

HAZUS-MH: Earthquake Event Report



Region Name: *Jefferson County*

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

Print Date: *January 26, 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 777.10 square miles and contains 133 census tracts. There are over 206 thousand households in the region and has a total population of 527,056 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 171 thousand buildings in the region with a total building replacement value (excluding contents) of 32,456 (millions of dollars). Approximately 99.00 % of the buildings (and 87.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,023 and 1,115 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 171 thousand buildings in the region which have an aggregate total replacement value of 32,456 (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 74% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

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

For essential facilities, there are 2 hospitals in the region with a total bed capacity of 545 beds. There are 214 schools, 19 fire stations, 13 police stations and 1 emergency operation facilities. With respect to HPL facilities, there are 75 dams identified within the region. Of these, 20 of the dams are classified as 'high hazard'. The inventory also includes 25 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 3,138.00 (millions of dollars). This inventory includes over 374 kilometers of highways, 364 bridges, 11,157 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	364	450.80
	Segments	56	1,315.50
	Tunnels	4	9.30
	Subtotal		1,775.60
Railways	Bridges	8	1.10
	Facilities	0	0.00
	Segments	17	50.20
	Tunnels	0	0.00
	Subtotal		51.30
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	0	0.00
	Subtotal		0.00
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	3	15.90
	Runways	6	180.90
	Subtotal		196.70
		Total	2,023.60

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	111.60
	Facilities	5	161.50
	Pipelines	0	0.00
	Subtotal		273.10
Waste Water	Distribution Lines	NA	66.90
	Facilities	13	839.80
	Pipelines	0	0.00
	Subtotal		906.80
Natural Gas	Distribution Lines	NA	44.60
	Facilities	5	5.30
	Pipelines	0	0.00
	Subtotal		49.90
Oil Systems	Facilities	1	0.10
	Pipelines	0	0.00
	Subtotal		0.10
Electrical Power	Facilities	1	106.70
	Subtotal		106.70
Communication	Facilities	25	2.40
	Subtotal		2.40
	Total		1,339.00

Earthquake Scenario

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

Scenario Name	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 4,219 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 29 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the HAZUS technical manual. Table 4 below summaries the expected damage by general occupancy for the buildings in the region. Table 5 summaries the expected damage by general building type.

Table 4: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	5	0.00	1	0.01	1	0.03	0	0.05	0	0.10
Commercial	1,412	0.90	159	1.46	104	2.89	25	4.24	2	7.06
Education	1	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	87	0.06	9	0.08	5	0.13	1	0.14	0	0.16
Industrial	100	0.06	13	0.12	10	0.27	2	0.40	0	0.56
Other Residential	5,079	3.25	581	5.33	311	8.65	45	7.62	3	9.38
Religion	49	0.03	5	0.05	3	0.08	1	0.11	0	0.16
Single Family	149,730	95.70	10,137	92.95	3,160	87.94	521	87.44	25	82.59
Total	156,464		10,905		3,594		596		30	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	118,686	75.86	7563	69.35	1,215	33.81	80	13.47	2	6.94
Steel	571	0.36	58	0.53	46	1.27	10	1.74	1	3.56
Concrete	534	0.34	63	0.58	36	1.00	7	1.18	0	1.28
Precast	221	0.14	27	0.25	27	0.74	9	1.58	0	1.63
RM	30,988	19.80	2155	19.76	1,616	44.98	350	58.71	5	15.65
URM	3,860	2.47	726	6.65	433	12.06	111	18.60	19	65.08
MH	1,604	1.03	314	2.88	220	6.13	28	4.73	2	5.85
Total	156,464		10,905		3,594		596		30	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 545 hospital beds available for use. On the day of the earthquake, the model estimates that only 510 hospital beds (94.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 99.00% of the beds will be back in service. By 30 days, 100.00% will be operational.

Table 6: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	2	0	0	2
Schools	214	0	0	214
EOCs	1	0	0	1
PoliceStations	13	0	0	13
FireStations	19	0	0	19

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 % After Day 1	After Day 7
Highway	Segments	56	0	0	56	56
	Bridges	364	0	0	364	364
	Tunnels	4	0	0	4	4
Railways	Segments	17	0	0	17	17
	Bridges	8	0	0	8	8
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	3	0	0	3	3
	Runways	6	0	0	6	6

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

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

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	5	0	0	5	5
Waste Water	13	0	0	12	13
Natural Gas	5	0	0	5	5
Oil Systems	1	0	0	1	1
Electrical Power	1	0	0	1	1
Communication	25	0	0	25	25

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	5,579	16	4
Waste Water	3,347	13	3
Natural Gas	2,232	14	3
Oil	0	0	0

Table 10: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	206,067	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 8 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 88 people and burn about 5 (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 247 households to be displaced due to the earthquake. Of these, 57 people (out of a total population of 527,056) 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	1	0	0	0
	Industrial	1	0	0	0
	Other-Residential	16	2	0	0
	Single Family	56	7	0	1
	Total	74	9	1	1
2 PM	Commercial	56	8	1	2
	Commuting	0	0	0	0
	Educational	8	1	0	0
	Hotels	0	0	0	0
	Industrial	9	1	0	0
	Other-Residential	3	0	0	0
	Single Family	9	1	0	0
	Total	83	12	1	2
5 PM	Commercial	44	7	1	1
	Commuting	0	0	0	0
	Educational	1	0	0	0
	Hotels	0	0	0	0
	Industrial	6	1	0	0
	Other-Residential	6	1	0	0
	Single Family	21	3	0	0
	Total	78	11	1	2

Economic Loss

The total economic loss estimated for the earthquake is 306.98 (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 275.70 (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 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	0.36	11.16	0.32	0.36	12.21
	Capital-Related	0.00	0.15	10.08	0.19	0.07	10.51
	Rental	5.06	3.52	5.90	0.09	0.12	14.70
	Relocation	0.52	0.09	0.31	0.01	0.04	0.96
	Subtotal	5.58	4.12	27.46	0.62	0.59	38.37
Capital Stock Losses							
	Structural	27.51	4.79	10.74	1.51	1.23	45.78
	Non_Structural	87.82	23.77	22.51	3.91	2.42	140.43
	Content	28.66	6.06	11.51	2.49	1.34	50.05
	Inventory	0.00	0.00	0.43	0.59	0.05	1.07
	Subtotal	143.98	34.61	45.20	8.50	5.04	237.33
	Total	149.56	38.73	72.65	9.12	5.64	275.70

Transportation and Utility Lifeline Losses

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

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

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

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	1,315.49	\$0.00	0.00
	Bridges	450.80	\$0.51	0.11
	Tunnels	9.31	\$0.00	0.01
	Subtotal	1775.60	0.50	
Railways	Segments	50.19	\$0.00	0.00
	Bridges	1.11	\$0.00	0.02
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	51.30	0.00	
Light Rail	Segments	0.00	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Bus	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Ferry	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Port	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Airport	Facilities	15.86	\$1.11	7.03
	Runways	180.89	\$0.00	0.00
	Subtotal	196.70	1.10	
	Total	2023.60	1.60	

Table 14: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.00	\$0.00	0.00
	Facilities	161.50	\$4.16	2.57
	Distribution Line	111.60	\$0.07	0.06
	Subtotal	273.08	\$4.23	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	839.80	\$24.19	2.88
	Distribution Line	66.90	\$0.06	0.09
	Subtotal	906.77	\$24.25	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	5.30	\$0.05	0.87
	Distribution Line	44.60	\$0.06	0.14
	Subtotal	49.92	\$0.11	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.10	\$0.00	1.13
	Subtotal	0.10	\$0.00	
Electrical Power	Facilities	106.70	\$1.03	0.97
	Subtotal	106.70	\$1.03	
Communication	Facilities	2.40	\$0.03	1.25
	Subtotal	2.43	\$0.03	
	Total	1,338.99	\$29.65	

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

	LOSS	Total	%
First Year			
	Employment Impact	317	0.20
	Income Impact	(1)	-0.01
Second Year			
	Employment Impact	121	0.08
	Income Impact	(6)	-0.06
Third Year			
	Employment Impact	0	0.00
	Income Impact	(9)	-0.09
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(9)	-0.10
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(9)	-0.10
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(9)	-0.10

Appendix A: County Listing for the Region

Jefferson,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Jefferson	527,056	28,329	4,126	32,456
Total State		527,056	28,329	4,126	32,456
Total Region		527,056	28,329	4,126	32,456

HAZUS-MH: Earthquake Event Report



Region Name: *Jefferson County*

Earthquake Scenario: *Frontal M7.0 CEUS Event*

Print Date: *January 26, 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 777.10 square miles and contains 133 census tracts. There are over 206 thousand households in the region and has a total population of 527,056 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 171 thousand buildings in the region with a total building replacement value (excluding contents) of 32,456 (millions of dollars). Approximately 99.00 % of the buildings (and 87.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,023 and 1,115 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 171 thousand buildings in the region which have an aggregate total replacement value of 32,456 (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 74% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

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

For essential facilities, there are 2 hospitals in the region with a total bed capacity of 545 beds. There are 214 schools, 19 fire stations, 13 police stations and 1 emergency operation facilities. With respect to HPL facilities, there are 75 dams identified within the region. Of these, 20 of the dams are classified as 'high hazard'. The inventory also includes 25 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 3,138.00 (millions of dollars). This inventory includes over 374 kilometers of highways, 364 bridges, 11,157 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	364	450.80
	Segments	56	1,315.50
	Tunnels	4	9.30
	Subtotal		1,775.60
Railways	Bridges	8	1.10
	Facilities	0	0.00
	Segments	17	50.20
	Tunnels	0	0.00
	Subtotal		51.30
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	0	0.00
	Subtotal		0.00
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	3	15.90
	Runways	6	180.90
	Subtotal		196.70
		Total	2,023.60

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	111.60
	Facilities	5	161.50
	Pipelines	0	0.00
	Subtotal		273.10
Waste Water	Distribution Lines	NA	66.90
	Facilities	13	839.80
	Pipelines	0	0.00
	Subtotal		906.80
Natural Gas	Distribution Lines	NA	44.60
	Facilities	5	5.30
	Pipelines	0	0.00
	Subtotal		49.90
Oil Systems	Facilities	1	0.10
	Pipelines	0	0.00
	Subtotal		0.10
Electrical Power	Facilities	1	106.70
	Subtotal		106.70
Communication	Facilities	25	2.40
	Subtotal		2.40
	Total		1,339.00

Earthquake Scenario

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

Scenario Name	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 6,290 buildings will be at least moderately damaged. This is over 4.00 % of the total number of buildings in the region. There are an estimated 65 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	4	0.00	1	0.01	1	0.03	1	0.06	0	0.13
Commercial	1,303	0.86	199	1.36	151	2.89	45	4.45	5	8.02
Education	1	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	80	0.05	11	0.08	8	0.15	2	0.16	0	0.19
Industrial	88	0.06	17	0.12	15	0.29	5	0.47	1	0.78
Other Residential	4,735	3.14	743	5.08	447	8.58	87	8.60	8	11.53
Religion	46	0.03	6	0.04	4	0.08	1	0.12	0	0.19
Single Family	144,398	95.85	13,665	93.32	4,586	87.98	872	86.14	52	79.16
Total	150,655		14,644		5,212		1,013		66	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	114,935	76.29	10556	72.09	1,914	36.73	137	13.51	4	5.64
Steel	526	0.35	71	0.49	67	1.28	19	1.87	3	4.09
Concrete	490	0.33	81	0.56	55	1.05	13	1.32	1	1.69
Precast	197	0.13	33	0.22	37	0.71	16	1.60	1	2.23
RM	29,517	19.59	2684	18.33	2,281	43.76	613	60.52	19	29.00
URM	3,572	2.37	839	5.73	547	10.50	158	15.59	33	49.83
MH	1,416	0.94	380	2.59	311	5.97	57	5.58	5	7.53
Total	150,655		14,644		5,212		1,013		66	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 545 hospital beds available for use. On the day of the earthquake, the model estimates that only 482 hospital beds (89.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 98.00% of the beds will be back in service. By 30 days, 100.00% will be operational.

Table 6: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	2	0	0	2
Schools	214	0	0	214
EOCs	1	0	0	1
PoliceStations	13	0	0	13
FireStations	19	0	0	19

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 % After Day 1	After Day 7
Highway	Segments	56	0	0	56	56
	Bridges	364	0	0	364	364
	Tunnels	4	0	0	4	4
Railways	Segments	17	0	0	17	17
	Bridges	8	0	0	8	8
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	3	0	0	3	3
	Runways	6	0	0	6	6

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

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

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	5	0	0	5	5
Waste Water	13	0	0	12	13
Natural Gas	5	0	0	5	5
Oil Systems	1	0	0	1	1
Electrical Power	1	0	0	1	1
Communication	25	0	0	25	25

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	5,579	26	6
Waste Water	3,347	20	5
Natural Gas	2,232	22	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	206,067	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 14 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 32 people and burn about 2 (millions of dollars) of building value.

Debris Generation

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

The model estimates that a total of 0.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 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 459 households to be displaced due to the earthquake. Of these, 108 people (out of a total population of 527,056 will seek temporary shelter in public shelters.

Casualties

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

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

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

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

Table 11: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	2	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	1	0	0	0
	Industrial	2	0	0	0
	Other-Residential	26	4	0	1
	Single Family	87	11	1	2
	Total	119	16	1	3
2 PM	Commercial	96	16	2	4
	Commuting	0	0	0	0
	Educational	13	2	0	0
	Hotels	0	0	0	0
	Industrial	17	3	0	1
	Other-Residential	5	1	0	0
	Single Family	14	2	0	0
	Total	143	24	3	5
5 PM	Commercial	75	13	1	3
	Commuting	1	1	1	0
	Educational	2	0	0	0
	Hotels	0	0	0	0
	Industrial	10	2	0	0
	Other-Residential	10	1	0	0
	Single Family	34	5	0	1
	Total	132	22	4	4

Economic Loss

The total economic loss estimated for the earthquake is 460.39 (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 427.29 (millions of dollars); 15 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 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	0.62	18.13	0.56	0.59	19.90
	Capital-Related	0.00	0.27	16.27	0.34	0.12	16.99
	Rental	7.74	5.89	9.55	0.18	0.22	23.58
	Relocation	0.79	0.14	0.49	0.02	0.06	1.51
	Subtotal	8.53	6.92	44.44	1.10	1.00	61.98
Capital Stock Losses							
	Structural	41.54	7.67	17.53	2.60	2.07	71.40
	Non_Structural	131.69	37.41	36.47	6.45	3.89	215.91
	Content	42.68	9.46	17.97	4.08	2.09	76.28
	Inventory	0.00	0.00	0.68	0.95	0.08	1.72
	Subtotal	215.91	54.54	72.65	14.08	8.13	365.30
	Total	224.44	61.46	117.09	15.18	9.13	427.29

Transportation and Utility Lifeline Losses

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

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

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

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	1,315.49	\$0.00	0.00
	Bridges	450.80	\$1.28	0.28
	Tunnels	9.31	\$0.00	0.04
	Subtotal	1775.60	1.30	
Railways	Segments	50.19	\$0.00	0.00
	Bridges	1.11	\$0.00	0.06
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	51.30	0.00	
Light Rail	Segments	0.00	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Bus	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Ferry	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Port	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Airport	Facilities	15.86	\$1.27	8.01
	Runways	180.89	\$0.00	0.00
	Subtotal	196.70	1.30	
	Total	2023.60	2.60	

