within a reasonable amount of time after an earthquake. Specific bridges require further study to assess their deficiencies and to formulate specific mitigation measures.

Figure 9 – Sample HAZUS Map: Highway Bridges Functionality



Flood, Hazardous Material and Fire Exposure

Besides building and lifeline-related damage, communities also can incur damage and loss of life from other earthquake-induced hazards: flooding from dam breaks, hazardous material releases and fires.

HAZUS' results may encourage your community to reduce the likelihood of dam or levee failure and to prepare for floods that may occur. As a first step in assessing the risk to your community, HAZUS identifies all dams and levees including a hazard classification (low, significant, high) based on downstream urban development and potential economic loss. In Figure 10, a HAZUS map displays dams in a study region located in soils subject to potential liquefaction. This information might lead your community to evaluate the structural integrity of one of more of the dams. Linked with inundation maps, these analyses could provide a basis for strengthening, replacing, or closing dams or taking precautionary measures, such as lowering their water levels, to avoid earthquake-caused downstream losses in case of the dams' partial or complete failure. Inundation maps, an essential element in accurately assessing a community's risk, are not produced in HAZUS. HAZUS has the capability, however, to import existing inundation maps which can be overlaid with population density maps or maps of inventory to estimate exposure.

HAZUS maps the locations of hazardous material facilities as shown in Figure 11 or in conjunction with ground motion, soils, population, and inventory maps. HAZUS also identifies the types and amounts of stored materials. Your community might conduct a preliminary assessment of potential consequences to highly vulnerable facilities, which can be followed up with detailed, site-specific studies. At a higher level of analysis, a plume (dispersion) map can be input into HAZUS to demonstrate exposure of populations to hazardous materials releases.

For fire-following-earthquake, HAZUS provides estimates of the percentage of burned area, number of ignitions, the population exposed, the dollar value exposed and fire demand in gallons per minute (gpm). With this information, your community might consider purchasing additional fire and specialized HAZMAT response apparatus or providing automatic gas valves that shut-off in the event of shaking.

