

HAZUS-MH: Earthquake Event Report



Region Name: *Summit County*

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

Print Date: *February 01, 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 618.48 square miles and contains 4 census tracts. There are over 9 thousand households in the region and has a total population of 23,548 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 11 thousand buildings in the region with a total building replacement value (excluding contents) of 2,805 (millions of dollars). Approximately 98.00 % of the buildings (and 86.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 746 and 581 (millions of dollars), respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 11 thousand buildings in the region which have an aggregate total replacement value of 2,805 (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 71% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

HAZUS breaks critical facilities into two (2) groups: essential facilities and high potential loss (HPL) facilities. Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 0 hospitals in the region with a total bed capacity of 0 beds. There are 2 schools, 2 fire stations, 5 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 11 dams identified within the region. Of these, 7 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 1,327.00 (millions of dollars). This inventory includes over 162 kilometers of highways, 48 bridges, 2,570 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	48	64.40
	Segments	15	618.30
	Tunnels	2	60.10
	Subtotal		742.80
Railways	Bridges	0	0.00
	Facilities	1	2.10
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		2.10
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	1	1.10
	Subtotal		1.10
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	0	0.00
	Runways	0	0.00
	Subtotal		0.00
		Total	746.00

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	25.70
	Facilities	2	64.60
	Pipelines	0	0.00
	Subtotal		90.30
Waste Water	Distribution Lines	NA	15.40
	Facilities	8	516.80
	Pipelines	0	0.00
	Subtotal		532.20
Natural Gas	Distribution Lines	NA	10.30
	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		10.30
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		0.00
Electrical Power	Facilities	0	0.00
	Subtotal		0.00
Communication	Facilities	3	0.30
	Subtotal		0.30
	Total		633.10

Earthquake Scenario

HAZUS uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

Scenario Name	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 551 buildings will be at least moderately damaged. This is over 5.00 % of the total number of buildings in the region. There are an estimated 3 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the HAZUS technical manual. Table 4 below summaries the expected damage by general occupancy for the buildings in the region. Table 5 summaries the expected damage by general building type.

Table 4: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	136	1.48	27	2.20	20	4.32	5	6.27	0	10.77
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	10	0.11	1	0.10	1	0.15	0	0.17	0	0.21
Industrial	10	0.11	2	0.18	2	0.35	0	0.56	0	0.78
Other Residential	1,167	12.66	209	17.01	108	23.11	13	16.82	1	15.79
Religion	5	0.05	1	0.08	1	0.16	0	0.24	0	0.38
Single Family	7,896	85.60	986	80.42	336	71.90	61	75.93	3	72.07
Total	9,224		1,226		468		80		4	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	6,766	73.35	837	68.27	160	34.10	11	14.28	0	3.56
Steel	79	0.85	14	1.14	13	2.71	3	3.95	0	6.98
Concrete	80	0.87	17	1.35	11	2.25	2	2.72	0	2.61
Precast	21	0.23	4	0.34	5	0.98	2	2.12	0	2.03
RM	1,669	18.09	192	15.65	169	36.18	43	53.74	1	17.25
URM	203	2.20	58	4.77	40	8.63	12	15.18	2	61.55
MH	406	4.40	104	8.49	71	15.15	6	8.00	0	6.02
Total	9,224		1,226		468		80		4	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

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

Table 6: Expected Damage to Essential Facilities

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

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	15	0	0	15	15
	Bridges	48	0	0	48	48
	Tunnels	2	0	0	2	2
Railways	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	1	0	0	1	1
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	1	0	0	1	1
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	0	0	0	0	0
	Runways	0	0	0	0	0

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 8-10 provide information on the damage to the utility lifeline systems. Table 8 provides damage to the utility system facilities. Table 9 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, HAZUS performs a simplified system performance analysis. Table 10 provides a summary of the system performance information.

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	2	0	0	2	2
Waste Water	8	0	0	8	8
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	3	0	0	3	3

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	1,285	7	2
Waste Water	771	6	1
Natural Gas	514	6	2
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	9,120	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 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

Debris Generation

HAZUS estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 0.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 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 30 households to be displaced due to the earthquake. Of these, 5 people (out of a total population of 23,548) 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	3	0	0	0
	Total	7	1	0	0
2 PM	Commercial	9	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	11	2	0	0
5 PM	Commercial	6	1	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	1	0	0	0
	Other-Residential	1	0	0	0
	Single Family	1	0	0	0
	Total	9	1	0	0

Economic Loss

The total economic loss estimated for the earthquake is 73.31 (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 51.62 (millions of dollars); 18 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 68 % of the total loss. Table 12 below provides a summary of the losses associated with the building damage.

Table 12: Building-Related Economic Loss Estimates
(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	0.34	2.33	0.05	0.09	2.80
	Capital-Related	0.00	0.15	2.40	0.03	0.02	2.58
	Rental	0.55	1.92	1.09	0.01	0.03	3.60
	Relocation	0.06	0.04	0.05	0.00	0.01	0.16
	Subtotal	0.61	2.44	5.86	0.08	0.14	9.14
Capital Stock Losses							
	Structural	2.71	1.99	1.71	0.22	0.22	6.85
	Non_Structural	9.34	11.47	4.12	0.62	0.56	26.10
	Content	3.33	3.16	2.19	0.36	0.31	9.35
	Inventory	0.00	0.00	0.08	0.09	0.00	0.17
	Subtotal	15.38	16.62	8.09	1.30	1.09	42.48
	Total	15.99	19.06	13.95	1.38	1.23	51.62

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, HAZUS computes the direct repair cost for each component only. There are no losses computed by HAZUS for business interruption due to lifeline outages. Tables 13 & 14 provide a detailed breakdown in the expected lifeline losses.

HAZUS estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 15 presents the results of the region for the given earthquake.

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

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	618.35	\$0.00	0.00
	Bridges	64.40	\$0.03	0.05
	Tunnels	60.10	\$0.01	0.02
	Subtotal	742.80	0.00	
Railways	Segments	0.00	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	2.11	\$0.23	10.77
	Subtotal	2.10	0.20	
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	\$0.14	13.26
	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	0.00	\$0.00	0.00
	Runways	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
	Total	746.00	0.40	

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	64.60	\$1.53	2.38
	Distribution Line	25.70	\$0.03	0.13
	Subtotal	90.30	\$1.57	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	516.80	\$19.65	3.80
	Distribution Line	15.40	\$0.03	0.17
	Subtotal	532.24	\$19.67	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Line	10.30	\$0.03	0.27
	Subtotal	10.28	\$0.03	
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	0.30	\$0.01	3.61
	Subtotal	0.29	\$0.01	
	Total	633.11	\$21.28	

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	-0.11
Second Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-0.33
Third Year			
	Employment Impact	0	0.00
	Income Impact	(2)	-0.43
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(2)	-0.43
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(2)	-0.43
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(2)	-0.43

Appendix A: County Listing for the Region

Summit,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Summit	23,548	2,399	405	2,805
Total State		23,548	2,399	405	2,805
Total Region		23,548	2,399	405	2,805

HAZUS-MH: Earthquake Event Report



Region Name: *Summit County*

Earthquake Scenario: *Frontal M7.0 CEUS Event*

Print Date: *February 01, 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 618.48 square miles and contains 4 census tracts. There are over 9 thousand households in the region and has a total population of 23,548 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 11 thousand buildings in the region with a total building replacement value (excluding contents) of 2,805 (millions of dollars). Approximately 98.00 % of the buildings (and 86.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 746 and 581 (millions of dollars), respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 11 thousand buildings in the region which have an aggregate total replacement value of 2,805 (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 71% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