Table 14: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.00	\$0.00	0.00
	Facilities	161.50	\$6.34	3.92
	Distribution Line	111.60	\$0.12	0.10
	Subtotal	273.08	\$6.45	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	839.80	\$22.02	2.62
	Distribution Line	66.90	\$0.09	0.14
	Subtotal	906.77	\$22.11	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	5.30	\$0.08	1.45
	Distribution Line	44.60	\$0.10	0.22
	Subtotal	49.92	\$0.17	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.10	\$0.00	1.86
	Subtotal	0.10	\$0.00	
Electrical Power	Facilities	106.70	\$1.77	1.66
	Subtotal	106.70	\$1.77	
Communication	Facilities	2.40	\$0.05	1.97
	Subtotal	2.43	\$0.05	
	Total	1,338.99	\$30.55	

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

	LOSS	Total	%
First Year			
	Employment Impact	453	0.29
	Income Impact	(1)	-0.02
Second Year			
	Employment Impact	194	0.12
	Income Impact	(9)	-0.10
Third Year			
	Employment Impact	5	0.00
	Income Impact	(13)	-0.14
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(13)	-0.15
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(14)	-0.15
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(14)	-0.15

Appendix A: County Listing for the Region

Jefferson,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Jefferson	527,056	28,329	4,126	32,456
Total State		527,056	28,329	4,126	32,456
Total Region		527,056	28,329	4,126	32,456

HAZUS-MH: Earthquake Event Report



Region Name: *Jefferson County*

Earthquake Scenario: *Golden M5.5 CEUS Event*

Print Date: *January 26, 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 777.10 square miles and contains 133 census tracts. There are over 206 thousand households in the region and has a total population of 527,056 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 171 thousand buildings in the region with a total building replacement value (excluding contents) of 32,456 (millions of dollars). Approximately 99.00 % of the buildings (and 87.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,023 and 1,115 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 171 thousand buildings in the region which have an aggregate total replacement value of 32,456 (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 74% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

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

For essential facilities, there are 2 hospitals in the region with a total bed capacity of 545 beds. There are 214 schools, 19 fire stations, 13 police stations and 1 emergency operation facilities. With respect to HPL facilities, there are 75 dams identified within the region. Of these, 20 of the dams are classified as 'high hazard'. The inventory also includes 25 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 3,138.00 (millions of dollars). This inventory includes over 374 kilometers of highways, 364 bridges, 11,157 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	364	450.80
	Segments	56	1,315.50
	Tunnels	4	9.30
	Subtotal		1,775.60
Railways	Bridges	8	1.10
	Facilities	0	0.00
	Segments	17	50.20
	Tunnels	0	0.00
	Subtotal		51.30
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	0	0.00
	Subtotal		0.00
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	3	15.90
	Runways	6	180.90
	Subtotal		196.70
		Total	2,023.60

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	111.60
	Facilities	5	161.50
	Pipelines	0	0.00
	Subtotal		273.10
Waste Water	Distribution Lines	NA	66.90
	Facilities	13	839.80
	Pipelines	0	0.00
	Subtotal		906.80
Natural Gas	Distribution Lines	NA	44.60
	Facilities	5	5.30
	Pipelines	0	0.00
	Subtotal		49.90
Oil Systems	Facilities	1	0.10
	Pipelines	0	0.00
	Subtotal		0.10
Electrical Power	Facilities	1	106.70
	Subtotal		106.70
Communication	Facilities	25	2.40
	Subtotal		2.40
	Total		1,339.00

Earthquake Scenario

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

Scenario Name	Golden M5.5 CEUS Event
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	5.50
Depth (Km)	10.00
Rupture Length (Km)	3.31
Rupture Orientation (degrees)	157.00
Attenuation Function	CEUS Event

Building Damage

Building Damage

HAZUS estimates that about 6,175 buildings will be at least moderately damaged. This is over 4.00 % of the total number of buildings in the region. There are an estimated 60 buildings that will be damaged beyond repair. The definition of the ' damage states' is provided in Volume 1: Chapter 5 of the HAZUS technical manual. Table 4 below summaries the expected damage by general occupancy for the buildings in the region. Table 5 summaries the expected damage by general building type.

Table 4: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	5	0.00	2	0.01	1	0.02	0	0.04	0	0.06
Commercial	1,398	0.92	164	1.23	110	2.12	29	3.07	3	4.38
Education	1	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	82	0.05	10	0.08	7	0.13	1	0.16	0	0.18
Industrial	95	0.06	14	0.11	12	0.22	3	0.36	0	0.42
Other Residential	4,853	3.19	726	5.46	385	7.44	52	5.62	3	5.14
Religion	48	0.03	6	0.04	4	0.07	1	0.09	0	0.12
Single Family	145,620	95.74	12,389	93.07	4,663	90.00	846	90.66	55	89.71
Total	152,102		13,312		5,181		933		61	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	114,798	75.47	9908	74.43	2,553	49.27	273	29.24	15	23.86
Steel	578	0.38	56	0.42	42	0.81	9	0.97	1	1.27
Concrete	525	0.35	69	0.52	39	0.76	7	0.80	0	0.57
Precast	213	0.14	29	0.22	30	0.59	11	1.21	1	1.00
RM	30,579	20.10	2223	16.70	1,835	35.41	468	50.16	9	15.14
URM	3,842	2.53	683	5.13	450	8.68	140	14.98	34	56.34
MH	1,567	1.03	343	2.58	233	4.49	25	2.63	1	1.81
Total	152,102		13,312		5,181		933		61	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 545 hospital beds available for use. On the day of the earthquake, the model estimates that only 515 hospital beds (95.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 99.00% of the beds will be back in service. By 30 days, 100.00% will be operational.

Table 6: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	2	0	0	2
Schools	214	0	0	209
EOCs	1	0	0	1
PoliceStations	13	0	0	13
FireStations	19	0	0	19

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 % After Day 1	After Day 7
Highway	Segments	56	0	0	56	56
	Bridges	364	0	0	364	364
	Tunnels	4	0	0	4	4
Railways	Segments	17	0	0	17	17
	Bridges	8	0	0	8	8
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	3	0	0	3	3
	Runways	6	0	0	6	6

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

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

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	5	3	0	2	5
Waste Water	13	4	0	4	13
Natural Gas	5	1	0	1	5
Oil Systems	1	1	0	0	1
Electrical Power	1	1	0	0	1
Communication	25	21	0	25	25

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	5,579	15	4
Waste Water	3,347	12	3
Natural Gas	2,232	13	3
Oil	0	0	0

Table 10: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	206,067	0	0	0	0	0
Electric Power		8,015	4,616	1,704	299	12

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 30 ignitions that will burn about 0.24 sq. mi 0.03 % of the region's total area.) The model also estimates that the fires will displace about 467 people and burn about 27 (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 390 households to be displaced due to the earthquake. Of these, 92 people (out of a total population of 527,056) 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	1	0	0	0
	Industrial	2	0	0	0
	Other-Residential	23	3	0	0
	Single Family	86	11	1	2
	Total	113	15	1	2
2 PM	Commercial	70	12	1	2
	Commuting	0	0	0	0
	Educational	9	1	0	0
	Hotels	0	0	0	0
	Industrial	12	2	0	0
	Other-Residential	4	1	0	0
	Single Family	14	2	0	0
	Total	109	17	2	3
5 PM	Commercial	55	9	1	2
	Commuting	0	0	1	0
	Educational	1	0	0	0
	Hotels	0	0	0	0
	Industrial	7	1	0	0
	Other-Residential	9	1	0	0
	Single Family	33	4	0	1
	Total	106	16	2	3

Economic Loss

The total economic loss estimated for the earthquake is 1,025.06 (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 860.92 (millions of dollars); 5 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 77 % 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	0.55	11.85	0.37	0.47	13.24
	Capital-Related	0.00	0.24	10.82	0.22	0.09	11.37
	Rental	7.70	5.47	6.50	0.13	0.19	19.99
	Relocation	0.79	0.13	0.33	0.02	0.05	1.33
	Subtotal	8.50	6.39	29.50	0.74	0.80	45.93
Capital Stock Losses							
	Structural	40.33	6.84	11.89	1.79	1.51	62.36
	Non_Structural	293.08	91.86	62.36	13.51	7.90	468.71
	Content	174.75	38.06	49.42	10.59	6.76	279.57
	Inventory	0.00	0.00	1.76	2.40	0.18	4.34
	Subtotal	508.16	136.75	125.43	28.29	16.36	814.99
	Total	516.66	143.14	154.93	29.03	17.16	860.92

Transportation and Utility Lifeline Losses

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

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

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

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	1,315.49	\$0.00	0.00
	Bridges	450.80	\$0.97	0.21
	Tunnels	9.31	\$0.45	4.80
	Subtotal	1775.60	1.40	
Railways	Segments	50.19	\$0.00	0.00
	Bridges	1.11	\$0.00	0.10
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	51.30	0.00	
Light Rail	Segments	0.00	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Bus	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Ferry	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Port	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Airport	Facilities	15.86	\$2.17	13.70
	Runways	180.89	\$0.00	0.00
	Subtotal	196.70	2.20	
	Total	2023.60	3.60	

Table 14: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.00	\$0.00	0.00
	Facilities	161.50	\$29.77	18.43
	Distribution Line	111.60	\$0.07	0.06
	Subtotal	273.08	\$29.84	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	839.80	\$98.61	11.74
	Distribution Line	66.90	\$0.05	0.08
	Subtotal	906.77	\$98.66	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	5.30	\$0.81	15.26
	Distribution Line	44.60	\$0.06	0.13
	Subtotal	49.92	\$0.87	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.10	\$0.03	27.32
	Subtotal	0.10	\$0.03	
Electrical Power	Facilities	106.70	\$30.58	28.66
	Subtotal	106.70	\$30.58	
Communication	Facilities	2.40	\$0.59	24.23
	Subtotal	2.43	\$0.59	
	Total	1,338.99	\$160.56	

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

	LOSS	Total	%
First Year			
	Employment Impact	1,182	0.76
	Income Impact	(2)	-0.02
Second Year			
	Employment Impact	460	0.29
	Income Impact	(17)	-0.18
Third Year			
	Employment Impact	10	0.01
	Income Impact	(24)	-0.26
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(25)	-0.27
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(25)	-0.27
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(25)	-0.27

Appendix A: County Listing for the Region

Jefferson,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Jefferson	527,056	28,329	4,126	32,456
Total State		527,056	28,329	4,126	32,456
Total Region		527,056	28,329	4,126	32,456

HAZUS-MH: Earthquake Event Report



Region Name: *Jefferson County*

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

Print Date: *June 28, 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 777.10 square miles and contains 133 census tracts. There are over 206 thousand households in the region and has a total population of 527,056 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 171 thousand buildings in the region with a total building replacement value (excluding contents) of 32,456 (millions of dollars). Approximately 99.00 % of the buildings (and 87.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,023 and 1,115 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 171 thousand buildings in the region which have an aggregate total replacement value of 32,456 (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 74% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

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

For essential facilities, there are 2 hospitals in the region with a total bed capacity of 545 beds. There are 214 schools, 19 fire stations, 13 police stations and 1 emergency operation facilities. With respect to HPL facilities, there are 75 dams identified within the region. Of these, 20 of the dams are classified as 'high hazard'. The inventory also includes 25 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 3,138.00 (millions of dollars). This inventory includes over 374 kilometers of highways, 364 bridges, 11,157 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	364	450.80
	Segments	56	1,315.50
	Tunnels	4	9.30
	Subtotal		1,775.60
Railways	Bridges	8	1.10
	Facilities	0	0.00
	Segments	17	50.20
	Tunnels	0	0.00
	Subtotal		51.30
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	0	0.00
	Subtotal		0.00
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	3	15.90
	Runways	6	180.90
	Subtotal		196.70
		Total	2,023.60

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	111.60
	Facilities	5	161.50
	Pipelines	0	0.00
	Subtotal		273.10
Waste Water	Distribution Lines	NA	66.90
	Facilities	13	839.80
	Pipelines	0	0.00
	Subtotal		906.80
Natural Gas	Distribution Lines	NA	44.60
	Facilities	5	5.30
	Pipelines	0	0.00
	Subtotal		49.90
Oil Systems	Facilities	1	0.10
	Pipelines	0	0.00
	Subtotal		0.10
Electrical Power	Facilities	1	106.70
	Subtotal		106.70
Communication	Facilities	25	2.40
	Subtotal		2.40
	Total		1,339.00

Earthquake Scenario

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

Scenario Name	Golden M6.5 Jefferson 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 54,824 buildings will be at least moderately damaged. This is over 32.00 % of the total number of buildings in the region. There are an estimated 3,483 buildings that will be damaged beyond repair. The definition of the ' damage states' is provided in Volume 1: Chapter 5 of the HAZUS technical manual. Table 4 below summaries the expected damage by general occupancy for the buildings in the region. Table 5 summaries the expected damage by general building type.

Table 4: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	1	0.00	1	0.00	2	0.01	2	0.01	2	0.05
Commercial	488	0.71	299	0.62	457	1.22	305	2.18	154	4.42
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	28	0.04	18	0.04	28	0.08	19	0.14	8	0.24
Industrial	27	0.04	18	0.04	34	0.09	28	0.20	18	0.51
Other Residential	1,784	2.59	1,530	3.19	1,633	4.37	794	5.67	278	7.99
Religion	18	0.03	11	0.02	15	0.04	9	0.07	5	0.13
Single Family	66,482	96.59	46,060	96.08	35,164	94.19	12,849	91.73	3,019	86.67
Total	68,827		47,937		37,333		14,007		3,483	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	53,393	77.58	41,326	86.21	25,975	69.57	5,993	42.79	859	24.65
Steel	186	0.27	99	0.21	186	0.50	134	0.96	81	2.33
Concrete	183	0.27	119	0.25	176	0.47	112	0.80	50	1.44
Precast	63	0.09	34	0.07	75	0.20	72	0.52	39	1.13
RM	13,508	19.63	4,915	10.25	8,805	23.58	6,285	44.87	1,600	45.94
URM	1,117	1.62	1,018	2.12	1,375	3.68	954	6.81	685	19.66
MH	376	0.55	425	0.89	741	1.99	457	3.26	169	4.84
Total	68,827		47,937		37,333		14,007		3,483	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 545 hospital beds available for use. On the day of the earthquake, the model estimates that only 247 hospital beds (45.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 78.00% of the beds will be back in service. By 30 days, 98.00% will be operational.