Figure 10 – Sample HAZUS Map: Dams Overlaid with Liquefaction Potential

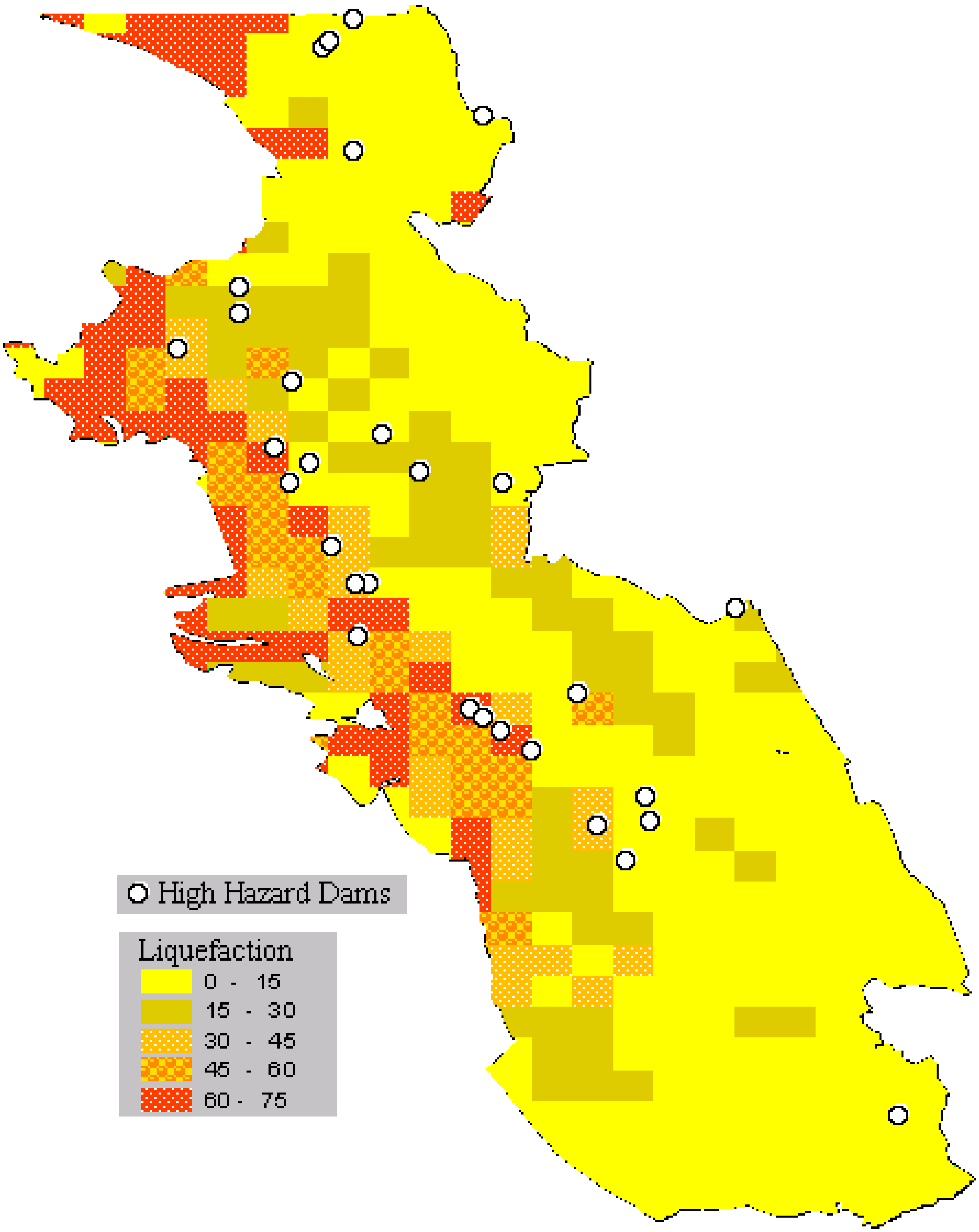
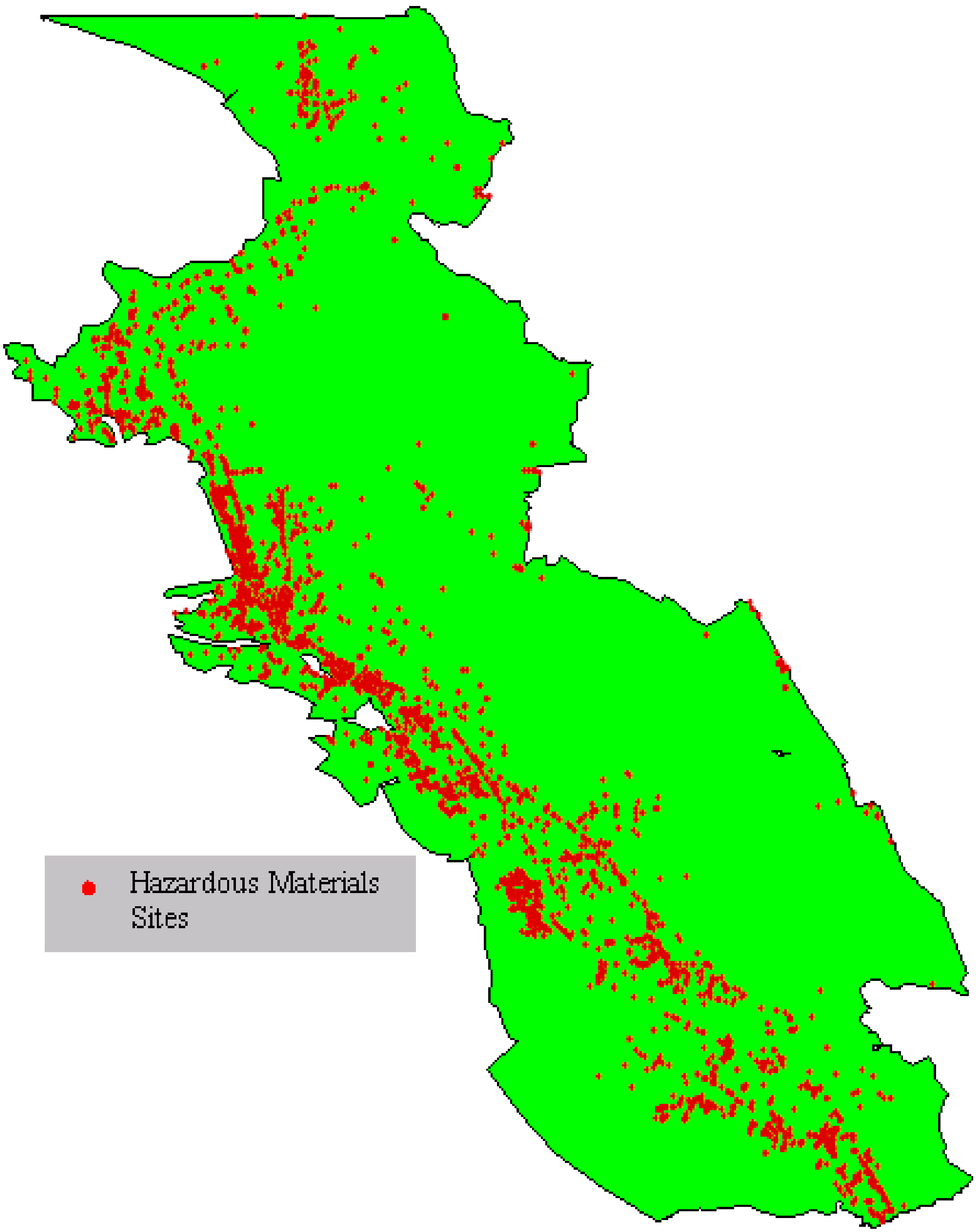