HAZUS breaks critical facilities into two (2) groups: essential facilities and high potential loss (HPL) facilities. Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 0 hospitals in the region with a total bed capacity of 0 beds. There are 2 schools, 2 fire stations, 5 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 11 dams identified within the region. Of these, 7 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 1,327.00 (millions of dollars). This inventory includes over 162 kilometers of highways, 48 bridges, 2,570 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	48	64.40
	Segments	15	618.30
	Tunnels	2	60.10
	Subtotal		742.80
Railways	Bridges	0	0.00
	Facilities	1	2.10
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		2.10
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	1	1.10
	Subtotal		1.10
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	0	0.00
	Runways	0	0.00
	Subtotal		0.00
		Total	746.00

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	25.70
	Facilities	2	64.60
	Pipelines	0	0.00
	Subtotal		90.30
Waste Water	Distribution Lines	NA	15.40
	Facilities	8	516.80
	Pipelines	0	0.00
	Subtotal		532.20
Natural Gas	Distribution Lines	NA	10.30
	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		10.30
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		0.00
Electrical Power	Facilities	0	0.00
	Subtotal		0.00
Communication	Facilities	3	0.30
	Subtotal		0.30
	Total		633.10

Earthquake Scenario

HAZUS uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

Scenario Name	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 6,602 buildings will be at least moderately damaged. This is over 60.00 % of the total number of buildings in the region. There are an estimated 961 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the HAZUS technical manual. Table 4 below summaries the expected damage by general occupancy for the buildings in the region. Table 5 summaries the expected damage by general building type.

Table 4: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	19	1.08	19	0.73	49	1.37	54	2.65	47	4.93
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	3	0.16	2	0.08	4	0.10	2	0.12	1	0.10
Industrial	1	0.06	1	0.06	4	0.10	4	0.19	4	0.39
Other Residential	209	11.98	327	12.29	496	13.78	320	15.67	147	15.27
Religion	1	0.04	1	0.04	2	0.05	2	0.09	1	0.15
Single Family	1,508	86.67	2,308	86.81	3,047	84.59	1,657	81.27	761	79.16
Total	1,740		2,659		3,601		2,039		961	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	1,296	74.51	2306	86.72	2,738	76.02	1,119	54.86	315	32.75
Steel	10	0.58	8	0.31	25	0.70	32	1.57	33	3.43
Concrete	14	0.81	14	0.53	30	0.83	29	1.42	23	2.35
Precast	3	0.15	2	0.08	7	0.20	10	0.49	10	1.06
RM	337	19.39	198	7.46	527	14.63	606	29.74	404	42.07
URM	23	1.34	37	1.39	73	2.04	77	3.79	105	10.97
MH	56	3.24	93	3.51	201	5.59	166	8.12	71	7.36
Total	1,740		2,659		3,601		2,039		961	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

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

Table 6: Expected Damage to Essential Facilities

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

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	15	0	0	15	15
	Bridges	48	6	1	42	44
	Tunnels	2	0	0	2	2
Railways	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	1	1	0	0	1
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	1	1	0	0	1
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	0	0	0	0	0
	Runways	0	0	0	0	0

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 8-10 provide information on the damage to the utility lifeline systems. Table 8 provides damage to the utility system facilities. Table 9 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, HAZUS performs a simplified system performance analysis. Table 10 provides a summary of the system performance information.

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	2	2	0	0	0
Waste Water	8	8	0	0	0
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	3	3	0	0	2

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	1,285	323	81
Waste Water	771	256	64
Natural Gas	514	273	68
Oil	0	0	0

Table 10: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	9,120	1,491	2	0	0	0
Electric Power		7,862	6,049	3,537	1,022	9

Induced Earthquake Damage

Fire Following Earthquake

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. HAZUS uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 8 ignitions that will burn about 0.05 sq. mi 0.01 % 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 1,379 households to be displaced due to the earthquake. Of these, 267 people (out of a total population of 23,548 will seek temporary shelter in public shelters.

Casualties

HAZUS estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 11 provides a summary of the casualties estimated for this earthquake

Table 11: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	5	2	0	1
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	16	5	1	1
	Industrial	6	2	0	1
	Other-Residential	97	25	3	6
	Single Family	125	33	5	9
	Total	248	66	9	18
2 PM	Commercial	287	88	15	29
	Commuting	0	0	1	0
	Educational	31	9	2	3
	Hotels	3	1	0	0
	Industrial	41	12	2	4
	Other-Residential	14	4	0	1
	Single Family	18	5	1	1
	Total	395	120	20	39
5 PM	Commercial	197	60	10	20
	Commuting	6	9	14	3
	Educational	4	1	0	0
	Hotels	5	1	0	0
	Industrial	26	8	1	2
	Other-Residential	37	10	1	2
	Single Family	49	13	2	3
	Total	324	102	29	32

Economic Loss

The total economic loss estimated for the earthquake is 1,345.36 (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 982.81 (millions of dollars); 13 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 73 % of the total loss. Table 12 below provides a summary of the losses associated with the building damage.

Table 12: Building-Related Economic Loss Estimates
(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	5.61	27.93	0.70	1.05	35.29
	Capital-Related	0.00	2.40	29.03	0.40	0.21	32.03
	Rental	12.18	33.53	11.52	0.11	0.49	57.83
	Relocation	1.28	0.66	0.53	0.01	0.13	2.61
	Subtotal	13.46	42.20	69.01	1.22	1.87	127.76
Capital Stock Losses							
	Structural	59.30	35.47	25.86	3.04	3.21	126.87
	Non_Structural	218.77	224.62	82.12	12.39	10.05	547.96
	Content	64.58	58.13	41.33	7.21	5.36	176.61
	Inventory	0.00	0.00	1.64	1.89	0.09	3.62
	Subtotal	342.65	318.22	150.96	24.53	18.71	855.06
	Total	356.11	360.42	219.97	25.75	20.58	982.81

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	618.35	\$0.00	0.00
	Bridges	64.40	\$7.78	12.09
	Tunnels	60.10	\$5.21	8.67
	Subtotal	742.80	13.00	
Railways	Segments	0.00	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	2.11	\$1.40	66.18
	Subtotal	2.10	1.40	
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	\$0.67	63.23
	Subtotal	1.10	0.70	
Ferry	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Port	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Airport	Facilities	0.00	\$0.00	0.00
	Runways	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
	Total	746.00	15.10	

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	64.60	\$38.73	59.95
	Distribution Line	25.70	\$1.46	5.66
	Subtotal	90.30	\$40.18	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	516.80	\$304.73	58.96
	Distribution Line	15.40	\$1.15	7.46
	Subtotal	532.24	\$305.88	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Line	10.30	\$1.23	11.97
	Subtotal	10.28	\$1.23	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	\$0.00	
Electrical Power	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	\$0.00	
Communication	Facilities	0.30	\$0.18	63.20
	Subtotal	0.29	\$0.18	
	Total	633.11	\$347.48	

