

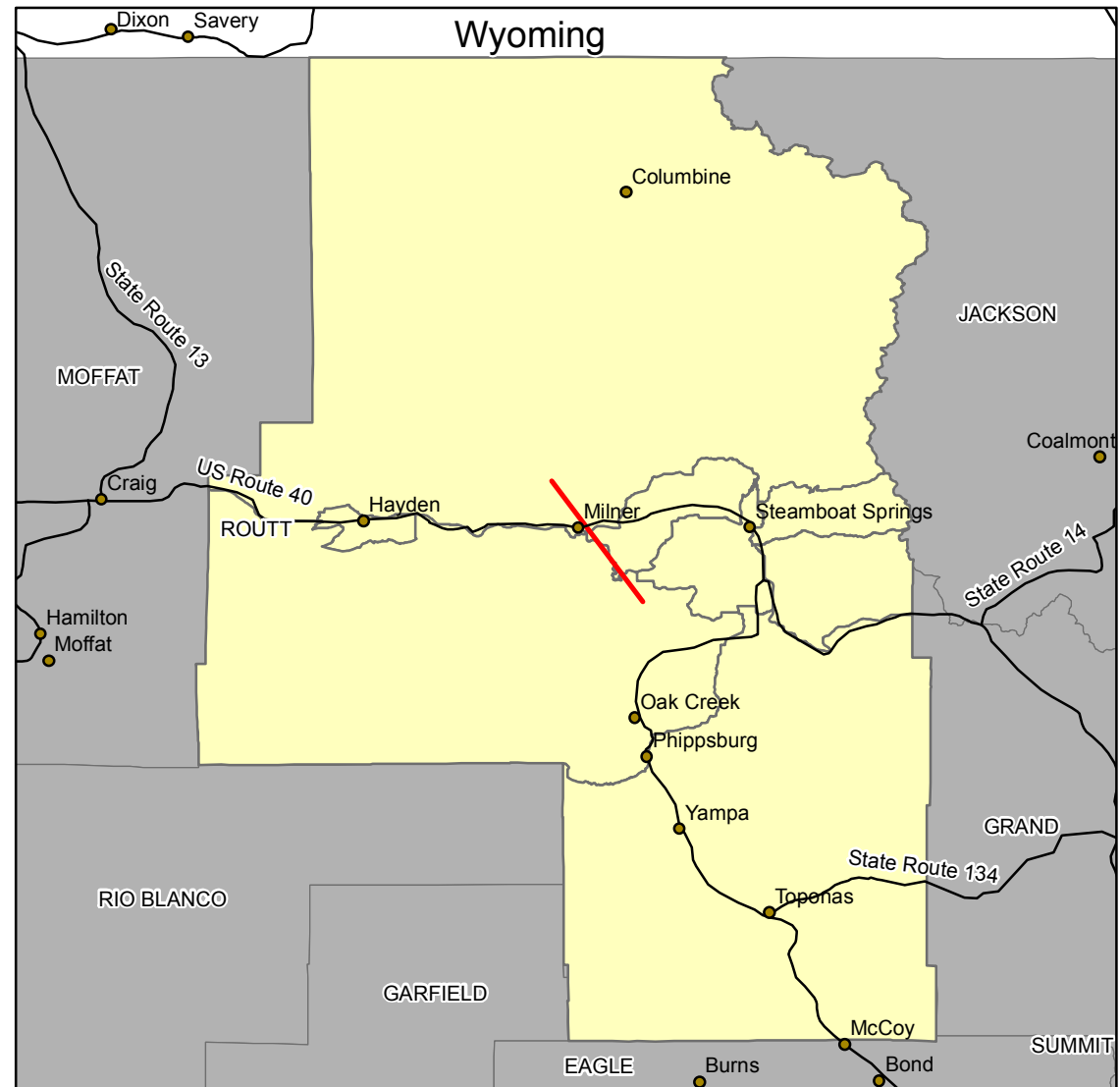
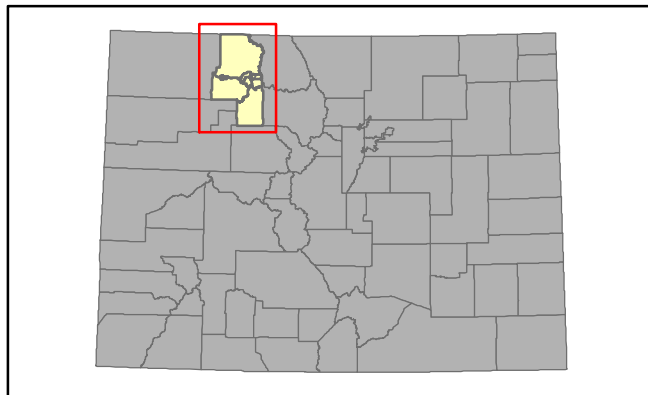
Study Region: Routt County

Hazard Scenario: Random Fault 6.5

Overview Map

Legend

- Cities
- Roads
- Fault
- Study Region Tract
- Counties



Created by: Colorado Geological Survey

Team: Matt Morgan and Scot Fitzgerald

Date Created: April 2013

Location: Routt County Colorado

Fault Parameters: arbitrary, magnitude 6.5, depth 10km

Data: Changed to CGS Landslides and CGS/FEMA Soils data

Projection: GCS North American 1983

0 10 20 40 Miles



HAZUS
EARTHQUAKE • WIND • FLOOD

Hazus-MH: Earthquake Event Report

Region Name: Routt County Random fault 2010Census

Earthquake Scenario: Random Routt County

Print Date: April 09, 2013

Totals only reflect data for those census tracts/blocks included in the user's study region.

Disclaimer:

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

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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 2,364.65 square miles and contains 8 census tracts. There are over 9 thousand households in the region which has a total population of 23,511 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 16 thousand buildings in the region with a total building replacement value (excluding contents) of 2,834 (millions of dollars). Approximately 93.00 % of the buildings (and 80.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 1,021 and 355 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 16 thousand buildings in the region which have an aggregate total replacement value of 2,834 (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 67% 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 facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 0 beds. There are 17 schools, 12 fire stations, 4 police stations and 1 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 57 dams identified within the region. Of these, 8 of the dams are classified as 'high hazard'. The inventory also includes 7 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 1 and 2.