Figure 11 – Sample HAZUS Map: Hazardous Materials Site



Community Mitigation Planning - The 10 Steps to Preparing a Successful Plan

Introduction

A community mitigation plan is an effective tool for "sustained action taken to reduce or eliminate long-term risk to people and their property from hazards and their effects" (FEMA). The plan is a written statement of facts, goals and objectives, a review of available and feasible alternatives, a compilation of recommendations, and a list of final actions to be pursued in the short- and long-term. Essential elements of the plan include assessing a community's hazards, determining its level of exposure to them, and estimating potential losses.

Anyone can prepare a plan, but only by following a proper planning process can one determine what is best for a community and get all those affected to agree on what to do to make the community less vulnerable. Preparing and adopting a community hazard mitigation plan can be implemented in the ten-step process described in this section.

Plans may address a single hazard, flooding being the most common, but increasingly mitigation plans address multiple hazards. Salem, Oregon's plan, for example, addresses floods, landslides, earthquakes, severe wind and ice storms, wildland-urban interface fires, volcanic eruptions and hazardous materials incidents. While tsunamis do not threaten Salem, the plan does recognize the city's potential role as an evacuation center for coastal residents and visitors if tsunami warnings are issued.

The elements of community mitigation planing include:

- Assessing a community's current mitigation activities and their effectiveness;

- Identifying additional mitigation measures that should be undertaken, such as setting aside flood hazard areas as open space;

- Defining strategies and methods to implement mitigation measures, such as using a capital improvement program to realign or replace roads; and,

- Serving as a qualifying document for various hazard mitigation programs, such as those administered by FEMA and the Corps of Engineers.

Successful mitigation planning depends on the committed involvement of people and organizations within an affected community. The process described in this section is a framework for structuring the involvement of affected parties. It also provides a helpful framework for discussing the use of HAZUS' loss estimation results for mitigation planning and, particularly, earthquake risk reduction planning.

Understanding Natural Hazards and Risks

Information about the existence, history, extent, and occurrence of earthquakes is essential to preventing future losses. The key concepts are understanding the words "hazard" and "risk" in this context. Hazard is used generally to describe the nature of the event-causing agent, such as the presence of active faults that generate earthquakes. Risk is used to describe the exposure or vulnerability of human settlements and systems to damage from earthquakes.

The best possible scientific, technical, engineering, social, economic, and demographic information is needed to support effective mitigation planning, programs, and practices. The HAZUS User's Manual (Chapter 1, especially Table 1.1) describes the national datasets included in the software for both ground shaking hazards and key risk components, such as the general building stock, essential facilities, and transportation and utility systems, and it provides instructions for setting up study regions and obtaining damage and loss results for key risk components, as well as identifying selected social and economic impacts. The manual also emphasizes the importance of supplementing HAZUS national data with more current and accurate local data.

Community Mitigation Planning - the Ten Steps

The process is the key. The shaded area on the following page contains an outline of the ten-steps and indicates the steps in the process where using HAZUS can be most helpful. While the principal objective in preparing a plan is formalizing mitigation planning, there are other benefits, too. It is educational as participants learn more about their own and others' concerns, and about the techniques and measures that can improve the disaster-resistance of the community. Additionally, the act of working together to produce the document gives the participants "ownership" of it. A more complete discussion of this process may be found in the first issue of the *Natural Hazards Informer* (see References).

The role of HAZUS in the process will be to serve as a tool for helping to understand the community's hazard and potential losses from scenario earthquakes, evaluating the accuracy of the national datasets, and identifying the sources of better or more current local information.

A Ten-Step Community Hazard Mitigation Planning Process
And how HAZUS can be useful to the process

Step 1 **Organize to Prepare the Plan**

Use HAZUS outputs as a resource for information and graphics when preparing planning documents.

Step 2 **Involve Citizens**

Use HAZUS outputs as exhibits at meetings to provide an illustration of potential hazards and losses.

Step 3 **Coordinate with Other Organizations**

Use HAZUS outputs at meetings to demonstrate the effects of earthquakes on the public and private sectors.

Step 4 **Assess the Hazard**

Use HAZUS to estimate the comparative severity of potential earthquakes and to identify historical earthquake threats.

Step 5 **Assess the Problem**

Use HAZUS products to document potential damages and losses.

