

HAZUS-MH: Earthquake Event Report



Region Name: *Eagle County*

Earthquake Scenario: *Chase Gulch M6.75 CEUS Event*

Print Date: *January 25, 2006*

Disclaimer:

The estimates of social and economic impacts contained in this report were produced using HAZUS loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.

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Table of Contents

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

General Description of the Region

HAZUS is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of HAZUS is to provide a methodology and software application to develop earthquake losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from earthquakes and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Colorado

Note:

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

The geographical size of the region is 1,689.68 square miles and contains 7 census tracts. There are over 15 thousand households in the region and has a total population of 41,659 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 14 thousand buildings in the region with a total building replacement value (excluding contents) of 3,003 (millions of dollars). Approximately 97.00 % of the buildings (and 78.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 1,581 and 291 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 14 thousand buildings in the region which have an aggregate total replacement value of 3,003 (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 63% 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 49 beds. There are 6 schools, 7 fire stations, 12 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 25 dams identified within the region. Of these, 6 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 1,872.00 (millions of dollars). This inventory includes over 240 kilometers of highways, 159 bridges, 6,960 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	159	223.80
	Segments	23	1,146.60
	Tunnels	0	0.00
	Subtotal		1,370.30
Railways	Bridges	6	0.90
	Facilities	2	4.20
	Segments	16	134.10
	Tunnels	0	0.00
	Subtotal		139.20
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	1	1.10
	Subtotal		1.10
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	2	10.60
	Runways	2	60.30
	Subtotal		70.90
		Total	1,581.40

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	69.60
	Facilities	1	32.30
	Pipelines	0	0.00
		Subtotal	101.90
Waste Water	Distribution Lines	NA	41.80
	Facilities	4	258.40
	Pipelines	0	0.00
		Subtotal	300.20
Natural Gas	Distribution Lines	NA	27.80
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	27.80
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	0.00
Electrical Power	Facilities	0	0.00
		Subtotal	0.00
Communication	Facilities	6	0.60
		Subtotal	0.60
		Total	430.50

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	Chase Gulch M6.75 CEUS Event
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-105.62
Latitude of Epicenter	39.00
Earthquake Magnitude	6.75
Depth (Km)	10.00
Rupture Length (Km)	27.86
Rupture Orientation (degrees)	157.00
Attenuation Function	CEUS Event

Building Damage

Building Damage

HAZUS estimates that about 411 buildings will be at least moderately damaged. This is over 3.00 % of the total number of buildings in the region. There are an estimated 1 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	3	0.02	0	0.02	0	0.02	0	0.03	0	0.02
Commercial	275	2.14	30	3.22	18	5.02	3	7.66	0	12.62
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	13	0.10	1	0.12	1	0.16	0	0.20	0	0.26
Industrial	28	0.22	3	0.27	1	0.39	0	0.62	0	0.58
Other Residential	2,497	19.47	328	34.70	173	47.54	15	34.66	1	33.59
Religion	23	0.18	2	0.26	1	0.37	0	0.54	0	0.75
Single Family	9,985	77.87	581	61.41	170	46.50	25	56.30	1	52.19
Total	12,824		946		365		44		2	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	8,418	65.65	471	49.78	69	18.97	4	9.42	0	0.96
Steel	124	0.97	16	1.65	12	3.30	3	5.67	0	9.48
Concrete	117	0.91	15	1.59	8	2.08	1	2.56	0	1.73
Precast	42	0.33	5	0.50	4	1.14	1	2.52	0	1.28
RM	2,182	17.01	135	14.30	94	25.73	17	39.12	0	4.47
URM	288	2.24	50	5.29	29	7.89	7	15.58	1	57.94
MH	1,652	12.89	254	26.90	149	40.88	11	25.12	0	24.15
Total	12,824		946		365		44		2	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 49 hospital beds available for use. On the day of the earthquake, the model estimates that only 36 hospital beds (74.00%) 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, 100.00% 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	0	0	1
Schools	6	0	0	6
EOCs	0	0	0	0
PoliceStations	12	0	0	12
FireStations	7	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	Locations/ Segments	Number of Locations_			
			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	159	0	0	159	159
	Tunnels	0	0	0	0	0
Railways	Segments	16	0	0	16	16
	Bridges	6	0	0	6	6
	Tunnels	0	0	0	0	0
	Facilities	2	0	0	2	2
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	1	0	0	1	1
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	2	0	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	1	0	0	1	1
Waste Water	4	0	0	4	4
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	6	0	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	3,480	15	4
Waste Water	2,088	12	3
Natural Gas	1,392	13	3
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	15,148	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 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 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 0.00% 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 21 households to be displaced due to the earthquake. Of these, 4 people (out of a total population of 41,659) 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	3	0	0	0
	Single Family	2	0	0	0
	Total	6	1	0	0
2 PM	Commercial	7	1	0	0
	Commuting	0	0	0	0
	Educational	1	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	9	1	0	0
5 PM	Commercial	5	1	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	1	0	0	0
	Total	7	1	0	0

Economic Loss

The total economic loss estimated for the earthquake is 33.91 (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 27.89 (millions of dollars); 25 % 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 56 % 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 Losses							
	Wage	0.00	0.32	2.00	0.03	0.07	2.42
	Capital-Related	0.00	0.14	2.14	0.02	0.02	2.31
	Rental	0.26	1.03	0.77	0.00	0.03	2.09
	Relocation	0.03	0.02	0.04	0.00	0.01	0.09
	Subtotal	0.29	1.51	4.94	0.05	0.12	6.91
Capital Stock Losses							
	Structural	1.34	1.01	1.13	0.13	0.20	3.82
	Non_Structural	4.15	4.76	2.96	0.34	0.49	12.70
	Content	1.27	1.15	1.51	0.18	0.26	4.37
	Inventory	0.00	0.00	0.03	0.05	0.00	0.09
	Subtotal	6.76	6.93	5.64	0.71	0.95	20.98
	Total	7.05	8.43	10.58	0.75	1.07	27.89