The total value of the lifeline inventory is over 1,376.00 (millions of dollars). This inventory includes over 180 kilometers of highways, 86 bridges, 5,745 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	86	32.50
	Segments	7	733.90
	Tunnels	0	0.00
	Subtotal		766.40
Railways	Bridges	1	0.10
	Facilities	0	0.00
	Segments	23	157.90
	Tunnels	0	0.00
	Subtotal		158.00
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	0	0.00
	Subtotal		0.00
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	2	21.30
	Runways	2	75.90
	Subtotal		97.20
		Total	1,021.60

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	70.30
	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		70.30
Waste Water	Distribution Lines	NA	42.20
	Facilities	5	323.00
	Pipelines	0	0.00
	Subtotal		365.20
Natural Gas	Distribution Lines	NA	28.10
	Facilities	0	0.00
	Pipelines	18	31.90
	Subtotal		60.10
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		0.00
Electrical Power	Facilities	8	0.00
	Subtotal		0.00
Communication	Facilities	6	0.60
	Subtotal		0.60
		Total	496.10

Earthquake Scenario

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

Scenario Name	Random Routt County
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-107.00
Latitude of Epicenter	40.47
Earthquake Magnitude	6.50
Depth (Km)	10.00
Rupture Length (Km)	17.18
Rupture Orientation (degrees)	150.00
Attenuation Function	Central & East US (CEUS 2008)

Building Damage

Building Damage

Hazus estimates that about 5,560 buildings will be at least moderately damaged. This is over 34.00 % of the buildings in the region. There are an estimated 1,277 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 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	20	0.27	11	0.29	12	0.43	10	0.63	12	0.93
Commercial	95	1.32	77	2.06	166	6.11	163	10.44	170	13.27
Education	4	0.05	3	0.07	4	0.14	4	0.24	3	0.23
Government	11	0.16	6	0.16	10	0.36	9	0.56	7	0.55
Industrial	34	0.47	28	0.74	59	2.17	58	3.72	71	5.54
Other Residential	2,235	30.98	1,203	32.21	934	34.32	639	40.97	560	43.81
Religion	10	0.14	7	0.18	10	0.36	10	0.64	9	0.74
Single Family	4,804	66.60	2,402	64.29	1,527	56.10	668	42.79	446	34.93
Total	7,213		3,736		2,723		1,560		1,277	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	6,126	84.93	3127	83.70	1,454	53.42	258	16.54	49	3.86
Steel	41	0.56	28	0.75	94	3.45	137	8.78	146	11.44
Concrete	66	0.92	58	1.56	135	4.96	137	8.76	96	7.48
Precast	27	0.38	15	0.41	44	1.63	60	3.83	71	5.55
RM	688	9.54	263	7.04	576	21.17	576	36.93	450	35.21
URM	113	1.56	89	2.38	116	4.24	80	5.13	87	6.78
MH	152	2.11	155	4.16	303	11.13	312	20.03	379	29.69
Total	7,213		3,736		2,723		1,560		1,277	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 0 hospital beds available for use. On the day of the earthquake, the model estimates that only 0 hospital beds (8.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 27.00% of the beds will be back in service. By 30 days, 73.00% will be operational.

Table 5: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	1	1	0	0
Schools	17	14	3	1
EOCs	1	0	0	0
PoliceStations	4	0	0	1
FireStations	12	0	0	7

Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

Table 6: 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	7	0	0	7	7
	Bridges	86	17	5	70	74
	Tunnels	0	0	0	0	0
Railways	Segments	23	0	0	23	23
	Bridges	1	0	0	1	1
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	2	2	0	2	2
	Runways	2	0	0	2	2

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

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 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 9 provides a summary of the system performance information.

Table 7 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	0	0	0	0	0
Waste Water	5	2	0	2	3
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	8	6	0	2	6
Communication	6	5	0	5	6

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	3,514	850	212
Waste Water	2,109	427	107
Natural Gas	122	17	4
Oil	0	0	0

Table 9: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	9,893	2,275	1,334	43	0	0
Electric Power		4,135	1,207	158	20	10

Induced Earthquake Damage

Fire Following Earthquake

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 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 0.32 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 26.00% 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 12,600 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

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 656 households to be displaced due to the earthquake. Of these, 326 people (out of a total population of 23,511) 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 10 provides a summary of the casualties estimated for this earthquake

Table 10: 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	10	3	0	1
	Industrial	7	2	0	1
	Other-Residential	52	13	1	2
	Single Family	89	27	5	9
	Total	162	47	7	14
2 PM	Commercial	248	79	14	27
	Commuting	0	0	0	0
	Educational	133	42	7	15
	Hotels	2	1	0	0
	Industrial	52	17	3	5
	Other-Residential	7	2	0	0
	Single Family	12	4	1	1
	Total	454	144	25	48
5 PM	Commercial	167	53	9	18
	Commuting	3	4	6	1
	Educational	19	6	1	2
	Hotels	3	1	0	0
	Industrial	33	10	2	3
	Other-Residential	19	5	0	1
	Single Family	35	10	2	3
	Total	278	89	21	29

Economic Loss

The total economic loss estimated for the earthquake is 805.25 (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 708.01 (millions of dollars); 22 % 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 49 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	3.95	31.60	1.03	3.12	39.70
	Capital-Related	0.00	1.72	30.36	0.58	0.54	33.20
	Rental	5.49	9.10	12.46	0.14	0.85	28.05
	Relocation	19.34	6.64	20.01	0.96	7.47	54.43
	Subtotal	24.83	21.41	94.44	2.72	11.97	155.39
Capital Stock Losses							
	Structural	40.26	14.04	29.88	4.87	9.28	98.33
	Non_Structural	130.71	62.81	93.59	18.96	28.09	334.16
	Content	37.29	13.85	42.06	10.21	12.87	116.28
	Inventory	0.00	0.00	1.30	2.40	0.16	3.85
	Subtotal	208.26	90.71	166.82	36.43	50.40	552.63
	Total	233.10	112.12	261.27	39.16	62.37	708.01

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 12 & 13 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 14 presents the results of the region for the given earthquake.

Table 12: Transportation System Economic Losses
(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	733.95	\$0.00	0.00
	Bridges	32.45	\$5.16	15.89
	Tunnels	0.00	\$0.00	0.00
	Subtotal	766.40	5.20	
Railways	Segments	157.95	\$0.00	0.00
	Bridges	0.06	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	158.00	0.00	
Light Rail	Segments	0.00	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Bus	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Ferry	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Port	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Airport	Facilities	21.30	\$8.96	42.07
	Runways	75.93	\$0.00	0.00
	Subtotal	97.20	9.00	
	Total	1021.60	14.10	

Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Lines	70.30	\$3.82	5.44
	Subtotal	70.29	\$3.82	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	323.00	\$76.53	23.69
	Distribution Lines	42.20	\$1.92	4.56
	Subtotal	365.18	\$78.45	
Natural Gas	Pipelines	31.90	\$0.02	0.07
	Facilities	0.00	\$0.00	0.00
	Distribution Lines	28.10	\$0.66	2.34
	Subtotal	60.06	\$0.68	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	\$0.00	
Electrical Power	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	\$0.00	
Communication	Facilities	0.60	\$0.15	26.41
	Subtotal	0.58	\$0.15	
	Total	496.11	\$83.11	

Table 14. Indirect Economic Impact with outside aid

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

LOSS	Total	%

Appendix A: County Listing for the Region

Routt,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Routt	23,511	2,269	564	2,834
Total State		23,511	2,269	564	2,834
Total Region		23,511	2,269	564	2,834