Table 6: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	2	0	0	1
Schools	214	28	0	65
EOCs	1	0	0	0
PoliceStations	13	0	0	5
FireStations	19	3	0	6

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 % After Day 1	After Day 7
Highway	Segments	56	0	0	56	56
	Bridges	364	23	5	345	347
	Tunnels	4	4	0	4	4
Railways	Segments	17	0	0	17	17
	Bridges	8	0	0	8	8
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	3	2	0	3	3
	Runways	6	0	0	6	6

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

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

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	5	5	0	0	4
Waste Water	13	12	0	1	8
Natural Gas	5	5	0	0	1
Oil Systems	1	1	0	0	0
Electrical Power	1	1	0	0	1
Communication	25	25	0	0	25

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	5,579	341	85
Waste Water	3,347	269	67
Natural Gas	2,232	288	72
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	206,067	927	0	0	0	0
Electric Power		153,809	104,528	50,184	11,646	196

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 70 ignitions that will burn about 0.49 sq. mi 0.06 % of the region's total area.) The model also estimates that the fires will displace about 1,556 people and burn about 89 (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 8,306 households to be displaced due to the earthquake. Of these, 1,839 people (out of a total population of 527,056 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	24	7	1	2
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	14	4	1	1
	Industrial	32	9	1	3
	Other-Residential	348	81	10	20
	Single Family	1,364	306	41	79
	Total	1,783	406	54	105
2 PM	Commercial	1,365	381	61	121
	Commuting	1	1	2	0
	Educational	193	52	8	16
	Hotels	3	1	0	0
	Industrial	236	67	11	21
	Other-Residential	59	14	2	3
	Single Family	211	48	7	12
	Total	2,067	563	91	174
5 PM	Commercial	1,072	296	48	92
	Commuting	23	29	51	10
	Educational	28	7	1	2
	Hotels	4	1	0	0
	Industrial	148	42	7	13
	Other-Residential	134	31	4	7
	Single Family	534	120	16	30
	Total	1,942	527	127	155

Economic Loss

The total economic loss estimated for the earthquake is 5,881.32 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

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

The total building-related losses were 5,413.26 (millions of dollars); 9 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 75 % 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	7.29	130.01	3.85	4.97	146.12
	Capital-Related	0.00	3.11	118.79	2.33	0.97	125.20
	Rental	90.06	60.20	61.94	1.31	2.53	216.05
	Relocation	9.46	1.30	3.16	0.12	0.58	14.62
	Subtotal	99.52	71.90	313.90	7.62	9.04	501.98
Capital Stock Losses							
	Structural	472.52	71.29	132.96	19.27	17.01	713.05
	Non_Structural	1,928.72	488.84	409.47	76.39	49.08	2,952.50
	Content	757.63	150.72	233.24	52.59	30.28	1,224.45
	Inventory	0.00	0.00	8.53	11.96	0.79	21.28
	Subtotal	3,158.87	710.84	784.20	160.21	97.15	4,911.28
	Total	3,258.40	782.74	1,098.11	167.82	106.19	5,413.26

Transportation and Utility Lifeline Losses

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

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

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

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	1,315.49	\$0.00	0.00
	Bridges	450.80	\$25.07	5.56
	Tunnels	9.31	\$1.61	17.27
	Subtotal	1775.60	26.70	
Railways	Segments	50.19	\$0.00	0.00
	Bridges	1.11	\$0.05	4.74
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	51.30	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	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Ferry	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Port	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Airport	Facilities	15.86	\$5.74	36.17
	Runways	180.89	\$0.00	0.00
	Subtotal	196.70	5.70	
	Total	2023.60	32.50	

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	161.50	\$72.90	45.14
	Distribution Line	111.60	\$1.53	1.37
	Subtotal	273.08	\$74.43	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	839.80	\$293.07	34.90
	Distribution Line	66.90	\$1.21	1.81
	Subtotal	906.77	\$294.28	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	5.30	\$2.57	48.54
	Distribution Line	44.60	\$1.30	2.90
	Subtotal	49.92	\$3.86	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.10	\$0.05	56.39
	Subtotal	0.10	\$0.05	
Electrical Power	Facilities	106.70	\$61.64	57.77
	Subtotal	106.70	\$61.64	
Communication	Facilities	2.40	\$1.33	54.95
	Subtotal	2.43	\$1.33	
	Total	1,338.99	\$435.59	

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

Jefferson,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Jefferson	527,056	28,329	4,126	32,456
Total State		527,056	28,329	4,126	32,456
Total Region		527,056	28,329	4,126	32,456

HAZUS-MH: Earthquake Event Report



Region Name: *Jefferson County*

Earthquake Scenario: *Mosquito M7.0 CEUS Event*

Print Date: *January 26, 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 777.10 square miles and contains 133 census tracts. There are over 206 thousand households in the region and has a total population of 527,056 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 171 thousand buildings in the region with a total building replacement value (excluding contents) of 32,456 (millions of dollars). Approximately 99.00 % of the buildings (and 87.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,023 and 1,115 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 171 thousand buildings in the region which have an aggregate total replacement value of 32,456 (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 74% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

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

For essential facilities, there are 2 hospitals in the region with a total bed capacity of 545 beds. There are 214 schools, 19 fire stations, 13 police stations and 1 emergency operation facilities. With respect to HPL facilities, there are 75 dams identified within the region. Of these, 20 of the dams are classified as 'high hazard'. The inventory also includes 25 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 3,138.00 (millions of dollars). This inventory includes over 374 kilometers of highways, 364 bridges, 11,157 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	364	450.80
	Segments	56	1,315.50
	Tunnels	4	9.30
	Subtotal		1,775.60
Railways	Bridges	8	1.10
	Facilities	0	0.00
	Segments	17	50.20
	Tunnels	0	0.00
	Subtotal		51.30
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	0	0.00
	Subtotal		0.00
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	3	15.90
	Runways	6	180.90
	Subtotal		196.70
		Total	2,023.60

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	111.60
	Facilities	5	161.50
	Pipelines	0	0.00
	Subtotal		273.10
Waste Water	Distribution Lines	NA	66.90
	Facilities	13	839.80
	Pipelines	0	0.00
	Subtotal		906.80
Natural Gas	Distribution Lines	NA	44.60
	Facilities	5	5.30
	Pipelines	0	0.00
	Subtotal		49.90
Oil Systems	Facilities	1	0.10
	Pipelines	0	0.00
	Subtotal		0.10
Electrical Power	Facilities	1	106.70
	Subtotal		106.70
Communication	Facilities	25	2.40
	Subtotal		2.40
	Total		1,339.00

Earthquake Scenario

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

Scenario Name	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 5,569 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 53 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the HAZUS technical manual. Table 4 below summaries the expected damage by general occupancy for the buildings in the region. Table 5 summaries the expected damage by general building type.

Table 4: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	5	0.00	2	0.01	1	0.03	1	0.06	0	0.13
Commercial	1,333	0.87	189	1.42	138	2.96	39	4.49	4	7.94
Education	1	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	82	0.05	11	0.08	7	0.15	1	0.16	0	0.18
Industrial	91	0.06	16	0.12	14	0.29	4	0.46	0	0.74
Other Residential	4,835	3.17	695	5.22	409	8.82	74	8.54	6	11.23
Religion	47	0.03	6	0.04	4	0.08	1	0.12	0	0.19
Single Family	146,313	95.81	12,395	93.10	4,071	87.67	752	86.18	42	79.60
Total	152,707		13,313		4,643		872		53	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	116,327	76.18	9462	71.07	1,640	35.32	114	13.07	3	5.87
Steel	536	0.35	70	0.52	62	1.32	16	1.87	2	4.06
Concrete	508	0.33	74	0.55	48	1.02	11	1.29	1	1.59
Precast	204	0.13	31	0.24	35	0.74	14	1.64	1	2.15
RM	30,016	19.66	2503	18.80	2,056	44.28	525	60.17	14	25.89
URM	3,655	2.39	808	6.07	514	11.08	143	16.43	28	53.13
MH	1,461	0.96	366	2.75	289	6.23	48	5.53	4	7.31
Total	152,707		13,313		4,643		872		53	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 545 hospital beds available for use. On the day of the earthquake, the model estimates that only 492 hospital beds (90.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 99.00% of the beds will be back in service. By 30 days, 100.00% will be operational.

Table 6: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	2	0	0	2
Schools	214	0	0	214
EOCs	1	0	0	1
PoliceStations	13	0	0	13
FireStations	19	0	0	19

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	56	0	0	56	56
	Bridges	364	0	0	364	364
	Tunnels	4	0	0	4	4
Railways	Segments	17	0	0	17	17
	Bridges	8	0	0	8	8
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	3	0	0	3	3
	Runways	6	0	0	6	6

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

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

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	5	0	0	5	5
Waste Water	13	0	0	12	13
Natural Gas	5	0	0	5	5
Oil Systems	1	0	0	1	1
Electrical Power	1	0	0	1	1
Communication	25	0	0	25	25

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	5,579	23	6
Waste Water	3,347	18	4
Natural Gas	2,232	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	206,067	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 12 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 67 people and burn about 4 (millions of dollars) of building value.

Debris Generation

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

The model estimates that a total of 0.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 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 390 households to be displaced due to the earthquake. Of these, 92 people (out of a total population of 527,056) 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	1	0	0	0
	Industrial	2	0	0	0
	Other-Residential	23	3	0	0
	Single Family	76	10	1	2
	Total	104	14	1	2
2 PM	Commercial	83	14	1	3
	Commuting	0	0	0	0
	Educational	11	2	0	0
	Hotels	0	0	0	0
	Industrial	14	2	0	0
	Other-Residential	4	1	0	0
	Single Family	12	2	0	0
	Total	124	20	2	4
5 PM	Commercial	65	11	1	2
	Commuting	0	1	1	0
	Educational	1	0	0	0
	Hotels	0	0	0	0
	Industrial	9	1	0	0
	Other-Residential	9	1	0	0
	Single Family	29	4	0	1
	Total	114	18	3	4

Economic Loss

The total economic loss estimated for the earthquake is 401.79 (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 372.91 (millions of dollars); 15 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 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	0.54	16.08	0.49	0.51	17.62
	Capital-Related	0.00	0.23	14.44	0.29	0.11	15.07
	Rental	6.79	5.12	8.45	0.15	0.19	20.71
	Relocation	0.69	0.12	0.43	0.02	0.06	1.33
	Subtotal	7.49	6.01	39.40	0.96	0.87	54.72
Capital Stock Losses							
	Structural	36.56	6.75	15.48	2.28	1.82	62.88
	Non_Structural	114.31	32.69	31.96	5.62	3.40	187.98
	Content	36.49	8.20	15.76	3.55	1.82	65.82
	Inventory	0.00	0.00	0.60	0.83	0.07	1.50
	Subtotal	187.37	47.64	63.80	12.27	7.11	318.19
	Total	194.85	53.65	103.20	13.23	7.98	372.91

Transportation and Utility Lifeline Losses

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

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

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

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	1,315.49	\$0.00	0.00
	Bridges	450.80	\$1.03	0.23
	Tunnels	9.31	\$0.00	0.03
	Subtotal	1775.60	1.00	
Railways	Segments	50.19	\$0.00	0.00
	Bridges	1.11	\$0.00	0.04
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	51.30	0.00	
Light Rail	Segments	0.00	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Bus	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Ferry	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Port	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Airport	Facilities	15.86	\$1.15	7.28
	Runways	180.89	\$0.00	0.00
	Subtotal	196.70	1.20	
	Total	2023.60	2.20	

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	161.50	\$5.54	3.43
	Distribution Line	111.60	\$0.10	0.09
	Subtotal	273.08	\$5.64	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	839.80	\$19.27	2.30
	Distribution Line	66.90	\$0.08	0.12
	Subtotal	906.77	\$19.35	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	5.30	\$0.06	1.22
	Distribution Line	44.60	\$0.09	0.19
	Subtotal	49.92	\$0.15	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.10	\$0.00	1.55
	Subtotal	0.10	\$0.00	
Electrical Power	Facilities	106.70	\$1.49	1.40
	Subtotal	106.70	\$1.49	
Communication	Facilities	2.40	\$0.04	1.67
	Subtotal	2.43	\$0.04	
	Total	1,338.99	\$26.69	

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

	LOSS	Total	%
First Year			
	Employment Impact	398	0.26
	Income Impact	(1)	-0.01
Second Year			
	Employment Impact	169	0.11
	Income Impact	(8)	-0.09
Third Year			
	Employment Impact	0	0.00
	Income Impact	(11)	-0.12
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(12)	-0.13
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(12)	-0.13
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(12)	-0.13

Appendix A: County Listing for the Region

Jefferson,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Jefferson	527,056	28,329	4,126	32,456
Total State		527,056	28,329	4,126	32,456
Total Region		527,056	28,329	4,126	32,456

HAZUS-MH: Earthquake Event Report



Region Name: *Jefferson County*

Earthquake Scenario: *N Sangre M7.5 CEUS Event*

Print Date: *January 26, 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 777.10 square miles and contains 133 census tracts. There are over 206 thousand households in the region and has a total population of 527,056 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 171 thousand buildings in the region with a total building replacement value (excluding contents) of 32,456 (millions of dollars). Approximately 99.00 % of the buildings (and 87.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,023 and 1,115 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 171 thousand buildings in the region which have an aggregate total replacement value of 32,456 (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 74% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

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

For essential facilities, there are 2 hospitals in the region with a total bed capacity of 545 beds. There are 214 schools, 19 fire stations, 13 police stations and 1 emergency operation facilities. With respect to HPL facilities, there are 75 dams identified within the region. Of these, 20 of the dams are classified as 'high hazard'. The inventory also includes 25 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 3,138.00 (millions of dollars). This inventory includes over 374 kilometers of highways, 364 bridges, 11,157 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	364	450.80
	Segments	56	1,315.50
	Tunnels	4	9.30
	Subtotal		1,775.60
Railways	Bridges	8	1.10
	Facilities	0	0.00
	Segments	17	50.20
	Tunnels	0	0.00
	Subtotal		51.30
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	0	0.00
	Subtotal		0.00
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	3	15.90
	Runways	6	180.90
	Subtotal		196.70
		Total	2,023.60

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	111.60
	Facilities	5	161.50
	Pipelines	0	0.00
	Subtotal		273.10
Waste Water	Distribution Lines	NA	66.90
	Facilities	13	839.80
	Pipelines	0	0.00
	Subtotal		906.80
Natural Gas	Distribution Lines	NA	44.60
	Facilities	5	5.30
	Pipelines	0	0.00
	Subtotal		49.90
Oil Systems	Facilities	1	0.10
	Pipelines	0	0.00
	Subtotal		0.10
Electrical Power	Facilities	1	106.70
	Subtotal		106.70
Communication	Facilities	25	2.40
	Subtotal		2.40
	Total		1,339.00

Earthquake Scenario

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

Scenario Name	N Sangre M7.5 CEUS Event
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-105.63
Latitude of Epicenter	37.90
Earthquake Magnitude	7.50
Depth (Km)	10.00
Rupture Length (Km)	100.00
Rupture Orientation (degrees)	161.00
Attenuation Function	CEUS Event

Building Damage

Building Damage

HAZUS estimates that about 4,016 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 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	5	0.00	1	0.01	1	0.04	1	0.10	0	0.28
Commercial	1,358	0.86	163	1.69	131	3.95	44	6.71	7	14.50
Education	1	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	84	0.05	9	0.10	6	0.19	1	0.22	0	0.30
Industrial	93	0.06	14	0.14	13	0.39	4	0.66	1	1.44
Other Residential	4,943	3.13	577	5.97	382	11.53	102	15.61	16	32.15
Religion	48	0.03	5	0.05	4	0.11	1	0.18	0	0.38
Single Family	151,374	95.86	8,897	92.04	2,777	83.79	500	76.52	25	50.94
Total	157,906		9,667		3,314		653		49	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	119,976	75.98	6518	67.43	988	29.80	64	9.78	1	1.58
Steel	513	0.33	67	0.70	71	2.16	27	4.21	6	12.89
Concrete	514	0.33	64	0.66	46	1.38	15	2.25	2	4.19
Precast	214	0.14	26	0.27	29	0.88	14	2.11	2	3.46
RM	31,257	19.79	1981	20.50	1,502	45.31	363	55.57	10	20.90
URM	3,966	2.51	679	7.03	392	11.83	96	14.72	16	32.63
MH	1,465	0.93	331	3.42	286	8.64	74	11.35	12	24.34
Total	157,906		9,667		3,314		653		49	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 545 hospital beds available for use. On the day of the earthquake, the model estimates that only 510 hospital beds (94.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 99.00% of the beds will be back in service. By 30 days, 100.00% will be operational.

Table 6: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	2	0	0	2
Schools	214	0	0	214
EOCs	1	0	0	1
PoliceStations	13	0	0	13
FireStations	19	0	0	19

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 % After Day 1	After Day 7
Highway	Segments	56	0	0	56	56
	Bridges	364	0	0	364	364
	Tunnels	4	0	0	4	4
Railways	Segments	17	0	0	17	17
	Bridges	8	0	0	8	8
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	3	0	0	3	3
	Runways	6	0	0	6	6

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

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

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	5	0	0	5	5
Waste Water	13	0	0	13	13
Natural Gas	5	0	0	5	5
Oil Systems	1	0	0	1	1
Electrical Power	1	0	0	1	1
Communication	25	0	0	25	25

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	5,579	22	5
Waste Water	3,347	17	4
Natural Gas	2,232	18	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	206,067	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 5 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 64 people and burn about 4 (millions of dollars) of building value.