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	1,146.55	\$0.00	0.00
	Bridges	223.76	\$0.12	0.05
	Tunnels	0.00	\$0.00	0.00
	Subtotal	1370.30	0.10	
Railways	Segments	134.10	\$0.00	0.00
	Bridges	0.85	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	4.23	\$0.14	3.36
	Subtotal	139.20	0.10	
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	1.06	\$0.08	7.87
	Subtotal	1.10	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	10.57	\$0.37	3.49
	Runways	60.30	\$0.00	0.00
	Subtotal	70.90	0.40	
	Total	1581.40	0.70	

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	32.30	\$0.07	0.23
	Distribution Line	69.60	\$0.07	0.10
	Subtotal	101.91	\$0.14	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	258.40	\$5.06	1.96
	Distribution Line	41.80	\$0.05	0.13
	Subtotal	300.17	\$5.11	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Line	27.80	\$0.06	0.20
	Subtotal	27.84	\$0.06	
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	0.60	\$0.00	0.69
	Subtotal	0.58	\$0.00	
	Total	430.50	\$5.31	

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	-0.03
Second Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-0.09
Third Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-0.11
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-0.11
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-0.11
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(1)	-0.11

Appendix A: County Listing for the Region

Eagle, CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Eagle	41,659	2,328	675	3,003
Total State		41,659	2,328	675	3,003
Total Region		41,659	2,328	675	3,003

HAZUS-MH: Earthquake Event Report



Region Name: *Eagle County*

Earthquake Scenario: *Frontal M7.0 CEUS Event*

Print Date: *January 25, 2006*

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Section	Page #
General Description of the Region	3
Building and Lifeline Inventory	4
Building Inventory	
Critical Facility Inventory	
Transportation and Utility Lifeline Inventory	
Earthquake Scenario Parameters	6
Direct Earthquake Damage	7
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Critical Facilities Damage	
Transportation and Utility Lifeline Damage	
Induced Earthquake Damage	11
Fire Following Earthquake	
Debris Generation	
Social Impact	12
Shelter Requirements	
Casualties	
Economic Loss	13
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Transportation and Utility Lifeline Inventory

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	Facilities	2	4.20
	Segments	16	134.10
	Tunnels	0	0.00
	Subtotal		139.20
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	1	1.10
	Subtotal		1.10
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	2	10.60
	Runways	2	60.30
	Subtotal		70.90
		Total	1,581.40

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	69.60
	Facilities	1	32.30
	Pipelines	0	0.00
		Subtotal	101.90
Waste Water	Distribution Lines	NA	41.80
	Facilities	4	258.40
	Pipelines	0	0.00
		Subtotal	300.20
Natural Gas	Distribution Lines	NA	27.80
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	27.80
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	0.00
Electrical Power	Facilities	0	0.00
		Subtotal	0.00
Communication	Facilities	6	0.60
		Subtotal	0.60
		Total	430.50

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	Frontal M7.0 CEUS Event
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-106.16
Latitude of Epicenter	39.68
Earthquake Magnitude	7.00
Depth (Km)	10.00
Rupture Length (Km)	42.66
Rupture Orientation (degrees)	156.00
Attenuation Function	CEUS Event

Building Damage

Building Damage

HAZUS estimates that about 3,880 buildings will be at least moderately damaged. This is over 27.00 % of the total number of buildings in the region. There are an estimated 329 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	0.03	1	0.02	0	0.02	0	0.02	0	0.01
Commercial	111	1.51	49	1.67	73	2.93	57	5.37	37	11.14
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	6	0.08	3	0.09	3	0.14	2	0.17	1	0.23
Industrial	14	0.20	6	0.22	7	0.29	3	0.31	1	0.21
Other Residential	1,222	16.62	653	22.18	745	29.91	307	28.93	88	26.66
Religion	9	0.12	5	0.15	6	0.24	4	0.42	3	0.88
Single Family	5,991	81.45	2,228	75.66	1,655	66.47	687	64.77	201	60.86
Total	7,355		2,945		2,491		1,060		330	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	5,119	69.60	2115	71.80	1,306	52.43	356	33.55	67	20.40
Steel	45	0.61	18	0.61	34	1.36	32	2.99	26	7.89
Concrete	40	0.55	23	0.77	35	1.41	27	2.53	16	4.80
Precast	16	0.22	6	0.22	12	0.50	11	1.03	6	1.90
RM	1,117	15.19	294	9.98	508	20.38	382	36.07	127	38.57
URM	122	1.66	69	2.33	82	3.30	56	5.27	46	14.01
MH	896	12.18	421	14.28	514	20.62	197	18.57	41	12.42
Total	7,355		2,945		2,491		1,060		330	

*Note:

RM Reinforced Masonry
 URM Unreinforced Masonry
 MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 49 hospital beds available for use. On the day of the earthquake, the model estimates that only 3 hospital beds (7.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 24.00% of the beds will be back in service. By 30 days, 70.00% 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	6	1	0	3
EOCs	0	0	0	0
PoliceStations	12	0	0	8
FireStations	7	1	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	Locations/ Segments	Number of Locations_			
			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	159	7	0	152	152
	Tunnels	0	0	0	0	0
Railways	Segments	16	0	0	16	16
	Bridges	6	0	0	6	6
	Tunnels	0	0	0	0	0
	Facilities	2	1	0	1	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	1	0	1	1
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	2	0	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	1	0	0	1	1
Waste Water	4	3	0	1	4
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	6	4	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	3,480	237	59
Waste Water	2,088	188	47
Natural Gas	1,392	200	50
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	15,148	50	0	0	0	0
Electric Power		1,469	1,017	491	111	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 4 ignitions that will burn about 0.03 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 0.00% 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 812 households to be displaced due to the earthquake. Of these, 163 people (out of a total population of 41,659) 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	4	1	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	19	5	1	2
	Industrial	2	0	0	0
	Other-Residential	54	12	1	3
	Single Family	51	11	2	3
	Total	131	31	4	8
2 PM	Commercial	238	70	11	23
	Commuting	0	0	0	0
	Educational	13	4	1	1
	Hotels	4	1	0	0
	Industrial	14	3	0	1
	Other-Residential	8	2	0	0
	Single Family	8	2	0	0
	Total	285	81	13	26
5 PM	Commercial	150	43	7	14
	Commuting	2	2	3	1
	Educational	3	1	0	0
	Hotels	6	2	0	0
	Industrial	9	2	0	1
	Other-Residential	21	5	1	1
	Single Family	20	4	1	1
	Total	209	59	12	18