Study Region: Routt County

Hazard Scenario: Random Fault 6.5

Airports Map

Legend

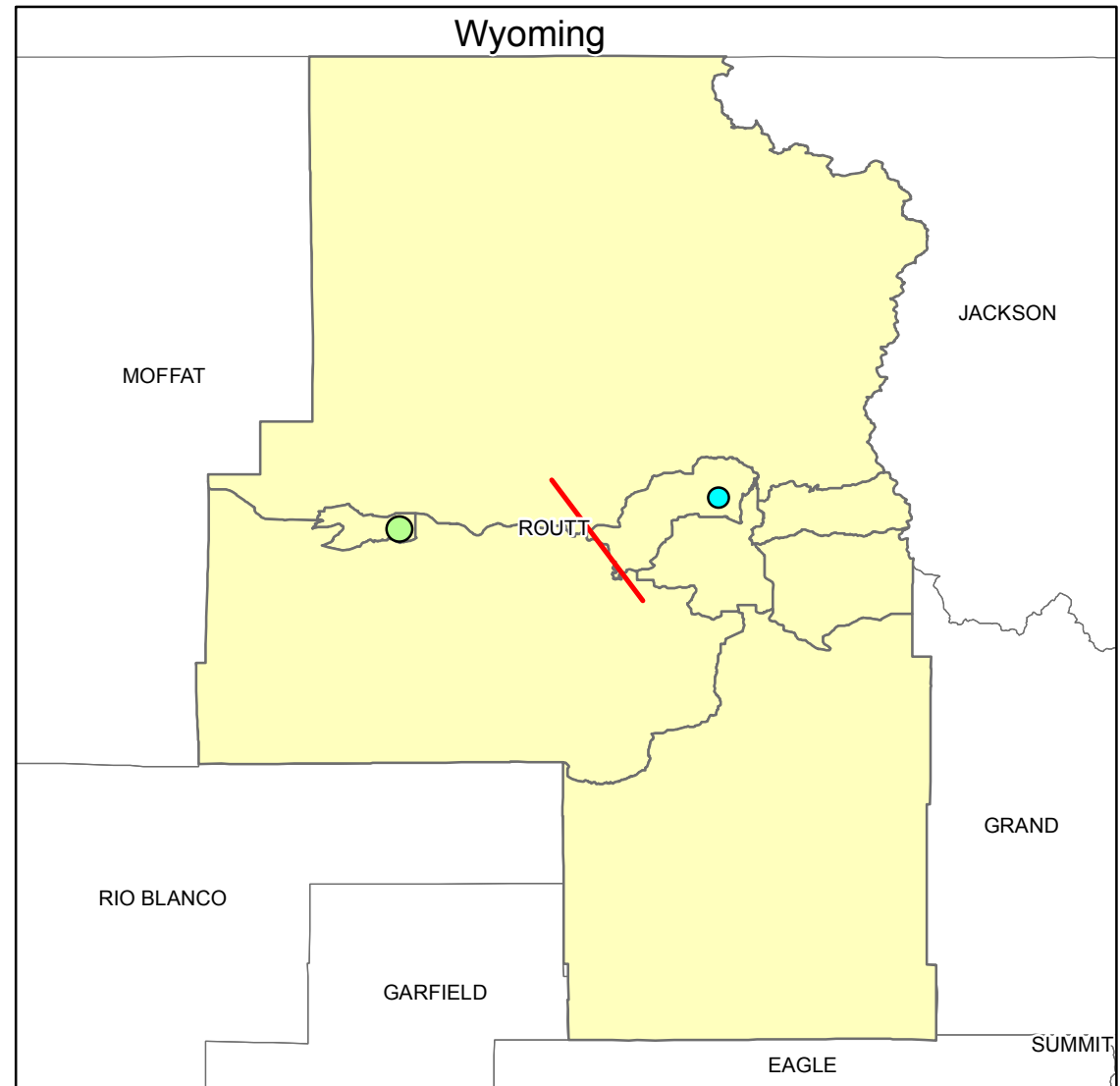
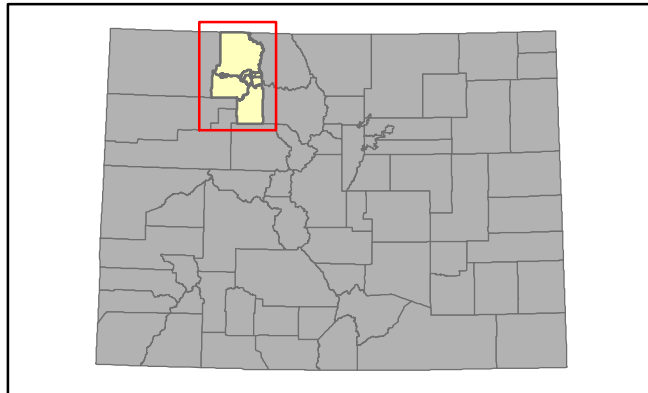
Airports

Probability Damage > Extensive

- 0 - 10%
- 10 - 20%
- 20 - 30%
- 30 - 40%
- 40 - 50%
- 50 - 70%
- 70 - 100%

Fault

Study Region Tract



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Projection: GCS North American 1983

0 10 20 40 Miles



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Bridges Map

Legend

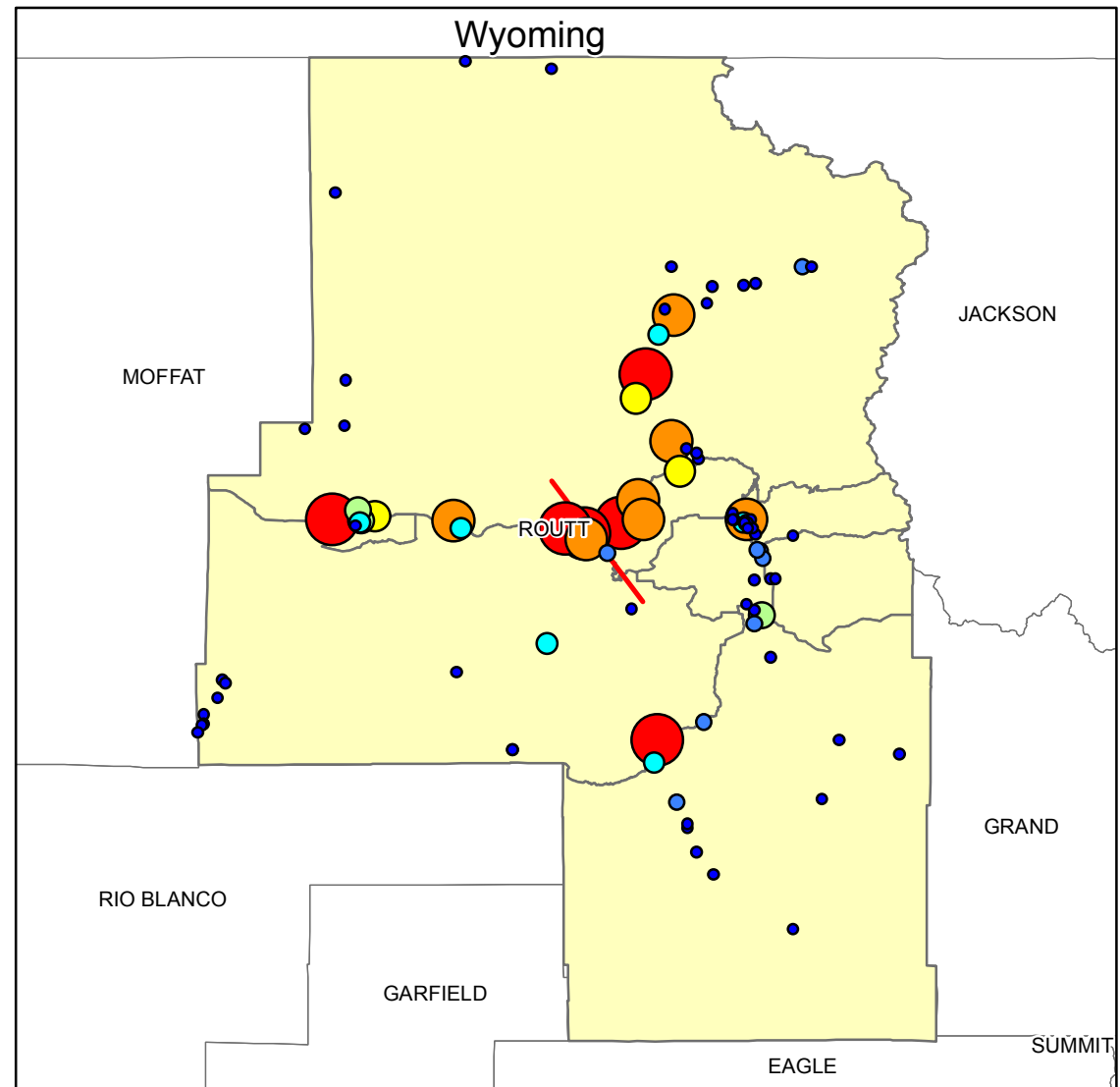
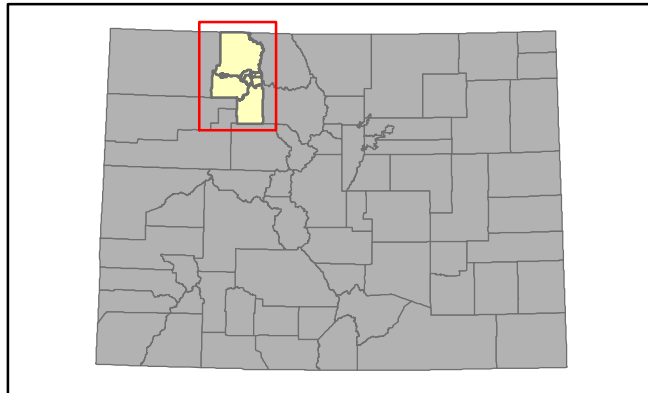
Bridges