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	(8)	-2.23
Second Year			
	Employment Impact	0	0.00
	Income Impact	(25)	-6.78
Third Year			
	Employment Impact	0	0.00
	Income Impact	(32)	-8.74
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(32)	-8.74
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(32)	-8.74
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(32)	-8.74

Appendix A: County Listing for the Region

Summit,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Summit	23,548	2,399	405	2,805
Total State		23,548	2,399	405	2,805
Total Region		23,548	2,399	405	2,805

HAZUS-MH: Earthquake Event Report



Region Name: *Summit County*

Earthquake Scenario: *Golden M6.5 CEUS Event Normal*

Print Date: *February 01, 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 618.48 square miles and contains 4 census tracts. There are over 9 thousand households in the region and has a total population of 23,548 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 11 thousand buildings in the region with a total building replacement value (excluding contents) of 2,805 (millions of dollars). Approximately 98.00 % of the buildings (and 86.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 746 and 581 (millions of dollars), respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 11 thousand buildings in the region which have an aggregate total replacement value of 2,805 (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 71% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

HAZUS breaks critical facilities into two (2) groups: essential facilities and high potential loss (HPL) facilities. Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 0 hospitals in the region with a total bed capacity of 0 beds. There are 2 schools, 2 fire stations, 5 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 11 dams identified within the region. Of these, 7 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 1,327.00 (millions of dollars). This inventory includes over 162 kilometers of highways, 48 bridges, 2,570 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	48	64.40
	Segments	15	618.30
	Tunnels	2	60.10
	Subtotal		742.80
Railways	Bridges	0	0.00
	Facilities	1	2.10
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		2.10
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	1	1.10
	Subtotal		1.10
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	0	0.00
	Runways	0	0.00
	Subtotal		0.00
		Total	746.00

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	25.70
	Facilities	2	64.60
	Pipelines	0	0.00
	Subtotal		90.30
Waste Water	Distribution Lines	NA	15.40
	Facilities	8	516.80
	Pipelines	0	0.00
	Subtotal		532.20
Natural Gas	Distribution Lines	NA	10.30
	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		10.30
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		0.00
Electrical Power	Facilities	0	0.00
	Subtotal		0.00
Communication	Facilities	3	0.30
	Subtotal		0.30
	Total		633.10

Earthquake Scenario

HAZUS uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

Scenario Name	Golden M6.5 CEUS Event Normal
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-105.22
Latitude of Epicenter	39.74
Earthquake Magnitude	6.50
Depth (Km)	10.00
Rupture Length (Km)	18.20
Rupture Orientation (degrees)	157.00
Attenuation Function	CEUS Event

Building Damage

Building Damage

HAZUS estimates that about 226 buildings will be at least moderately damaged. This is over 2.00 % 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	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	165	1.63	15	2.31	8	3.93	1	5.14	0	7.98
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	11	0.11	1	0.11	0	0.16	0	0.17	0	0.17
Industrial	12	0.12	1	0.19	1	0.34	0	0.51	0	0.46
Other Residential	1,329	13.12	117	18.20	48	23.99	4	15.06	0	11.41
Religion	6	0.06	1	0.08	0	0.13	0	0.15	0	0.20
Single Family	8,609	84.97	509	79.10	143	71.45	20	78.97	1	79.78
Total	10,132		643		200		25		1	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	7,312	72.17	402	62.53	56	27.93	3	12.70	0	0.12
Steel	94	0.92	9	1.34	5	2.74	1	3.65	0	4.02
Concrete	96	0.95	9	1.45	4	1.93	0	1.75	0	0.91
Precast	27	0.27	3	0.40	2	1.01	0	1.87	0	0.76
RM	1,871	18.47	114	17.68	76	37.79	13	50.79	0	5.07
URM	243	2.40	43	6.62	24	12.08	6	22.46	1	85.34
MH	488	4.82	64	9.98	33	16.53	2	6.78	0	3.78
Total	10,132		643		200		25		1	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

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

Table 6: Expected Damage to Essential Facilities

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

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	15	0	0	15	15
	Bridges	48	0	0	48	48
	Tunnels	2	0	0	2	2
Railways	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	1	0	0	1	1
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	1	0	0	1	1
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	0	0	0	0	0
	Runways	0	0	0	0	0

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 8-10 provide information on the damage to the utility lifeline systems. Table 8 provides damage to the utility system facilities. Table 9 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, HAZUS performs a simplified system performance analysis. Table 10 provides a summary of the system performance information.

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	2	0	0	2	2
Waste Water	8	0	0	8	8
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	3	0	0	3	3

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	1,285	3	1
Waste Water	771	2	1
Natural Gas	514	3	1
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	9,120	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 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

Debris Generation

HAZUS estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 0.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 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 9 households to be displaced due to the earthquake. Of these, 1 people (out of a total population of 23,548 will seek temporary shelter in public shelters.

Casualties

HAZUS estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 11 provides a summary of the casualties estimated for this earthquake

Table 11: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	1	0	0	0
	Single Family	1	0	0	0
	Total	3	0	0	0
2 PM	Commercial	3	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	4	1	0	0
5 PM	Commercial	2	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	3	0	0	0

Economic Loss

The total economic loss estimated for the earthquake is 27.05 (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 18.96 (millions of dollars); 17 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 70 % of the total loss. Table 12 below provides a summary of the losses associated with the building damage.

Table 12: Building-Related Economic Loss Estimates
(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	0.10	0.79	0.02	0.03	0.93
	Capital-Related	0.00	0.04	0.83	0.01	0.01	0.88
	Rental	0.22	0.70	0.39	0.00	0.01	1.31
	Relocation	0.02	0.02	0.02	0.00	0.00	0.06
	Subtotal	0.24	0.86	2.02	0.03	0.05	3.19
Capital Stock Losses							
	Structural	1.10	0.80	0.61	0.08	0.07	2.66
	Non_Structural	3.61	4.32	1.44	0.22	0.19	9.77
	Content	1.17	1.11	0.76	0.13	0.10	3.27
	Inventory	0.00	0.00	0.03	0.03	0.00	0.06
	Subtotal	5.88	6.23	2.84	0.46	0.36	15.77
	Total	6.12	7.08	4.86	0.49	0.41	18.96

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	618.35	\$0.00	0.00
	Bridges	64.40	\$0.00	0.01
	Tunnels	60.10	\$0.01	0.02
	Subtotal	742.80	0.00	
Railways	Segments	0.00	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	2.11	\$0.12	5.59
	Subtotal	2.10	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	\$0.07	6.43
	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	0.00	\$0.00	0.00
	Runways	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
	Total	746.00	0.20	

Table 14: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.00	\$0.00	0.00
	Facilities	64.60	\$0.52	0.80
	Distribution Line	25.70	\$0.01	0.05
	Subtotal	90.30	\$0.53	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	516.80	\$7.33	1.42
	Distribution Line	15.40	\$0.01	0.07
	Subtotal	532.24	\$7.34	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Line	10.30	\$0.01	0.11
	Subtotal	10.28	\$0.01	
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	0.30	\$0.00	0.86
	Subtotal	0.29	\$0.00	
	Total	633.11	\$7.88	

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

	LOSS	Total	%
First Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.04
Second Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.13
Third Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-0.16
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-0.16
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-0.16
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(1)	-0.16

Appendix A: County Listing for the Region

Summit,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Summit	23,548	2,399	405	2,805
Total State		23,548	2,399	405	2,805
Total Region		23,548	2,399	405	2,805