Economic Loss

The total economic loss estimated for the earthquake is 571.47 (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 502.75 (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 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	7.05	28.18	0.31	0.89	36.43
	Capital-Related	0.00	3.01	29.58	0.18	0.22	32.99
	Rental	4.81	19.46	8.92	0.04	0.55	33.79
	Relocation	0.50	0.34	0.47	0.01	0.15	1.46
	Subtotal	5.32	29.87	67.15	0.53	1.81	104.67
Capital Stock Loses							
	Structural	23.35	17.35	17.27	1.41	3.44	62.81
	Non_Structural	78.62	99.65	59.11	4.55	9.81	251.74
	Content	22.99	23.38	28.32	2.60	4.90	82.19
	Inventory	0.00	0.00	0.60	0.66	0.07	1.34
	Subtotal	124.97	140.37	105.31	9.21	18.22	398.08
	Total	130.29	170.24	172.46	9.74	20.03	502.75

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	1,146.55	\$0.00	0.00
	Bridges	223.76	\$11.61	5.19
	Tunnels	0.00	\$0.00	0.00
	Subtotal	1370.30	11.60	
Railways	Segments	134.10	\$0.00	0.00
	Bridges	0.85	\$0.00	0.11
	Tunnels	0.00	\$0.00	0.00
	Facilities	4.23	\$1.57	37.17
	Subtotal	139.20	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	1.06	\$0.44	41.93
	Subtotal	1.10	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	10.57	\$1.38	13.01
	Runways	60.30	\$0.00	0.00
	Subtotal	70.90	1.40	
	Total	1581.40	15.00	

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	32.30	\$0.51	1.58
	Distribution Line	69.60	\$1.07	1.53
	Subtotal	101.91	\$1.58	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	258.40	\$50.27	19.46
	Distribution Line	41.80	\$0.84	2.02
	Subtotal	300.17	\$51.12	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Line	27.80	\$0.90	3.24
	Subtotal	27.84	\$0.90	
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	0.60	\$0.11	19.74
	Subtotal	0.58	\$0.11	
	Total	430.50	\$53.71	

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)	-0.53
Second Year			
	Employment Impact	0	0.00
	Income Impact	(11)	-1.62
Third Year			
	Employment Impact	0	0.00
	Income Impact	(15)	-2.09
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(15)	-2.09
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(15)	-2.09
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(15)	-2.09

Appendix A: County Listing for the Region

Eagle, CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Eagle	41,659	2,328	675	3,003
Total State		41,659	2,328	675	3,003
Total Region		41,659	2,328	675	3,003

HAZUS-MH: Earthquake Event Report



Region Name: *Eagle County*

Earthquake Scenario: *Mosquito M7.0 CEUS Event*

Print Date: *January 25, 2006*

Disclaimer:

The estimates of social and economic impacts contained in this report were produced using HAZUS loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.

Table of Contents

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

General Description of the Region

HAZUS is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of HAZUS is to provide a methodology and software application to develop earthquake losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from earthquakes and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Colorado

Note:

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

The geographical size of the region is 1,689.68 square miles and contains 7 census tracts. There are over 15 thousand households in the region and has a total population of 41,659 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 14 thousand buildings in the region with a total building replacement value (excluding contents) of 3,003 (millions of dollars). Approximately 97.00 % of the buildings (and 78.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 1,581 and 291 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 14 thousand buildings in the region which have an aggregate total replacement value of 3,003 (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 63% 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 49 beds. There are 6 schools, 7 fire stations, 12 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 25 dams identified within the region. Of these, 6 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 1,872.00 (millions of dollars). This inventory includes over 240 kilometers of highways, 159 bridges, 6,960 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	159	223.80
	Segments	23	1,146.60
	Tunnels	0	0.00
	Subtotal		1,370.30
Railways	Bridges	6	0.90
	Facilities	2	4.20
	Segments	16	134.10
	Tunnels	0	0.00
	Subtotal		139.20
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	1	1.10
	Subtotal		1.10
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	2	10.60
	Runways	2	60.30
	Subtotal		70.90
		Total	1,581.40

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	69.60
	Facilities	1	32.30
	Pipelines	0	0.00
		Subtotal	101.90
Waste Water	Distribution Lines	NA	41.80
	Facilities	4	258.40
	Pipelines	0	0.00
		Subtotal	300.20
Natural Gas	Distribution Lines	NA	27.80
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	27.80
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	0.00
Electrical Power	Facilities	0	0.00
		Subtotal	0.00
Communication	Facilities	6	0.60
		Subtotal	0.60
		Total	430.50

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	Mosquito M7.0 CEUS Event
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-106.16
Latitude of Epicenter	39.38
Earthquake Magnitude	7.00
Depth (Km)	10.00
Rupture Length (Km)	42.66
Rupture Orientation (degrees)	9.00
Attenuation Function	CEUS Event