Debris Generation

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

The model estimates that a total of 0.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 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 433 households to be displaced due to the earthquake. Of these, 103 people (out of a total population of 527,056) will seek temporary shelter in public shelters.

Casualties

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

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

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

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

Table 11: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	2	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	1	0	0	0
	Industrial	2	0	0	0
	Other-Residential	24	4	0	1
	Single Family	51	6	0	1
	Total	80	11	1	2
2 PM	Commercial	85	16	2	4
	Commuting	0	0	0	0
	Educational	11	2	0	0
	Hotels	0	0	0	0
	Industrial	16	3	0	1
	Other-Residential	4	1	0	0
	Single Family	8	1	0	0
	Total	125	23	3	5
5 PM	Commercial	65	12	1	3
	Commuting	0	1	1	0
	Educational	2	0	0	0
	Hotels	0	0	0	0
	Industrial	10	2	0	0
	Other-Residential	9	1	0	0
	Single Family	20	2	0	0
	Total	106	19	3	4

Economic Loss

The total economic loss estimated for the earthquake is 285.25 (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 274.58 (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 57 % of the total loss. Table 12 below provides a summary of the losses associated with the building damage.

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

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	0.50	17.48	0.56	0.50	19.04
	Capital-Related	0.00	0.21	15.79	0.33	0.12	16.45
	Rental	4.58	5.02	8.60	0.17	0.20	18.58
	Relocation	0.47	0.12	0.44	0.02	0.06	1.11
	Subtotal	5.05	5.85	42.31	1.08	0.88	55.17
Capital Stock Losses							
	Structural	24.84	6.72	16.25	2.49	2.03	52.32
	Non_Structural	66.75	24.83	29.20	4.88	3.00	128.67
	Content	17.09	4.73	11.37	2.78	1.26	37.24
	Inventory	0.00	0.00	0.44	0.68	0.06	1.18
	Subtotal	108.68	36.28	57.26	10.84	6.35	219.40
	Total	113.73	42.13	99.57	11.92	7.22	274.58

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	1,315.49	\$0.00	0.00
	Bridges	450.80	\$0.96	0.21
	Tunnels	9.31	\$0.00	0.00
	Subtotal	1775.60	1.00	
Railways	Segments	50.19	\$0.00	0.00
	Bridges	1.11	\$0.00	0.04
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	51.30	0.00	
Light Rail	Segments	0.00	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Bus	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Ferry	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Port	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Airport	Facilities	15.86	\$0.57	3.62
	Runways	180.89	\$0.00	0.00
	Subtotal	196.70	0.60	
	Total	2023.60	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	161.50	\$1.86	1.15
	Distribution Line	111.60	\$0.10	0.09
	Subtotal	273.08	\$1.96	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	839.80	\$6.67	0.79
	Distribution Line	66.90	\$0.08	0.11
	Subtotal	906.77	\$6.74	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	5.30	\$0.02	0.30
	Distribution Line	44.60	\$0.08	0.18
	Subtotal	49.92	\$0.10	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.10	\$0.00	0.31
	Subtotal	0.10	\$0.00	
Electrical Power	Facilities	106.70	\$0.33	0.31
	Subtotal	106.70	\$0.33	
Communication	Facilities	2.40	\$0.01	0.41
	Subtotal	2.43	\$0.01	
	Total	1,338.99	\$9.14	

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

	LOSS	Total	%
First Year			
	Employment Impact	269	0.17
	Income Impact	(1)	-0.01
Second Year			
	Employment Impact	109	0.07
	Income Impact	(6)	-0.06
Third Year			
	Employment Impact	0	0.00
	Income Impact	(8)	-0.09
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(9)	-0.09
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(9)	-0.09
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(9)	-0.09

Appendix A: County Listing for the Region

Jefferson,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Jefferson	527,056	28,329	4,126	32,456
Total State		527,056	28,329	4,126	32,456
Total Region		527,056	28,329	4,126	32,456

HAZUS-MH: Earthquake Event Report



Region Name: *Jefferson County*

Earthquake Scenario: *N Sangre M7.5 WUS-Extensional*

Print Date: *January 26, 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 777.10 square miles and contains 133 census tracts. There are over 206 thousand households in the region and has a total population of 527,056 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 171 thousand buildings in the region with a total building replacement value (excluding contents) of 32,456 (millions of dollars). Approximately 99.00 % of the buildings (and 87.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,023 and 1,115 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 171 thousand buildings in the region which have an aggregate total replacement value of 32,456 (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 74% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

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

For essential facilities, there are 2 hospitals in the region with a total bed capacity of 545 beds. There are 214 schools, 19 fire stations, 13 police stations and 1 emergency operation facilities. With respect to HPL facilities, there are 75 dams identified within the region. Of these, 20 of the dams are classified as 'high hazard'. The inventory also includes 25 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 3,138.00 (millions of dollars). This inventory includes over 374 kilometers of highways, 364 bridges, 11,157 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	364	450.80
	Segments	56	1,315.50
	Tunnels	4	9.30
	Subtotal		1,775.60
Railways	Bridges	8	1.10
	Facilities	0	0.00
	Segments	17	50.20
	Tunnels	0	0.00
	Subtotal		51.30
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	0	0.00
	Subtotal		0.00
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	3	15.90
	Runways	6	180.90
	Subtotal		196.70
		Total	2,023.60

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	111.60
	Facilities	5	161.50
	Pipelines	0	0.00
	Subtotal		273.10
Waste Water	Distribution Lines	NA	66.90
	Facilities	13	839.80
	Pipelines	0	0.00
	Subtotal		906.80
Natural Gas	Distribution Lines	NA	44.60
	Facilities	5	5.30
	Pipelines	0	0.00
	Subtotal		49.90
Oil Systems	Facilities	1	0.10
	Pipelines	0	0.00
	Subtotal		0.10
Electrical Power	Facilities	1	106.70
	Subtotal		106.70
Communication	Facilities	25	2.40
	Subtotal		2.40
	Total		1,339.00

Earthquake Scenario

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

Scenario Name	N Sangre M7.5 WUS-Extensional
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-105.63
Latitude of Epicenter	37.90
Earthquake Magnitude	7.50
Depth (Km)	10.00
Rupture Length (Km)	100.00
Rupture Orientation (degrees)	161.00
Attenuation Function	WUS Shallow Crustal Event - Extensional

Building Damage

Building Damage

HAZUS estimates that about 327 buildings will be at least moderately damaged. This is over 0.00 % of the total number of buildings in the region. There are an estimated 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	8	0.00	0	0.03	0	0.04	0	0.06	0	0.05
Commercial	1,663	0.98	29	2.49	10	3.48	1	4.62	0	5.36
Education	1	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	99	0.06	1	0.11	0	0.11	0	0.11	0	0.08
Industrial	122	0.07	2	0.21	1	0.32	0	0.43	0	0.22
Other Residential	5,880	3.46	106	9.21	33	11.17	1	5.15	0	4.27
Religion	57	0.03	1	0.07	0	0.08	0	0.09	0	0.11
Single Family	162,286	95.40	1,008	87.89	253	84.80	25	89.54	1	89.91
Total	170,114		1,147		299		27		1	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	127,005	74.66	497	43.31	43	14.54	1	2.26	0	0.00
Steel	672	0.39	10	0.90	4	1.25	0	1.28	0	1.54
Concrete	629	0.37	10	0.84	2	0.73	0	0.52	0	0.07
Precast	275	0.16	6	0.53	3	1.13	1	1.98	0	0.26
RM	34,580	20.33	366	31.94	151	50.60	16	56.85	0	0.00
URM	4,888	2.87	183	15.91	68	22.86	9	34.41	1	96.02
MH	2,066	1.21	75	6.57	27	8.89	1	2.70	0	2.12
Total	170,114		1,147		299		27		1	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 545 hospital beds available for use. On the day of the earthquake, the model estimates that only 541 hospital beds (99.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 100.00% of the beds will be back in service. By 30 days, 100.00% will be operational.

Table 6: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	2	0	0	2
Schools	214	0	0	214
EOCs	1	0	0	1
PoliceStations	13	0	0	13
FireStations	19	0	0	19

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 % After Day 1	After Day 7
Highway	Segments	56	0	0	56	56
	Bridges	364	0	0	364	364
	Tunnels	4	0	0	4	4
Railways	Segments	17	0	0	17	17
	Bridges	8	0	0	8	8
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	3	0	0	3	3
	Runways	6	0	0	6	6

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

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

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	5	0	0	5	5
Waste Water	13	0	0	13	13
Natural Gas	5	0	0	5	5
Oil Systems	1	0	0	1	1
Electrical Power	1	0	0	1	1
Communication	25	0	0	25	25

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	5,579	6	2
Waste Water	3,347	5	1
Natural Gas	2,232	5	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	206,067	0	0	0	0	0
Electric Power		0	0	0	0	0

Induced Earthquake Damage

Fire Following Earthquake

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. HAZUS uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 0 ignitions that will burn about 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

Debris Generation

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

The model estimates that a total of 0.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 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, 2 people (out of a total population of 527,056 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	4	0	0	0
	Total	5	1	0	0
2 PM	Commercial	4	0	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	1	0	0	0
	Total	6	1	0	0
5 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	2	0	0	0
	Total	6	1	0	0

Economic Loss

The total economic loss estimated for the earthquake is 15.55 (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 14.74 (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 63 % of the total loss. Table 12 below provides a summary of the losses associated with the building damage.

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

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	0.02	0.85	0.02	0.03	0.92
	Capital-Related	0.00	0.01	0.78	0.01	0.01	0.81
	Rental	0.33	0.13	0.37	0.00	0.00	0.84
	Relocation	0.04	0.01	0.02	0.00	0.00	0.07
	Subtotal	0.37	0.17	2.03	0.04	0.04	2.65
Capital Stock Losses							
	Structural	2.01	0.36	0.87	0.12	0.09	3.46
	Non_Structural	4.19	1.26	1.26	0.19	0.13	7.01
	Content	0.74	0.22	0.46	0.10	0.05	1.57
	Inventory	0.00	0.00	0.02	0.03	0.00	0.05
	Subtotal	6.94	1.83	2.61	0.44	0.27	12.09
	Total	7.31	2.00	4.64	0.49	0.31	14.74

Transportation and Utility Lifeline Losses

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

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

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

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	1,315.49	\$0.00	0.00
	Bridges	450.80	\$0.13	0.03
	Tunnels	9.31	\$0.00	0.00
	Subtotal	1775.60	0.10	
Railways	Segments	50.19	\$0.00	0.00
	Bridges	1.11	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	51.30	0.00	
Light Rail	Segments	0.00	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Bus	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Ferry	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Port	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Airport	Facilities	15.86	\$0.08	0.53
	Runways	180.89	\$0.00	0.00
	Subtotal	196.70	0.10	
	Total	2023.60	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	161.50	\$0.16	0.10
	Distribution Line	111.60	\$0.03	0.02
	Subtotal	273.08	\$0.19	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	839.80	\$0.36	0.04
	Distribution Line	66.90	\$0.02	0.03
	Subtotal	906.77	\$0.38	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	5.30	\$0.00	0.01
	Distribution Line	44.60	\$0.02	0.05
	Subtotal	49.92	\$0.02	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.10	\$0.00	0.00
	Subtotal	0.10	\$0.00	
Electrical Power	Facilities	106.70	\$0.01	0.01
	Subtotal	106.70	\$0.01	
Communication	Facilities	2.40	\$0.00	0.01
	Subtotal	2.43	\$0.00	
	Total	1,338.99	\$0.60	

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

Appendix A: County Listing for the Region

Jefferson,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Jefferson	527,056	28,329	4,126	32,456
Total State		527,056	28,329	4,126	32,456
Total Region		527,056	28,329	4,126	32,456

HAZUS-MH: Earthquake Event Report



Region Name: *Jefferson County*

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

Print Date: *January 26, 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 777.10 square miles and contains 133 census tracts. There are over 206 thousand households in the region and has a total population of 527,056 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 171 thousand buildings in the region with a total building replacement value (excluding contents) of 32,456 (millions of dollars). Approximately 99.00 % of the buildings (and 87.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,023 and 1,115 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 171 thousand buildings in the region which have an aggregate total replacement value of 32,456 (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 74% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

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

For essential facilities, there are 2 hospitals in the region with a total bed capacity of 545 beds. There are 214 schools, 19 fire stations, 13 police stations and 1 emergency operation facilities. With respect to HPL facilities, there are 75 dams identified within the region. Of these, 20 of the dams are classified as 'high hazard'. The inventory also includes 25 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 3,138.00 (millions of dollars). This inventory includes over 374 kilometers of highways, 364 bridges, 11,157 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	364	450.80
	Segments	56	1,315.50
	Tunnels	4	9.30
	Subtotal		1,775.60
Railways	Bridges	8	1.10
	Facilities	0	0.00
	Segments	17	50.20
	Tunnels	0	0.00
	Subtotal		51.30
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	0	0.00
	Subtotal		0.00
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	3	15.90
	Runways	6	180.90
	Subtotal		196.70
		Total	2,023.60

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	111.60
	Facilities	5	161.50
	Pipelines	0	0.00
	Subtotal		273.10
Waste Water	Distribution Lines	NA	66.90
	Facilities	13	839.80
	Pipelines	0	0.00
	Subtotal		906.80
Natural Gas	Distribution Lines	NA	44.60
	Facilities	5	5.30
	Pipelines	0	0.00
	Subtotal		49.90
Oil Systems	Facilities	1	0.10
	Pipelines	0	0.00
	Subtotal		0.10
Electrical Power	Facilities	1	106.70
	Subtotal		106.70
Communication	Facilities	25	2.40
	Subtotal		2.40
	Total		1,339.00

Earthquake Scenario

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

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

Building Damage

Building Damage

HAZUS estimates that about 3,197 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 18 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	6	0.00	1	0.01	1	0.03	0	0.06	0	0.11
Commercial	1,454	0.91	141	1.61	87	3.15	19	4.53	1	7.76
Education	1	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	89	0.06	8	0.09	4	0.15	1	0.15	0	0.21
Industrial	103	0.06	12	0.14	8	0.30	2	0.45	0	0.64
Other Residential	5,184	3.25	520	5.91	276	10.01	37	8.82	2	11.44
Religion	51	0.03	4	0.05	2	0.09	0	0.11	0	0.18
Single Family	152,702	95.68	8,116	92.19	2,381	86.26	359	85.88	15	79.66
Total	159,589		8,803		2,761		418		19	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	120,731	75.65	5905	67.09	855	30.99	53	12.78	1	3.47
Steel	580	0.36	55	0.62	41	1.50	9	2.14	1	4.82
Concrete	551	0.35	55	0.63	29	1.05	5	1.23	0	1.34
Precast	231	0.14	24	0.28	23	0.82	7	1.70	0	1.43
RM	31,818	19.94	1816	20.62	1,244	45.07	234	55.98	2	9.89
URM	4,038	2.53	648	7.36	364	13.18	86	20.49	13	71.44
MH	1,640	1.03	299	3.40	204	7.40	24	5.68	1	7.60
Total	159,589		8,803		2,761		418		19	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 545 hospital beds available for use. On the day of the earthquake, the model estimates that only 530 hospital beds (97.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 100.00% of the beds will be back in service. By 30 days, 100.00% will be operational.

Table 6: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	2	0	0	2
Schools	214	0	0	214
EOCs	1	0	0	1
PoliceStations	13	0	0	13
FireStations	19	0	0	19

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	56	0	0	56	56
	Bridges	364	0	0	364	364
	Tunnels	4	0	0	4	4
Railways	Segments	17	0	0	17	17
	Bridges	8	0	0	8	8
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	3	0	0	3	3
	Runways	6	0	0	6	6

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

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

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	5	0	0	5	5
Waste Water	13	0	0	13	13
Natural Gas	5	0	0	5	5
Oil Systems	1	0	0	1	1
Electrical Power	1	0	0	1	1
Communication	25	0	0	25	25

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	5,579	14	4
Waste Water	3,347	11	3
Natural Gas	2,232	12	3
Oil	0	0	0

Table 10: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	206,067	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 5 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 64 people and burn about 4 (millions of dollars) of building value.