Step 6 **Set Goals**

Use HAZUS products to support identification of mitigation goals and objectives.

Step 7 **Review Possible Activities**

Use HAZUS products to support identification of mitigation measures.

Step 8 **Draft an Action Plan**

Use HAZUS analyses to provide supporting documentation for a mitigation plan.

Step 9 **Adopt the Plan**

Use HAZUS outputs to continue to serve as informational, consensus building, and decision support aids.

Step 10 **Implement, Evaluate, and Revise**

Use HAZUS to update inventory data on your community's built environment.
Use HAZUS' updated inventories to produce more reliable loss estimation results.
Use HAZUS' periodic improvements to expand HAZUS' mitigation support roles.

Step 1. Organize to Prepare the Plan

The planning process will succeed only if the right people and agencies are involved at the right times. This requires organizing staff, appointing a planning committee and a lead planner, and holding meetings to discuss objectives and to monitor progress.

The Planner: The person in charge of the planning process is the "Planner." Selecting that person is the crucial first step in the process. The appointed planner must be officially designated as having the authority to develop the plan and is responsible for completing the plan in a reasonable amount of time, ensuring its adoption, and monitoring its implementation. In some communities, a planning department official may fill this role. In others, it may be filled by an emergency manager, council member, or the chair of the citizens' planning committee. While a consultant may provide valuable guidance, the person in charge should be a local official or citizen.

The planner needs an open mind about the variety of possible risk reduction measures that should be considered. Different professionals will bring their own preferences to the process. For example, planning implemented by engineers often favors structural measures; plans prepared by emergency managers may emphasize preparedness activities; and planners may favor regulatory or land-use policies.

Staff Resources: Staff from all affected departments should participate in the planning process. Which staff to involve depends on the community's organization and the mitigation measures that will likely be reviewed and/or selected during the planning process. Staff who likely will be responsible for helping to implement the plan should be involved in the planning process, as they need to understand what is expected of them and be willing to work toward the plan's implementation. Also, the planner will need technical support from engineers and other staff professionals who are more familiar with some of the appropriate mitigation measures. Involving participants from various disciplines, professions, and interest groups will make the plan more comprehensive.

HAZUS supports this process by focusing attention on losses to identify potential mitigation strategies and to study possible risk reduction measures. An earlier section of this *Guide* describes several of the most common mitigation strategies available to communities.

Planning Committee: It is recommended that a Planning Committee of 10 to 15 people comprised of local officials, community staff and private citizens conduct the planning process. This structure has proven to be very helpful in providing information on the needs and concerns of the groups, and in keeping the community up-to-date on how the plan is progressing. An individual should be appointed to head the planning committee as the Chairman. The head of the planning committee should be chosen for his or her ability to get people to work together and get things done. The planner or other staff member provides administrative support, such as taking minutes and sending out meeting notices.

The committee will likely need subcommittees who can spend more time on details that do not need to be discussed during the meetings of the main committee. Usually the Chairman is given the authority to name subcommittees and appoint their members.

A planning committee can:

- Be an effective forum for matching the technical requirements of a program to the community's needs,
- Give the participants a feeling of "ownership" of the plan and its recommendations, which helps build public support for it, and
- Form a constituency that will have a stake in ensuring that the plan is implemented.

Using HAZUS' results as a point of departure, community staff members can support the mitigation planning process. For example, the planning and community development representatives can explain the community's historic evolution, current configuration, future development patterns, and current growth management policies and interpret these in light of potential hazards issues. The building official can supply information about the earth-

Staff and Expertise to be Included in the Mitigation Plan

- Land-Use Planner: existing land uses, demographics, building occupancies, infrastructure, planning direction and coordination with other plans and programs
- Geotechnical Engineer: local geological and soil conditions
- Structural/Civil Engineer: hazardous sites, building and lifeline vulnerabilities, codes and structural mitigation measures
- Utility and Public Works Representative: streets, highways, bridges, utilities, mitigation measures and maintenance
- GIS Specialist: databases, maps, map analyses, data input into HAZUS
- Emergency Manager: emergency services planning, response and recovery needs
- Police and Fire Officials: emergency services
- Building Code Official: building codes and zoning ordinances
- Fire Marshal: hazardous design practices, materials, buildings and sites
- Parks Official: open space, parks and forest preserves
- Public Relations: community relations and public information on property protection measures and public involvement
- Governing Board or City Manager's Representative: political acceptance and adoption of mitigation plans

quake design requirements of earlier and current building codes, often very useful in establishing "benchmark" years when at least some earthquake resistant design requirements were initiated. The identification of areas with poor soils could help staff from the parks and recreation department define areas that should remain as open space or recreational areas.