Probability Damage > Extensive

- 0 - 10%
- 10 - 20%
- 20 - 30%
- 30 - 40%
- 40 - 50%
- 50 - 70%
- 70 - 100%

Fault

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Building Economic Loss Map

Legend

— Fault

Building Economic Loss in Thousands of Dollars

3728 - 39704

39704 - 75680

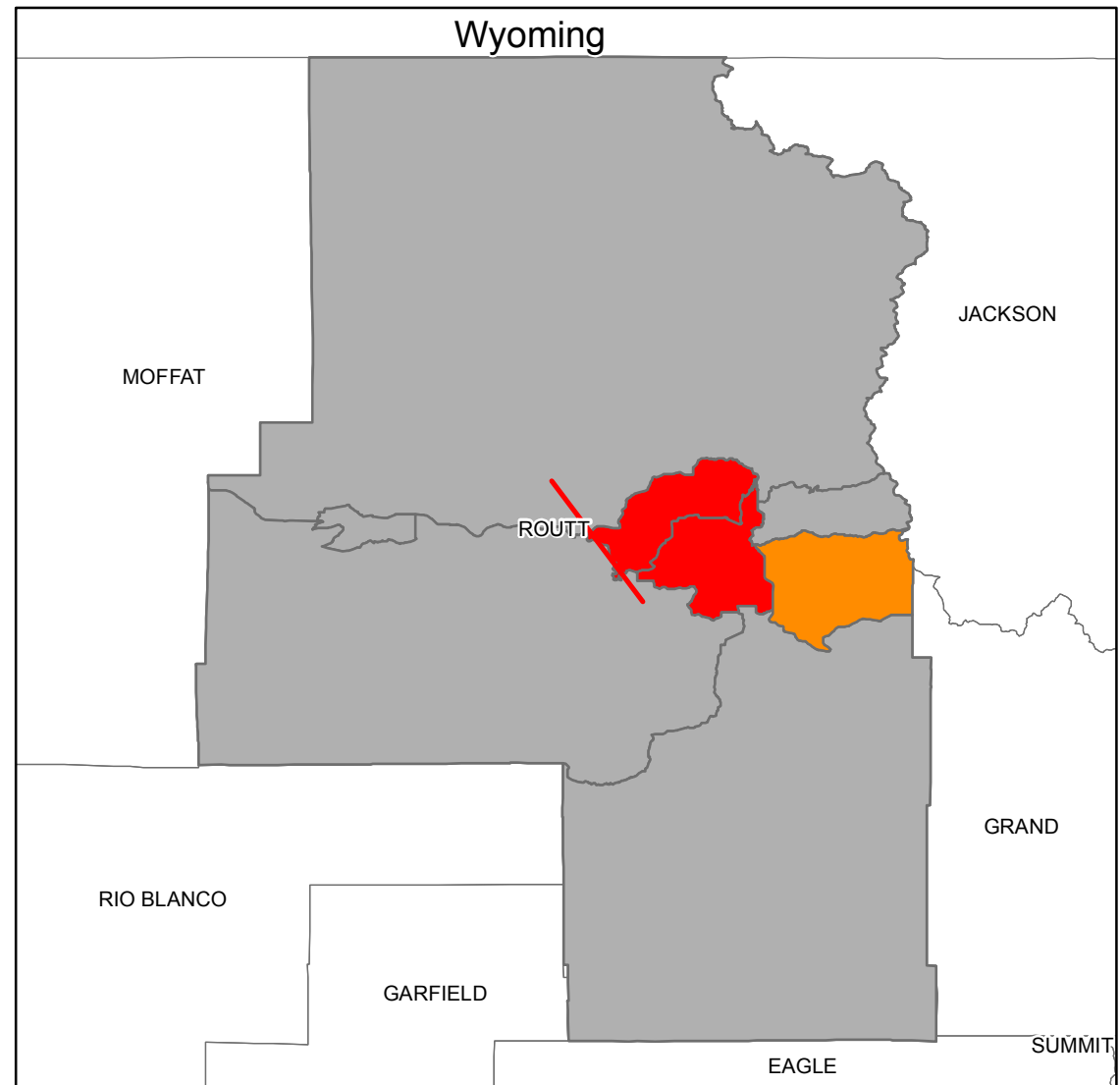
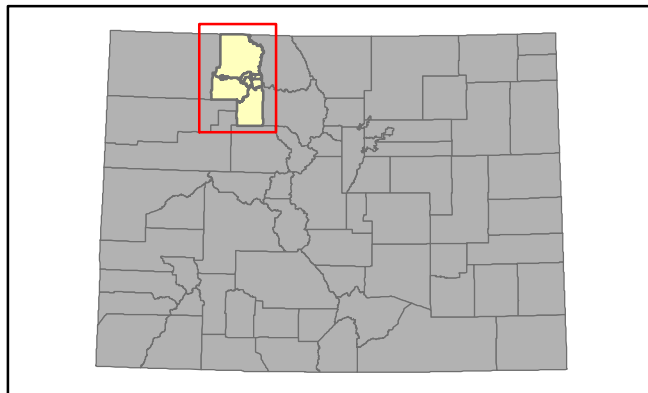
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111656 - 147632