Building Damage

Building Damage

HAZUS estimates that about 3,111 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 159 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	1	0.02	0	0.02	0	0.02	0	0.02
Commercial	114	1.40	55	1.87	83	3.79	54	7.05	21	13.15
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	7	0.08	3	0.09	3	0.16	2	0.21	0	0.27
Industrial	15	0.18	7	0.22	7	0.33	3	0.40	0	0.30
Other Residential	1,371	16.93	692	23.29	694	31.75	218	28.40	40	25.31
Religion	9	0.11	5	0.18	7	0.32	4	0.58	2	1.03
Single Family	6,581	81.27	2,210	74.33	1,390	63.63	486	63.33	96	59.91
Total	8,097		2,972		2,185		767		160	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	5,614	69.33	2089	70.27	1,031	47.19	205	26.71	25	15.43
Steel	48	0.59	21	0.71	40	1.85	30	3.95	15	9.41
Concrete	45	0.55	26	0.87	38	1.74	24	3.12	8	5.04
Precast	17	0.21	7	0.24	13	0.62	11	1.44	4	2.34
RM	1,267	15.65	310	10.43	483	22.10	308	40.24	60	37.54
URM	140	1.73	73	2.47	81	3.71	49	6.35	31	19.51
MH	967	11.94	446	15.00	498	22.80	140	18.20	17	10.72
Total	8,097		2,972		2,185		767		160	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 49 hospital beds available for use. On the day of the earthquake, the model estimates that only 6 hospital beds (13.00%) 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, 83.00% 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	6	0	0	3
EOCs	0	0	0	0
PoliceStations	12	0	0	8
FireStations	7	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	Locations/ Segments	Number of Locations_			
			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	159	7	0	154	157
	Tunnels	0	0	0	0	0
Railways	Segments	16	0	0	16	16
	Bridges	6	0	0	6	6
	Tunnels	0	0	0	0	0
	Facilities	2	1	0	1	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	1	0	1	1
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	2	0	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	1	0	0	1	1
Waste Water	4	2	0	1	4
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	6	4	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	3,480	125	31
Waste Water	2,088	98	25
Natural Gas	1,392	105	26
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	15,148	0	0	0	0	0
Electric Power		1,591	919	339	58	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 3 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 0.00% 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 513 households to be displaced due to the earthquake. Of these, 103 people (out of a total population of 41,659) 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	3	1	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	13	3	0	1
	Industrial	1	0	0	0
	Other-Residential	34	7	1	1
	Single Family	32	6	1	2
	Total	83	18	2	4
2 PM	Commercial	159	43	7	13
	Commuting	0	0	0	0
	Educational	8	2	0	1
	Hotels	2	1	0	0
	Industrial	11	2	0	1
	Other-Residential	5	1	0	0
	Single Family	5	1	0	0
	Total	191	50	8	15
5 PM	Commercial	100	26	4	8
	Commuting	1	1	2	0
	Educational	2	0	0	0
	Hotels	4	1	0	0
	Industrial	7	1	0	0
	Other-Residential	13	3	0	1
	Single Family	13	3	0	1
	Total	138	36	7	10

Economic Loss

The total economic loss estimated for the earthquake is 416.76 (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 363.74 (millions of dollars); 23 % 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 Losses							
	Wage	0.00	5.52	22.50	0.26	0.72	29.00
	Capital-Related	0.00	2.36	23.90	0.15	0.18	26.59
	Rental	3.37	13.97	7.61	0.03	0.44	25.42
	Relocation	0.35	0.24	0.39	0.01	0.12	1.11
	Subtotal	3.73	22.08	54.40	0.45	1.46	82.11
Capital Stock Losses							
	Structural	16.18	12.01	13.73	1.20	2.75	45.87
	Non_Structural	53.78	66.49	43.42	3.82	7.33	174.83
	Content	16.53	15.97	21.31	2.22	3.79	59.83
	Inventory	0.00	0.00	0.46	0.57	0.06	1.10
	Subtotal	86.49	94.47	78.92	7.82	13.93	281.62
	Total	90.21	116.54	133.32	8.27	15.39	363.74

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	1,146.55	\$0.00	0.00
	Bridges	223.76	\$8.40	3.76
	Tunnels	0.00	\$0.00	0.00
	Subtotal	1370.30	8.40	
Railways	Segments	134.10	\$0.00	0.00
	Bridges	0.85	\$0.00	0.04
	Tunnels	0.00	\$0.00	0.00
	Facilities	4.23	\$1.22	28.93
	Subtotal	139.20	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	1.06	\$0.36	34.48
	Subtotal	1.10	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	10.57	\$1.14	10.76
	Runways	60.30	\$0.00	0.00
	Subtotal	70.90	1.10	
	Total	1581.40	11.10	

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	32.30	\$0.69	2.12
	Distribution Line	69.60	\$0.56	0.81
	Subtotal	101.91	\$1.25	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	258.40	\$39.65	15.34
	Distribution Line	41.80	\$0.44	1.06
	Subtotal	300.17	\$40.10	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Line	27.80	\$0.47	1.70
	Subtotal	27.84	\$0.47	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	\$0.00	
Electrical Power	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	\$0.00	
Communication	Facilities	0.60	\$0.08	13.42
	Subtotal	0.58	\$0.08	
	Total	430.50	\$41.89	

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	(3)	-0.37
Second Year			
	Employment Impact	0	0.00
	Income Impact	(8)	-1.14
Third Year			
	Employment Impact	0	0.00
	Income Impact	(10)	-1.47
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(10)	-1.47
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(10)	-1.47
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(10)	-1.47

Appendix A: County Listing for the Region

Eagle, CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Eagle	41,659	2,328	675	3,003
Total State		41,659	2,328	675	3,003
Total Region		41,659	2,328	675	3,003

HAZUS-MH: Earthquake Event Report



Region Name: *Eagle County*

Earthquake Scenario: *N Sawatch M7.0 CEUS Event*

Print Date: *January 25, 2006*

Disclaimer:

The estimates of social and economic impacts contained in this report were produced using HAZUS loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.