Debris Generation

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

The model estimates that a total of 0.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 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 185 households to be displaced due to the earthquake. Of these, 43 people (out of a total population of 527,056) 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	0	0	0	0
	Industrial	1	0	0	0
	Other-Residential	12	1	0	0
	Single Family	41	5	0	1
	Total	56	6	0	1
2 PM	Commercial	43	6	1	1
	Commuting	0	0	0	0
	Educational	6	1	0	0
	Hotels	0	0	0	0
	Industrial	7	1	0	0
	Other-Residential	2	0	0	0
	Single Family	6	1	0	0
	Total	64	9	1	1
5 PM	Commercial	34	5	0	1
	Commuting	0	0	0	0
	Educational	1	0	0	0
	Hotels	0	0	0	0
	Industrial	4	1	0	0
	Other-Residential	5	1	0	0
	Single Family	16	2	0	0
	Total	60	8	1	1

Economic Loss

The total economic loss estimated for the earthquake is 205.49 (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 193.38 (millions of dollars); 16 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 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	0.28	8.92	0.27	0.30	9.76
	Capital-Related	0.00	0.12	8.13	0.16	0.06	8.46
	Rental	3.71	2.74	4.65	0.08	0.09	11.27
	Relocation	0.38	0.07	0.24	0.01	0.03	0.73
	Subtotal	4.08	3.21	21.94	0.51	0.48	30.22
Capital Stock Losses							
	Structural	20.41	3.84	8.48	1.24	0.99	34.95
	Non_Structural	59.45	16.85	16.09	2.77	1.75	96.92
	Content	16.68	3.81	7.50	1.69	0.87	30.57
	Inventory	0.00	0.00	0.29	0.40	0.03	0.72
	Subtotal	96.55	24.51	32.36	6.10	3.65	163.16
	Total	100.63	27.71	54.30	6.61	4.13	193.38

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	1,315.49	\$0.00	0.00
	Bridges	450.80	\$0.49	0.11
	Tunnels	9.31	\$0.00	0.00
	Subtotal	1775.60	0.50	
Railways	Segments	50.19	\$0.00	0.00
	Bridges	1.11	\$0.00	0.02
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	51.30	0.00	
Light Rail	Segments	0.00	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Bus	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Ferry	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Port	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Airport	Facilities	15.86	\$0.66	4.16
	Runways	180.89	\$0.00	0.00
	Subtotal	196.70	0.70	
	Total	2023.60	1.10	

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	161.50	\$2.53	1.57
	Distribution Line	111.60	\$0.06	0.06
	Subtotal	273.08	\$2.59	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	839.80	\$7.71	0.92
	Distribution Line	66.90	\$0.05	0.08
	Subtotal	906.77	\$7.76	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	5.30	\$0.02	0.40
	Distribution Line	44.60	\$0.05	0.12
	Subtotal	49.92	\$0.08	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.10	\$0.00	0.52
	Subtotal	0.10	\$0.00	
Electrical Power	Facilities	106.70	\$0.53	0.49
	Subtotal	106.70	\$0.53	
Communication	Facilities	2.40	\$0.01	0.61
	Subtotal	2.43	\$0.01	
	Total	1,338.99	\$10.96	

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

	LOSS	Total	%
First Year			
	Employment Impact	208	0.13
	Income Impact	(1)	-0.01
Second Year			
	Employment Impact	82	0.05
	Income Impact	(4)	-0.05
Third Year			
	Employment Impact	0	0.00
	Income Impact	(6)	-0.07
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(6)	-0.07
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(6)	-0.07
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(6)	-0.07

Appendix A: County Listing for the Region

Jefferson,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Jefferson	527,056	28,329	4,126	32,456
Total State		527,056	28,329	4,126	32,456
Total Region		527,056	28,329	4,126	32,456

HAZUS-MH: Earthquake Event Report



Region Name: *Jefferson County*

Earthquake Scenario: *Rampart M7.0 CEUS Event*

Print Date: *January 26, 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 777.10 square miles and contains 133 census tracts. There are over 206 thousand households in the region and has a total population of 527,056 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 171 thousand buildings in the region with a total building replacement value (excluding contents) of 32,456 (millions of dollars). Approximately 99.00 % of the buildings (and 87.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,023 and 1,115 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 171 thousand buildings in the region which have an aggregate total replacement value of 32,456 (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 74% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

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

For essential facilities, there are 2 hospitals in the region with a total bed capacity of 545 beds. There are 214 schools, 19 fire stations, 13 police stations and 1 emergency operation facilities. With respect to HPL facilities, there are 75 dams identified within the region. Of these, 20 of the dams are classified as 'high hazard'. The inventory also includes 25 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 3,138.00 (millions of dollars). This inventory includes over 374 kilometers of highways, 364 bridges, 11,157 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	364	450.80
	Segments	56	1,315.50
	Tunnels	4	9.30
	Subtotal		1,775.60
Railways	Bridges	8	1.10
	Facilities	0	0.00
	Segments	17	50.20
	Tunnels	0	0.00
	Subtotal		51.30
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	0	0.00
	Subtotal		0.00
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	3	15.90
	Runways	6	180.90
	Subtotal		196.70
		Total	2,023.60

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	111.60
	Facilities	5	161.50
	Pipelines	0	0.00
	Subtotal		273.10
Waste Water	Distribution Lines	NA	66.90
	Facilities	13	839.80
	Pipelines	0	0.00
	Subtotal		906.80
Natural Gas	Distribution Lines	NA	44.60
	Facilities	5	5.30
	Pipelines	0	0.00
	Subtotal		49.90
Oil Systems	Facilities	1	0.10
	Pipelines	0	0.00
	Subtotal		0.10
Electrical Power	Facilities	1	106.70
	Subtotal		106.70
Communication	Facilities	25	2.40
	Subtotal		2.40
	Total		1,339.00

Earthquake Scenario

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

Scenario Name	Rampart M7.0 CEUS Event
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-104.92
Latitude of Epicenter	39.06
Earthquake Magnitude	7.00
Depth (Km)	10.00
Rupture Length (Km)	42.66
Rupture Orientation (degrees)	171.00
Attenuation Function	CEUS Event

Building Damage

Building Damage

HAZUS estimates that about 16,764 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 412 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the HAZUS technical manual. Table 4 below summaries the expected damage by general occupancy for the buildings in the region. Table 5 summaries the expected damage by general building type.

Table 4: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	3	0.00	2	0.01	2	0.02	1	0.03	0	0.06
Commercial	1,036	0.81	267	0.97	264	2.04	112	3.24	24	5.89
Education	1	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	63	0.05	16	0.06	15	0.12	5	0.16	1	0.18
Industrial	71	0.06	21	0.08	23	0.18	9	0.27	2	0.38
Other Residential	3,941	3.10	1,088	3.95	748	5.80	211	6.10	33	7.96
Religion	37	0.03	10	0.03	8	0.06	3	0.09	1	0.13
Single Family	122,173	95.95	26,098	94.90	11,838	91.78	3,113	90.12	352	85.40
Total	127,324		27,501		12,898		3,454		412	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	98,719	77.53	21629	78.65	6,407	49.68	743	21.50	49	11.80
Steel	424	0.33	94	0.34	111	0.86	45	1.31	12	2.81
Concrete	392	0.31	110	0.40	98	0.76	36	1.04	6	1.39
Precast	151	0.12	39	0.14	56	0.43	33	0.95	6	1.41
RM	23,840	18.72	4135	15.04	4,880	37.83	2,085	60.36	174	42.21
URM	2,657	2.09	1050	3.82	907	7.04	388	11.22	147	35.64
MH	1,141	0.90	444	1.61	439	3.40	125	3.62	20	4.75
Total	127,324		27,501		12,898		3,454		412	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 545 hospital beds available for use. On the day of the earthquake, the model estimates that only 441 hospital beds (81.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 97.00% of the beds will be back in service. By 30 days, 100.00% will be operational.

Table 6: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	2	0	0	2
Schools	214	0	0	187
EOCs	1	0	0	1
PoliceStations	13	0	0	13
FireStations	19	0	0	19

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 % After Day 1	After Day 7
Highway	Segments	56	0	0	56	56
	Bridges	364	3	0	362	363
	Tunnels	4	0	0	4	4
Railways	Segments	17	0	0	17	17
	Bridges	8	0	0	8	8
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	3	0	0	3	3
	Runways	6	0	0	6	6

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

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

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	5	1	0	4	5
Waste Water	13	1	0	8	13
Natural Gas	5	0	0	5	5
Oil Systems	1	0	0	1	1
Electrical Power	1	0	0	1	1
Communication	25	0	0	25	25

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	5,579	75	19
Waste Water	3,347	59	15
Natural Gas	2,232	63	16
Oil	0	0	0

Table 10: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	206,067	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 22 ignitions that will burn about 0.11 sq. mi 0.01 % of the region's total area.) The model also estimates that the fires will displace about 402 people and burn about 22 (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 1,559 households to be displaced due to the earthquake. Of these, 350 people (out of a total population of 527,056) 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	1	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	2	0	0	0
	Industrial	6	1	0	0
	Other-Residential	73	13	1	3
	Single Family	294	51	6	11
	Total	380	67	8	15
2 PM	Commercial	299	67	9	19
	Commuting	0	0	0	0
	Educational	40	8	1	2
	Hotels	0	0	0	0
	Industrial	42	9	1	2
	Other-Residential	12	2	0	0
	Single Family	44	8	1	2
	Total	437	94	13	25
5 PM	Commercial	237	53	7	14
	Commuting	4	4	8	2
	Educational	5	1	0	0
	Hotels	1	0	0	0
	Industrial	26	5	1	1
	Other-Residential	28	5	1	1
	Single Family	114	20	2	4
	Total	414	89	19	23

Economic Loss

The total economic loss estimated for the earthquake is 1,297.64 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

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

The total building-related losses were 1,213.08 (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 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	1.58	43.35	1.15	1.43	47.51
	Capital-Related	0.00	0.68	38.83	0.69	0.29	40.48
	Rental	23.39	15.37	21.83	0.37	0.66	61.62
	Relocation	2.43	0.35	1.12	0.04	0.17	4.11
	Subtotal	25.82	17.98	105.13	2.26	2.54	153.73
Capital Stock Losses							
	Structural	123.38	18.84	42.05	5.46	4.92	194.66
	Non_Structural	410.94	101.07	95.97	14.83	10.32	633.12
	Content	139.04	26.17	47.16	9.47	5.54	227.39
	Inventory	0.00	0.00	1.79	2.21	0.19	4.18
	Subtotal	673.36	146.08	186.97	31.97	20.97	1,059.35
	Total	699.18	164.06	292.10	34.23	23.51	1,213.08

Transportation and Utility Lifeline Losses

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

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

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

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	1,315.49	\$0.00	0.00
	Bridges	450.80	\$4.19	0.93
	Tunnels	9.31	\$0.01	0.11
	Subtotal	1775.60	4.20	
Railways	Segments	50.19	\$0.00	0.00
	Bridges	1.11	\$0.00	0.24
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	51.30	0.00	
Light Rail	Segments	0.00	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Bus	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Ferry	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Port	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Airport	Facilities	15.86	\$2.32	14.62
	Runways	180.89	\$0.00	0.00
	Subtotal	196.70	2.30	
	Total	2023.60	6.50	

Table 14: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.00	\$0.00	0.00
	Facilities	161.50	\$12.49	7.73
	Distribution Line	111.60	\$0.34	0.30
	Subtotal	273.08	\$12.83	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	839.80	\$59.82	7.12
	Distribution Line	66.90	\$0.27	0.40
	Subtotal	906.77	\$60.09	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	5.30	\$0.26	4.99
	Distribution Line	44.60	\$0.29	0.64
	Subtotal	49.92	\$0.55	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.10	\$0.00	4.23
	Subtotal	0.10	\$0.00	
Electrical Power	Facilities	106.70	\$4.44	4.16
	Subtotal	106.70	\$4.44	
Communication	Facilities	2.40	\$0.13	5.23
	Subtotal	2.43	\$0.13	
	Total	1,338.99	\$78.04	

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

	LOSS	Total	%
First Year			
	Employment Impact	1,356	0.87
	Income Impact	(4)	-0.05
Second Year			
	Employment Impact	568	0.36
	Income Impact	(27)	-0.29
Third Year			
	Employment Impact	13	0.01
	Income Impact	(38)	-0.41
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(39)	-0.42
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(39)	-0.42
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(39)	-0.42

Appendix A: County Listing for the Region

Jefferson,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Jefferson	527,056	28,329	4,126	32,456
Total State		527,056	28,329	4,126	32,456
Total Region		527,056	28,329	4,126	32,456

HAZUS-MH: Earthquake Event Report



Region Name: *Jefferson County*

Earthquake Scenario: *RMA M6.25 CEUS Event*

Print Date: *January 26, 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 777.10 square miles and contains 133 census tracts. There are over 206 thousand households in the region and has a total population of 527,056 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 171 thousand buildings in the region with a total building replacement value (excluding contents) of 32,456 (millions of dollars). Approximately 99.00 % of the buildings (and 87.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,023 and 1,115 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 171 thousand buildings in the region which have an aggregate total replacement value of 32,456 (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 74% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

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

For essential facilities, there are 2 hospitals in the region with a total bed capacity of 545 beds. There are 214 schools, 19 fire stations, 13 police stations and 1 emergency operation facilities. With respect to HPL facilities, there are 75 dams identified within the region. Of these, 20 of the dams are classified as 'high hazard'. The inventory also includes 25 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 3,138.00 (millions of dollars). This inventory includes over 374 kilometers of highways, 364 bridges, 11,157 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	364	450.80
	Segments	56	1,315.50
	Tunnels	4	9.30
	Subtotal		1,775.60
Railways	Bridges	8	1.10
	Facilities	0	0.00
	Segments	17	50.20
	Tunnels	0	0.00
	Subtotal		51.30
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	0	0.00
	Subtotal		0.00
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	3	15.90
	Runways	6	180.90
	Subtotal		196.70
		Total	2,023.60

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	111.60
	Facilities	5	161.50
	Pipelines	0	0.00
	Subtotal		273.10
Waste Water	Distribution Lines	NA	66.90
	Facilities	13	839.80
	Pipelines	0	0.00
	Subtotal		906.80
Natural Gas	Distribution Lines	NA	44.60
	Facilities	5	5.30
	Pipelines	0	0.00
	Subtotal		49.90
Oil Systems	Facilities	1	0.10
	Pipelines	0	0.00
	Subtotal		0.10
Electrical Power	Facilities	1	106.70
	Subtotal		106.70
Communication	Facilities	25	2.40
	Subtotal		2.40
	Total		1,339.00

Earthquake Scenario

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

Scenario Name	RMA M6.25 CEUS Event
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-104.90
Latitude of Epicenter	39.90
Earthquake Magnitude	6.25
Depth (Km)	10.00
Rupture Length (Km)	11.89
Rupture Orientation (degrees)	130.00
Attenuation Function	CEUS Event

Building Damage

Building Damage

HAZUS estimates that about 15,294 buildings will be at least moderately damaged. This is over 9.00 % of the total number of buildings in the region. There are an estimated 419 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the HAZUS technical manual. Table 4 below summaries the expected damage by general occupancy for the buildings in the region. Table 5 summaries the expected damage by general building type.