147632 - 183608

183608 - 219582

Study Region Tract



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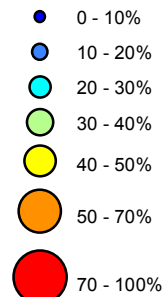
Hazard Scenario: Random Fault 6.5

Care Facilities Map

Legend

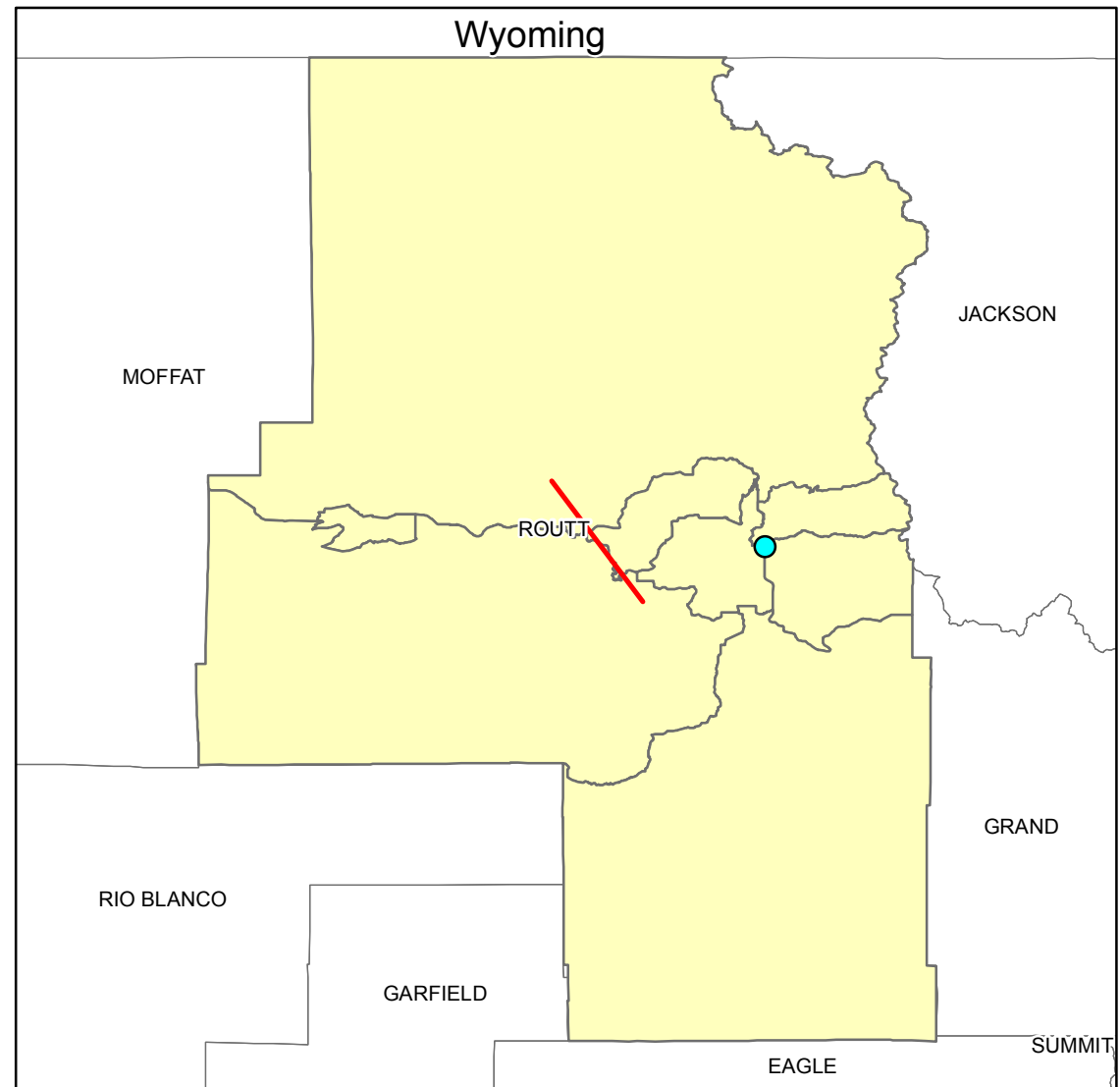
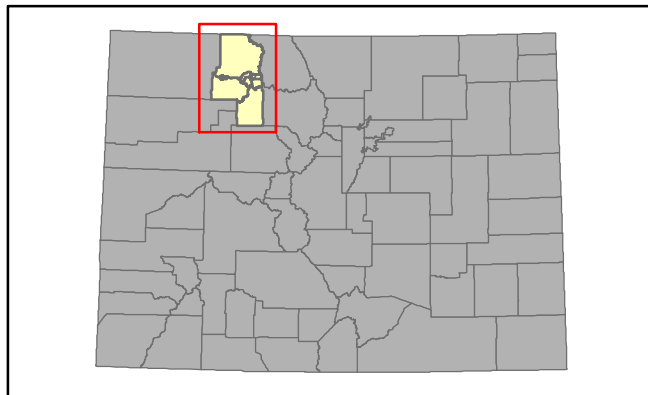
Care Facilities