Table of Contents

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

General Description of the Region

HAZUS is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of HAZUS is to provide a methodology and software application to develop earthquake losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from earthquakes and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Colorado

Note:

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

The geographical size of the region is 1,689.68 square miles and contains 7 census tracts. There are over 15 thousand households in the region and has a total population of 41,659 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 14 thousand buildings in the region with a total building replacement value (excluding contents) of 3,003 (millions of dollars). Approximately 97.00 % of the buildings (and 78.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 1,581 and 291 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 14 thousand buildings in the region which have an aggregate total replacement value of 3,003 (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 63% 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 49 beds. There are 6 schools, 7 fire stations, 12 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 25 dams identified within the region. Of these, 6 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 1,872.00 (millions of dollars). This inventory includes over 240 kilometers of highways, 159 bridges, 6,960 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	159	223.80
	Segments	23	1,146.60
	Tunnels	0	0.00
	Subtotal		1,370.30
Railways	Bridges	6	0.90
	Facilities	2	4.20
	Segments	16	134.10
	Tunnels	0	0.00
	Subtotal		139.20
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	1	1.10
	Subtotal		1.10
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	2	10.60
	Runways	2	60.30
	Subtotal		70.90
		Total	1,581.40

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	69.60
	Facilities	1	32.30
	Pipelines	0	0.00
		Subtotal	101.90
Waste Water	Distribution Lines	NA	41.80
	Facilities	4	258.40
	Pipelines	0	0.00
		Subtotal	300.20
Natural Gas	Distribution Lines	NA	27.80
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	27.80
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	0.00
Electrical Power	Facilities	0	0.00
		Subtotal	0.00
Communication	Facilities	6	0.60
		Subtotal	0.60
		Total	430.50

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	N Sawatch M7.0 CEUS Event
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-106.39
Latitude of Epicenter	39.15
Earthquake Magnitude	7.00
Depth (Km)	10.00
Rupture Length (Km)	42.66
Rupture Orientation (degrees)	147.00
Attenuation Function	CEUS Event

Building Damage

Building Damage

HAZUS estimates that about 3,676 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 127 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	0.02	1	0.02	1	0.02	0	0.03	0	0.04
Commercial	104	1.53	65	1.77	96	3.62	50	5.57	11	8.90
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	5	0.08	3	0.08	4	0.16	2	0.23	0	0.30
Industrial	11	0.16	7	0.19	9	0.34	4	0.48	1	0.66
Other Residential	1,058	15.55	763	20.63	847	32.02	303	33.53	43	34.11
Religion	9	0.14	6	0.16	7	0.28	4	0.41	1	0.59
Single Family	5,616	82.52	2,854	77.16	1,682	63.56	540	59.75	71	55.39
Total	6,806		3,699		2,646		903		127	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	4,954	72.79	2694	72.83	1,142	43.16	162	17.91	11	8.90
Steel	45	0.66	26	0.70	49	1.86	27	3.03	7	5.80
Concrete	43	0.64	30	0.82	43	1.61	21	2.34	4	2.77
Precast	14	0.21	8	0.21	16	0.59	12	1.37	2	1.94
RM	1,032	15.16	367	9.92	617	23.34	374	41.38	39	30.29
URM	95	1.40	83	2.24	103	3.91	62	6.90	31	24.18
MH	623	9.15	491	13.28	676	25.54	245	27.08	33	26.11
Total	6,806		3,699		2,646		903		127	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 49 hospital beds available for use. On the day of the earthquake, the model estimates that only 10 hospital beds (21.00%) 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, 91.00% 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	0	0	0
Schools	6	0	0	3
EOCs	0	0	0	0
PoliceStations	12	0	0	8
FireStations	7	0	0	4

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: Expected Damage to the Transportation Systems

System	Component	Locations/ Segments	Number of Locations_			
			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	159	1	0	158	159
	Tunnels	0	0	0	0	0
Railways	Segments	16	0	0	16	16
	Bridges	6	0	0	6	6
	Tunnels	0	0	0	0	0
	Facilities	2	0	0	2	2
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	1	0	0	1	1
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	2	0	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	1	0	0	1	1
Waste Water	4	3	0	0	4
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	6	1	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	3,480	149	37
Waste Water	2,088	118	29
Natural Gas	1,392	126	31
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	15,148	2	0	0	0	0
Electric Power		377	226	88	16	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 3 ignitions that will burn about 0.05 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 5 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 0.00% 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 437 households to be displaced due to the earthquake. Of these, 88 people (out of a total population of 41,659) 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	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	8	2	0	0
	Industrial	2	0	0	0
	Other-Residential	33	6	1	1
	Single Family	41	8	1	2
	Total	86	16	2	3
2 PM	Commercial	111	26	4	7
	Commuting	0	0	0	0
	Educational	10	2	0	1
	Hotels	1	0	0	0
	Industrial	13	3	0	1
	Other-Residential	5	1	0	0
	Single Family	6	1	0	0
	Total	148	34	5	9
5 PM	Commercial	75	18	3	5
	Commuting	1	1	2	0
	Educational	1	0	0	0
	Hotels	2	1	0	0
	Industrial	8	2	0	0
	Other-Residential	12	2	0	0
	Single Family	16	3	0	1
	Total	117	27	5	7

Economic Loss

The total economic loss estimated for the earthquake is 386.86 (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 329.18 (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 59 % 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 Losses							
	Wage	0.00	3.98	18.45	0.35	0.69	23.46
	Capital-Related	0.00	1.70	19.87	0.20	0.16	21.92
	Rental	3.69	10.42	7.36	0.04	0.41	21.91
	Relocation	0.39	0.19	0.36	0.01	0.10	1.05
	Subtotal	4.08	16.28	46.03	0.60	1.35	68.34
Capital Stock Losses							
	Structural	18.03	9.73	12.59	1.51	2.41	44.28
	Non_Structural	60.42	50.68	35.67	4.80	5.93	157.50
	Content	20.53	12.98	18.23	2.79	3.26	57.80
	Inventory	0.00	0.00	0.45	0.74	0.07	1.26
	Subtotal	98.98	73.39	66.94	9.85	11.67	260.83
	Total	103.06	89.67	112.98	10.45	13.02	329.18