Table 4: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	2	0.00	2	0.01	2	0.02	1	0.05	0	0.12
Commercial	1,109	0.84	238	0.98	229	1.95	101	3.25	26	6.12
Education	1	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	71	0.05	14	0.06	12	0.10	3	0.10	0	0.08
Industrial	69	0.05	18	0.07	23	0.19	12	0.39	3	0.79
Other Residential	4,091	3.10	993	4.08	658	5.60	227	7.26	51	12.27
Religion	41	0.03	8	0.03	6	0.05	3	0.08	1	0.13
Single Family	126,547	95.92	23,091	94.78	10,823	92.09	2,775	88.87	338	80.49
Total	131,931		24,364		11,753		3,122		419	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	100,559	76.22	19385	79.57	6,550	55.73	962	30.82	89	21.32
Steel	456	0.35	84	0.34	95	0.81	40	1.27	11	2.70
Concrete	422	0.32	99	0.41	84	0.71	31	0.98	6	1.33
Precast	162	0.12	35	0.14	50	0.42	31	1.00	7	1.70
RM	26,061	19.75	3468	14.23	3,857	32.82	1,589	50.90	139	33.06
URM	2,975	2.26	939	3.85	778	6.62	327	10.49	129	30.81
MH	1,295	0.98	354	1.45	339	2.89	142	4.54	38	9.09
Total	131,931		24,364		11,753		3,122		419	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 545 hospital beds available for use. On the day of the earthquake, the model estimates that only 359 hospital beds (66.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 91.00% of the beds will be back in service. By 30 days, 100.00% will be operational.

Table 6: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	2	0	0	2
Schools	214	0	0	195
EOCs	1	0	0	1
PoliceStations	13	0	0	11
FireStations	19	0	0	19

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 % After Day 1	After Day 7
Highway	Segments	56	0	0	56	56
	Bridges	364	4	0	360	364
	Tunnels	4	0	0	4	4
Railways	Segments	17	0	0	17	17
	Bridges	8	0	0	8	8
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	3	1	0	3	3
	Runways	6	0	0	6	6

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

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

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	5	3	0	2	5
Waste Water	13	1	0	10	13
Natural Gas	5	0	0	2	5
Oil Systems	1	0	0	1	1
Electrical Power	1	0	0	1	1
Communication	25	0	0	25	25

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	5,579	47	12
Waste Water	3,347	37	9
Natural Gas	2,232	40	10
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	206,067	0	0	0	0	0
Electric Power		13,705	7,876	2,903	507	21

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 30 ignitions that will burn about 0.19 sq. mi 0.02 % of the region's total area.) The model also estimates that the fires will displace about 921 people and burn about 48 (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 1,562 households to be displaced due to the earthquake. Of these, 369 people (out of a total population of 527,056) 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	2	0	0	0
	Industrial	7	2	0	0
	Other-Residential	76	14	1	3
	Single Family	274	47	5	10
	Total	363	64	7	13
2 PM	Commercial	256	58	8	16
	Commuting	0	0	0	0
	Educational	31	6	1	2
	Hotels	0	0	0	0
	Industrial	50	12	2	3
	Other-Residential	14	3	0	0
	Single Family	43	8	1	2
	Total	394	86	12	23
5 PM	Commercial	197	44	6	12
	Commuting	3	4	6	1
	Educational	4	1	0	0
	Hotels	1	0	0	0
	Industrial	31	7	1	2
	Other-Residential	29	5	1	1
	Single Family	107	19	2	4
	Total	371	80	16	20

Economic Loss

The total economic loss estimated for the earthquake is 1,416.08 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

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

The total building-related losses were 1,330.04 (millions of dollars); 10 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 72 % of the total loss. Table 12 below provides a summary of the losses associated with the building damage.

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

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	1.38	38.37	1.28	1.05	42.07
	Capital-Related	0.00	0.59	33.64	0.76	0.25	35.24
	Rental	21.23	15.28	19.03	0.44	0.45	56.42
	Relocation	2.21	0.36	0.97	0.04	0.12	3.70
	Subtotal	23.44	17.59	92.00	2.53	1.87	137.43
Capital Stock Losses							
	Structural	108.64	18.69	37.24	5.95	4.38	174.90
	Non_Structural	444.85	128.29	104.34	20.35	10.29	708.12
	Content	183.12	39.48	60.45	13.93	6.68	303.66
	Inventory	0.00	0.00	2.32	3.33	0.27	5.92
	Subtotal	736.61	186.46	204.35	43.57	21.62	1,192.61
	Total	760.05	204.05	296.35	46.10	23.49	1,330.04

Transportation and Utility Lifeline Losses

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

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

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

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	1,315.49	\$0.00	0.00
	Bridges	450.80	\$4.86	1.08
	Tunnels	9.31	\$0.02	0.19
	Subtotal	1775.60	4.90	
Railways	Segments	50.19	\$0.00	0.00
	Bridges	1.11	\$0.01	0.49
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	51.30	0.00	
Light Rail	Segments	0.00	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Bus	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Ferry	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Port	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Airport	Facilities	15.86	\$2.65	16.69
	Runways	180.89	\$0.00	0.00
	Subtotal	196.70	2.60	
	Total	2023.60	7.50	

Table 14: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.00	\$0.00	0.00
	Facilities	161.50	\$24.47	15.15
	Distribution Line	111.60	\$0.21	0.19
	Subtotal	273.08	\$24.68	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	839.80	\$45.84	5.46
	Distribution Line	66.90	\$0.17	0.25
	Subtotal	906.77	\$46.01	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	5.30	\$0.54	10.26
	Distribution Line	44.60	\$0.18	0.40
	Subtotal	49.92	\$0.72	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.10	\$0.00	4.95
	Subtotal	0.10	\$0.00	
Electrical Power	Facilities	106.70	\$6.96	6.52
	Subtotal	106.70	\$6.96	
Communication	Facilities	2.40	\$0.13	5.55
	Subtotal	2.43	\$0.13	
	Total	1,338.99	\$78.51	

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

	LOSS	Total	%
First Year			
	Employment Impact	1,509	0.97
	Income Impact	(4)	-0.05
Second Year			
	Employment Impact	637	0.41
	Income Impact	(28)	-0.31
Third Year			
	Employment Impact	14	0.01
	Income Impact	(40)	-0.44
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(41)	-0.45
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(42)	-0.45
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(42)	-0.45

Appendix A: County Listing for the Region

Jefferson,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Jefferson	527,056	28,329	4,126	32,456
Total State		527,056	28,329	4,126	32,456
Total Region		527,056	28,329	4,126	32,456

HAZUS-MH: Earthquake Event Report



Region Name: *Jefferson County*

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

Print Date: *January 26, 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 777.10 square miles and contains 133 census tracts. There are over 206 thousand households in the region and has a total population of 527,056 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 171 thousand buildings in the region with a total building replacement value (excluding contents) of 32,456 (millions of dollars). Approximately 99.00 % of the buildings (and 87.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,023 and 1,115 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 171 thousand buildings in the region which have an aggregate total replacement value of 32,456 (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 74% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

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

For essential facilities, there are 2 hospitals in the region with a total bed capacity of 545 beds. There are 214 schools, 19 fire stations, 13 police stations and 1 emergency operation facilities. With respect to HPL facilities, there are 75 dams identified within the region. Of these, 20 of the dams are classified as 'high hazard'. The inventory also includes 25 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 3,138.00 (millions of dollars). This inventory includes over 374 kilometers of highways, 364 bridges, 11,157 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	364	450.80
	Segments	56	1,315.50
	Tunnels	4	9.30
	Subtotal		1,775.60
Railways	Bridges	8	1.10
	Facilities	0	0.00
	Segments	17	50.20
	Tunnels	0	0.00
	Subtotal		51.30
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	0	0.00
	Subtotal		0.00
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	3	15.90
	Runways	6	180.90
	Subtotal		196.70
		Total	2,023.60

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	111.60
	Facilities	5	161.50
	Pipelines	0	0.00
	Subtotal		273.10
Waste Water	Distribution Lines	NA	66.90
	Facilities	13	839.80
	Pipelines	0	0.00
	Subtotal		906.80
Natural Gas	Distribution Lines	NA	44.60
	Facilities	5	5.30
	Pipelines	0	0.00
	Subtotal		49.90
Oil Systems	Facilities	1	0.10
	Pipelines	0	0.00
	Subtotal		0.10
Electrical Power	Facilities	1	106.70
	Subtotal		106.70
Communication	Facilities	25	2.40
	Subtotal		2.40
	Total		1,339.00

Earthquake Scenario

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

Scenario Name	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 3,876 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 26 buildings that will be damaged beyond repair. The definition of the ' damage states' is provided in Volume 1: Chapter 5 of the HAZUS technical manual. Table 4 below summaries the expected damage by general occupancy for the buildings in the region. Table 5 summaries the expected damage by general building type.

Table 4: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	5	0.00	1	0.01	1	0.03	0	0.06	0	0.14
Commercial	1,411	0.90	160	1.56	105	3.16	25	4.67	2	8.67
Education	1	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	87	0.06	9	0.08	5	0.14	1	0.14	0	0.20
Industrial	99	0.06	14	0.13	10	0.30	2	0.46	0	0.76
Other Residential	5,057	3.21	581	5.68	328	9.89	51	9.45	4	13.69
Religion	49	0.03	5	0.05	3	0.09	1	0.12	0	0.21
Single Family	150,767	95.74	9,467	92.48	2,863	86.38	456	85.09	20	76.33
Total	157,476		10,237		3,315		536		26	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	119,374	75.80	7022	68.60	1,079	32.55	71	13.17	1	3.04
Steel	559	0.36	63	0.61	51	1.53	12	2.27	1	5.72
Concrete	536	0.34	62	0.60	35	1.07	7	1.36	0	1.77
Precast	223	0.14	26	0.26	26	0.78	9	1.68	0	1.75
RM	31,300	19.88	2035	19.88	1,473	44.45	302	56.37	3	13.37
URM	3,921	2.49	701	6.85	409	12.34	101	18.90	17	64.94
MH	1,563	0.99	328	3.20	241	7.28	33	6.25	2	9.40
Total	157,476		10,237		3,315		536		26	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 545 hospital beds available for use. On the day of the earthquake, the model estimates that only 508 hospital beds (93.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 99.00% of the beds will be back in service. By 30 days, 100.00% will be operational.

Table 6: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	2	0	0	2
Schools	214	0	0	214
EOCs	1	0	0	1
PoliceStations	13	0	0	13
FireStations	19	0	0	19

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 % After Day 1	After Day 7
Highway	Segments	56	0	0	56	56
	Bridges	364	0	0	364	364
	Tunnels	4	0	0	4	4
Railways	Segments	17	0	0	17	17
	Bridges	8	0	0	8	8
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	3	0	0	3	3
	Runways	6	0	0	6	6

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

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

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	5	0	0	5	5
Waste Water	13	0	0	13	13
Natural Gas	5	0	0	5	5
Oil Systems	1	0	0	1	1
Electrical Power	1	0	0	1	1
Communication	25	0	0	25	25

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	5,579	19	5
Waste Water	3,347	15	4
Natural Gas	2,232	16	4
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	206,067	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 6 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 4 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 245 households to be displaced due to the earthquake. Of these, 57 people (out of a total population of 527,056) 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	1	0	0	0
	Industrial	1	0	0	0
	Other-Residential	16	2	0	0
	Single Family	50	6	0	1
	Total	68	8	1	1
2 PM	Commercial	54	8	1	1
	Commuting	0	0	0	0
	Educational	7	1	0	0
	Hotels	0	0	0	0
	Industrial	9	1	0	0
	Other-Residential	3	0	0	0
	Single Family	8	1	0	0
	Total	81	12	1	2
5 PM	Commercial	43	6	1	1
	Commuting	0	0	1	0
	Educational	1	0	0	0
	Hotels	0	0	0	0
	Industrial	6	1	0	0
	Other-Residential	6	1	0	0
	Single Family	19	2	0	0
	Total	75	11	2	2

Economic Loss

The total economic loss estimated for the earthquake is 253.29 (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 238.50 (millions of dollars); 16 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 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	0.36	11.27	0.34	0.36	12.32
	Capital-Related	0.00	0.15	10.22	0.20	0.08	10.65
	Rental	4.53	3.46	5.86	0.10	0.12	14.06
	Relocation	0.46	0.09	0.30	0.01	0.04	0.90
	Subtotal	4.99	4.06	27.65	0.66	0.59	37.94
Capital Stock Losses							
	Structural	24.79	4.75	10.65	1.57	1.25	43.00
	Non_Structural	72.63	20.62	20.24	3.44	2.16	119.10
	Content	20.52	4.64	9.26	2.09	1.06	37.58
	Inventory	0.00	0.00	0.35	0.49	0.04	0.89
	Subtotal	117.93	30.01	40.51	7.60	4.52	200.56
	Total	122.92	34.06	68.15	8.25	5.10	238.50

Transportation and Utility Lifeline Losses

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

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

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

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	1,315.49	\$0.00	0.00
	Bridges	450.80	\$0.78	0.17
	Tunnels	9.31	\$0.00	0.01
	Subtotal	1775.60	0.80	
Railways	Segments	50.19	\$0.00	0.00
	Bridges	1.11	\$0.00	0.03
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	51.30	0.00	
Light Rail	Segments	0.00	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Bus	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Ferry	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Port	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Airport	Facilities	15.86	\$0.74	4.67
	Runways	180.89	\$0.00	0.00
	Subtotal	196.70	0.70	
	Total	2023.60	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	161.50	\$2.68	1.66
	Distribution Line	111.60	\$0.09	0.08
	Subtotal	273.08	\$2.76	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	839.80	\$9.75	1.16
	Distribution Line	66.90	\$0.07	0.10
	Subtotal	906.77	\$9.82	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	5.30	\$0.03	0.48
	Distribution Line	44.60	\$0.07	0.17
	Subtotal	49.92	\$0.10	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.10	\$0.00	0.72
	Subtotal	0.10	\$0.00	
Electrical Power	Facilities	106.70	\$0.56	0.52
	Subtotal	106.70	\$0.56	
Communication	Facilities	2.40	\$0.02	0.78
	Subtotal	2.43	\$0.02	
	Total	1,338.99	\$13.26	

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

	LOSS	Total	%
First Year			
	Employment Impact	249	0.16
	Income Impact	(1)	-0.01
Second Year			
	Employment Impact	99	0.06
	Income Impact	(5)	-0.06
Third Year			
	Employment Impact	0	0.00
	Income Impact	(7)	-0.08
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(8)	-0.08
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(8)	-0.08
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(8)	-0.08

Appendix A: County Listing for the Region

Jefferson,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Jefferson	527,056	28,329	4,126	32,456
Total State		527,056	28,329	4,126	32,456
Total Region		527,056	28,329	4,126	32,456

HAZUS-MH: Earthquake Event Report



Region Name: *Jefferson County*

Earthquake Scenario: *Ute Pass M7.0 Jefferson 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 777.10 square miles and contains 133 census tracts. There are over 206 thousand households in the region and has a total population of 527,056 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 171 thousand buildings in the region with a total building replacement value (excluding contents) of 32,456 (millions of dollars). Approximately 99.00 % of the buildings (and 87.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,023 and 1,115 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 171 thousand buildings in the region which have an aggregate total replacement value of 32,456 (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 74% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

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

For essential facilities, there are 2 hospitals in the region with a total bed capacity of 545 beds. There are 214 schools, 19 fire stations, 13 police stations and 1 emergency operation facilities. With respect to HPL facilities, there are 75 dams identified within the region. Of these, 20 of the dams are classified as 'high hazard'. The inventory also includes 25 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 3,138.00 (millions of dollars). This inventory includes over 374 kilometers of highways, 364 bridges, 11,157 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	364	450.80
	Segments	56	1,315.50
	Tunnels	4	9.30
	Subtotal		1,775.60
Railways	Bridges	8	1.10
	Facilities	0	0.00
	Segments	17	50.20
	Tunnels	0	0.00
	Subtotal		51.30
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	0	0.00
	Subtotal		0.00
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	3	15.90
	Runways	6	180.90
	Subtotal		196.70
		Total	2,023.60

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	111.60
	Facilities	5	161.50
	Pipelines	0	0.00
	Subtotal		273.10
Waste Water	Distribution Lines	NA	66.90
	Facilities	13	839.80
	Pipelines	0	0.00
	Subtotal		906.80
Natural Gas	Distribution Lines	NA	44.60
	Facilities	5	5.30
	Pipelines	0	0.00
	Subtotal		49.90
Oil Systems	Facilities	1	0.10
	Pipelines	0	0.00
	Subtotal		0.10
Electrical Power	Facilities	1	106.70
	Subtotal		106.70
Communication	Facilities	25	2.40
	Subtotal		2.40
	Total		1,339.00

Earthquake Scenario

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

Scenario Name	Ute Pass M7.0 Jefferson 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 10,130 buildings will be at least moderately damaged. This is over 6.00 % of the total number of buildings in the region. There are an estimated 159 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the HAZUS technical manual. Table 4 below summaries the expected damage by general occupancy for the buildings in the region. Table 5 summaries the expected damage by general building type.