Probability Damage > Extensive



Fault

Study Region Tract



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EARTHQUAKE • WIND • FLOOD

Study Region: Routt County

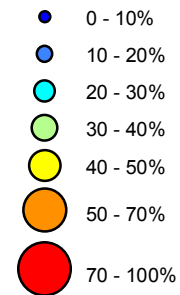
Hazard Scenario: Random Fault 6.5

Electrical Facilities Map

Legend

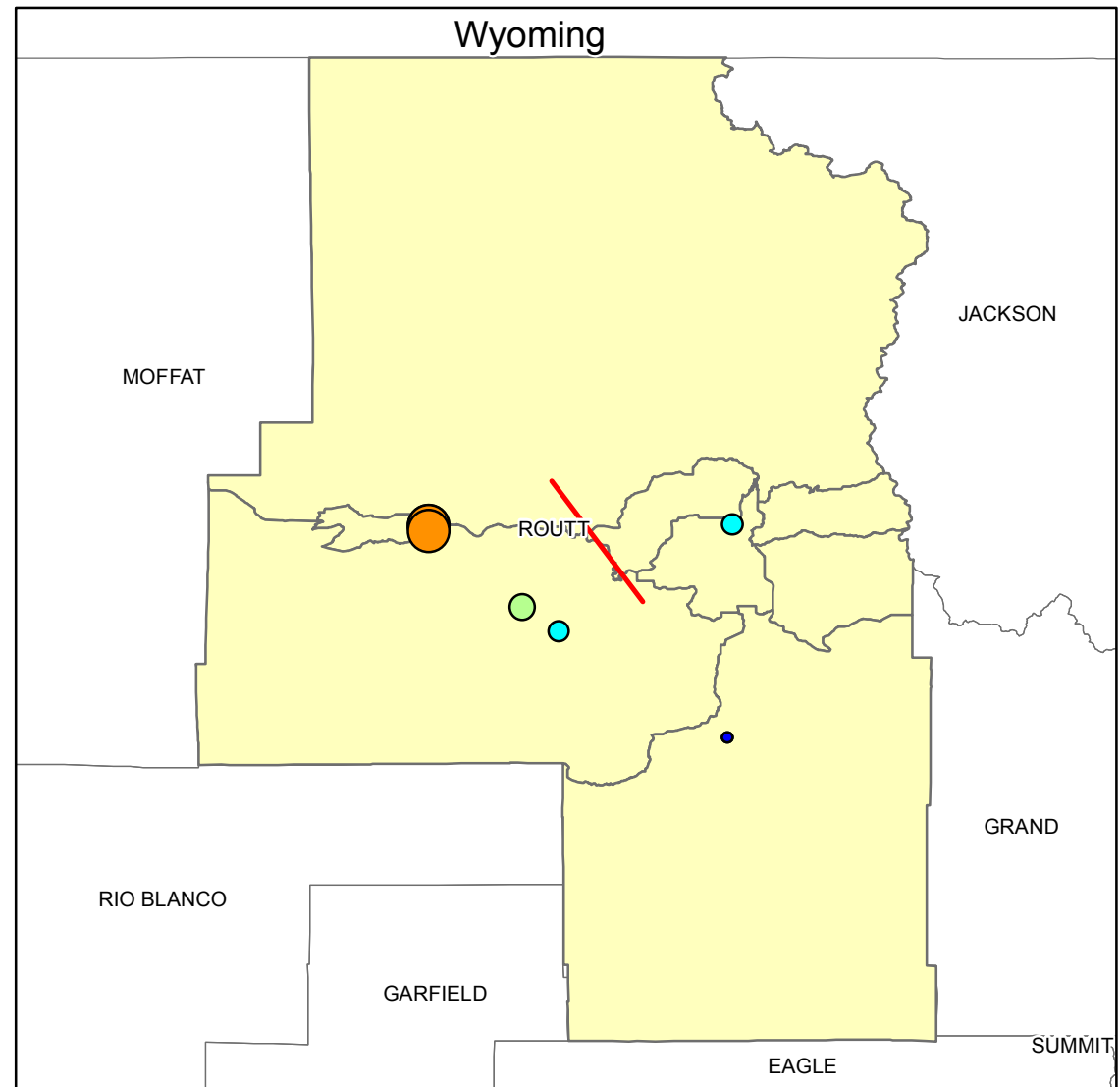
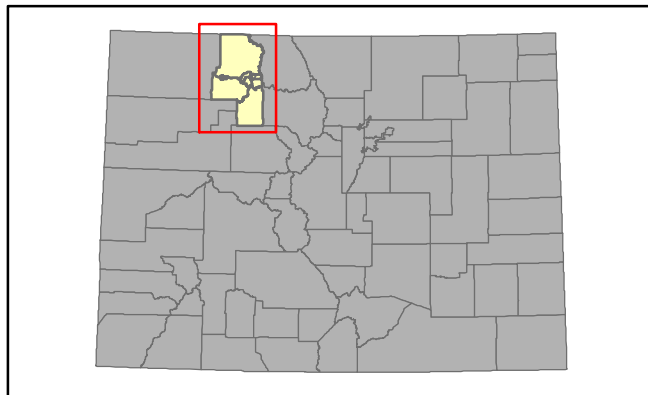
Electrical Power Facilities

Probability Damage > Extensive



— Fault

Study Region Tract



Created by: Colorado Geological Survey

Team: Matt Morgan and Scot Fitzgerald

Date Created: April 2013

Location: Routt County Colorado

Fault Parameters: arbitrary, magnitude 6.5, depth 10km

Data: Changed to CGS Landslides and CGS/FEMA Soils data

Projection: GCS North American 1983

0 10 20 40 Miles



HAZUS
EARTHQUAKE • WIND • FLOOD

Study Region: Routt County

Hazard Scenario: Random Fault 6.5

Fire Stations Map

Legend

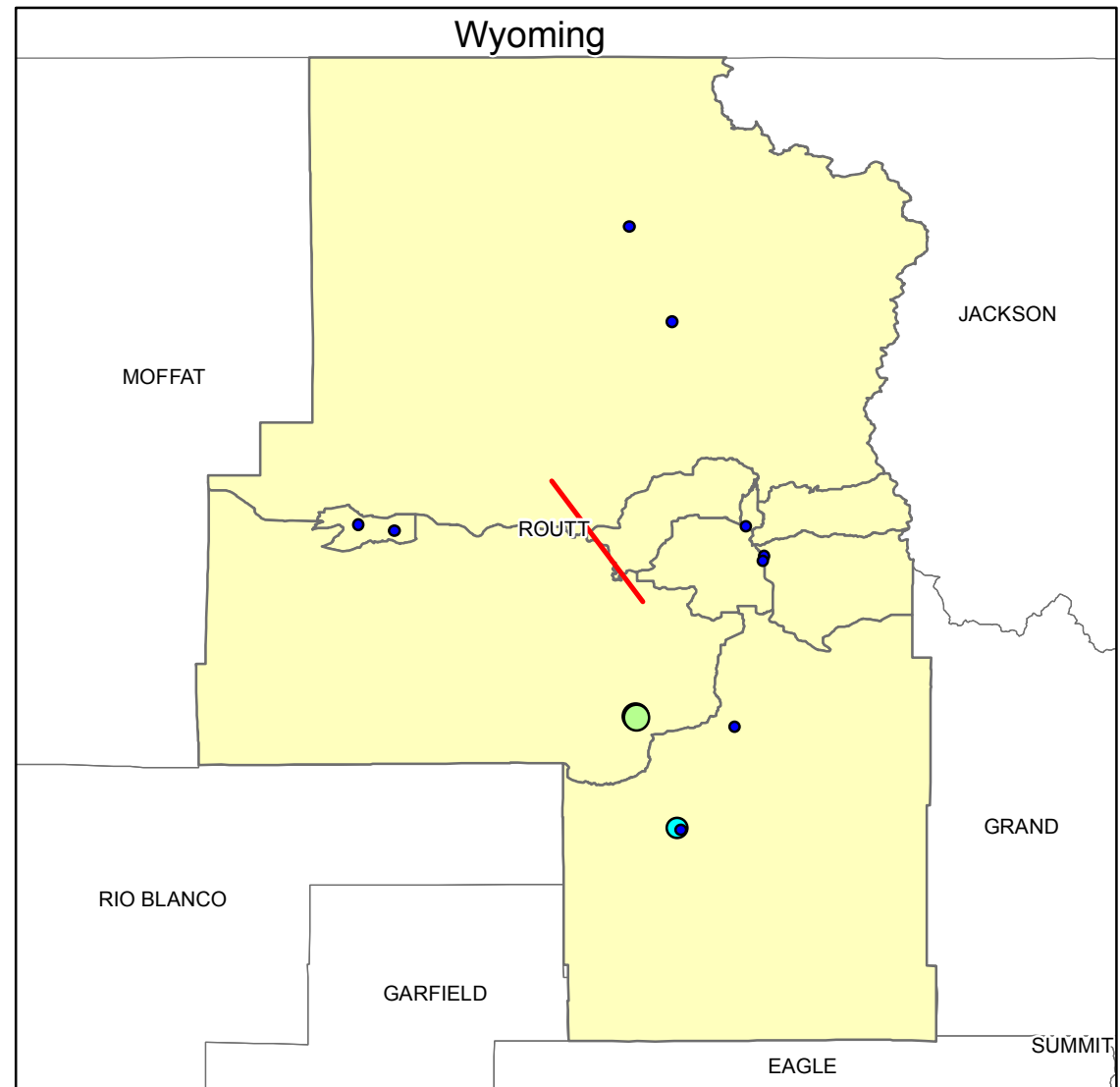
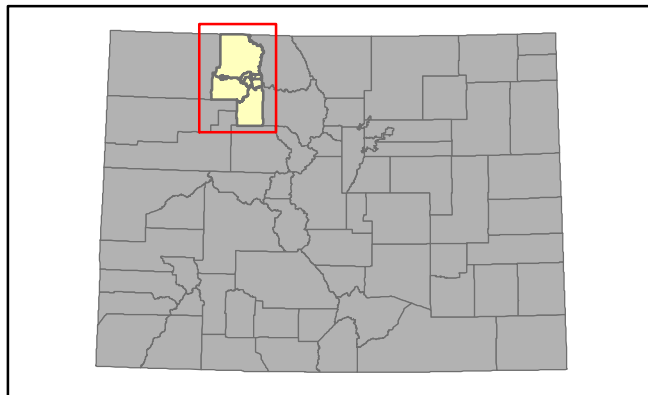
Fire Stations