HAZUS-MH: Earthquake Event Report



Region Name: *Summit County*

Earthquake Scenario: *Mosquito M7.0 CEUS Event*

Print Date: *February 01, 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 618.48 square miles and contains 4 census tracts. There are over 9 thousand households in the region and has a total population of 23,548 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 11 thousand buildings in the region with a total building replacement value (excluding contents) of 2,805 (millions of dollars). Approximately 98.00 % of the buildings (and 86.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 746 and 581 (millions of dollars), respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 11 thousand buildings in the region which have an aggregate total replacement value of 2,805 (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 71% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

HAZUS breaks critical facilities into two (2) groups: essential facilities and high potential loss (HPL) facilities. Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 0 hospitals in the region with a total bed capacity of 0 beds. There are 2 schools, 2 fire stations, 5 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 11 dams identified within the region. Of these, 7 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 1,327.00 (millions of dollars). This inventory includes over 162 kilometers of highways, 48 bridges, 2,570 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	48	64.40
	Segments	15	618.30
	Tunnels	2	60.10
	Subtotal		742.80
Railways	Bridges	0	0.00
	Facilities	1	2.10
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		2.10
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	1	1.10
	Subtotal		1.10
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	0	0.00
	Runways	0	0.00
	Subtotal		0.00
		Total	746.00

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	25.70
	Facilities	2	64.60
	Pipelines	0	0.00
	Subtotal		90.30
Waste Water	Distribution Lines	NA	15.40
	Facilities	8	516.80
	Pipelines	0	0.00
	Subtotal		532.20
Natural Gas	Distribution Lines	NA	10.30
	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		10.30
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		0.00
Electrical Power	Facilities	0	0.00
	Subtotal		0.00
Communication	Facilities	3	0.30
	Subtotal		0.30
	Total		633.10

Earthquake Scenario

HAZUS uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

Scenario Name	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 5,177 buildings will be at least moderately damaged. This is over 47.00 % of the total number of buildings in the region. There are an estimated 505 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the HAZUS technical manual. Table 4 below summaries the expected damage by general occupancy for the buildings in the region. Table 5 summaries the expected damage by general building type.

Table 4: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	27	1.00	24	0.76	52	1.63	49	3.28	37	7.39
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	3	0.13	2	0.08	3	0.11	2	0.13	1	0.16
Industrial	2	0.06	2	0.06	4	0.12	4	0.24	3	0.56
Other Residential	303	11.13	373	12.02	480	15.07	258	17.35	84	16.71
Religion	1	0.03	1	0.03	2	0.06	2	0.12	2	0.32
Single Family	2,389	87.65	2,697	87.04	2,644	83.01	1,173	78.88	379	74.87
Total	2,725		3,099		3,185		1,487		506	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	2,069	75.93	2648	85.46	2,235	70.19	677	45.52	144	28.51
Steel	15	0.57	11	0.36	29	0.91	29	1.97	24	4.73
Concrete	20	0.74	17	0.56	32	1.00	25	1.70	15	3.03
Precast	4	0.14	3	0.09	8	0.25	10	0.65	8	1.54
RM	498	18.26	256	8.27	580	18.21	534	35.90	206	40.69
URM	36	1.32	49	1.59	84	2.65	74	5.00	72	14.33
MH	83	3.05	114	3.67	216	6.79	138	9.27	36	7.18
Total	2,725		3,099		3,185		1,487		506	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

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

Table 6: Expected Damage to Essential Facilities

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

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	15	0	0	15	15
	Bridges	48	1	0	47	47
	Tunnels	2	0	0	2	2
Railways	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	1	1	0	0	1
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	1	1	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	0	0	0	0	0
	Runways	0	0	0	0	0

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 8-10 provide information on the damage to the utility lifeline systems. Table 8 provides damage to the utility system facilities. Table 9 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, HAZUS performs a simplified system performance analysis. Table 10 provides a summary of the system performance information.

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	2	2	0	0	0
Waste Water	8	8	0	0	0
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	3	3	0	0	3

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	1,285	165	41
Waste Water	771	130	33
Natural Gas	514	139	35
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	9,120	69	0	0	0	0
Electric Power		6,861	4,570	2,176	517	9

Induced Earthquake Damage

Fire Following Earthquake

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. HAZUS uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 5 ignitions that will burn about 0.07 sq. mi 0.01 % 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 849 households to be displaced due to the earthquake. Of these, 162 people (out of a total population of 23,548 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	14	4	1	1
	Industrial	4	1	0	0
	Other-Residential	60	14	2	3
	Single Family	65	16	2	4
	Total	147	36	5	10
2 PM	Commercial	208	62	10	20
	Commuting	0	0	0	0
	Educational	17	5	1	2
	Hotels	3	1	0	0
	Industrial	27	8	1	2
	Other-Residential	8	2	0	0
	Single Family	9	2	0	1
	Total	272	79	13	25
5 PM	Commercial	136	40	7	13
	Commuting	3	5	7	1
	Educational	2	1	0	0
	Hotels	4	1	0	0
	Industrial	17	5	1	2
	Other-Residential	23	6	1	1
	Single Family	26	6	1	2
	Total	212	63	17	19

Economic Loss

The total economic loss estimated for the earthquake is 1,056.71 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 723.25 (millions of dollars); 14 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 71 % of the total loss. Table 12 below provides a summary of the losses associated with the building damage.

Table 12: Building-Related Economic Loss Estimates
(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	4.98	23.61	0.53	0.89	30.01
	Capital-Related	0.00	2.13	24.29	0.30	0.18	26.90
	Rental	8.23	26.24	9.57	0.09	0.42	44.55
	Relocation	0.86	0.52	0.45	0.01	0.11	1.95
	Subtotal	9.09	33.86	57.92	0.94	1.61	103.41
Capital Stock Losses							
	Structural	39.91	26.47	20.09	2.37	2.74	91.59
	Non_Structural	144.98	168.00	63.54	9.17	8.74	394.43
	Content	44.79	44.29	32.02	5.50	4.63	131.24
	Inventory	0.00	0.00	1.09	1.42	0.06	2.58
	Subtotal	229.69	238.76	116.74	18.47	16.17	619.83
	Total	238.78	272.62	174.66	19.41	17.78	723.25

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	618.35	\$0.00	0.00
	Bridges	64.40	\$7.24	11.24
	Tunnels	60.10	\$3.59	5.97
	Subtotal	742.80	10.80	
Railways	Segments	0.00	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	2.11	\$1.36	64.35
	Subtotal	2.10	1.40	
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	\$0.73	69.45
	Subtotal	1.10	0.70	
Ferry	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Port	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Airport	Facilities	0.00	\$0.00	0.00
	Runways	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
	Total	746.00	12.90	

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	64.60	\$36.19	56.02
	Distribution Line	25.70	\$0.74	2.89
	Subtotal	90.30	\$36.93	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	516.80	\$282.22	54.61
	Distribution Line	15.40	\$0.59	3.81
	Subtotal	532.24	\$282.81	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Line	10.30	\$0.63	6.11
	Subtotal	10.28	\$0.63	
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	0.30	\$0.17	58.73
	Subtotal	0.29	\$0.17	
	Total	633.11	\$320.54	