Table 4: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	4	0.00	2	0.01	2	0.02	1	0.04	0	0.09
Commercial	1,189	0.84	232	1.17	201	2.48	71	3.75	11	6.84
Education	1	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	73	0.05	14	0.07	11	0.14	3	0.16	0	0.18
Industrial	82	0.06	18	0.09	18	0.22	6	0.33	1	0.51
Other Residential	4,452	3.14	867	4.36	555	6.86	131	6.95	15	9.44
Religion	42	0.03	8	0.04	6	0.07	2	0.10	0	0.15
Single Family	135,733	95.87	18,742	94.26	7,288	90.20	1,677	88.67	132	82.79
Total	141,575		19,883		8,080		1,891		159	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	108,894	76.92	14952	75.20	3,391	41.97	297	15.71	13	8.00
Steel	483	0.34	83	0.41	86	1.06	29	1.52	5	3.34
Concrete	444	0.31	97	0.49	75	0.93	23	1.19	2	1.57
Precast	178	0.13	36	0.18	45	0.56	23	1.21	3	1.77
RM	27,068	19.12	3367	16.93	3,422	42.35	1,196	63.22	61	38.55
URM	3,183	2.25	953	4.79	706	8.73	243	12.82	65	40.81
MH	1,326	0.94	396	1.99	355	4.39	82	4.31	10	5.97
Total	141,575		19,883		8,080		1,891		159	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 545 hospital beds available for use. On the day of the earthquake, the model estimates that only 475 hospital beds (87.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 98.00% of the beds will be back in service. By 30 days, 100.00% will be operational.

Table 6: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	2	0	0	2
Schools	214	0	0	212
EOCs	1	0	0	1
PoliceStations	13	0	0	13
FireStations	19	0	0	19

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	56	0	0	56	56
	Bridges	364	1	0	363	364
	Tunnels	4	0	0	4	4
Railways	Segments	17	0	0	17	17
	Bridges	8	0	0	8	8
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	3	0	0	3	3
	Runways	6	0	0	6	6

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

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

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	5	0	0	5	5
Waste Water	13	1	0	11	13
Natural Gas	5	0	0	5	5
Oil Systems	1	0	0	1	1
Electrical Power	1	0	0	1	1
Communication	25	0	0	25	25

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	5,579	47	12
Waste Water	3,347	37	9
Natural Gas	2,232	40	10
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	206,067	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 13 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 128 people and burn about 7 (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 809 households to be displaced due to the earthquake. Of these, 185 people (out of a total population of 527,056) will seek temporary shelter in public shelters.

Casualties

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

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

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

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

Table 11: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	3	1	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	1	0	0	0
	Industrial	3	1	0	0
	Other-Residential	41	6	1	1
	Single Family	154	23	2	4
	Total	203	31	3	6
2 PM	Commercial	163	32	4	8
	Commuting	0	0	0	0
	Educational	22	4	0	1
	Hotels	0	0	0	0
	Industrial	25	5	1	1
	Other-Residential	7	1	0	0
	Single Family	23	4	0	1
	Total	240	45	6	11
5 PM	Commercial	129	25	3	6
	Commuting	2	2	4	1
	Educational	3	1	0	0
	Hotels	0	0	0	0
	Industrial	16	3	0	1
	Other-Residential	16	2	0	0
	Single Family	60	9	1	2
	Total	225	42	9	10

Economic Loss

The total economic loss estimated for the earthquake is 769.60 (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 705.70 (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 69 % of the total loss. Table 12 below provides a summary of the losses associated with the building damage.

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

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	0.93	27.81	0.78	0.90	30.42
	Capital-Related	0.00	0.40	24.88	0.47	0.19	25.93
	Rental	13.32	9.17	14.34	0.25	0.38	37.46
	Relocation	1.37	0.22	0.74	0.03	0.10	2.46
	Subtotal	14.69	10.71	67.78	1.52	1.57	96.27
Capital Stock Losses							
	Structural	70.83	11.56	26.78	3.65	3.13	115.94
	Non_Structural	228.74	58.81	57.70	9.40	6.13	360.79
	Content	77.39	15.07	28.40	5.96	3.28	130.10
	Inventory	0.00	0.00	1.08	1.40	0.12	2.60
	Subtotal	376.96	85.44	113.96	20.40	12.67	609.43
	Total	391.65	96.15	181.74	21.92	14.24	705.70

Transportation and Utility Lifeline Losses

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

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

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

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	1,315.49	\$0.00	0.00
	Bridges	450.80	\$2.30	0.51
	Tunnels	9.31	\$0.00	0.04
	Subtotal	1775.60	2.30	
Railways	Segments	50.19	\$0.00	0.00
	Bridges	1.11	\$0.00	0.12
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	51.30	0.00	
Light Rail	Segments	0.00	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Bus	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Ferry	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Port	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Airport	Facilities	15.86	\$1.73	10.93
	Runways	180.89	\$0.00	0.00
	Subtotal	196.70	1.70	
	Total	2023.60	4.00	

Table 14: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.00	\$0.00	0.00
	Facilities	161.50	\$8.31	5.15
	Distribution Line	111.60	\$0.21	0.19
	Subtotal	273.08	\$8.52	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	839.80	\$48.34	5.76
	Distribution Line	66.90	\$0.17	0.25
	Subtotal	906.77	\$48.50	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	5.30	\$0.13	2.52
	Distribution Line	44.60	\$0.18	0.40
	Subtotal	49.92	\$0.31	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.10	\$0.00	2.37
	Subtotal	0.10	\$0.00	
Electrical Power	Facilities	106.70	\$2.45	2.30
	Subtotal	106.70	\$2.45	
Communication	Facilities	2.40	\$0.07	2.93
	Subtotal	2.43	\$0.07	
	Total	1,338.99	\$59.86	

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

Jefferson,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Jefferson	527,056	28,329	4,126	32,456
Total State		527,056	28,329	4,126	32,456
Total Region		527,056	28,329	4,126	32,456

HAZUS-MH: Earthquake Event Report



Region Name: *Jefferson County*

Earthquake Scenario: *Valmont M5.0 CEUS Event*

Print Date: *January 26, 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 777.10 square miles and contains 133 census tracts. There are over 206 thousand households in the region and has a total population of 527,056 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 171 thousand buildings in the region with a total building replacement value (excluding contents) of 32,456 (millions of dollars). Approximately 99.00 % of the buildings (and 87.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,023 and 1,115 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 171 thousand buildings in the region which have an aggregate total replacement value of 32,456 (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 74% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

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

For essential facilities, there are 2 hospitals in the region with a total bed capacity of 545 beds. There are 214 schools, 19 fire stations, 13 police stations and 1 emergency operation facilities. With respect to HPL facilities, there are 75 dams identified within the region. Of these, 20 of the dams are classified as 'high hazard'. The inventory also includes 25 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 3,138.00 (millions of dollars). This inventory includes over 374 kilometers of highways, 364 bridges, 11,157 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	364	450.80
	Segments	56	1,315.50
	Tunnels	4	9.30
	Subtotal		1,775.60
Railways	Bridges	8	1.10
	Facilities	0	0.00
	Segments	17	50.20
	Tunnels	0	0.00
	Subtotal		51.30
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	0	0.00
	Subtotal		0.00
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	3	15.90
	Runways	6	180.90
	Subtotal		196.70
		Total	2,023.60

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	111.60
	Facilities	5	161.50
	Pipelines	0	0.00
	Subtotal		273.10
Waste Water	Distribution Lines	NA	66.90
	Facilities	13	839.80
	Pipelines	0	0.00
	Subtotal		906.80
Natural Gas	Distribution Lines	NA	44.60
	Facilities	5	5.30
	Pipelines	0	0.00
	Subtotal		49.90
Oil Systems	Facilities	1	0.10
	Pipelines	0	0.00
	Subtotal		0.10
Electrical Power	Facilities	1	106.70
	Subtotal		106.70
Communication	Facilities	25	2.40
	Subtotal		2.40
	Total		1,339.00

Earthquake Scenario

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

Scenario Name	Valmont M5.0 CEUS Event
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-105.20
Latitude of Epicenter	40.03
Earthquake Magnitude	5.00
Depth (Km)	10.00
Rupture Length (Km)	1.41
Rupture Orientation (degrees)	75.00
Attenuation Function	CEUS Event

Building Damage

Building Damage

HAZUS estimates that about 142 buildings will be at least moderately damaged. This is over 0.00 % of the total number of buildings in the region. There are an estimated 0 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the HAZUS technical manual. Table 4 below summaries the expected damage by general occupancy for the buildings in the region. Table 5 summaries the expected damage by general building type.

Table 4: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	8	0.00	0	0.03	0	0.05	0	0.07	0	0.04
Commercial	1,685	0.99	12	2.33	5	3.49	1	4.60	0	4.47
Education	1	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	101	0.06	0	0.07	0	0.07	0	0.07	0	0.09
Industrial	123	0.07	2	0.29	1	0.48	0	0.67	0	0.24
Other Residential	5,959	3.49	46	8.70	14	10.83	1	4.27	0	1.99
Religion	58	0.03	0	0.07	0	0.09	0	0.09	0	0.09
Single Family	162,979	95.36	472	88.50	110	84.99	11	90.24	0	93.09
Total	170,913		534		130		12		0	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	127,263	74.46	260	48.68	22	17.17	1	8.09	0	0.00
Steel	682	0.40	3	0.61	1	0.84	0	0.84	0	0.03
Concrete	635	0.37	5	0.87	1	0.82	0	0.56	0	0.00
Precast	280	0.16	3	0.59	2	1.32	0	2.20	0	0.13
RM	34,890	20.41	153	28.62	64	49.49	6	53.07	0	0.00
URM	5,039	2.95	78	14.52	28	21.74	4	33.21	0	99.83
MH	2,124	1.24	33	6.11	11	8.63	0	2.03	0	0.00
Total	170,913		534		130		12		0	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 545 hospital beds available for use. On the day of the earthquake, the model estimates that only 544 hospital beds (100.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 100.00% of the beds will be back in service. By 30 days, 100.00% will be operational.

Table 6: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	2	0	0	2
Schools	214	0	0	214
EOCs	1	0	0	1
PoliceStations	13	0	0	13
FireStations	19	0	0	19

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 % After Day 1	After Day 7
Highway	Segments	56	0	0	56	56
	Bridges	364	0	0	364	364
	Tunnels	4	0	0	4	4
Railways	Segments	17	0	0	17	17
	Bridges	8	0	0	8	8
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	3	0	0	3	3
	Runways	6	0	0	6	6

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

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

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	5	0	0	5	5
Waste Water	13	0	0	13	13
Natural Gas	5	0	0	5	5
Oil Systems	1	0	0	1	1
Electrical Power	1	0	0	1	1
Communication	25	0	0	25	25

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	5,579	0	0
Waste Water	3,347	0	0
Natural Gas	2,232	0	0
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	206,067	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 5 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 72 people and burn about 4 (millions of dollars) of building value.

Debris Generation

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

The model estimates that a total of 0.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 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 3 households to be displaced due to the earthquake. Of these, 0 people (out of a total population of 527,056 will seek temporary shelter in public shelters.

Casualties

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

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

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

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

Table 11: Casualty Estimates

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

Economic Loss

The total economic loss estimated for the earthquake is 50.44 (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 38.67 (millions of dollars); 3 % 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	0.01	0.35	0.01	0.01	0.38
	Capital-Related	0.00	0.00	0.31	0.01	0.00	0.32
	Rental	0.14	0.06	0.15	0.00	0.00	0.35
	Relocation	0.02	0.00	0.01	0.00	0.00	0.03
	Subtotal	0.15	0.07	0.83	0.02	0.01	1.08
Capital Stock Losses							
	Structural	0.89	0.15	0.37	0.07	0.04	1.51
	Non_Structural	12.08	4.03	3.86	1.24	0.37	21.58
	Content	8.00	1.76	3.11	0.93	0.32	14.13
	Inventory	0.00	0.00	0.12	0.22	0.02	0.36
	Subtotal	20.97	5.94	7.46	2.46	0.75	37.59
	Total	21.13	6.01	8.29	2.49	0.76	38.67

Transportation and Utility Lifeline Losses

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

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

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

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	1,315.49	\$0.00	0.00
	Bridges	450.80	\$0.01	0.00
	Tunnels	9.31	\$0.00	0.00
	Subtotal	1775.60	0.00	
Railways	Segments	50.19	\$0.00	0.00
	Bridges	1.11	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	51.30	0.00	
Light Rail	Segments	0.00	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Bus	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Ferry	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Port	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Airport	Facilities	15.86	\$0.93	5.85
	Runways	180.89	\$0.00	0.00
	Subtotal	196.70	0.90	
	Total	2023.60	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	161.50	\$3.35	2.08
	Distribution Line	111.60	\$0.00	0.00
	Subtotal	273.08	\$3.36	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	839.80	\$7.02	0.84
	Distribution Line	66.90	\$0.00	0.00
	Subtotal	906.77	\$7.02	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	5.30	\$0.06	1.15
	Distribution Line	44.60	\$0.00	0.00
	Subtotal	49.92	\$0.06	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.10	\$0.00	0.31
	Subtotal	0.10	\$0.00	
Electrical Power	Facilities	106.70	\$0.39	0.36
	Subtotal	106.70	\$0.39	
Communication	Facilities	2.40	\$0.01	0.45
	Subtotal	2.43	\$0.01	
	Total	1,338.99	\$10.84	

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	0.00
Second Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-0.01
Third Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-0.01
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-0.01
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-0.01
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(1)	-0.01

Appendix A: County Listing for the Region

Jefferson,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Jefferson	527,056	28,329	4,126	32,456
Total State		527,056	28,329	4,126	32,456
Total Region		527,056	28,329	4,126	32,456

HAZUS-MH: Earthquake Event Report



Region Name: *Jefferson County*

Earthquake Scenario: *Walnut Creek M6.0 Jefferson 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 777.10 square miles and contains 133 census tracts. There are over 206 thousand households in the region and has a total population of 527,056 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 171 thousand buildings in the region with a total building replacement value (excluding contents) of 32,456 (millions of dollars). Approximately 99.00 % of the buildings (and 87.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,023 and 1,115 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 171 thousand buildings in the region which have an aggregate total replacement value of 32,456 (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 74% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

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

For essential facilities, there are 2 hospitals in the region with a total bed capacity of 545 beds. There are 214 schools, 19 fire stations, 13 police stations and 1 emergency operation facilities. With respect to HPL facilities, there are 75 dams identified within the region. Of these, 20 of the dams are classified as 'high hazard'. The inventory also includes 25 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 3,138.00 (millions of dollars). This inventory includes over 374 kilometers of highways, 364 bridges, 11,157 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	364	450.80
	Segments	56	1,315.50
	Tunnels	4	9.30
	Subtotal		1,775.60
Railways	Bridges	8	1.10
	Facilities	0	0.00
	Segments	17	50.20
	Tunnels	0	0.00
	Subtotal		51.30
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	0	0.00
	Subtotal		0.00
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	3	15.90
	Runways	6	180.90
	Subtotal		196.70
		Total	2,023.60

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	111.60
	Facilities	5	161.50
	Pipelines	0	0.00
	Subtotal		273.10
Waste Water	Distribution Lines	NA	66.90
	Facilities	13	839.80
	Pipelines	0	0.00
	Subtotal		906.80
Natural Gas	Distribution Lines	NA	44.60
	Facilities	5	5.30
	Pipelines	0	0.00
	Subtotal		49.90
Oil Systems	Facilities	1	0.10
	Pipelines	0	0.00
	Subtotal		0.10
Electrical Power	Facilities	1	106.70
	Subtotal		106.70
Communication	Facilities	25	2.40
	Subtotal		2.40
	Total		1,339.00

Earthquake Scenario

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

Scenario Name	Walnut Creek M6.0 Jefferson CEUS Event
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-105.15
Latitude of Epicenter	39.88
Earthquake Magnitude	6.00
Depth (Km)	10.00
Rupture Length (Km)	7.76
Rupture Orientation (degrees)	31.00
Attenuation Function	CEUS Event

Building Damage

Building Damage

HAZUS estimates that about 21,750 buildings will be at least moderately damaged. This is over 13.00 % of the total number of buildings in the region. There are an estimated 882 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the HAZUS technical manual. Table 4 below summaries the expected damage by general occupancy for the buildings in the region. Table 5 summaries the expected damage by general building type.