Probability Damage > Extensive



— Fault

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HAZUS
EARTHQUAKE • WIND • FLOOD

Study Region: Routt County

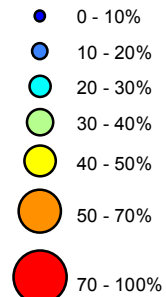
Hazard Scenario: Random Fault 6.5

Police Stations Map

Legend

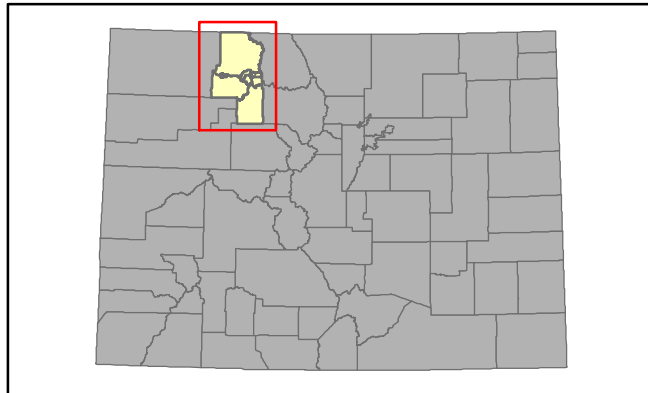
Police Stations

Probability Damage > Extensive



Fault

Study Region Tract



Created by: Colorado Geological Survey

Team: Matt Morgan and Scot Fitzgerald

Date Created: April 2013

Location: Routt County Colorado

Fault Parameters: arbitrary, magnitude 6.5, depth 10km

Data: Changed to CGS Landslides and CGS/FEMA Soils data

Projection: GCS North American 1983

0 10 20 40 Miles



HAZUS
EARTHQUAKE • WIND • FLOOD

Study Region: Routt County

Hazard Scenario: Random Fault 6.5

Schools Map

Legend

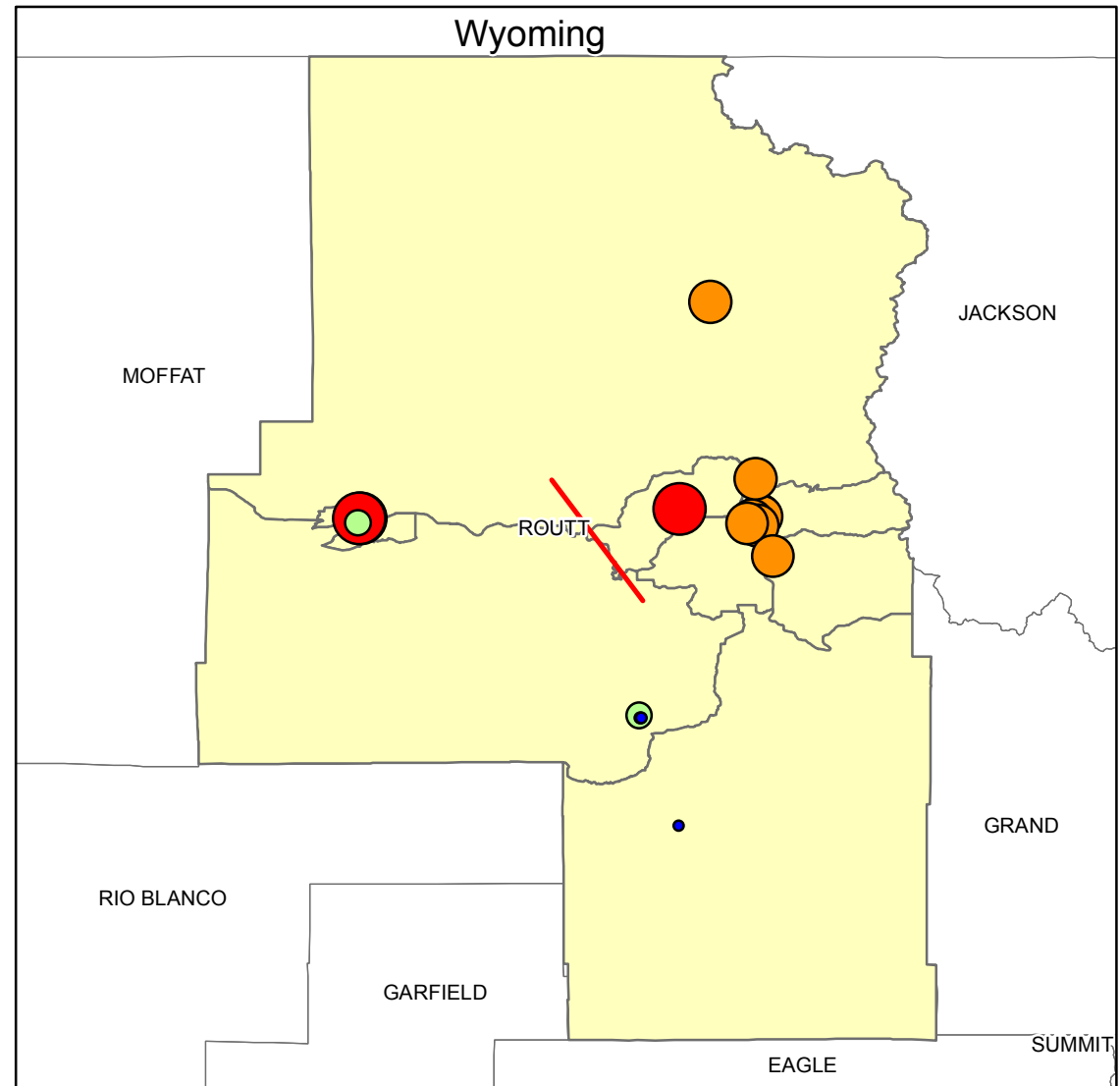
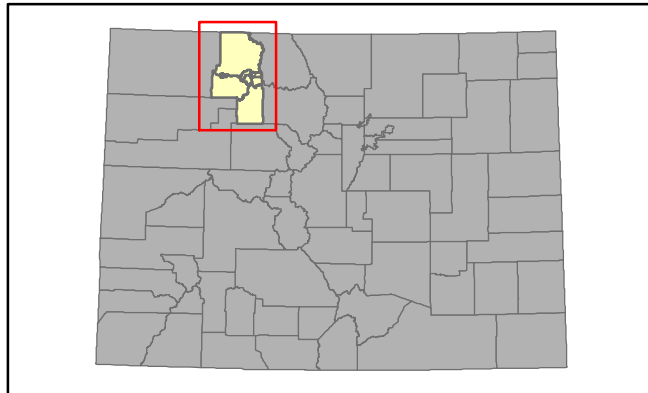
Schools