Meetings: At the first Planning Committee meeting, a schedule should be established. Depending on deadlines, time constraints, and staff time available, committee meetings could be held as often as once or twice a month. Scheduling meetings in advance should be done so as many people are included as often as possible.

HAZUS' outputs, such as maps and tables, can serve as effective exhibits at committee meetings, and can provide a continuing source of shared information that is enriched throughout the process so increasingly accurate information is used, confidence is built, and the crafting of effective, practical, and acceptable mitigation measures can occur.

Determining who has a vote usually is not necessary, as issues are usually decided by consensus.

One key threat to the planning process is that it starts to drag and become a bore. Nine months of monthly meetings with nothing to show but a draft piece of paper can discourage many committee members. It is important to maintain momentum throughout the process.

Field trips are very educational and allow committee members to see the problems and examples of solutions first hand. Such field trips often change the minds of those skeptical about some of the potential measures. They also can serve to break up the monotony.

The Planning Committee's work is not done when the governing board adopts the plan. The Planner should give the committee assignments, such as developing some recommendations in more detail, helping with the design and implementation of some projects, and monitoring the community's progress in implementing the action plan.

Consensus: *Ideally, various groups should seek consensus on procedures, goals, and issues.* Consensus *means a general agreement or something everyone can live with.* Consensus *does not mean majority vote.*

Step 2. Involve Citizens

The involvement of citizens is critical to the success of mitigation planning. Citizens have their own missions, obligations, and concerns and hazard mitigation may not be one of their highest priorities. Citizens can help in designing effective programs by providing support for them.

Citizens include:

- Owners and renters of vulnerable houses and commercial buildings,
- Representatives of homeowner, business, or neighborhood organizations,
- Managers of critical facilities, such as large businesses, power stations, and schools,
- Land developers, real estate agents, lenders, and others who affect the future of the community's land use and building standards, and
- Representatives of special purpose districts, councils, or associations such as fire protection districts, water districts, and councils of government.

Citizens may become involved in a variety of ways including:

- Serving on the Planning Committee,
- Attending meetings that address the issues that are most important to them,
- Providing input to the process through questionnaires or by hosting a workshop to gather input and give guidance to the Planning Committee,
- Conducting an "Earthquake Preparedness Week" or a demonstration project to attract public attention and raise the community's level of awareness and interest in earthquake risks, and
- Providing review of the draft plan.

The level of citizen involvement depends on how much time they have available and how strongly the issues affect them. One of the most important things is that they are asked to participate and that they are offered a chance to have a say in your planning work. A good leader will make sure everyone is heard. You need them to make sure that committee proposals will be acceptable to their constituencies.

Step 3. Coordinate with Other Organizations

There are two reasons to involve other organizations in the planning process. First, others may be implementing, or planning to implement, activities that may affect your community's exposure to earthquake risk. You need to make sure that your efforts are not going to be in conflict with a government program or duplicate the efforts of another organization. State, regional and federal agencies may be undertaking various mitigation efforts or projects. While such planning initiatives may not address all local issues, they likely will thoroughly evaluate mitigation alternatives applicable to their programs, which can save you a lot of work.

Secondly, outside agencies and organizations may offer help in the form of hazard data, technical information on various risk reduction measures, guidance on regulatory requirements, advice and assistance in the planning process, implementation of a recommended measure, and financial assistance.

Step 4. Assess the Hazard

Earthquake hazards and the related risks to the community need to be assessed before decisions can be made about their implications, relative importance and the scope of a plan's recommendations and the structure of its specific actions. The Planning Committee should identify the nature, frequency, and characteristics of all significant earthquake hazards and risks over an often-lengthy period of time (100-200 years is not unusual). Historical information is very important, as are research and technical studies that provide information about severity, probabilities of occurrence, and other factors.

HAZUS, as noted earlier, will help to identify the comparative severity of potential earthquakes. Major to great earthquakes may rarely occur, but they are capable of causing enormous regional losses and impacts. Small to moderate earthquakes occur relatively frequently and can result in limited but possibly locally severe damage. But potential losses from frequent relatively minor events add up to great losses over time. This analysis helps determine the appropriateness and priority given to mitigation efforts. It may be judged prudent and cost-effective to strengthen existing earthquake hazardous buildings so life safety risk and economic and service interruption are greatly reduced for the more frequent moderate events, but these same buildings could be allowed to suffer extensive damage in very rare great events. On the other hand, the same community's fire stations may be strengthened to a higher performance level because, as critical facilities, their response capabilities cannot be impaired.

Step 5. Assess the Problem

Getting everyone to agree on a problem statement is the first step in getting them to agree on goals and solutions to solve the problem. Developing a problem description, including data and maps, such as those that can be provided by HAZUS, is an essential first step in assessing the problem. How much time and effort is spent on collecting data depends on the time and resources available. However, the planning process should not be delayed while waiting for more data in order to develop a detailed problem description.