Table 4: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	1	0.00	2	0.01	2	0.02	2	0.04	1	0.08
Commercial	1,007	0.83	260	0.91	267	1.66	129	2.66	41	4.60
Education	1	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	64	0.05	16	0.06	15	0.09	5	0.11	1	0.08
Industrial	56	0.05	18	0.06	27	0.17	18	0.37	7	0.75
Other Residential	3,656	3.01	1,155	4.06	835	5.22	295	6.08	79	8.90
Religion	37	0.03	8	0.03	8	0.05	4	0.08	1	0.15
Single Family	116,548	96.03	27,010	94.88	14,859	92.80	4,402	90.68	754	85.43
Total	121,370		28,469		16,013		4,855		883	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	92,537	76.24	23113	81.18	9,833	61.41	1,840	37.90	224	25.34
Steel	411	0.34	91	0.32	110	0.69	53	1.10	21	2.35
Concrete	381	0.31	107	0.37	99	0.62	42	0.87	11	1.27
Precast	143	0.12	36	0.13	55	0.34	39	0.80	12	1.37
RM	24,118	19.87	3745	13.15	4,615	28.82	2,285	47.06	351	39.73
URM	2,661	2.19	968	3.40	881	5.50	425	8.76	214	24.19
MH	1,118	0.92	410	1.44	419	2.62	170	3.51	51	5.75
Total	121,370		28,469		16,013		4,855		883	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 545 hospital beds available for use. On the day of the earthquake, the model estimates that only 338 hospital beds (62.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 89.00% of the beds will be back in service. By 30 days, 99.00% will be operational.

Table 6: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	2	0	0	2
Schools	214	1	0	179
EOCs	1	0	0	1
PoliceStations	13	0	0	11
FireStations	19	0	0	17

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	56	0	0	56	56
	Bridges	364	7	0	357	362
	Tunnels	4	0	0	4	4
Railways	Segments	17	0	0	17	17
	Bridges	8	0	0	8	8
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	3	1	0	2	3
	Runways	6	0	0	6	6

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

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

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	5	4	0	1	5
Waste Water	13	3	0	6	12
Natural Gas	5	4	0	1	5
Oil Systems	1	1	0	0	1
Electrical Power	1	1	0	0	1
Communication	25	18	0	25	25

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	5,579	87	22
Waste Water	3,347	69	17
Natural Gas	2,232	74	18
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	206,067	0	0	0	0	0
Electric Power		58,635	36,805	15,557	3,122	80

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 22 ignitions that will burn about 0.14 sq. mi 0.02 % of the region's total area.) The model also estimates that the fires will displace about 417 people and burn about 21 (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 2,584 households to be displaced due to the earthquake. Of these, 601 people (out of a total population of 527,056) will seek temporary shelter in public shelters.

Casualties

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

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

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

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

Table 11: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	7	2	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	4	1	0	0
	Industrial	12	3	0	1
	Other-Residential	116	23	3	5
	Single Family	447	87	10	20
	Total	585	116	14	27
2 PM	Commercial	396	96	14	28
	Commuting	0	0	0	0
	Educational	54	13	2	4
	Hotels	1	0	0	0
	Industrial	88	23	3	7
	Other-Residential	21	4	1	1
	Single Family	71	14	2	3
	Total	631	151	22	43
5 PM	Commercial	312	76	11	22
	Commuting	6	8	14	3
	Educational	7	2	0	0
	Hotels	1	0	0	0
	Industrial	55	14	2	4
	Other-Residential	45	9	1	2
	Single Family	174	34	4	8
	Total	601	143	33	39

Economic Loss

The total economic loss estimated for the earthquake is 2,307.28 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

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

The total building-related losses were 2,131.03 (millions of dollars); 9 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 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	2.12	50.01	1.83	1.52	55.47
	Capital-Related	0.00	0.90	44.73	1.10	0.36	47.09
	Rental	32.36	22.10	24.90	0.66	0.71	80.74
	Relocation	3.38	0.50	1.27	0.06	0.19	5.40
	Subtotal	35.75	25.62	120.91	3.66	2.77	188.70
Capital Stock Losses							
	Structural	166.67	26.58	50.00	8.81	6.33	258.40
	Non_Structural	740.83	199.09	158.35	34.54	17.10	1,149.90
	Content	325.26	65.20	97.89	24.47	11.53	524.34
	Inventory	0.00	0.00	3.67	5.63	0.39	9.68
	Subtotal	1,232.75	290.87	309.90	73.44	35.36	1,942.33
	Total	1,268.50	316.49	430.81	77.10	38.13	2,131.03

Transportation and Utility Lifeline Losses

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

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

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

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	1,315.49	\$0.00	0.00
	Bridges	450.80	\$7.92	1.76
	Tunnels	9.31	\$0.29	3.12
	Subtotal	1775.60	8.20	
Railways	Segments	50.19	\$0.00	0.00
	Bridges	1.11	\$0.02	1.37
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	51.30	0.00	
Light Rail	Segments	0.00	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Bus	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Ferry	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Port	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Airport	Facilities	15.86	\$3.69	23.25
	Runways	180.89	\$0.00	0.00
	Subtotal	196.70	3.70	
	Total	2023.60	11.90	

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	161.50	\$41.00	25.39
	Distribution Line	111.60	\$0.39	0.35
	Subtotal	273.08	\$41.39	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	839.80	\$95.44	11.36
	Distribution Line	66.90	\$0.31	0.46
	Subtotal	906.77	\$95.75	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	5.30	\$1.74	32.93
	Distribution Line	44.60	\$0.33	0.74
	Subtotal	49.92	\$2.07	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.10	\$0.02	17.22
	Subtotal	0.10	\$0.02	
Electrical Power	Facilities	106.70	\$24.67	23.13
	Subtotal	106.70	\$24.67	
Communication	Facilities	2.40	\$0.43	17.58
	Subtotal	2.43	\$0.43	
	Total	1,338.99	\$164.33	

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

Jefferson,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Jefferson	527,056	28,329	4,126	32,456
Total State		527,056	28,329	4,126	32,456
Total Region		527,056	28,329	4,126	32,456

HAZUS-MH: Earthquake Event Report



Region Name: *Jefferson County*

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

Print Date: *January 26, 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 777.10 square miles and contains 133 census tracts. There are over 206 thousand households in the region and has a total population of 527,056 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 171 thousand buildings in the region with a total building replacement value (excluding contents) of 32,456 (millions of dollars). Approximately 99.00 % of the buildings (and 87.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,023 and 1,115 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 171 thousand buildings in the region which have an aggregate total replacement value of 32,456 (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 74% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

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

For essential facilities, there are 2 hospitals in the region with a total bed capacity of 545 beds. There are 214 schools, 19 fire stations, 13 police stations and 1 emergency operation facilities. With respect to HPL facilities, there are 75 dams identified within the region. Of these, 20 of the dams are classified as 'high hazard'. The inventory also includes 25 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 3,138.00 (millions of dollars). This inventory includes over 374 kilometers of highways, 364 bridges, 11,157 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	364	450.80
	Segments	56	1,315.50
	Tunnels	4	9.30
	Subtotal		1,775.60
Railways	Bridges	8	1.10
	Facilities	0	0.00
	Segments	17	50.20
	Tunnels	0	0.00
	Subtotal		51.30
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	0	0.00
	Subtotal		0.00
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	3	15.90
	Runways	6	180.90
	Subtotal		196.70
		Total	2,023.60

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	111.60
	Facilities	5	161.50
	Pipelines	0	0.00
	Subtotal		273.10
Waste Water	Distribution Lines	NA	66.90
	Facilities	13	839.80
	Pipelines	0	0.00
	Subtotal		906.80
Natural Gas	Distribution Lines	NA	44.60
	Facilities	5	5.30
	Pipelines	0	0.00
	Subtotal		49.90
Oil Systems	Facilities	1	0.10
	Pipelines	0	0.00
	Subtotal		0.10
Electrical Power	Facilities	1	106.70
	Subtotal		106.70
Communication	Facilities	25	2.40
	Subtotal		2.40
	Total		1,339.00

Earthquake Scenario

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

Scenario Name	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 3,842 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 26 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the HAZUS technical manual. Table 4 below summaries the expected damage by general occupancy for the buildings in the region. Table 5 summaries the expected damage by general building type.

Table 4: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	5	0.00	1	0.01	1	0.03	0	0.06	0	0.12
Commercial	1,425	0.90	153	1.51	99	3.00	24	4.45	2	7.38
Education	1	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	88	0.06	8	0.08	4	0.13	1	0.14	0	0.16
Industrial	99	0.06	13	0.13	10	0.31	3	0.48	0	0.69
Other Residential	5,100	3.24	570	5.62	304	9.25	44	8.25	3	10.21
Religion	50	0.03	5	0.05	3	0.08	1	0.11	0	0.18
Single Family	150,838	95.71	9,389	92.59	2,861	87.19	463	86.51	21	81.27
Total	157,606		10,140		3,281		535		26	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	119,427	75.78	6967	68.70	1,081	32.96	70	13.01	1	4.50
Steel	577	0.37	56	0.55	43	1.30	10	1.78	1	3.59
Concrete	539	0.34	61	0.60	34	1.03	6	1.21	0	1.33
Precast	222	0.14	27	0.26	26	0.80	9	1.73	0	1.84
RM	31,306	19.86	2021	19.93	1,472	44.85	311	58.06	4	16.34
URM	3,923	2.49	699	6.89	408	12.44	102	19.00	17	65.93
MH	1,611	1.02	311	3.06	217	6.61	28	5.22	2	6.47
Total	157,606		10,140		3,281		535		26	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 545 hospital beds available for use. On the day of the earthquake, the model estimates that only 509 hospital beds (93.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 99.00% of the beds will be back in service. By 30 days, 100.00% will be operational.

Table 6: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	2	0	0	2
Schools	214	0	0	214
EOCs	1	0	0	1
PoliceStations	13	0	0	13
FireStations	19	0	0	19

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 % After Day 1	After Day 7
Highway	Segments	56	0	0	56	56
	Bridges	364	0	0	364	364
	Tunnels	4	0	0	4	4
Railways	Segments	17	0	0	17	17
	Bridges	8	0	0	8	8
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	3	0	0	3	3
	Runways	6	0	0	6	6

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

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

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	5	0	0	5	5
Waste Water	13	0	0	13	13
Natural Gas	5	0	0	5	5
Oil Systems	1	0	0	1	1
Electrical Power	1	0	0	1	1
Communication	25	0	0	25	25

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	5,579	13	3
Waste Water	3,347	10	3
Natural Gas	2,232	11	3
Oil	0	0	0

Table 10: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	206,067	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 11 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 54 people and burn about 3 (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 229 households to be displaced due to the earthquake. Of these, 54 people (out of a total population of 527,056) 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	1	0	0	0
	Industrial	1	0	0	0
	Other-Residential	15	2	0	0
	Single Family	51	6	0	1
	Total	68	8	1	1
2 PM	Commercial	51	8	1	1
	Commuting	0	0	0	0
	Educational	7	1	0	0
	Hotels	0	0	0	0
	Industrial	9	1	0	0
	Other-Residential	3	0	0	0
	Single Family	8	1	0	0
	Total	78	11	1	2
5 PM	Commercial	40	6	1	1
	Commuting	0	0	0	0
	Educational	1	0	0	0
	Hotels	0	0	0	0
	Industrial	6	1	0	0
	Other-Residential	6	1	0	0
	Single Family	20	2	0	0
	Total	72	10	1	2

Economic Loss

The total economic loss estimated for the earthquake is 273.83 (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 253.23 (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 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	0.35	10.37	0.32	0.33	11.37
	Capital-Related	0.00	0.15	9.36	0.19	0.07	9.77
	Rental	4.55	3.33	5.51	0.10	0.11	13.60
	Relocation	0.46	0.08	0.28	0.01	0.04	0.88
	Subtotal	5.02	3.91	25.52	0.63	0.54	35.62
Capital Stock Losses							
	Structural	24.78	4.56	10.06	1.51	1.16	42.07
	Non_Structural	78.54	22.84	21.15	3.92	2.27	128.73
	Content	25.24	5.87	10.87	2.52	1.26	45.76
	Inventory	0.00	0.00	0.41	0.59	0.05	1.05
	Subtotal	128.56	33.27	42.50	8.54	4.75	217.61
	Total	133.58	37.18	68.01	9.17	5.29	253.23

Transportation and Utility Lifeline Losses

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

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

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

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	1,315.49	\$0.00	0.00
	Bridges	450.80	\$0.47	0.10
	Tunnels	9.31	\$0.00	0.02
	Subtotal	1775.60	0.50	
Railways	Segments	50.19	\$0.00	0.00
	Bridges	1.11	\$0.00	0.02
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	51.30	0.00	
Light Rail	Segments	0.00	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Bus	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Ferry	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Port	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Airport	Facilities	15.86	\$0.93	5.89
	Runways	180.89	\$0.00	0.00
	Subtotal	196.70	0.90	
	Total	2023.60	1.40	

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	161.50	\$4.51	2.79
	Distribution Line	111.60	\$0.06	0.05
	Subtotal	273.08	\$4.57	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	839.80	\$13.30	1.58
	Distribution Line	66.90	\$0.05	0.07
	Subtotal	906.77	\$13.34	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	5.30	\$0.05	0.94
	Distribution Line	44.60	\$0.05	0.11
	Subtotal	49.92	\$0.10	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.10	\$0.00	1.24
	Subtotal	0.10	\$0.00	
Electrical Power	Facilities	106.70	\$1.15	1.08
	Subtotal	106.70	\$1.15	
Communication	Facilities	2.40	\$0.03	1.26
	Subtotal	2.43	\$0.03	
	Total	1,338.99	\$19.19	

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

	LOSS	Total	%
First Year			
	Employment Impact	269	0.17
	Income Impact	(1)	-0.01
Second Year			
	Employment Impact	108	0.07
	Income Impact	(6)	-0.06
Third Year			
	Employment Impact	0	0.00
	Income Impact	(8)	-0.09
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(8)	-0.09
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(8)	-0.09
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(8)	-0.09

Appendix A: County Listing for the Region

Jefferson,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Jefferson	527,056	28,329	4,126	32,456
Total State		527,056	28,329	4,126	32,456
Total Region		527,056	28,329	4,126	32,456