Probability Damage > Extensive

- 0 - 10%
- 10 - 20%
- 20 - 30%
- 30 - 40%
- 40 - 50%
- 50 - 70%
- 70 - 100%

Fault

Study Region Tract



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Team: Matt Morgan and Scot Fitzgerald

Date Created: April 2013

Location: Routt County Colorado

Fault Parameters: arbitrary, magnitude 6.5, depth 10km

Data: Changed to CGS Landslides and CGS/FEMA Soils data

Projection: GCS North American 1983

0 10 20 40 Miles



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EARTHQUAKE • WIND • FLOOD

Study Region: Routt County

Hazard Scenario: Random Fault 6.5

Waste Water Facilities Map

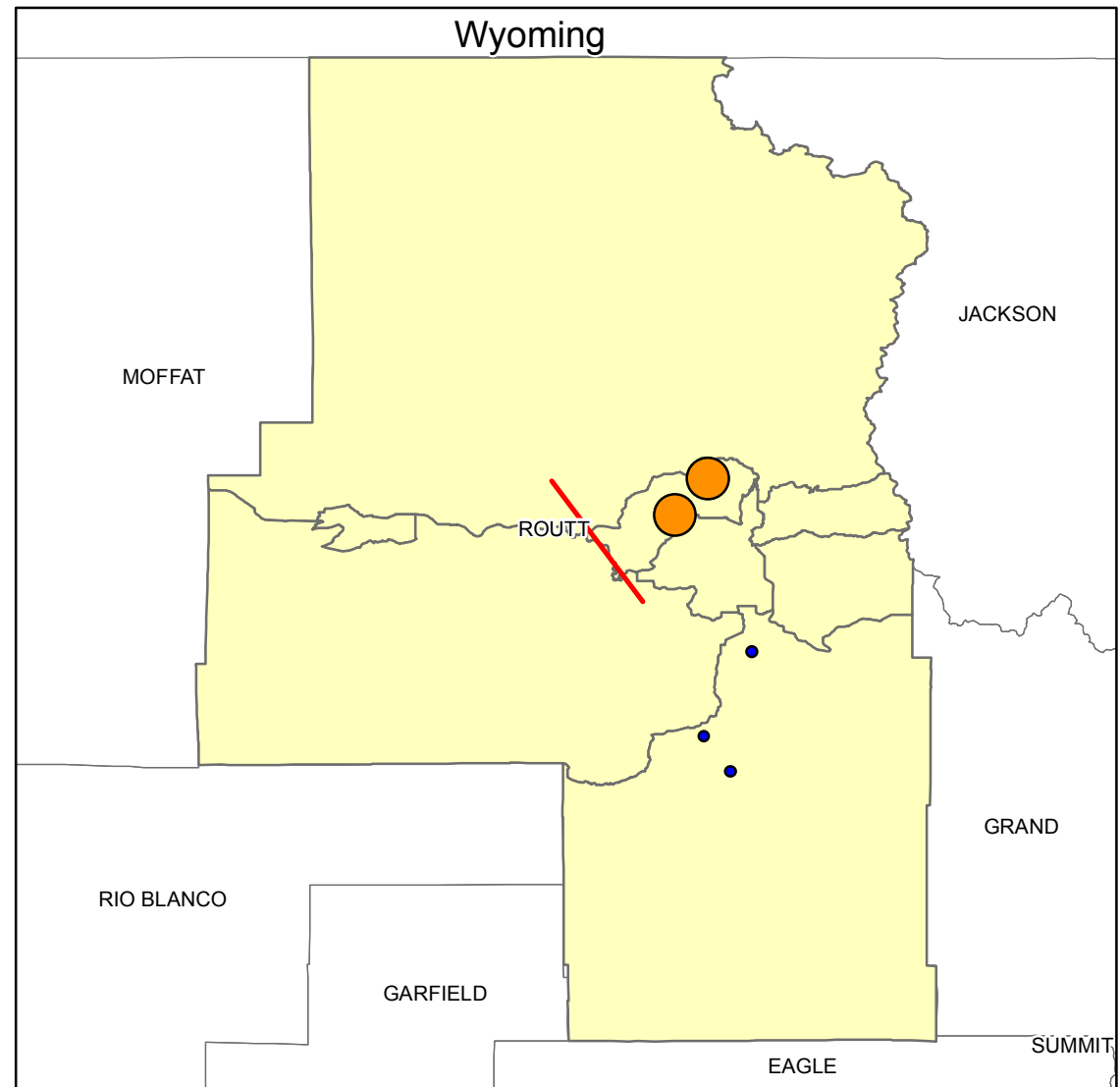
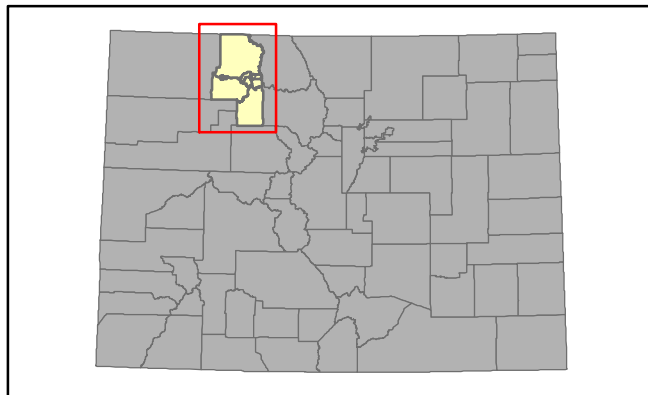
Legend

Waste Water Facilities

Probability Damage > Extensive



Fault
Study Region Tract



Created by: Colorado Geological Survey

Team: Matt Morgan and Scot Fitzgerald

Date Created: April 2013

Location: Routt County Colorado

Fault Parameters: arbitrary, magnitude 6.5, depth 10km

Data: Changed to CGS Landslides and CGS/FEMA Soils data

Projection: GCS North American 1983

0 10 20 40 Miles



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