Since earthquakes impact more than just buildings, HAZUS and other information should be used to assess potential effects on the following:

- Road, bridges, and transportation facilities likely to be closed
- Critical facilities affected (e.g., hospitals damaged or isolated)
- Areas of potentially extensive damage (e.g., those with weak soils)
- Vulnerable utility systems (e.g., water, electricity, natural gas)
- Damage from past earthquakes in the community or other communities
- Undeveloped areas as well as areas slated for planned development
- Special or historic structures or areas

A final topic that should be addressed is the future. Your problem definition should review expected changes to the community (e.g., existing Master Plans), including the development potential of vacant land and plans for the redevelopment of existing areas.

Step 6. Set Goals

Up to now, the planning work has been relatively non-controversial. The process has mostly involved talking to agencies and organizations and collecting and recording facts. Now comes the tough part: getting people to agree on what should be done by setting goals.

Those involved in the planning process will need to prepare a clear statement of goals and objectives to identify and clarify concerns and develop the means for addressing them. Goals are general statements of direction, such as "reduce potential earthquake damage to existing buildings" or "improve building codes for new construction." Objectives are more specific targets. Examples of objectives that support these two goals could be "require that all unreinforced masonry buildings between Main Street and 1st and 3rd Streets be structurally upgraded to meet the seismic requirements of the most recent version of the International Building Code" and "ensure the adoption of the latest building code and its effective enforcement by qualified and trained people from our Department of Building Inspection."

Reaching Agreement: It is often easy to reach agreement on overall goals, but it is not unusual to take a long time to reach consensus on specific objectives. The time spent on reaching consensus on objectives is well spent because it is vital to gaining agreement and cooperation from all affected parties. The Planner should strive for unanimous support so that no one will oppose a goal or objective. If unanimous agreement is not possible, a decision by majority vote is common although voting is always potentially divisive.

It helps if goals are positive statements, something people can work for, not negative statements about the community. Where possible, settle on goals and objectives that support more than one interest (e.g., implement seismic rehabilitation measures for existing buildings in areas to be redeveloped and made more economically viable to the community).

The following approach may be used to reach agreement:

- Have all participants write down their goals and objectives,
- Post them for all to see, combining those that are the same or similar,
- Restate them in summary form, using positive statements,
- Identify those that all agree on,
- Discuss the problems with the remaining goals and objectives, and
- Determine if agreement can be reached with some changes.

If this approach fails to work, there are two options. Either drop the more detailed statements and get consensus on the general goals or invite an experienced facilitator to help the group move through a formal process of consensus-building. A facilitator can be very helpful as a neutral outsider to give all interests a chance to be heard. Facilitators also know numerous exercises and other ways to identify common concerns and minimize differences. They are skilled in separating issues and interests from discussions of people and positions and can build an environment where give and take is easier and productive. A facilitator should be lined up in advance so momentum is not lost in arguing over details.

Step 7. Review Possible Activities

Different mitigation measures can be used to meet the objectives. Many of them are inexpensive and easy to implement, while others are more complex and costly. Successful planning requires careful examination of all possibilities.

The many mitigation measures likely to be suggested can be used as a checklist to ensure that everything has been considered. While some of the measures may be quickly eliminated as inappropriate, most deserve careful consideration, especially to ensure full understanding of how they work, their impacts on the community's current and future configuration, and their general benefits and costs. The potential measures should be systematically reviewed, discarding only those that do not meet the following criteria:

- Technically appropriate for reducing earthquake risk,
- Support the goals and objectives,
- Benefits equal or exceed costs,
- Affordable and has a funding source,
- Complies with all local, state, and federal regulations,
- Politically acceptable, and
- Administratively feasible.

In some cases, answers will not be readily available. Questions about technical aspects or agency programs should be directed to experts or representatives from agencies or organizations.

Money is often the most important issue in reviewing alternatives. Three questions arise: "Is the action worth the expense?" "Who pays and who benefits and when?" and "Where can we get the money?" The answers will greatly determine the final structuring of the proposed mitigation action and its acceptability to community interests.

This is also where the agencies and organizations that have been involved in the process can be of great assistance. There are literally hundreds of public and private funding programs, but they usually have several prerequisites, such as a written plan, a budget and an explanation of the benefits. For example, one project might be funded by several different parties, each of which is serving one or more objectives. Often, the agencies can fund only a part of the project, and they favor those projects that have other sources of funding. In other words, they want their money to go farthest, so they will support multi-objective projects. Often, "in-kind" (non-cash) services can be counted toward the local share needed to match an outside source of funds.