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	(6)	-1.60
Second Year			
	Employment Impact	0	0.00
	Income Impact	(18)	-4.89
Third Year			
	Employment Impact	0	0.00
	Income Impact	(23)	-6.29
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(23)	-6.29
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(23)	-6.29
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(23)	-6.29

Appendix A: County Listing for the Region

Summit,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Summit	23,548	2,399	405	2,805
Total State		23,548	2,399	405	2,805
Total Region		23,548	2,399	405	2,805

HAZUS-MH: Earthquake Event Report



Region Name: *Summit County*

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

Print Date: *February 01, 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 618.48 square miles and contains 4 census tracts. There are over 9 thousand households in the region and has a total population of 23,548 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 11 thousand buildings in the region with a total building replacement value (excluding contents) of 2,805 (millions of dollars). Approximately 98.00 % of the buildings (and 86.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 746 and 581 (millions of dollars), respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 11 thousand buildings in the region which have an aggregate total replacement value of 2,805 (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 71% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

HAZUS breaks critical facilities into two (2) groups: essential facilities and high potential loss (HPL) facilities. Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 0 hospitals in the region with a total bed capacity of 0 beds. There are 2 schools, 2 fire stations, 5 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 11 dams identified within the region. Of these, 7 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 1,327.00 (millions of dollars). This inventory includes over 162 kilometers of highways, 48 bridges, 2,570 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	48	64.40
	Segments	15	618.30
	Tunnels	2	60.10
	Subtotal		742.80
Railways	Bridges	0	0.00
	Facilities	1	2.10
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		2.10
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	1	1.10
	Subtotal		1.10
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	0	0.00
	Runways	0	0.00
	Subtotal		0.00
		Total	746.00

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	25.70
	Facilities	2	64.60
	Pipelines	0	0.00
	Subtotal		90.30
Waste Water	Distribution Lines	NA	15.40
	Facilities	8	516.80
	Pipelines	0	0.00
	Subtotal		532.20
Natural Gas	Distribution Lines	NA	10.30
	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		10.30
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		0.00
Electrical Power	Facilities	0	0.00
	Subtotal		0.00
Communication	Facilities	3	0.30
	Subtotal		0.30
	Total		633.10

Earthquake Scenario

HAZUS uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

Scenario Name	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 1,531 buildings will be at least moderately damaged. This is over 14.00 % of the total number of buildings in the region. There are an estimated 49 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the HAZUS technical manual. Table 4 below summaries the expected damage by general occupancy for the buildings in the region. Table 5 summaries the expected damage by general building type.

Table 4: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	89	1.20	33	1.57	41	3.64	21	6.05	5	10.81
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	8	0.11	2	0.08	1	0.12	0	0.12	0	0.15
Industrial	6	0.08	3	0.13	3	0.29	2	0.49	0	0.86
Other Residential	924	12.49	305	14.72	211	18.57	51	14.71	7	14.53
Religion	3	0.04	1	0.06	1	0.13	1	0.24	0	0.44
Single Family	6,367	86.07	1,730	83.44	878	77.25	271	78.39	36	73.22
Total	7,397		2,073		1,136		346		49	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	5,616	75.92	1565	75.48	522	45.96	66	18.97	5	10.04
Steel	54	0.73	16	0.77	23	2.06	12	3.49	3	6.95
Concrete	57	0.77	20	0.98	21	1.88	9	2.69	2	3.43
Precast	13	0.18	4	0.21	7	0.66	5	1.54	1	2.49
RM	1,205	16.29	271	13.08	377	33.21	199	57.43	21	42.94
URM	137	1.86	67	3.23	65	5.75	32	9.34	15	29.72
MH	314	4.25	129	6.24	119	10.48	23	6.54	2	4.43
Total	7,397		2,073		1,136		346		49	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

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

Table 6: Expected Damage to Essential Facilities

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

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	15	0	0	15	15
	Bridges	48	0	0	48	48
	Tunnels	2	0	0	2	2
Railways	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	1	0	0	1	1
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	1	0	0	1	1
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	0	0	0	0	0
	Runways	0	0	0	0	0

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 8-10 provide information on the damage to the utility lifeline systems. Table 8 provides damage to the utility system facilities. Table 9 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, HAZUS performs a simplified system performance analysis. Table 10 provides a summary of the system performance information.

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	2	0	0	2	2
Waste Water	8	1	0	4	8
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	3	0	0	3	3

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	1,285	31	8
Waste Water	771	25	6
Natural Gas	514	27	7
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	9,120	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 3 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 1 people and burn about 0 (millions of dollars) of building value.

Debris Generation

HAZUS estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 0.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 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 148 households to be displaced due to the earthquake. Of these, 27 people (out of a total population of 23,548) 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	1	0	0
	Industrial	1	0	0	0
	Other-Residential	11	2	0	0
	Single Family	12	2	0	1
	Total	27	5	1	1
2 PM	Commercial	42	10	1	3
	Commuting	0	0	0	0
	Educational	3	1	0	0
	Hotels	1	0	0	0
	Industrial	6	1	0	0
	Other-Residential	1	0	0	0
	Single Family	2	0	0	0
	Total	54	13	2	3
5 PM	Commercial	27	6	1	2
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	1	0	0	0
	Industrial	3	1	0	0
	Other-Residential	4	1	0	0
	Single Family	5	1	0	0
	Total	41	9	2	3

Economic Loss

The total economic loss estimated for the earthquake is 217.41 (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 164.38 (millions of dollars); 19 % 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 66 % 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	1.40	7.95	0.17	0.24	9.75
	Capital-Related	0.00	0.60	8.02	0.09	0.06	8.77
	Rental	1.90	6.35	3.42	0.03	0.11	11.82
	Relocation	0.20	0.13	0.16	0.00	0.03	0.52
	Subtotal	2.10	8.48	19.54	0.30	0.44	30.86
Capital Stock Losses							
	Structural	9.18	6.27	6.20	0.75	0.76	23.16
	Non_Structural	29.20	34.23	14.95	2.07	1.89	82.33
	Content	9.47	8.85	7.02	1.19	0.93	27.46
	Inventory	0.00	0.00	0.25	0.31	0.01	0.57
	Subtotal	47.84	49.35	28.42	4.31	3.60	133.53
	Total	49.95	57.83	47.96	4.61	4.03	164.38

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	618.35	\$0.00	0.00
	Bridges	64.40	\$0.73	1.14
	Tunnels	60.10	\$0.05	0.08
	Subtotal	742.80	0.80	
Railways	Segments	0.00	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	2.11	\$0.46	21.89
	Subtotal	2.10	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	\$0.29	26.97
	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	0.00	\$0.00	0.00
	Runways	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
	Total	746.00	1.50	

Table 14: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.00	\$0.00	0.00
	Facilities	64.60	\$4.02	6.22
	Distribution Line	25.70	\$0.14	0.55
	Subtotal	90.30	\$4.16	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	516.80	\$47.09	9.11
	Distribution Line	15.40	\$0.11	0.72
	Subtotal	532.24	\$47.20	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Line	10.30	\$0.12	1.16
	Subtotal	10.28	\$0.12	
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	0.30	\$0.03	8.69
	Subtotal	0.29	\$0.03	
	Total	633.11	\$51.50	

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)	-0.35
Second Year			
	Employment Impact	0	0.00
	Income Impact	(4)	-1.06
Third Year			
	Employment Impact	0	0.00
	Income Impact	(5)	-1.37
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(5)	-1.37
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(5)	-1.37
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(5)	-1.37