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	1,146.55	\$0.00	0.00
	Bridges	223.76	\$5.59	2.50
	Tunnels	0.00	\$0.00	0.00
	Subtotal	1370.30	5.60	
Railways	Segments	134.10	\$0.00	0.00
	Bridges	0.85	\$0.00	0.13
	Tunnels	0.00	\$0.00	0.00
	Facilities	4.23	\$0.99	23.34
	Subtotal	139.20	1.00	
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	1.06	\$0.29	27.54
	Subtotal	1.10	0.30	
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	10.57	\$1.93	18.23
	Runways	60.30	\$0.00	0.00
	Subtotal	70.90	1.90	
	Total	1581.40	8.80	

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	32.30	\$2.64	8.19
	Distribution Line	69.60	\$0.67	0.96
	Subtotal	101.91	\$3.31	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	258.40	\$44.41	17.18
	Distribution Line	41.80	\$0.53	1.27
	Subtotal	300.17	\$44.94	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Line	27.80	\$0.57	2.04
	Subtotal	27.84	\$0.57	
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	0.60	\$0.07	11.70
	Subtotal	0.58	\$0.07	
	Total	430.50	\$48.89	

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)	-0.34
Second Year			
	Employment Impact	0	0.00
	Income Impact	(7)	-1.04
Third Year			
	Employment Impact	0	0.00
	Income Impact	(9)	-1.34
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(9)	-1.34
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(9)	-1.34
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(9)	-1.34

Appendix A: County Listing for the Region

Eagle, CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Eagle	41,659	2,328	675	3,003
Total State		41,659	2,328	675	3,003
Total Region		41,659	2,328	675	3,003

HAZUS-MH: Earthquake Event Report



Region Name: *Eagle County*

Earthquake Scenario: *S Sawatch M7.25 CEUS Event*

Print Date: *January 25, 2006*

Disclaimer:

The estimates of social and economic impacts contained in this report were produced using HAZUS loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.

Table of Contents

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

General Description of the Region

HAZUS is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of HAZUS is to provide a methodology and software application to develop earthquake losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from earthquakes and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Colorado

Note:

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

The geographical size of the region is 1,689.68 square miles and contains 7 census tracts. There are over 15 thousand households in the region and has a total population of 41,659 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 14 thousand buildings in the region with a total building replacement value (excluding contents) of 3,003 (millions of dollars). Approximately 97.00 % of the buildings (and 78.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 1,581 and 291 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 14 thousand buildings in the region which have an aggregate total replacement value of 3,003 (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 63% 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 49 beds. There are 6 schools, 7 fire stations, 12 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 25 dams identified within the region. Of these, 6 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 1,872.00 (millions of dollars). This inventory includes over 240 kilometers of highways, 159 bridges, 6,960 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	159	223.80
	Segments	23	1,146.60
	Tunnels	0	0.00
	Subtotal		1,370.30
Railways	Bridges	6	0.90
	Facilities	2	4.20
	Segments	16	134.10
	Tunnels	0	0.00
	Subtotal		139.20
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	1	1.10
	Subtotal		1.10
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	2	10.60
	Runways	2	60.30
	Subtotal		70.90
		Total	1,581.40

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	69.60
	Facilities	1	32.30
	Pipelines	0	0.00
		Subtotal	101.90
Waste Water	Distribution Lines	NA	41.80
	Facilities	4	258.40
	Pipelines	0	0.00
		Subtotal	300.20
Natural Gas	Distribution Lines	NA	27.80
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	27.80
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	0.00
Electrical Power	Facilities	0	0.00
		Subtotal	0.00
Communication	Facilities	6	0.60
		Subtotal	0.60
		Total	430.50

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	S Sawatch M7.25 CEUS Event
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-106.18
Latitude of Epicenter	38.75
Earthquake Magnitude	7.25
Depth (Km)	10.00
Rupture Length (Km)	65.31
Rupture Orientation (degrees)	148.00
Attenuation Function	CEUS Event

Building Damage

Building Damage

HAZUS estimates that about 1,615 buildings will be at least moderately damaged. This is over 11.00 % of the total number of buildings in the region. There are an estimated 24 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	0.02	0	0.03	0	0.03	0	0.03
Commercial	183	1.79	61	2.61	60	4.68	20	6.76	3	10.58
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	9	0.09	3	0.12	3	0.20	1	0.25	0	0.30
Industrial	19	0.18	6	0.26	5	0.41	2	0.58	0	0.77
Other Residential	1,706	16.68	634	27.13	544	42.17	120	39.86	11	46.65
Religion	16	0.16	5	0.21	4	0.34	1	0.50	0	0.70
Single Family	8,295	81.09	1,627	69.65	673	52.17	157	52.03	10	40.96
Total	10,229		2,336		1,290		301		25	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	7,159	69.98	1426	61.03	347	26.88	30	9.95	1	5.57
Steel	78	0.76	27	1.14	35	2.71	13	4.30	2	8.66
Concrete	72	0.71	30	1.26	28	2.21	9	3.12	1	3.64
Precast	26	0.25	8	0.35	12	0.90	6	1.97	1	2.18
RM	1,654	16.17	305	13.04	343	26.56	123	40.87	5	18.66
URM	205	2.00	79	3.37	63	4.86	23	7.51	6	23.90
MH	1,036	10.12	463	19.81	463	35.88	97	32.29	9	37.40
Total	10,229		2,336		1,290		301		25	

*Note:

RM Reinforced Masonry
 URM Unreinforced Masonry
 MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 49 hospital beds available for use. On the day of the earthquake, the model estimates that only 17 hospital beds (37.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 71.00% of the beds will be back in service. By 30 days, 97.00% 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	0	0	0
Schools	6	0	0	6
EOCs	0	0	0	0
PoliceStations	12	0	0	12
FireStations	7	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	Locations/ Segments	Number of Locations_			
			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	159	0	0	159	159
	Tunnels	0	0	0	0	0
Railways	Segments	16	0	0	16	16
	Bridges	6	0	0	6	6
	Tunnels	0	0	0	0	0
	Facilities	2	0	0	2	2
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	1	0	0	1	1
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	2	0	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	1	0	0	1	1
Waste Water	4	0	0	0	4
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	6	0	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	3,480	77	19
Waste Water	2,088	61	15
Natural Gas	1,392	65	16
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	15,148	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 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 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 0.00% 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 136 households to be displaced due to the earthquake. Of these, 27 people (out of a total population of 41,659) 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	1	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	3	0	0	0
	Industrial	1	0	0	0
	Other-Residential	12	2	0	0
	Single Family	11	2	0	0
	Total	27	4	0	1
2 PM	Commercial	37	7	1	2
	Commuting	0	0	0	0
	Educational	3	0	0	0
	Hotels	0	0	0	0
	Industrial	5	1	0	0
	Other-Residential	2	0	0	0
	Single Family	2	0	0	0
	Total	48	9	1	2
5 PM	Commercial	24	5	1	1
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	1	0	0	0
	Industrial	3	0	0	0
	Other-Residential	4	1	0	0
	Single Family	4	1	0	0
	Total	37	7	1	1

Economic Loss

The total economic loss estimated for the earthquake is 145.56 (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 120.12 (millions of dollars); 25 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 55 % of the total loss. Table 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	1.56	8.59	0.15	0.31	10.60
	Capital-Related	0.00	0.66	9.12	0.08	0.07	9.94
	Rental	1.22	4.29	3.33	0.02	0.17	9.02
	Relocation	0.13	0.08	0.16	0.00	0.04	0.42
	Subtotal	1.34	6.59	21.20	0.25	0.58	29.97
Capital Stock Loses							
	Structural	5.95	4.10	5.25	0.65	0.99	16.93
	Non_Structural	18.73	18.60	12.93	1.65	2.11	54.01
	Content	6.25	4.47	6.12	0.90	1.06	18.81
	Inventory	0.00	0.00	0.15	0.24	0.02	0.41
	Subtotal	30.93	27.17	24.44	3.44	4.19	90.15
	Total	32.27	33.76	45.64	3.68	4.77	120.12

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	1,146.55	\$0.00	0.00
	Bridges	223.76	\$1.91	0.86
	Tunnels	0.00	\$0.00	0.00
	Subtotal	1370.30	1.90	
Railways	Segments	134.10	\$0.00	0.00
	Bridges	0.85	\$0.00	0.02
	Tunnels	0.00	\$0.00	0.00
	Facilities	4.23	\$0.45	10.75
	Subtotal	139.20	0.50	
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	1.06	\$0.16	15.21
	Subtotal	1.10	0.20	
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	10.57	\$1.13	10.65
	Runways	60.30	\$0.00	0.00
	Subtotal	70.90	1.10	
	Total	1581.40	3.70	

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	32.30	\$1.09	3.37
	Distribution Line	69.60	\$0.35	0.50
	Subtotal	101.91	\$1.43	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	258.40	\$19.76	7.65
	Distribution Line	41.80	\$0.27	0.66
	Subtotal	300.17	\$20.03	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Line	27.80	\$0.29	1.05
	Subtotal	27.84	\$0.29	
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	0.60	\$0.02	3.23
	Subtotal	0.58	\$0.02	
	Total	430.50	\$21.78	

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)	-0.12
Second Year			
	Employment Impact	0	0.00
	Income Impact	(3)	-0.37
Third Year			
	Employment Impact	0	0.00
	Income Impact	(3)	-0.47
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(3)	-0.47
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(3)	-0.47
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(3)	-0.47

Appendix A: County Listing for the Region

Eagle, CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Eagle	41,659	2,328	675	3,003
Total State		41,659	2,328	675	3,003
Total Region		41,659	2,328	675	3,003

HAZUS-MH: Earthquake Event Report



Region Name: *Eagle County*

Earthquake Scenario: *Williams Fork M6.75 CEUS Event*

Print Date: *June 30, 2005*

Disclaimer:

The estimates of social and economic impacts contained in this report were produced using HAZUS loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.

Table of Contents

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

General Description of the Region

HAZUS is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of HAZUS is to provide a methodology and software application to develop earthquake losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from earthquakes and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Colorado

Note:

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

The geographical size of the region is 1,689.68 square miles and contains 7 census tracts. There are over 15 thousand households in the region and has a total population of 41,659 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 14 thousand buildings in the region with a total building replacement value (excluding contents) of 3,003 (millions of dollars). Approximately 97.00 % of the buildings (and 78.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 1,581 and 291 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 14 thousand buildings in the region which have an aggregate total replacement value of 3,003 (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 63% 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 49 beds. There are 6 schools, 7 fire stations, 12 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 25 dams identified within the region. Of these, 6 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 1,872.00 (millions of dollars). This inventory includes over 240 kilometers of highways, 159 bridges, 6,960 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	159	223.80
	Segments	23	1,146.60
	Tunnels	0	0.00
	Subtotal		1,370.30
Railways	Bridges	6	0.90
	Facilities	2	4.20
	Segments	16	134.10
	Tunnels	0	0.00
	Subtotal		139.20
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	1	1.10
	Subtotal		1.10
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	2	10.60
	Runways	2	60.30
	Subtotal		70.90
		Total	1,581.40

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	69.60
	Facilities	1	32.30
	Pipelines	0	0.00
		Subtotal	101.90
Waste Water	Distribution Lines	NA	41.80
	Facilities	4	258.40
	Pipelines	0	0.00
		Subtotal	300.20
Natural Gas	Distribution Lines	NA	27.80
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	27.80
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	0.00
Electrical Power	Facilities	0	0.00
		Subtotal	0.00
Communication	Facilities	6	0.60
		Subtotal	0.60
		Total	430.50