Local businesses and other organizations will frequently support projects that benefit their customers, employees, or members, or that make for good advertising. Many projects have direct financial benefits as well. For example, a shared resources program to seismically strengthen dwellings owned by employees of major local employers achieves multiple benefits: reduced employee losses and the costs of dislocation, employees' more rapid return to work resulting in lower business interruption losses for the employer, and fewer insurance claims and applications for disaster assistance.

Step 8. Draft an Action Plan

Only after assessing the problem, setting goals and objectives, and reviewing all the possible solutions, can the most appropriate actions be recommended in the written plan. The plan should contain the recommendations detailing what will be done, by whom, and when.

The plan can be in any format but should include three sections:

1. A description of how the plan was prepared: This helps readers (and potential funding agencies) understand the background and rationale for the plan and how public input was obtained. HAZUS can be used to help produce supporting documentation for aspects of the plan addressing hazard assessment and potential damage and losses.

2. Recommended actions: The plan should clearly identify who will do what, over what time frame and whether existing resources are adequate or new ones needed. Special attention should be given to actions that need to be taken by others, such as a state's legislature.

3. A budget: The plan should explain how its recommendations will be financed. It should note those recommendations that can be implemented as part of a community or organization's normal operations without special funding.

Step 9. Adopt the Plan

The community should make the draft plan available for review by affected businesses, appropriate community government departments, interested organizations, state and federal agencies, and neighboring communities. After allowing several weeks of review time to digest the plan, a public meeting or workshop should be held. A public meeting is a requirement for many funding programs. As with many activities during this process, HAZUS' outputs continue to serve important informational, consensus-building, and decision-support roles.

A public meeting is not the same as a public hearing. State or local laws usually require a public hearing when a community is considering adopting or amending a land use plan or zoning ordinance. There are specific legal requirements for notifying the public and conducting such a hearing. These legal requirements need not be met for mitigation plans in most communities.

In preparing for a public meeting, adequate notice of the date, time and place should be given, and information about the plan should be distributed well in advance. The notice should tell people where to obtain a copy of the draft plan for review before the meeting.

After the meeting, the community's mitigation Planning Committee should make appropriate changes to the plan. The governing board should adopt the final plan. It is always helpful to gain support from other entities. If Planning Committee members were selected to represent a particular interest or organization, those organizations should pass a resolution or otherwise officially support the plan.

Step 10. Implement, Evaluate, and Revise

Adoption of the earthquake hazard mitigation plan by the various participants is not the last step. Monitoring and follow-up will be needed to ensure that the plan is implemented. The plan can be periodically improved by adding new building inventory data and local geologic data to increase the reliability of damage and loss estimates. This will allow more effective decisions to be made about allocating mitigation resources.

HAZUS is also revised and reissued periodically and can continue to serve loss reduction by portraying changes in the community, especially its physical development; noting the implementation of mitigation measures, such as zoning restrictions in poor soils areas; and improving disaster response capabilities, such as by labeling those fire stations that have been seismically rehabilitated. In addition, new improvements to HAZUS' methodologies and software can be used to improve and update the mitigation plan's supporting documentation.

Implementation: The key to successful implementation is that all the involved parties responsible for the various recommendations understand what is expected of them and are willing to work toward implementation. It is helpful for the plan to identify the implementing agency or organization and a designated person to be responsible for implementing each recommendation.

The plan should identify visible and generally acceptable actions that can be quickly implemented, such as evaluating the expected earthquake performance of the jurisdiction's fire stations or adopting the latest building code seismic provisions governing new construction. Immediate progress helps encourage citizens and the Planning Committee participants. Caution should be exercised when actions are retroactive in nature, such as requiring owners of existing buildings to improve them within a short time. Such proposals often founder on the rocks of political unacceptability.

Monitoring: No plan is perfect. As implementation proceeds, changes will be needed. The plan should have a formal process to measure progress and to develop recommended changes. A monitoring system helps ensure that all parties act on their assignments in a timely manner. This can be in the form of a checklist maintained by the person designated as responsible for the plan or by using a more formal reporting system to a higher authority, such as the governing board or an oversight committee.

Evaluating and Seizing Opportunities: Even with full implementation, the plan should be evaluated periodically to determine progress and to evaluate changed conditions. The Planning Committee should meet to review progress and submit its recommendations to the agencies and organizations responsible for implementation.

While a plan will usually produce the best and most efficient program, a community should be ready to act fast to take advantage of opportunities provided by the necessity of dealing with disasters, extra end-of-the-year money, changes in other public concerns, or heightened public interest due to disasters elsewhere. There may be a chance to effect major changes quickly. Research and experience have clearly shown that "windows of opportunity" open, sometimes only for very short periods.