Appendix A: County Listing for the Region

Summit,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Summit	23,548	2,399	405	2,805
Total State		23,548	2,399	405	2,805
Total Region		23,548	2,399	405	2,805

HAZUS-MH: Earthquake Event Report



Region Name: *Summit County*

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

Print Date: *February 01, 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 618.48 square miles and contains 4 census tracts. There are over 9 thousand households in the region and has a total population of 23,548 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 11 thousand buildings in the region with a total building replacement value (excluding contents) of 2,805 (millions of dollars). Approximately 98.00 % of the buildings (and 86.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 746 and 581 (millions of dollars), respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 11 thousand buildings in the region which have an aggregate total replacement value of 2,805 (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 71% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

HAZUS breaks critical facilities into two (2) groups: essential facilities and high potential loss (HPL) facilities. Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 0 hospitals in the region with a total bed capacity of 0 beds. There are 2 schools, 2 fire stations, 5 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 11 dams identified within the region. Of these, 7 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 1,327.00 (millions of dollars). This inventory includes over 162 kilometers of highways, 48 bridges, 2,570 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	48	64.40
	Segments	15	618.30
	Tunnels	2	60.10
	Subtotal		742.80
Railways	Bridges	0	0.00
	Facilities	1	2.10
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		2.10
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	1	1.10
	Subtotal		1.10
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	0	0.00
	Runways	0	0.00
	Subtotal		0.00
		Total	746.00

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	25.70
	Facilities	2	64.60
	Pipelines	0	0.00
	Subtotal		90.30
Waste Water	Distribution Lines	NA	15.40
	Facilities	8	516.80
	Pipelines	0	0.00
	Subtotal		532.20
Natural Gas	Distribution Lines	NA	10.30
	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		10.30
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		0.00
Electrical Power	Facilities	0	0.00
	Subtotal		0.00
Communication	Facilities	3	0.30
	Subtotal		0.30
	Total		633.10

Earthquake Scenario

HAZUS uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

Scenario Name	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 1,096 buildings will be at least moderately damaged. This is over 10.00 % of the total number of buildings in the region. There are an estimated 21 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the HAZUS technical manual. Table 4 below summaries the expected damage by general occupancy for the buildings in the region. Table 5 summaries the expected damage by general building type.

Table 4: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	102	1.25	33	1.89	37	4.28	15	6.70	3	12.16
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	9	0.11	2	0.10	1	0.14	0	0.15	0	0.19
Industrial	7	0.09	3	0.15	3	0.34	1	0.56	0	0.99
Other Residential	1,004	12.33	276	15.63	178	20.87	36	16.36	3	16.51
Religion	4	0.05	1	0.07	1	0.15	1	0.27	0	0.48
Single Family	7,011	86.18	1,453	82.16	635	74.21	168	75.97	15	69.67
Total	8,136		1,769		855		221		21	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	6,137	75.43	1275	72.10	329	38.53	31	13.91	2	7.44
Steel	59	0.73	17	0.95	22	2.57	9	4.10	2	8.44
Concrete	62	0.77	21	1.17	19	2.25	7	3.07	1	3.89
Precast	15	0.19	5	0.26	7	0.83	4	1.90	1	2.93
RM	1,364	16.77	258	14.59	312	36.46	131	59.37	8	40.26
URM	166	2.04	66	3.76	56	6.51	22	9.88	7	31.23
MH	332	4.08	127	7.17	110	12.86	17	7.79	1	5.81
Total	8,136		1,769		855		221		21	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

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

Table 6: Expected Damage to Essential Facilities

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

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	15	0	0	15	15
	Bridges	48	0	0	48	48
	Tunnels	2	0	0	2	2
Railways	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	1	0	0	1	1
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	1	0	0	1	1
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	0	0	0	0	0
	Runways	0	0	0	0	0

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 8-10 provide information on the damage to the utility lifeline systems. Table 8 provides damage to the utility system facilities. Table 9 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, HAZUS performs a simplified system performance analysis. Table 10 provides a summary of the system performance information.

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	2	0	0	2	2
Waste Water	8	0	0	6	8
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	3	0	0	3	3

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	1,285	22	6
Waste Water	771	18	4
Natural Gas	514	19	5
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	9,120	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 0.04 sq. mi 0.01 % of the region's total area.) The model also estimates that the fires will displace about 1 people and burn about 0 (millions of dollars) of building value.

Debris Generation

HAZUS estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 0.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 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 91 households to be displaced due to the earthquake. Of these, 17 people (out of a total population of 23,548) will seek temporary shelter in public shelters.

Casualties

HAZUS estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 11 provides a summary of the casualties estimated for this earthquake

Table 11: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	2	0	0	0
	Industrial	0	0	0	0
	Other-Residential	7	1	0	0
	Single Family	7	1	0	0
	Total	16	3	0	1
2 PM	Commercial	25	5	1	1
	Commuting	0	0	0	0
	Educational	2	0	0	0
	Hotels	0	0	0	0
	Industrial	3	1	0	0
	Other-Residential	1	0	0	0
	Single Family	1	0	0	0
	Total	33	7	1	2
5 PM	Commercial	16	3	0	1
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	2	0	0	0
	Other-Residential	3	0	0	0
	Single Family	3	0	0	0
	Total	25	5	1	1

Economic Loss

The total economic loss estimated for the earthquake is 140.74 (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 108.52 (millions of dollars); 20 % 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 65 % 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	0.92	5.74	0.12	0.18	6.96
	Capital-Related	0.00	0.39	5.81	0.07	0.04	6.32
	Rental	1.24	4.35	2.53	0.02	0.08	8.22
	Relocation	0.13	0.09	0.12	0.00	0.02	0.36
	Subtotal	1.37	5.75	14.20	0.21	0.33	21.86
Capital Stock Losses							
	Structural	5.97	4.36	4.34	0.54	0.54	15.75
	Non_Structural	18.48	22.34	9.63	1.34	1.23	53.01
	Content	6.07	5.70	4.43	0.76	0.60	17.54
	Inventory	0.00	0.00	0.16	0.20	0.01	0.36
	Subtotal	30.52	32.39	18.55	2.83	2.37	86.67
	Total	31.88	38.15	32.75	3.05	2.70	108.52

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	618.35	\$0.00	0.00
	Bridges	64.40	\$0.33	0.51
	Tunnels	60.10	\$0.02	0.04
	Subtotal	742.80	0.30	
Railways	Segments	0.00	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	2.11	\$0.32	14.99
	Subtotal	2.10	0.30	
Light Rail	Segments	0.00	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Bus	Facilities	1.06	\$0.20	19.02
	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	0.00	\$0.00	0.00
	Runways	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
	Total	746.00	0.90	

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	64.60	\$2.26	3.50
	Distribution Line	25.70	\$0.10	0.39
	Subtotal	90.30	\$2.36	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	516.80	\$28.81	5.58
	Distribution Line	15.40	\$0.08	0.51
	Subtotal	532.24	\$28.89	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Line	10.30	\$0.08	0.82
	Subtotal	10.28	\$0.08	
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	0.30	\$0.01	5.05
	Subtotal	0.29	\$0.01	
	Total	633.11	\$31.35	