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	Williams Fork M6.75 CEUS Event
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-106.15
Latitude of Epicenter	39.87
Earthquake Magnitude	6.75
Depth (Km)	10.00
Rupture Length (Km)	27.86
Rupture Orientation (degrees)	140.00
Attenuation Function	CEUS Event

Building Damage

Building Damage

HAZUS estimates that about 1,753 buildings will be at least moderately damaged. This is over 12.00 % of the total number of buildings in the region. There are an estimated 52 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	188	1.84	49	2.24	56	4.25	27	7.17	6	12.32
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	10	0.10	2	0.11	2	0.15	1	0.18	0	0.22
Industrial	22	0.22	5	0.22	4	0.29	1	0.32	0	0.29
Other Residential	1,837	17.95	583	26.61	465	35.18	115	30.28	15	29.19
Religion	16	0.15	4	0.20	4	0.33	2	0.56	0	0.88
Single Family	8,162	79.73	1,547	70.62	791	59.79	232	61.47	30	57.09
Total	10,238		2,190		1,322		378		53	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	6,914	67.53	1447	66.05	523	39.54	74	19.45	6	11.07
Steel	80	0.78	21	0.97	32	2.41	17	4.40	4	8.51
Concrete	72	0.71	26	1.17	28	2.13	12	3.30	2	4.02
Precast	28	0.28	7	0.31	10	0.75	6	1.63	1	2.18
RM	1,675	16.36	246	11.21	327	24.70	165	43.63	17	31.44
URM	198	1.93	69	3.17	63	4.75	30	8.02	14	26.95
MH	1,271	12.41	375	17.11	340	25.71	74	19.57	8	15.84
Total	10,238		2,190		1,322		378		53	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 49 hospital beds available for use. On the day of the earthquake, the model estimates that only 13 hospital beds (27.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 60.00% of the beds will be back in service. By 30 days, 94.00% 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	0	0	0
Schools	6	0	0	4
EOCs	0	0	0	0
PoliceStations	12	0	0	11
FireStations	7	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	Locations/ Segments	Number of Locations_			
			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	159	0	0	159	159
	Tunnels	0	0	0	0	0
Railways	Segments	16	0	0	16	16
	Bridges	6	0	0	6	6
	Tunnels	0	0	0	0	0
	Facilities	2	0	0	2	2
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	1	0	0	1	1
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	2	0	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	1	0	0	1	1
Waste Water	4	1	0	1	4
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	6	0	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	3,480	79	20
Waste Water	2,088	62	16
Natural Gas	1,392	67	17
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	15,148	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 2 ignitions that will burn about 0.03 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 3 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 0.00% 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 228 households to be displaced due to the earthquake. Of these, 45 people (out of a total population of 41,659) 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	1	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	5	1	0	0
	Industrial	1	0	0	0
	Other-Residential	15	3	0	0
	Single Family	14	2	0	1
	Total	36	7	1	1
2 PM	Commercial	61	14	2	4
	Commuting	0	0	0	0
	Educational	3	1	0	0
	Hotels	1	0	0	0
	Industrial	4	1	0	0
	Other-Residential	2	0	0	0
	Single Family	2	0	0	0
	Total	74	17	2	5
5 PM	Commercial	39	9	1	3
	Commuting	0	0	0	0
	Educational	1	0	0	0
	Hotels	2	0	0	0
	Industrial	2	0	0	0
	Other-Residential	6	1	0	0
	Single Family	5	1	0	0
	Total	55	12	2	3

Economic Loss

The total economic loss estimated for the earthquake is 206.95 (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 174.32 (millions of dollars); 23 % 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 59 % 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 Losses							
	Wage	0.00	2.51	11.39	0.12	0.35	14.37
	Capital-Related	0.00	1.07	11.87	0.07	0.08	13.09
	Rental	1.66	6.98	3.69	0.01	0.20	12.54
	Relocation	0.17	0.12	0.19	0.00	0.05	0.55
	Subtotal	1.84	10.69	27.14	0.20	0.68	40.54
Capital Stock Losses							
	Structural	7.94	6.15	6.27	0.54	1.21	22.10
	Non_Structural	26.24	33.49	18.28	1.56	2.97	82.54
	Content	8.68	8.61	8.96	0.89	1.54	28.68
	Inventory	0.00	0.00	0.20	0.23	0.02	0.45
	Subtotal	42.86	48.24	33.71	3.22	5.74	133.78
	Total	44.70	58.93	60.85	3.42	6.42	174.32

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	1,146.55	\$0.00	0.00
	Bridges	223.76	\$2.35	1.05
	Tunnels	0.00	\$0.00	0.00
	Subtotal	1370.30	2.30	
Railways	Segments	134.10	\$0.00	0.00
	Bridges	0.85	\$0.00	0.01
	Tunnels	0.00	\$0.00	0.00
	Facilities	4.23	\$0.83	19.73
	Subtotal	139.20	0.80	
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	1.06	\$0.27	25.95
	Subtotal	1.10	0.30	
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	10.57	\$0.93	8.78
	Runways	60.30	\$0.00	0.00
	Subtotal	70.90	0.90	
	Total	1581.40	4.40	

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	32.30	\$0.19	0.59
	Distribution Line	69.60	\$0.35	0.51
	Subtotal	101.91	\$0.55	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	258.40	\$27.08	10.48
	Distribution Line	41.80	\$0.28	0.67
	Subtotal	300.17	\$27.36	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Line	27.80	\$0.30	1.08
	Subtotal	27.84	\$0.30	
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	0.60	\$0.04	6.98
	Subtotal	0.58	\$0.04	
	Total	430.50	\$28.24	

Table 15. Indirect Economic Impact with outside aid

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

<u>LOSS</u>	<u>Total</u>	<u>%</u>

Appendix A: County Listing for the Region

Eagle, CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Eagle	41,659	2,328	675	3,003
Total State		41,659	2,328	675	3,003
Total Region		41,659	2,328	675	3,003