A Closing Reminder

Earthquake loss reduction is a complex long-term commitment. It requires the continuing participation of a team of people from virtually all of the city's departments, regional providers of key services (such as utility companies and special districts), and others whose holdings and services affect the city. The importance of a strong mitigation planning team is discussed in *Community Mitigation Planning - The 10 Steps to Preparing a Successful Plan*. While it may be difficult to assemble and sustain such a team in many localities, such a structure is absolutely essential to designing and implementing effective hazard mitigation programs.

Mitigation requires trade-offs for practical economic, social, and political reasons. A community might require strengthening for its few conventional masonry buildings because local opposition is small. A neighboring community with a large number of such buildings might prefer improved codes for new construction and avoid retroactive requirements. This course might be seen as politically safer, less costly, and not as socially disruptive.

Preventing earthquake losses through effective hazard mitigation programs and plans implemented in advance and over the long-term is the key to protecting people, buildings, and systems and to saving money. This *Guide* is a small addition to other materials available to users to help them understand their earthquake vulnerability and to take effective measures to limit their exposure. The benefits from effective mitigation are many: lives saved, injuries avoided, utility services operational, businesses open, transportation and communications systems working, and potentially enormous response and recovery costs avoided.

If you have successfully used HAZUS in an earthquake mitigation program, providing others with the benefit of your experience is in itself a powerful mitigation tool. We ask you to contact the Federal Emergency Management Agency, Mitigation Directorate or the National Institute of Building Sciences, Multihazard Loss Estimation Program to add your experience to the growing list of HAZUS success stories.

Important Message to HAZUS Users

HAZUS is designed to produce loss estimates for use by federal, state, regional and local governments in planning for earthquake risk mitigation, emergency preparedness, response and recovery. The methodology deals with nearly all aspects of the built environment, and a wide range of different types of losses. Extensive national databases are embedded within HAZUS, containing information such as demographic aspects of the population in a study region, square footage for different occupancies of buildings, and numbers and locations of bridges. Default databases and parameters have been included as needed. Using this default information, users can carry out general loss estimates for a region. The HAZUS methodology and software are flexible enough so that locally developed inventories and other data that more accurately reflect the local environment can be substituted, resulting in increased accuracy.

Uncertainties are inherent in any loss estimation methodology. They arise in part from incomplete scientific knowledge concerning earthquakes and their effects upon buildings and facilities. They also result from the approximations and simplifications that are necessary for comprehensive analyses. Incomplete or inaccurate inventories of the built environment, demographics and economic parameters add to the uncertainty. These factors can result in a range of uncertainty in loss estimates produced by HAZUS, possibly at best *a factor of two or more.*

The methodology has been tested against the judgment of experts and, to the extent possible, against records from several past earthquakes. However, limited and incomplete data about actual earthquake damage precludes complete calibration of the methodology. Nevertheless, when used with default inventories and parameters, HAZUS has provided a credible estimate of such aggregated losses as the total cost of damage and numbers of casualties. HAZUS has done less well in estimating more detailed results - such as the number of buildings or bridges experiencing different degrees of damage. Such results depend heavily upon accurate inventories. HAZUS assumes the same default soil condition for all locations, and this has proved satisfactory for estimating regional losses. Of course, the geographic distribution of damage may be influenced markedly by local soil conditions. In the few instances where HAZUS has been partially tested using actual inventories of structures plus correct soils maps, it has performed reasonably well.

Users should be aware of the following specific limitations:

- While HAZUS can be used to estimate losses for an individual building, the results must be considered as average for a group of similar buildings. It is frequently noted that nominally similar buildings have experienced vastly different damage and losses during an earthquake.
- When using default inventories, accuracy of losses associated with lifelines may be less than for losses from the general building stock. The default databases and assumptions used to characterize the lifeline systems in a study region are necessarily incomplete and oversimplified.
- Based on several initial studies, the losses from small magnitude earthquakes (less than M6.0) centered within an extensive urban region appear to be overestimated.
- Because of approximations in modeling of faults in California, there may be discrepancies in motions predicted within small areas immediately adjacent to faults.
- There is considerable uncertainty related to the characteristics of ground motion in the Eastern U.S. The default attenuation relations in HAZUS, which are commonly those recommended for design, tend to be conservative. Hence, use of these relations may lead to overestimation of losses in this region, both for scenario events and when using probabilistic ground motions.
- As yet, there have not been adequate tests for the following features of HAZUS:
  - Effects of liquefaction and landsliding
  - Debris generation
  - Indirect economic losses

HAZUS should still be regarded as a work in progress. Additional damage and loss data from actual earthquakes and further experience in using the software will contribute to improvements in future releases. To assist us in further improving HAZUS, users are invited to submit comments on methodological and software issues to Philip Schneider at pschneider@nibs.org.

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