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)	-0.23
Second Year			
	Employment Impact	0	0.00
	Income Impact	(3)	-0.69
Third Year			
	Employment Impact	0	0.00
	Income Impact	(3)	-0.89
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(3)	-0.89
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(3)	-0.89
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(3)	-0.89

Appendix A: County Listing for the Region

Summit,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Summit	23,548	2,399	405	2,805
Total State		23,548	2,399	405	2,805
Total Region		23,548	2,399	405	2,805

HAZUS-MH: Earthquake Event Report



Region Name: *Summit County*

Earthquake Scenario: *Ute Pass M7.0 CEUS Event*

Print Date: *February 01, 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 618.48 square miles and contains 4 census tracts. There are over 9 thousand households in the region and has a total population of 23,548 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 11 thousand buildings in the region with a total building replacement value (excluding contents) of 2,805 (millions of dollars). Approximately 98.00 % of the buildings (and 86.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 746 and 581 (millions of dollars), respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 11 thousand buildings in the region which have an aggregate total replacement value of 2,805 (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 71% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

HAZUS breaks critical facilities into two (2) groups: essential facilities and high potential loss (HPL) facilities. Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 0 hospitals in the region with a total bed capacity of 0 beds. There are 2 schools, 2 fire stations, 5 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 11 dams identified within the region. Of these, 7 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 1,327.00 (millions of dollars). This inventory includes over 162 kilometers of highways, 48 bridges, 2,570 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	48	64.40
	Segments	15	618.30
	Tunnels	2	60.10
	Subtotal		742.80
Railways	Bridges	0	0.00
	Facilities	1	2.10
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		2.10
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	1	1.10
	Subtotal		1.10
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	0	0.00
	Runways	0	0.00
	Subtotal		0.00
		Total	746.00

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	25.70
	Facilities	2	64.60
	Pipelines	0	0.00
	Subtotal		90.30
Waste Water	Distribution Lines	NA	15.40
	Facilities	8	516.80
	Pipelines	0	0.00
	Subtotal		532.20
Natural Gas	Distribution Lines	NA	10.30
	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		10.30
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		0.00
Electrical Power	Facilities	0	0.00
	Subtotal		0.00
Communication	Facilities	3	0.30
	Subtotal		0.30
	Total		633.10

Earthquake Scenario

HAZUS uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

Scenario Name	Ute Pass M7.0 CEUS Event
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-105.00
Latitude of Epicenter	38.92
Earthquake Magnitude	7.00
Depth (Km)	10.00
Rupture Length (Km)	42.66
Rupture Orientation (degrees)	152.00
Attenuation Function	CEUS Event

Building Damage

Building Damage

HAZUS estimates that about 378 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 2 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the HAZUS technical manual. Table 4 below summaries the expected damage by general occupancy for the buildings in the region. Table 5 summaries the expected damage by general building type.

Table 4: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	148	1.53	22	2.41	15	4.55	3	6.35	0	10.65
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	10	0.11	1	0.11	1	0.17	0	0.19	0	0.21
Industrial	11	0.11	2	0.20	1	0.38	0	0.62	0	0.74
Other Residential	1,238	12.78	168	18.02	82	25.04	9	18.42	0	16.81
Religion	6	0.06	1	0.09	1	0.16	0	0.23	0	0.34
Single Family	8,276	85.42	739	79.17	229	69.70	36	74.20	2	71.25
Total	9,689		933		328		48		2	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	7,059	72.86	608	65.18	100	30.40	6	12.82	0	5.79
Steel	82	0.85	13	1.37	11	3.36	3	5.31	0	8.87
Concrete	87	0.90	14	1.46	7	2.28	1	2.55	0	1.92
Precast	24	0.25	4	0.39	4	1.07	1	2.18	0	1.30
RM	1,777	18.34	154	16.49	118	36.03	24	50.48	0	10.71
URM	223	2.30	51	5.50	32	9.81	9	17.73	1	64.53
MH	437	4.51	90	9.62	56	17.05	4	8.93	0	6.89
Total	9,689		933		328		48		2	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

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

Table 6: Expected Damage to Essential Facilities

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

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	15	0	0	15	15
	Bridges	48	0	0	48	48
	Tunnels	2	0	0	2	2
Railways	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	1	0	0	1	1
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	1	0	0	1	1
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	0	0	0	0	0
	Runways	0	0	0	0	0

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 8-10 provide information on the damage to the utility lifeline systems. Table 8 provides damage to the utility system facilities. Table 9 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, HAZUS performs a simplified system performance analysis. Table 10 provides a summary of the system performance information.

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	2	0	0	2	2
Waste Water	8	0	0	8	8
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	3	0	0	3	3

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	1,285	7	2
Waste Water	771	6	1
Natural Gas	514	6	1
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	9,120	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 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

Debris Generation

HAZUS estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 0.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 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 20 households to be displaced due to the earthquake. Of these, 3 people (out of a total population of 23,548) will seek temporary shelter in public shelters.

Casualties

HAZUS estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 11 provides a summary of the casualties estimated for this earthquake

Table 11: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	2	0	0	0
	Single Family	2	0	0	0
	Total	5	1	0	0
2 PM	Commercial	6	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	8	1	0	0
5 PM	Commercial	4	1	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	1	0	0	0
	Other-Residential	1	0	0	0
	Single Family	1	0	0	0
	Total	6	1	0	0

Economic Loss

The total economic loss estimated for the earthquake is 42.72 (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 32.15 (millions of dollars); 20 % 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 67 % 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	0.22	1.62	0.04	0.06	1.93
	Capital-Related	0.00	0.09	1.67	0.02	0.01	1.80
	Rental	0.36	1.33	0.75	0.00	0.02	2.47
	Relocation	0.04	0.03	0.03	0.00	0.01	0.11
	Subtotal	0.40	1.67	4.08	0.06	0.10	6.30
Capital Stock Losses							
	Structural	1.79	1.43	1.18	0.16	0.15	4.70
	Non_Structural	5.67	6.98	2.58	0.38	0.34	15.94
	Content	1.77	1.69	1.26	0.21	0.17	5.10
	Inventory	0.00	0.00	0.05	0.06	0.00	0.10
	Subtotal	9.23	10.10	5.07	0.80	0.66	25.85
	Total	9.62	11.76	9.14	0.86	0.76	32.15

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, HAZUS computes the direct repair cost for each component only. There are no losses computed by HAZUS for business interruption due to lifeline outages. Tables 13 & 14 provide a detailed breakdown in the expected lifeline losses.

HAZUS estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 15 presents the results of the region for the given earthquake.

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

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	618.35	\$0.00	0.00
	Bridges	64.40	\$0.03	0.04
	Tunnels	60.10	\$0.01	0.01
	Subtotal	742.80	0.00	
Railways	Segments	0.00	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	2.11	\$0.14	6.61
	Subtotal	2.10	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	\$0.09	8.49
	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	0.00	\$0.00	0.00
	Runways	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
	Total	746.00	0.30	

Table 14: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.00	\$0.00	0.00
	Facilities	64.60	\$0.69	1.06
	Distribution Line	25.70	\$0.03	0.12
	Subtotal	90.30	\$0.72	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	516.80	\$9.53	1.84
	Distribution Line	15.40	\$0.02	0.16
	Subtotal	532.24	\$9.56	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Line	10.30	\$0.03	0.26
	Subtotal	10.28	\$0.03	
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	0.30	\$0.00	1.37
	Subtotal	0.29	\$0.00	
	Total	633.11	\$10.30	

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	-0.07
Second Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-0.21
Third Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-0.27
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-0.27
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-0.27
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(1)	-0.27

Appendix A: County Listing for the Region

Summit,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Summit	23,548	2,399	405	2,805
Total State		23,548	2,399	405	2,805
Total Region		23,548	2,399	405	2,805

HAZUS-MH: Earthquake Event Report



Region Name: *Summit 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 618.48 square miles and contains 4 census tracts. There are over 9 thousand households in the region and has a total population of 23,548 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 11 thousand buildings in the region with a total building replacement value (excluding contents) of 2,805 (millions of dollars). Approximately 98.00 % of the buildings (and 86.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 746 and 581 (millions of dollars), respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 11 thousand buildings in the region which have an aggregate total replacement value of 2,805 (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 71% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

HAZUS breaks critical facilities into two (2) groups: essential facilities and high potential loss (HPL) facilities. Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 0 hospitals in the region with a total bed capacity of 0 beds. There are 2 schools, 2 fire stations, 5 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 11 dams identified within the region. Of these, 7 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 1,327.00 (millions of dollars). This inventory includes over 162 kilometers of highways, 48 bridges, 2,570 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	48	64.40
	Segments	15	618.30
	Tunnels	2	60.10
	Subtotal		742.80
Railways	Bridges	0	0.00
	Facilities	1	2.10
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		2.10
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	1	1.10
	Subtotal		1.10
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	0	0.00
	Runways	0	0.00
	Subtotal		0.00
		Total	746.00

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	25.70
	Facilities	2	64.60
	Pipelines	0	0.00
	Subtotal		90.30
Waste Water	Distribution Lines	NA	15.40
	Facilities	8	516.80
	Pipelines	0	0.00
	Subtotal		532.20
Natural Gas	Distribution Lines	NA	10.30
	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		10.30
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		0.00
Electrical Power	Facilities	0	0.00
	Subtotal		0.00
Communication	Facilities	3	0.30
	Subtotal		0.30
	Total		633.10

Earthquake Scenario

HAZUS uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

Scenario Name	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 2,840 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 214 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the HAZUS technical manual. Table 4 below summaries the expected damage by general occupancy for the buildings in the region. Table 5 summaries the expected damage by general building type.

Table 4: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	86	1.51	31	1.26	40	2.12	23	3.10	9	4.22
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	7	0.12	2	0.09	2	0.11	1	0.09	0	0.03
Industrial	6	0.10	2	0.10	3	0.17	2	0.26	1	0.38
Other Residential	775	13.66	337	13.55	266	14.13	91	12.24	29	13.45
Religion	3	0.06	1	0.06	1	0.08	1	0.08	0	0.05
Single Family	4,796	84.54	2,113	84.95	1,572	83.39	623	84.23	176	81.87
Total	5,673		2,488		1,885		740		215	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	4,166	73.43	2012	80.88	1,227	65.07	316	42.64	53	24.72
Steel	49	0.86	15	0.62	23	1.22	14	1.93	7	3.38
Concrete	50	0.89	20	0.80	23	1.20	12	1.67	5	2.11
Precast	13	0.23	4	0.17	7	0.38	6	0.75	2	1.01
RM	1,009	17.78	250	10.05	409	21.71	307	41.43	98	45.83
URM	103	1.82	61	2.44	70	3.73	46	6.24	36	16.77
MH	283	4.99	125	5.04	126	6.68	40	5.35	13	6.18
Total	5,673		2,488		1,885		740		215	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

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

Table 6: Expected Damage to Essential Facilities

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

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	15	0	0	15	15
	Bridges	48	2	0	46	46
	Tunnels	2	0	0	2	2
Railways	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	1	1	0	1	1
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	1	0	0	1	1
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	0	0	0	0	0
	Runways	0	0	0	0	0

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 8-10 provide information on the damage to the utility lifeline systems. Table 8 provides damage to the utility system facilities. Table 9 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, HAZUS performs a simplified system performance analysis. Table 10 provides a summary of the system performance information.

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	2	2	0	0	2
Waste Water	8	7	0	0	8
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	3	0	0	3	3

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	1,285	79	20
Waste Water	771	62	16
Natural Gas	514	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	9,120	0	0	0	0	0
Electric Power		1,936	1,310	611	134	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 0.02 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 407 households to be displaced due to the earthquake. Of these, 79 people (out of a total population of 23,548 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	1	0	0
	Industrial	2	0	0	0
	Other-Residential	29	7	1	2
	Single Family	41	10	1	3
	Total	77	18	2	5
2 PM	Commercial	75	21	3	7
	Commuting	0	0	0	0
	Educational	10	3	0	1
	Hotels	1	0	0	0
	Industrial	12	3	1	1
	Other-Residential	4	1	0	0
	Single Family	6	2	0	0
	Total	109	30	5	9
5 PM	Commercial	55	15	2	5
	Commuting	2	2	4	1
	Educational	1	0	0	0
	Hotels	1	0	0	0
	Industrial	8	2	0	1
	Other-Residential	11	3	0	1
	Single Family	16	4	1	1
	Total	94	27	8	8

Economic Loss

The total economic loss estimated for the earthquake is 436.15 (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 317.58 (millions of dollars); 14 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 74 % of the total loss. Table 12 below provides a summary of the losses associated with the building damage.

Table 12: Building-Related Economic Loss Estimates
(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	1.60	9.79	0.25	0.27	11.90
	Capital-Related	0.00	0.68	10.08	0.14	0.06	10.96
	Rental	4.40	10.64	4.37	0.04	0.14	19.59
	Relocation	0.46	0.22	0.20	0.00	0.04	0.92
	Subtotal	4.86	13.13	24.44	0.43	0.51	43.37
Capital Stock Losses							
	Structural	20.76	11.80	9.19	1.06	0.93	43.75
	Non_Structural	73.13	70.24	23.92	3.62	2.43	173.33
	Content	21.97	18.74	11.91	2.03	1.34	55.99
	Inventory	0.00	0.00	0.57	0.54	0.03	1.14
	Subtotal	115.86	100.78	45.59	7.25	4.72	274.21
	Total	120.73	113.91	70.03	7.68	5.23	317.58

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	618.35	\$0.00	0.00
	Bridges	64.40	\$1.16	1.80
	Tunnels	60.10	\$4.96	8.25
	Subtotal	742.80	6.10	
Railways	Segments	0.00	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	2.11	\$0.75	35.36
	Subtotal	2.10	0.70	
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	25.65
	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	0.00	\$0.00	0.00
	Runways	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
	Total	746.00	7.10	

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	64.60	\$11.24	17.40
	Distribution Line	25.70	\$0.35	1.38
	Subtotal	90.30	\$11.60	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	516.80	\$99.22	19.20
	Distribution Line	15.40	\$0.28	1.82
	Subtotal	532.24	\$99.51	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Line	10.30	\$0.30	2.92
	Subtotal	10.28	\$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	0.30	\$0.04	13.13
	Subtotal	0.29	\$0.04	
	Total	633.11	\$111.44	

Table 15. Indirect Economic Impact with outside aid

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

LOSS	Total	%

Appendix A: County Listing for the Region

Summit,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Summit	23,548	2,399	405	2,805
Total State		23,548	2,399	405	2,805
Total Region		23,548	2,399	405	2,805